SUBMITTAL COVER SHEET

DATE: 9/30/2016	X	NEW SUBMITTAL	0430105-208
		RESUBMITTAL	

TO:	(Owner) Arlington County: 3201 S. Eads Street Arlington, VA 22202 (Architect) STV, Inc. - 2722 Merrilee Dr. Suite 350 Fairfax, VA 22031 (Engineer) Atkins N. America, Inc. - 2318 Mill Rd., Suite 1040 Alexandria, VA 22314	FROM:	W. M. SCHLOSSER CO., INC. 2400 51ST PLACE HYATTSVILLE, MD 20781
ATTN:	Rami Natour, Jeremy Jenkins, Patrick Standiford, George Clark		

ART Bus Facility and Streetscape Improvements
Contract Agreement 722-15

ITEM NO.	DESCRIPTION OF ITEM SUBMITTED	Subcontractor, Manufacturer, Supplier	PROJECT SPEC SECTION	REVIEW CLASSIFICATION: A/E=ARCHITECT/ENGINEER/MIN APPROVAL I=INFORMATION ONLY	NO. OF COPIES P=PAPER E=ELECTRONIC
	CNG Facility and Operations	Subcontractor, Manufacturer, Supplier	Spec. #	A/E	1E
	CNG - Single Dispenser O&M Manual	(Sub)Clean Energy	0430105	A/E	1E

Clarifications, Deviations and Comments:

This is a preliminary submittal only. Final O&M manuals will be submitted as a package per spec section 017823 - Operational and Maintenance Data. - CC, WMS

I HEREBY CERTIFY THAT THE EQUIPMENT, MATERIAL AND/OR ARTICLE SHOWN/MARKED IN THIS SUBMITTAL IS IN COMPLIANCE WITH THE CONTRACT DRAWINGS AND SPECIFICATIONS, CAN BE INSTALLED IN THE ALLOCATED SPACES AND IS APPROVED FOR USE.

NAME AND SIGNATURE OF CONTRACTOR

Chris Chapman, WMS

***************** THIS SECTION FOR OWNER / ARCHITECT / ENGINEER USE ONLY *****************

NAME, TITLE AND SIGNATURE OF APPROVING AUTHORITY

NAME: ______________________________

TITLE: ______________________________

SIGNATURE: ______________________________

DATE IN:

DATE OUT:

ACTION TAKEN BY CONSTRUCTION MANAGER (CHECK APPLICABLE BOX):

_________ APPROVED (A)

_________ APPROVED AS NOTED (AAN)

_________ DISAPPROVED, REVISE AND RESUBMIT (RR)

_________ INFORMATION ONLY/NOT REVIEWED (FIO)

ANGI SERIES II DISPENSER

Basic Operation Manual

Rev. 13

WARNING

1. SAFETY

- Read this entire manual before operating, servicing, adjusting, repairing or maintaining this Equipment.
- Never adjust or repair machinery while it is in operation. Always stop the engine or electric motor before cleaning, servicing or repairing. Place all controls in the off position to prevent accidental restarting. Before restarting, make sure that all tools and other materials are removed from the equipment.
- Do not wear loose clothing around machinery. Loose clothing: neckties, rings, wristwatch, bracelets, hand rags, etc. are potential hazards.
- Do not smoke within 50 feet of the unit
- Make sure you are equipped with all required safety equipment: hearing protection, safety glasses, hard hats, safety shoes and fire extinguisher.
- Do not modify the fuel station or its systems.
- Do not tamper with, modify, or bypass fuel station safety and shutdown equipment.
- Do not exceed maximum allowable fuel station pressures and temperatures.
- Record operating hours, maintenance work, and repairs etc. in a logbook.
- ANGI Energy Systems, Inc. reserves the right to make changes or modifications to the equipment designs without notice.
- ANGI must authorize all modification to this equipment. Any unauthorized modification to this equipment and or software will void the warranty. Modification may damage the equipment and cause bodily injury.
- ANGI disclaims any responsibilities whatsoever to the customer or to any person for injury or damage to, or loss of, property or value resulting from the use of its products which have been subjected to misuse, accidents, misapplied, repaired by unauthorized person, or improperly installed.
- EXPLOSIVE HAZARD DO NOT DISCONNECT WHILE THE CIRCUIT IS LIVE OR UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITABLE CONCENTRATIONS.

NOTICE

This manual is as current as possible at the time of printing and is subject to change without notice. For information not covered in this manual or further clarification, contact ANGI Customer Service at 1-800-934-5219

- CONTRACTOR OR INSTALLER: Leave this manual with the Unit station after installation is complete.
- CUSTOMER: Retain this manual for future reference.

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1. Introduction

The ANGI Series II dispenser offers precision sequencing and temperature compensation for refueling natural gas vehicles. The Series II is a microprocessor-controlled system that controls the dispenser's operation using ANGI's proprietary software. The dispenser measures and delivers gas by using mass flow meters, pressure sensors, and valves to start and stop flow from a high-pressure gas supply source. The dispenser fills a vehicle tank to a temperature-compensated final pressure and displays the delivered mass and sale amount. The dispenser is programmed to perform a coordinated shutdown in the event of an emergency or loss of power.

The Series II dispenser is offered in single and two hose models. This documentation is written for a two hose application; for single applications, the second hose's functions will be non-operative.

2. Refueling Instructions

1. Remove the dust cap from the vehicle's nozzle receptacle.
2. Remove the fueling nozzle from the dispenser.
3. Confirm that the nozzle valve is in the OFF position.
4. Connect the fueling nozzle securely to the vehicle's nozzle receptacle.
5. Optional: Authorize the fuel management system.
6. Turn the Nozzle's Valve the FILL position.
7. Turn the dispenser handle the START position.
8. Optional: Enter sale preset amount or full.
9. When the gas flow slows or stops, turn the nozzle's valve to the OFF position.
10. Turn the handle to the STOP position.
11. Disconnect the fueling nozzle from the vehicle and return the fueling nozzle to its holder.
12. Install the dust cap on the vehicle's receptacle.

Note: Turn off the engine while refueling. No smoking while refueling.

3. Dispenser Fill Sequence

All display windows will show all segments on for 10 seconds after power is applied to the dispenser. After 10 seconds, the unit and sale values for the last sale will be displayed.

The dispenser fills a vehicle from three supply tanks: low bank, mid bank, and high bank. The dispenser operates a valve that connects the fill line to each of these supplies. The controller cycles through these supplies, or “banks,” one at a time to fill a vehicle. The dispenser will perform a fill sequence when initiated by the user.

The dispenser will sit idle and monitor the pressure of the hose; the hose is typically charged to full pressure. The operator will begin the sequence by connecting the hose to the vehicle and open the nozzle valve. This action discharges the hose and the controller detects the pressure drop, which is also known as a “hose drop.” Once the controller senses a hose drop, it is assumed that the vehicle is connected and the nozzle valve is open. The controller retains this information for 60 seconds. When the handle is turned to the START position and the dispenser is authorized to begin fueling, the controller begins the fill sequence. The display flashes with all the LCD segments on for one second, and then display sale and quantity are cleared to zero. If the dispenser is not authorized the display will read all 1s (or 2s if the extra authorize input is used).
The display will be cleared and the fill-sequence will start as soon as the dispenser gets the authorization signal. For dispensers with the sale preset option the display will read “PRESET” in the quantity field and will wait for a sale amount to be entered into the sale total field. The display will clear to zero after the operator pushes the START key. After zeroing, all gas flow will be measured. The controller measures the hose pressure, which is understood to be the vehicle tank pressure, and the ambient temperature. From these measurements, it calculates a target pressure for a full tank. The controller stops when the vehicle tank pressure reaches the target pressure.

Note: some fuel management systems authorize the dispenser by a valid card swipe prior to receiving card approval. This allows the dispenser to run before the fuel management system gets the approval. That fuel management system will remove authorization from the dispenser if it detects it is filling without approval (error code E6).

The fill sequence starts on the low supply or “low bank.” The low bank fills most of the vehicle’s tank. The controller switches off of the low bank, pauses, and then switches to the mid bank. During the pause, the controller samples the actual tank pressure for filling adjustments. The mid bank continues to fill the vehicle. Finally, the controller switches off of the mid bank, pauses, and then switches to the high bank to fill the final amount. After the final target is reached the high bank valve shuts off. The control pauses one last time to let the pressure and flow settle. Mass flow measurement is then halted, the displayed values are final, and the fill data is recorded in the controller’s permanent memory. This completes the filling sequence. If the sale-preset amount was entered, the dispenser will stop before the sale amount is reached and coast to the exact amount. This can happen anytime during the sequence. Any extra mass is clipped off the total to get the exact sale. The dispenser then goes through the above description of ending the process. Note: this function is used only where law allows it. The operator completes the process by turning the handle to the STOP position. While the dispenser is filling the vehicle, the controller continuously updates the dispenser’s display, and updates the sale and unit quantity information to the station control.

An extra step is added if the nozzle valve has not opened by the user before the handle is turned to the START position. The controller does not detect a hose drop. The dispenser performs the extra sequence step to confirm that the nozzle valve has been opened, which is called a ”hose check.” When the handle is turned to the START position, the display value is cleared. To see if the nozzle valve is opened, the controller turns on the high bank valve for a short time. The controller measures the amount of mass delivered during this time. If the amount is substantially more than the hose can hold, it is assumed that the nozzle valve is opened and all the mass went into the vehicle. This mass measurement is retained and the dispenser then begins the normal fill sequence.

If the mass delivered is the amount that the hose can hold or less, it is assumed the user did not open the nozzle valve. The dispenser control waits 60 seconds for the user to open the nozzle valve. When the nozzle valve is opened, the hose pressure will drop to the vehicle tank pressure. The controller will detect the hose drop, and the controller disregards the mass from the hose drop and zeroes the display values again. The controller starts the regular fill sequence. The dispenser controller will report an error if the valve is not opened within 60 seconds. It is assumed the user has left the dispenser unattended with the handle in the START position. The dispenser will not proceed to the fill sequence. The user must return the handle to the STOP position and start the cycle over (see Error Codes).

The dispenser will terminate a fill sequence immediately if:

- The authorization signal is removed
- The handle is turned from the START position
- The dispenser detects an abnormal fill event or an error

4. Display Operation During Fills

During the fill sequence, the display reports the amount of gas being dispensed and the sale amount. When the handle is turned to the START position, the display will show all segments on. This occurs so the user may detect any missing or failed LCD segments before filling. The user can abort the fill if the display is faulty by returning the handle to the STOP position. Any error codes displayed will be cleared when the handle is turned to the START position.

If authorization is present, all segments will stay on for one second after the handle is turned to the START position. After one second, the control will start the fill sequence. (See Sale Preset section 14 if you have that feature). If the authorization is not present after one second, the display will show all “1’s” until the request to fill is authorized. The controller will start the fill sequence once it is authorized.

If the operator turns the handle to the OFF position before authorization is granted or during the one-second period, the display will return to the previous fill values.

At the start of the fill sequence the display unit quantity and the sale values are cleared to zero. The cleared values will be displayed for 1/3 of a second before the fill sequence starts flow. Any amount of gas that flows will be continuously recorded in the Unit display window. The sale value will update with the unit quantity value. The bar graph will scroll up as the gas is being dispensed. The bar graph shows the percentage of mass being delivered with respect to the tank size. The tank size value is adjusted during the fill.

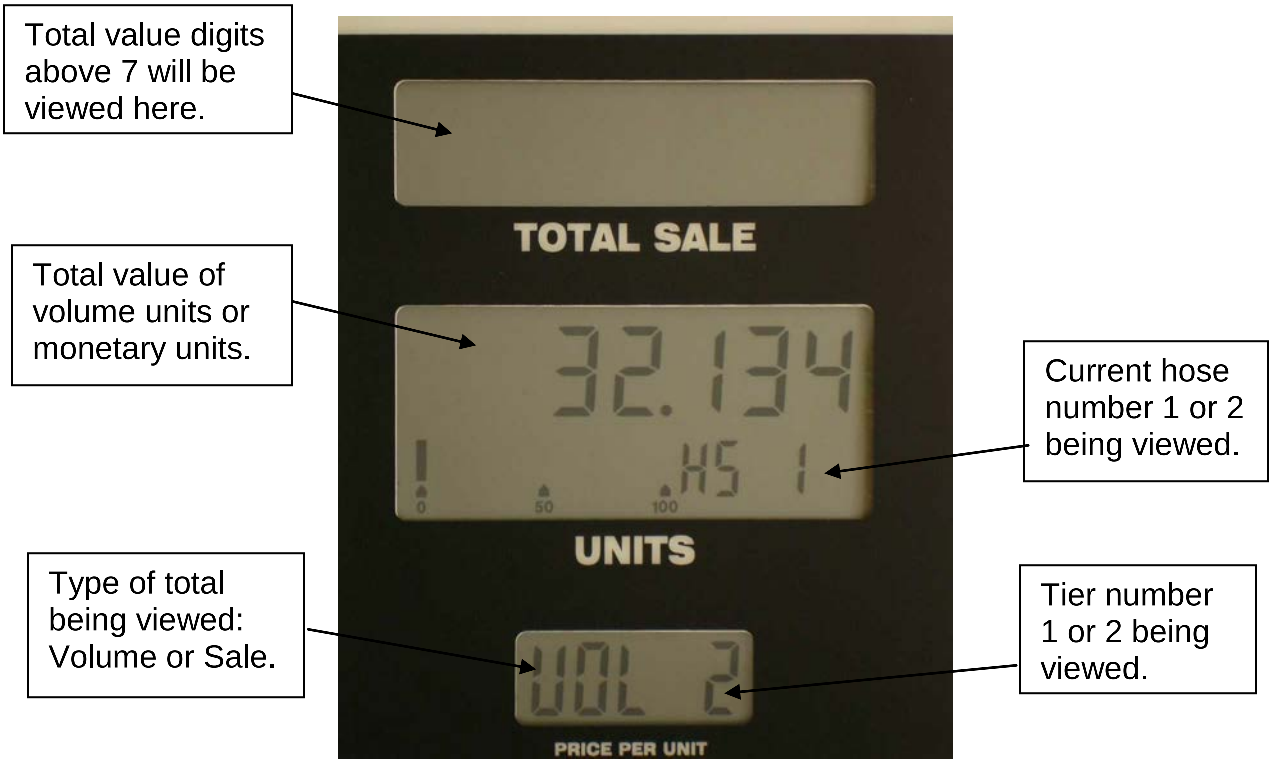
The lower 4-digit display shown in the Units window will monitor the estimated tank pressure. When the fill is complete, the bar graph will show 100% and the pressure will be replaced with the word “FULL”. The final tank pressure value will return to the 4-digit display when the user turns the handle to the STOP position. The quantity and sale values will remain on the display until the next fill. If there is an error, an ERROR CODE will replace the pressure in the Units window. The ERROR CODE is displayed using an “E” or “F” followed by an error code number (see Error Codes). For dispensers operating with program revs 3.910 and greater there is an overfill word “OvEr” is the dispenser malfunctioned in a way to put more gas than targeted instead of an error code. The amount of pressure above target to indicate an over fill is set by an internal parameter. Default is 15%. For program revs 3.961 there are two words added as event indicators. One is an under fill word ”Undr” displayed instead of the error code E1. The amount of pressure below target to indicate an under fill is set by an internal parameter. Default is 0%. The second is a power loss “PloS”. A power loss condition is detected when the internal dispenser DC power supply voltage goes below 21 vdc during a fill. This is to finish up a fill, by force, and record the transaction results before the power goes away completely. The dispenser typically has ½ second of charge to do this. If for some reason the power supply is low, below 21 volts, but does not lead to a complete power loss the display will show “PloS” and all “8” on the display if the handle is turned on. The dispenser will not start a fill sequence with the power supply not at the proper voltage above 22 vdc.

5. Keypad Operation

The keypad is a tool used to control the display of the running totals, to set price per unit, and to select tier pricing. The ANGI Series II dispenser retains a running total of all gas dispensed for each hose during a shift and an accumulated total from the initial start-up of the dispenser. Running totals are the accumulated amount of all fills, both volume and sale for each hose. There are two types of running totals: a clearable total or SHIFT total, and a non-clearable total. Price per unit is the amount charged per unit of mass, which is used to calculate the total sale. Each hose has the ability to pre-assign two prices for each hose. This is called tier pricing. Tier pricing allows the attendant or fuel management system to easily switch between two prices for various customers. These totals are retained in the controller’s permanent memory, which holds these values when power is removed from the dispenser. (See the Sale Preset Operation section if your dispenser has this option).

6. Displaying Totals

To display a desired total for a hose, press a key marked TOTAL or SHIFT and the “3” or “6” key. The “3” key selects A hose. The “6” key selects B hose. This displays the total amount on all of the LCD displays. The number is displayed starting in the Units window. If the total number expands larger than 7 digits, the upper additional digits will be displayed in the Total Sale window. The number can expand up to 12 digits.

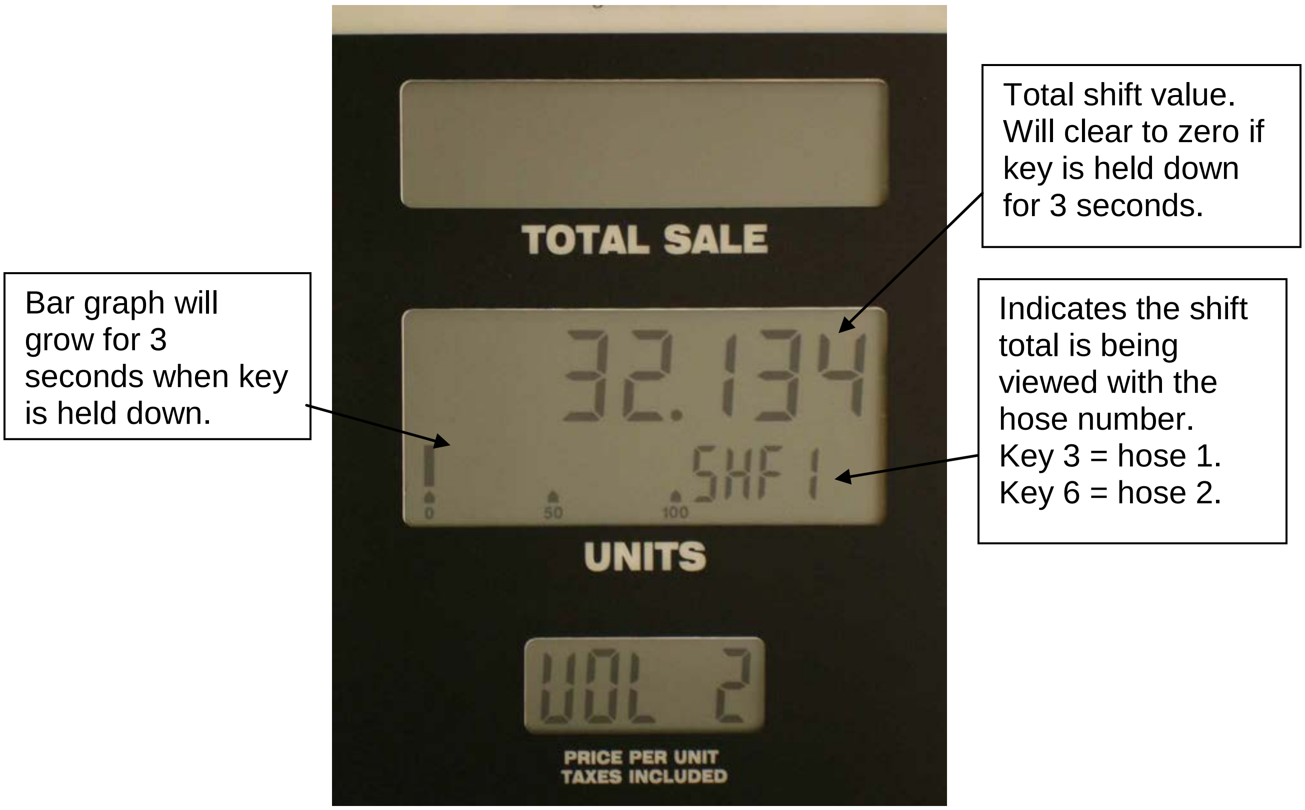


The Price Per Unit window will indicate “SALE_” or “VOL _” and specify which pricing tier has been selected. Example: If you press TOTAL SALE T2 (the “4” key), the Price Per Unit window will display “SALE2.” If you press TOTAL VOL T1 (the “2” key), the Price Per Unit window will display “VOL 1.” The 4-digit display in the Units window will indicate “HS _” for the selected hose. Pressing the “3” key will display “HS 1” for hose A. Pressing the “6” key will display “HS 2” for hose B. The total will not be displayed until a hose is chosen. Pressing the DISPLAY RESET button will return the display to the normal running mode. If a key is not pressed, the display will return to the normal running mode after 60 seconds.

The SHIFT totals are clearable to zero. A SHIFT total will be cleared by pressing and holding the key down for 3 seconds. After performing this function, the display will indicate zero. Pushing the DISPLAY RESET key accepts the cleared value. The SHIFT total will restart from this point. The previous shift value is deleted and is not recoverable.

If the DISPLAY RESET is not pressed following the 3-second hold, the previous value can be returned by simply pressing the SHIFT total key again or pressing any other key except the DISPLAY RESET key.

If a key is not pressed for 60 seconds, the display returns to the normal running mode and the SHIFT total is returned to the previous value; the previous value will not be cleared.



To display the total volume units dispensed from a hose since the dispenser's initial start-up, press the MASS key (the "9" key) and then a hose key: "3" or "6." The MASS function displays the total volume delivered from that hose. This number is not clearable. The price per unit window will show "ALL V" and the 4-digit display in the Units window will show "HS 1" for hose A or "HS 2" for hose B. Press the PRICE SET HOSE A TIER 1 key to display the total number of fills for that hose. The price per unit window will show "ALL C". Press the DISPLAY RESET key to return to the normal running display.

Total volume value up to 13 digits. Digits 8 – 13 roll up in the sale field above.

Hose number 1 or 2.
Key 3 = hose 1.
Key 6 = hose 2.

Viewing volume (mass) dispensed from one hose sum of both tiers.

Total number of fills values up to 10 digits.

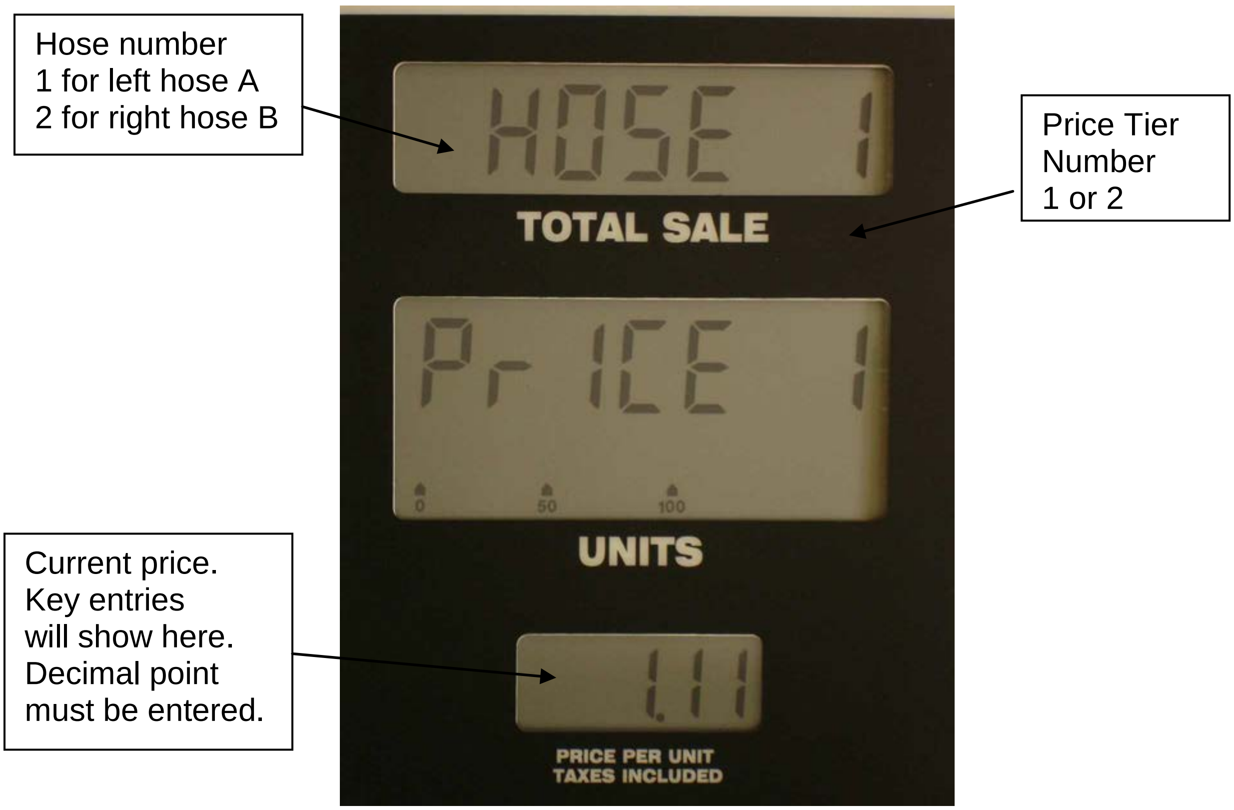
Hose number 1 or 2.

Viewing total number of fills dispensed from one hose sum of both tiers.

7. Price Setting

The ANGI Series II Dispenser has the ability two assign two prices for each hose. This is called tier pricing. Tier pricing allows the user to easily switch between two different prices for various customers. There are four keys that enable prices entering for each hose and each pricing tier:

- PRICE SET HOSE A TIER 1
- PRICE SET HOSE B TIER 1
- PRICE SET HOSE A TIER 2
- PRICE SET HOSE B TIER 2



Pressing these keys will put the dispenser in the price setting mode. To enter new prices, the handle must be in the STOP position. In the price setting mode, the number and the decimal point keys are enabled. The Total Sale window will indicate which hose is being edited, “HOSE 1” for hose A and “HOSE 2” for hose B. The Units window will indicate the pricing tier, either “PrICE 1” for tier 1 or “PrICE 2” for tier 2. The present price will continue to be displayed until a number key is pressed. Once a number key is pressed, the old price is cleared and the pressed number is placed in the price display’s lowest digit. The numbers entered will shift to the left; the new digit always enters at the right. The decimal point must be used if it is required. Example: to get “1.23,” press keys: 1, decimal point, 2, and 3, in that order. After the new price is entered, press the PRICE ENTER key to save the new value. If the numbers entered are not correct, press the PRICE SET key again and the old price will return, closing the price setting mode. In the price setting mode, all displays will show the same price value during editing regardless of which display you are looking at.

8. Price Tier Selection

The price tier used by the dispenser is selected by two methods:

- The price tier is selected using the keypad
- The price tier is selected by a hard-wired input

These methods are selected in the control parameters in the dispenser's software program.

9. Using the Keypad for the Tier Selection

To change the pricing tier, confirm that the Start/Stop handle is in the STOP position, and press the desired PRICE SET key twice. This will update the display to the desired price. Example: To display the tier 2 price for hose A, press the "PRICE SET - HOSE A - TIER 2" key once to show the selection. The display will show "HOSE 1," "PRICE 2," and the price. Press the "PRICE SET - HOSE A - TIER 2" key again to accept the selection. This sets the current price for hose A at tier 2 pricing. The display returns to the normal running mode. All future sales will be calculated at this price.

While the price is being updated:

- The Start/Stop handle must be in the STOP position
- The hose is non-operative
- The Start/Stop handle will be non-functional
- The dispenser will not operate if the handle is turned to the START position
- The dispenser will not start the next fill sequence if the handle was left in the START position after the price was entered. The handle must be returned to the STOP position before the next sequence can begin.
- The price change mode cannot be entered if the Start/Stop handle is in the START position
- The displayed sale amount from the last fill will not be recalculated when the price is changed; it will retain the values calculated from the previous fill.

10. Using a Hard-Wired Input for Tier Selection

The dispenser can be programmed to allow remote selection of the price tier. This function is provided by a hard-wired control board input for each hose (reference TB3 on the Interface Board). The dispenser uses the tier 1 pricing when the input if OFF and the tier 2 pricing when the input is ON for each hose. Price tier selection by the keypad is disabled when the dispenser is programmed with this function. When using this function, the tier price can be remotely changed any time the dispenser is idle.

When the user starts the fill, the price tier displayed is the one used for the sale calculation. This allows an optional remote system to set the price before the dispenser is authorized and before the handle is turned to the START position. The displayed price tier is protected from being changed during a fill; the input is disabled. If the input is changed to the other price tier during a fill, the controller will not update that change until the fill is complete and the handle is turned to the STOP position.

11. Special Mass Unit Selection

The dispenser can be set to temporarily display a standard mass unit different from its programmed mass unit. To display a “special mass unit” press and hold the “MASS” key (the “9” key) for three seconds. Pressing the “3” key will scroll through four standard conversions. The Price Per Unit window will display “SPU 0” for the normal programmed unit. The Unit window will display the grams per mass unit conversion. The four choices are:

- “SPU 1” Kilograms 1000.0 grams/Kg
- “SPU 2” Pounds 453.6 grams/lb
- “SPU 3” Equivalent Liters 667.7 grams/Eliter
- “SPU 4” Equivalent Gallons 2567.4 grams/Egal
- “SPU 5” Standard Cubic Meters 769.1 grams/SCM

Pressing the DISPLAY RESET key will accept the displayed units. All fills, totals, and shift totals unit quantities will be displayed in the selected units. Example for weights and measures testing: to display pounds, press and hold the “9” key for three seconds (with the handle in the STOP position). Press the “3” key twice to get to “SPU 2” “453.6” and press the DISPLAY RESET key. The display will return to the normal running mode. The displays will read how many pounds of gas were last dispensed.

The dispenser will retain these units as long as the power is on. If power is cycled, the units revert back to the programmed units: “SPU 0.” Going into the selections again and choosing “SPU 0” can select the normal running units. This should be done after a weights and measures test is completed.
Note: For controllers with rev. 3.05 or lower the mass pulses to the card reader were scaled to the special mass units. For rev. 3.06 and higher the mass pulses remain scaled by the normal programmed units SPU 0.

12. Error Codes

An error code is displayed in the 4-digit Units window when a hardware fault or a fill sequence fault occurs. It shows a capital “E “for fill events and an “F “for faults followed by a decimal number for fill events. All errors will remain displayed until they are cleared by cycling the START/STOP handle or cycling the dispenser’s power. Intermittent hardware errors are detected and retained. The display will cycle through multiple errors by displaying each error code for one second. Hardware and fill errors shut the fill sequence down. The fill sequence continues on events.

Error	**Definition** Possible cause	Event Type
E1	**Final Bank stop due to low flow and underfill, cannot reach pressure target** Bank shift due to hitting low flow target instead of pressure target.	**Fill event**
F2	**Bank pressure exceeds fixed allowable pressure** Pressure greater than fixed pressure trip.	**Fill error**
F3	**Bank pressure exceeds 155% (Pmax) of calculated pressure target** Pressure greater than pressure target multiplied by Smax parameter (1.35 typical).	**Fill error**
E4	**Tank pressure exceeds target pressure during bank shift, do not continue to next bank** Measured tank pressure greater than target pressure during bank shift, or tank is already full.	**Fill event**
E5	**Operator aborted fill; Handle turned off before complete** Fill was aborted by operator, handle turned off.	**Fill event**
E6	**Authorization removed during fill; Fill aborted by fuel management** Fill was aborted by removal of the authorize signal.	**Fill event**
F7	**Hose exceeded allowable maximum flow; "hose burst" (fixed burst threshold)** Excessive flow, hose burst.	**Fill error**
F8	**Flow detected with valves closed, cannot sequence, meter lost zero or leak, 15 second** Flow is not zero for 15 seconds after all valves are off. Valve leak or bad flow signal.	**Fill error**
E9	**Hose drop timed out; Dispenser left unattended while attached to vehicle** Dispenser waited too long for operator to open the nozzle valve.	**Fill error**
E10	**Meter busy zeroing or an internal error** Flow meter has internal error or is busy performing a zeroing function.	**Event**
E11	**Switch1 #1 is ON, Encore hybrid Cal-Program switch is to the right in program mode** Calibration Switch1 is in the ON position.	**Hardware**
E12	**Flow detected when the dispenser is off, meter lost zero or leak** Gas flowing while dispenser is idle.	**Event**
F13	**Ambient temperature out of range** Temperature out of working range.	**Error**
F14	**Broken wire or signal loss of the main pressure sensor** Main pressure sensor wire disconnected.	**Hardware**
F15	**Flow meter not communicating** Flow meter serial communication loss.	**Hardware**
F16	**Display not communicating** Display serial communication loss.	**Hardware**
F17	**Redundant pressure sensor not in agreement with main sensor** Pressure reading discrepancy between main and secondary pressure sensors.	**Fill Error**
E18	**Gilbarco comm link overrun error** Verify POS communication settings and connections.	**Comm Error**
E19	**Gilbarco comm link parity error** Verify POS communication settings and connections.	**Comm Error**
E20	**Gilbarco comm link framing error** Verify POS communication settings and connections.	**Comm Error**
E21	**Gilbarco comm link checksum error** Verify POS communication settings and connections.	**Comm Error**
E22	**Gilbarco comm link data length error** Verify POS communication settings and configuration.	**Comm Error**
E23	**Gilbarco comm link invalid command error** Verify POS communication settings and configuration.	**Comm Error**
E24	**Gilbarco comm link invalid grade error** Verify POS communication settings and configuration.	**Comm Error**
E25	**Parameter value different than what is stored in memory** Current and stored parameter values are different.	**Data Error**
F26	**Meter programmed with the wrong mass flow unit** Meter not programmed with Kg/s.	**Data Error**
F27	**Meter programmed with the wrong mass unit** Meter not programmed with Kg.	**Data Error**

F28	**Broken wire or signal loss of the secondary pressure sensor** Secondary pressure sensor wire is disconnected.	**Hardware**
F29	**Shorted wire or signal loss of secondary pressure sensor** Secondary pressure sensor wire shorted to power supply.	**Hardware**
F30	**Shorted wire or signal loss of main pressure sensor** Main pressure sensor wire shorted to power supply.	**Hardware**
E31	**Gilbarco Comm off line** Verify POS communication settings and connections.	**Hardware**
F32	**Sudden hose pressure drop during fill**	**Fill Error**
F33	**Control air pressure low** Check control air pressure	**Hardware**
F34	**Control air pressure sensor wire broken** Check control air pressure wire	**Hardware**
F35	**Control air pressure sensor wire shorted** Check control air pressure wire	**Hardware**
F36	**Not defined**	
F37	**Not defined**	
F38	**Negative flow detected with valves closed, cannot sequence, 15 second timeout**	**Fill error**
F39	**Meter measured mass jump, change of mass out of expected range, miscount**	**Fill error**
F40	**Communication loss with the remote I/O module. Disabled when not using remote I/O.**	**Hardware**
E41	**Program switch in program mode, Series II only. Disabled in Encore Hybrid.** Verify correct position of program switch.	**Hardware**
E42	**Stop on volume display limit: Series II = 9999.999, Encore hybrid = 999.999**	**Fill error**
E43	**Stop on money display limit: Series II = 9999.999, Encore hybrid = 999.999**	**Fill error**
F44	**Meter mass totalizer did not clear at sequence start step**	**Fill error**
F45	**Meter mass totalizer did not clear at nozzle open sequence step**	**Fill error**
E46	**Transaction registered in dispenser pending pickup by the fuel management.** Waiting on fuel management system.	**Fill event**
E47	**Fill stop registered in dispenser pending pickup by the fuel management.** Waiting on fuel management system.	**Fill event**
F48	**Sudden calculated tank pressure drop during fill** Check tank drop parameter.	**Fill Error**
F49	**A hose left PPU not communicating or not installed, Encore hybrid only** Check PPU module.	**Hardware**
F50	**A hose right PPU not communicating or not installed, Encore hybrid only** Check PPU module.	**Hardware**
F51	**A hose left nozzle switch not plugged in with A left hose enabled, Encore hybrid only** Check nozzle switch connections.	**Hardware**
F52	**A hose right nozzle switch not plugged in with A right hose enabled, Encore hybrid only** Check nozzle switch connections.	**Hardware**
F53	**B hose left PPU not communicating or not installed, Encore hybrid only** Check PPU module.	**Hardware**
F54	**B hose right PPU not communicating or not installed, Encore hybrid only** Check PPU module.	**Hardware**
F55	**B hose left nozzle switch not plugged in with B left hose enabled, Encore hybrid only** Check nozzle switch connections.	**Hardware**

F56	**B hose right nozzle switch not plugged in with B right hose enabled, Encore hybrid only** Check nozzle switch connections.	**Hardware**
F57	**Burst from pressure** Excessive pressure hose burst.	**Fill Error**
E58	**Meter parameter difference** Check Ameter or Bmeter parameters.	**Data Error**

13. Diagnostic Keypad Functions

The keypad provides an access to the internal workings of the dispenser controller by displaying the program parameters and variable values areas on the dispenser's LCD screens. Flow-meter parameters and the parameter change log (Audit Trail) are also viewable. The values are displayed in the Sale and Unit Total fields with the least significant digit in the right most digit in the units field. Numbers larger than seven digits roll over into the Sale field. Technicians troubleshooting the dispenser can change parameter values from the keypad. The parameter changes are password protected.

Accessing these areas are done with the 1, 2, 4, and 5 keys. To open an area, press and hold the key for 3 seconds. The bar graph will grow from the left to the right for that time. Press the DISPLAY RESET key to exit and return to normal. The price set keys will be redefined for scrolling and editing functions depending on the area being viewed. The areas are:

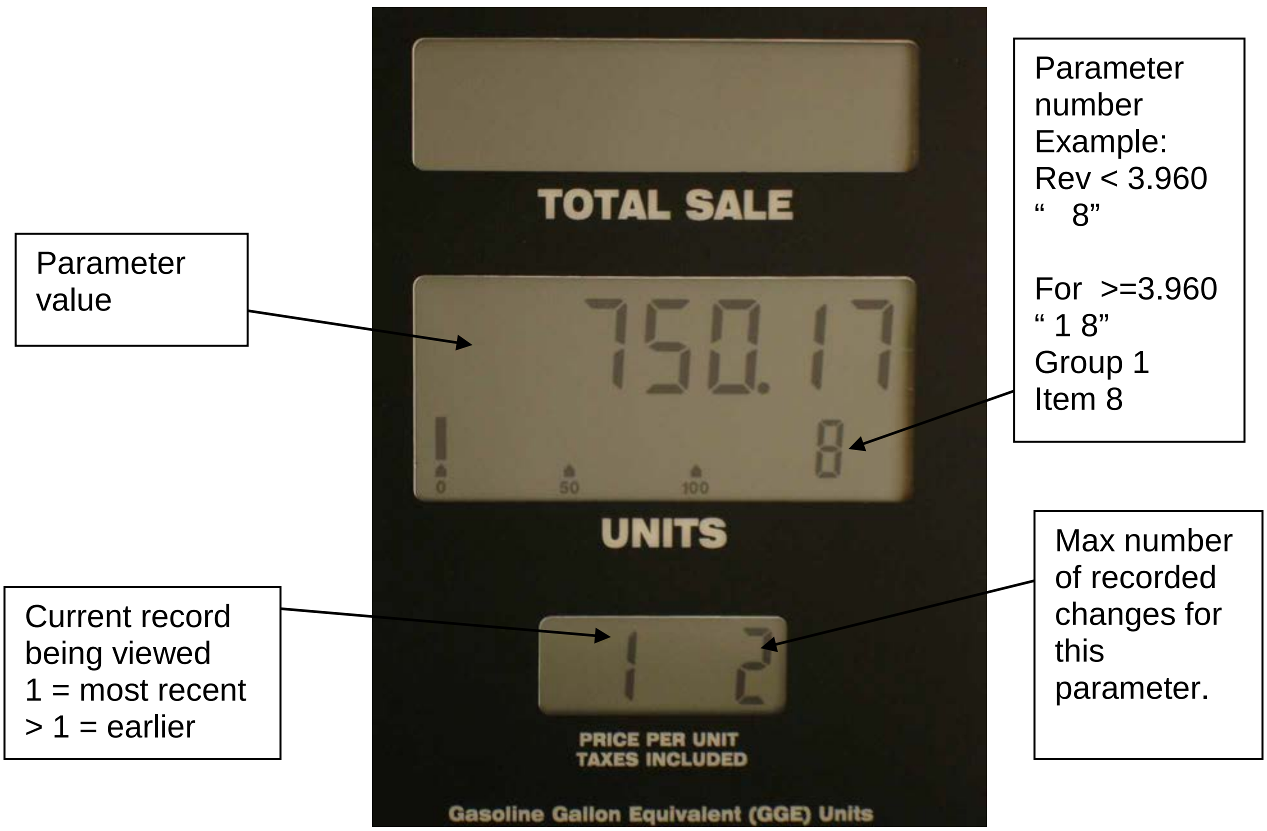
Key 1: Audit Trail, parameter change log.
Key 2: Hose "A" flow-meter parameters and variables.
Key 4: Dispenser controller parameters and variables.
Key 5: Hose "B" flow-meter parameters and variables.

13.1. Audit Trail

The dispenser audit trail logs all and any parameter changes that have occurred through the dispenser's entire lifetime. The audit trail is stored in non-volatile memory that retains the information without the dispenser being powered. This permits the dispenser to be used for legal custody transfer of product without resorting to use of a physical seal on the dispenser control cabinet. It also allows the dispenser control to be accessed by remote communication devices where parameter changes are password protected. When a parameter is changed, the new value is stored in the trail along with the date, time, and change count. The date and time is read from the dispenser controllers on board clock. A maximum of 1024 changes can be recorded. When the audit area is full, any change writes over the oldest record. For dispenser controllers that are running on program revision 3.08 or higher, flow-meter parameter changes are also recorded if the changes are done through the controller with the PC-based monitoring tool.

In the audit trail view mode, the value is displayed in the units and sale fields. There are two types of values displayed: decimal numbers up to 10 digits with a decimal point or real numbers display in scientific notation. Real numbers will all start with a sign, one units digit followed by a decimal point, 6 decimals, an “E” for to indicate the exponent, an exponent sign, and the two digit exponent. Example 1.200000E –01 means the value is 0.12. The pressure field on the LCD will display the parameter number. The number can use to look up the parameter in a table. The price field will show two numbers: the right most number is the total number of changes recorded for that parameter, the left most number indicates which change is displayed starting with the most recent. For program revisions 3.960 and higher, the parameter number is split into a group and item field that matches how parameters and variables are stored in the dispenser controller and displayed by the monitor software one can run on a computer. See Series II Technical Function Manual for the parameter and variable list.

The controller program sorts the audit trail for display. Pressing the PRICE SET HOSE

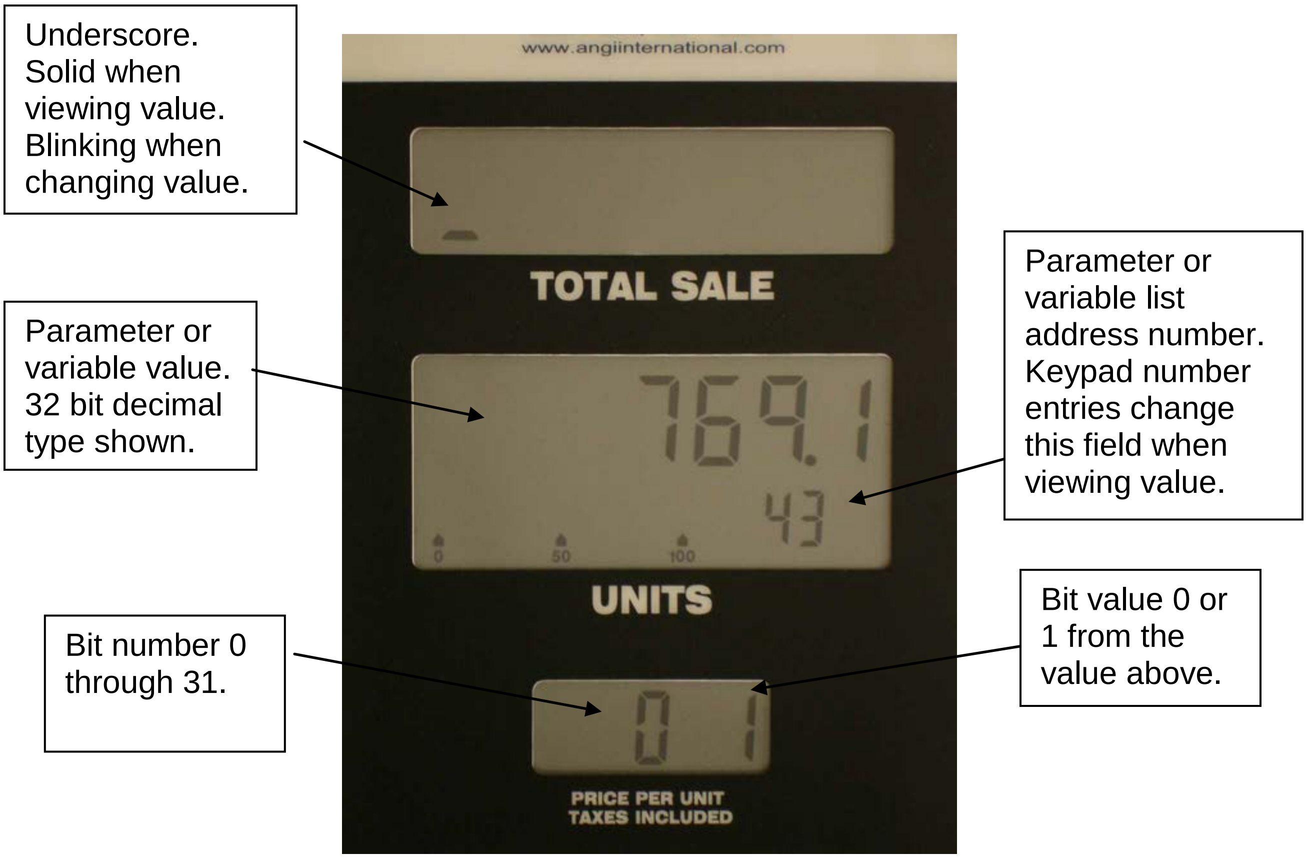


B TIER 2 key scrolls through the trail starting with the lowest number parameter. When at the end of the trail the scroll returns to the lowest parameter number. Parameters that have never been changed are not displayed. The PRICE SET HOSE A TIER 1 key scrolls back to earlier changes. The left most number in the price field will increment up. The scroll will stop when number reaches the maximum number of changes. The PRICE SET HOSE B TIER 1 key scrolls forward to later changes. The scroll will stop when left most number in the price filed reaches one. Pressing the PRICE SET HOSE A TIER 2 key displays the time and date of the parameter change. The time is displayed in the sale filed. The date is displayed in the units field. When a flow-meter change is displayed, the pressure field will display in left most digit the hose letter, “A” or “b”, followed by the meter parameter number. The meter manufacturer defines the meter parameter number. For MicroMotion meters some parameters are displayed in a special format. Real numbers are displayed in scientific notation described previously. Non-real numbers are displayed up to 10 digits. The flow calibration number is displayed with underscores where the decimal points are shown on the nameplate. Example: the nameplate number flowcal = 111.434.50 will display as 111_434_50.

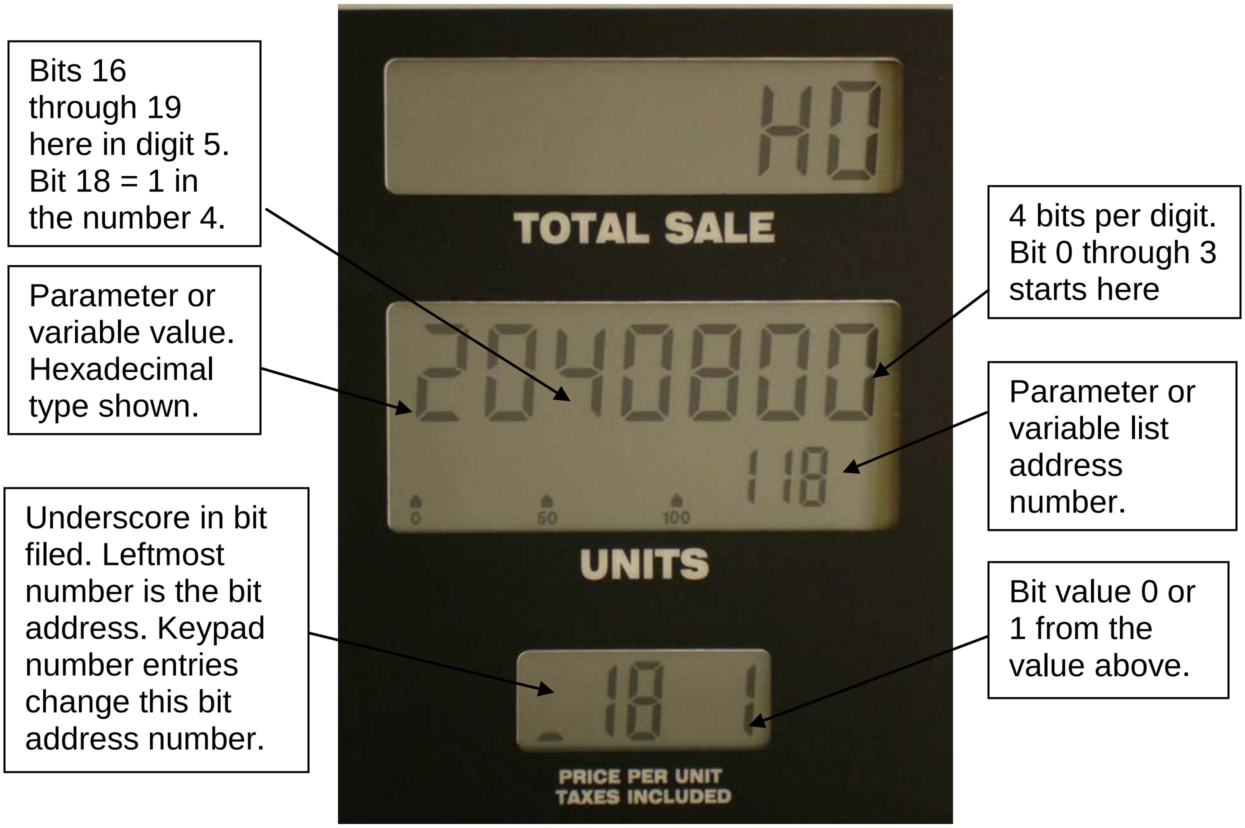
13.2. Dispenser Controller Variables and Parameters

Key 4 opens the controller variable and parameter area. The values are displayed in the units and sale filed. Each value in the dispenser controller is a 32 bit wide number. The number value can range from 0 to 4,294,967,295. The values can be displayed in decimal, hexadecimal, or scientific format depending on their definition in the controller’s program. The hexadecimal format starts with an “H” followed by 8 digits. The digits are 0-9 and A, b, C, d, E, and F for 10-15 respectively. The variable and parameter address number is displayed in the pressure field. The price field displays the individual bit value. The left most number in the price field is the bit number 0 – 31. The right most number is the bit value of 0 or 1.

Scrolling through the parameters is done with the PRICE SET HOSE A TIER 1 and the PRICE SET HOSE B TIER 1 keys. Pressing the PRICE SET HOSE A TIER 1 key will increment the parameter number in the pressure field by one. Pressing the PRICE SET HOSE B TIER 1 key will decrement the parameter address number in the pressure field by one. A parameter address number can be entered directly with the number keys. Pressing a number key puts that number into the least significant digit, the rightmost digit, in the pressure field. The decimal point key acts as a backspace removing the rightmost digit. An underscore “_” will be displayed in the left most digit of the sale field. This indicates the focus is on the parameter value.



To scroll through the bit values of the parameter value, press the PRICE SET HOSE A TIER 2 key. This will switch the focus to the bit values in the price field. The underscore will be moved to the leftmost digit in the price field. The PRICE SET HOSE A TIER 1 and the PRICE SET HOSE B TIER 1 keys will change the bit address number from 0 through 31, the leftmost number in the price field. The number keys will enter a bit address number directly. Pressing the decimal point key will backspace the bit number. Pressing the PRICE SET HOSE A TIER 2 key again will return the focus to the parameter value. The underscore will return to the sale field.



Parameter values can be changed from the keypad. The write-protect status for a parameter is indicated by the bar graph. No bar indicates the value can not be changed. A bar graph 30%, 60%, or 100% indicates the number can be changed. The dispenser controller's parameters are all write protected on power-up. To change parameter values, the write-protect must be "unlocked" by entering a password number in a certain variable. The password number and variable is not given in this manual but must be obtained from ANGI International LLC for authorized personnel only. Once the write-protect is unlocked, it will stay unlocked as long as the parameters are being viewed. The write-protect will stay unlocked for one hour after exiting. To open a parameter for changing, make sure the underscore is in the sale field and press the PRICE SET HOSE B TIER 2 key. The underscore will blink once a second indicating the number can be edited. New values are written with the number keys. The SHIFT SALE T2 key backspaces out numbers. The decimal point in all values is fixed and is not changeable. New values are accepted and stored in the controller memory by pressing the PRICE ENTER key. These new values are always stored in the audit trail. To discard a change and escape, press the PRICE SET HOSE A TIER 1 key. Pressing the PRICE SET HOSE B TIER 1 and PRICE SET HOSE B TIER 2 key will do nothing in at this time.

Pressing the PRICE SET HOSE B TIER 2 will switch focus to the bit number. The underscore will move to the price field and will continue to blink. Pressing the PRICE SET HOSE B TIER 1 key can toggle individual bit values from zero to one. The parameter value will reflect the change in the bit value. The number keys will change the bit number and not the value of the bit. The new bit value is saved or aborted by the same keys described for the main value. After a new value is entered or escaped from, the underscore will stop blinking and the key functions will revert back to their value viewing actions.

When changing real number values, the PRICE SET HOSE A TIER 2 key will toggle the focus between the mantissa (the first 7-digit number) and the exponent. The underscore will shift from before the mantissa to after the “E” in the exponent. The PRICE SET HOSE B TIER 1 key will toggle the sign before the value. The number keys and the SHIFT SALE T2 key are used to change the values in the same way as described for decimal numbers described above. Bit values cannot be changed in real numbers.

Underscore here changes are made to the mantissa. Example 1.247753 Decimal point is fixed.

Parameter or variable real type shown. +1.247753E +01

Underscore after the E changes are made to the exponent., Example +01.

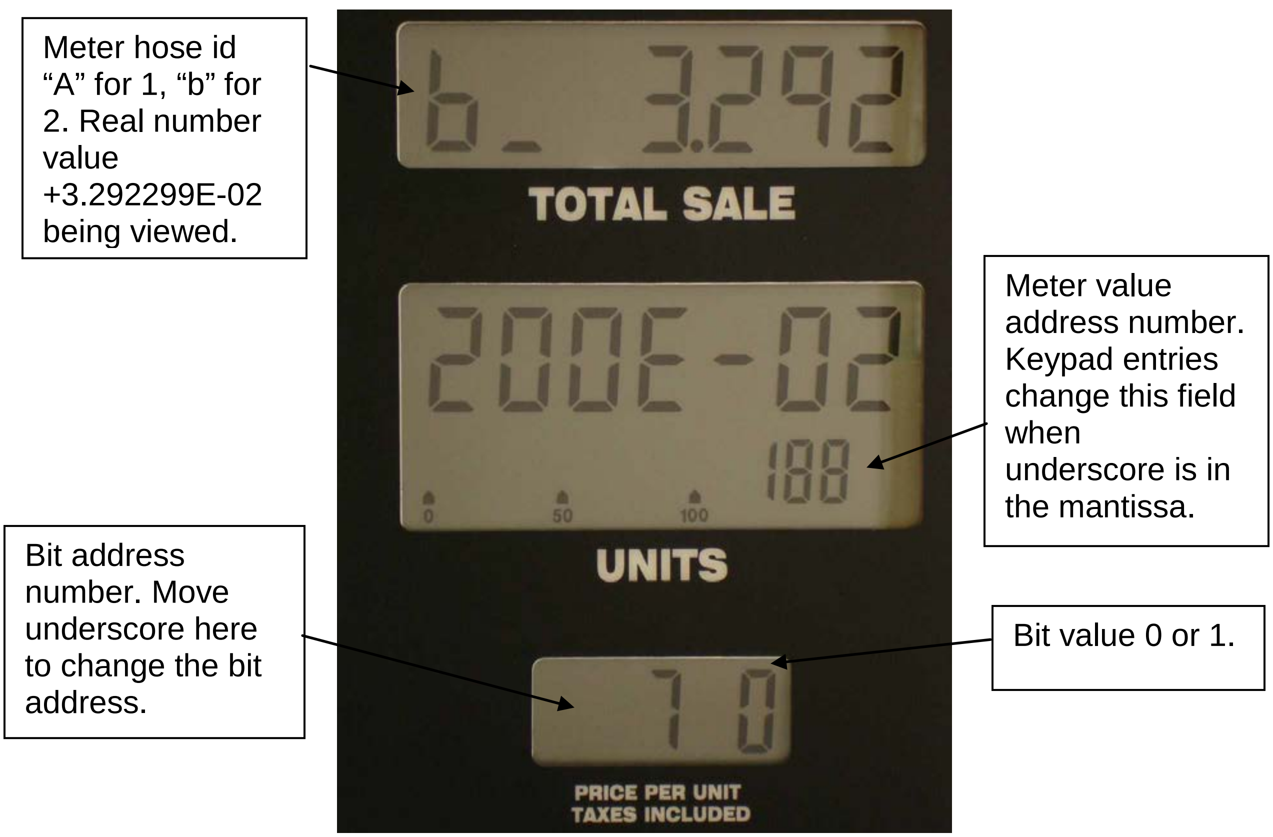
Parameter or variable list address number.

When changing hexadecimal numbers, the PRICE SET HOSE B TIER 1 key toggles between the 0 – 9 numbers and the A – F numbers. After entering into the change value mode by pressing the PRICE SET HOSE B TIER 2 key, the display will show a “0-9” before the hexadecimal value. The number keys will enter 0 through 9. Pressing the PRICE SET HOSE B TIER 1 key will change the display to “A-F” before the number. A value of 10 is added to the number keys so that the zero key equal 10 or A, the one key equals 11 or b, and so on to the five key equaling 15 or F. Keys six through nine do nothing. Bit values are changed in the same way as described above for decimal numbers. Press PRICE SET HOSE A TIER 2 to enter the bit change mode.

13.3. Meter Variables and Parameters.

The register values in the MicroMotion mass flow meters can be read through the display. Pressing and holding the two key for three seconds enters the hose A values and the five key for hose B values. The values in the meter cannot be changed from the keypad. The parameter address number is displayed in the pressure field. This address number is used to lookup what parameters or variable is displayed from a manual table. An “A” or a “b” is displayed in the leftmost digit of the sale field to indicate which meter is being read. An underscore will be displayed after this letter. The PRICE SET HOSE A TIER 1 and PRICE SET HOSE B TIER 1 keys scroll through the parameters one at a time. The number keys edit the parameter address number directly. The SHIFT SALE T2 key backspaces out the parameter address number. Unlike the dispenser controller, the values from the meter are 16 bits wide. The values range from 0 to 65536. To represent numbers larger than that or real numbers, two address numbers are used together. All real numbers in the meter start on odd address numbers. Even address numbers will display the same value as the address directly below it. The PRICE SET HOSE A TIER 2 key toggles between the main value and the bit value. The underscore will shift to the price field. The PRICE SET HOSE A TIER 1 and PRICE SET HOSE B TIER 1 keys scroll through the bit addresses one at a time. The number keys enter the bit addresses directly. The SHIFT SALE T2 key will backspace out the bit address number.

The meter display mode will only display meter values that are retrieved by the dispenser controller. Addresses that are not retrieved will come up zero on the LCD. The display will also be zero if the meter is not communicating with the dispenser.



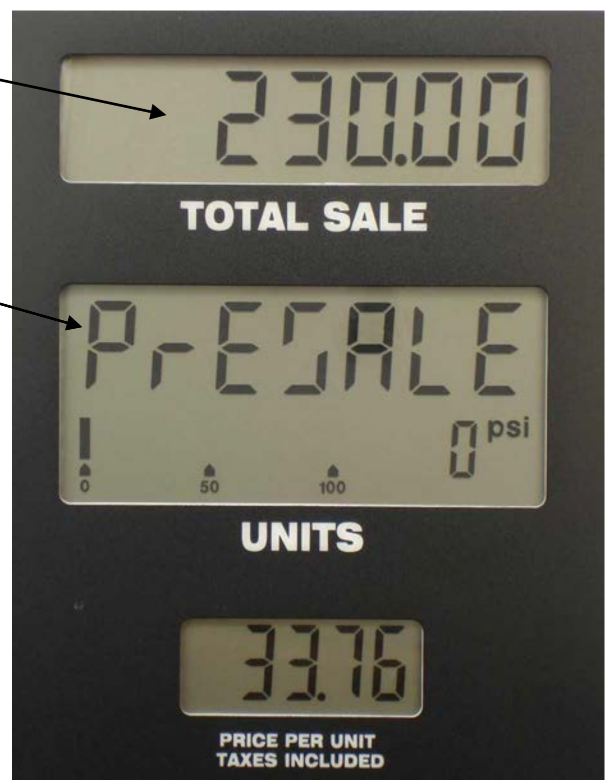
14. Sale Preset Operation.

This option allows the user to enter in a final sale amount before filling for a partial fill. The dispenser will stop filling when the sale total gets close to the preset amount and “rolls up” to the exact amount. The fill is stopped at a mass amount calculated from the current flow taking into account the time it takes for the flow to settle. A parameter is adjusted to get the target as close as possible. Yet any extra mass that flowed beyond what makes the exact sale amount is ignored (the mass amount is clipped). This option is not supplied to sites where it violates a type approval requirement. A user accessible keypad is mounted next to each main hose display. An extra step is added to the fill sequence for the sale amount entry. After connecting the hose to the vehicle and pushing the start button, the user is prompted to enter a sale amount after the dispenser is started. The user then pushes the START key on the keypad to begin filling. The key descriptions are as follows:

0-9:	Number entry keys.
CLEAR:	Clears the entry to zero.
->:	Backspace key. Removes the least significant digit from the entered amount.
F:	Selects a full fill instead of the preset. The dispenser fills to the temperature compensated pressure target. The display will read “FULL” in the sale field when active.
ENTER:	Escapes from the full selection. Goes back to entering a preset sale amount.
STOP:	Aborts the preset and fill sequence. Does not stop the dispenser once it is started.
START:	Begins the fill sequence after an amount is entered or full is selected. Will not start if the amount entered is zero.

Enter in desired sale amount with the keypad or press “F” for full.

Prompt to enter amount. The display will return to the quantity after pushing the start key.



The preset sale keypad is also used to enter the price-per-unit. The door keypad takes place of the internal keypad described in section 5. The button layout on the door keypad is identical to the internal keypad. Price changing is allowed only when not filling with the start button not pushed. An extra security option allows price changing only if the display door is unlocked and opened by an attendant. This keeps customers from entering their own price.

Number Keys:
1: Sale Tier 1
2: Volume Tier 1
3: Hose A
4: Sale Tier 2
5: Volume Tier 2
6: Hose B
7: Shift Sale Tier 1
8:: Shift Volume Tier 1
9: Mass Total
Clear: Shift Sale Tier 2
0: Shift Volume Tier 2

Hose A Tier 1
Hose B Tier 1
Hose A Tier 2
Hose B Tier 2

Decimal Point

Enter Price /
Reset Display

15. Revision History

Rev 1: Corrections to original the release. 5-19-2004.
Rev 2: Added section 11, Special Unit selection. 11-10-2004.
Rev 3: Changed the error code section to reflect the “F” and “E” types of errors. 4-28-2006.
Rev 4: Added section 13.1, 13.2, and 13.3 Keypad diagnostic functions. Display pictures added. 12-12-2006.
Rev 5: Added Sale Preset Operation section.
Rev 6. Added new fault/event description for E12, was undefined.
Rev 7. Added new fault/evens F29, F30, F31, and F32. (EXCO) 4-14-2009
Rev 8. Added descriptions of new event “words” “OvEr”, “Undr”, and “PloS”. E1 not defined for revs 3.961. Added example of parameter number being displayed as group/item in the audit trail display for revs >= 3.960.
Rev 11 added Safety Warnings
Rev 12 Logo Swap
Rev 13 Updated Error Code List

Series II Dispenser Error Code List

Code Displayed	Definition Possible cause	Category	Event Type
E1	**Final Bank stop due to low flow and underfill, cannot reach pressure target** Bank shift due to hitting low flow target instead of pressure target. (normally not implemented).	1	Fill event
F2	**Bank pressure exceeds fixed allowable pressure** Pressure greater than fixed pressure trip.	2	Fill error
F3	**Bank pressure exceeds 155% (Pmax) of calculated pressure target** Pressure greater than pressure target multiplied by Smax parameter (1.35 typical).	2	Fill error
E4	**Tank pressure exceeds target pressure during bank shift, do not continue to next bank, finish instead.** Measured tank pressure greater than target pressure during bank shift, or tank is already full.	2	Fill event
E5	**Operator aborted fill; Handle turned off before complete** Fill was aborted by operator, handle turned off.	2	Fill event
E6	**Authorization removed during fill; Fill aborted by fuel management** Fill was aborted by removal of the authorize signal. POS fill limit reached.	2	Fill event
F7	**Hose exceeded allowable maximum flow; “hose burst” (fixed burst threshold)** Excessive flow, hose burst.	2	Fill error
F8	**Flow detected with valves closed, cannot sequence, meter lost zero or leak, 15 second** Flow is not zero for 15 seconds after all valves are off. Valve leak or bad flow signal. Perform zero calibration on the flow meter. Clean “slug” out of the meter. Replace.	2	Fill error
E9	**Hose drop timed out; Dispenser left unattended while attached to vehicle** Dispenser waited too long for operator to open the nozzle valve.	2	Fill error
E10	**Meter busy zeroing or an internal error** Flow meter has internal error or is busy performing a zeroing function.	1	Event
E11	**Switch1 #1 is ON (Series II), Encore hybrid Cal-Program switch is to the right in program mode** Calibration Switch is in the ON position	3	Hardware
E12	**Flow detected when the dispenser is off,** Gas flowing signal while dispenser is idle. Meter lost zero calibration, meter misread.	1	Event
F13	**Ambient temperature out of range** Temperature out of working range -40 F to 60F. Check connections and associated hardware.	3	Error
F14	**Broken wire or signal loss of the main pressure sensor** Main pressure sensor wire disconnected.	3	Hardware
F15	**Flow meter not communicating** Flow meter serial communication loss. Check connections and associated hardware.	3	Hardware
F16	**Display not communicating** Display serial communication loss. Check connections and associated hardware.	3	Hardware
F17	**Redundant pressure sensor not in agreement with main sensor** Pressure reading discrepancy between main and secondary pressure sensors.	2	Fill Error
E18	**Gilbarco comm link overrun error** Verify POS communication settings and connections. Received POS data wrong.	1	Comm Error
E19	**Gilbarco comm link parity error** Verify POS communication settings and connections. Received POS data wrong. POS/ to dispenser comm settings don’t match.	1	Comm Error
E20	**Gilbarco comm link framing error** Verify POS communication settings and connections. POS/pump settings don’t match.	1	Comm Error
E21	**Gilbarco comm link checksum error** Verify POS communication settings and connections. Received POS data wrong.	1	Comm Error
E22	**Gilbarco comm link data length error** Verify POS communication settings and configuration. Received POS data wrong.	1	Comm Error
E23	**Gilbarco comm link invalid command error** Verify POS communication settings and configuration. POS sent unknown command.	1	Comm Error
E24	**Gilbarco comm link invalid grade error** Verify POS communication settings and configuration. POS sent grade out of range.	1	Comm Error

Code Displayed	**Definition** Possible cause	Category	Event Type
E25	**Parameter value different than what is stored in memory** Current and stored parameter values are different. Save or restore parameters.	**3**	**Data Error**
F26	**Meter programmed with the wrong mass flow unit** Meter not programmed with Kg/sec. Adjust meter's engineering units.	**3**	**Hardware Data Error**
F27	**Meter programmed with the wrong mass unit** Meter not programmed with Kg. Adjust meter's engineering units.	**3**	**Hardware Data Error**
F28	**Broken wire or signal loss of the secondary pressure sensor** Secondary pressure sensor wire is disconnected.	**3**	**Hardware**
F29	**Shorted wire or signal loss of secondary pressure sensor** Secondary pressure sensor wire shorted to power supply.	**3**	**Hardware**
F30	**Shorted wire or signal loss of main pressure sensor** Main pressure sensor wire shorted to power supply.	**3**	**Hardware**
E31	**Gilbarco Comm off line** Verify POS communication settings and connections. POS not poling dispenser.	**1**	**Hardware**
F32	**Sudden hose pressure drop during fill.** Rupture or loss of pneumatic containment incident Interruption/loss of supply pressure. Check parameter value for nuisance faults when occurring under normal conditions.	**2**	**Fill Error**
F33	**Control air pressure low** Check control air pressure		**Hardware**
F34	**Control air pressure sensor wire broken** Check control air pressure wire		**Hardware**
F35	**Control air pressure sensor wire shorted** Check control air pressure wire		**Hardware**
F36	**Not defined**		
F37	**Not defined**		
F38	**Negative flow detected with valves closed, cannot sequence, 15 second timeout** Same as F8 but with the flow signal reporting backward flow.		**Fill error**
F39	**Meter measured mass jump, change of mass out of expected range, miscount.** Not as yet implemented. For future code requirement.		**Fill error**
F40	**Communication loss with the remote I/O module. Disabled when not using remote I/O.**		**Hardware**
E41	**Program switch in program mode, Series II only. Not defined in Encore Hybrid.** Verify correct position of program switch. Left for dispenser run mode.		**Hardware**
E42	**Stop on volume display limit: Series II = 9999.999, Encore hybrid = 999.999** The fill is deliberately stopped before the limit it can display is reached.		**Fill error**
E43	**Stop on money display limit: Series II = 9999.999, Encore hybrid = 999.999** The fill is deliberately stopped before the limit it can display is reached.		**Fill error**
F44	**Meter mass totalizer did not clear at sequence start step** Not as yet implemented. For future code requirement.		**Fill error**
F45	**Meter mass totalizer did not clear at nozzle open sequence step** Not as yet implemented. For future code requirement.		**Fill error**
E46	**Transaction registered in dispenser pending pickup by the fuel management.** Waiting on fuel management system.		**Fill event**
E47	**Fill stop registered in dispenser pending pickup by the fuel management.** Waiting on fuel management system.		**Fill event**
F48	**Sudden calculated tank pressure drop during fill** Rupture or loss of pneumatic containment incident Interruption/loss of supply pressure. Check parameter value for nuisance faults when occurring under normal conditions.		**Fill Error**
F49	**A hose left PPU not communicating or not installed, Encore hybrid only** Check PPU module and its connections.		**Hardware**

Code Displayed	**Definition** Possible cause	Category	Event Type
F50	**A hose right PPU not communicating or not installed, Encore hybrid only** Check PPU module and its connections.		**Hardware**
F51	**A hose left nozzle switch not plugged in with A left hose enabled, Encore hybrid only** Check nozzle switch connections.		**Hardware**
F52	**A hose right nozzle switch not plugged in with A right hose enabled, Encore hybrid only** Check nozzle switch connections.		**Hardware**
F53	**B hose left PPU not communicating or not installed, Encore hybrid only** Check PPU module and its connections.		**Hardware**
F54	**B hose right PPU not communicating or not installed, Encore hybrid only** Check PPU module and its connections.		**Hardware**
F55	**B hose left nozzle switch not plugged in with B left hose enabled, Encore hybrid only** Check nozzle switch connections.		**Hardware**
F56	**B hose right nozzle switch not plugged in with B right hose enabled, Encore hybrid only** Check nozzle switch connections.		**Hardware**
F57	**Burst from pressure** Excessive flow hose burst from hose pressure transducer calculation.		**Fill Error**
E58	**Meter parameter difference** Check Ameter or Bmeter parameters. Meter values changed or have not been saved.		**Data Error**
E59	**Program checksum difference. Hybrid only.** Checksum value from program does not match what is saved. Program corrupt or another program version was loaded but its checksum was not saved.		**Data Error**
E60	**Not defined**		
E61	**Not defined**		
E62	**Not defined**		
E63	**Calibration level 2 unlocked by communication to dispenser, "CAL2" on display.** Fill parameters only open for change.		**Indication**
E64	**Calibration level 1 unlocked by communication to dispenser, "CAL1" on display.** Fill parameters, Weights & Measures parameters, and configuration open for change. Also means the calibration switch is on.		**Indication**

ANGI SERIES II DISPENSER

Monitoring Tool Manual

Rev 05

WARNING

1. SAFETY

- Read this entire manual before operating, servicing, adjusting, repairing or maintaining this Equipment.
- Never adjust or repair machinery while it is in operation. Always stop the engine or electric motor before cleaning, servicing or repairing. Place all controls in the off position to prevent accidental restarting. Before restarting, make sure that all tools and other materials are removed from the equipment.
- Do not wear loose clothing around machinery. Loose clothing: neckties, rings, wristwatch, bracelets, hand rags, etc. are potential hazards.
- Do not smoke within 50 feet of the unit
- Make sure you are equipped with all required safety equipment: hearing protection, safety glasses, hard hats, safety shoes and fire extinguisher.
- Do not modify the fuel station or its systems.
- Do not tamper with, modify, or bypass fuel station safety and shutdown equipment.
- Do not exceed maximum allowable fuel station pressures and temperatures.
- Record operating hours, maintenance work, and repairs etc. in a logbook.
- ANGI Energy Systems, Inc. reserves the right to make changes or modifications to the equipment designs without notice.
- ANGI must authorize all modification to this equipment. Any unauthorized modification to t his equipment and or software will void the warranty. Modification may damage the equipment and cause bodily injury.
- ANGI disclaims any responsibilities whatsoever to the customer or to any person for injury or damage to, or loss of, property or value resulting from the use of its products which have been subjected to misuse, accidents, misapplied, repaired by unauthorized person, or improperly installed.
- EXPLOSIVE HAZARD DO NOT DISCONNECT WHILE THE CIRCUIT IS LIVE OR UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITABLE CONCENTRATIONS.
- The Control Board is sutible for use in Class 1, Division 2 groups D

NOTICE

This manual is as current as possible at the time of printing and is subject to change without notice. For information not cov ered in this manual or further clarification, contact ANGI Customer Service at 1-800-934-5219

- CONTRACTOR OR INSTALLER: Leave this manual with the Unit station after installation is complete.

- CUSTOMER: Retain this manual for future reference.

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1. INTRODUCTION

The ANGI Series II dispenser-monitoring Tool is a computer program that offers access to the Series II dispenser controller's set-up and diagnostic functions. The access to the dispenser is by a computer's serial port through a straight RS232 cable or over an RS485 network link. The controller's system variables and parameters are viewable in a visually based program that runs on the Windows Operating System. The values are individually displayed in a text format that can be selected with a click of the mouse. The computer keyboard is the input device that can enter new values on the selected item. The Tool also uses visual command buttons and check boxes. This manual explains and illustrates how to use the Tool.

2. FEATURES

The main feature of the Tool is the display of the set-up parameters and system variables in a master list. In the list, one can edit parameters and influence variables by selecting the item with the mouse and entering values from the keyboard. Other features are:

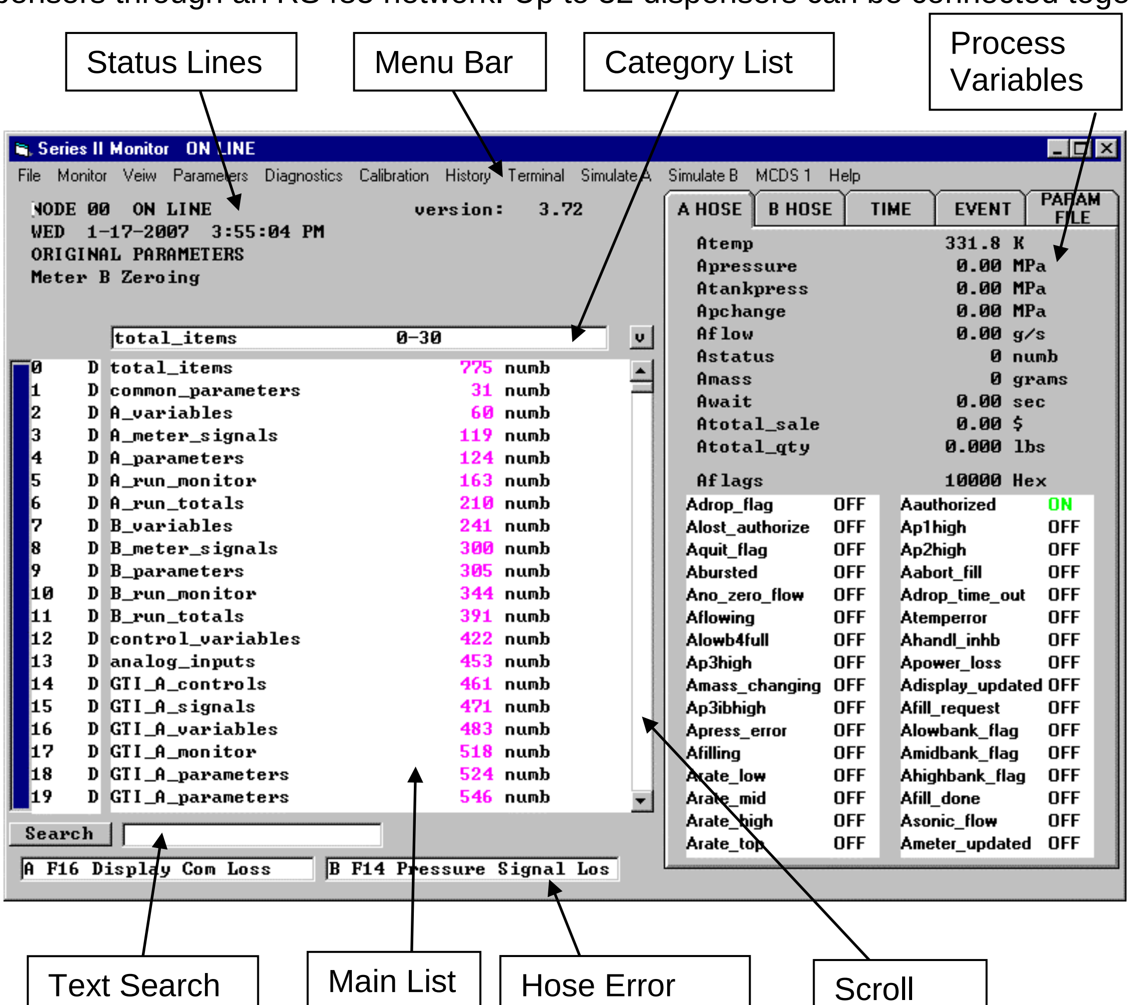
1) Retrieving and saving parameter values to a file.
2) Displays fill variables and flags for real-time monitoring of a fill sequence.
3) Historical logs of parameter changes, fill results, and totalizer results.
4) Real-time 25 sample-per-second process variable log for a single fill.
5) Diagnostic functions of hardware output force, keypad test, and pulse train force.
6) Step-by-step calibration for mass, temperature, and pressure measurements.
7) Mass flow meter zeroing function.
8) A terminal panel to access the dispenser controller's microprocessor for board level programming.
9) A panel for accessing the system parameters and variables of the older MCDS dispensers.
10) A parameter and variable name search function.

3. DISPENSER DESCRIPTION

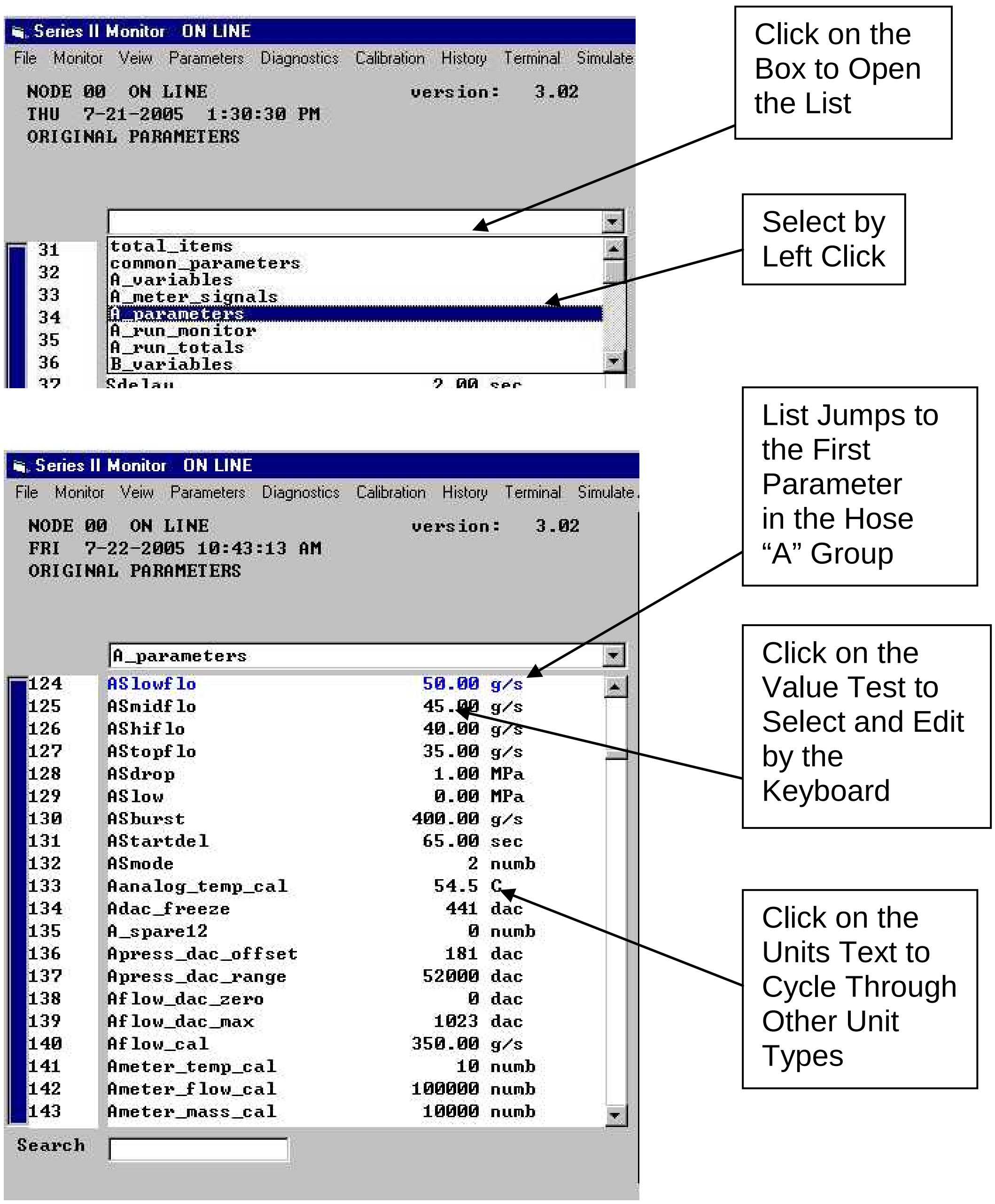
The Series II Dispenser is an electronic microprocessor controlled device that dispenses high-pressure natural gas by a pressure-based algorithm. This algorithm is written into the microprocessor's program along with a set of functions to operate the dispenser's hardware such as LCD displays, communication links, valves, etc. The Series II microprocessor controller runs on one single program that performs all of the dispenser's functions. In the program's algorithm and functions, there are two kinds of numbers used: variables and parameters. The variables are the signals within the program that represent process measurement (pressure, flow, mass, etc.), control (valve on/off, handle on/off, etc.), and process report (sale amount, volume amount, totals, etc.). The parameters are numbers that represent measurement scaling, calibration, control set points, and dispenser function configuration. The parameter numbers adjust the dispenser's performance and do not change once they are set. The controller runs the program in its RAM (Random Access Memory.) RAM holds data only when the power is on. The program is stored in the controller's FLASH memory; memory that retains its data without power. The program is copied from the FLASH to the RAM when the dispenser is powered-up. The parameters and historical records are also stored in the FLASH. The Series II dispenser control provides access to the program, parameters, and variables through standard serial communication ports by a custom ANGI protocol. The Tool uses this protocol.

4. MAIN PANEL DESCRIPTION

The picture below is the main panel. On the left side is the main list of variables and parameters. A mouse click on the value number will select the number. The selected number will be highlighted and ready for editing. The list scroll bar will move up and down the through the list. Clicking to the right of the value on the units text will change the units. Example: Clicking on the pressure unit "MPa" will change to "Bar," clicking again will change to "PSI." The value to the left will be converted to the correct value for that unit. The status line reports on the state of the controller. The top line shows the communication node for the dispenser and connection status. The node number indicates which dispenser is on-line, providing the Tool is connected to a set of dispensers through an RS485 network. Up to 32 dispensers can be connected together.

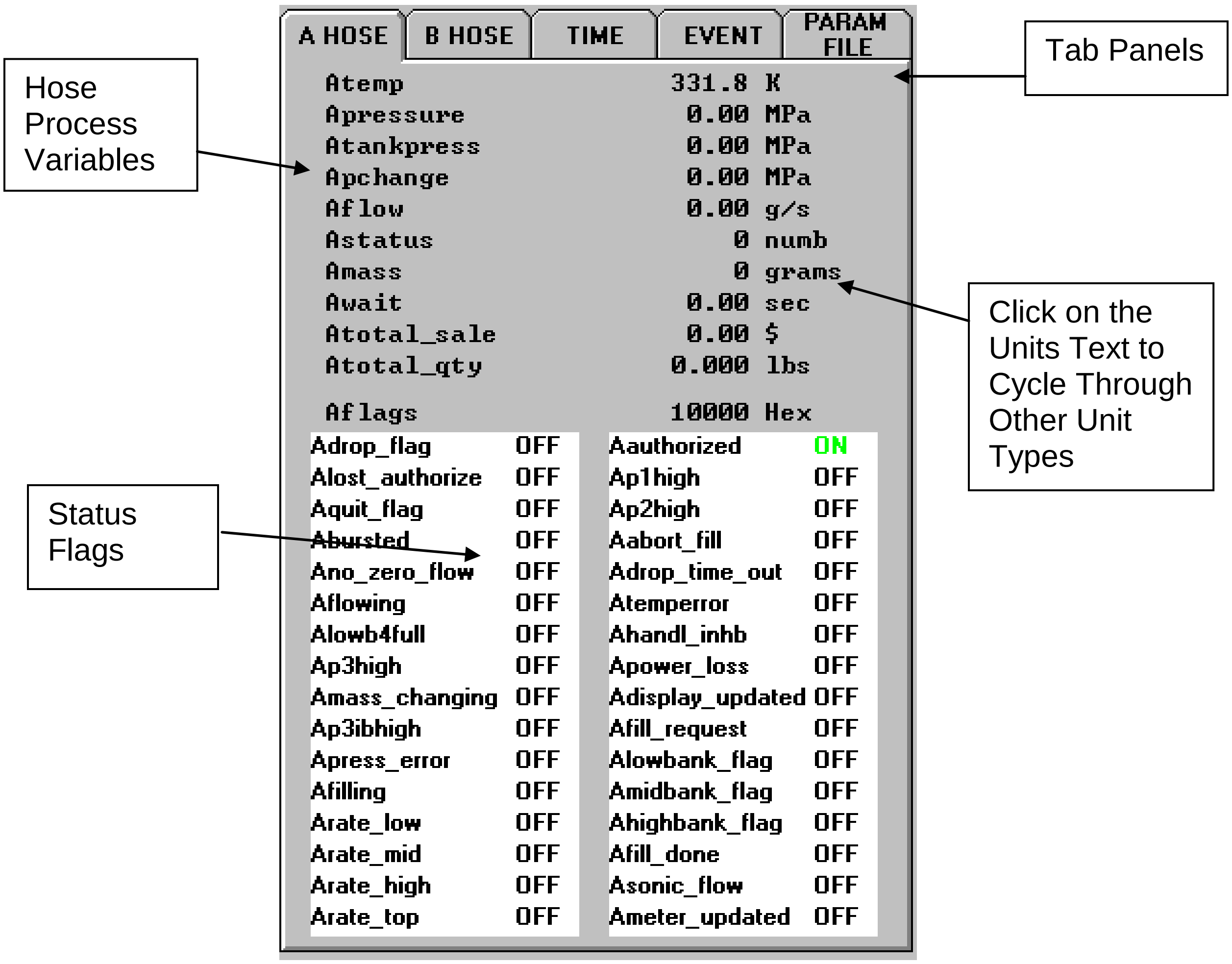


The node number is always is zero (NODE 00) when connecting directly to a dispenser by the dispenser's RS232 port. The top line also shows the communication status of either "ON LINE" if connected or "OFF LINE" if not connected. The top line also indicates the calibration mode of the controller. The dispenser will not operate if the line indicates
"Cal Switch On" (calibrate switch sw1-1). The second line is the date and time from the dispenser controller's on board clock, formally called a Real Time Clock. This clock provides the time-date stamp for recorded events in the controller. The third line is the parameter status indicating if any parameters have been edited and not stored in the controller's permanent memory. The line to the right indicates the controller's program version number.

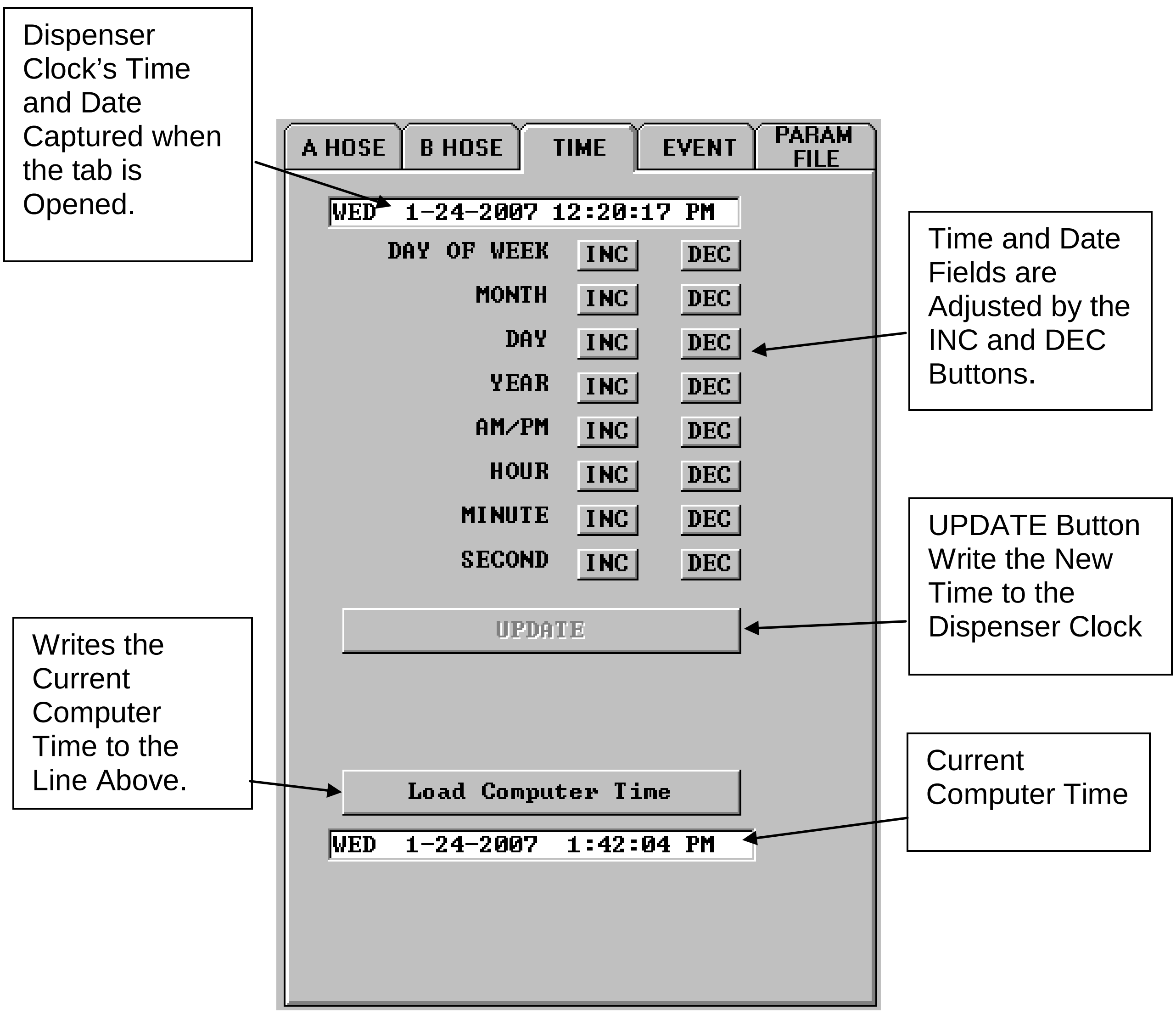


The category list is a drop down list of groups of parameters and variables. Clicking on an item in the category list will make the main list jump to that group. In the example below, the main list will start at the first parameter for the A hose after clicking on the highlighted item “A_parameters.”

On the right side of the main panel, shown below, is the process variable tab. It is a list of a few hose variables to monitor during a fill sequence. Just as in the main list, clicking on the unit text will change the units to another type. Below is a list of flags for program functions that are either on or off. The tabs on top of the panel will select between the A or B hose and other functions described later in this manual.



The Time tab is used to set the dispenser's real time clock. When the Time tab panel is opened, the current time from the clock is captured and displayed in the text box on the top. The time and date is adjusted by clicking on the INC and DEC buttons. The INC button increases the number. The DEC button decreases the number. Writing a new time and date requires an unlock password to enable the "UPDATE" button (see unlocking parameters). Clicking on the "UPDATE" button will write the new time into the dispenser clock. The time and date displayed in the bottom text box comes from the computer's clock. Clicking on the "Load Computer Time" button will write that time and date into the top text box. This is an alternative to using the INC/DEC buttons.

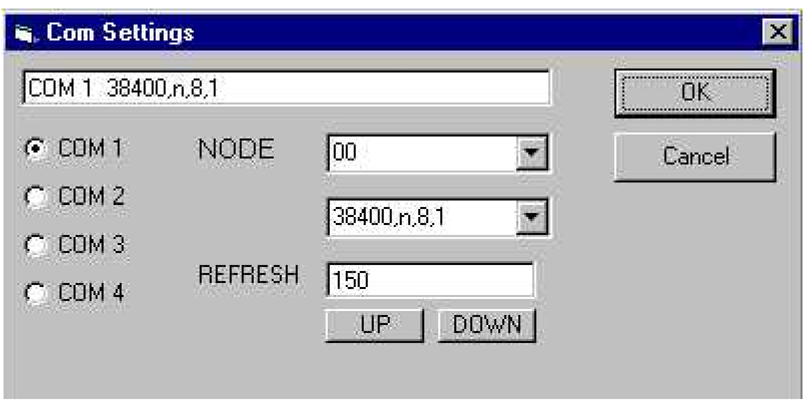


On the top of the panel is the menu bar. Clicking on the menu items will bring up a list of other choices under that category. The main menu functions are:

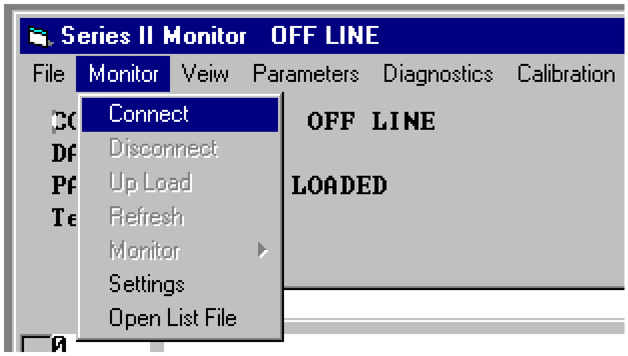
1) File: Used to open existing or save files on the computer. The Tool uses and creates files such as parameter, program, process, and historical logs.
2) Monitor: Starts or ends communication to the dispenser, uploads parameter data, and selects communication settings.
3) View: Opens particular variables and real-time process logs.
4) Diagnostics: Tests of hardware functions such as hardwired outputs.
5) Calibration: Set-up of various dispenser configurations and scale the process measurements such as mass, mass flow, pressure, and temperature.
6) History: Opens viewers for historical logs of totals, fill results, and parameter changes (audit trail).
7) Terminal: Opens a terminal text window used to communicate to the controller's microprocessor for program downloads and debugging.
8) Simulate A/B: Enables a program algorithm that performs a virtual fill sequence to check dispenser functions without actually dispensing gas.
9) MCDS1: Opens a set of panels to view and edit the parameters of the older ANGI MCDS dispenser.
10) Help: Opens a dialog box used to identify the Tool's program version number.

5. CONNECTING TO A DISPENSER

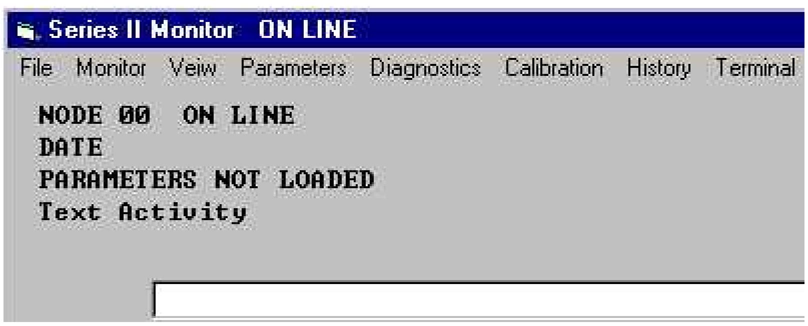
To get started using the monitoring Tool, the computer must be connected to the controller by a communication link. Typically, it is a straight-through cable connecting the 9-pin RS232 port on a computer to the COM-0 9-pin RS232 port on the dispenser interface board. The Series II dispenser comes with an access junction box (located behind the main control enclosure) with an RS232 cable plugged into the controller port. This allows access in the event that the electrical cabinet is sealed. An optional connection is via an RS232 to RS485 converter connected to the COM-5 port on TB6. The settings for the computer's COM port are under the "Monitor" -> "Settings" menu item. Clicking on "Settings" submenu item brings up the Com Settings box. This box allows the selection of the computer's COM port, BAUD rate, dispenser node, and refresh rate. The default settings, shown in the example below, will typically work. The dispenser controller's BAUD rate is fixed at 38.4K. The com-port selection of 1 through 4 may need to be changed depending on the computer's available port number. The NODE number should be left at zero unless one has multiple dispensers on an RS485 network. DIPswitches SW1-2 through SW1-6 on the dispenser interface board set the NODE number for the dispenser. Each dispenser on the network should have its own unique number. The NODE drop down box provides a list of node numbers. The Tool will connect to the dispenser that has that node number. The dispenser's RS232 port node number is always zero.



The REFRESH rate box sets the communication polling time. The polling time may need to be adjusted for an older computer. The Tool repeatedly sends out a data update request to the dispenser and expects a response back. The computer needs time to process the data. If it does not have enough time, the Tool will miss the next response. The Tool is "ON-LINE" if it gets a response back every time. The Tool status line will report a "Retry" is it does not receive a response. After twenty attempts without a response, the Tool will go off-line. The time between these attempts is the refresh rate. The default rate is 150 milliseconds. This works on current computers and laptops. Older computers may need more time the process the response. The "UP" and "DOWN" buttons adjust the refresh number. An example of an old laptop would be a Pentium 90 running Windows 95. The refresh rate should be adjusted up between 500 – 700 milliseconds for these types. Click the "OK" button when finished. The "Cancel" button will abandon any changes.

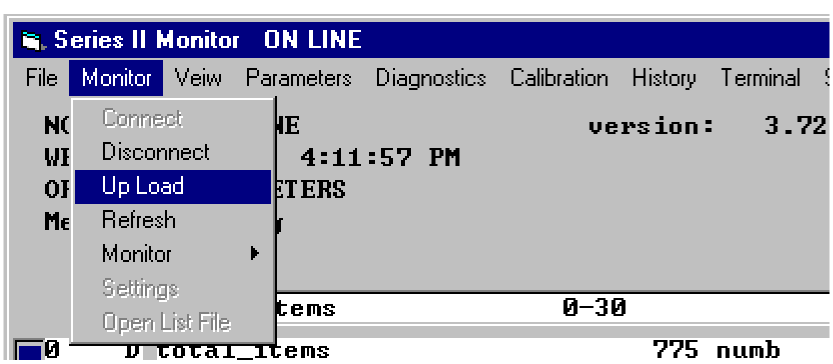


To get the Tool to monitor the Series II controller, click on the “Monitor” main menu item. The “Monitor” sub menu item list will come down. Then left click on the “Connect” sub menu item. The Tool will start to communicate with the controller. The status line will read “ON LINE” if the connection is successful. The status line also indicates which dispenser the Tool is connected to by its NODE number.



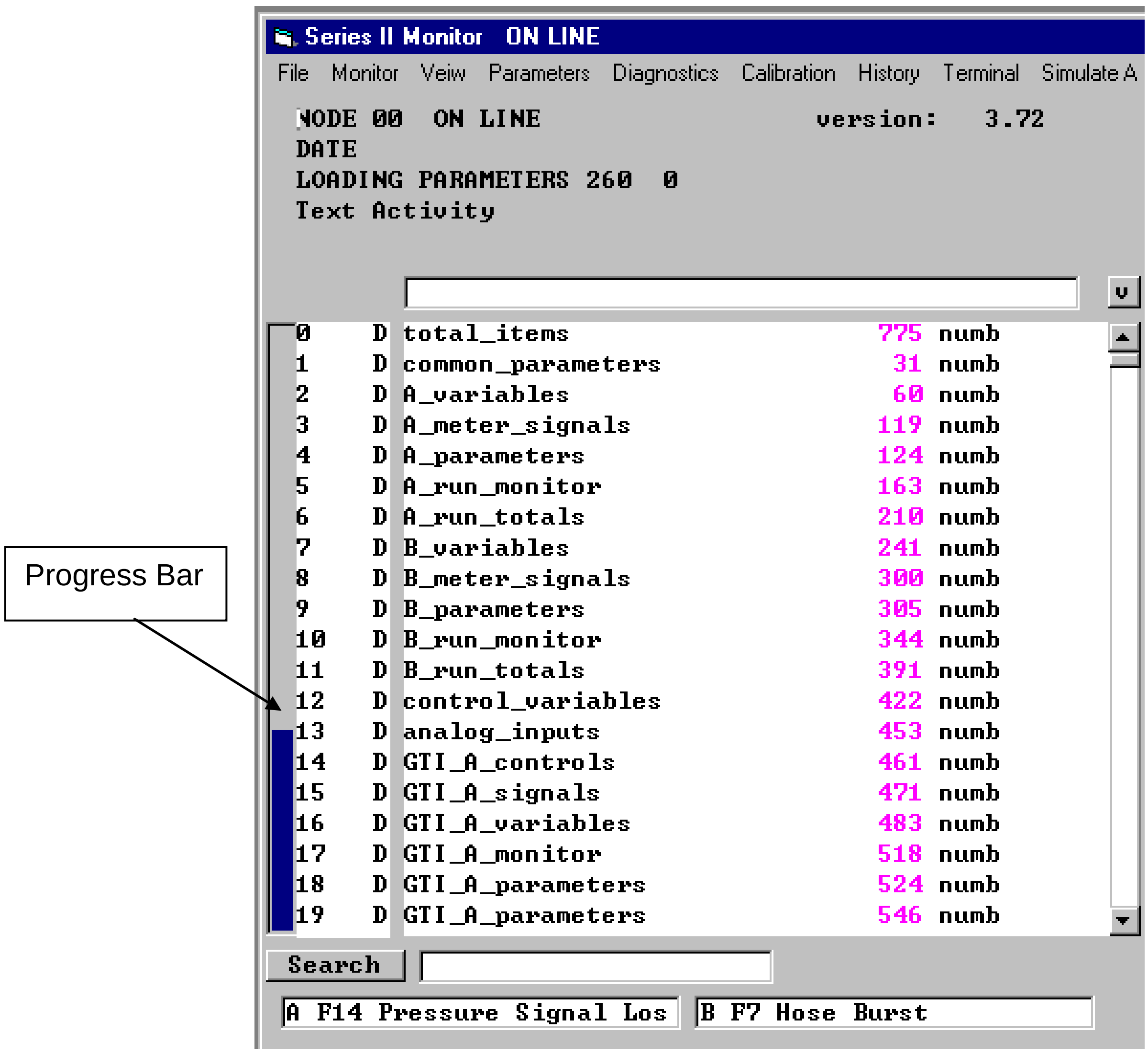
6. UPLOADING PARAMTERS

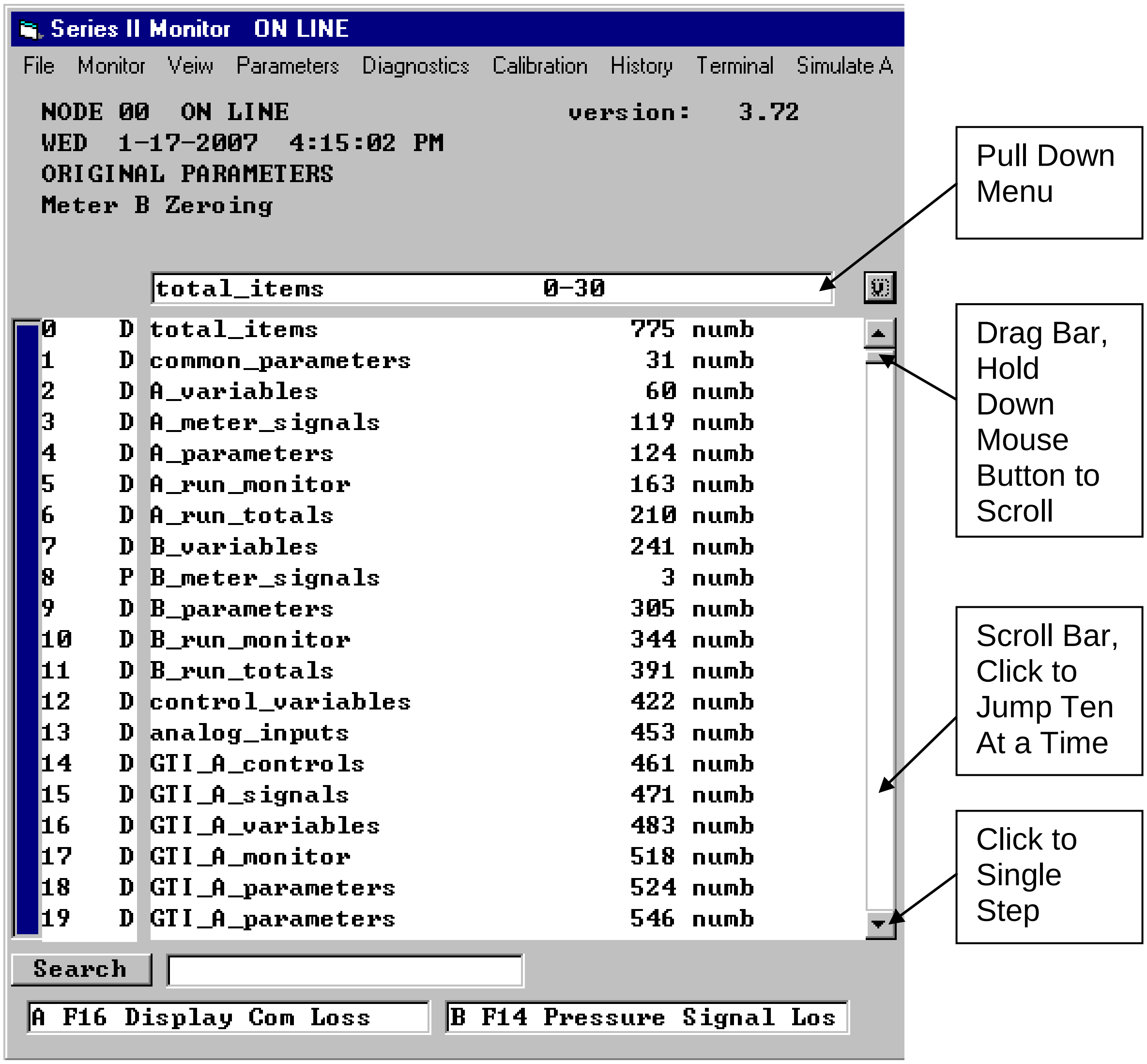
When connecting for the first time, the status lines will indicate the parameters are not yet retrieved from the controller. All the information about the parameters and variables for the dispenser controller are stored in the dispenser’s control board. They must be uploaded from the controller into the Tool before they can be monitored or changed. To do this, click on the “Monitor” main menu item. Then click on the “Up Load” sub menu item.



The Tool will start uploading the parameter's information. The status line will show the parameter number being loaded at the moment. The progress bar on the left of the list will give a visual indication of where the percent complete in the upload process. When the progress bar reaches the top, the upload is complete.

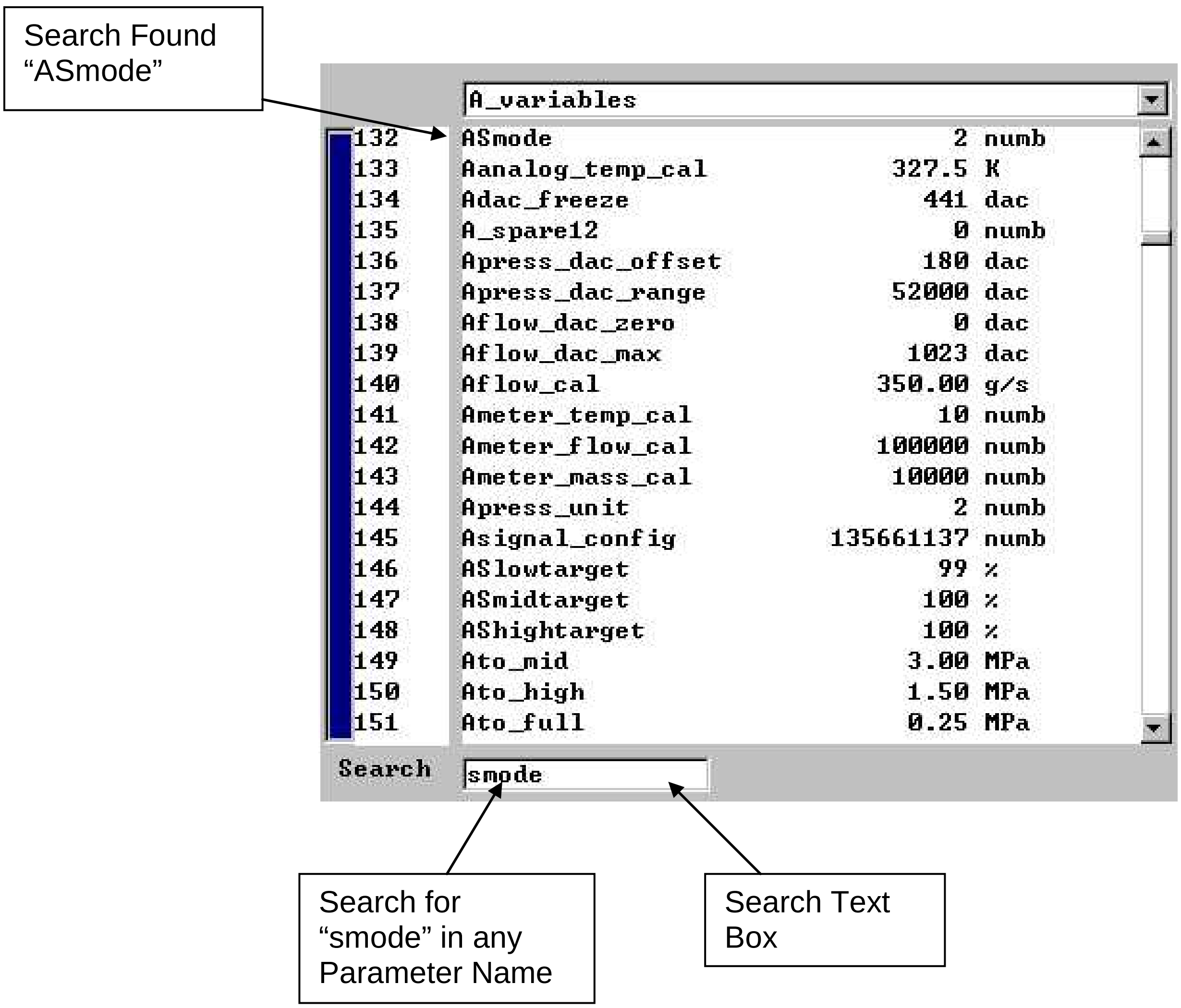
When the upload is complete, the Tool will continuously monitor the variable changes. Values that change and get refreshed will be highlighted red (magenta). The status lines will show the date and time of the clock that is in the dispenser controller, the version of firmware that is loaded in the dispenser, and the state of the parameters. The dispenser's time clock will update every second.





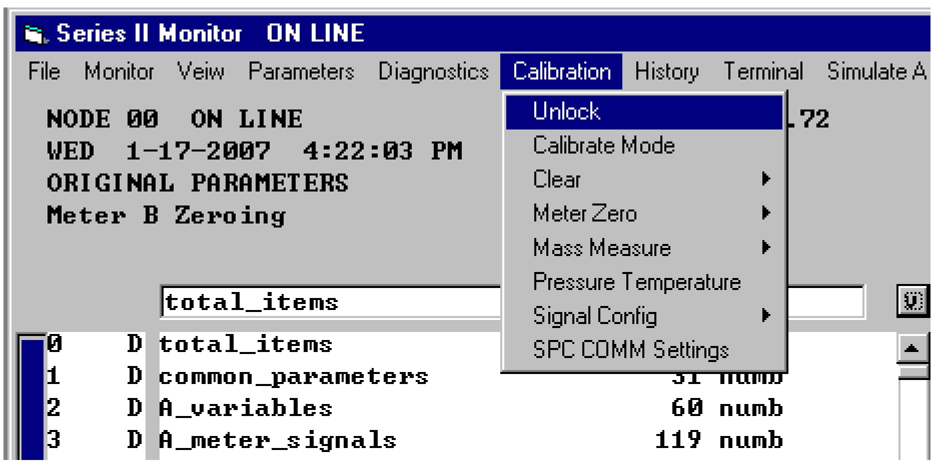
All the parameters and variables will be listed in the main list. This part of the main list shows the names on the left, the current value in the middle, and the units on the right. The parameters are write protected and cannot be edited at this time. To edit the parameters, they must be "unlocked" by a password. Click on and hold the drag bar on the right with the mouse pointer to move through the list. The parameters and variables are divided into sections according to their function. These sections are listed first as a directory. The directory is also listed in the pull down menu. Clicking on the pull down menu item will make the main list jump to that section (described earlier).

The “Search” text box located at the bottom left of the main panel is used to find a parameter if the name or part of the name in known. The example below shows part of a parameter name “smode” which is entered into the “Search” text box. Pressing the Enter Key starts the search of all the parameter names. The search found a match in the parameter name “ASmode” and put the parameter on the top of the list. Pressing the Enter Key again will find the next occurrence of “smode” which will be “BSmode.” Pressing the Enter Key will search for another match down the list. The search function will start over at the top of the list if no other matches were found. The search function is not case sensitive.

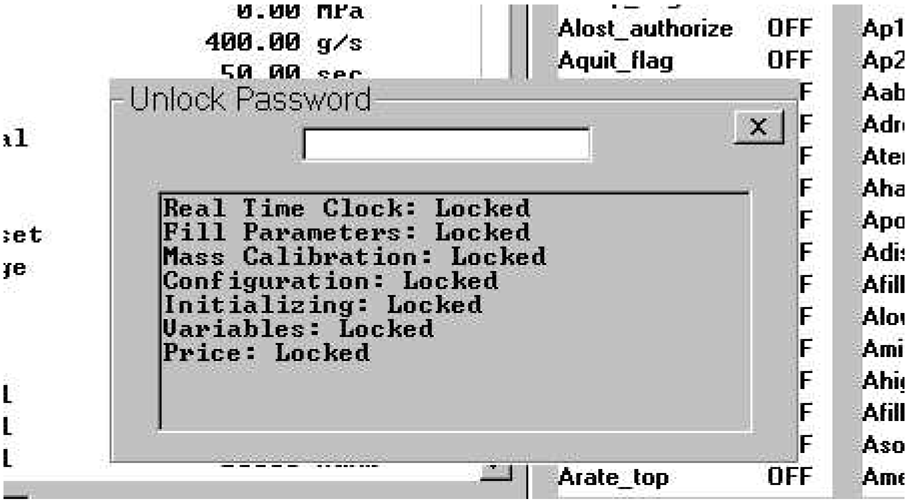


7. UNLOCKING THE WRITE PROTECT

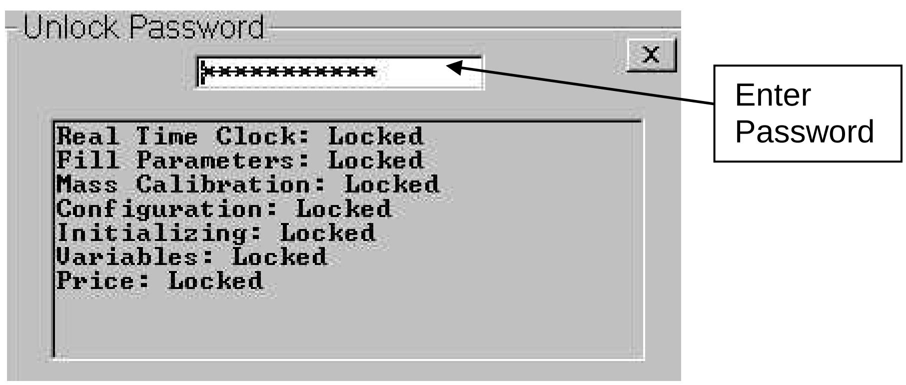
All parameters and variables are write protected. This is to keep unauthorized personnel from changing parameter values. To “unlock” the write protect, a set of passwords must be entered and sent to the dispenser controller. These passwords are necessary to meet the weights-and-measures approval requirements. This allows for the calibration of the dispenser without breaking the weights-and-measures seal on the electrical cabinet. There are three levels of password protection based on the function of the parameter. Each level gets its own password. The first level parameters are the “Fill” parameters; they do not affect mass measurement, scaling, or calibration. Such parameters adjust pressure, temperature, and performance parameters. The second level is mass scaling and calibration parameters. These parameters affect the volume display and mass-pulse train scaling. The third level is the configuration parameters and real time variable write. This level should only be open to technicians for hardware set-up during test, start-up, or diagnostics. Access to the third level must also include setting a hardware DIP switch on the dispenser controller board.



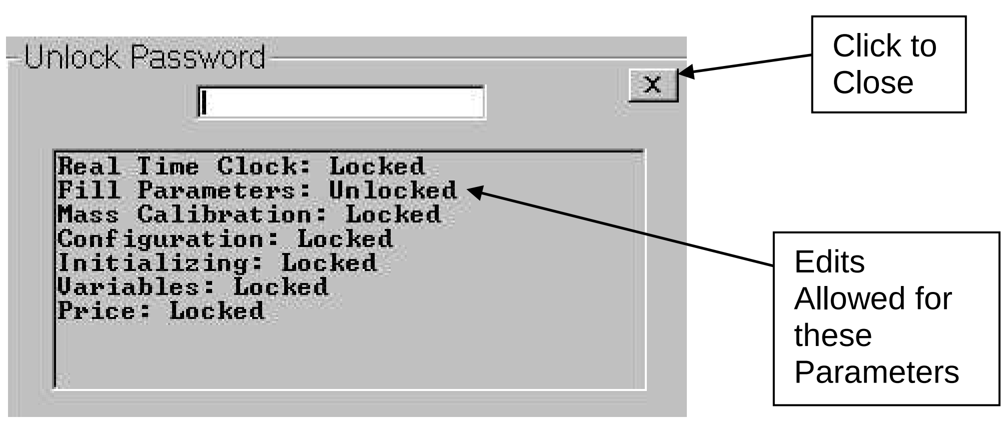
To gain access to edit the parameters, click on the “Calibration” main menu item for the calibration list. Next, click on the “Unlock” sub menu item. The “Unlock” panel will appear in the middle of the screen. Click on the text box on the top of the panel and enter a password. The password is case sensitive; if the password is in capitals, the capitals must be entered. Hyphens must be typed in also. Mistakes can be backspaced over and the correct characters re-entered.



In the example below, the password to unlock the Fill Parameters is has been entered. The password will not be shown. Asterisks will be shown in place of the letters, numbers, or hyphens.



After the password is entered, pressing the Enter Key sends it to the controller. If the password is correct, the parameters should unlock as shown below. If anything other than a correct password is entered, the status line will indicate “INVALID PASSWORD” and the write protect will go back to the “locked” state. Clicking the “X” button can close the Unlock Password window.



The parameters will remain unlocked as long as the Tool is on-line and connected to the dispenser controller. The write protect will go back to the locked state if communication between the Tool and the dispenser is stopped.

8. EDITING PARAMTERS

To edit a parameter, click on the parameter value. The parameter will be highlighted in blue.

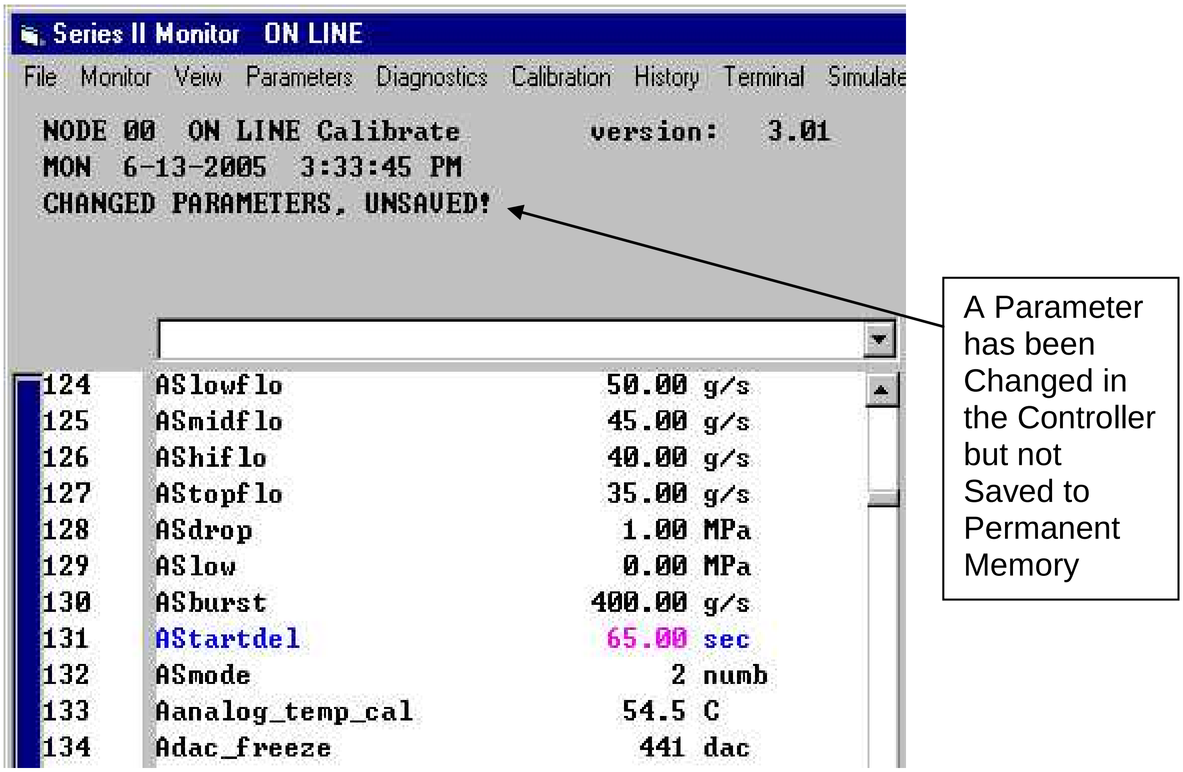
To remove the old number, use the backspace key. This will backspace the old number to the right and delete the least significant number. The parameter will be highlighted in red indicating it has been changed.

To remove the number completely, keep backspacing until the number is zero.

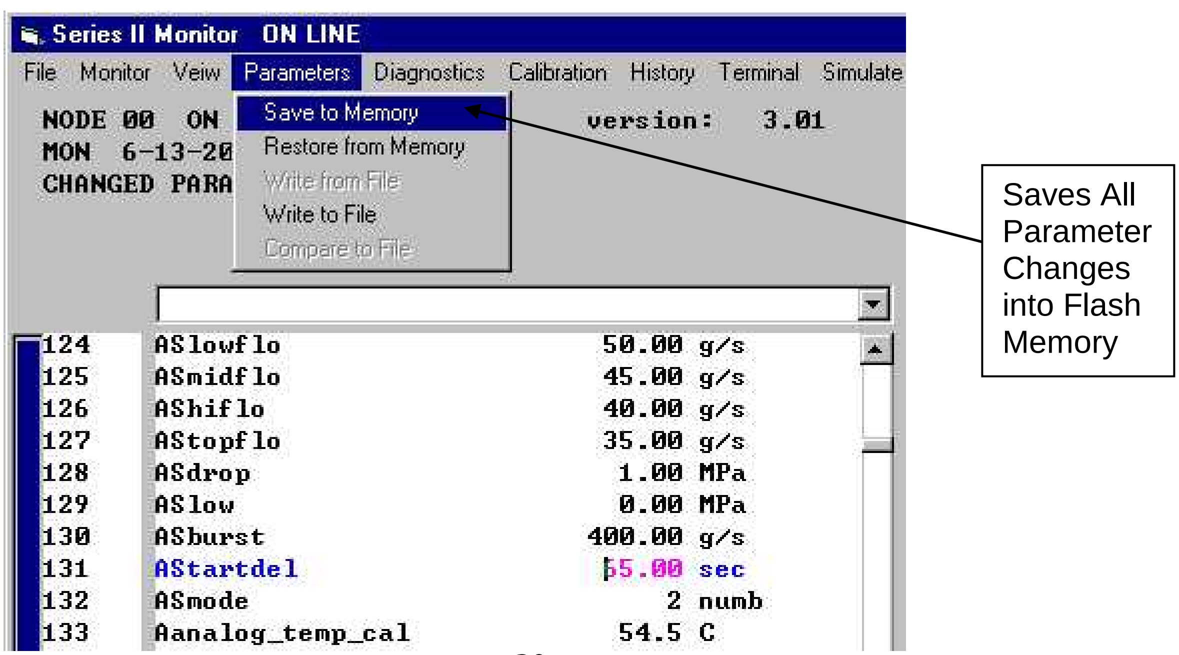
Type in the new number. The numbers will shift to the left as they are typed. The decimal point will remain fixed. In the example below, the number entered is 6500.

At the moment, the number is *only* changed on the screen and is *not* sent to the dispenser controller. The escape key can be hit to abort the change and return to the original number. The original number will return if another parameter is selected. The new number is sent to the dispenser controller by hitting the enter key.

The new parameter value is now in the dispenser. The status lines indicate that a parameter has been changed and is different than what is in the dispenser's permanent memory. Additional parameters may be edited. If all the parameter values are returned to their original values, the status line will state "ORIGINAL PARAMETERS."

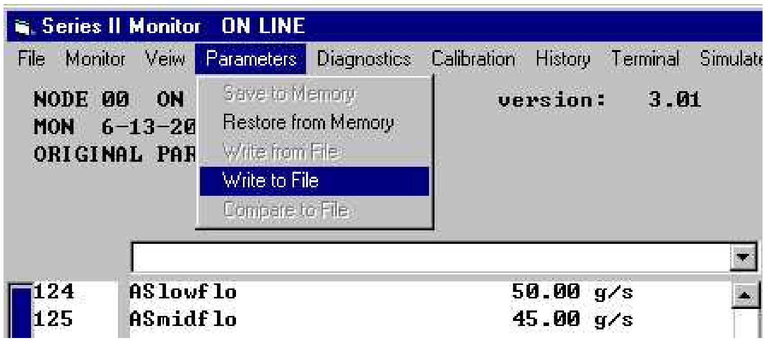


The dispenser will not operate if the parameters are changed, but not saved to memory. To save the changes, click on the "Parameters" main menu item and then click on the "Save to Memory" sub menu item. This will save all the parameters.



9. SAVING PARAMETERS TO A FILE

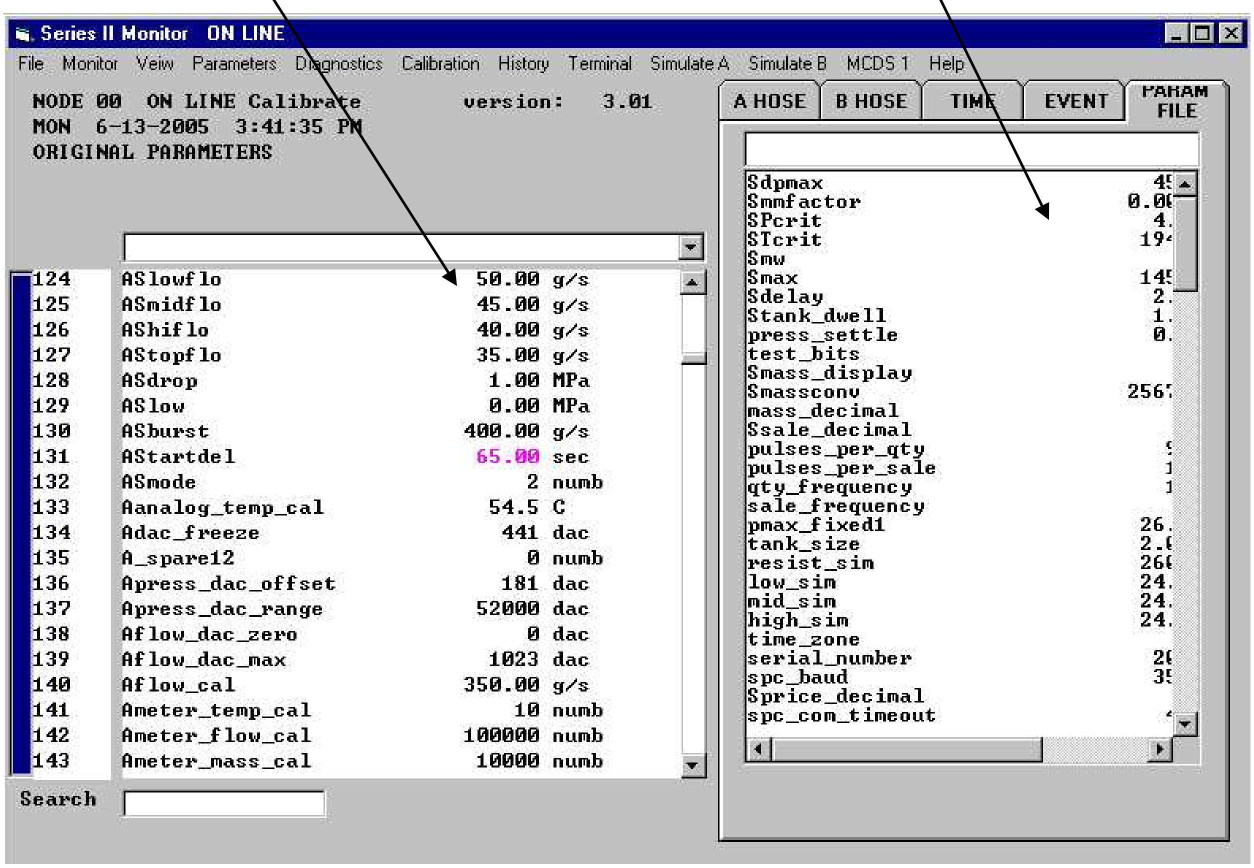
The parameters from the Tool list can be saved to a new or existing file for record keeping purposes. To create a file, click on the "Parameters" main menu item and then click on "Write to File" sub menu item.



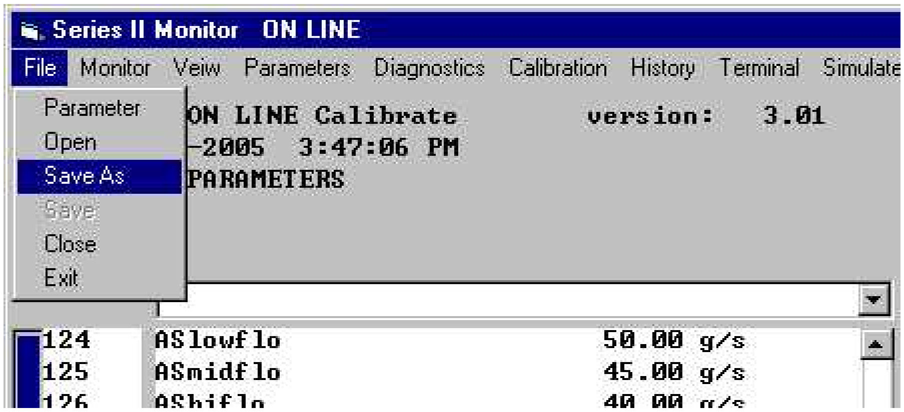
This takes the present parameters on the main list and creates a file displayed under the "Param File" tab to the right. This overwrites any parameter file that was previously displayed in the tab box. The values in the file are always in the base units used by the controller.

List of Parameter Values Uploaded from the Dispenser.

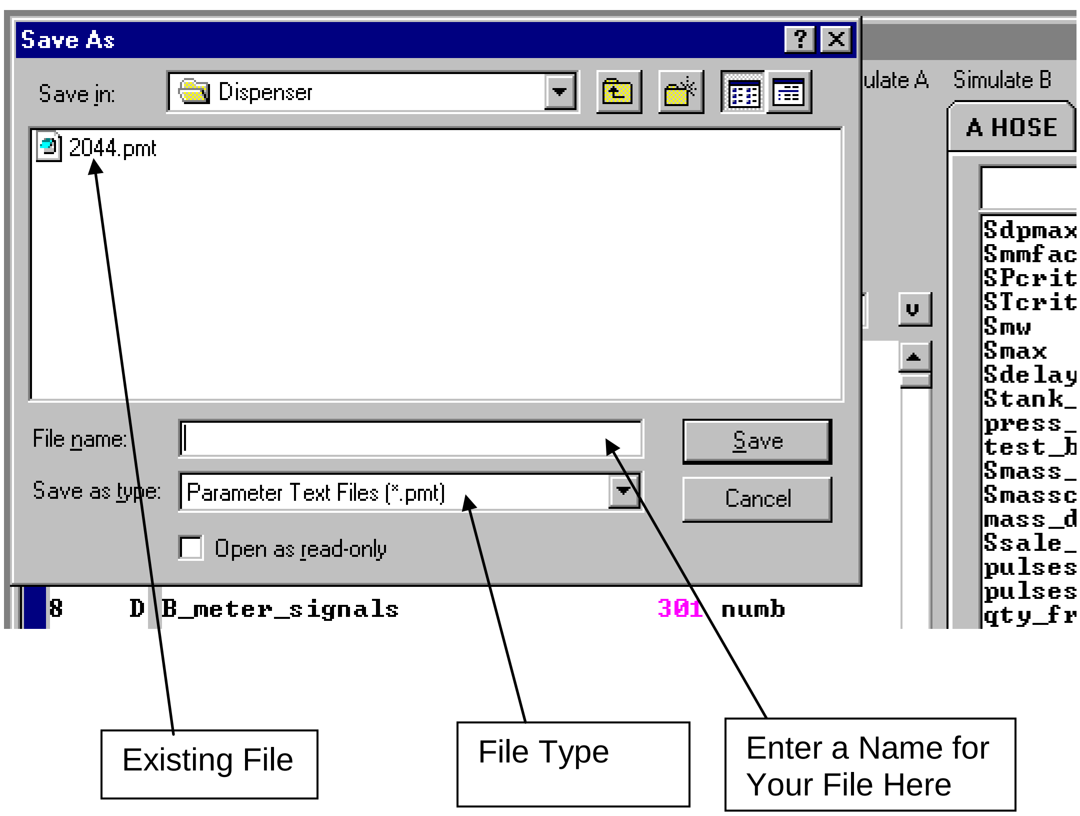
New Parameter File Created from the List. File is Not Yet Named.



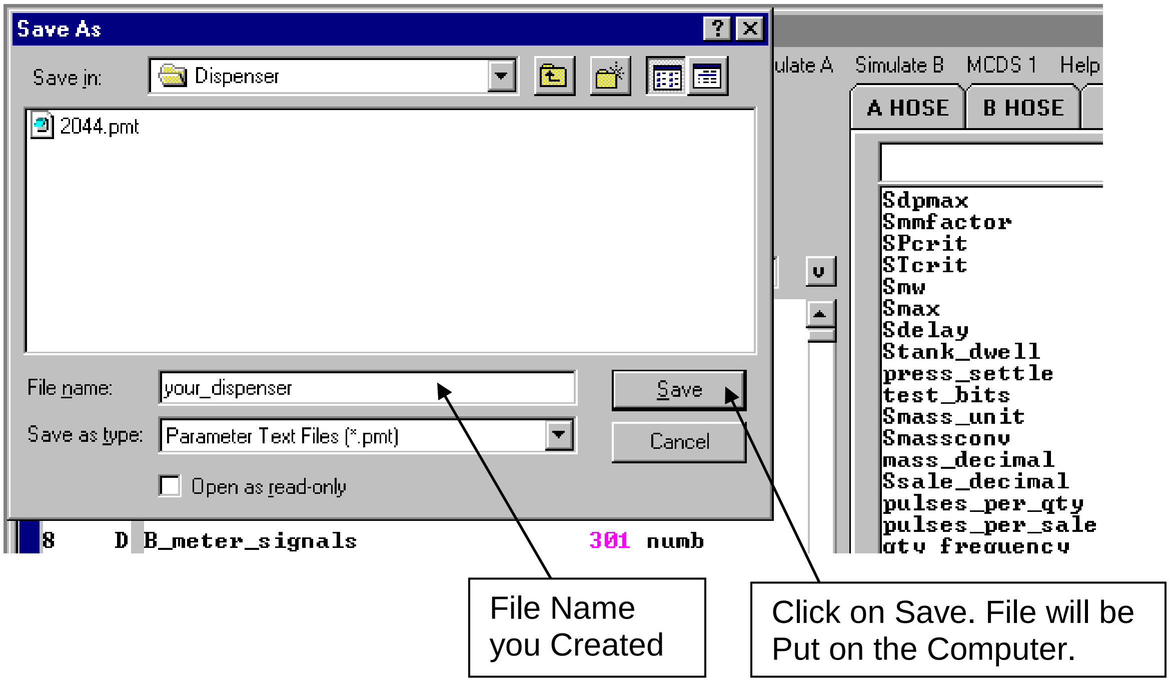
To save this file to the computer, click the “File” main menu item and then click on the “Save As” sub menu item.



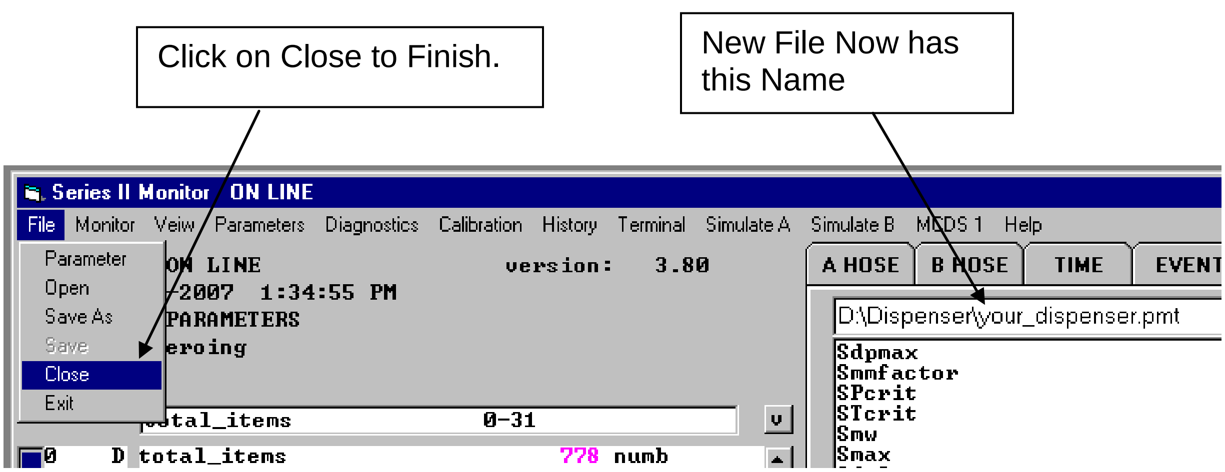
This brings up the standard Windows file save dialog box. Entering a name in the “File name” box and clicking on the “Save” button will create a new file. The file extension “.prt” will automatically be added to the name.



The example below shows the entered name as “Dispenser201.” It will be saved in the example folder called “Parameters.”

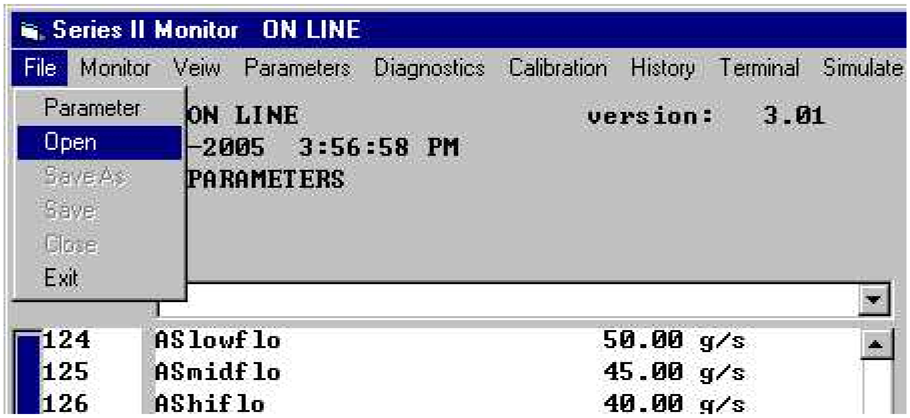


When finished with editing and saving the parameters, the file can be closed. This will clear the displayed file under the “PARAM FILE” tab.

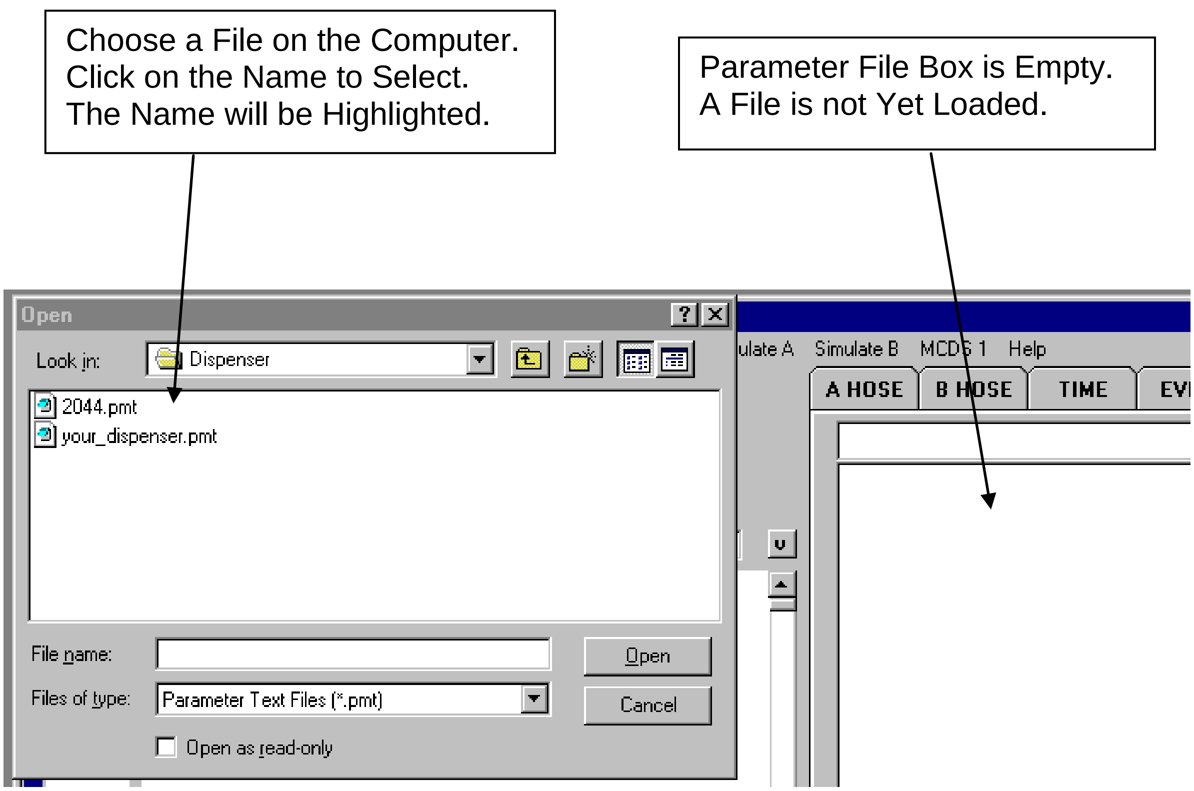


10. OPENING AN EXISTING PARAMETER FILE

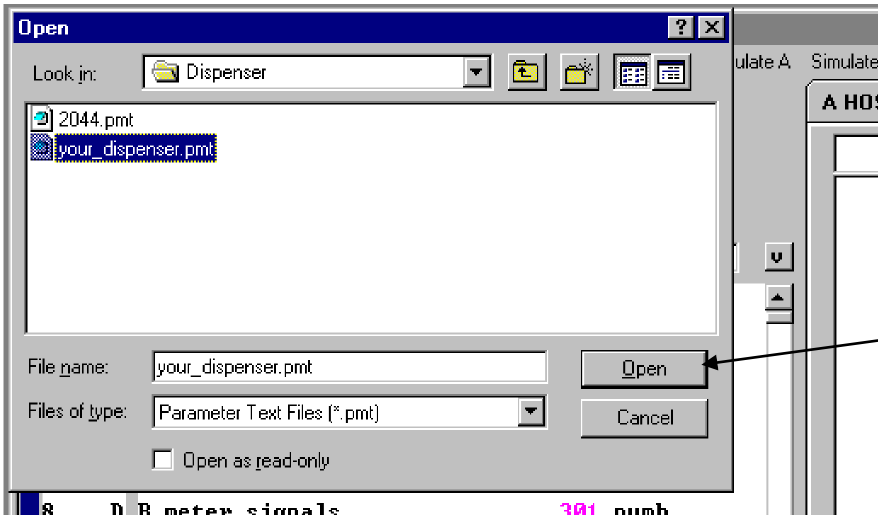
Parameters that are saved in a file can be loaded into a dispenser controller. Dispensers that are started up for the first time and have no parameters loaded can be initialized this way with a default set of parameters. To get a parameter file, click on the “File” main menu item and then click on the “Open” sub menu item.



The standard Window’s Open file dialog box will appear. In the example below, there are two files to choose from. Pick a parameter file by clicking on its name on the list with the mouse cursor.



In the example below, the file Dispenser202.prm was selected and highlighted. Its name will appear in the “File name” box indicating the selected file. Next, click on the “Open” button. This will load the file in the box under the “Param File” tab.

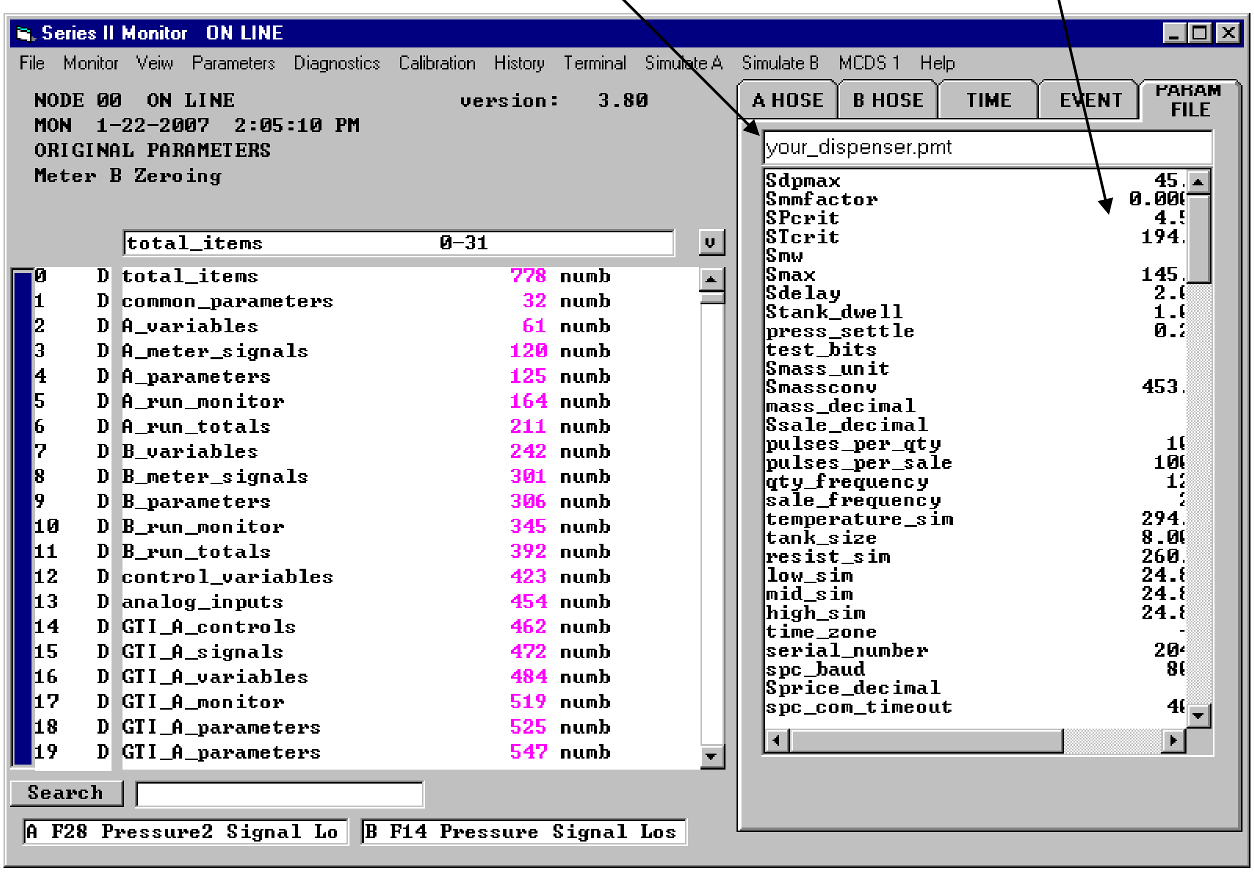


Click on OPEN

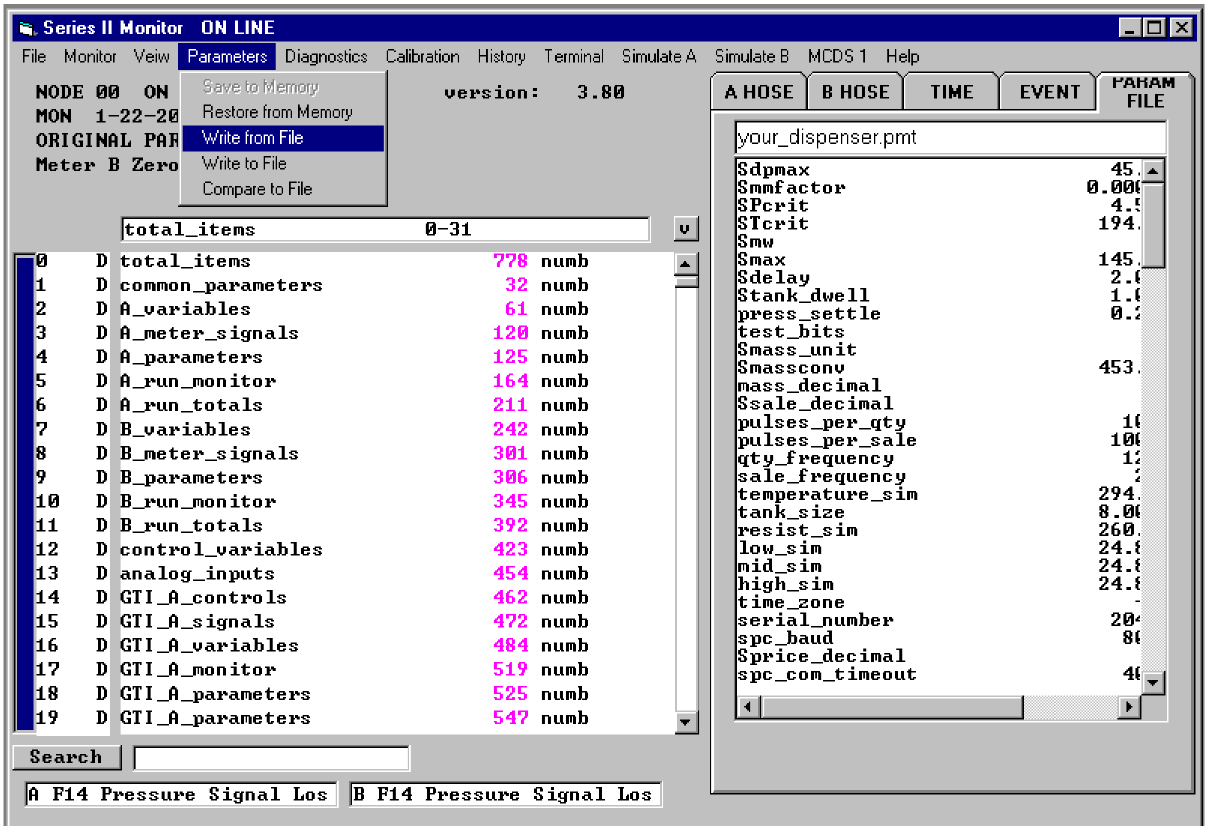
The file name will be shown under the “PARAM FILE” tab.

Parameter Values Loaded from the File off the Computer.

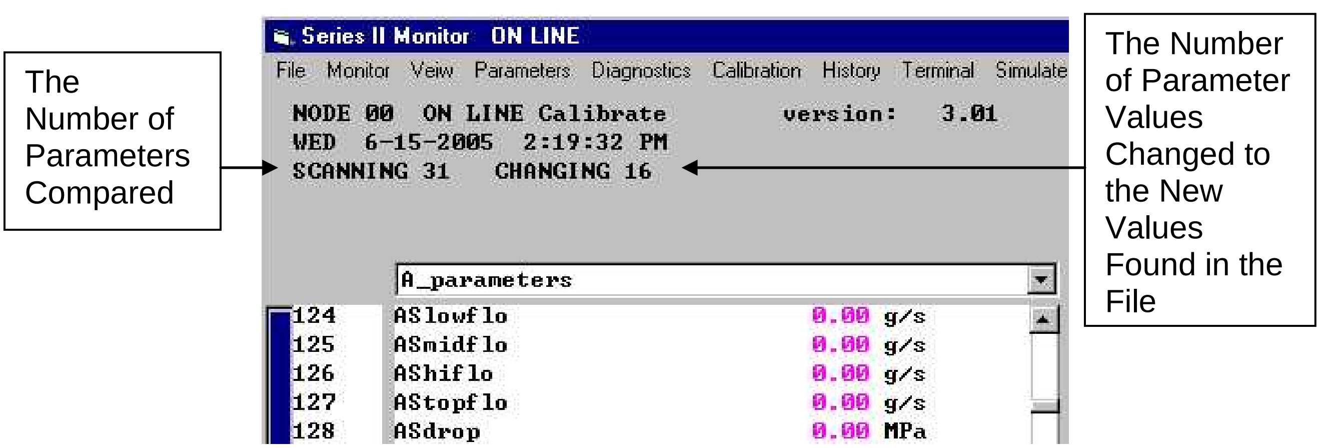
File Name.



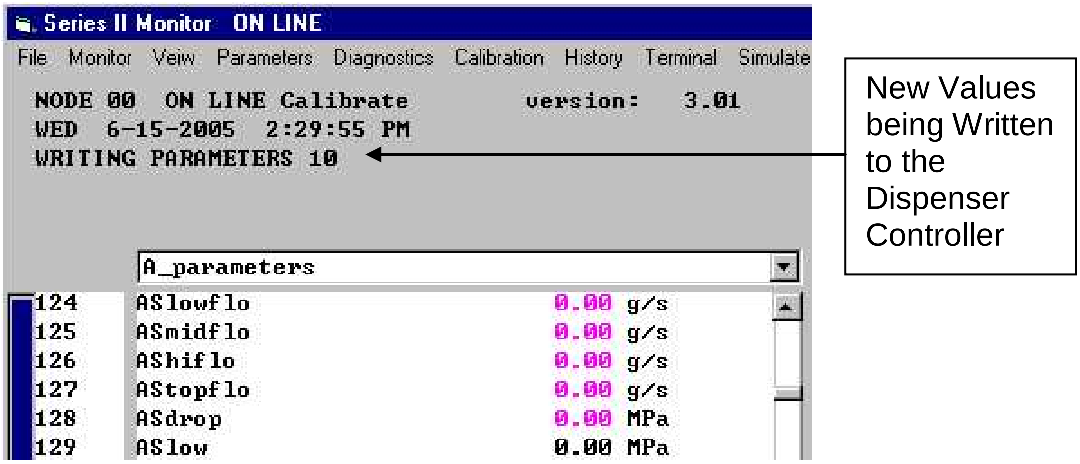
A set of parameters can now be loaded into the dispenser controller. The example below shows a controller without a set of parameters loaded. First, follow the parameter write protect unlock procedure described previously in this manual. Click on the "Parameters" main menu item and then on the "Write from File" sub menu item.



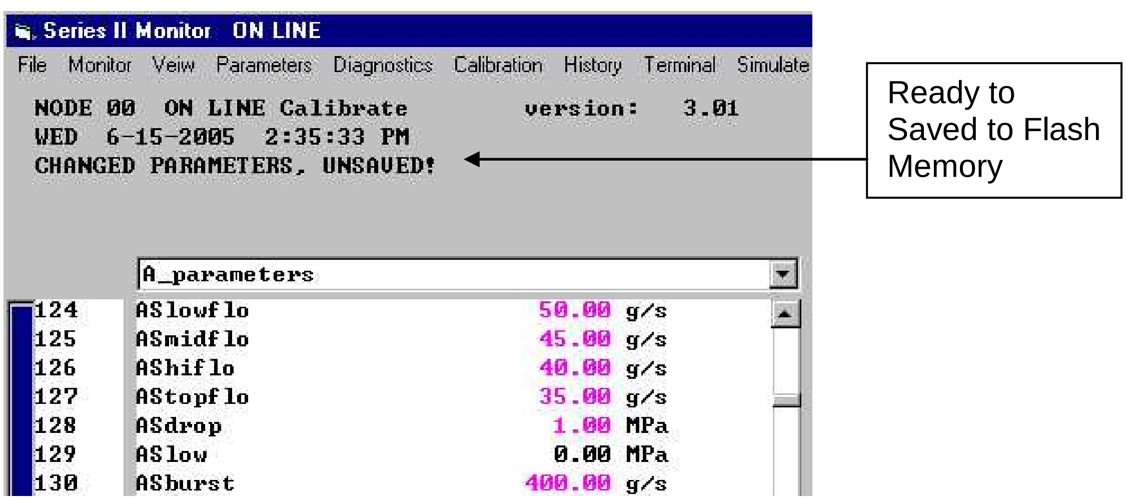
The status lines will indicate the loading process, which begins by scanning the current parameter values in the main list with the values in the open file to find values that are different. The scanning process counts the parameter's values that will be change and written to the dispenser controller.



Once the scanning process is finished, the Tool will write the new parameters into the dispenser controller.

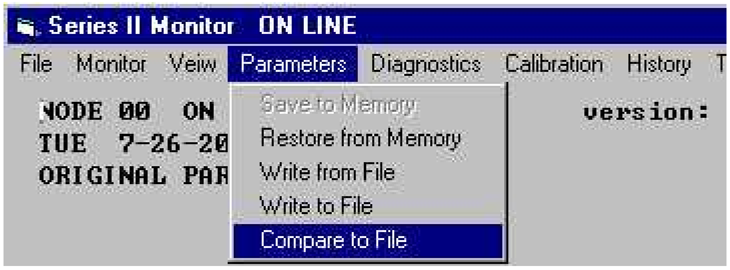


The status line will indicate the parameters were changed and not yet saved after the writing process is complete. Follow the procedure to save parameters to memory described previously in this manual.

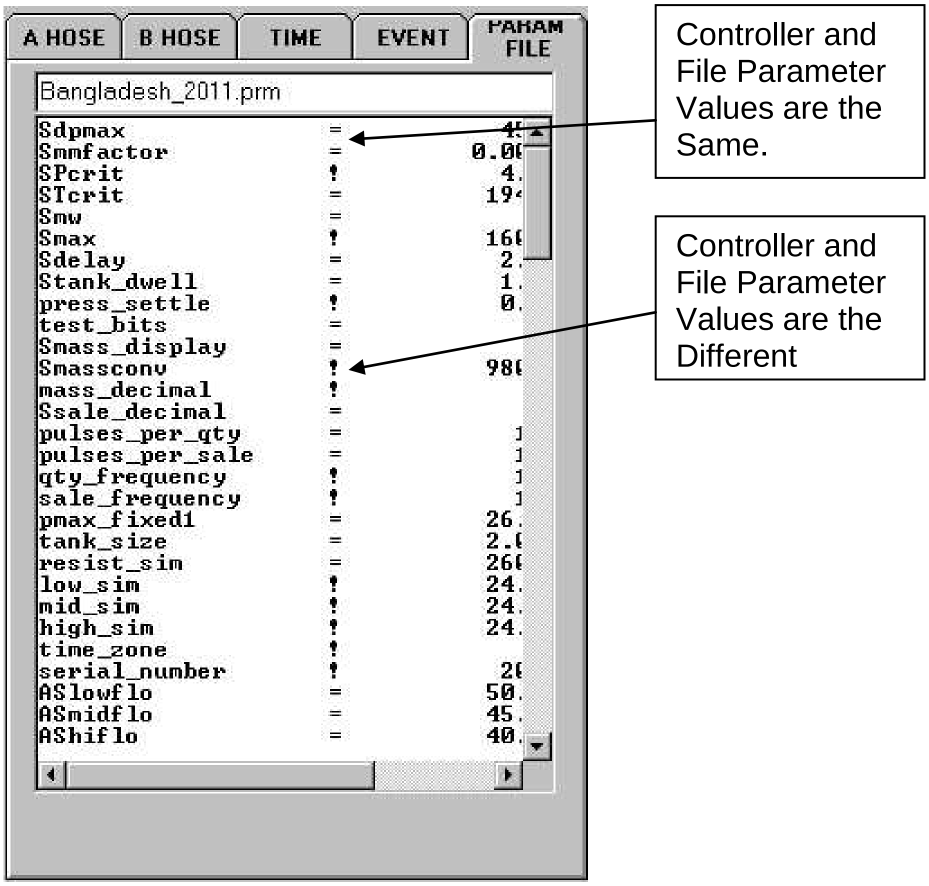


11. COMPARING PARAMETERS TO A FILE

The parameters from the controller can be compared to a set of parameters in a file. Assuming a file is open in the "PARMAM FILE" box, click on "Parameters" main menu item, then click on "Compare to File" sub-menu item.



The status lines will display the progress of scanning through the parameters and noting the unequal values. The parameter file list will be refreshed to show the results of the comparisons after the scanning is complete. An equal sign (=) indicates the parameter value in the controller matches the parameter value in the file. The exclamation point (!) indicates the parameter values are different.



12. PARAMETER FILE STRUCTURE

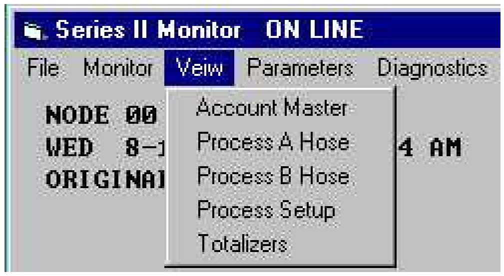
The parameter file saved on the computer is a text file that can be opened and read by any text-editing program. Below is an example of the structure for file with a ".pmt" extension. The each line in the file structure is dedicated to one parameter. Each line starts with the parameter name followed by the value, the units, a unit code, and a cast code. When the file is opened, the monitoring tool expects exactly this order with no deviation. The tool searches each line for the parameter name to identify the parameter. The name must be exact and is case sensitive. The parameter line will not be processed if the tool comes across a name it does not recognize. The value is accepted if the decimal point is in the right place with only number characters. The unit text is ignored but the unit code is compared to the units in the main list. The parameter is not processed if the unit code does not match. A text editor can change the values as long as the decimal point placement is respected. The units is for reference only and should be left alone. The cast number is used to distinguish between 32 bit numbers and floating point numbers. This should also be left alone. Parameters that have individual bit definitions are broken out over 32 lines for each bit. In the example below the parameter "Asignal_config" has an asterisk instead of a numerical value. This character tells the tool to assemble the parameter value from the 32 following lines. The name for each bit is pre-appended with a backslash to indicate it is a bit name. The order starts with bit zero and proceeds up to bit 31. Any more lines than 32 are ignored. The tool adds the bit weights, 1, 2, 4, etc. to derive the 32-bit parameter value.

Parameter Name	Value	Unit	Unit code	Cast Code
ASlowflo	50.00	g/s	40	0
ASmidflo	45.00	g/s	40	0
AShiflo	40.00	g/s	40	0
AStopflo	35.00	g/s	40	0
ASdrop	1.00	MPa	30	0
ASlow	0.00	MPa	30	0
ASburst	600.00	g/s	40	0
AStartdel	65.00	sec	10	0
ASmode	4	numb	0	0
Apress_unit	2	numb	0	0
Asignal_config	*	Hex	1	0
\Ause_meter_mass_flow	1			
\Ause_meter_vol_flow	0			
\Ause_analog_mass_flow	0			
\Ause_meter_vol_total	0			
\Ause_meter_mass_total	1			
\Ause_pulse_mass_counter	0			
….(more)				

32 Bit Names Under Asignal_config		32 Bit Values. 1 for ON. 0 for OFF.

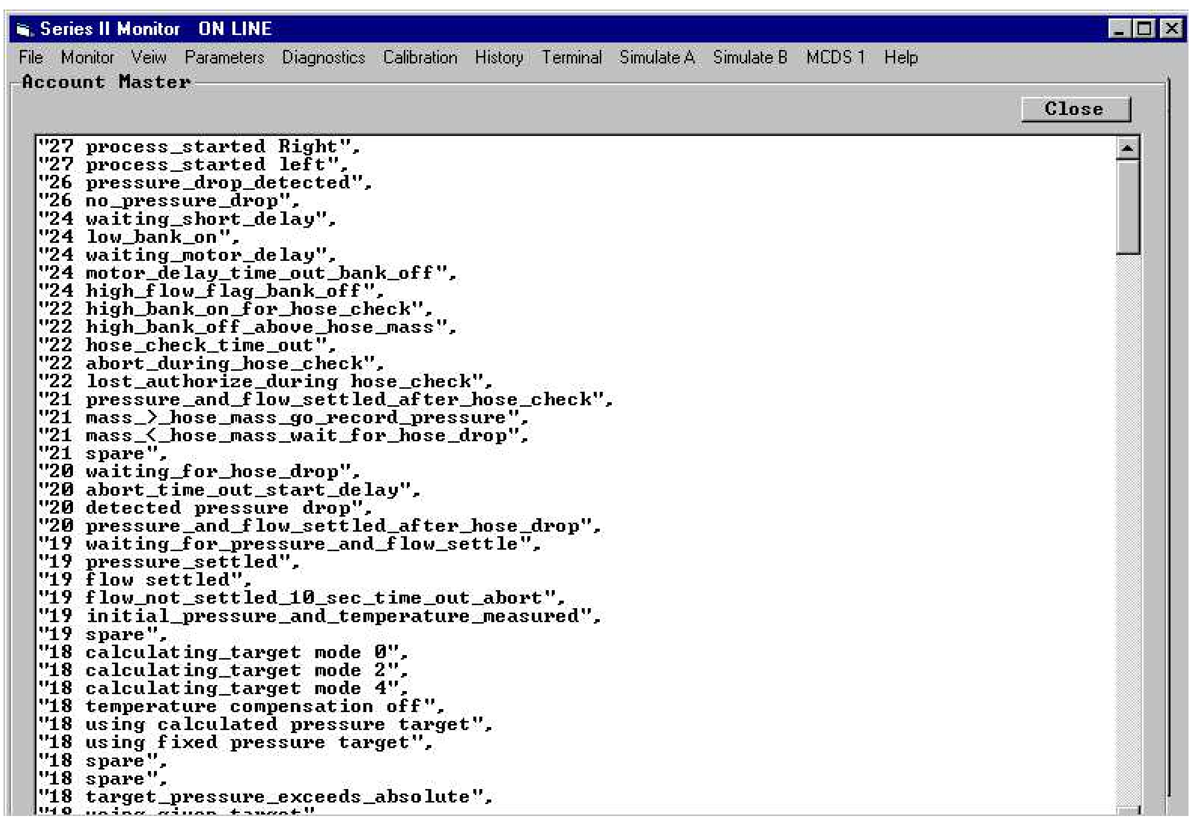
13. VIEW

Under the “View” main menu item is a list of panels to read miscellaneous variables and functions.

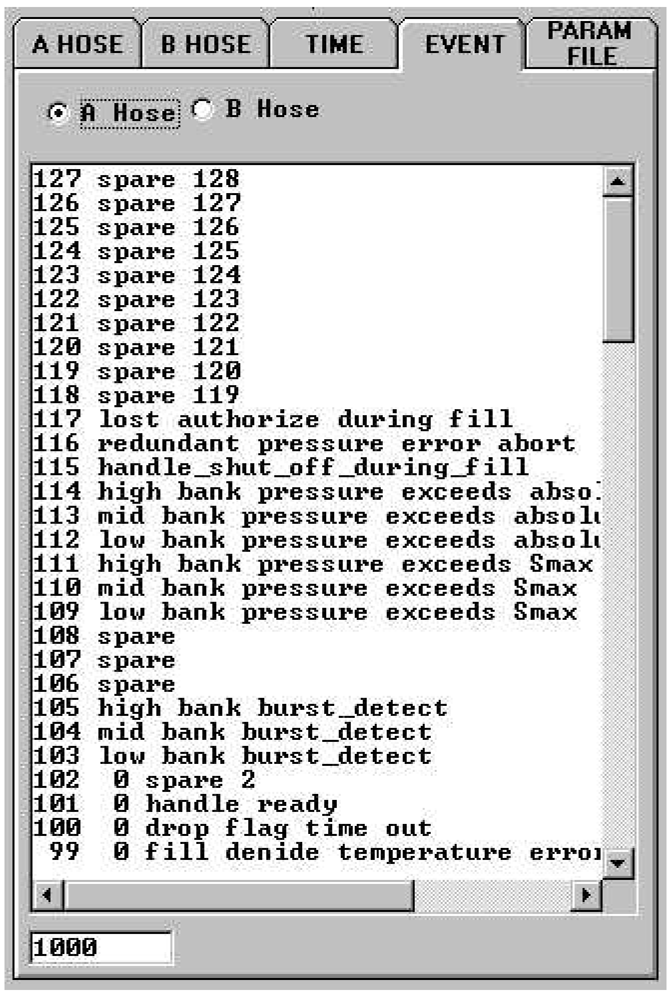


14. VIEW: ACCOUNT MASTER

The Account Master is a list of all the point-by-point actions and decisions made by the fill sequence program from start to finish. This list is referenced by the “EVENT” tab function to generate a list of actions that happen during a fill sequence. The event function picks a line out of the master list according to whether a bit is on or off in the “Account” monitor variables. If an event occurred, the bit is on. If the bit is off, that event did not occur. Example: if operator opened the hose valve and a hose drop occurred,

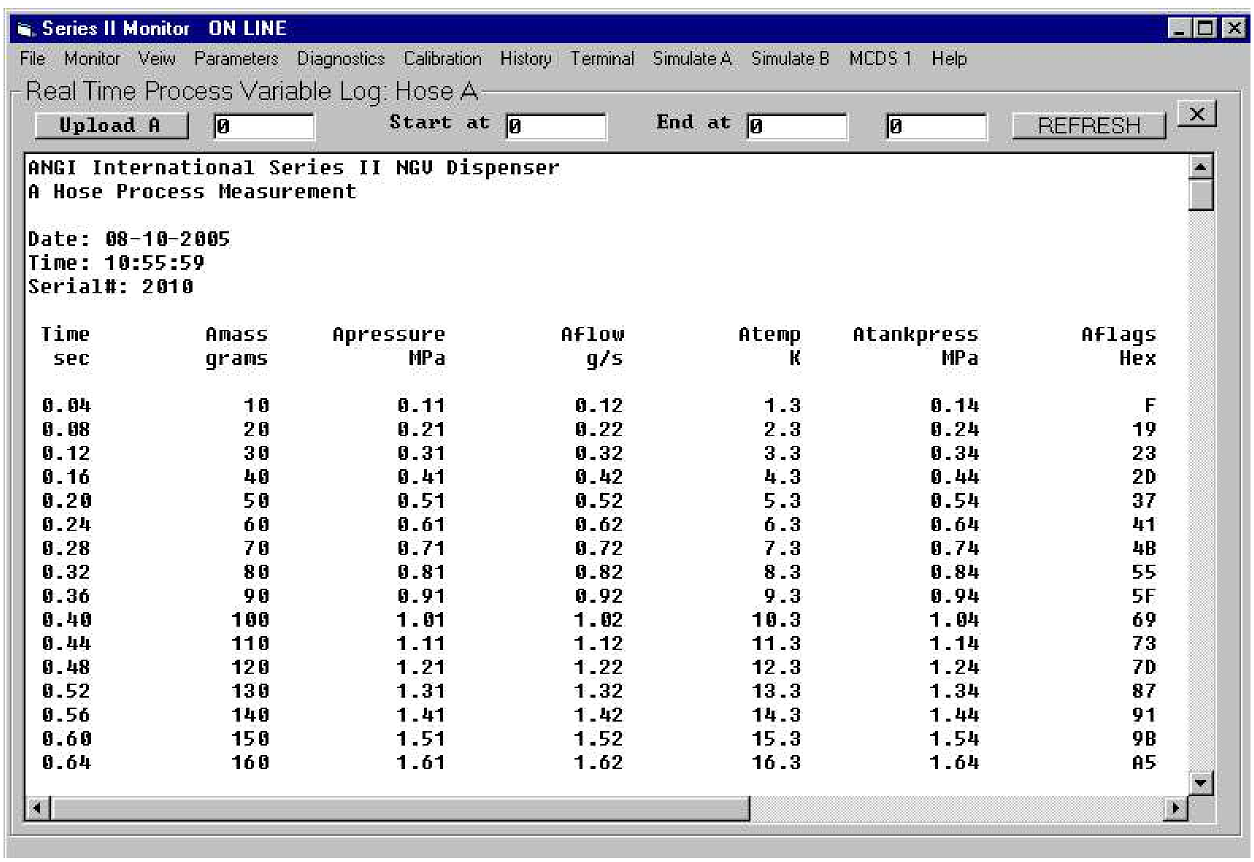


the “drop flag” will be on. When the program gets to the point of checking for the hose drop, the program will set a bit on that corresponds to the line “26 pressure drop detected” and keep the bit off that corresponds to the line “26 no pressure drop.” When the “EVENT” function makes its list, only the line “26 pressure drop detected” gets listed. The “EVENT” list is resolved every time the monitor variables “account1,” “account2,” “account3,” and “account4” change value. This means if the “EVENT” tab is open, the list will be generated as the fill sequence progresses in real time. This list makes it easy to diagnose why a certain fill had problems or why it aborted.



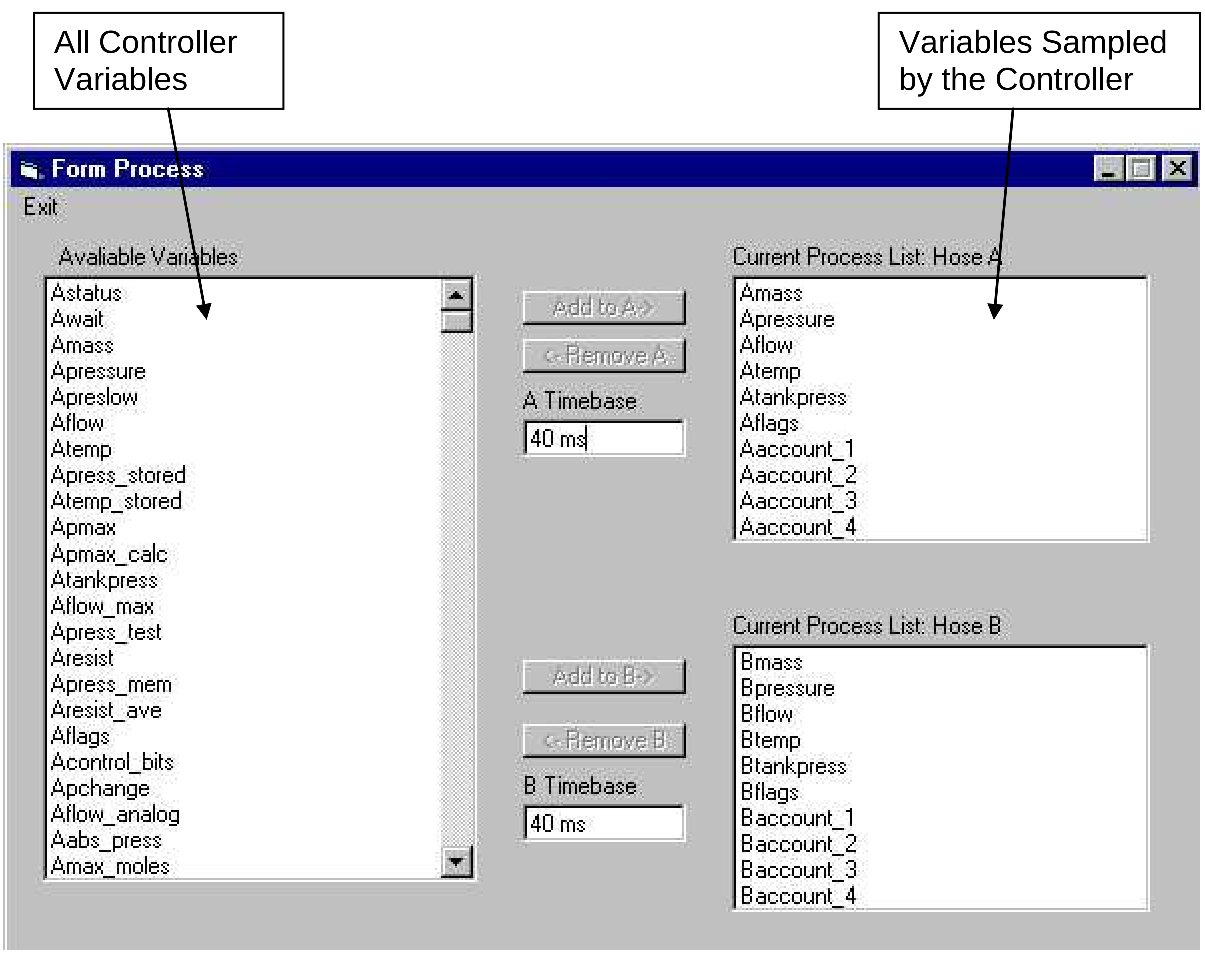
15. VIEW: PROCESS A / B

The process panel displays a time-based list of the fill process variables for a single fill. The process variables such as mass, flow, pressure, etc. are sampled and recorded by the dispenser controller. The sample rate is a multiple of 40 milliseconds, based on the controller's program cycle. The results can be uploaded to the process text box. This list can be saved to disk as a text file. Click the "File" main menu item "Save As" sub menu item to bring up the Save As dialog box. Name and save the file. The values entered in the "Start At" and "End At" boxes will specify the section of time to upload. These values must be entered before uploading. To upload, click the "Upload A/B" button. The box to the left of the button will indicate the upload progress. Click on the "Refresh" button to generate the list once the upload is complete.



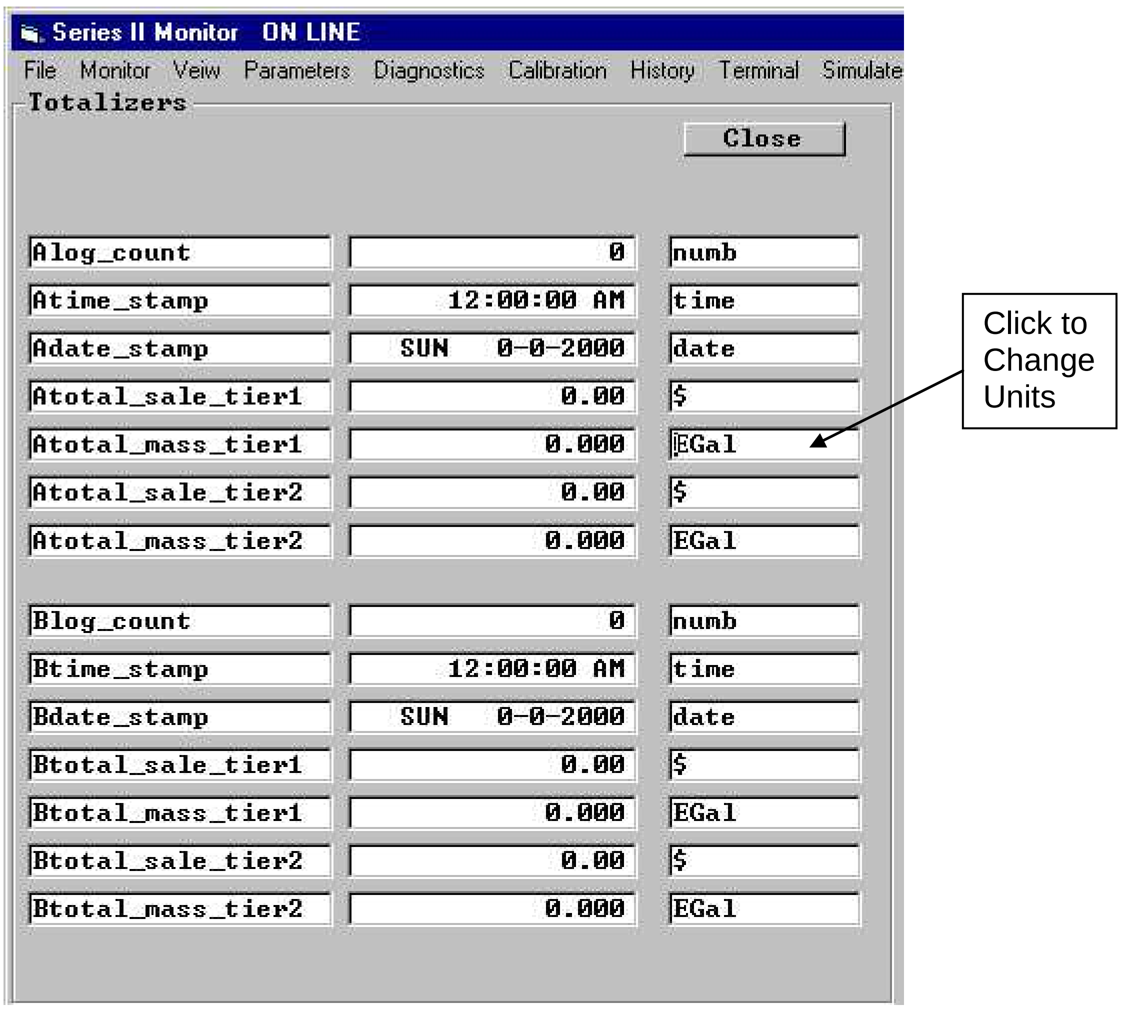
16. VIEW: PROCESS SETUP

The selection of the variables and sample rates for the process list are set-up in the “Process Setup” dialog box. The box opens with the default selection for each hose in the list boxes on the right. All the variables that can be sampled are in the left list box. To change an entry, click on the variable name in the right boxes labeled “Current Process List Hose A/B.” The text will highlight and the “< -Remove” button will activate. Click on the “< -Remove” button to delete the selected variable from the list. To select another variable, click on the variable name in the left “Available Variables” box. The name will highlight and the “Add to ->” button will activate. Click on the “Add to ->” button to add the selected variable to the list. The limit of the number of variables in the sample list is ten. The minimum default time base is 40 milliseconds. The time-base can be increased by 40 millisecond increments by clicking on the “A/B Timebase” boxes and pressing the up and down arrow-keys. These selections are sent and stored in the dispenser controller. This set-up should be done before the fill and not during the fill. The selection goes to the default list when the dispenser power is cycled.



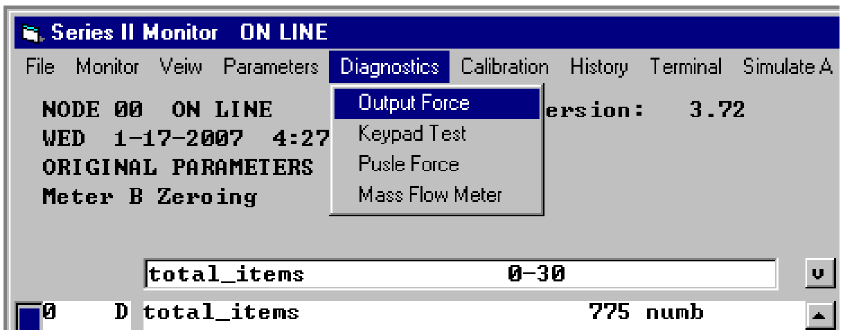
17. VIEW: TOTALIZERS

The totalizer panel lists the dispenser's totalizer values for both A and B hoses. The same totalizers that can be viewed on the dispenser LCD display via the dispenser keypad. Clicking on the unit box can change the mass units. The units will cycle through grams, pounds, kilograms, EGals, and Eliters. The time and date stamps are the time and date of the most recent fill. The sale totals are displayed in the monetary units shown on the dispenser's LCD display. The log count is the number of hose fills performed by the dispenser in its lifetime.

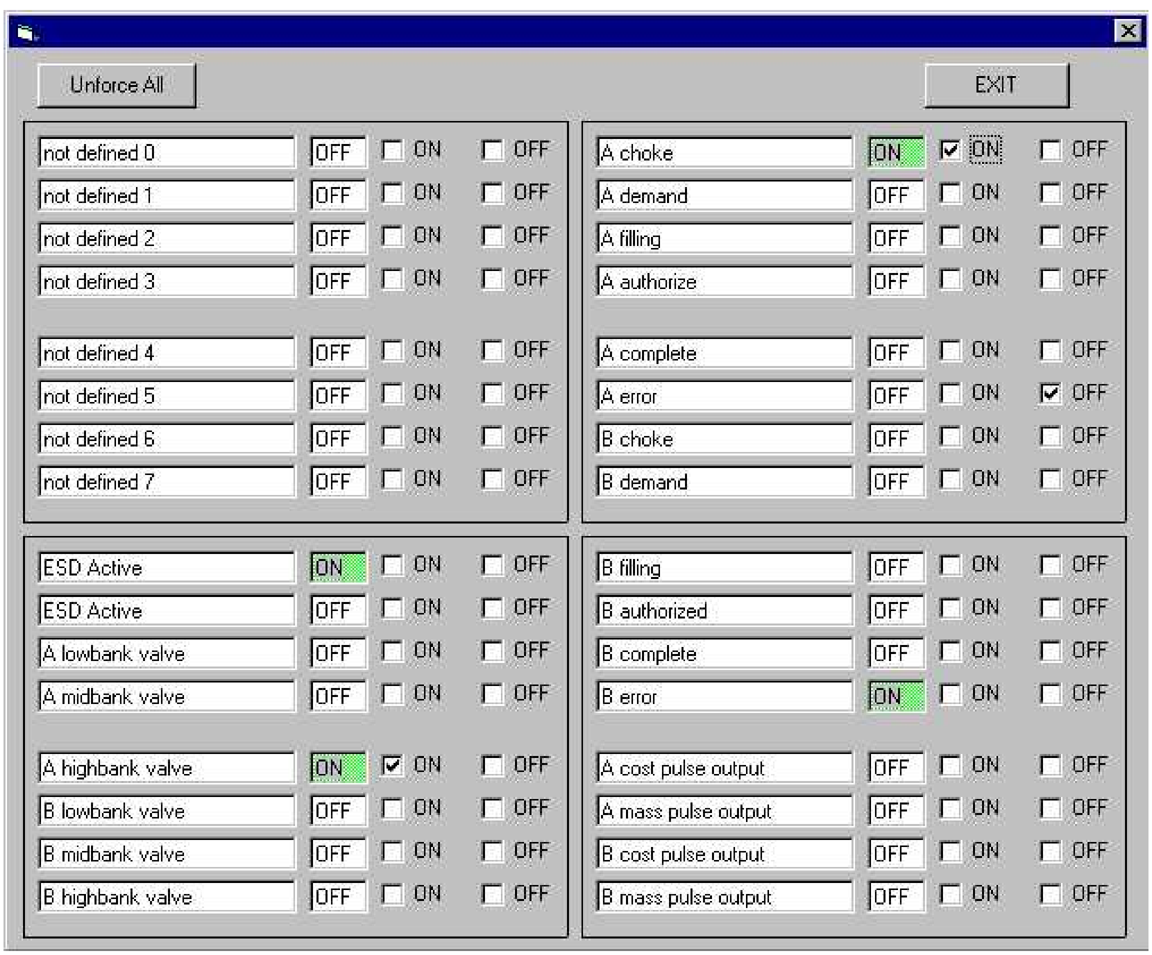


18. DIAGNOSTICS, OUTPUT FORCE

The Output Force panel is used to diagnose and test the hardware output functions of the dispenser controller. Click on "Diagnostics" main menu item and then "Output Force" sub menu item to open the panel. The DIP switch SW1-1 must be up and "Variables" must be unlocked to enable the panel.



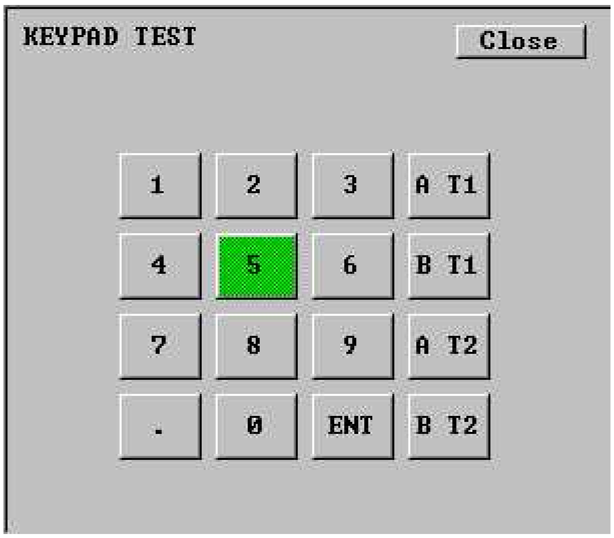
Clicking the "ON" check box will force an output on. The example below shows the "A highbank valve" and "A choke" forced on. The "A error" output is forced off with its "OFF" box checked. Clicking on a check box again will remove the force. The "Unforce All" button removes all forces; unchecks all boxes. Outputs with blank check boxes are not



forced and are on or off from the controller logic. The dialog box below shows “ESD Active” and “B error” on without forcing. The forces are automatically removed if the Tool communication stops (goes off line.) Click the “Exit” button or the “X” to close the panel.

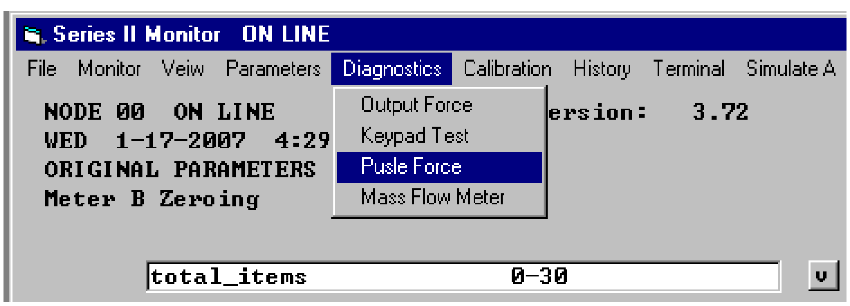
19. DIAGNOSTICS, KEYPAD TEST

The keypad test panel is used to test the dispenser’s keypad. Pressing a key on the keypad will highlight the corresponding key on the screen. The example below shows key 5 highlighted green when key 5 is pressed.



20. DIAGNOSTICS: PULSE FORCE

The pulse output test panel is used to force pulses out of the mass and sale outputs to the fuel management system. Click on the “Diagnostics” main menu item and the “Pulse Force” submenu item to open the panel.

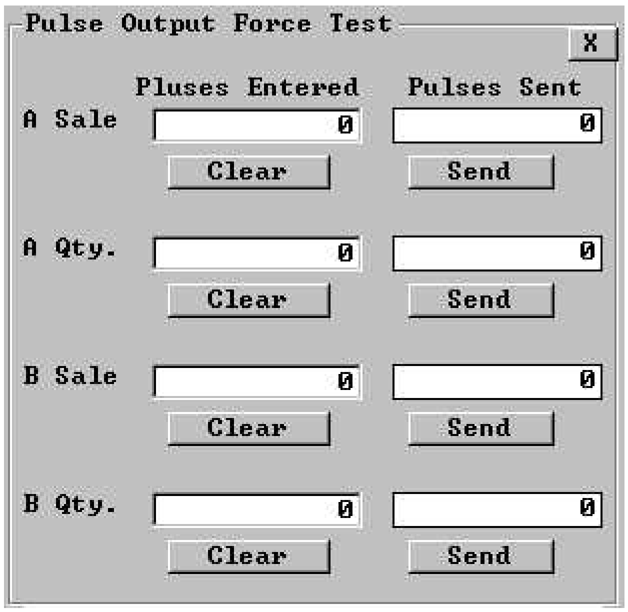


The variable write protect must be unlocked and the DIPswitch SW1-1 must be in the on position before the panel will operate. The four pulse outputs are:

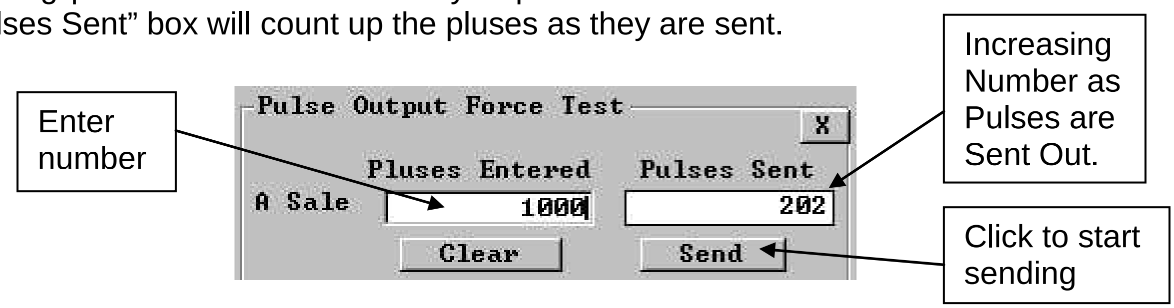
1) A Sale: sale pulses for the A hose. Also called a “penny pulser.”
2) A Qty: mass or volume pulses for the A hose.

3) B Sale: sale pulses for the B hose. Also called a “penny pulser.”
4) B Qty: mass or volume pulses for the B hose.

The pulse scaling is set by the parameters pulses-per-qty and pulses-per-sale for both hoses. Typically, one pulse equals one unit of the least significant digit on the dispenser’s LCD display or the fuel management’s printout number. The pulse width is set by the parameters qty-frequency and sale-frequency.



Click on any of the “Pulses Entered” boxes and enter a number. The output will start sending pulses when the Enter-Key is pressed or if the “Send” button is clicked. The “Pulses Sent” box will count up the pluses as they are sent.

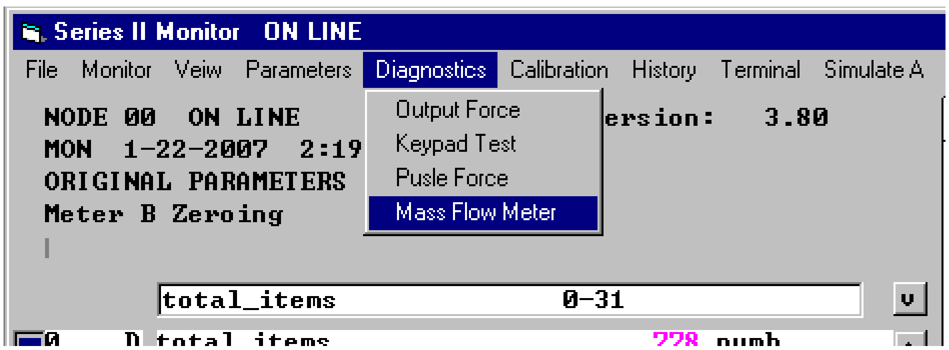


The output will stop pulsing when the “Pulses Sent” amount equals the “Pulses Entered” amount. To start the output pulsing again, click on the “Clear” button and enter another number. The “Clear” button will reset the number to zero.

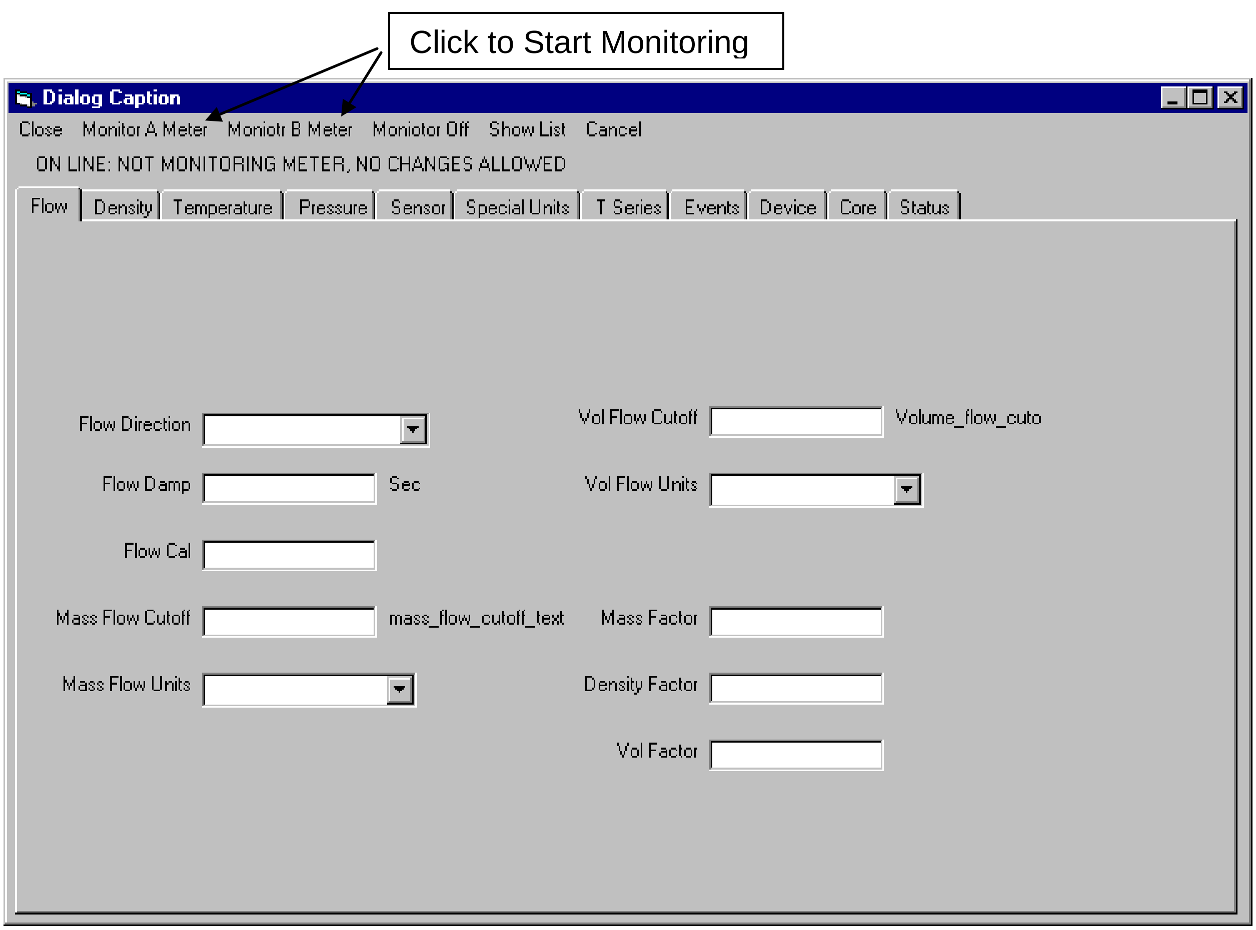
Close the Pulse Force panel by clicking on the “X” box.

21. DIAGNOSTICS: MASS FLOW METER

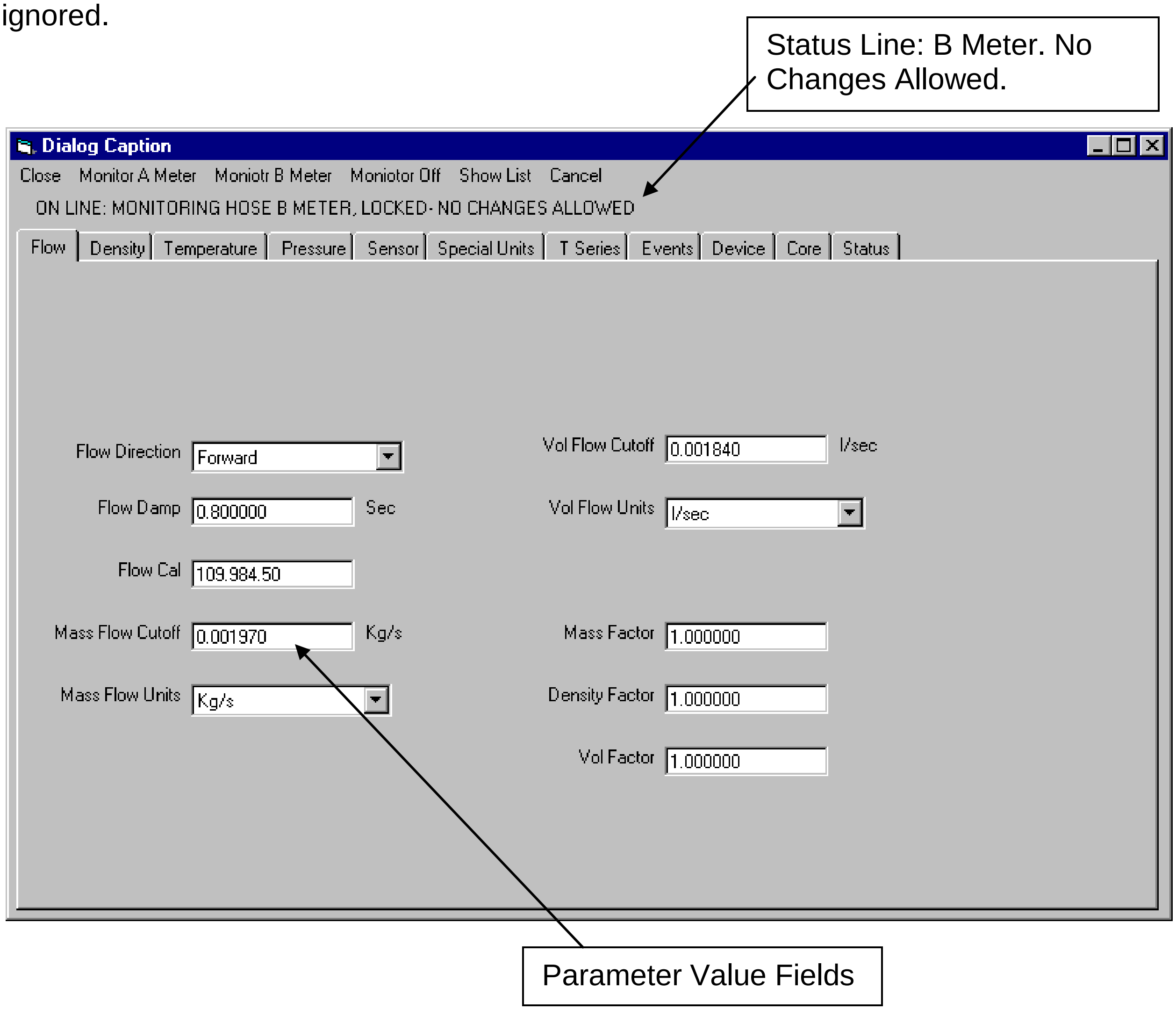
The Mass Flow Meter menu brings up a panel to access the parameters in the MicroMotion mass flow meters in dispensers operating with rev 3.80 firmware or greater. Meter parameter values can be viewed and edited. Operational variables and status bits are viewable for diagnostic purposes. The tool must be “ON LINE” as shown below to monitor a meter. To open the panel, click on the “Mass Flow Meter” submenu.



The panel shown below the meter’s parameters organized under categories with a tab panel for each. The fields are blank when not monitoring a meter. Click on “Monitor A Meter” menu item to load the A hose meter values. Click on “Monitor B Meter” menu item to load the B hose meter values. Click on “Monitor Off” to stop monitoring.



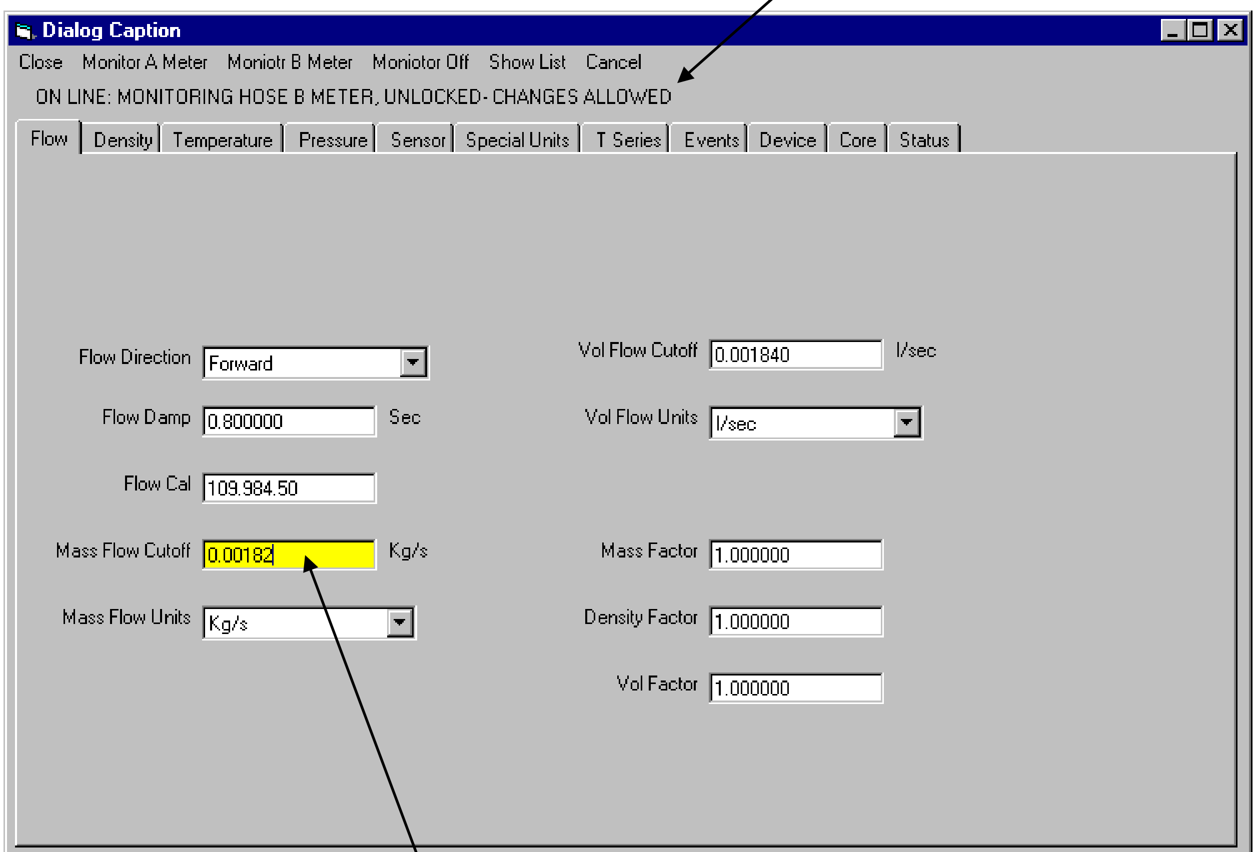
The panel below shows the values retrieved from the B meter through the dispenser control. The values are continuously updated. These parameter values are write protected just as the dispenser parameters are by the same unlock passwords. The status line shows the parameter write is locked. Any value entries in the fields are ignored.



If a meter value is not retrieved by the dispenser control system, the field will show a single tilde character “~ “.

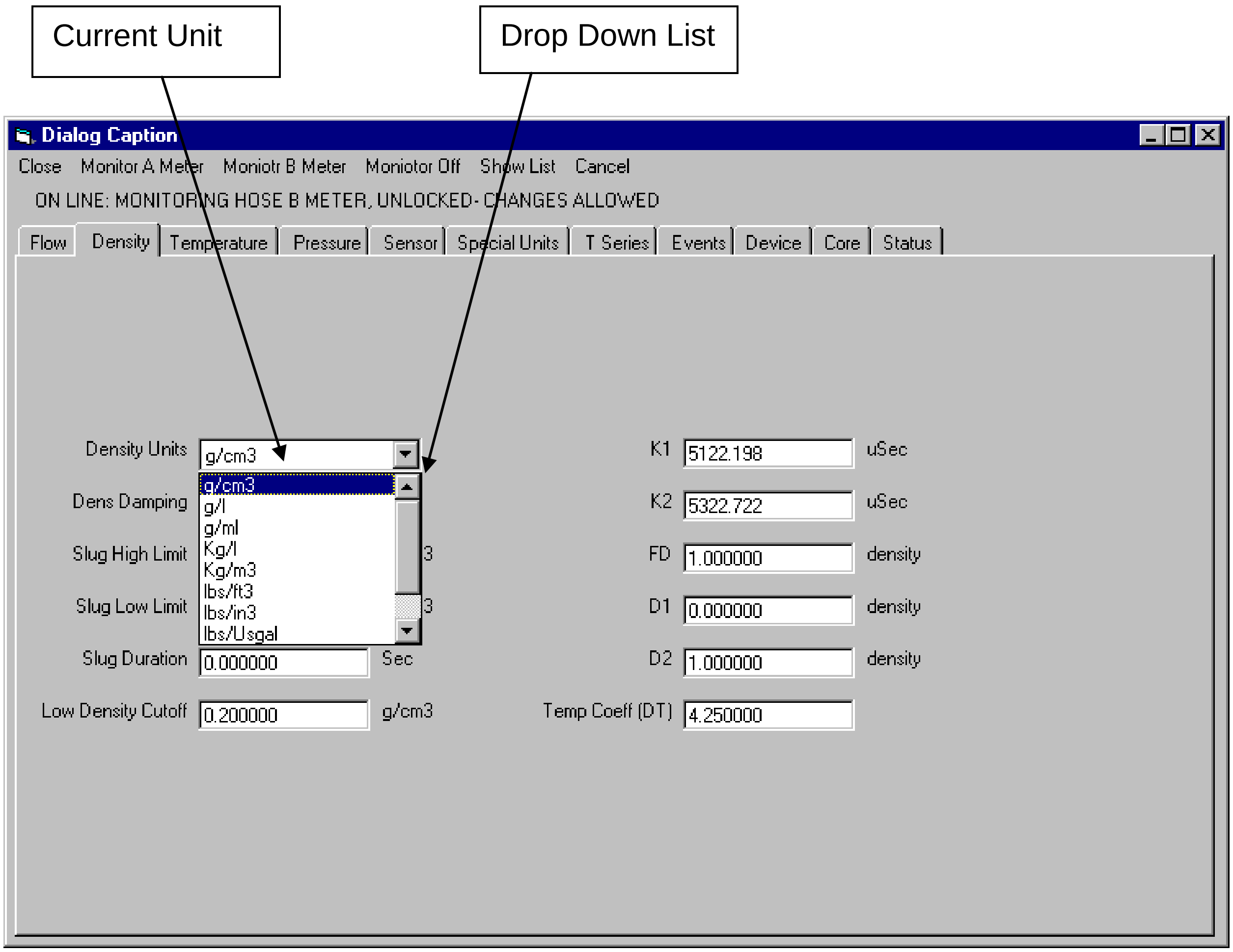
The panel below shows a value being edited will be highlighted yellow. The status line states the parameter value write protect has been unlocked. The new value will stay highlighted until it is written to the meter or aborted. Pressing the enter key will write the new value to the meter and log the change on the audit trail. Pressing the escape key will abort the change and return the old value. Changes will also be aborted if the monitoring is stopped or the panel is closed. Numbers, the minus sign, and the decimal point must be entered. Any other characters entered are invalid and will be automatically aborted when the enter key is pressed.

Status Line: Unlocked.

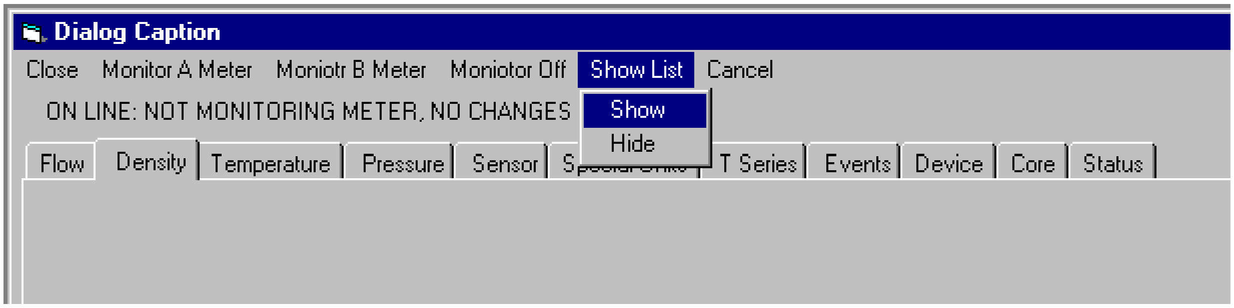


New Value Entered. Highlighted Yellow Until Written to the Meter. Press the enter key to write. Press the escape key to abort.

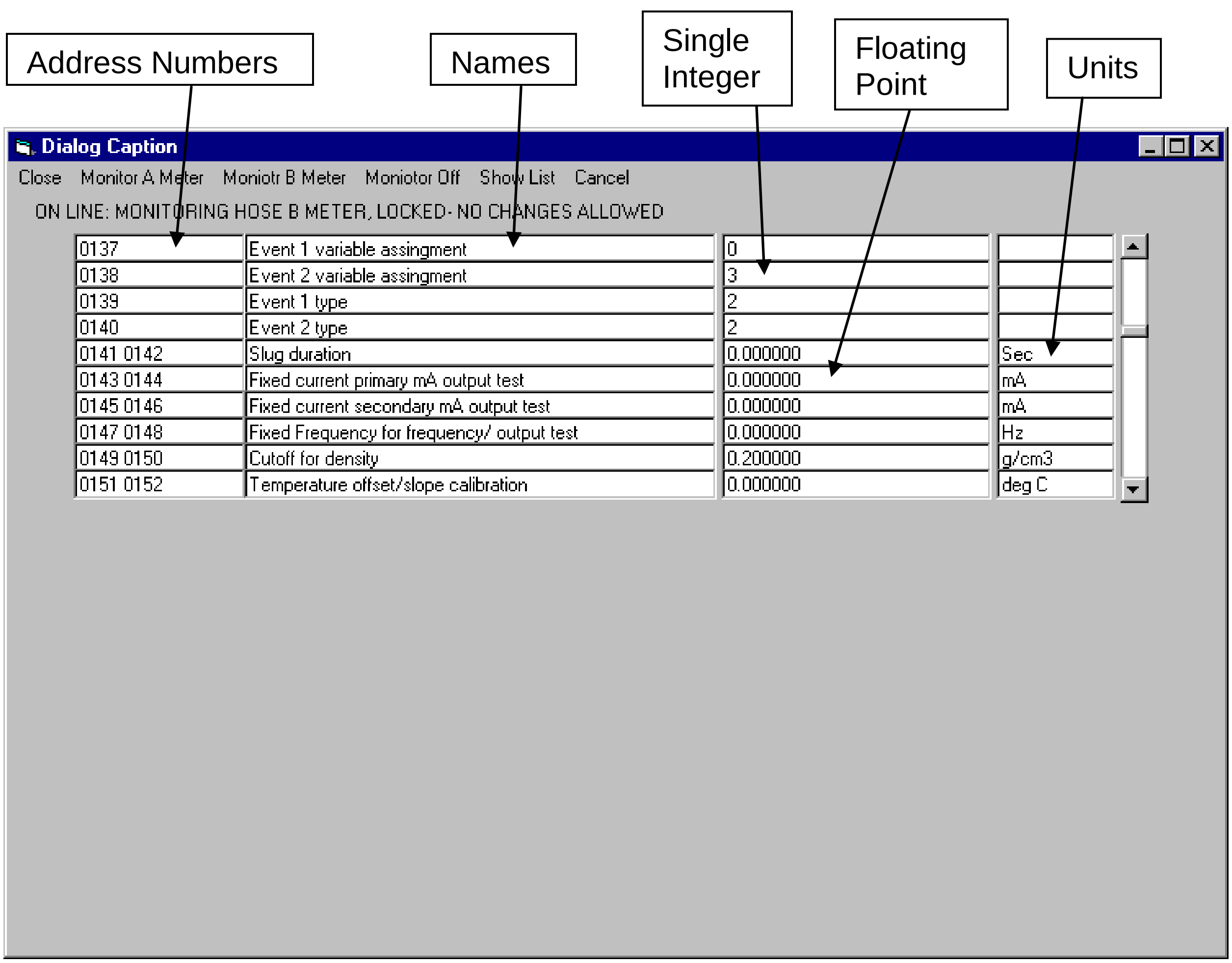
The panel below shows an example drop down list of density units. The highlighted unit is the current unit shown in the top field box. Clicking on another unit in the list changes the units in the top field box. Like the other number fields, the drop down list field will highlight yellow when it is changed. Pressing the enter key will write the change. Pressing the escape key will abort the change and return the original units.



The last feature of the meter monitor is the comprehensive list of all the meter parameters and variables. Click on the main menu item “Show List” and the submenu item “Show” to bring up this panel. Click on the submenu item “Hide” to get the tab panels back.

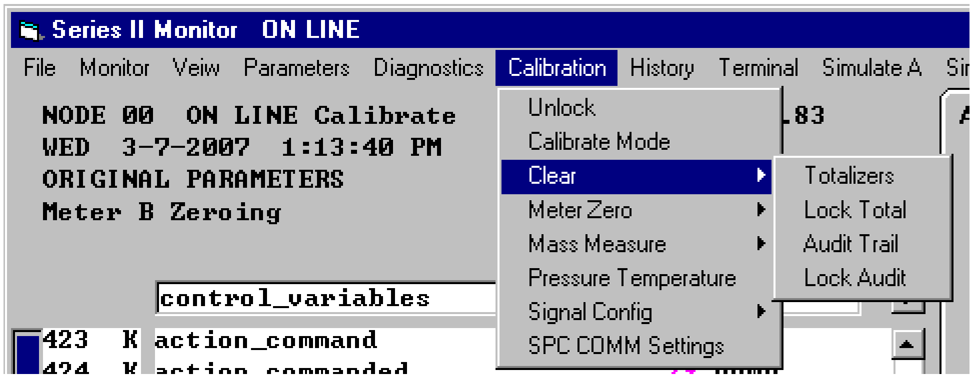


The list gives the parameter/variable address number, name, value, and units. The number refers to the ModBuss address. Single address numbers are integers with a value range of 0 to 65536. Larger and floating-point numbers require two address numbers. These address numbers start as odd numbers followed by the next greater even number. Parameter values can not be edited in the list.



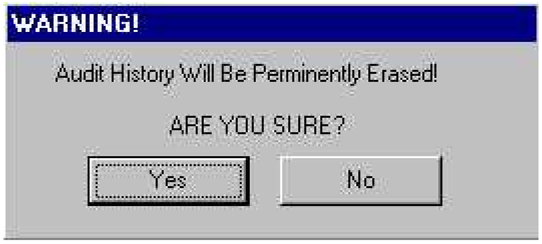
22. CALIBRATION: CLEAR TOTALIZERS AND AUDIT TRAIL

This calibration function is used to initialize the record keeping functions: the non-resettable mass and sale totalizers and parameter change log (audit trail). The clearing functions are performed only in manufacturing test. They are unlocked by their own unique password. These clearing functions can be permanently disabled by the "Lock _" menu items. Once locked the dispenser controller will not let a clear to be performed again. The clearing functions are locked before a dispenser is shipped from the factory.

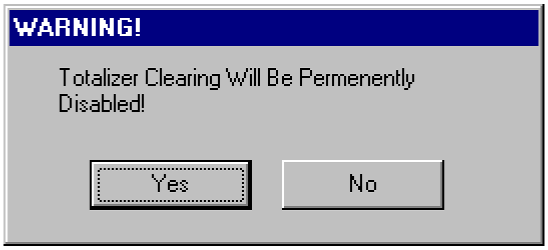


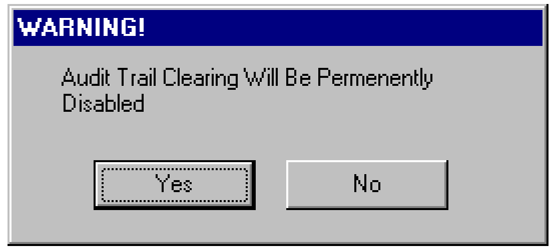
After clicking on the "Totalizers" submenu item, a dialog box will pop up for confirmation. Clicking the "Yes" button will start the process of setting the totalizer FLASH memory areas to zero. Click the "No" button will exit without clearing to memory. The confirmation box will close after selecting "Yes" or "No."

After clicking on the "Audit Trail" submenu item, a dialog box will pop up for confirmation. Clicking the "Yes" button will start the process of setting the audit trail FLASH memory areas to zero. Clicking the "No" button will exit without clearing the memory. The confirmation box will close after selecting "Yes" or "No."



Clicking on the “Lock Total” submenu item, a dialog box will pop up for confirmation. Clicking the “Yes” button will disable the “Clear/Totalizer” function. Once disabled, the clear totalizer function can not be re-enabled. Clicking the “No” button will cancel. The “Lock Audit” submenu item functions the same way for the “Clear/Audit Trail” submenu item.



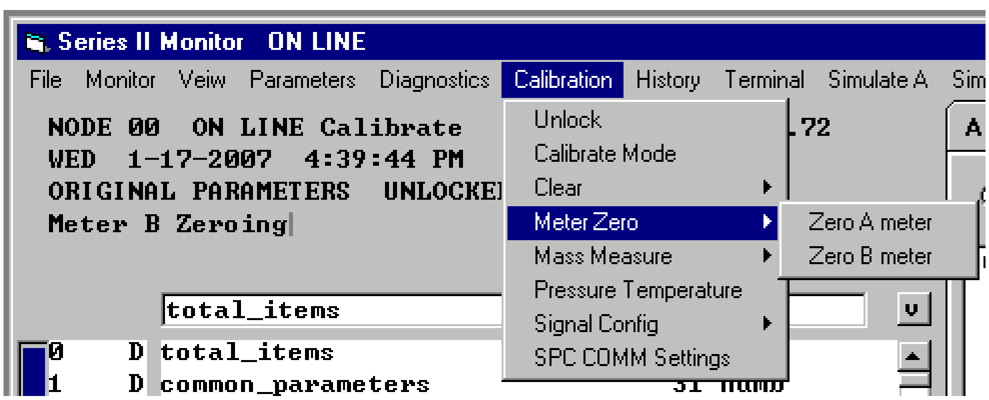


23. CALIBRATION: METER ZERO

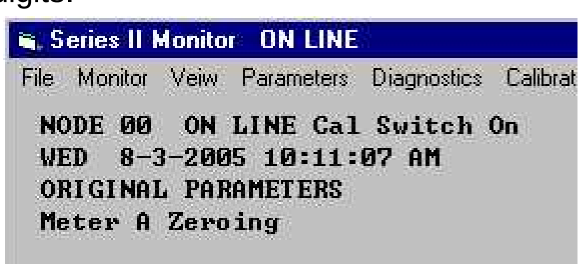
The “Meter Zero” function starts the meter flow zeroing process in the mass flow meter. This process takes ten to twenty seconds. To zero a meter, one must:

1) Insure the gas pressure in the meter is up to rated pressure or at least > 2000 PSI.
2) Insure there is no flow and will be no flow during the process.

Clicking on the submenu item “Zero A Meter” or “Zero B Meter” will start the process.

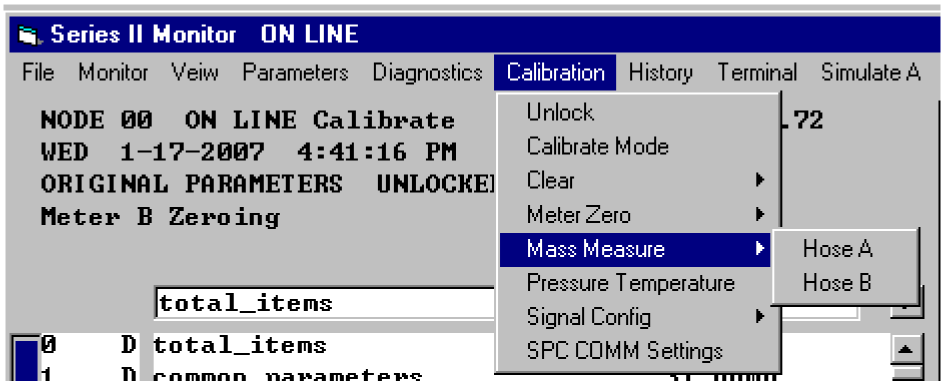


The fourth status line will indicate a meter is busy zeroing. The status line will indicate the process is complete when it goes blank. The dispenser LCD display will indicate an “E10” in the pressure digits.

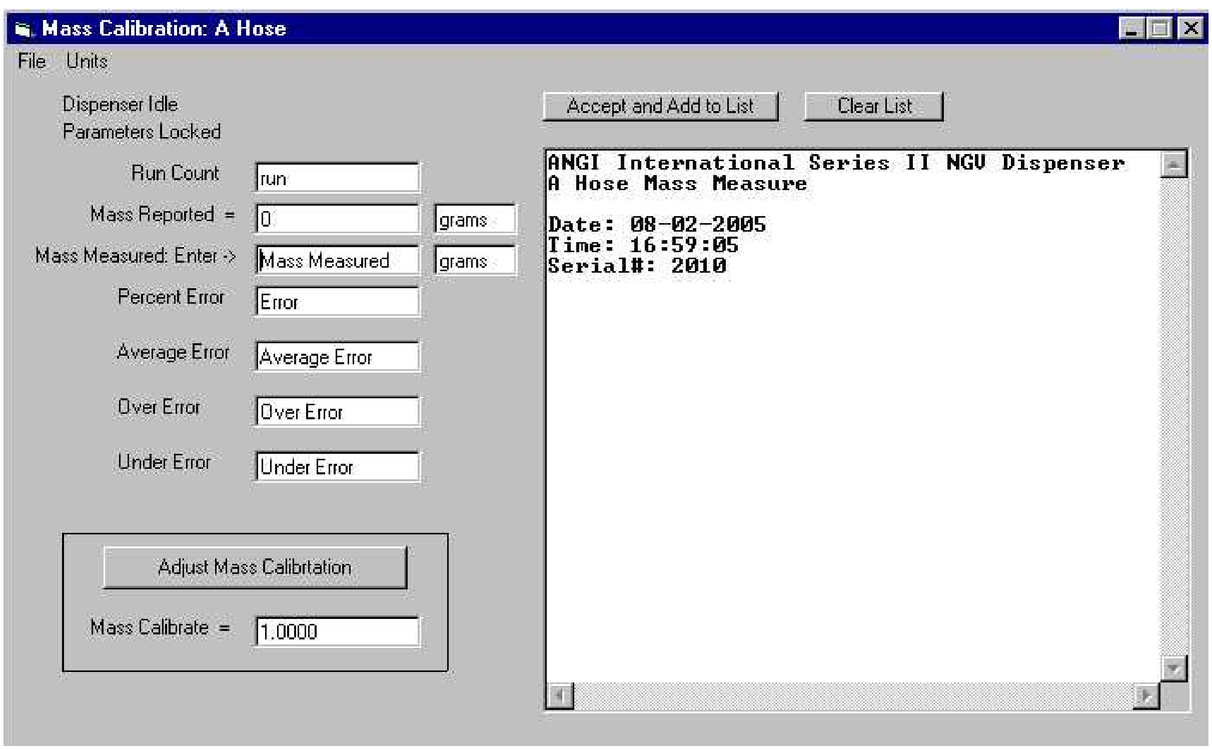


24. CALIBRATION: MASS MEASURE

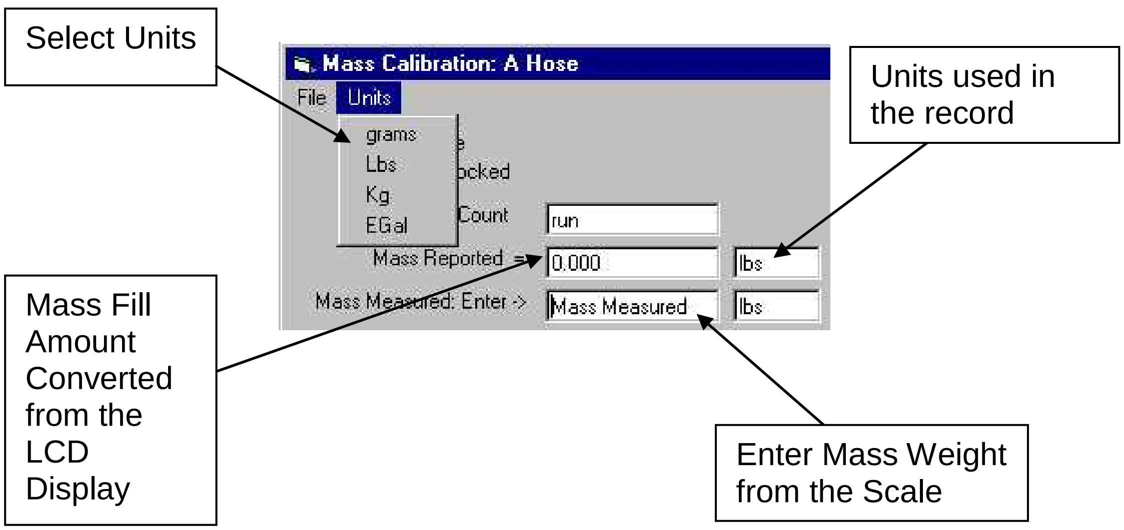
The “Mass Measure” submenu item brings up a panel that is used to record the results of a weights-and-measures test. Click on “Hose A” or “Hose B” to open the panel for that respective hose.



The results of a test tank fill are recorded in the text box on the right. The contents of this box can be saved to disk under the “File” main menu item “Save As” submenu on the panel. It will be saved as a (*.txt) text file. The header states the hose, date, time, and dispenser serial number automatically. The data and time come from the clock on the computer and not from the clock in the dispenser controller.



Before performing a fill, select the units under the main menu item “Units.” These are the mass units used in this panel. The units that are used on the dispenser’s LCD display will be converted to the units selected for the panel.

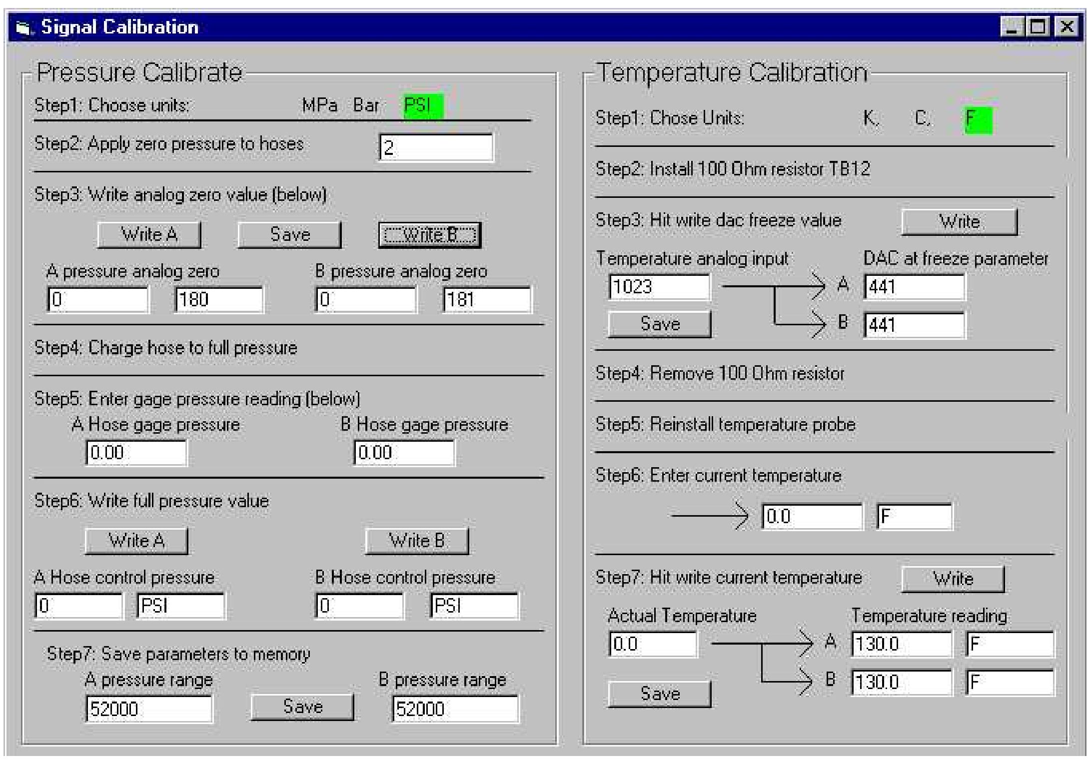


For example: if the mass unit on the LCD display is in EGals and the unit selected in the test panel is pounds, then the value on the LCD display will be converted to pounds in the “Mass Reported” field. In a weights-and-measures test, the dispenser hose is connected to a test tank on a weight scale. The units used in the panel should be the units used on the scale. A test starts with zeroing the scale. Next, the tank is filled. When the fill is complete, the mass values from the dispenser controller will appear in the “Mass Reported” field. The reading from the weight scale should be manually entered in the “Mass Measured” field. The values for over and under error will automatically be calculated. Next click on the “Accept and Add to List” button. The field values will be recorded in the text box. The “Run Count” field will increment with every fill. A file of the results can be saved to disk once enough samples are taken. The “Average Error” field indicates the accuracy of the dispenser over all the accepted and recorded measurements. The “Adjust Mass Calibration” button is used to adjust the dispenser’s mass measurement calibration parameter based on the “Average Error” field. Clicking on this button will change that parameter. Save the parameter to memory in the main panel. If the “Average Error” result is acceptable, the calibration can be left, as set (does not require adjustment).

25. CALIBRATION: PRESSURE TEMPERATURE

This panel is a step-by-step procedure function for calibrating the hose pressure and temperature measurements. The fill parameter write protect must be unlocked for this panel to work. DIP switch SW1-1 does not need to be in the on position. Calibration can be performed with the control enclosure sealed. The pressure calibration goes as follows:

1) Select the preferred pressure units. Click on the unit text to select the units.
2) Have zero pressure in the hoses. Empty the hose if necessary.
3) Click on the “Write” button for the hose being calibrated. The number in the left text box, “pressure analog zero,” will be written in the right text box.
4) Save parameters to memory by clicking on the “Save” button or “Save to Memory” in the main panel.
5) Cycle the handle to enable a hose charge. Fill the hose to rated pressure, if possible, or at least the current storage pressure.
6) Enter the analog pressure gauge reading in the text box.
7) Click on the “Write” button for the hose being calibrated. The text box below should match the gauge pressure value. The new “pressure range” parameter value will be automatically calculated.
8) To finish, save the parameters to memory by clicking on the “Save” button.



Temperature calibration requires a 100.0-ohm resistor to replace the temperature sensor for simulating 32 degrees Fahrenheit. The sensor wires are removed from TB12 terminals 90 and 91 and the resistor is wired across these terminals. A 110.7-ohm resistor can be used to simulate 76 degrees F if the actual temperature is below 70 F.

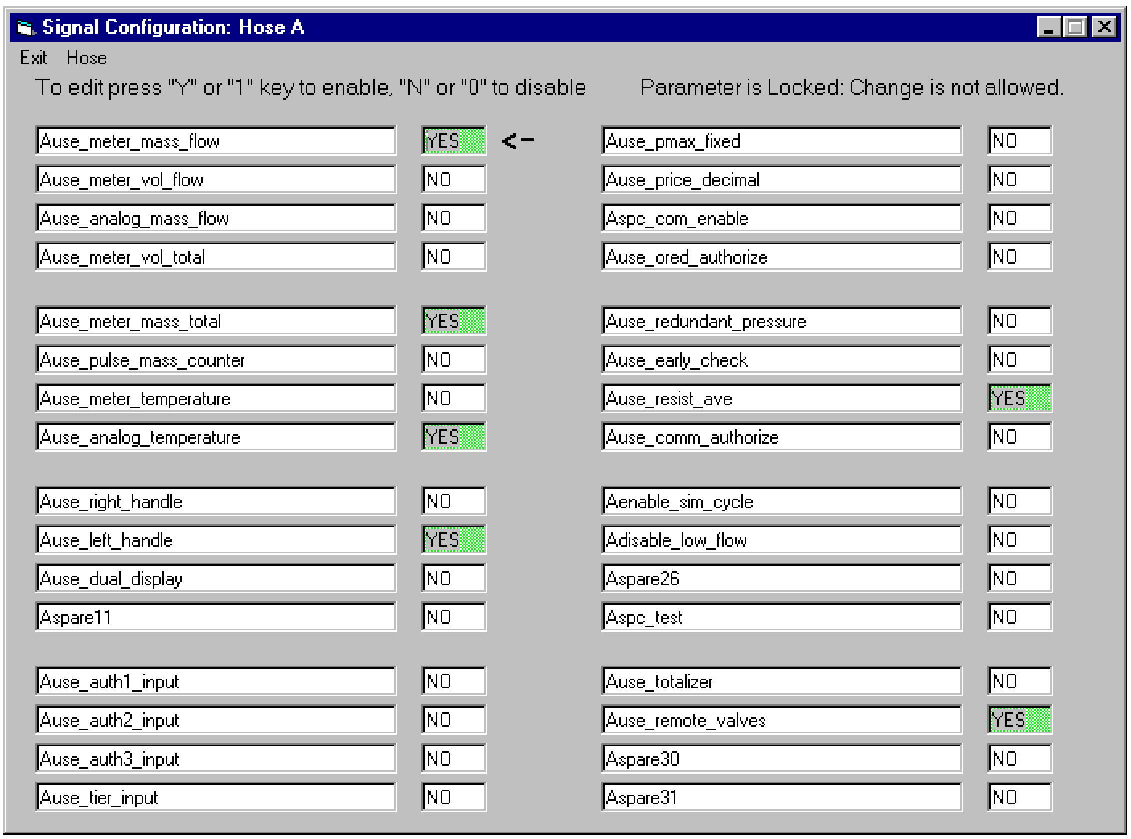
The temperature probe calibration goes as follows:

1) Select the preferred temperature units. Click on the unit text to select the units.
2) Unwire or unplug the temperature sensor. Install the 100.0-ohm resistor.

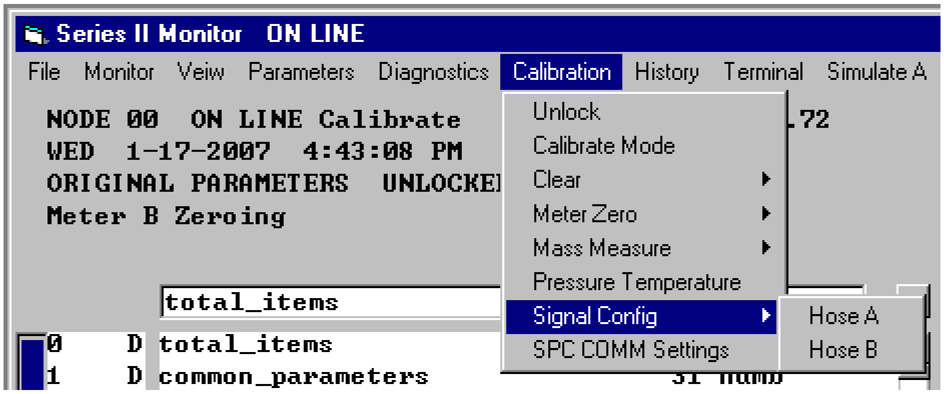
3) Click the “Write” button. The value in the left box should be written to the A and B boxes on the right. Click the “Save” button.
4) Remove the 100.0-ohm resistor.
5) Plug in the temperature sensor or install a 110.7-ohm resistor.
6) Enter the current temperature in the text box. If using the 110.7-ohm resistor, enter in the number 76 (76.0 degrees F.)
7) Click on the “Write” button. The actual temperature in the left box should be reflected in the right A and B boxes. Click the “Write” button.
8) Click the “Save” button.
9) Remove the 110.7-ohm resistor and reconnect the temperature probe wires.

26. CALIBRATION: SIGNAL CONFIGURATION

The signal configuration panel breaks down the functions of the configuration parameter. Each of the 32 bits in the parameter is a switch that toggles a function on or off: “YES” for on and “NO” for off. Click on the box and press the “Y” key for yes or the “N” key for no. The cursor keys can be used to select a bit as well.



DIP switch SW1-1 must be on and the parameters unlocked to make any changes. There is a separate panel for each hose. Open the panel by clicking on the “Calibration” main menu item, “Signal Config” submenu item, then “A Hose” or “B Hose.”

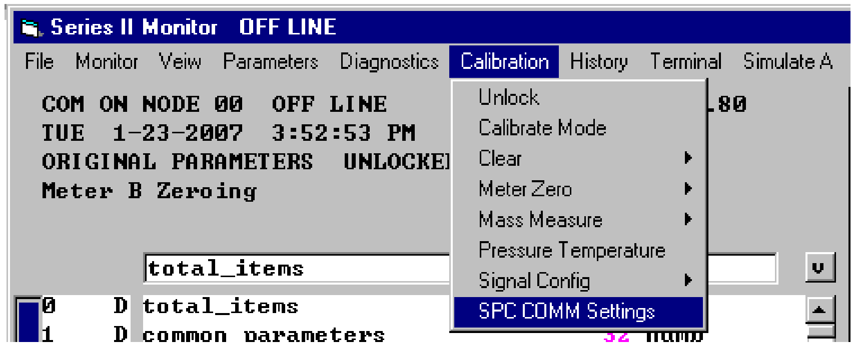


The configuration functions are:

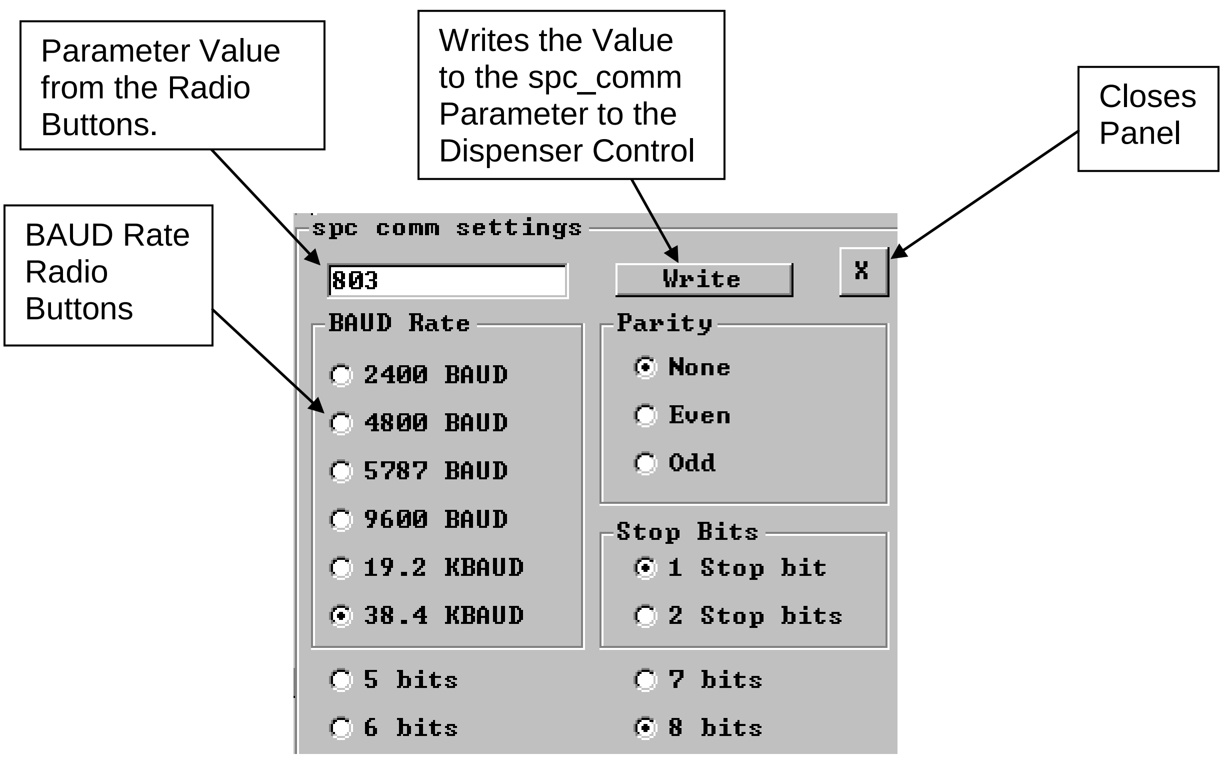
1) Use-meter-mass-flow: The mass flow variable value in the controller is read from the mass flow meter's mass flow register through the serial com-link. Bits 2 and 3 must be off to use this function.
2) Use-meter-vol-flow: The mass flow variable value in the controller is read from the mass flow meter's volume flow register through the serial com-link. Bits 1 and 3 must be off to use this function.
3) Use-analog-mass-flow: The mass flow variable value in the controller is read from a 4-20 Ma analog signal input. Bits 1 and 2 must be off to use this function.
4) Use-meter-vol-total: The mass variable value in the controller is read from the resetable volume totalizer register through the serial com-link. Bits 5 and 6 must be off to use this function.
5) Use-meter-mass-total: The mass variable value in the controller is read from the resetable mass totalizer register through the serial com-link. Bits 4 and 6 must be off to use this function.
6) Use-pulse-mass-counter: The mass variable value in the controller is read from a pulse counter tied to a hardwired pulse input. Bits 4 and 5 must be off to use this function.
7) Use-meter-temperature: The temperature variable value is read from the temperature register in the mass flow meter through the serial com-link. Bit 8 must be off.
8) Use-analog-temperature: The temperature variable value is derived from the analog temperature probe. Bit 7 must be off.
9) Use-right-handle: The handle or on/off switch input is tied to the right handle input on TB10. The right handle input of one hose will lockout the use of the other hose tied to its right handle input. Only one hose can operate at a time. This is used when two hoses share one meter and valve stack. Simultaneous hose use is possible if the handles are wired to the opposite input, i.e. the other hose wired to the left handle input. ON will enable the input. OFF will disable the input.
10) Use-left-handle: The handle or on/off switch input is tied to the left handle input on TB10. The same rules apply as the right handle input.
11) Use-dual-display: On when the dispenser has two LCD displays per hose and Off when there is one display per hose.
12) Spare23: Not used.
13) Use-auth1-input: Enables the hardwired authorize input #1.

14) Use-auth2-input: Enables the hardwired authorize input #2.
15) Use-auth3-input: Enables the hardwired authorize input #3. When an "Authorize Input" is enabled by the configuration, the authorization will pass through if the input is on. The authorization will be stopped if the input is off. If the input is not enabled by the configuration, the authorization test skips that input. If none of the hardwire inputs are enabled, the dispenser is always authorized.
16) Use-tier-input: Enables the tier hardwire input to select between the two price tiers. If not enabled, the price tier is selected from the keypad.
17) Use-pmax-fixed: The final fill pressure target is a fixed value parameter. The temperature compensated value is not used. Off uses the temp-comp value.
18) Use-price-decimal: Enables the "price_decimal" parameter to control the placement of the decimal point in the LCD price display. The decimal point will be fixed. Off allows the keypad entry to place the decimal point.
19) Spc-COM-enable: Turns on the Gilbarco two-wire communication protocol for COM 5 TB6 RS485 port. This function takes over price entry, tier selection, and authorize functions. It delivers fill mass and money total data. Off reverts to the ANGI monitoring Tool protocol.
20) Use-ored-authorize: Enables the hardware authorize digital inputs to be used in parallel with comm-link authorizing. Works with Gilbarco and ANGI protocols.
21) Use-redundant-pressure: Enables a pressure difference trip error. A second pressure sensor is installed in the dispenser for a redundant pressure reading. A fill stop error will occur if the second pressure reading differs from the main pressure reading by a set percentage.
22) Use-early-check: Enables a high-bank hose check stop based on an amount mass delivered. The stop will occur when the mass delivered is more than what fills a hose. This is used to check for an open nozzle valve at the start of a fill. If this is not enabled, the hose check will stop after a two-second time period.
23) Use-resist-average: Enables an algorithm that calculates the hose resistance continuously during sonic flow and produces an accumulated average value during the first bank fill. If not enabled, the hose resistance is calculated once at the start of the first fill.
24) Use-comm-authorize: Enables authorization through the serial communication links. Writing a specific set of action commands to the action control variable can authorize and de-authorize a dispenser hose. ANGI protocol only.
25) Enable-sim-cycle: Turns on a demo routine for show purposes.
26) Disable-low-flow: Turns off low flow threshold bank shift. Bank shift on pressure target or time-out.
27) Spare: Not implemented.
28) SPC-test: Diagnostic test of the Gilbarco communication link.
29) Use-totalizer: Enables the use of an electromechanical mass totalizer. The "Demand" digital output sends out pulses. One pulse per mass unit.
30) Use-remote-valves: Changes the "Filling" digital output to go on and off with the bank valves. Used for operating a local valve when the bank valves are not in the dispenser.

27. CALIBRATION: SPC COMM SETTINGS



This panel breaks out the communication settings for the Comm 5 RS485 serial port on TB6. When the panel is opened the current scp_comm parameter value is displayed and broken out over the radio buttons. New communication settings are selected by clicking on the individual radio buttons. One button each gets highlighted for BAUD rate, parity, number of stop bits, and number of data bits. The new spc_comm parameter value will automatically be created show in the upper left text box. Clicking on the "Write" button will write this parameter value to the spc_comm parameter in the dispenser controller. A parameter "Save to Memory" must then be performed. Click on the "X" button to close this panel.



The value shown in this example above is the default setting. It matches the default Comm 0 RS232 port setting. The 5787-BAUD rate is a non-standard rate used by the Gilbarco communication protocol. If the Gilbarco communication protocol is not enabled, the comm 5 port will work with the ANGI Series II protocol.

28. HISTORY

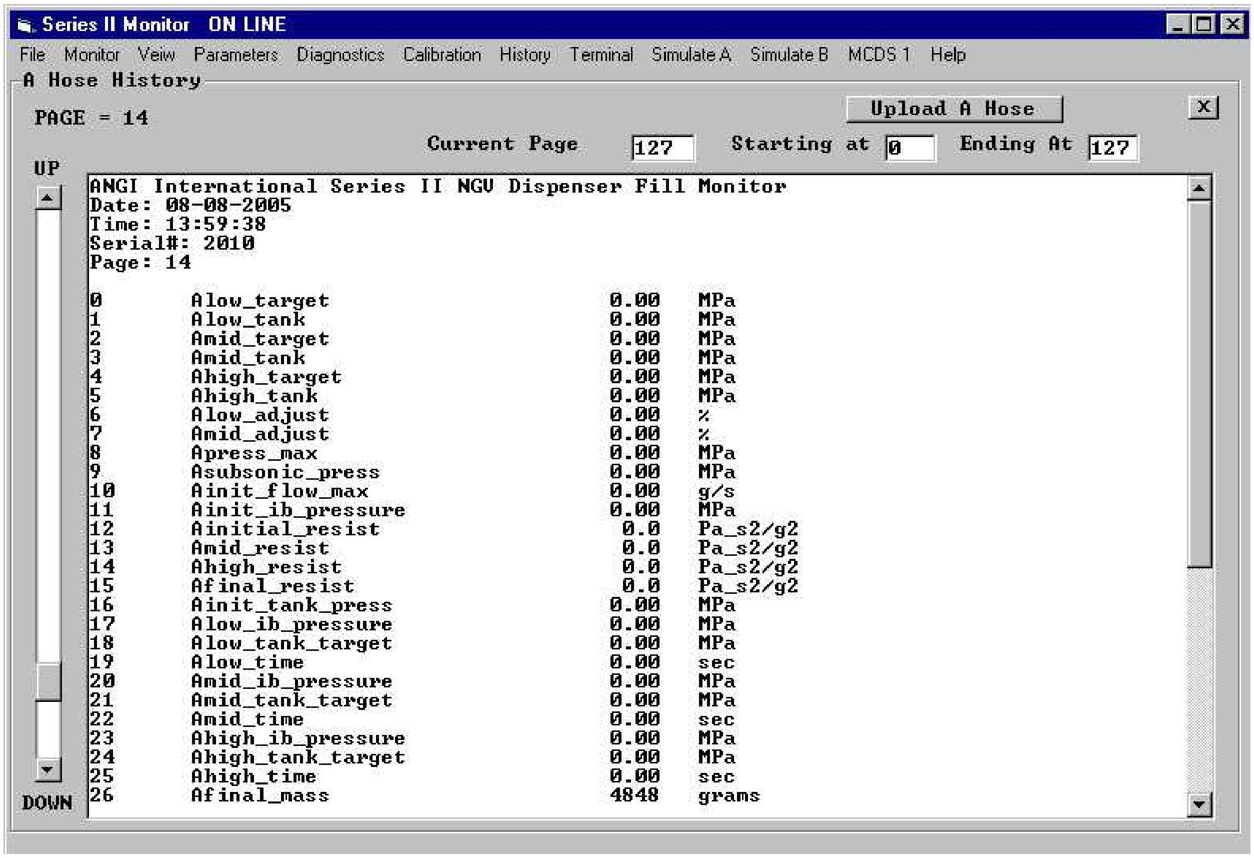
The Series II dispenser keeps fill, total, and parameter change records in its FLASH memory. The “History” main menu item has a list that opens a viewing panel for each of these categories:

1) Hose A / Hose B: A record of variables captured during a fill for showing fill performance. The record contains 128 of the most recent fills for each hose.
2) Audit Trail: A record of all of the parameter changes ever made in the dispenser. The list can record 1024 most resent changes including a time-date stamp.
3) Totals: A record of the mass, sale, and valve cycle totalizers. The record contains 128 of the most resent fills for each hose.

Each of these records can be downloaded from the dispenser controller. Once downloaded, they can be saved to a text file.

29. HISTORY: A HOSE / B HOSE

Below is the A Hose History panel. This list is a copy of the A monitor variables saved to the FLASH memory after a fill is completed or terminated. These copies must be uploaded by clicking on the “Upload A Hose” button. The upload process takes about a minute. Specifying the start and end page boxes can upload a smaller set of pages. Clicking on the vertical scroll bar on the left will page through the last 128 saves. The example below is at page 14. The controller fills the pages up starting at zero and continues to 127. The controller goes back to page zero when the memory is full. The page for the 129th most previous fill is overwritten. The most recent page is displayed in the “Current Page” field. The “File” main menu item will save all the pages to a text file. The units shown are always the units used in the controller.

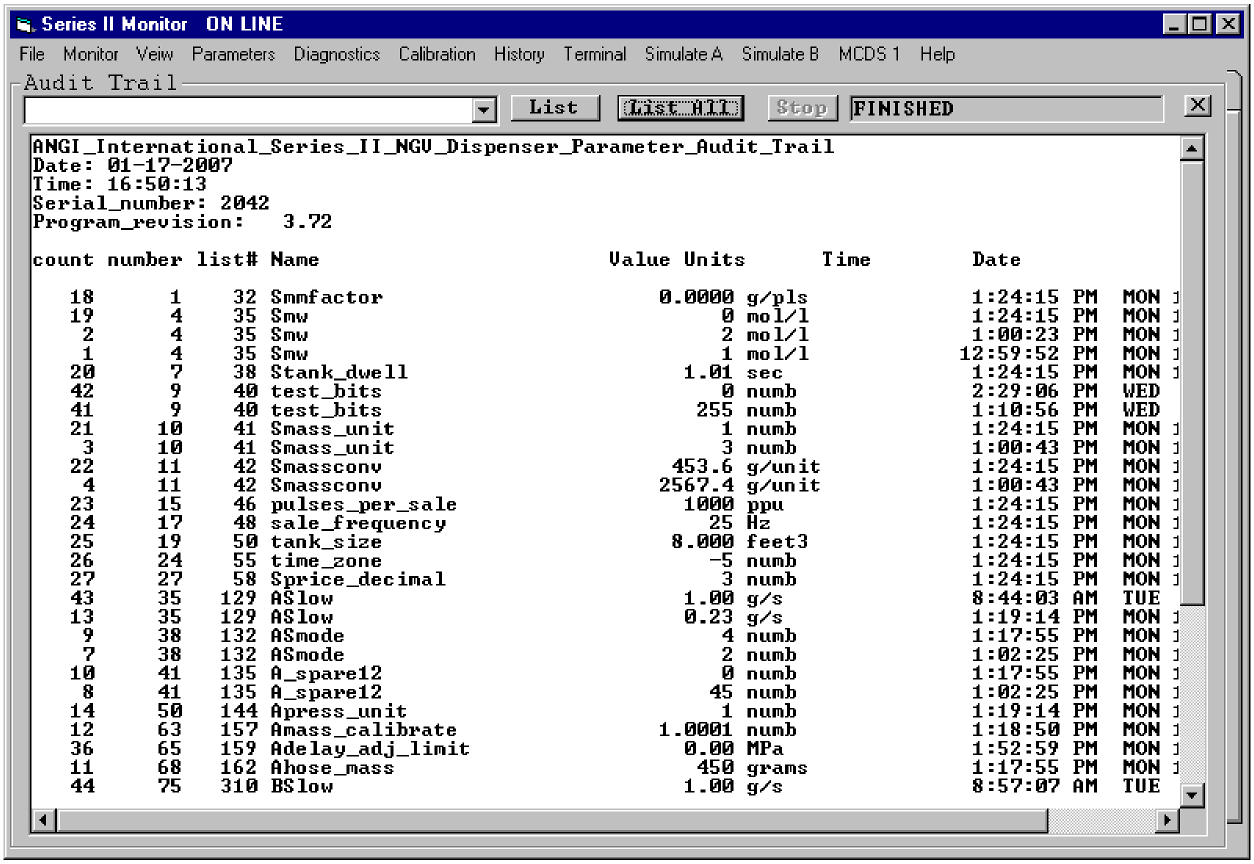


30. HISTORY: AUDIT TRAIL

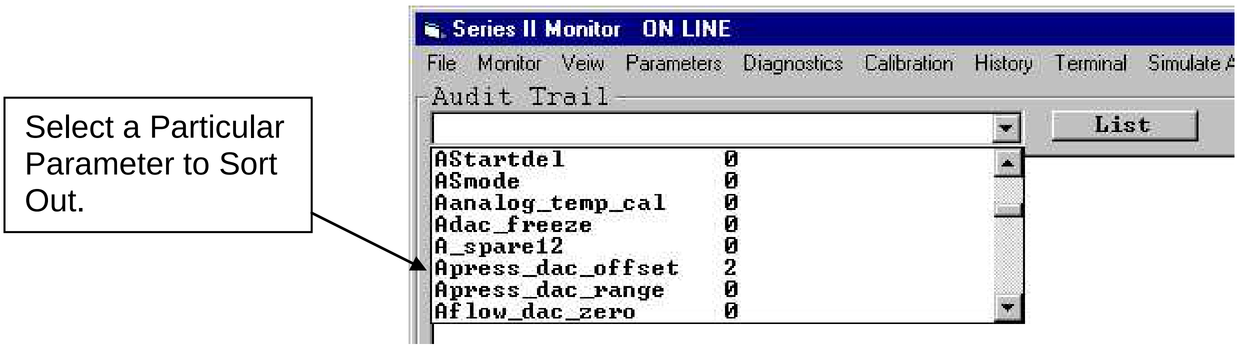
The audit trail panel generates a listing of any or all of the parameters that have been changed over time. The audit trail can store 1024 changes. Changes beyond 1024 will overwrite the oldest change.

Note: The purpose of the audit trail is to keep a legal record of parameters that affect mass calibration in order to detect fraud. This legal condition covers the remote access ability to calibrate the dispenser without breaking the physical seal and needing a supervising official. The dispenser is electronically “sealed” by a password that unlocks parameter changes only by authorized personnel. Each change lists the parameter number, name, new value, time, and date.

The list is uploaded from the controller by clicking on the “List All” button. The example below is a list all download. The list can be saved to disk under the “File” “Save As” main menu item as a text file.

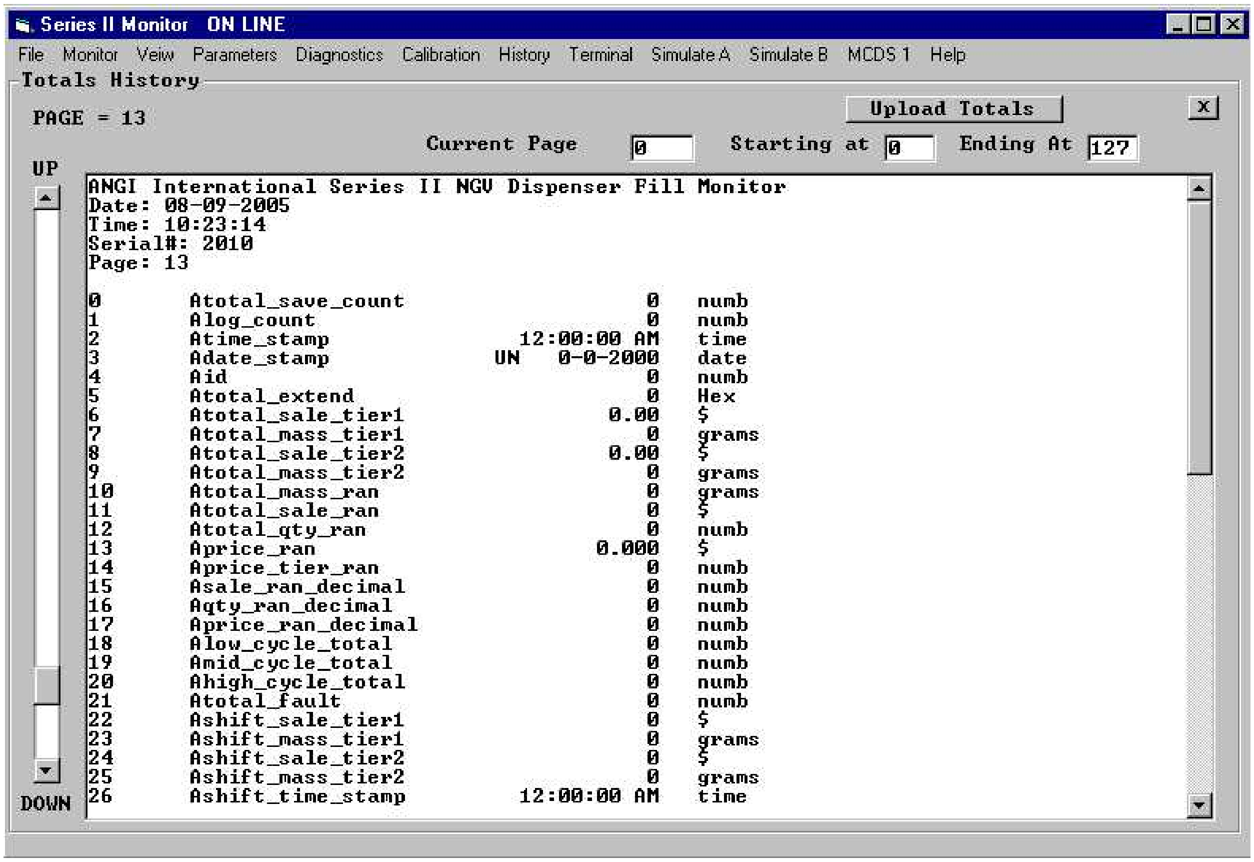


The pull down list on the top left is a list of all of the parameters and the number of times they have been changed. Selecting a the parameter in the list will start a sorting process in the controller that tags the selected parameter. Clicking on the “List“ button will download only the changes made to the selected parameter. The sorting process may take some time if there is a large number of changes.



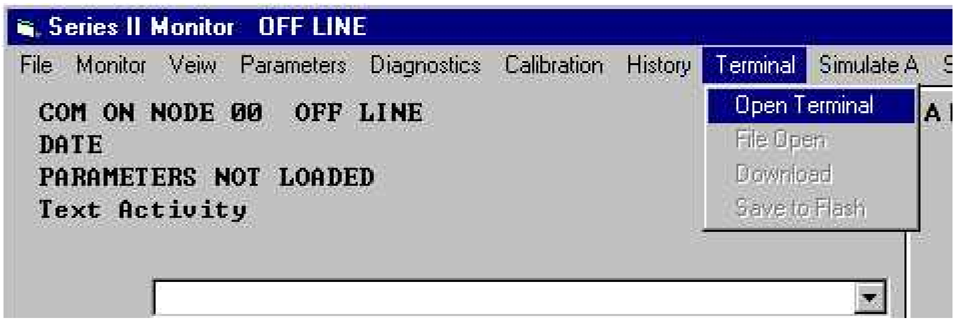
31. HISTORY: TOTALS

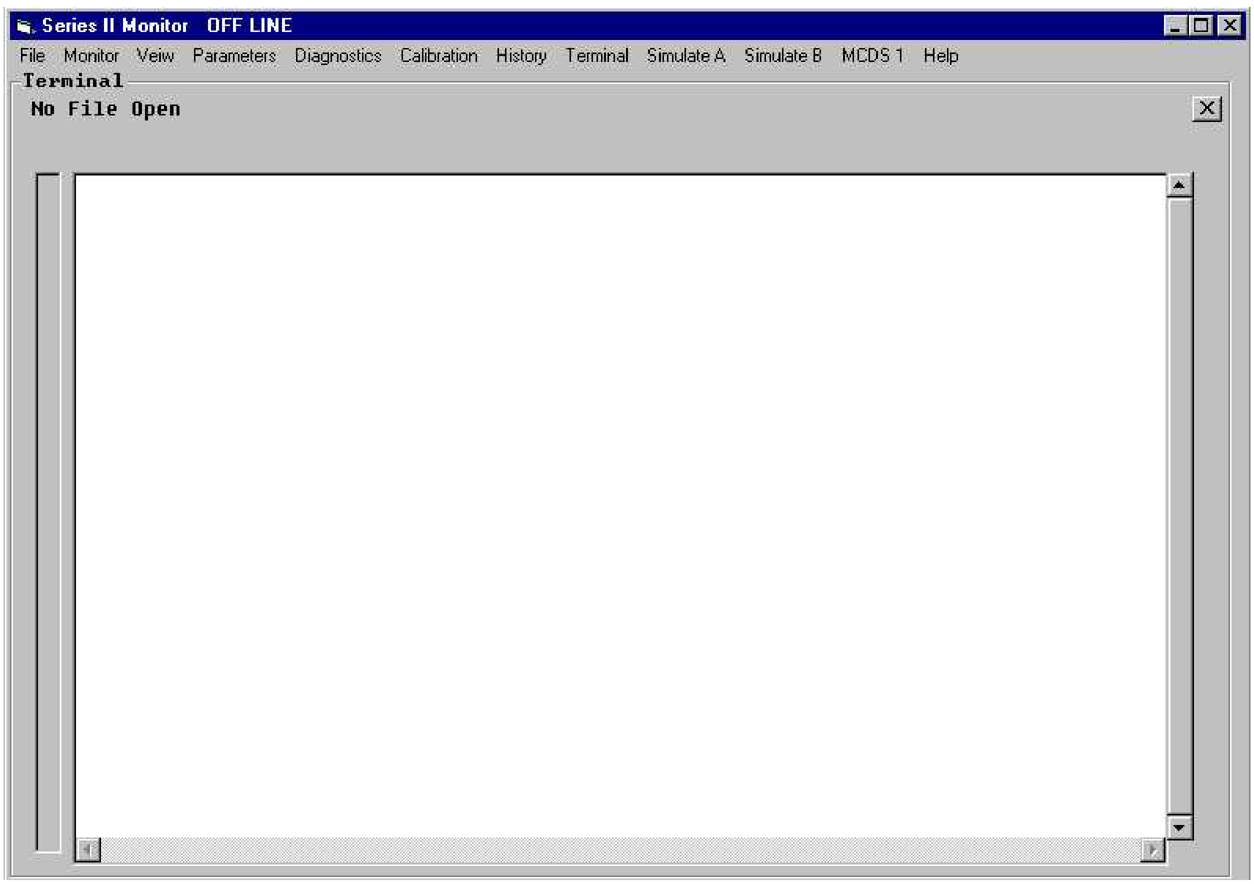
Below is the Totals History list. Like the Fill Results list, the totals for the last 128 fills are recorded in the FLASH memory. The totals are updated at the end of a fill and written to a page. The oldest page is overwritten as new totals are recorded. Both A and B hose totals are contained on a page. Clicking on the “Upload Totals” button will retrieve the total data from the controller. Clicking on the vertical scroll bar will page through the 128 pages. All the pages can be saved to disc as a text fill by clicking on the “File” main menu item then the “Save As” sub menu item.



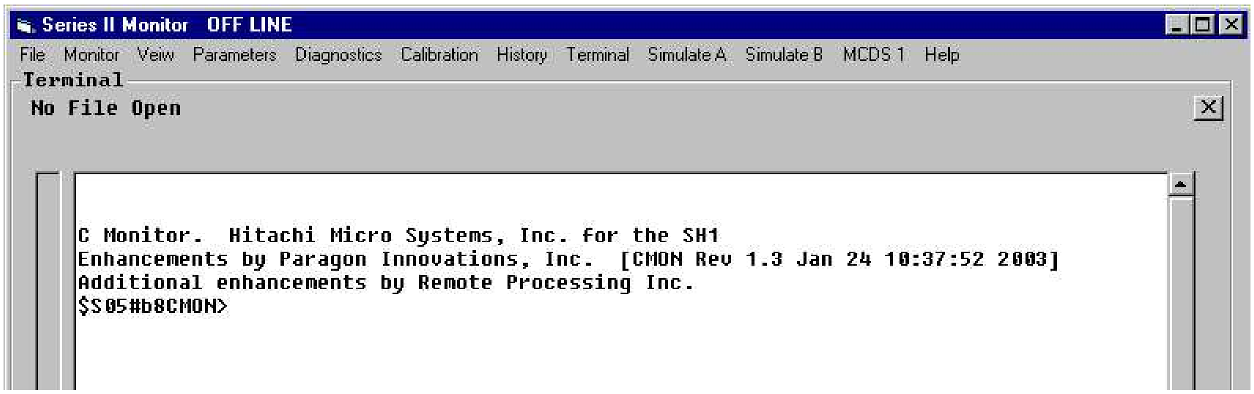
32. TERMINAL PANEL

The terminal window is a Tool used to access the dispenser controller CPU for program loading and diagnostics. The dispenser controller CPU can be accessed directly through the terminal window when the controller CPU is placed in terminal or program mode. The dispenser controller will respond to commands entered on the computer keyboard to perform tasks such as viewing memory values and loading programs. Commands execute when the Enter Key is pressed. To enter the Terminal sub menu item. A blank terminal window will appear. Clicking on the “X” box on the upper right will closed the window.

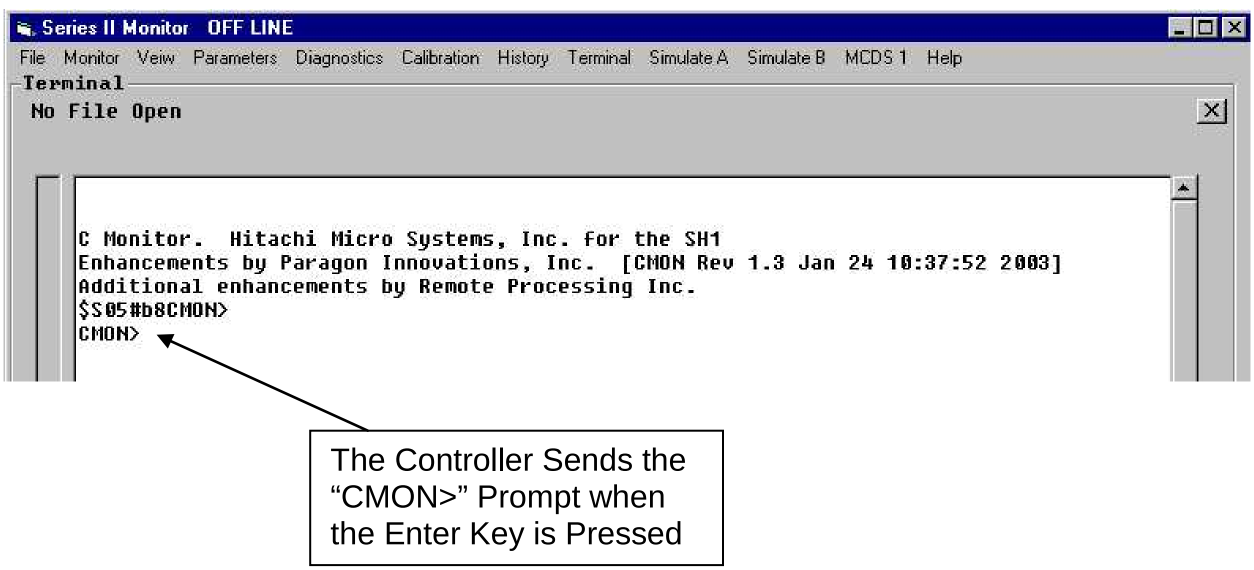




The Terminal window will send typed characters out to the dispenser controller board via the serial port on the computer. When the dispenser controller is placed in the program mode, these typed in characters will be sent back and displayed in the window. To place the dispenser controller in the program mode, switch DIP switch SW3 on the Dispenser Interface board in the dispenser electrical enclosure to the right.and push the RESET button or cycle the power. The controller will “boot up” in the terminal mode and will send out an introduction prompt.

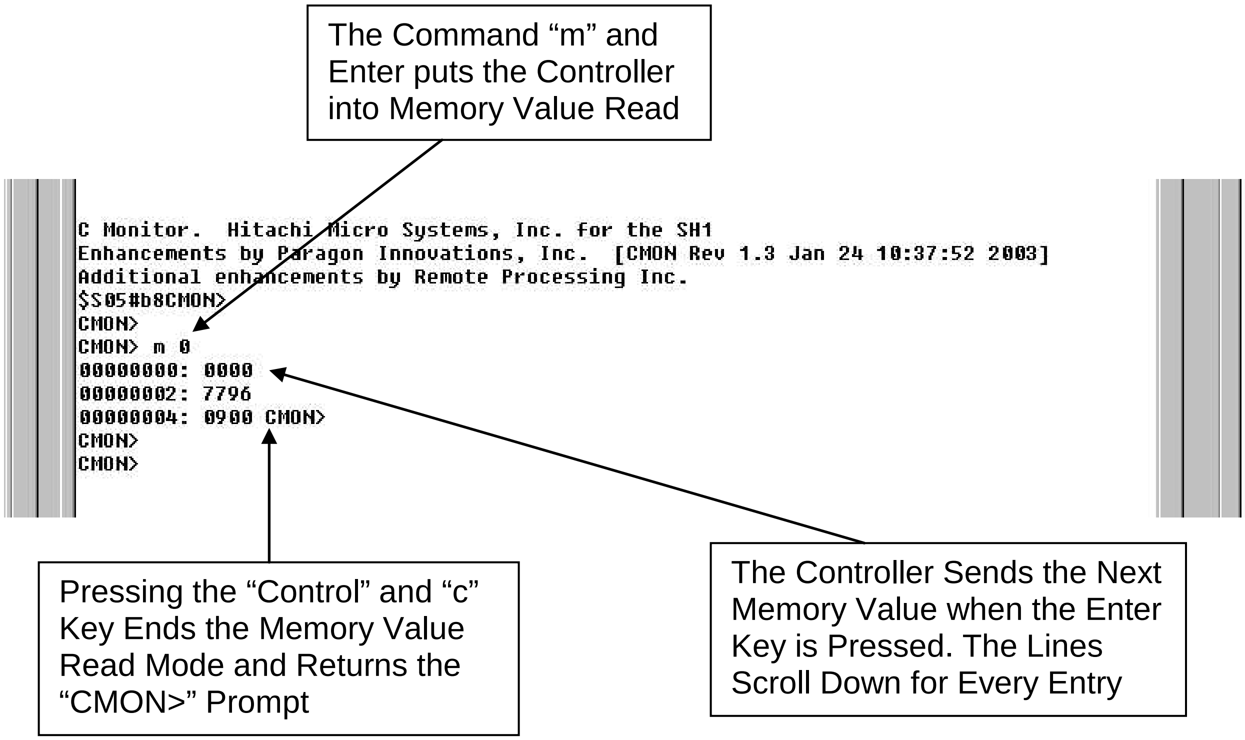


The intro should show the Hitachi Micro Systems and Remote Processing brand names, firmware revision, and processor type used in the dispenser controller. A blinking cursor should appear after the prompt. This is where typed characters will appear. Pressing the Enter Key will test the communication to the controller. The controller will respond with the command prompt “CMON>.”



Characters entered will not appear if the communication to the controller is disconnected.

Below is an example of a command sent to the controller and the response back. The “m” key is a code for looking at single controller memory values. In the example below, an ”m 0 Enter” is entered to start looking at memory point zero. The controller sends the “m 0 Enter” characters back and they appear right after the “CMON>” prompt.



The controller then goes into displaying the memory values. Each time the Enter Key is pressed, the next memory value is displayed on the next line. Pushing the “Control” and “c” keys together ends this mode and returns the “CMON>” prompt.

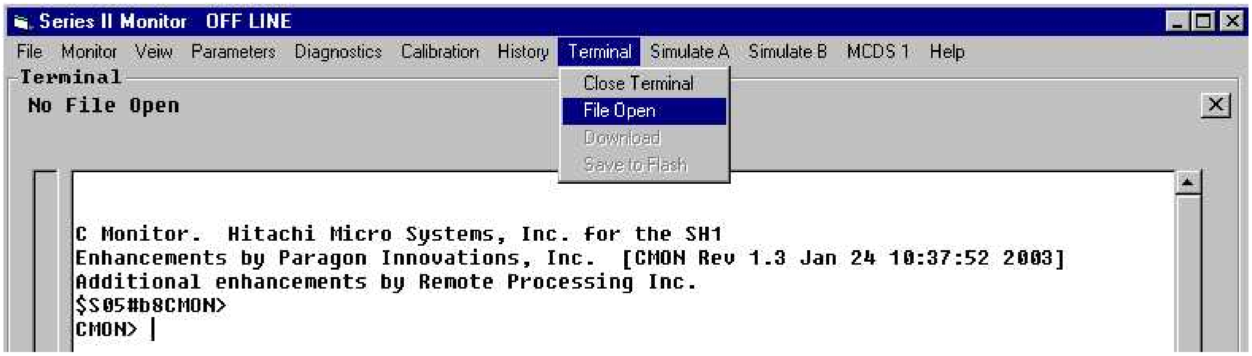
33. LOADING A PROGRAM

The dispenser controller runs on a single program in the CPU’s RAM. The program is stored in the FLASH memory. The FLASH memory stores information without the need for the power to be on. When the dispenser is powered up, the CPU starts a “boot-up” program from FLASH memory. This program first checks its system for hardware errors. It then reads the “RUN-PROGRAM” switch to decide which mode to operate: the terminal mode or run the dispenser program. In the run mode, the boot program copies the dispenser program from the FLASH memory into the RAM. It then exits the boot program and runs the dispenser program. The controller continues to run the dispenser program until the power is removed. Under the program mode, the boot program runs as a terminal as described in the previous section. One of the functions in the terminal mode is to load the dispenser program into the FLASH memory. Loading a program into the dispenser controller takes a set of typed commands in four steps:

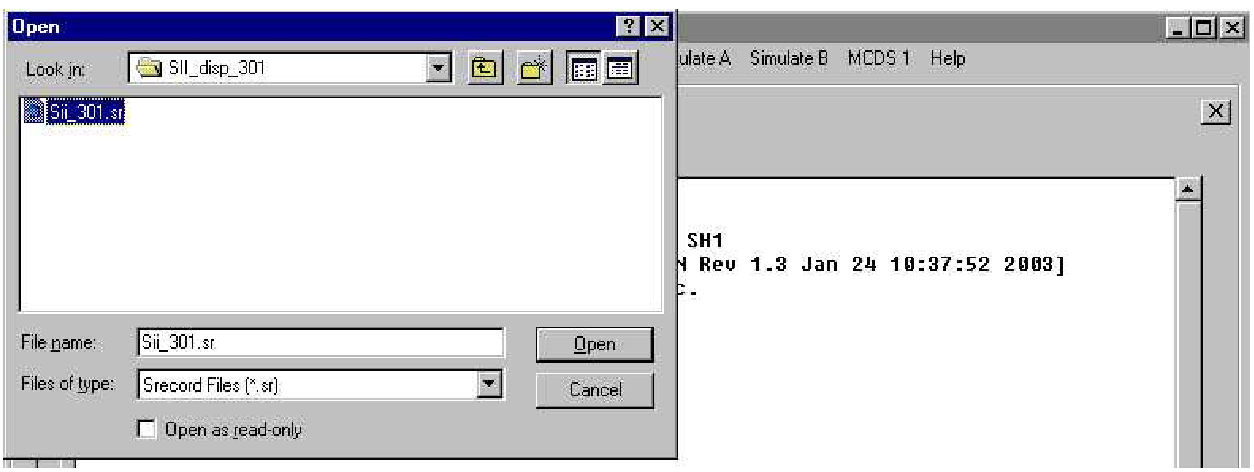
1) The first step is opening the program file on the computer.
2) Second is typing the load command: “L” and Enter-Key at the terminal cursor.
3) Third is downloading the program to RAM.

4) Fourth is saving the program from the RAM to the FLASH memory.

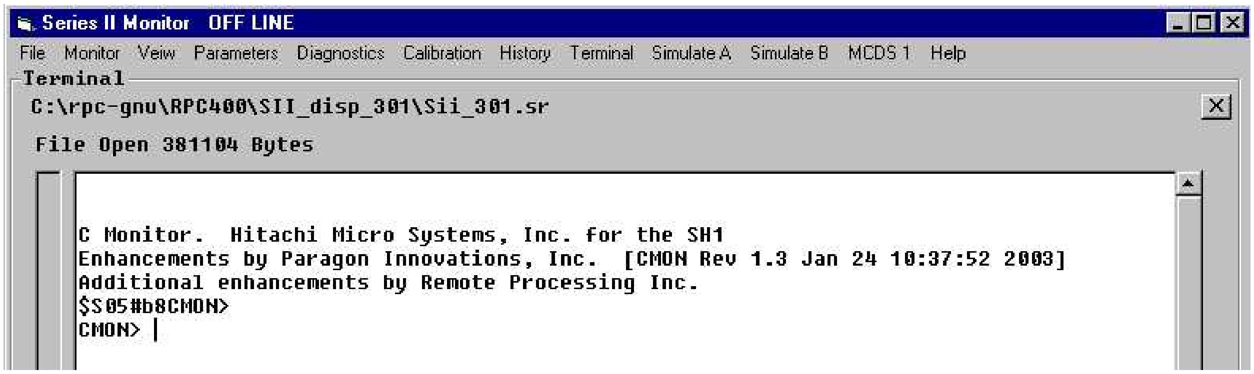
To load a dispenser program into the controller, bring up the Terminal window and put the controller in the terminal mode as described in the previous section. Click on either the “File” main menu item then the “Open” sub menu item, or the “Terminal” main menu item then the “File Open” sub menu item.



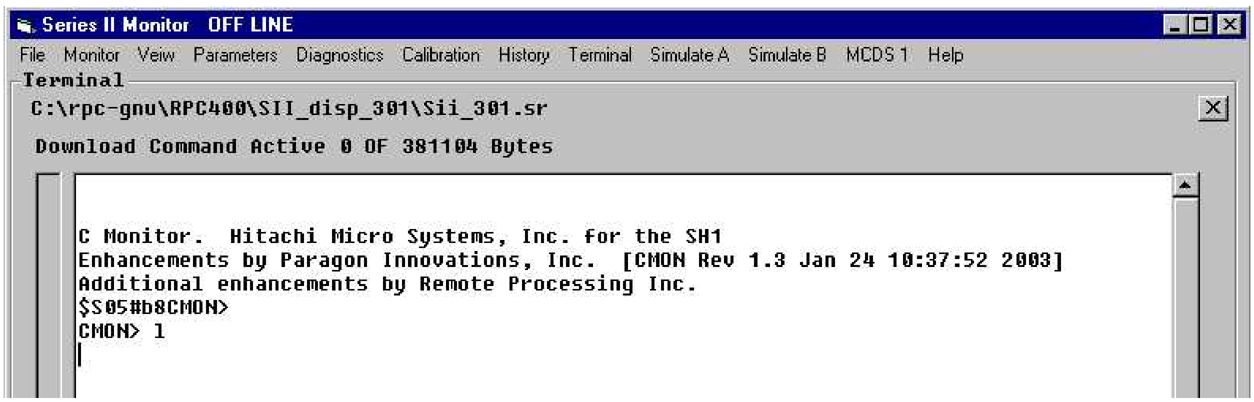
The standard Window’s “File Open” dialog box will appear. The file type to open will have an “.sr” extension, which is called an S-Record file. The example below shows the dispenser program “SII_301.sr” which stands for Series 2 rev 3.01. After clicking on the “Open” button, the Tool will check the file to determine that it truly is an S-Record.



After the file passes the check, the status lines will show the path, the name of the file, and the file size. If the file is not an S-record type, the status lines will indicate that the file is invalid.

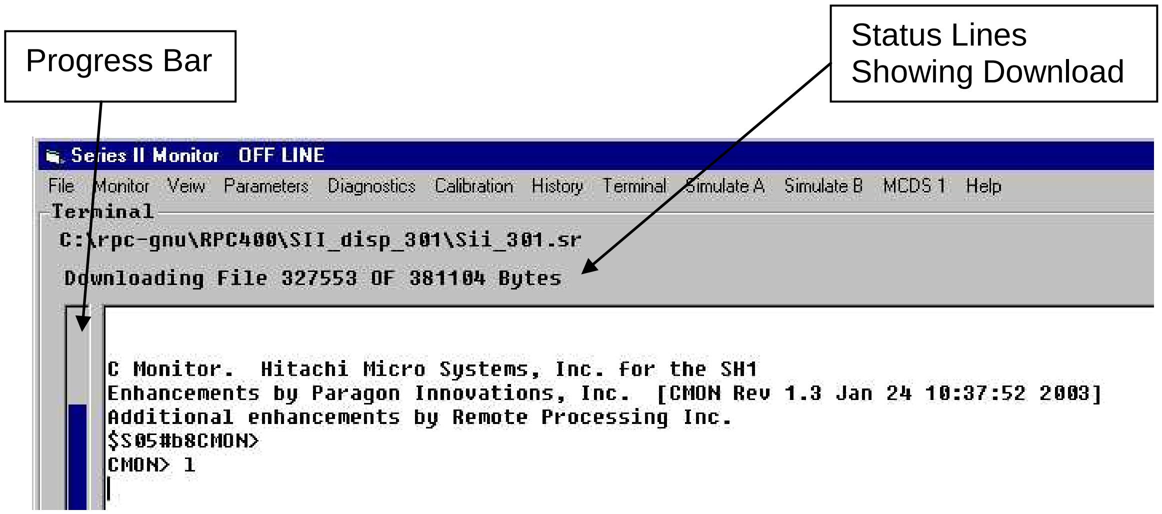


Next enter an upper case “L” or a lower case “l” and hit Enter. This puts the controller in the download ready mode. The status lines indicate this mode is active.

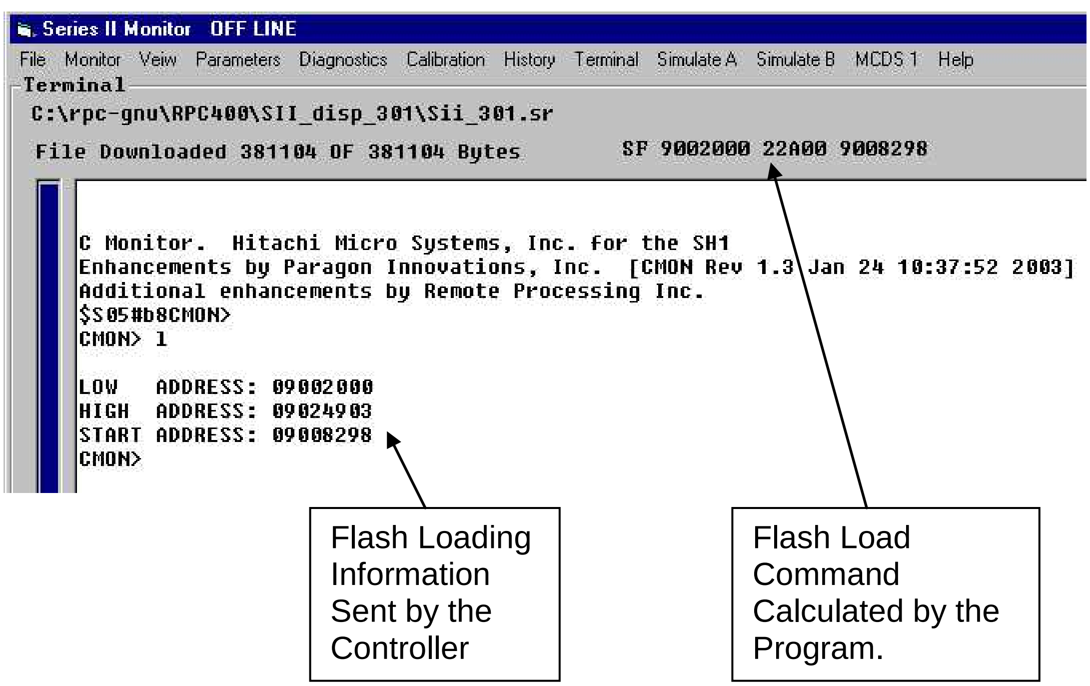


Next click on the “Terminal” main menu item and then click on the “Download” sub menu item to start downloading the program into the controller’s RAM.

The status lines will indicate how much of the program was sent to the controller. A progress bar on the left gives a visual indication of the progress. Downloading will be complete when the bar rises all the way to the top. The status lines will also indicate when the download is complete.

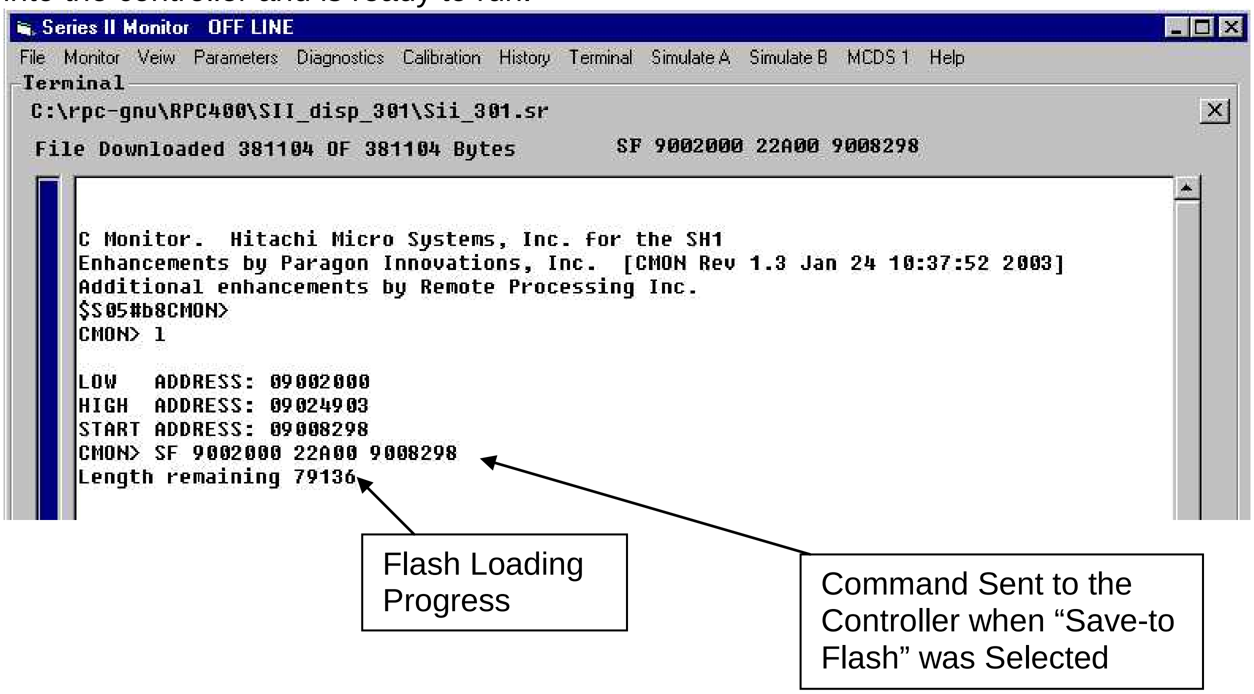


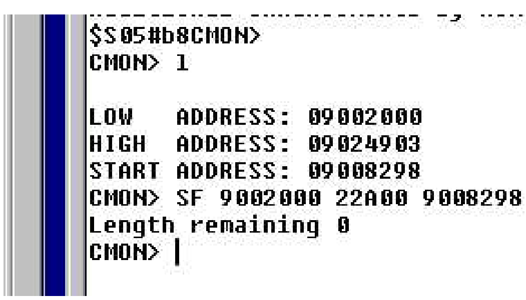
When the download is completed, the controller sends the program size and the location addresses to the Terminal for copying the program to the FLASH. The Tool will automatically calculate the size of the program and construct the command to start the process.



Next click on the "Terminal" main menu item and the "Save to Flash" sub menu item. This will start transferring the program from the RAM to the FLASH.

The “Save-to-Flash” command will be sent to the controller and will automatically appear after the cursor. The controller will send back information on the progress by reporting the length of program remaining to save. The save is complete when the length remaining goes to zero and the prompt returns. The dispenser program is loaded into the controller and is ready to run.



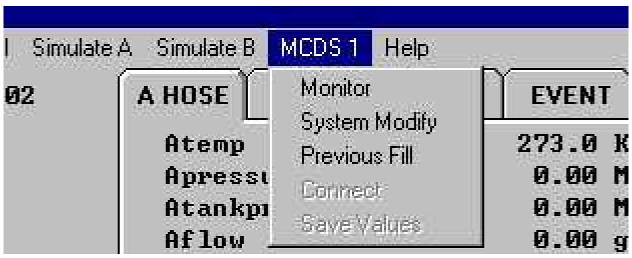


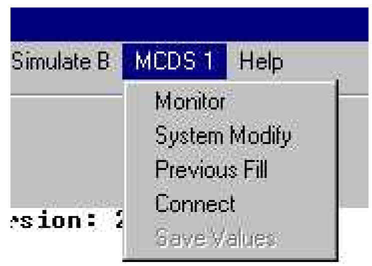
To run the dispenser, move the “RUN-PROGRAM” switch to the left in the run position and cycle the power.

34. MCDS1

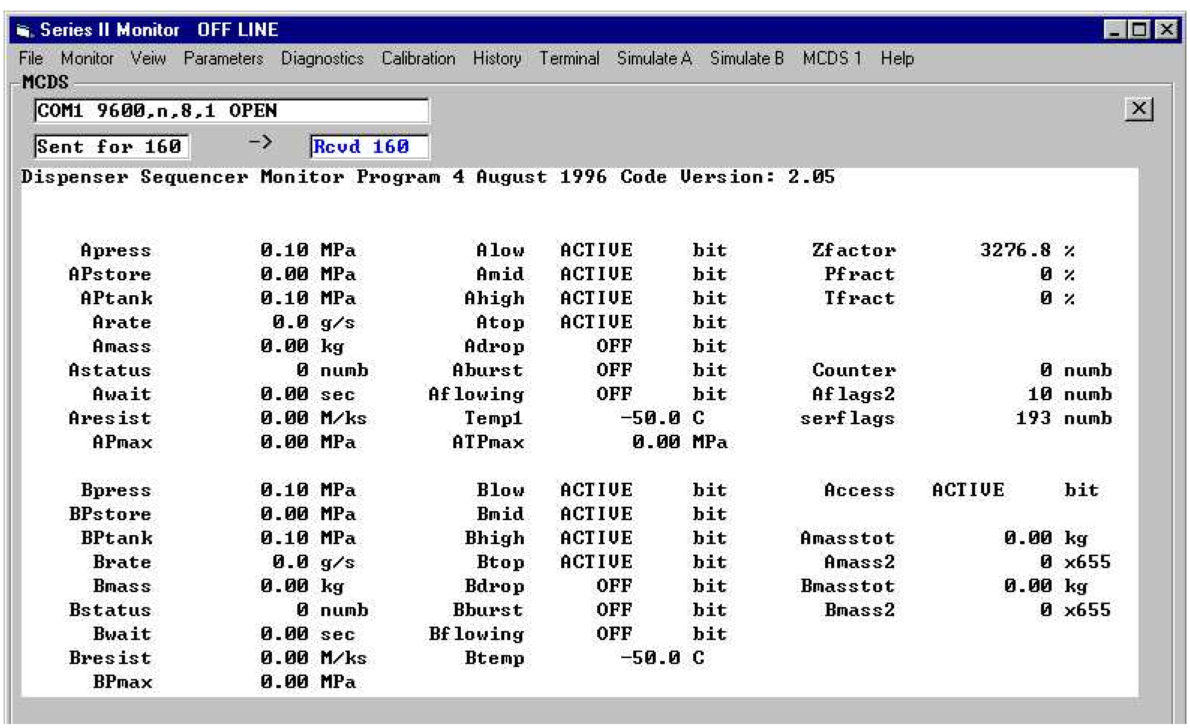
Under the MCDS1 main menu item is a list of panels that interface with the previous generation of ANGI MCDS dispensers. The panels match the MSDOS based DMON program which was originally used for this purpose. The panels are:

1) Monitor: Brings up fill variables that are continuously updated to monitor the actions of a fill sequence.
2) System Modify: Brings up the calibration parameters. The parameters can be edited and saved to FLASH memory.
3) Previous Fill: Brings up the fill results.

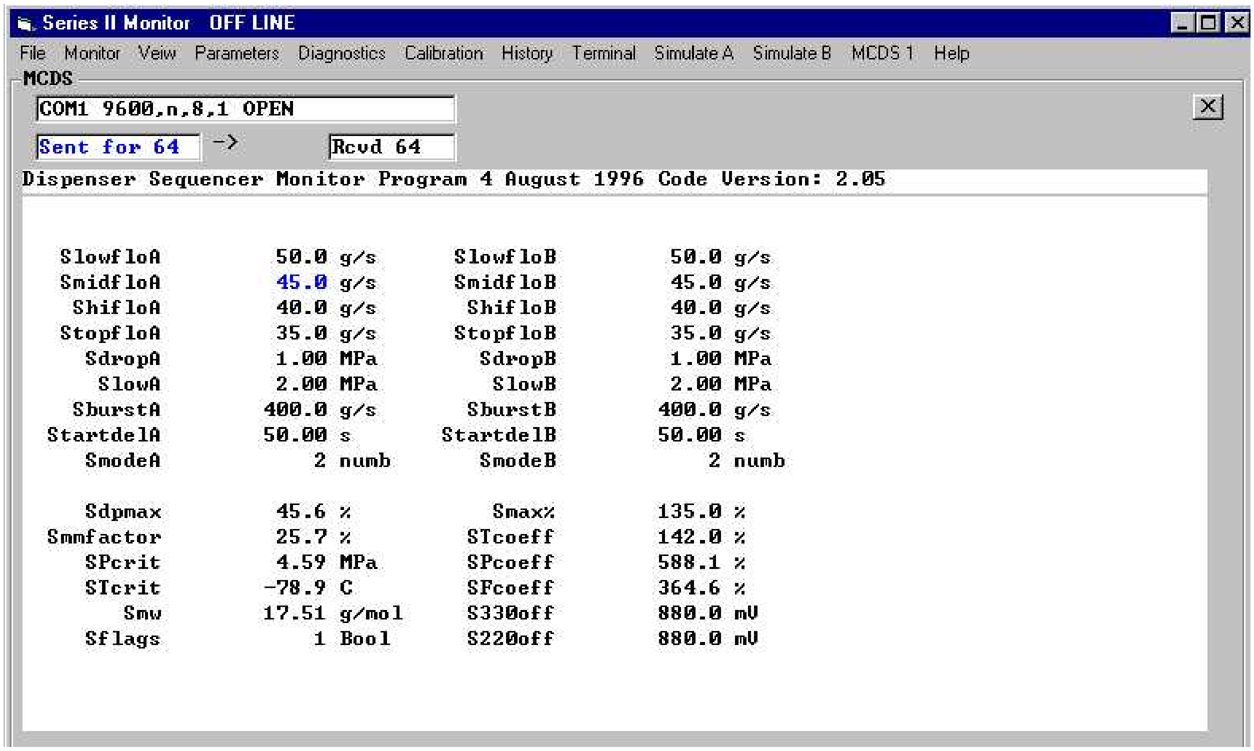




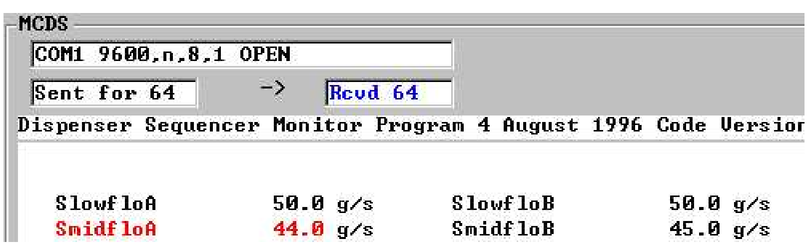
Below is the monitor panel. Clicking on the "Monitor" sub menu item opens the monitor panel. The "Connect" sub menu item will activate when a panel is opened. The MCDS dispenser controller is connect to a computer through an RS232 link box. With the box and cable connected, click on the "Connect" sub menu item. The Tool will start sending data. The "Sent for X" and "Rcvd X" status boxes will indicate the communication action. The Tool will first send for the program date and revision level, then monitor the variables. All the variables will be refreshed three times per second.



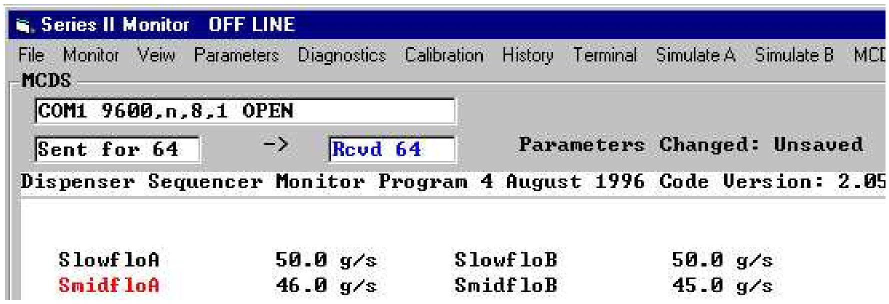
Below is the System Modify panel. Clicking on the “Connect” sub menu item will upload the version, program date, and parameter values from the MCDS controller. If the Tool is already connected in another panel, switching between panels will also perform an upload. The parameters can be edited on the text screen by clicking on the number. The number will be highlighted in blue.



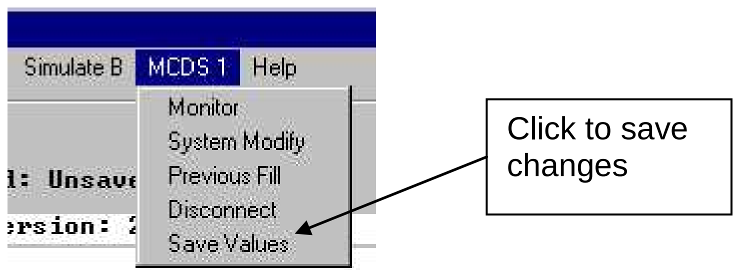
The number and name will be highlighted in red when its value is changed. The standard Windows mouse click, select, and replace actions work in the value text field. The decimal point will remain fixed. Press the Enter Key to send the number to the MCDS controller. Pressing the Escape Key will abort the change and return the original number.



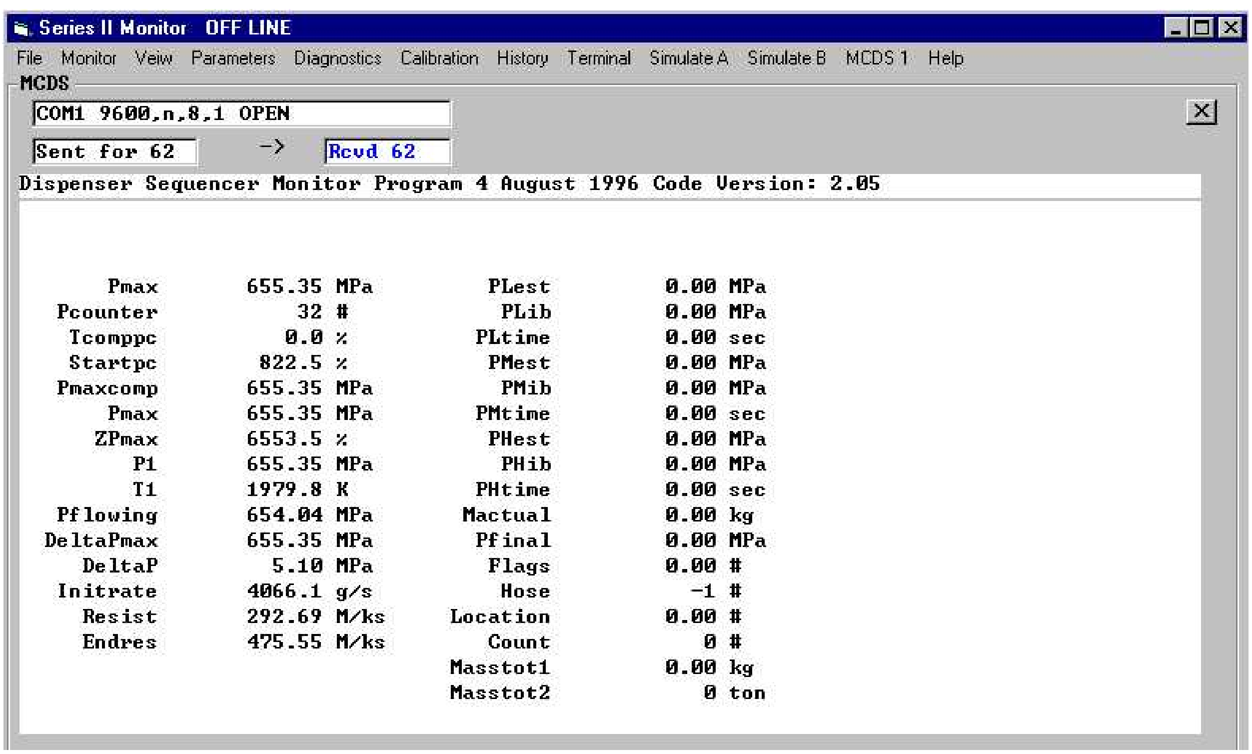
After sending the number to the MCDS controller a status line will report “Parameters Changed: Unsaved,” indicating the new value has not been save to the FLASH memory. If the power is removed from the controller at this point, the value will revert back to the original number.



The "Save Values" sub menu item will activate after any value edit. Click on the "Save Values" sub menu item to save the new parameter values to the controller's FLASH.



After saving the edited values, the status line will revert to its original blank state and the text highlighting will be removed. The "Previous Fill" panel shows the values of the variables captured during a complete fill. Only the most recent fill is retained.



ANGI SERIES II DISPENSER

Technical Function Manual

Rev 11

WARNING

1. SAFETY

- Read this entire manual before operating, servicing, adjusting, repairing or maintaining this Equipment.
- Never adjust or repair machinery while it is in operation. Always stop the engine or electric motor before cleaning, servicing or repairing. Place all controls in the off position to prevent accidental restarting. Before restarting, make sure that all tools and other materials are removed from the equipment.
- Do not wear loose clothing around machinery. Loose clothing: neckties, rings, wristwatch, bracelets, hand rags, etc. are potential hazards.
- Do not smoke within 50 feet of the unit
- Make sure you are equipped with all required safety equipment: hearing protection, safety glasses, hard hats, safety shoes and fire extinguisher.
- Do not modify the fuel station or its systems.
- Do not tamper with, modify, or bypass fuel station safety and shutdown equipment.
- Do not exceed maximum allowable fuel station pressures and temperatures.
- Record operating hours, maintenance work, and repairs etc. in a logbook.
- ANGI Energy Systems, Inc. reserves the right to make changes or modifications to the equipment designs without notice.
- ANGI must authorize all modification to this equipment. Any unauthorized modification to this equipment and or software will void the warranty. Modification may damage the equipment and cause bodily injury.
- ANGI disclaims any responsibilities whatsoever to the customer or to any person for injury or damage to, or loss of, property or value resulting from the use of its products which have been subjected to misuse, accidents, misapplied, repaired by unauthorized person, or improperly installed.
- EXPLOSIVE HAZARD DO NOT DISCONNECT WHILE THE CIRCUIT IS LIVE OR UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITABLE CONCENTRATIONS.
- The Control Board is sutible for use in Class 1, Division 2 groups D

NOTICE

This manual is as current as possible at the time of printing and is subject to change without notice. For information not co vered in this manual or further clarification, contact ANGI Customer Service at 1-800-934-5219

- CONTRACTOR OR INSTALLER: Leave this manual with the Unit station after installation is complete.

- CUSTOMER: Retain this manual for future reference.

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1. ANGI SERIES II Operation

1.1 ANGI SERIES II Description

The ANGI SERIES II is a microprocessor controlled single or two hose dispenser sequencer. Two hose dispensers come with the option of a shared supply (single valve / meter) or an independent supply (dual valve / meter). The single meter configuration allows for only one hose to operate at a time while the dual meter configuration allows for simultaneous use of both hoses. The software uses independent sequence functions of each hose for both configurations. The software contains two fill algorithms: 1) A pressure target algorithm based on a summary of the American Gas Association (AGA) supercompressibility tables that calculates a temperature compensated value for final fill pressure based on measured ambient temperature. An empirical value is derived to compensate for the effect of compression heating. 2) A mass target algorithm based on the Gas Technology Institute (GTI) temperature compensated gas density formula. Compression heating is figured into the mass target formula based on a mass to pressure rise measure of tank size.

The empirical value is derived from Table 1 of a paper titled "Microprocessor Control of Natural Gas Vehicle Fast Fills" by Dr. E. J. Farkas of the Canadian Gas Research Institute presented at the 1992 International Gas Research Conference.

The ANGI SERIES II control hardware consists of a Hitachi SH1 microprocessor running a single dedicated program that operates the hardware and contains the sequencer algorithms. The program is written in the C programming language and compiled with a GNU compiler (RPC-GNU). The micro resides on a pc board with 1 Meg of RAM and 512K of EEPROM. It is attached to an interface pc board that holds the necessary 24v inputs, outputs, 120v triac outputs, 4-20mA analog inputs, RS485 com ports, pulse counters, real time clock, LCD display power loss ride through, and ESD relay driver output. One RS232 monitoring and programming port resides in the electrical cabinet for service use. One electrically isolated RS485 com port is provided for a multidrop connection for remote access monitoring. Mass flow is measured by Micromotion core processor flow meters that connect to the system by an RS485 link using a RTU Modbus protocol. Update rate is 40 ms. Customer interface is an ANGI proprietary LCD display connected by an RS485 link using a custom ASCII character protocol. Update rate is 100 ms. A keypad for price entry is provided for the attendant behind locked door access. Pressure is measured by four 20 mA sensors. All components external to the main electrical panel are connected through off-the-shelf, intrinsically safe current limiting barriers.

1.2 Measurement Units

Engineering units used in the Series II ANGI dispenser control program are SI units. Common units are:

g	gram	mass
MPa	megapascal	pressure
g/s	gram per second	flow
g/cm3	grams per cubic centimeter	density
K	Kelvin	temperature
s	seconds	time
mV	milliVolts	electromotive force
mA	milliAmps	electric current
Ω	ohm	electric resistance

Other units mentioned are:

Mass:

Kg	Kilograms
LB	Pounds
EGal	Gasoline equivalent gallon
Eliter	Gasoline equivalent liter
SCM	Standard cubic Meter (at atmosphere)

Pressure:

Bar	barometric pressure
PSI	Pounds per square inch

Flow:

Lbs/min	Pounds per minute
SCFM	Standard cubic feet per minute (at atmosphere)

Temperature:

C	degrees Celsius
F	degrees Fahrenheit

Mass conversion table

1 gram	1Kg	1 LB	1 EGal	1 Eliter	1 SCM	=
1	1000	453.6	2567.4	667.7	769.1	Grams
0.001	1	0.4536	2.5674	0.6677	0.7691	Kg
0.0022	2.205	1	5.66	1.4720	1.6955	Lbs.
0.0003895	0.3895	0.1767	1	0.2601	0.2998	EGal
0.0014977	1.4977	0.6793	3.8451	1	1.1519	Eliter
0.0013002	1.3002	0.5898	3.3382	0.8682	1	SCM

Pressure conversion table

1 MPa	1 Bar	1 PSI	=
1	0.1	0.006895	MPa
10	1	0.06895	Bar
145.04	14.504	1	PSI

Flow conversion table

1 g/s	1 lbs/min	1 SCFM	=
1	7.5597	0.36296	G/s
0.13228	1	0.04801	Lbs/min
2.7551	20.828	1	SCFM

Temperature conversion table

^oC (Degrees Centigrade)	**K (Kelvin)**	**^oF** (Degrees Fahrenheit)
$^oC = {}^oC$	$K = {}^oC + 273.16$	$^oF = {}^oC \times 1.8 + 32$
$^oC = K - 273.16$	$K = K$	$^oF = K \times 1.8 - 459.69$
$^oC = ({}^oF - 32)/1.8$	$K = ({}^oF + 459.69)/1.8$	$^oF = {}^oF$

1.3 Sequencer Operation

A normal fill sequence operates in the following way with the pressure target algorithm:

1 The process starts assuming the hose is pressurized from the previous fill. The control program notes a pressure drop in the fill hose if the nozzle valve is opened and the hose pressure equalizes with the vehicle's tank pressure. This sets up a sequence decision before the handle is turn on to start filling. A pressure drop indicates that the fill valve has opened to the vehicle tank. This sets a pressure drop flag in the program.

2 When the handle is operated, a discrete, hardwired signal is provided to tell the fuel management system a fill is requested at that dispenser (authorize). The system waits for an authorization signal from the fuel management system if it not present. When the authorization signal arrives or is already present, the sequence proceeds after one second. If the signal does not arrive within 2 minutes, the system shuts down and ignores the authorization signal from then on. The dispenser handle must be cycled to start again. If the preset sale feature is used the display will prompt the user for a final sale entry after the one second delay. A mass target stop point will be calculated from the entry based on the price-per-unit value.

3 With the handle on and the authorization signal present, the system is now in the fill sequence mode. A discrete hardware signal is provided to indicate this (filling). If the handle or authorization signal is removed from now on, the system will shut down immediately. The system will only restart when the handle is cycled and authorization is reapplied in step 2 above.

The system checks the state of the hose pressure drop flag. If a pressure drop flag is off, a "hose check" sequence is ran to test whether the nozzle valve is opened or closed. The sequencer turns on to high bank valve for 2 seconds or until the mass delivered is greater than a set parameter hose_mass. This pressurizes the hose if the hose valve is closed. (The hose_mass parameter should reflect the total amount of mass the hose can hold up to the maximum pressure at the lowest temperature).

If more mass as flowed through the hose than the parameter hose_mass and the pressure difference between before the charge and after does not indicate filling just a hose, it is assumed that a vehicle is connected to the hose and that the hose valve is open. The mass that was delivered is counted on the quantity display total and is assumed to be in the vehicle tank.

If less mass as flowed through the hose than the parameter hose_mass and the pressure difference between before the charge and indicates just a hose was filled, the system waits for a pressure drop. It is assumed the nozzle valve is closed. The mass that was delivered is not counted on the quantity display total. If no pressure drop occurs within 2 minutes, the system shuts down and waits for the dispenser handle to be cycled.

4 When a pressure drop has occurred, the system waits for the pressure and flow to settle. The mass delivered in this wait period is not counted on the quantity display total. The pressure is considered settled when the instantaneously measured pressure is within bounds to a pressure over time averaging value. The flow is considered settled when it is under a low cutoff value. After the pressure and flow are settled, the pressure sensor value is stored. This is assumed to be the pressure in the vehicle tank. The ambient temperature value is also stored.

Initial_pressure = Pressure
Initial_temperature = temperature

If the flow does not settled after 10 seconds, the system faults assuming a leak or faulty meter reading.

5 The program takes the initial tank pressure and ambient temperature values and iteratively calculates the temperature compensated full tank pressure using the supercompressibility tables. This result is the full tank pressure after compression heating is dissipated. Next an empirical temperature-pressure factor for compression heating multiplied to the above full tank pressure value. This factor generates the final target pressure. The fill sequence will stop at this pressure and end the fill. The pressure in the tank is expected to settle to a value after the gas cools off to the ambient temperature. This should give a standard “full tank mass” regardless of the ambient temperature. This final target pressure is checked against an absolute maximum value for the tank and is limited to the maximum value to keep from over-pressurizing the tank. Then the initial pressure is checked to 95% of the final target pressure to determine whether the tank is already close to full. If it is, this condition is flagged and the fill is aborted. The system now will fill the vehicle tank to the final target pressure.

PFinal_target (pmax)

6 The system now will fill the vehicle tank to the low bank target pressure. The low bank target is set lower than the final target by a static difference:

Pto_mid = 3MPa (typically)
PLow_target = PFinal_target – Pto_mid

The system opens the solenoid valve to the low bank. The program checks for flow. The program will skip the low bank step if no flow is detected. It is assumed the valve is stuck. The following initial resistance calculations are postponed for the next bank. Maximum flow rate and pressure are recorded when the flow rate has peaked and is steady, i.e. not increasing and also after 2 seconds. From the difference between flowing pressure, static pressure, and the maximum flow rate, a vehicle fill line resistance is calculated from the following equation:

Pflowing: pressure recorded by the sensor upstream of the hose during max flow.
Pstatic: pressure at end of the hose.

Pstatic = Initial_pressure
Resistance = (Pflowing - Pstatic) / flowrate^2

Note that under sonic flow conditions, the pressure differential through the line cannot be more than 56% of Pflowing (for natural gas) even though the tank pressure may be below this pressure (see *fluid flow theory*).

If **Pflowing – Pstatic > Pflowing * 56%** then **Resistance = Pflowing * 56% / flowrate^2**
Init_resistance = Resistance

The resistance is calculated at the beginning of the fill at maximum detected flow after 2 seconds from the low bank start. The resistance calculation stops when subsonic flow conditions are reached. If the subsonic condition already exist, the resistance is calculated once at the start at maximum flow after 2 seconds.
Throughout the fill, the tank pressure can be estimated using the following equation:

Tank pressure: theoretical pressure in the tank. Only valid in the subsonic flow condition.
Tank pressure = Pflowing - Resistance * flowrate^2

7 If the mass flow rate drops below a preset limit (normally 50g/s **SlowFlo**) or when the estimated tank pressure is at the Plow_target pressure, the sequencer shuts off the lowbank valve. A sample of the supply pressure is recorded right before the valve is closed.

low_ibpressure: supply pressure sample at bank stop
low_ibpressure = Pflowing

8 The system waits for the pressure and flow to settle. If the pressure and flow does not settle after 10 seconds the program faults assuming a leak or erroneous flow value. The pressure between bank fills is measured and assumed to be the vehicle tank pressure.

Low_tank = pressure (from sensor with valves off no flow)

9 The vehicle tank pressure is compared against the last recorded target pressure before the sequencer left low bank. Their difference from the supply pressure is used to calculate a percentage error in the resistance value previously used. The error is used to correct the previous resistance value. The error and new resistance are recorded.

Resist_error = (low_ibpressure – PLow_target) / ((low_ibpressure– Low_tank)
New_resistance = Resistance * Resist_error
Mid_ resistance = New_resistance

10 The mid bank valve is turned on to resume the fill. A mid bank target is calculated.

Pto_hi = 1.5MPa (typically)
Pmid_target = PFinal_target – Pto_hi

11 If the mass flow rate drops below a preset limit (normally 45g/s **SmidFlo**) during the mid bank fill or when the estimated tank pressure at the Pmid_target pressure, the sequencer turns off the midbank valve. A sample of the supply pressure is recorded right before the valve is closed.

mid_ibpressure: supply pressure sample at bank stop
mid_ibpressure = Pflowing

12 Again, the system waits for the pressure and flow to settle. If the pressure and flow does not settle after 10 seconds the program faults assuming a leak or erroneous flow value. The pressure between banks is measured and assumed to be the vehicle tank pressure.

Mid_tank = pressure (from sensor with valves off no flow)

13 The vehicle tank pressure is compared against the recorded last calculated tank pressure before the sequencer left mid bank. Their difference from the supply pressure is used to calculate a percentage error in the resistance value previously used. The error is used to correct the previous resistance value. The error and new resistance are recorded.

Resist_error = (mid_ibpressure – PMid_target) / ((mid_ibpressure – Mid_tank)
New_resistance = Resistance * Resist_error
High_ resistance = New_resistance

14 The highbank valve is opened. A high bank target is calculated.

Pto_full = 0.25MPa (typically)
PHigh_target = PFinal_target – Pto_full

15 When the estimated tank pressure is at the Phigh_target pressure or If the mass flow rate drops below a preset limit (normally 40g/s **ShiFlo**) during the high bank fill, the sequencer shifts to the off position. The highbank valve is closed. A sample of the supply pressure is recorded right before the valve is closed.

high_ibpressure: supply pressure sample at bank stop
high_ibpressure = Pflowing

16 After pressure and flow have settled, the tank pressure is measure for the last time.

High_tank = pressure (from sensor with valves off no flow)

17 The vehicle tank pressure is compared against the recorded last calculated tank pressure before the sequencer left high bank. Their difference from the supply pressure is used to calculate a percentage error in the resistance value previously used. The error is used to correct the previous resistance value. The error and new resistance are recorded. The fill is complete.

Resist_error = (high_ibpressure – PHigh_target) / ((high_ibpressure – High_tank)
New_resistance = Resistance * Resist_error
Final_ resistance = New_resistance
Final_pressure = High_tank

18 After the fill is complete or if an abnormal shutdown occurs, the system will update the totalizers and data in the fill log. The totalizers and fill log are stored in non-volatile memory. A discrete signal is provided to indicate the fill is complete to the fuel management system (done). The signal to indicate the system is in fill mode (filling) is turned off. The mass quantity display count and sale amount is frozen.

If a preset sale amount is entered the fill will stop when the accumulated mass value hits a calculated target. All other stop and target conditions are ignored, as the mass stop target becomes the highest priority. The target is calculated from the preset sale entry, the current mass flow, a static mass amount parameter, and a duration parameter. The bank fill is stopped an amount before the desired target is reached. The fill then "coasts" to the final amount. The actual sale amount is limited to the entered preset sale amount. The parameters can be adjusted for the best accuracy.

Stop_Mass = (Sale_Preset / Price_per_Unit) * grams_per_unit i.e. final target
Coast_mass = mass_flow * coast_factor - coast_adder i.e. stop look-ahead
Stop_Target = Stop_Mass - Coast_mass
When Mass >= Stop_Target -> **close valve to stop fill**
Final_sale = Round_and_Limit ((stop_mass / grams_per_unit) *** price_per_unit)**

Anytime the system is shutdown by an error, or an error occurs while the system is idle, a discrete signal is provided (error or event). Error codes will be put in the pressure readout portion of the user LCD display to indicate which error(s) is present or have happened during a fill. Fill sequence errors are cleared when the handle is turned to the start position. Present hardware errors remain on the display until they are fixed. Hardware errors will not allow a fill sequence to start.

2. System Parameters

2.1 System Parameters General Description

System parameters allow calibration changes to be made on the system. These changes are only allowable when vehicles are not being filled from the dispenser. System parameters should only be adjusted when absolutely necessary and by a trained technician.

Note: It is possible to cause the dispenser miss-operate by altering system variables.

System parameters can be adjusted using the ANGI SERIES II monitoring program loaded on a Windows based computer. The monitor program connects to the dispenser control through a standard 9-pin RS232 cable to the computer serial port. Computer without a 9-pin serial port can use a USB to serial port converter. System parameters can also be adjusted using the or through the dispenser's keypad and LCD display running with program rev. 3.06 or higher. See section 5.

IMPORTANT: ONLY VALUES WITH (*) SHOULD BE CHANGED, UNLESS BY AN ANGI TECHNICIAN

2.2 System Parameters Common to Both Hoses

#	Parameter	Default	Function
0	**Sdpmax**	45.6	(%) This value should be calculated from the ratio of specific heats (k) for natural gas used. It is the maximum pressure drop under sonic flow conditions at the fill line exit point. May need recalculation if composition is abnormal. Sdpmax = (2/(k + 1))^(k/(k - 1))
1	**Smmfactor**	2.5700	(g/pulse) This is the Micromotion pulse calibration factor when using a mass pulse input train. Set to 2.57 for D38 meter (2.57g/pulse).
2	**Spcrit**	4.59	(MPa) This is the critical pressure of the natural gas used. May need recalculation if composition is abnormal.
3	**Stcrit**	194.1	(K) This is the critical temperature of the natural gas used. May need recalculation if composition is abnormal.
4	**Smw**	17.51	(g/mol) This is the weighted average molecular weight of the natural gas used. May need recalculation if composition is abnormal.
5	**Smax%**	135.0	(%) Maximum percentage over temperature compensated pressure allowed in hose. Pressures above Smax*Pmax will shut down the filling process. Set at 135%
6	**Sdelay**	2.00	(sec) A set delay after a valve is turned on before pressure and flow measurements are used for resistance calculations and stop targets. Allows for the flow to accelerate and stablize.
7	**Stank_dwell**	1.00	(sec) This is the minimum time dwell between bank shifts for allowing the pressure and flow to settle before making a tank pressure measurement. (obsolete / not used)
8	**Spress_settle**	0.25	(MPa) This is the window of immediate pressure reading to a slow integrated pressure average to detect whether the pressure has settled.
9	**Testbits**	0	(numb) Diagnostic bits that turn internal functions on and off. This parameter function is normally disabled in the controller's program.
10	**Smass_unit**	0	(numb) This value selects the mass quantity display unit from a list of commonly used units. The g/unit conversion is placed in the Smassconv parameter. 0 = custom, 1 = Lbs, 2 = Kg, 3 = EGals, 4 = Eliters, 5 = SCM.
11	**Smassconv**	2567.4	(g/unit) This is the value to display custom mass units other that the selection available in Smass_unit parameter.
12	**Smass_decimal**	3	(numb) This is the number of decimal points in the mass quantity display field.
13	**Ssale_decimal**	2	(numb) This is the number of decimal points to display in the total sale display field.

#	Parameter	Default	Function
14	**Pulses_per_qty**	1000	(ppu) This number calibrates the mass pulse output. The value determines the number of pulses per mass display unit. Example if display = 1.000 Kg then 1000 would send 1 pulse per gram.
15	**Pulses_per_sale**	100	(ppu) This number calibrates the sale pulse output The value determines the number of pulses per sale display unit. Example if display = 1.00 $ then 100 would send 1 pulse per penny.
15	**Qty_frequency**	100	(Hz) Sets maximum pulses per second out of the mass pulse output.
17	**Sale_frequency**	25	(Hz) Sets maximum pulses per second out of the sale pulse output.
18	**Temperature_sim**	294.1	(K) Sets the temperature used by the internal fill simulator.
19	**Tank_size**	2500	(ft3) Sets the water volume size of the simulated tank.
20	**Resist_sim**	260.0	(Pa_s2/g2) Sets the hose resistance used by the internal fill simulator.
21	**low_sim**	31.00	(MPa) Sets the simulated low bank pressure.
22	**mid_sim**	31.00	(MPa) Sets the simulated mid bank pressure.
23	**high_sim**	31.00	(MPa) Sets the simulated high bank pressure.
24	**Time_zone**	x	(numb) holds the time zone for where the dispenser is in the world. –12 to + 12. Eastern Standard Time = -5.
25	**Serial_number**	x	(numb) Serial number of the dispenser
26	**Spc_baud**	803 hex	(numb) Encoded number that sets the baud rate, parity, data bit size, and stop bit size for serial port 5 RS485 link.
27	**Sprice_decimal**	3	(numb) Fixes the decimal point place on the display if use_price_decimal signal configuration bit is on.
28	**Spc_com_timeout**	400	(ms) Sets the Gilbarco Comm link non-response time out.
29	**Overfill_factor**	10	(%) Threshold for indicating an overfill a percent above final target. Shared by both hoses. (Rev. 3.90 and 4.05)

2.3 Hose Specific System Parameters Program Rev 3.xx

A	B	Parameters	Default	Function
30	**70**	**SlowFlo**	50.00 (*)	(g/s) Below this gas flow rate, the dispenser will switch from low bank to mid bank.
31	**71**	**SmidFlo**	45.00 (*)	(g/s) Below this gas flow rate, the dispenser will switch from mid bank to high bank.
32	**72**	**ShiFlo**	40.00 (*)	(g/s) Below this gas flow rate, the dispenser will switch from high bank to off.
33	**73**	**StopFlo**	35.00 (*)	(g/s) Below this gas flow rate, the dispenser will switch from top bank to off in a four bank system.
34	**74**	**Sdrop**	1.00	(MPa) When the difference between a slow integrator of hose pressure and instantaneous pressure reaches this value, the drop flag will be set. This indicates to the system that a vehicle has been connected and the fill-valve has been opened causing a pressure drop in the hose.
35	**75**	**Slow**	1.00	(g/s) Low mass flow detection level for sequence progression. The flow level is checked after a valve is shut off. The sequence is aborted if still above this value for 10 seconds. Unused in rev. 3.06 and earlier.
36	**76**	**Sburst**	400.00	(g/s) Above this gas flow rate it is assumed that the hose has burst. The valves are shut off if the flow rate remains above this value for more than 1 second. The fill is aborted.
37	**77**	**Sstartdel**	50.00	(sec) If the handle is operated but a pressure drop is not detected when the fill-valve on the end of the hose is opened, this is the wait time before the system cancels the fill.
38	**78**	**Smode**	2 (*)	(unitless) A hose mode selection. Mode 0 is for 16.5 MPa (2400psi) systems. Mode 2 is for 20.7 MPa (3000psi) systems. Mode 4 is for 24.8 MPa (3600psi) systems.
39	**79**	**Temp_cal**	x	(K/dac) This is the coefficient used to scale the analog temperature probe input.
40	**80**	**Temp_freeze**	x	(dac) This is the value of the 10bit digital to analog converter value at freezing 0 C (32 F).
41	**81**	**No_Flow_Time**	0.00	(Sec) This value sets a time delay before switching banks on detecting low flow. Program rev. 3.82.
42	**82**	**press_dac_zero**	181	(dac) This is the value of the 10bit digital to analog converter value at 0 Mpa (4 mA)
43	**83**	**press_dac_range**	52000	( ) This is the value of the scaler to convert the pressure input to 34.50 Mpa (5000psi)

A	B	Parameters	Default	Function
44	**84**	**flow_dac_zero**	0	(dac) This is the value of the 10bit digital to analog converter value at zero flow: 181 if 4 mA, 0 if 0 volts.
45	**85**	**flow_dac_max**	900	(dac). This is the value of the 10bit digital to analog converter value at max flow.
46	**86**	**flow_cal**	350.00	(g/sec) This is the value of the scaler to convert the analog flow input to 340.00 g/sec
47	**86**	**meter_temp_cal**	10	(ratio) This is the value to scale Micromotion temperature floating point register value to the system value. 1.000000 C to 1.0 C
48	**88**	**meter_flow _cal**	100000	(ratio) This is the value to scale Micromotion flow rate floating point register value to the system value. 1.000000 Kg/sec to 1.00 g/sec.
49	**89**	**meter_mass_cal**	10000	(ratio) This is the value to scale Micromotion mass floating point register value to the system value. 1.000000 Kg to 1 g.
50	**90**	**press_unit**	2	(numb) Selects the pressure units on the LCD display. 0 = Bar, 1 = %, 2 = PSI
51	**91**	**signal_config**	x	(numb) Individual bits that selects signal sources and optional functions. (See Table)
52	**92**	**lowtarget**	100 (*)	(%) A hose value as a percentage of final pressure target to stop the low bank fill. An alternative to Ato_mid.
53	**93**	**midtarget**	100 (*)	(%) A hose as a percentage from final pressure target to stop the mid bank fill. An alternative to Ato_high.
54	**94**	**hightarget**	100 (*)	(%) A hose value as a percentage final pressure target to stop the high bank fill and complete An alternative to Ato_full.
55	**95**	**valve_off_dwell**	0.80	(sec) This is the value to compensate for the off delay some types of valves i.e. air actuated valves. The flow continues for a specific time after the signal is removed from the valve. 0 for fast-action valves.
56	**96**	**to_mid**	3.00 (*)	(MPa) A hose value subtracted from final pressure target to stop the low bank fill.
57	**97**	**to_high**	1.50 (*)	(MPa) A hose value subtracted from final pressure target to stop the mid bank fill.
58	**98**	**to_full**	0.25 (*)	(MPa) A hose value subtracted from final pressure target to stop the high bank fill and complete
59	**99**	**press2_dac_zero**	181	(dac) This is the value of the 10bit digital to analog converter value at 0 Mpa (4 mA) for the redundant check pressure sensor.
60	**100**	**press2_dac_range**	52000	(numb) This is the value of the scaler to convert the pressure input to 4.50 Mpa (5000psi) for the redundant check pressure sensor.

A	B	Parameters	Default	Function
61	**101**	**press2_trip**	200	(MPa) This is the fault trip value of the difference between the main pressure sensor and the secondary pressure sensor.
62	**102**	**bank_time_limit**	120 / 360	(sec) Maximum allowable time for a bank to be on. The sequence will shift to the next bank if this time is exceeded.
63	**103**	**mass_calibrate**	1.0000	(ratio) Mass measurement correction factor.
64	**104**	**pressure_trip**	30.34	(MPa) Static overpressure trip. Set 100 MPa below safety relief valves.
65	**105**	**delay_adjust_limit**	1.50	(MPa) A limit to the extra pressure added by a valve delay. Set to 0 for fast acting valves.
66	**106**	**pmax_fixed**	24.80	(MPa) Fixed final pressure target, no temperature compensation. Default value is for 3600 PSI.
67	**107**	**min_resist**	40.0 10.0*	(Pa_s2/g2) Minimum hose resistance limit. Maximum resist limit = 10 x Minimum resist limit.(added rev. 3.05) * indicates a high flow transit setting.
68	**108**	**hose_mass**	100 400*	(g) The amount of mass held by the hose at max pressure. Used for determining an open nozzle valve after a hose charge. The second value * is for high flow transit dispensers. (added rev. 3.05) * indicates a high flow transit setting.
69	**109**	**Pressure_dip**	400	(MPa/sec) Threshold to detect a sudden hose pressure drop during the fill. (rev 3.90)

Hose Specific System Parameters Program Rev 4.xx

A	B	Parameters	Default	Function
30	**75**	**SlowFlo**	50.00 (*)	(g/s) Below this gas flow rate, the dispenser will switch from low bank to mid bank.
31	**76**	**SmidFlo**	45.00 (*)	(g/s) Below this gas flow rate, the dispenser will switch from mid bank to high bank.
32	**77**	**ShiFlo**	40.00 (*)	(g/s) Below this gas flow rate, the dispenser will switch from high bank to off.
33	**78**	**StopFlo**	35.00 (*)	(g/s) Below this gas flow rate, the dispenser will switch from top bank to off in a four bank system.
34	**79**	**Sdrop**	1.00	(MPa) When the difference between a slow integrator of hose pressure and instantaneous pressure reaches this value, the drop flag will be set. This indicates to the system that a vehicle has been connected and the fill-valve has been opened causing a pressure drop in the hose.

A	B	Parameters	Default	Function
35	**80**	**Slow**	1.00	(g/s) Low mass flow detection level for sequence progression. The flow level is checked after a valve is shut off. The sequence is aborted if still above this value for 10 seconds. Unused in rev. 3.06 and earlier.
36	**81**	**Sburst**	400.00	(g/s) Above this gas flow rate it is assumed that the hose has burst. The valves are shut off if the flow rate remains above this value for more than 1 second. The fill is aborted.
37	**82**	**Sstartdel**	50.00	(sec) If the handle is operated but a pressure drop is not detected when the fill-valve on the end of the hose is opened, this is the wait time before the system cancels the fill.
38	**83**	**Smode**	2 (*)	(unitless) A hose mode selection. Mode 0 is for 16.5 MPa (2400psi) systems. Mode 2 is for 20.7 MPa (3000psi) systems. Mode 4 is for 24.8 MPa (3600psi) systems.
39	**84**	**Temp_cal**	x	(K/dac) This is the coefficient used to scale the analog temperature probe input.
40	**85**	**Temp_freeze**	x	(dac) This is the value of the 10bit digital to analog converter value at freezing 0 C (32 F).
41	**86**	**No_Flow_Time (Rev. >= 3.82)**	0.00	(Sec) This value sets a time delay before switching banks on detecting low flow.
42	**87**	**press_dac_zero**	181	(dac) This is the value of the 10bit digital to analog converter value at 0 Mpa (4 mA)
43	**88**	**press_dac_range**	52000	( ) This is the value of the scaler to convert the pressure input to 34.50 Mpa (5000psi)
44	**89**	**flow_dac_zero**	0	(dac) This is the value of the 10bit digital to analog converter value at zero flow: 181 if 4 mA, 0 if 0 volts.
45	**90**	**flow_dac_max**	900	(dac). This is the value of the 10bit digital to analog converter value at max flow.
46	**91**	**flow_cal**	350.00	(g/sec) This is the value of the scaler to convert the analog flow input to 340.00 g/sec
47	**92**	**meter_temp_cal**	10	(ratio) This is the value to scale Micromotion temperature floating point register value to the system value. 1.000000 C to 1.0 C
48	**93**	**meter_flow _cal**	100000	(ratio) This is the value to scale Micromotion flow rate floating point register value to the system value. 1.000000 Kg/sec to 1.00 g/sec.
49	**94**	**meter_mass_cal**	10000	(ratio) This is the value to scale Micromotion mass floating point register value to the system value. 1.000000 Kg to 1 g.

A	B	Parameters	Default	Function
50	**95**	**press_unit**	2	(numb) Selects the pressure units on the LCD display. 0 = Bar, 1 = %, 2 = PSI
51	**96**	**signal_config**	x	(numb) Individual bits that selects signal sources and optional functions. (See Table)
52	**97**	**lowtarget**	100 (*)	(%) A hose value as a percentage of final pressure target to stop the low bank fill. An alternative to Ato_mid.
53	**98**	**midtarget**	100 (*)	(%) A hose as a percentage from final pressure target to stop the mid bank fill. An alternative to Ato_high.
54	**99**	**hightarget**	100 (*)	(%) A hose value as a percentage final pressure target to stop the high bank fill and complete An alternative to Ato_full.
55	**100**	**valve_off_dwell**	0.80	(sec) This is the value to compensate for the off delay some types of valves i.e. air actuated valves. The flow continues for a specific time after the signal is removed from the valve. 0 for fast-action valves.
56	**101**	**to_mid**	3.00 (*)	(MPa) A hose value subtracted from final pressure target to stop the low bank fill.
57	**102**	**to_high**	1.50 (*)	(MPa) A hose value subtracted from final pressure target to stop the mid bank fill.
58	**103**	**to_full**	0.25 (*)	(MPa) A hose value subtracted from final pressure target to stop the high bank fill and complete
59	**104**	**press2_dac_zero**	181	(dac) This is the value of the 10bit digital to analog converter value at 0 Mpa (4 mA) for the redundant check pressure sensor.

A	B	Parameters	Default	Function
60	**105**	**press2_dac_range**	52000	(numb) This is the value of the scaler to convert the pressure input to 4.50 Mpa (5000psi) for the redundant check pressure sensor.
61	**106**	**press2_trip**	200	(MPa) This is the fault trip value of the difference between the main pressure sensor and the secondary pressure sensor.
62	**107**	**bank_time_limit**	120 / 360	(sec) Maximum allowable time for a bank to be on. The sequence will shift to the next bank if this time is exceeded.
63	**108**	**mass_calibrate**	1.0000	(ratio) Mass measurement correction factor.
64	**109**	**pressure_trip**	30.34	(MPa) Static overpressure trip. Set 100 MPa below safety relief valves.
65	**110**	**delay_adjust_limit**	1.50	(MPa) A limit to the extra pressure added by a valve delay. Set to 0 for fast acting valves. (See valve_off_dwell parameter)

A	B	Parameters	Default	Function
66	**111**	**pmax_fixed**	24.80	(MPa) Fixed final pressure target, no temperature compensation. Default value is for 3600 PSI.
67	**112**	**min_resist**	40.0 10.0*	(Pa_s2/g2) Minimum hose resistance limit. Maximum resist limit = 10 x Minimum resist limit.(added rev. 3.05) * indicates a high flow transit setting.
68	**113**	**hose_mass**	100 400*	(g) The amount of mass held by the hose at max pressure. Used for determining an open nozzle valve after a hose charge. The second value * is for high flow transit dispensers. (added rev. 3.05) * indicates a high flow transit setting.
69	**114**	**coast_factor** **(Rev. >= 4.00)**	1.200	(sec) A factor for calculating the look-ahead mass stop point for the preset sale feature. It is multiplied by the current mass flow to get a mass amount in grams. This mass amount is subtracted from a calculated mass target for the entered sale amount. This parameter is adjusted to get the actual mass ran close to the target.
70	**115**	**coast_adder** **(Rev. >= 4.00)**	15	(g) An amount added to the look-ahead mass described above to adjust the accuracy of low flow stops.
71	**116**	**Pressure_dip**	400	(MPa/sec) Threshold to detect a sudden hose pressure drop during the fill. (rev 4.05)
72	**117**	**spare**		
73	**118**	**spare**		
74	**119**	**spare**		

2.4 Signal Configuration Parameter Bit Definitions

The system parameters for the “B” hose are identical to the “A” hose. The variable name begins with a “B” instead of an “A.”

Bit	Name	Typ.	Function
0	**Use_meter_mass_flow**	On	The mass flow signal comes from the flow meter’s mass flow variable by the RS485 meter Comm link
1	**Use_meter_vol_flow**	Off	The mass flow signal comes from the flow meter’s volume flow variable by the RS485 meter Comm link. (not normally used).
2	**Use_analog_mass_flow**	Off	The mass flow signal comes from the 4-20Ma/0-5V analog input.
3	**Use_meter_volume_ total**	Off	The mass signal comes from the flow meter’s resetable volume totalizer. (not normally used).
4	**Use_meter_mass_ total**	On	The mass signal comes from the flow meter’s resetable mass totalizer.

Bit	Name	Typ.	Function
5	**Use_pulse_mass_counter**	Off	The mass signal comes from the pulse counter input from a meters pulse output.
6	**Use_meter_temperature**	Off	The temperature used for target calculation comes from the meter's internal gas temperature probe. (not to be used).
7	**Use_analog_temperature**	On	The temperature used for target calculation comes from the ambient temperature probe.
8	**Use_right_handle**	x	The right handle digital input is enabled if "On" for the hose on the right side of the dispenser.
9	**Use_left_handle**	x	The left handle digital input is enabled if "On" for the hose on the left side of the dispenser.
10	**Use_dual_display**	x	"On" if there are two displays per hose. "Off" if there is one display.
11	**Use_sale_preset (Rev. >= 4.00)**	Off	On to enable the sale preset feature.
12	**Use_auth1_input**	On	Enables the authorization 1 digital input. "Off" bypasses input.
13	**Use_auth2_input**	Off	Enables the authorization 2 digital input. "Off" bypasses input.
14	**Use_auth3_input**	Off	Enables the authorization 3 digital input. "Off" bypasses input.
15	**Use_tier_input**	Off	Enables the tier digital input to select the price tier. The keypad price tier selection is disabled.
16	**Use_pmax_fixed**	Off	The target pressure comes from the **pmax_fixed** parameter,not the temperature compensated value.
17	**Use_price_decimal**	Off	The decimal point in the price per unit display field is fixed by the Sprice_decimal parameter. "Off" the decimal point is entered with the keypad.
18	**Spc_comm_enable**	Off	Enables the Gilbarco communication link on Comm 5 RS485 port. "Off" defaults to Monitor link protocol.
19	**Use_ored_authorize**	Off	Adds the authorize digital input 1 signal to the Comm link authorize for bypass capability.
20	**Use_redundant_pressure**	Off	Enables the secondary pressure sensor for pressure sensor failure trip.
21	**Use_early_check**	Off	Enable the hose check function to shut off earlier that the standard 2 second charge if the mass delivered exceeded the hose_mass parameter value.
22	**Use_resist_ave**	On	Enables the hose resistance calculation to continue through the sonic flow state instead of a one-time calculation at the start of a bank fill. The resistance is averaged over time.
23	**Use_comm_authorize**	Off	Enables an authorize by the ANGI monitor Comm link
24	**Enable_sim_cycle (obsolete, removed)**	Off	Enables a demo that has the dispenser perform a simulated filling sequence. The simulation cycles.

Bit	Name	Typ.	Function
24	**Limit_pmax** **(Rev. >= 4.05)** **(Rev. >= 3.90)**	Off	"On" will limit the temperature compensated target pmax to the value in pmax_fixed parameter. Use_pmax_fixed bit must be off to use this feature.
25	**Disable_flow_max** **(Rev >= 3.90)**	Off	"On" disables sampling the maximum pressure during the bank start time. The sample is taken at the end of the bank start time. Sample is for resistance calc.
26	**Use_price_switch** **(Rev. >= 4.00)**	Off	"On" enables the price entry door switch. Price entry is disallowed if the display door is closed for door mounted keypads.
27	**Share _display** **(Rev. >= 3.84)**	Off	"On" for two hose dispensers with one shared display.
28	**Use_totalizer**	Off	Enables a pulse output on the Demand digital output for an external mechanical totalizer. One pulse per mass unit.
29	**Use_remote_valves** **(Rev >= 3.83)**	Off	Changes the function of the "Filling" digital output to go on and off with the valve outputs. Used to cycle a local valve in the dispenser when the bank valve stack is in a remote location away from the dispenser.
30	**Use_EH_meter** **(Rev. >= 4.00)**	Off	"On" Enables the flowmeter communication for the Endress-Houser meters. "Off" defaults to MicroMotion meters.
30	**Single_bank_valve** **(Rev >= 3.87)**	Off	"On" the sequence uses only the high bank output for one bank and sequence step buffer fill systems.
31	**meter_9739_type** **(Rev. >= 3.87)**	Off	"On" for MicroMotion 9739 meter communication. 38.4 KBAUD 80 ms update rate.

3. Process Variables

3.1 Hose Operation Variables

The following are the real time process variables used in for the process calculations and measurements. All variables are prefixed with a single capital letter indicating the hose (example: Aflow, Bflow). All variables can be monitored by a computer based monitoring program. The variables are normally write protected. Useful variables are as follows:

status	(numb) State counter during fill sequence (See table).
wait	(0.00 sec) Length of time at current state count .
mass	(0 g) any mass measured during fill.
press	(0.00 MPa) Instantaneous Pressure derived from analog pressure sensor
preslow	(0.00 MPa) time averaged Pressure. Compared to instantaneous pressure.
flow	(0.00 g/sec) mass flow from meter through analog input or meter com link
temp	(0.0 K) ambient temperature from analog input or meter com link.
press_store	(0.00 MPa) Stored initial vehicle pressure.
temp_store	(0.00 MPa) Stored ambient temperature.
pmax	(0.00 MPa) Calculated final pressure target or max limit used in fill
pmax_calc	(0.00 MPa) Temperature compensated pressure target not limited.
tankpress	(0.00 MPa) Estimated tank pressure derived from hose resist and flow.
flow_max	(0.00 g/s) Flow rate used in resistance calculation. Captured at peak steady flow.
press_test	(0.00 MPa) Sonic pressure drop across hose used in resistance calculation.
resist	(0.0 $Pa.s^{-2}/g^{2}$) Flow path resistance estimate
press_mem	(0.00 MPa) Memory of the target pressure used in the resistance calculation between banks
flow_analog	(0.00 g/s) Flow rate from analog input.
flags	(hex numb) 32 bit status flag register (See flag definitions).
control	(hex numb) 32 bit internal control Boolean register.(See control definitions).
pchange	(0.00 MPa) Bank change pressure target if using percentage parameters.
flow_analog	(0.00 g/s) flow rate from the 4-20mA/0-5V analog input.
abs_press	(0.00 MPa) Absolute pressure limit selected by mode parameter.
max_moles	(0.00 moles) Mole amount selected by mode parameter.
sim_press_preset	(0.00 MPa) Preset value for the initial tank pressure in the fill simulator.
sim_dpmax	(0.0 %) Sdpmax value used in the fill simulator.
press_delta	(0.00 MPa) difference between supply pressure and tank pressure.
error_reg	(numb) Error Booleans for a fill or system error.

error_code (numb) Error code that cycles on the display during a fill or system error.
press2_in (0.00 MPa) 2nd pressure sensor value.
psim (0.00 MPa) Supply pressure value from fill simulator.
temp_analog (0.0 K) ambient temperature from analog input.
sonic_pressure (0.0 Mpa) Pressure level at the hose end where the flow becomes sonic.
press_display (0000 Mpa/bar/%) Pressure readout on customer LCD display.
resist_temp (0.0 $Pa.s^{-2}/g^{2}$) Temporary holding register for the resistance calculation.
press_target (0.00 Mpa) current pressure target for the active bank.
mass_ran (0 g) the mass counted for the quantity sold.
qty_pulses (0 pls) Pulses to send out for the displayed mass quantity delivered.
sale_pulses (0 pls) Pulses to send out for the total sale.
qty_pulses_sent (0 pls) real-time output pulse count for the displayed mass quantity.
sale_pulses_sent (0 pls) real-time output pulse count for the total sale.
total_sale ($) Total sale value displayed on LCD customer interface.
total_qty (mass unit) Total mass value displayed on LCD customer interface.
price_per_unit ($/unit) Price displayed on LCD customer interface.
pmax_used (0.00 MPa) Calculated or fixed final pressure target not limited.
meter_mass_flow_unit (numb) Coded number for the mass flow units used in the meter.
meter_mass_unit (numb) Coded number for the mass units used in the meter.
meter_temp_unit (numb) Coded number for the temperature units used in the meter.
full_mass (g) estimated tank size in final mass amount. Used only in the bar graph.
tank_mass (g) estimated mass amount in the tank. Used only in the bar graph.
final_process_count (numb) number of samples taken by the real-time process monitor.
final_process_mod (numb) time base samples taken by the real-time process monitor.
process_mod (numb) sets the time base of the samples taken by the process monitor.
gass_temperature (0.0 K) gas temperature from the meter.
totalizer_pulses (0 pls.) pulses to be sent to the external totalizer. Fixed 1 pulse / mass unit.
totl_pulses_sent (0 pls.) real-time output pulse count output to the external totalizer.
vars55 (numb) spare.
mon_ROM_address (hex) starting memory location for the run monitor history.
meter_status (hex) status Booleans from the meter.
sale_preset ($) sale preset amount entered from the door keypad. Rev 4.xx.
sale_stop (numb) sale preset function status.
coast_mass (grams) the amount of mass subtracted from the stop_mass target . The bank fill is stopped ahead of the target by this amount
stop_mass (grams) the mass stopping point calculated from the preset sale amount.
actual_mass (grams) the actual mass ran in a preset sale.

3.1.1 Status number definitions.

status	Function name	Description
0	system_off	Idle, standing by to detect a "fill_request" bit from the handle turned to the start position. Do nothing if the handle is inhibited by a price change in progress, a keypad function is in use, configure switch 1_1 is on, or during 5 second waiting period if the handle was turned off.
27	handlon	Handle was turned on. Clear the log. Clear all error status. All display segments on for one second. Check authorize signal after one second. Display the authorize number if the signal is not present. Check for unclearable errors, abort if errors are present. Go to 26 if not an error. If there is an error, go to 3.
26	pdyesno	Check for hose pressure drop (nozzle valve was opened). If no drop go to 22. If there was go to 19.
22	fforward	High bank valve on for 2 second hose check.
21	chkmass	Check mass delivered and pressure increase. Decide if the nozzle valve is opened or closed. If closed go to 20. If opened go to 19.
20	waitforpd	Wait for the operator to open the nozzle valve. Abort after a time-out, go to 3 (start_delay). Go to 19 if a pressure drop is detected.
19	recordpt	Check for flow and pressure to settle. If settled, record the pressure as the initial tank pressure and the ambient temperature. Abort to 3 if the flow has not gone to zero after 10 seconds.
18	checkp	Calculate the target pressure. Check the initial tank pressure and abort if it is 95% of the target. Got to 4 if abort. Go to 9 to start the fill.
9	Fillbank (low)	Turn on the low bank valve. If not flowing, proceed directly to the mid bank. Calculate the initial resistance if flowing. Turn off the low bank valve when the pressure target is reached, if the flow is below the low-flow set-point, an error occurs, or if aborted. Take sample readings of the bank pressure, target pressure, and flow just before shutting the valve off. Proceed to the mid bank if not an error or abort. If there is an error or abort, go to 4.
8	Fillbank (mid)	Wait for pressure and flow to settle. If the flow does not settle for 10 seconds, abort to 3. Take a sample of the tank pressure and recalculated the resistance. Abort if the flow does not go to zero after 10 seconds. Turn on the mid bank valve. If not flowing, proceed directly to the high bank. Calculate the initial resistance if flowing and if not calculated previously. Turn off the mid bank valve when the pressure target is reached, if the flow is below the mid-flow set-point, an error occurs, or if aborted. Take sample readings of the bank pressure, target pressure, and flow. Proceed to the high bank if not an error or abort. If there is an error or abort, go to 4.

status	Function name	Description
7	Fillbank (high)	Wait for pressure and flow to settle. If the flow does not settle for 10 seconds, abort to 3. Take a sample of the tank pressure and recalculated the resistance. Abort if the flow does not go to zero after 10 seconds. Turn on the high bank valve. If not flowing, go directly to 4. Calculate the initial resistance if flowing and if not calculated previously. Turn off the high bank valve when the pressure target is reached, if the flow is below the high-flow set-point, an error occurs, or if aborted. Take sample readings of the bank pressure, target pressure, and flow. Go to 4.
4	full	Wait for pressure and flow to settle or if waiting for 4 seconds has gone by. Take a final tank pressure sample. Stop accumulating mass counts. Recalculate the resistance. Go to 1.
3	shutd_pause	Wait for pressure and flow to settle or if waiting for 5 seconds has gone by after an abnormal stop. Stop accumulating mass. Go to 2.
2	shutd	Update totalizers and save to the flash memory. Wait for the handle to be turned off.
1	shutdown	Update totalizers and save to the flash memory. Wait for the handle to be turned off.

3.1.2 Flag Definitions Bits 0 through 31

drop_flag Hose pressure drop detected when on.
lost_authorize Authorization signal was removed during the fill sequence.
quit_flag Tank is too full to start when on. Shows as an error.
bursted Excess and unreasonable flow detected when on. Shows as an error.
no_zero_flow Flow is not going to zero when the valves are off after 10 seconds.
flowing Flow reached peak after valve is opened when on. Off when valves are off.
lowb4full Bank shift on low flow when on. Bank shift on pressure target when off.
p3high Abnormal shutdown on pressure exceeding Sdpmax.
mass_changing the value of the mass signal from meter is changing at least 1 g/s.
filling Fill sequence started when on. Fill sequence finished when off.
p3ibhigh Tank pressure measured between banks > final target.
press_error Pressure discrepancy between check sensor exceeding Sptrip.
filling Fill sequence started when on. Fill sequence finished when off.
ratelow Low bank low flow when on.
ratemid Mid bank low flow when on.
ratehigh High bank low flow when on.
ratetop Top bank low flow when on.
authorized dispenser is authorized to fill. Rev. 3.07 (was burst in previous revisions)
p1high Calculated final pressure target exceeds absolute pressure limit when on.

p2high Supply pressure target exceeds absolute pressure limit when on. Shows as an error.
abort_fill Handle or authorization removed during fill when on. Shows as an error.
drop_time_out Time expired waiting for nozzle valve to be opened by the operator.
temperror Temperature outside operating range when on. Shows as an error.
handle_inhb Condition exists that prohibits starting a fill sequence when on.
power_loss Power lost during a fill when on.
display_updated LCD display is communicating with microcontroller when on.
fill_request Handle is in the on position or start button has been pushed when on.
lowbank_flag Lowbank valve is commanded to open when on.
midbank_flag Midbank valve is commanded to open when on.
highbank_flag Highbank valve is commanded to open when on.
fill_done Fill sequence has ended, successfully or in error, when on.
sonic_flow Flow is over the Sdpmax parameter calc., estimated pressure valid when off.
meter_updated Mass flow meter communicating with microcontroller when on.

3.1.3 Control Boolean Definitions Bits 0 through 31

force_mass_freq Forces pulses out of the mass pulse output.
force_sale_freq Forces pulses out of the sale pulse output.
force_comp_bit Turns the temperature compensation off. Leaves compression heating active.
force_screen_bit Turns all the LCD segments on.
blank_screen_bit Turns all the LCD segments off.
simulate_fill Activates the fill simulator.
sim_preset Writes a pre-determined tank pressure into the simulated tank. Self clears
first_resist_bit Indicates the first resistance calculation has been accomplished.
error_bit Indicates a hardware fault. If the bit is on the sequence will not start.
sim_handle The handle input for the simulator. Written through the monitor Comm link.
wait_enable Enables the sequence step timer..
flow_settled_bit Indicates the flow is below a low threshold (zero) and the pressure is steady.
other_Left Indicates the left handle is on.
other_Right Indicates the right handle in on.
handleL_fill Indicates the dispenser is filling from a left handle input.
handleR_fill Indicates the dispenser is filling from a right handle input.
send_authorize Turns on the authorize output when the handle is on and not inhibited.
burst Indicates the flow has exceeded the burst parameter value. Does not latch.

fill_data_recvd Indicates the meter communication has responded. Data is valid and ready.
power_on_dwel_bit On during the first 10 seconds after power-up.
comm_authorize An authorization signal set or reset by the monitor Comm link.
tank_measured_bit Indicates the tank pressure has been measured between bank shifts.
choke_bit Turns the choke output on or off when the fill reaches 95% target.
pressure_broken Indicates the 4-20Ma pressure signal is below 3.5Ma (broken wire).
pressure2_broken Indicates the second 4-20Ma pressure signal is below 3.5Ma (broken wire).
save_log Starts the totalizer save-to-flash memory process.
fill_request Handle is in the on position or start button has been pushed when on.
fill_acknowlage Confirms the handle on fill request has been processed.
qty_enable Enables the mass counter for the display quantity.
meter_mass_twice Indicates there has been two successful meter comm link reads for the mass.
meter_vol_twice Indicates there has been two successful meter comm link reads for the vol.

3.1.4 System Errors: Faults, and Events

The system checks for events and faults in the hardware, data transfer, or fill process occurrences. Error categories are 1: an event is recognized but may or may not shut the fill sequence down, 2: a fill process fault that shuts down the fill sequence, 3: a hardware fault that can shut down the fill sequence or not let the sequence start. These Booleans are in the **error_reg** variable. Error 1 corresponds to bit 0, error 2 to bit 1, etc. These events codes will be displayed as an E#. Fault code will be displayed as an F#. Faults will turn on the hardware error output, events will not (see output bit definitions).

Code Displayed	**Definition** Possible cause	**Category**	**Event Type**
E1	**Final Bank stop due to low flow and underfill, cannot reach pressure target** Bank shift due to hitting low flow target instead of pressure target.	**1**	**Fill event**
F2	**Bank pressure exceeds fixed allowable pressure** Pressure greater than fixed pressure trip.	**2**	**Fill error**
F3	**Bank pressure exceeds 155% (Pmax) of calculated pressure target** Pressure greater than pressure target multiplied by Smax parameter (1.35 typical).	**2**	**Fill error**
E4	**Tank pressure exceeds target pressure during bank shift, do not continue to next bank** Measured tank pressure greater than target pressure during bank shift, or tank is already full.	**2**	**Fill event**
E5	**Operator aborted fill; Handle turned off before complete** Fill was aborted by operator, handle turned off.	**2**	**Fill event**
E6	**Authorization removed during fill; Fill aborted by fuel management** Fill was aborted by removal of the authorize signal.	**2**	**Fill event**
F7	**Hose exceeded allowable maximum flow; "hose burst" (fixed burst threshold)** Excessive flow, hose burst.	**2**	**Fill error**

F8	**Flow detected with valves closed, cannot sequence, meter lost zero or leak, 15 second** Flow is not zero for 15 seconds after all valves are off. Valve leak or bad flow signal.	**2**	**Fill error**
E9	**Hose drop timed out; Dispenser left unattended while attached to vehicle** Dispenser waited too long for operator to open the nozzle valve.	**2**	**Fill error**
E10	**Meter busy zeroing or an internal error** Flow meter has internal error or is busy performing a zeroing function.	**1**	**Event**
E11	**Switch1 #1 is ON, Encore hybrid Cal-Program switch is to the right in program mode** Calibration Switch1 is in the ON position.	**3**	**Hardware**
E12	**Flow detected when the dispenser is off, meter lost zero or leak** Gas flowing while dispenser is idle.	**1**	**Event**
F13	**Ambient temperature out of range** Temperature out of working range.	**3**	**Error**
F14	**Broken wire or signal loss of the main pressure sensor** Main pressure sensor wire disconnected.	**3**	**Hardware**
F15	**Flow meter not communicating** Flow meter serial communication loss.	**3**	**Hardware**
F16	**Display not communicating** Display serial communication loss.	**3**	**Hardware**
F17	**Redundant pressure sensor not in agreement with main sensor** Pressure reading discrepancy between main and secondary pressure sensors.	**2**	**Fill Error**
E18	**Gilbarco comm link overrun error** Verify POS communication settings and connections.	**1**	**Comm Error**
E19	**Gilbarco comm link parity error** Verify POS communication settings and connections.	**1**	**Comm Error**
E20	**Gilbarco comm link framing error** Verify POS communication settings and connections.	**1**	**Comm Error**
E21	**Gilbarco comm link checksum error** Verify POS communication settings and connections.	**1**	**Comm Error**
E22	**Gilbarco comm link data length error** Verify POS communication settings and configuration.	**1**	**Comm Error**
E23	**Gilbarco comm link invalid command error** Verify POS communication settings and configuration.	**1**	**Comm Error**
E24	**Gilbarco comm link invalid grade error** Verify POS communication settings and configuration.	**1**	**Comm Error**
E25	**Parameter value different than what is stored in memory** Current and stored parameter values are different.	**3**	**Data Error**
F26	**Meter programmed with the wrong mass flow unit** Meter not programmed with Kg/s.	**3**	**Data Error**
F27	**Meter programmed with the wrong mass unit** Meter not programmed with Kg.	**3**	**Data Error**
F28	**Broken wire or signal loss of the secondary pressure sensor** Secondary pressure sensor wire is disconnected.	**3**	**Hardware**
F29	**Shorted wire or signal loss of secondary pressure sensor** Secondary pressure sensor wire shorted to power supply.	**3**	**Hardware**
F30	**Shorted wire or signal loss of main pressure sensor** Main pressure sensor wire shorted to power supply.	**3**	**Hardware**
E31	**Gilbarco Comm off line** Verify POS communication settings and connections.	**1**	**Hardware**
F32	**Sudden hose pressure drop during fill**	**2**	**Fill Error**
F33	**Control air pressure low** Check control air pressure		**Hardware**
F34	**Control air pressure sensor wire broken** Check control air pressure wire		**Hardware**
F35	**Control air pressure sensor wire shorted** Check control air pressure wire		**Hardware**
F36	**Not defined**		

F37	**Not defined**		
F38	**Negative flow detected with valves closed, cannot sequence, 15 second timeout**		**Fill error**
F39	**Meter measured mass jump, change of mass out of expected range, miscount**		**Fill error**
F40	**Communication loss with the remote I/O module. Disabled when not using remote I/O.**		**Hardware**
E41	**Program switch in program mode, Series II only. Disabled in Encore Hybrid.** Verify correct position of program switch.		**Hardware**
E42	**Stop on volume display limit: Series II = 9999.999, Encore hybrid = 999.999**		**Fill error**
E43	**Stop on money display limit: Series II = 9999.999, Encore hybrid = 999.999**		**Fill error**
F44	**Meter mass totalizer did not clear at sequence start step**		**Fill error**
F45	**Meter mass totalizer did not clear at nozzle open sequence step**		**Fill error**
E46	**Transaction registered in dispenser pending pickup by the fuel management.** Waiting on fuel management system.		**Fill event**
E47	**Fill stop registered in dispenser pending pickup by the fuel management.** Waiting on fuel management system.		**Fill event**
F48	**Sudden calculated tank pressure drop during fill** Check tank drop parameter.		**Fill Error**
F49	**A hose left PPU not communicating or not installed, Encore hybrid only** Check PPU module.		**Hardware**
F50	**A hose right PPU not communicating or not installed, Encore hybrid only** Check PPU module.		**Hardware**
F51	**A hose left nozzle switch not plugged in with A left hose enabled, Encore hybrid only** Check nozzle switch connections.		**Hardware**
F52	**A hose right nozzle switch not plugged in with A right hose enabled, Encore hybrid only** Check nozzle switch connections.		**Hardware**
F53	**B hose left PPU not communicating or not installed, Encore hybrid only** Check PPU module.		**Hardware**
F54	**B hose right PPU not communicating or not installed, Encore hybrid only** Check PPU module.		**Hardware**
F55	**B hose left nozzle switch not plugged in with B left hose enabled, Encore hybrid only** Check nozzle switch connections.		**Hardware**
F56	**B hose right nozzle switch not plugged in with B right hose enabled, Encore hybrid only** Check nozzle switch connections.		**Hardware**
F57	**Burst from pressure** Excessive pressure hose burst.		**Fill Error**
E58	**Meter parameter difference** Check Ameter or Bmeter parameters.		**Data Error**
59	**Not defined**		
60	**Not defined**		
61	**Not defined**		

62	Not defined		
E63	"CAL2" displayed for non-weights-and-measures parameters unlocked for changes		Event
E64	"CAL1" displayed for weights-and-measures and all parameters unlocked for changes		Event

3.2 Meter Signal Definitions

“Meter Signals” are values read directly from the flow meter that is necessary for the fill sequence. All meter values are read when the dispenser is not filling. The “Meter Signal” values, along with the meter_status variable are the only values read during a fill. All are floating point values to six decimal points.

meter_temp (C) Gas temperature.
meter_flow (Kg/s) Mass flow.
meter_mass (Kg) Mass total. Clearable to zero. Cleared at fill start.
meter_vol (liters) Volume. Clearable to zero. Cleared at fill start.
meter_ mass_inv (Kg) Mass inventory total. Non-clearable. Lifetime total.

3.3 Target Pressure Algorithm Data Values (ANGI algorithm)

This is a description of the data values used in generating the temperature compensated target pressure. These values exist in the system but are not brought out for monitoring.

Psettle The maximum settled pressure permitted at ambient temperature T1 (MPa)
Pcounter The number of iterations used to arrive at Psettle (dimensionless should not exceed 10)
Tcomppc Compression heating compensation as a percentage increase in Psettle (%)
Startpc P1 as a percentage of Psettle (%)
Pmaxcomp This is the compression heating compensated value of Psettle (MPa)
Pmaxcomp = Psettle*[1 + (1 - Startpc)*Tcomppc]
Pmax Desired final pressure at end of fill (MPa)
Zpmax Supercompressibility factor Z at temperature T1, pressure Psettle (%)
Order Number used in sequencing log record blocks

3.4 Previous Fill Log

This function captures process values during pivotal moments of the fill sequence and stores the results in non-volatile memory record. The end of each normal or aborted fill sequence records pertinent algorithm calculation results and mass/sale amounts and totals. 128 records are backed up for each hose. The logging “wraps around,” writing over the oldest record first. . All these registers are read only. The following is a description of the logged data values useful in troubleshooting the system.

low_target	Tank pressure target to end the low bank fill (0.00 Mpa).
low_tank	Actual tank pressure sample after low bank fill (0.00 Mpa).
mid_target	Tank pressure target to end the mid bank fill (0.00 Mpa).
mid_tank	Actual tank pressure sample after mid bank fill (0.00 Mpa).
high_target	Tank pressure target to end the high bank fill (0.00 Mpa).
high_tank	Actual tank pressure sample after high bank fill (0.00 Mpa).
low_error	Percentage difference between initial resistance and resistance calculated after low bank stop (0.00 %).
mid_error	Percentage difference between low bank resistance and resistance calculated after mid bank stop (0.00 %).
pressure_max	Supply pressure used in initial resistance calculation (0.00 Mpa).
subsonic_press	Pressure drop threshold across the hose at which flow is constant during initial resistance calculation (0.44 * Pflowing for natural gas) (0.00 Mpa).
init_flow_max	Peak flow value used in initial resistance calculation (0.00 g/s).
init_ib_pressure	Supply pressure at start of low bank fill (0.00 Mpa).
low_init_resist	Resistance calculated at the start of low bank fill (0.00 Pa_s2/g2).
mid_resist	Resistance recalculated at end of the low bank fill (0.00 Pa_s2/g2).
high_resist	Resistance recalculated at end of the mid bank fill (0.00 Pa_s2/g2).
final_resist	Resistance recalculated at end of high bank fill (0.00 Pa_s2/g2).
init_tank_press	Initial vehicle tank pressure sample (0.00 MPa).
low_ib_pressure	Supply pressure at the end of the low bank fill (0.00 Mpa).
low_tank_target	Target tank pressure value for the low bank stop (0.00 MPa).
low_time	Time spent on the low bank (sec).
mid_ib_pressure	Supply pressure at end of the mid bank fill (0.00 Mpa).
mid_tank_target	Target tank pressure value for the mid bank stop (0.00 MPa).
mid_time	Time spent on the mid bank (sec).
high_ib_pressure	Supply pressure at the end of high bank fill (0.00 Mpa).
high_tank_target	Target tank pressure value for the high bank stop (0.00 MPa).
high_time	Time spent on the high bank (sec).
final_mass	Mass delivered over the entire fill that is counted on the display (g) .
final_pressure	Pressure of the full tank after the high bank stop (0.00 Mpa).
low_stop_mass	Estimated mass change recorded after the low stop (g).
mid_stop_mass	Estimated mass change recorded after the mid bank stop (g).
high_stop_mass	Estimated mass change recorded after the high bank stop (g).
low_stop_flow	Flow recorded at the low bank stop (g/s).
mid_stop_flow	Flow recorded at the mid bank stop (g/s).
high_stop_flow	Flow recorded at the high bank stop (g/s).

low_stop_adj	Pressure increase calculation due to low bank valve delay off (0.00 MPa).
mid_stop_adj	Pressure increase calculation due to mid bank valve delay off (0.00 MPa).
high_stop_adj	Pressure increase calculation due to high bank valve delay off (0.00 MPa).
final_flags	State of flags at end of fill. (numb).
spare44	Not defined (numb).
account1	Recorded sequence events 32 bit (numb) #1.
account2	Recorded sequence events 32 bit (numb) #2
account3	Recorded sequence events 32 bit (numb) #3.
account4	Recorded sequence events 32 bit (numb) #4.
algorithm_type	Number to indicate the algorithm used ANGI = 0, GTI = 1 (numb).
time	Real time clock time stamp at the end of the fill (time).
date	Real time clock date stamp at the end of the fill (date).

3.4.1 Account Registers Bit Definitions.

No.	Reg-Bit	Status#-Event
0	1-0	27 process started right handle
1	1-1	27 process started left handle
2	1-2	26 pressure drop detected
3	1-3	26 no pressure drop detected
4	1-4	24 waiting short delay
5	1-5	24 low bank on
6	1-6	24 waiting motor delay
7	1-7	24 motor delay time out bank off
8	1-8	24 high flow flag bank off
9	1-9	22 high bank on for hose check
10	1-10	22 high bank off above hose mass
11	1-11	22 hose check time out
12	1-12	22 abort during hose check
13	1-13	22 lost authorize during hose check
14	1-14	21 pressure and flow settled after hose check
15	1-15	21 mass >= hose mass, go record pressure
16	1-16	21 mass < hose mass, wait for hose drop
17	1-17	21 spare
18	1-18	20 waiting for hose drop
19	1-19	20 abort time out start delay
20	1-20	20 detected pressure drop (nozzle valve opened)
21	1-21	20 pressure and flow settled after hose drop
22	1-22	19 waiting for pressure and flow to settled
23	1-23	19 pressure settled
24	1-24	19 flow settled
25	1-25	19 flow not settled 10 sec time out abort

No.	Reg-Bit	Status#-Event
26	**1-26**	19 initial pressure and temperature measured
27	**1-27**	19 spare
28	**1-28**	18 calculating target mode 0 (2400psi)
29	**1-29**	18 calculating target mode 2 (3000psi)
30	**1-30**	18 calculating target mode 4 (3600psi)
31	**1-31**	18 temperature compensation off
32	**2-0**	18 using calculated pressure target
33	**2-1**	18 using fixed pressure target
34	**2-2**	18 spare
35	**2-3**	18 spare
36	**2-4**	18 target pressure exceeds absolute
37	**2-5**	18 using given target
38	**2-6**	18 tank already > 95% full abort
39	**2-7**	18 spare
40	**2-8**	16 resist measure
41	**2-9**	16 flow maximum during resist measure
42	**2-10**	16 pressure difference sonic
43	**2-11**	16 pressure difference subsonic
44	**2-12**	16 resistance within range
45	**2-13**	16 resistance exceeds maximum
46	**2-14**	16 resistance below maximum
47	**2-15**	16 spare
48	**2-16**	9 low bank fill all banks off
49	**2-17**	9 low bank fill flow settled
50	**2-18**	9 low bank fill low bank on
51	**2-19**	9 low bank fill resistance increased
52	**2-20**	9 low bank fill resistance decreased
53	**2-21**	9 low bank fill waiting Sdelay
54	**2-22**	9 low bank fill in process
55	**2-23**	9 low bank fill abort inter-bank pressure high
56	**2-24**	9 low bank fill change on pressure limit
57	**2-25**	9 low bank fill change on pressure target
58	**2-26**	9 low bank fill abort on pressure high
59	**2-27**	9 low bank fill change on low flow
60	**2-28**	9 low bank fill time out
61	**2-29**	9 low bank spare 1
62	**2-30**	9 low bank spare 2
63	**2-31**	8 mid bank fill all banks off
64	**3-0**	8 mid bank fill flow settled
65	**3-1**	8 mid bank fill mid bank on
66	**3-2**	8 mid bank fill resistance increased
67	**3-3**	8 mid bank fill resistance decreased
68	**3-4**	8 mid bank fill waiting Sdelay

No.	Reg-Bit	Status#-Event
69	**3-5**	8 mid bank fill in process
70	**3-6**	8 mid bank fill abort inter-bank pressure high
71	**3-7**	8 mid bank fill change on pressure limit
72	**3-8**	8 mid bank fill change on pressure target
73	**3-9**	8 mid bank fill abort on pressure high
74	**3-10**	8 mid bank fill change on low flow
75	**3-11**	8 mid bank fill time out
76	**3-12**	8 mid bank spare 1
77	**3-13**	8 mid bank spare 2
78	**3-14**	7 high bank fill all banks off
79	**3-15**	7 high bank fill flow settled
80	**3-16**	7 high bank fill high bank on
81	**3-17**	7 high bank fill resistance increased
82	**3-18**	7 high bank fill resistance decreased
83	**3-19**	7 high bank fill waiting Sdelay
84	**3-20**	7 high bank fill in process
85	**3-21**	7 high bank fill abort inter-bank pressure high
86	**3-22**	7 high bank fill change on pressure limit
87	**3-23**	7 high bank fill change on pressure target
88	**3-24**	7 high bank fill abort on pressure high
89	**3-25**	7 high bank fill change on low flow
90	**3-26**	7 high bank fill time out
91	**3-27**	7 high bank spare 1
92	**3-28**	7 high bank spare 2
93	**3-29**	4 fill complete wait for settle
94	**3-30**	4 fill complete
95	**3-31**	2 abnormal shutdown
96	**4-0**	1 data recorded wait for handle off
97	**4-1**	1 spare
98	**4-2**	0 spare
99	**4-3**	0 fill denied temperature error (not implemented)
100	**4-4**	0 drop flag time out (not implemented)
101	**4-5**	spare
102	**4-6**	spare
103	**4-7**	9 low bank burst detect
104	**4-8**	8 mid bank burst detect
105	**4-9**	7 high bank burst detect
106	**4-10**	spare
107	**4-11**	spare
108	**4-12**	spare
109	**4-13**	low bank pressure exceeds Smax
110	**4-14**	mid bank pressure exceeds Smax
111	**4-15**	high bank pressure exceeds Smax
112	**4-16**	low bank pressure exceeds absolute

No.	Reg-Bit	Status#-Event
113	**4-17**	mid bank pressure exceeds absolute
114	**4-18**	high bank pressure exceeds absolute
115	**4-19**	handle shut off during fill
116	**4-20**	redundant pressure error abort
117	**4-21**	lost authorize during fill
118	**4-22**	Spare 119
119	**4-23**	Spare 120
120	**4-24**	Spare 121
121	**4-25**	Spare 122
122	**4-26**	Spare 123
123	**4-27**	Spare 124
124	**4-28**	Spare 125
125	**4-29**	Spare 126
126	**4-30**	Spare 127
127	**4-31**	Spare 128

3.5 Totalizer Data Values

This function captures mass and sale values and at the end of the fill sequence, accumulates the results in their respective totalizers, and stores the results in a non-volatile memory record. 128 records are backed up for each hose. The logging “wraps around,” writing over the oldest record first. All these registers are read only.

total_save _count Number of fills counted since dispenser was put into service (numb).
log_count Number of hose fills counted since dispenser was put into service (numb).
time_stamp Real time clock time stamp at the end of the fill (time).
date_stamp Real time clock date stamp at the end of the fill (date).
id Hose Id: 0 = A, 1 = B (numb).
total_extend Value extension of the 4 totalizers beyond 32-bit long word. Each 32-bit totalizer words below get an extended 8-bit part for 40 bits max (numb)
total_sale_tier1 Sale totalizer for tier1 price since dispenser was put into service ($)
total_mass_tier1 Mass totalizer for tier1 price since dispenser was put into service (g)
total_sale_tier2 Sale totalizer for tier2 price since dispenser was put into service ($)
total_mass_tier2 Mass totalizer for tier2 price since dispenser was put into service (g)
price_tier_ran Number indicating which tier was used, 1 or 2 (numb).
total_mass_ran Mass amount counted for the on display at the end of the fill (g).
total_sale_ran Sale amount on display at end of the fill ($).
total_qty_ran Mass amount on the display at the end of the fill (display mass units).
price_ran Price on display at the time of the fill ($).
sale_ran_decimal Decimal point used in the sale amount on the display (numb).
qty_ran_decimal Decimal point used in the quantity amount on the display (numb).
price_ran_decimal Decimal point used in the price amount on the display (numb).

sale_ran_decimal Decimal point used in the sale amount on the display (numb).
low_cycle_total Number of lifetime cycles for the low bank valve (numb).
mid_cycle_total Number of lifetime cycles for the mid bank valve (numb).
high_cycle_total Number of lifetime cycles for the high bank valve (numb).
total_fault Number of faults during the sequence (numb).
shift_sale_tier1 Sale totalizer for tier1 price since last cleared by the attendant ($).
shift _mass_tier1 Mass totalizer for tier1 price since last cleared by the attendant (g).
shift _sale_tier2 Sale totalizer for tier2 price since last cleared by the attendant ($).
shift _mass_tier2 Mass totalizer for tier2 price since last cleared by the attendant (g).
shift_time_stamp1 Time recorded when tier1 shift was cleared by the attendant (time).
shift_date_stamp1 Date recorded when tier1 shift was cleared by the attendant (date).
shift_time_stamp2 Time recorded when tier2 shift was cleared by the attendant (time).
shift_date_stamp2 Date recorded when tier2 shift was cleared by the attendant (date).
qty_remainder Decimal mass amount remaining on the display at the end of the fill. Used for the external totalizer. Added to the next fill (display mass units).

3.6 Control Registers

These register variables are to do with hardware and program control. There is a mix of read only, write protected, and read-write types.

action_command Writing a number to this register performs a task (see table). Will be immediately returned to zero by the program. Always accessible.
action_commanded Displays the number written in the action_commanded register if the action was permitted and valid. Return zero if not permitted or if the number written is not valid. Read only.
io_inputs Digital input bits from the MCDS Interface board. Read only.
io_outputs Digital output bits to the MCDS Interface board. Read only.
force_out_off Register to force the digital output bits off. Normally read only. Write enabled by password unlock and SW1_1 = on.
force_out_on Register to force the digital output bits off. Normally read only. Write enabled by password unlock and SW1_1 = on.
keyset_0 Number for indicating the keypad button being pushed from display node zero.
keyset_1 Number for indicating the keypad button being pushed from display node one.
main_loop_Boolean Control bits used by the program (see table).
keyset_2 Number for indicating the keypad button being pushed from display node two.
keyset_3 Number for indicating the keypad button being pushed from display node three.
RTC_time Time from the real time clock on the dispenser control board. Read / password write.

RTC_date Date from the real time clock on the dispenser control board. Read / password write.
time_control Register to control the real time clock. 0 = run. 1 = stop and allow for update. 2 = write new time and restart.. 3 = stop, write, and restart. 4 and greater = ignore and clear time_control to zero.
average_scan The main loop scan time averaged over one second in microseconds.
maximum_scan Largest main loop scan time recorded over one second in microseconds.
minimum_scan Smallest main loop scan time recorded over one second in microseconds.
key_mode Coded number for a keypad action (see table).
rom_save_addr Parameter address to lookup a changed parameter. Write.
value_addr Returned section and offset address of a changed parameter. Read only.
ram_value Returned parameter value from the RAM memory. Read only.
rom_value Returned parameter value from the Flash memory. Read only.
trail_list_base Flash memory address for the audit trail lookup list record.
data_trail_base Flash memory address for the audit trail changed parameter value record.
pass_number_1 Unlock password register. Always accessible. Write. Read = 0. A valid number unlocks the write protect on the parameters and variables according to an access level. The unlocked state is maintained as long as the Comm link communication is refreshed within 2 seconds. An invalid number locks the write protect.
pass_number_2 Concurrent password register. Always accessible. Write. Read = 0. A special unlock of write protects for some commands and registers. Must be written simultaneously with the data by a Comm link packet. The write protect on these functions immediately re-locks.
access_level A coded number for what range of write protect is unlocked.
backup_ROM The flash memory address for the totalizers values copied during a clear.

3.6.1 Action Command Code Definitions:

action_command =	Function
0	Do nothing.
1	Refresh the RAM parameter values from the Flash memory. Parameter restore.
2	Do nothing.
3	Write the RAM parameters values to the Flash memory. Parameter save.
4	Clear and initialize the audit trail. Initialize protect must be unlocked and the action command must be accompanied by a pass_number_2 value. For program revs 3.81 and earlier this function only acts one time and will be permanently disabled afterward. See action 27.
5	Refresh the price values from the Flash memory.

action_command =	Function
6	Loads the process addresses into the process log.
7 - 9	Do nothing.
10	Clear the simulator monitor log in the flash memory.
11	Clear and initialize the totalizers. Initialize protect must be unlocked and the action command must be accompanied by a pass_number_2 value. For program revs 3.81 and earlier this function only acts one time and will be permanently disabled afterward. See action 26.
12	Do nothing
13	Perform a meter zero calibration on hose “A”. Disabled when filling.
14	Perform a meter zero calibration on hose “B”. Disabled when filling.
15	Clear the meter mass totalizer on hose “A”. Disabled when filling.
16	Clear the meter mass totalizer on hose “B”. Disabled when filling.
17-19	Do nothing.
20	Authorize the “A” hose by the Comm link. Must be accompanied by a pass_number_2 value = 20.
21	De-authorize the “A” hose by the Comm link. Must be accompanied by a pass_number_2 value = 21.
22	Authorize the “B” hose by the Comm link. Must be accompanied by a pass_number_2 value = 22.
23	De-authorize the “B” hose by the Comm link. Must be accompanied by a pass_number_2 value = 23.
24	Clear hose A fault display. Program rev. 3.82 and higher.
25	Clear hose B fault display. Program rev. 3.82 and higher.
26	Permanently disables action 11. Totalizers can not be cleared afterward. Disabling can not be undone. Program rev. 3.82 and higher.
27	Permanently disables action 4. Audit trail can not be cleared afterward. Disabling can not be undone. Program rev. 3.82 and higher.

3.6.2 Digital Input Bit Definitions:

Input bit	Terminal	Input Name
0	TB10-77	A_handle_left
1	TB10-76	A_handle_right
2	TB10-75	A_handle_hose_seated
3	TB10-74	A_spare_input
4	TB10-73	B_handle_left
5	TB10-72	B_handle_right
6	TB10-71	B_handle_hose_seated
7	TB10-70	B_spare_input
8	TB3-19	A_authorization_1
9	TB3-20	A_authorization_2
10	TB3-21	A_authorization_3
11	TB3-22	A_tier_2

Input bit	Terminal	Input Name
12	TB3-24	B_authorization_1
13	TB3-25	B_authorization_2
14	TB3-26	B_authorization_3
15	TB3-27	B_tier_2
16	NA	SW1_1
17	NA	SW1_2
18	NA	SW1_3
19	NA	SW1_4
20	NA	SW1_5
21	NA	SW1_6
22	NA	SW1_7
23	NA	SW1_8
24	NA	spare_24
25	NA	spare_25
26	NA	spare_26
27	NA	spare_27
28	NA	spare_28
29	NA	spare_29
30	NA	spare_30
31	NA	spare_31

3.6.3 Digital Output Bit Definitions:

Output bit	Terminal	Output Name
0	NA	not_defined_0
1	NA	not_defined_1
2	NA	not_defined_2
3	NA	not_defined_3
4	NA	not_defined_4
5	NA	not_defined_5
6	NA	not_defined_6
7	NA	not_defined_7
8	NA	ESD_Active, toggles every program cycle.
9	NA	ESD_Active, toggles every program cycle.
10	TB4-31	A_lowbank_valve, on for low bank fill.
11	TB4-32	A_midbank_valve, on for mid bank fill.
12	TB4-33	A_highbank_valve, on for high bank fill.
13	TB4-35	B_lowbank_valve, on for low bank fill.
14	TB4-36	B_midbank_valve, on for mid bank fill.
15	TB4-37	B_highbank_valve, on for high bank fill.
16	TB1-1	A_choke, on when the A tank pressure is > 90% of the target pressure.
17	TB1-2	A_demand, on when in the A fill cycle.
18	TB1-3	A_filling, on when in the A fill cycle or with the A valve outputs.
19	TB1-4	A_authorize, on when the A handle input is on.

Output bit	Terminal	Output Name
20	TB1-5	A_complete, on at the end of the A fill cycle, off with the A handle off.
21	TB1-6	A_error, on when a fault occures. An “F” error code will be displayed.
22	TB1-7	B_choke, on when the B tank pressure is > 90% of the target pressure
23	TB1-8	B_demand, on when in the B fill cycle.
24	TB1-9	B_filling, on when in the B fill cycle or with the B valve outputs.
25	TB1-10	B_authorize, on when the B handle input is on.
26	TB1-11	B_complete, on at the end of the B fill cycle, off with the B handle off.
27	TB1-12	B_error on when a B fault occurs. An “F” error code will be displayed.
28	TB2-13	A_sale_pulse_output, pulses when the A sale display value increases.
29	TB2-14	A_mass_pulse_output, pulses when the A mass display value increases.
30	TB2-16	B_sale_pulse_output, pulses when the B sale display value increases.
31	TB2-17	B_mass_pulse_output, pulses when the B mass display value increases.

3.6.4 Main Loop Booleans Definitions

Spare	Was “get_changes” before rev. 3.06.
not_writing_flash	Indicates the flash memory is not being written to. Allows interrupts
one_sec_os	Turns on once a second for one program scan..
GTI_algorithm	Enables the Gas Institute of Technology algorithm. Turns off ANGI control.
single_meter	Enables the use of one flow meter for two hoses. Connected to SW1_8
calibrate_enable	On when the Comm link password is cleared.
sw1_1_on	Indicates the state of switch1_1. Configuration calibration enable.
display_0_ok	Indicates the display at node 0 is communicating.
display_1_ok	Indicates the display at node 1 is communicating.
audit_sorted	Indicates the audit trail sorting function is finished.
single_step	Single step diagnostic function.
supply_above_22v	On when the controller supply voltage is above 22 volts.
supply_below_21v	On when the controller supply voltage is below 21 volts.
supply_was_ok	Latches on when the supply voltage went above 22 volts.
supply_loss	Latches on when the supply voltage goes below 21 volts and was OK before
supply_loss_ack	Acknowledges the supply voltage drop as a power loss. Saves data.
param_changed	Indicates a parameter value in the program is different that what is stored.
param_scanned	Indicates all the parameters have been check to what is stored in memory.
quick_scan	Not implemented.
fill_A_right	The “A” hose right handle input is acknowledged.
fill_A_left	The “A” hose left handle input is acknowledged
fill_B_right	The “B” hose right handle input is acknowledged
fill_B_left	The “B” hose left handle input is acknowledged
display_2_ok	Indicates the display at node 2 is communicating.

display_3_ok	Indicates the display at node 3 is communicating.
totals_ready	Enable the refresh of the totalizer values from memory. Off when writing.
simulating_fill	Indicates the fill simulator is enabled.
display_totals_bit	Enables the display of the totalizers.
comm_connected	Indicates there is ANGI monitor communication active on Comm 0 or 5.
meter_data_force	Forces the meter communication to read only the meter values used in fill.
tier_display_bit	Selects which price tier to display during price changing.

3.6.5 Key Mode Code Definitions:

Key_mode	Function
0	Normal run mode.
1	Price set hose "A" tier 1
2	Price set hose "A" tier 2
3	Price set hose "B" tier 1
4	Price set hose "B" tier 2
5	View total sale tier 1. key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
6	View total mass quantity tier 1. key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
7	View total sale tier 2. key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
8	View total mass quantity tier 2 key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
9	View shift total sale tier 1. key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
10	View shift total mass quantity tier 1. key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
11	View shift total sale tier 2. key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
12	View shift total mass quantity tier 2 key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
13	View "A" hose meter totalizer.
14	View "B" hose meter totalizer.
15	View combined mass total of both tiers. key_sub_mode = 'A': hose "A" key_sub_mode = 'B': hose "B"
16	Save the changes to previously active shift total mode to memory. Go to 0.
17	Enable the view for changing the mass display units.
18	View the audit trail with the displays.
19	View the parameter and variable values with the displays.
20	View the flow meter register values with the displays. Meter_view_stat = 0: "A" meter. Meter_view_stat = 1: "B" meter.

3.6.6 Access for Write Enable Bit State Definitions:

access_level bit	Parameter, Variable, or Function Type	Switch 1_1
0 (01 hex)	Real Time Clock	Don't Care
1 (02 hex)	Fill parameters, non-mass calibration type.	Don't Care
2 (04 hex)	Mass calibration parameters.	Don't Care
3 (08 hex)	Configuration parameters.	On = Allow / Off = Forbid
4 (10 hex)	Initializing actions.	On = Allow / Off = Forbid
5 (20 hex)	Variables.	On = Allow / Off = Forbid
6 (40 hex)	Price Change.	On = Allow / Off = Forbid
7 (80 hex)	Not Implemented.	Don't Care
8 (100 hex)	Control functions. Always write enabled.	Don't Care
8 (200 hex)	Audit trail clearing lock status. 1 = locked, 0 = not locked.	Don't Care
8 (400 hex)	Totalizer clearing lock status. 1 = locked, 0 = not locked.	Don't Care

3.7 Analog Inputs.

10-bit values from the on-chip analog to digital converter. 0 = 0mA or 0V. 1023 = 20mA or 5V.

AIN0 Analog input 0 input value; 0-1023. "A" flow or second pressure sensor.
AIN1 Analog input 1 input value; 0-1023. "B" flow or second pressure sensor.
AIN2 Analog input 2 input value; 0-1023. "A" pressure.
AIN3 Analog input 3 input value; 0-1023. "B" pressure.
AIN4 Analog input 4 input value; 0-1023. 24vdc power supply voltage.
AIN5 Analog input 5 input value; 0-1023. Temperature probe.
AIN6 Analog input 6 input value; 0-1023. Spare.
AIN7 Analog input 7 input value; 0-1023. Spare.

3.8 Price Values.

These are the registers that retain the price per mass-unit values. Normally read only. Write protect is unlocked with pass_number_1. Write protected if the handle is on.

Aprice_per_unit_t1 "A" hose price for tier 1.
Aprice_per_unit_t2 "A" hose price for tier 2.
Aprice_decimal_t1 "A" hose price decimal point for tier 1.
Aprice_decimal_t2 "A" hose price decimal point for tier 2.

Atier_select_mem	“A” hose active tier number.
Bprice_per_unit_t1	“B” hose price for tier 1.
Bprice_per_unit_t2	“B” hose price for tier 2.
Bprice_decimal_t1	“B” hose price decimal point for tier 1.
Bprice_decimal_t2	“B” hose price decimal point for tier 2.
Btier_select_mem	“B” hose active tier number

3.9 Process Log Addresses.

The process function is a real-time record of the fill process variables during a fill sequence. A maximum of ten variables can be sampled. Any variable on the Series II Monitor program list can be sampled. To sample a variable, the list address for that variable must be written to one of the process addresses before a fill. Samples of ten variables are taken in multiple intervals of 40 milliseconds. The default minimum interval is 40ms (process_mod = 0). The process_mod variable is used to select longer interval samples, process_mod = 1: 80ms, process_mod = 2: 120ms, etc. The process sampling starts when the display is reset to zeros after the all segment test (status = 22, filling = On). The process sampling halts when the fill is finished (status = 2 or 3, filling = off). The final number of samples taken are stored in the variable **final_process_count.** The Series II Monitoring program is used to upload the process log. The process sample function stores only the most current fill data in RAM memory. The data is written over by another fill or lost is the power is removed. The maximum number of sample sets is 6536.

Defaults:

AProcess_1	Amass
AProcess_2	Apressure
AProcess_3	Aflow
AProcess_4	Atemperature
AProcess_5	Atank_pressure
AProcess_6	Aflags
AProcess_7	Aaccount_1
AProcess_8	Aaccount_2
AProcess_9	Aaccount_3
AProcess_10	Aaccount_4
BProcess_1	Bmass
BProcess_2	Bpressure
BProcess_3	Bflow
BProcess_4	Btemperature
BProcess_5	Btank_pressure
BProcess_6	Bflags
BProcess_7	Baccount_1
BProcess_8	Baccount_2
BProcess_9	Baccount_3
BProcess_10	Baccount_4

3.10 Gilbarco Communication Link Variables (spc variables).

The spc_comm functions are part of the Gilbarco communication protocol. Only the A hose variables are shown as examples.

Apump_node A number indicating the hose number and dispenser number as a communication address. Hose A or B can be odd or even numbers but not the same. Dispensers are identified by increments of 2. Example: **Apump_node** = 0: A hose dispenser 1, **Apump_node** = 1: B hose dispenser 1, **Apump_node** = 2: A hose dispenser 2, **Apump_node** = 3: B hose dispenser 2, etc. Written by the dispenser.

Apump_status A coded number indicating the hose state (see table). Written by the dispenser.

Aspc_ident A bit coded number for indicating what command has been processed.

Aspc_grade The current fuel grade in use written by the host controller. Only grade 1 is valid in a NGV dispenser.

The final letter in the names below ***x* =** grade number 1-6. Six sets of grades with eight variables.

Aspc_price1_g*x* Price for tier 1. Written by the host controller.

Aspc_price2_g*x* Price for tier 2. Written by the host controller.

Aspc_tier_g*x* The current price tier in use. Written by the host controller.

Aspc_price_g*x* The current price used. Written by the dispenser.

Aspc_vol_g*x* The final mass dispensed by a fill in the displayed mass units. Read only.

Aspc_money_g*x* The final sale total for a fill. Read only.

Aspc_vol_total_g*x* The mass totalizers for both tiers converted into displayed mass units. Read only.

Aspc_mon_total_g*x* The sale totalizer for both tiers. Read only.

pump_status code	Description
0	Error.
6	Pump is off. Handle is off.
7	Call for authorization. Handle is on.
8	Authorized. Pump is not on. Handle is off.
9	Busy. Filling in progress. Handle is on and the dispenser is authorized.
10	Transaction complete. Filling is done.
11	Transaction complete. Filling is done. Waiting for the host controller to read the transaction data.
12	Stop. Not a valid state in an NGV dispenser. The stop command will go to 10: Transaction complete.
13	Send data. Host controller writing the price, tier, grade, or reading totals.

4. ANGI Series II Monitor Communication Link Protocol.

4.1 Communication Protocol General Description.

The Series II can be accessed through standard RS232 and RS485 ports using a custom protocol developed at ANGI for a computer program that runs on a Windows based system. This program is referred to as Monitor program throughout this document. The protocol uses the standard 8-bit ASCII code character set with the typical start character, node number, data, checksum, and terminating character. The ASCII code character set represents the characters on a computer keyboard (typewriter), letters, numbers, punctuation, special characters, and Teletype control. The general function of communication is to read or write number or letter character data or perform actions. A set of coded commands is used to accomplish this. There are a number of data areas to access in the dispenser control. Each area is a list of number storage points. They are:

1) A “Main” list of parameters and variables.
2) Flow meter parameters and variables.
3) CPU memory.
4) Audit trail data.
5) Process logs.

Individual elements like parameter, variable, and memory points are specifically access by their address number. The address number is their place on a list. Example: the 512K byte flash memory begins at address 2000000 hex and ends at 2080000 hex under CPU memory. The “Main” list begins at address 0 and ends at 999. For the most part in the dispenser controller, each point is a 32-bit number or what is called a “long word” in the programming world. These points can hold a number value from 0 to 4294967295.

4.2 Basic Serial Communication.

The serial communication function on a computer port and the Series II control board port transfers data serially one bit at a time at a clocked rate called a BAUD rate. Bits are either a zero or a one. Each bit is sent out of a port at the set clock time. The next bit will be sent out the next clock time and so on. The BAUD rate is how many bits per second are sent. Example: If the rate = 1000 the clock rate is 1 bit every millisecond. 1000 bit can be sent in one second. The ASCII character data is 8-bits long. Any 8-bits of data is contained in a structure of bits that the electronics can recognize. This is so the electronics can definitively transfer one character at a time. The typical “packet” has 10 or 11 bits. The first bit is always a zero. The electronics uses the arrival of this first bit to recognize the start of a packet and to start the timing of the oncoming bits. Next, the 8 bits of data are sent in order from lowest to highest. The next bit is the parity bit. This single bit is used to check weather if any data bit is in error. It is one or zero depending on weather the count of the one bits in the data are even or odd. For “even parity” the transmitter counts the data bits that are one and sets the parity bit to one if the is an even count. If the receiver counts an even number of data bits that are one, it assumes no error. If it counts an odd number then the receiver indicates a “parity” error. For “odd parity” the parity bit is set to one on an odd count of data bits that are one. For “no parity” this bit is not transmitted or expected to be received. Next is either a single or two stop bits to indicate the packet has ended. These bits are always one. The electronics will then indicate one character has been received and to expect another packet to immediately follow. The structure used by the transmitter must match the structure used by the receiver. If the number of stop bits, parity type selection, or BAUD rates are different between the transmitter and receiver, a “framing” error will occur.

A serial protocol is built from a set of 8-bits of data. Essentially the same job of detecting when this larger level of “packet” begins and ends applies. Some protocols, like ModBus RTU, do this with timing and “quiet” periods. Number data is written right in to the 8-bits. Protocols built with ASCII characters use special characters to indicate the start and stop. Number data are encoded into the letter and number characters. These are called “strings” of characters contained in the packet. Numbers can be represented by decimal characters 0-9 (dec for short), or with hexadecimal characters 0-9 A-F (hex for short). A-F is 10-15. Example: a hex number 1A is 1 x 16 + 10 of 26 dec, 12E is 1 x 256 + 2 x 16 + 14 or 302 dec. Another function that is typically part of a protocol is an error checking function usually called a checksum. It is similar to the parity bit in the 8-bit structure. There are many schemes to checksums but they all are put next to the end and generate a number from all the characters sent before. The basic one is to take each character’s ASCII number and exclusive or all of then together. Example the ASCII number for “0” is 30 hex and for “9” is 39. 30 exor 39 is 09. Two characters “09” is tagged on to the end of the packet string. The result is converted to two hex number characters.

4.3 Specific Series II Protocol.

The Series II protocol is an ASCII character protocol that has one start, two node, two action, data, two checksum, and one end character(s). Number data is represented in hex. Special non-letter and non-number characters are used for data control.

Node: the communication address number (0 – 255) to access a particular dispenser on the network.

Action: a coded number that commands the dispenser control to perform a communication task (0-255). Data string: a string with control characters followed by an associated hex number.
The basic string structure is

	ASCII Value hex	ASCII Character	Description
1	01	Start heading	Start character
2	30-39, 41-46	0-9, A-F	Node msb
3	30-39, 41-46	0-9, A-F	Node lsb
4	30-39, 41-46	0-9, A-F	Action msb
5	30-39, 41-46	0-9, A-F	Action lsb
6		0-9 A-F ! @ # $ % ^ & * |	First byte of data string
n		0-9 A-F ! @ # $ % ^ & * |	Subsequent bytes

	ASCII Value hex	ASCII Character	Description
7+n	30-39, 41-46	0-9, A-F	Checksum msb
8+n	30-39, 41-46	0-9, A-F	Checksum lsb
9+n	0D	Carriage return	End character

The action number specifies the communication function to return. If the action involves acting on variable and parameter values, up to ten addresses can be specified at one time.

Action number	Action performed
0	Echo back node, action, and nothing else.
1	Return with all the particulars that go with an address. Address, type, audit, value, decimal point, unit and name.
2	Read or write a parameter or variable at a specific address. Will return the value, decimal point, and unit code. Will not return a decimal point if the value is a floating-point number.
3	Read or write a parameter or variable at a specific address. Will return the value, decimal point, but not a unit code. Will not return a decimal point if the value is a floating-point number.
4	Returns whatever parameter and variable values, decimal point placements, units, and audit history have changed since the last transmission. The number of values is limited to keeping the response packet under 254 bytes. This function will cycle through all the addresses in sequential order to monitor all changes as long as the action is polled.
5	Returns the values in the “A” hose process log starting at a particular address. As many values are returned that can keep the packet length under 254 bytes.
6	Returns the values in the “B” hose process log starting at a particular address. As many values are returned that can keep the packet length under 254 bytes.
7	Returns with all the particulars starting at a particular address and continues in upward sequential order. Address, type, audit, value, decimal point, unit and name. As much data are returned that can keep the packet length under 254 bytes. For initial listing by the Monitor program.
8	Reads the Flash memory starting from any arbitrary address. Returns values in unsigned long word. A certain count can be specified. If not specified, as many values are returned that can keep the packet length under 254 bytes.
9	Reads the audit trail values.
10	Reads the “A” flow meter register values. Reads a single integer.
11	Reads the “B” flow meter register values. Reads a single integer.
12	Reads the “A” flow meter register values. Reads multiple arbitrary addresses. Converts between integers and floating points.
13	Reads the “B” flow meter register values. Reads multiple arbitrary addresses. Converts between integers and floating points.

Data string structure control character definitions to the dispenser control:

<table>
<tr><th>Character</th><th>Function</th><th>Following hex number or string.</th><th>Example</th></tr>
<tr><td>?</td><td>Read a value</td><td>At this address</td><td>?1E8</td></tr>
<tr><td>!</td><td>Write a value</td><td>At this address</td><td>!1E8</td></tr>
<tr><td>|</td><td>Or a value to the existing value</td><td>At this address</td><td>|1E8</td></tr>
<tr><td>&</td><td>And an inverse value to the existing value</td><td>At this address</td><td>&1E8</td></tr>
<tr><td>@</td><td>Bit address under main address</td><td>At this bit</td><td>?1E8@4</td></tr>
<tr><td>#</td><td>Follow write, or, not and</td><td>Provided value</td><td>#1234</td></tr>
<tr><td>*</td><td>Write decimal point placement</td><td>Decimal point value</td><td>*3</td></tr>
<tr><td>:</td><td>Follow write to bit x of 31</td><td>Provide bit placement</td><td>:6</td></tr>
<tr><td>$</td><td>Read string</td><td>String</td><td>$srghyu</td></tr>
<tr><td>\</td><td>Split an address value</td><td>Directory address \ item sub-address</td><td>34\24</td></tr>
</table>

Data string structure control character definitions from the dispenser control:

<table>
<tr><th>Character</th><th>Function</th><th>Following hex number or string.</th><th>Example</th></tr>
<tr><td>!</td><td>Requested value or string</td><td>Is at this address</td><td>!1E8</td></tr>
<tr><td>@</td><td>Requested bit placement</td><td>Is at this bit placement</td><td>!1E8@12</td></tr>
<tr><td>#</td><td>Requested value</td><td>Read value with cast qualifier prefix
Prefix = 0: unsigned long
Prefix = 2: floating point</td><td>#01234</td></tr>
<tr><td>$</td><td>Requested string</td><td>Parameter, variable, or bit name</td><td>$Aburst</td></tr>
<tr><td>*</td><td>Requested value’s decimal</td><td>Is the decimal point placement value</td><td>*3</td></tr>
<tr><td>&</td><td>Requested value’s units</td><td>Code for the engineering units</td><td>&141</td></tr>
<tr><td>|</td><td>Requested value’s type</td><td>Letter for parameter, variable, etc. with a number for the audit trail.</td><td>|D1022</td></tr>
</table>

The data string structure is pieced to together with the address command first following the value commands. Examples shown exclude the start, checksum, and end characters:

Read the value at address 35E hex dispenser node 1. Action = 3.

To dispenser: 0 1 0 3 ? 3 5 E
Response: 0 1 0 3 ! 3 5 E # 0 1 2 3 4 * 2

The value is an unsigned long 1234 hex (from #01234) with 2 decimal places (from *2). The hex number 1234 is 4660 dec. The displayed decimal value becomes 46.60.

Read the all at address 1F hex dispenser node 5. Action = 1.

To dispenser: 0 5 0 1 ? 1 F
Response: 0 5 0 1 ! 1 F **|** P 1 0 0 1 # 0 1 C 8 * 1 & 9 6 $ S d p m a x

The type is "P" for parameter, audit = 1 change, value is 1C8 hex with 1 decimal place, unit code is 96 hex or 140 dec for "%", and the name is "Sdpmax". The displayed number is Sdpmax 45.6 %.

Write a value 432 hex at address 35E hex dispenser node 1. Action = 3. Access permitted.

To dispenser: 0 1 0 3 ! 3 5 E # 4 3 2
Response: 0 1 0 3

The value was 1234 hex with 2 decimal places, the value is now 432 hex still with 2 decimal places.

Write a value 432 hex at address 35E hex dispenser node 1. Action = 3. Access denied.

To dispenser: 0 1 0 3 ! 3 5 E # 4 3 2
Response: 0 1 0 3 ! 3 5 E # 0 1 2 3 4 * 2

The value remains 1234 hex with 2 decimal places, response comes back with the original unchanged value.

Write a decimal point placement at address 35E hex dispenser node 1. Action = 3. Access permitted.

To dispenser: 0 1 0 3 ! 3 5 E * 3
Response: 0 1 0 3

The value was 1234 hex with 2 decimal places, the value is still 1234 hex with 3 decimal places.
Read the value at address 1F hex dispenser node 1. Action = 2.

To dispenser: 0 1 0 2 ? 1 F
Response: 0 1 0 2 ! 1F # 0 1 C 8 * 1 & 9 6

The value is an unsigned long 1C8 hex (from #01C8) with 1 decimal places (from *1) and % units (from &96). The hex number 1234 is 4660 dec. The displayed decimal value becomes 46.60.

Read three sequential values in the flash memory starting at byte address 2001000 hex dispenser node 1. Action = 8. The values are four bytes long.

To dispenser: 0 1 0 8 ? 2 0 0 1 0 0 0 # 3
Response: 0 1 0 8 ! 2 0 0 1 0 0 0 # 4 3 F 6 ! # D 2 F 7 5 ! # 5 4

The three values are 43F6, D2F75, 54 hex. The first exclamation point "!" is followed by the starting address. The first "#" is followed by the value 43F6 read at that address. The second "!" is not followed by a hex number but goes right to the "#" symbol. This implies the next address 2001004. (Addresses from the memory read are incremented by 4 bytes). The second "#" is followed by the next value D2F75. The last "!" and "#" implies address 2001008 with value 54.

Read the "A" meter register values at address 257 dec (101hex) dispenser node 1. Action = 5.

To dispenser: 0 1 0 5 ? 1 0 1
Response: 0 1 0 5 ! 1 0 1 # 2 4 0 C 0 0 0 0 0

The value is a floating point # 40C00000 hex. The float number 4 0 C 0 0 0 0 0 is 1.500000 E+00. The ModBus address is 257 and 258. Each address in the meter is a 16-bit integer value. A floating point value uses two meter addresses to make a 32-bit value.

5. ANGI SERIES II Monitoring Program

The ANGI SERIES II monitoring tool is a Windows based program that gives access to the system parameters, on-line variable monitoring, previous fill result data, actual time process signal recording, and program download capability. It also has pass-through monitoring and parameter editing access to the MicroMotion mass flow meter registers.

The tool connects to the ANGI SERIES II system through a standard RS232 com port found on a typical laptop or desktop computer. The ANGI SERIES II Interface board supplies an RS232 port for monitoring or programming (COM0). It also provides an RS485 port for monitoring only (COM5). Multiple dispensers, up to 32, can be connected on an RS485 network using a unique node address for each dispenser. The monitoring tool and the dispenser communicate with a custom protocol using the ASCII character format. Once connected and on-line, the monitoring tool downloads the parameter and variable names, values, and units from the dispenser microcontroller. It displays them on a master list. Once the download is complete, the monitoring tool will continually retrieve changing system variables

The ANGI SERIES II monitoring tool allows the user to modify system parameters as described in section 2.

System parameters allow calibration changes to be made on the system, only when the system is not sequencing. The system parameters and variables are normally write-protected. The write protect must be unlocked by entering a password. There different passwords for certain levels of access for 1) setting the real time clock, 2) parameters that effect fill behavior, 3) parameters that affect mass measurement, 4) parameters that effect hardware set-up, 5) influencing operational variables 6) initializing totalizers, and 7) adjusting the price per unit. Levels 4, 5, and 6 must also have the physical switch SW1_1 flipped to the on position from the off position to unlock. Access to this switch is in the main electrical cabinet. The dispenser is inhibited from sequencing any time SW1_1 is on. Changes made to the system parameters are first written to volatile memory (RAM). The system will operate with the changes when SW1_1 is returned to the off position. Changes then must be stored in non-volatile memory (EEPROM) to reload them on power up. This is done with the ANGI SERIES II monitoring tool by clicking on the "save to memory" menu item.

Any changes stored to non-volatile memory are also stored to a change audit trail log. Each set of changes is time stamped. 1024 single changes can be recorded before the log "wraps around." The ANGI SERIES II monitoring tool can download the change log for display and save as a text file.

System parameters should only be adjusted when absolutely necessary. It is possible to completely disrupt the dispenser operation by altering system parameters incorrectly.

6. Parameter Change Audit Trail

The parameter change audit trail is an historical log that retains parameter value changes in non-volatile memory. Any parameter value changed through the communication link will be recorded. The new value is recorded along with a time and date stamp from the on board real-time clock and an overall change count. The trail can keep 1024 changes. Changes beyond a count of 1024 will write over the oldest changes. The change counter will count up to 32768 before wrapping around to zero. The dispenser program continually runs an algorithm that sorts through the trail and groups the changes by the parameter number (see section 2.2 and 2.3 for the numbers). The sorted results can be viewed through the dispenser displays and keypad or downloaded to the PC based monitoring tool. The monitoring tool can save the downloaded results to a text file. The audit trail also records changes to the MicroMotion mass-flow meters if the changes were done through the dispenser control by the monitoring tool (dispenser firmware rev 3.80 or greater). The trail records the ModBus address number of the parameter. In dispenser program revisions 3.81 and lower, there is a one-time audit trail clear function that erases this log and then disables any further erasures. This function is to get rid of parameter adjustments during the dispenser's factory test. Parameter changes recorded after test are all changes done in the field. In dispenser program revisions 3.82 and higher, the clearing and clear-disable functions are separated. The trail can be cleared multiple times until the clear-disable function is activated. Once the clear-disable function is executed the trail can not be cleared ever again. This is accomplished in the dispenser controller.

Installation Manual
20002586, Rev BA
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Micro Motion® CNG050 Sensors

Micro Motion

EMERSON
Process Management

Safety and approval information

This Micro Motion product complies with all applicable European directives when properly installed in accordance with the instructions in this manual. Refer to the EC declaration of conformity for directives that apply to this product. The EC declaration of conformity, with all applicable European directives, and the complete ATEX Installation Drawings and Instructions are available on the internet at www.micromotion.com/atex or through your local Micro Motion support center.

Information affixed to equipment that complies with the Pressure Equipment Directive can be found on the internet at www.micromotion.com/documentation.

For hazardous installations in Europe, refer to standard EN 60079-14 if national standards do not apply.

Other information

Full product specifications can be found in the product data sheet. Troubleshooting information can be found in the transmitter configuration manual. Product data sheets and manuals are available from the Micro Motion web site at www.micromotion.com/documentation.

Return policy

Micro Motion procedures must be followed when returning equipment. These procedures ensure legal compliance with government transportation agencies and help provide a safe working environment for Micro Motion employees. Failure to follow Micro Motion procedures will result in your equipment being refused delivery.

Information on return procedures and forms is available on our web support system at www.micromotion.com, or by phoning the Micro Motion Customer Service department.

Micro Motion customer service

Location		Telephone number
U.S.A.		800-522-MASS (800-522-6277) (toll free)
Canada and Latin America		+1 303-527-5200 (U.S.A.)
Asia	Japan	3 5769-6803
	All other locations	+65 6777-8211 (Singapore)
Europe	U.K.	0870 240 1978 (toll-free)
	All other locations	+31 (0) 318 495 555 (The Netherlands)
Customers outside the U.S.A. can also send an email to flow.support@emerson.com.		

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1 Planning

Topics covered in this chapter:

- *Installation checklist*
- *Best practices*
- *Environmental limits*

1.1 Installation checklist

- ☐ Make sure that the hazardous area specified on the sensor approval tag is suitable for the environment in which the sensor is installed.
- ☐ Verify that the local ambient and process temperatures are within the limits of the sensor. See *Environmental limits*.
- ☐ If your sensor has an integral transmitter, no wiring is required between the sensor and transmitter. Follow the wiring instructions in the transmitter installation manual for signal and power wiring.
- ☐ If your transmitter has remote-mounted electronics, follow the instructions in this manual for wiring between the sensor and the transmitter, and then follow the instructions in the transmitter installation manual for power and signal wiring.
- ☐ For the wiring between the sensor and the transmitter, consider maximum cable lengths (see *Table 1-1* and *Table 1-2*). The maximum distance between the sensor and transmitter depends on the cable type. For all types of wiring, Micro Motion recommends using Micro Motion cable.

Table 1-1: Maximum lengths for Micro Motion cable

Cable type	To transmitter	Maximum length
Micro Motion 4-wire	All 4-wire MVD transmitters	1000 ft (300 m)

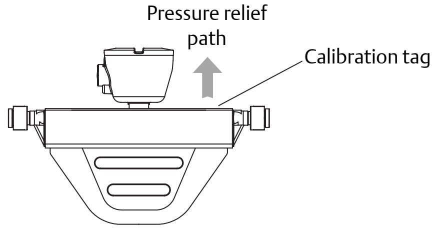
Table 1-2: Maximum lengths for user-supplied 4-wire cable

Wire function	Wire size	Maximum length
Power (VDC)	22 AWG (0,35 mm^2)	300 ft (90 m)
	20 AWG (0,5 mm^2)	500 ft (150 m)
	18 AWG (0,8 mm^2)	1000 ft (300 m)
Signal (RS-485)	22 AWG (0,35 mm^2) or larger	1000 ft (300 m)

- ☐ The sensor will work in any orientation as long as the flow tubes remain full of process fluid.
- ☐ The sensor has a pressure relief feature to evacuate the case in the unlikely event of a tube breach. The pressure relief feature is located underneath the calibration tag.

Orient the sensor so that personnel and equipment will not be exposed to escaping pressurized discharge. See *Figure 1-1*.

Figure 1-1: Pressure relief feature



⚠ **CAUTION!**

Failure to properly orient the sensor could result in exposure to pressurized discharge. Orient the sensor in a way that will not expose personnel and equipment to the pressure relief path.

☐ Install the sensor so that the flow direction arrow on the sensor matches the actual forward flow of the process.

1.2 Best practices

The following information can help you get the most from your sensor.

- There are no pipe run requirements for Micro Motion sensors. Straight runs of pipe upstream or downstream are unnecessary.
- If the sensor is installed in a vertical pipeline, liquids and slurries should flow upward through the sensor. Gases may flow upward or downward.
- Keep the sensor tubes full of process fluid.
- For halting flow through the sensor with a single valve, install the valve downstream from the sensor.
- Minimize bending and torsional stress on the meter. Do not use the meter to align misaligned piping.
- The sensor does not require external supports. The flanges will support the sensor in any orientation.

1.3 Environmental limits

The environmental limits of the sensor are as follows:

- Process fluid: –40 to +257 °F (–40 to +125 °C)
- Ambient temperature: –40 to +140 °F (–40 to +60 °C)

- Temperature limits may be further restricted by hazardous area approvals. Refer to the hazardous area approvals documentation shipped with the sensor or available from the Micro Motion web site (www.micromotion.com).

2 Mounting

2.1 Mount the sensor

Use your common practices to minimize torque and bending load on process connections.

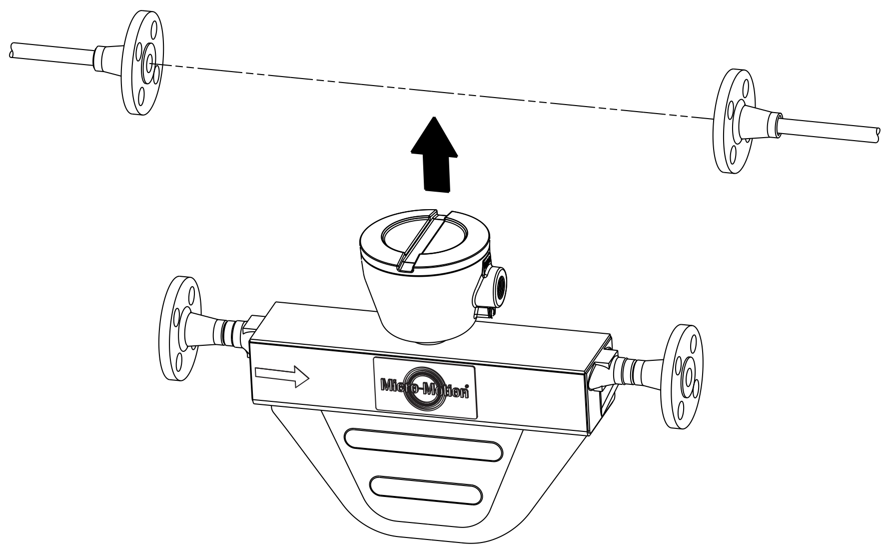
Tip

To reduce the risk of condensation or excessive moisture, the conduit opening should not point upward (if possible). The conduit opening of the core processor can be rotated freely to facilitate wiring.

Procedure

Mount the sensor in the pipeline (see *Figure 2-1*).

Figure 2-1: Mounting the sensor



Notes

- *Do not use the sensor to support the piping.*
- *The sensor does not require external supports. The flanges will support the sensor in any orientation.*

⚠ CAUTION!

Do not lift the sensor by the electronics. Lifting the sensor by the electronics can damage the device.

3 Wiring

Topics covered in this chapter:

- *Options for wiring*
- *Connect 4-wire cable*

3.1 Options for wiring

The wiring procedure you follow depends on which electronics option you have.

See *Table 3-1* for the wiring options for each sensor electronics option.

Table 3-1: Wiring procedures by electronics option

Electronics option	Wiring procedure
Integral transmitter	No wiring required between sensor and transmitter. See the transmitter installation manual for wiring the power and signal cable to the transmitter.
MVD™ Direct Connect™	No transmitter to wire. See the MVD Direct Connect manual for wiring the power and signal cable between the sensor and the direct host.
Core processor	See *Connect 4-wire cable*.

⚠ **CAUTION!**

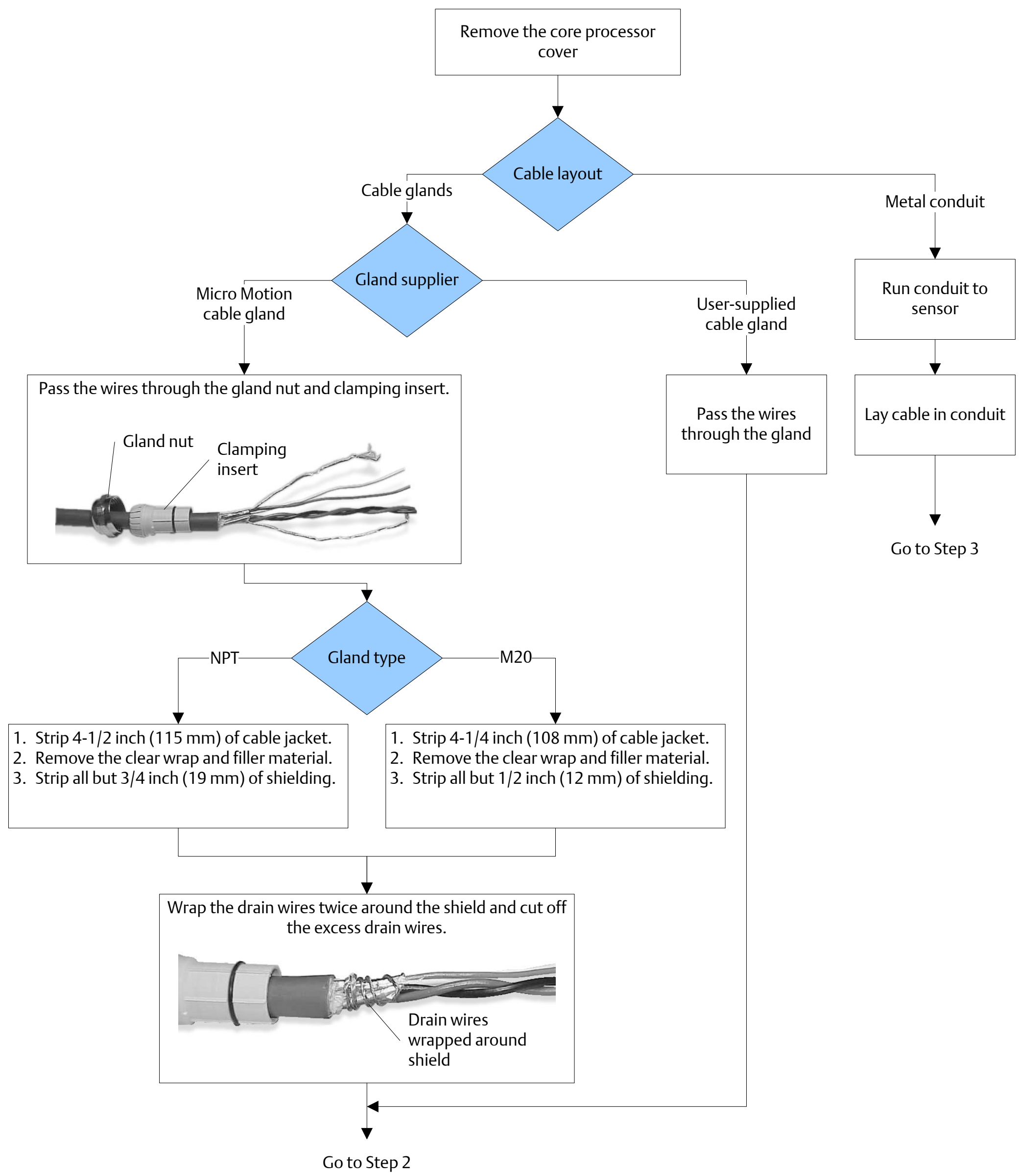
Make sure the hazardous area specified on the sensor approval tag is suitable for the environment in which the sensor will be installed. Failure to comply with the requirements for intrinsic safety in a hazardous area could result in an explosion.

⚠ **CAUTION!**

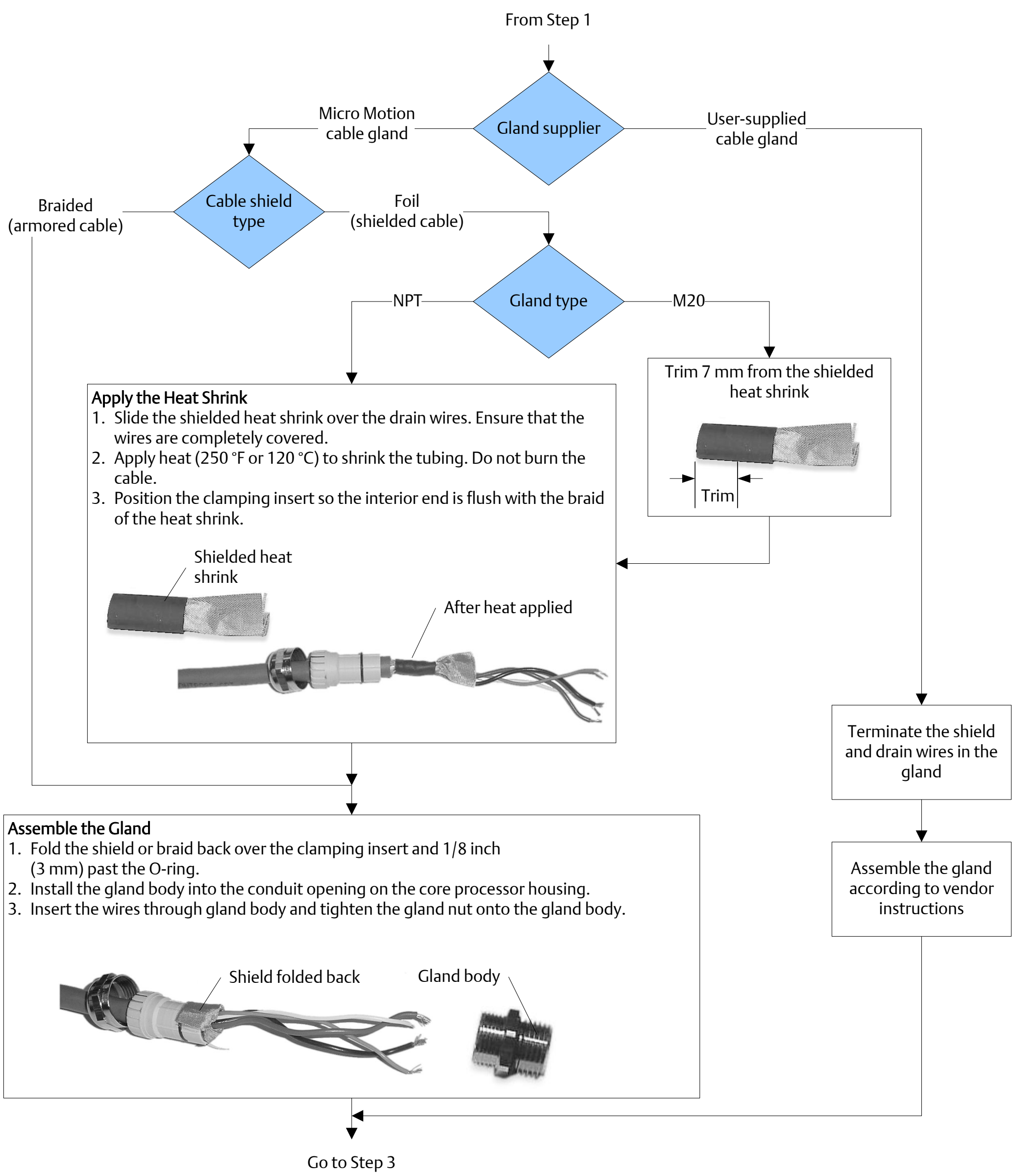
Fully close and tighten all housing covers and conduit openings. Improperly sealed housings can expose electronics to moisture, which can cause measurement error or flowmeter failure. Inspect and grease all gaskets and O-rings.

3.2 Connect 4-wire cable

Step 1: Cable preparation



Step 2: Shield termination

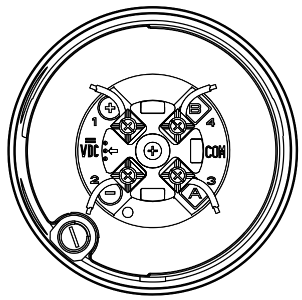


Step 3: Terminal connections

From Step 1 or 2

Connect the wires to the core processor terminals:

Red wire > Terminal 1 (Power supply +)
Black wire > Terminal 2 (Power supply –)
White wire > Terminal 3 (RS-485/A)
Green wire > Terminal 4 (RS-485/B)



Reinstall and tighten the core processor cover

Connect the wires to the transmitter terminals
(see the transmitter manual)

4 Grounding

The sensor must be grounded according to the standards that are applicable at the site. The customer is responsible for knowing and complying with all applicable standards.

Prerequisites

Micro Motion suggests the following guides for grounding practices:

- In Europe, IEC 79-14 is applicable to most installations, in particular Sections 12.2.2.3 and 12.2.2.4.
- In the U.S.A. and Canada, ISA 12.06.01 Part 1 provides examples with associated applications and requirements.

If no external standards are applicable, follow these guidelines to ground the sensor:

- Use copper wire, 14 AWG (2,0 mm^2) or larger wire size.
- Keep all ground leads as short as possible, less than 1 Ω impedance.
- Connect ground leads directly to earth, or follow plant standards.

⚠ **CAUTION!**

Ground the flowmeter to earth, or follow ground network requirements for the facility. Improper grounding can cause measurement error.

Procedure

Check the joints in the pipeline.

- If the joints in the pipeline are ground-bonded, the sensor is automatically grounded and no further action is necessary (unless required by local code).
- If the joints in the pipeline are not grounded, connect a ground wire to the grounding screw located on the sensor electronics.

Tip

The sensor electronics may be a transmitter, core processor, or junction box. The grounding screw may be internal or external.

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Micro Motion Inc. USA
Worldwide Headquarters
7070 Winchester Circle
Boulder, Colorado 80301
T +1 303-527-5200
T +1 800-522-6277
F +1 303-530-8459
www.micromotion.com

Micro Motion Europe
Emerson Process Management
Neonstraat 1
6718 WX Ede
The Netherlands
T +31 (0) 318 495 555
F +31 (0) 318 495 556
www.micromotion.nl

Micro Motion Asia
Emerson Process Management
1 Pandan Crescent
Singapore 128461
Republic of Singapore
T +65 6777-8211
F +65 6770-8003

Micro Motion United Kingdom
Emerson Process Management Limited
Horsfield Way
Bredbury Industrial Estate
Stockport SK6 2SU U.K.
T +44 0870 240 1978
F +44 0800 966 181

Micro Motion Japan
Emerson Process Management
1-2-5, Higashi Shinagawa
Shinagawa-ku
Tokyo 140-0002 Japan
T +81 3 5769-6803
F +81 3 5769-6844

Installation Instructions
P/N 20001965, Rev. E
March 2008

CSA-D-IS Installation Instructions, MVD Transmitters

For installations approved by the Canadian Standards Association

Micro Motion®

EMERSON™
Process Management

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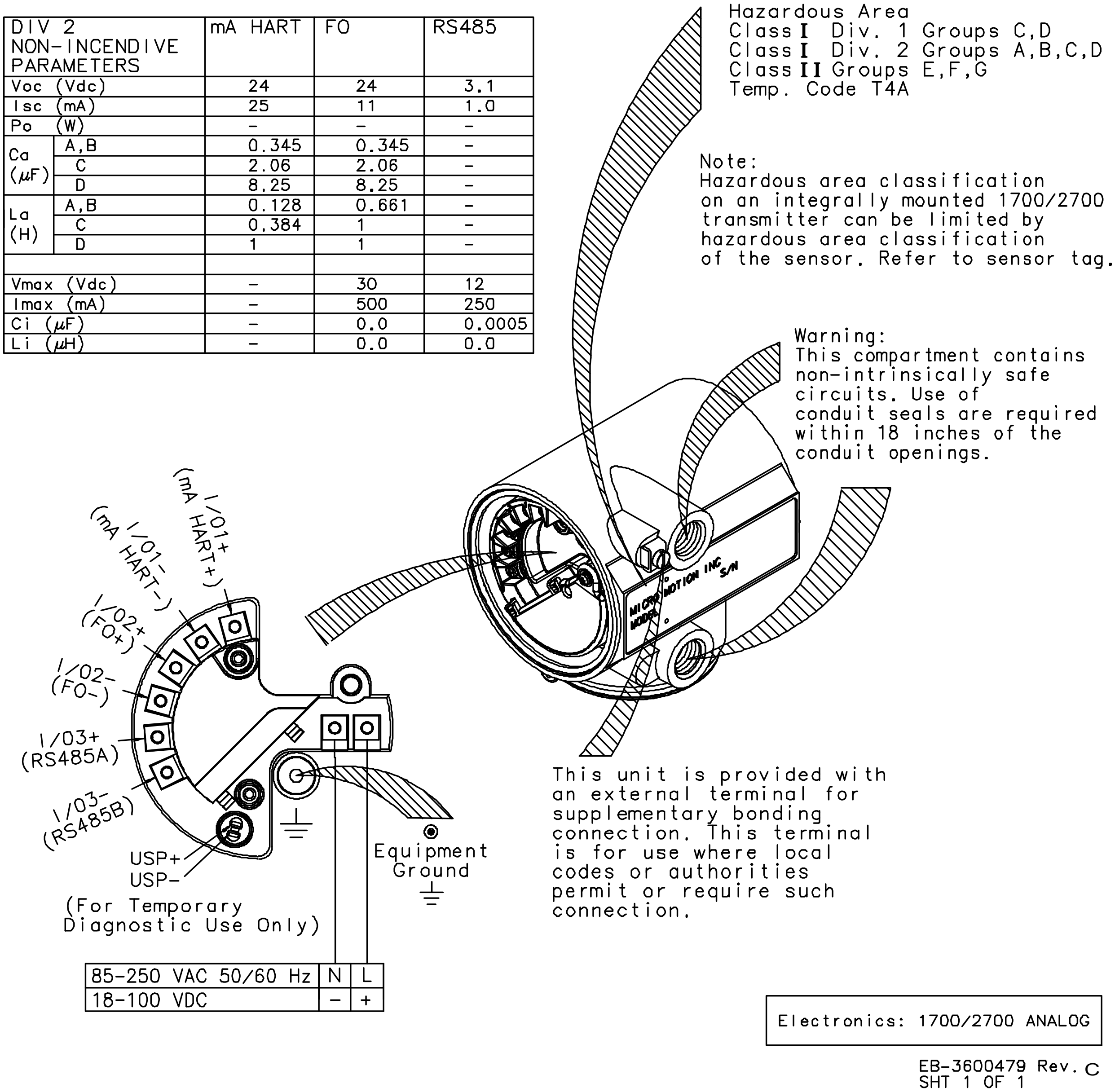
Transmitter Output Installation

Analog outputs

MODEL 1700/2700 WITH ANALOG OUTPUTS IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

DIV 2 NON-INCENDIVE PARAMETERS		mA HART	FO	RS485
Voc (Vdc)		24	24	3.1
Isc (mA)		25	11	1.0
Po (W)		-	-	-
Ca (μF)	A,B	0.345	0.345	-
	C	2.06	2.06	-
	D	8.25	8.25	-
La (H)	A,B	0.128	0.661	-
	C	0.384	1	-
	D	1	1	-
Vmax (Vdc)		-	30	12
Imax (mA)		-	500	250
Ci (μF)		-	0.0	0.0005
Li (μH)		-	0.0	0.0



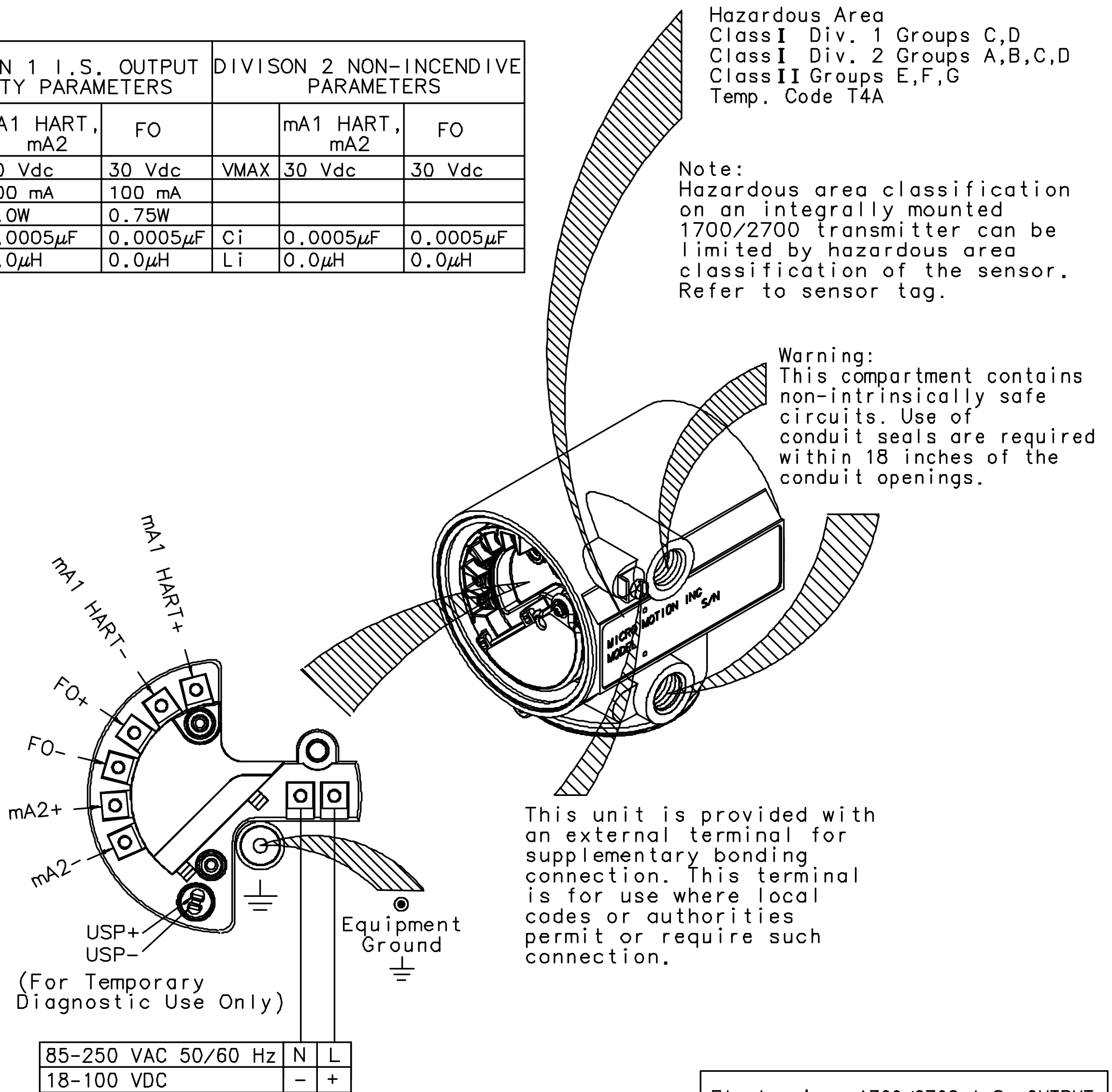
Transmitter Output Installation

Intrinsically safe outputs

MODEL 1700/2700 WITH I.S. OUTPUTS IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

DIVISON 1 I.S. OUTPUT ENTITY PARAMETERS			DIVISON 2 NON-INCENDIVE PARAMETERS		
	mA1 HART, mA2	FO		mA1 HART, mA2	FO
VMAX	30 Vdc	30 Vdc	VMAX	30 Vdc	30 Vdc
Imax	300 mA	100 mA			
Pmax	1.0W	0.75W			
Ci	0.0005μF	0.0005μF	Ci	0.0005μF	0.0005μF
Li	0.0μH	0.0μH	Li	0.0μH	0.0μH



Electronics: 1700/2700 I.S. OUTPUT

EB-3600629 Rev. D
SHT 1 OF 1

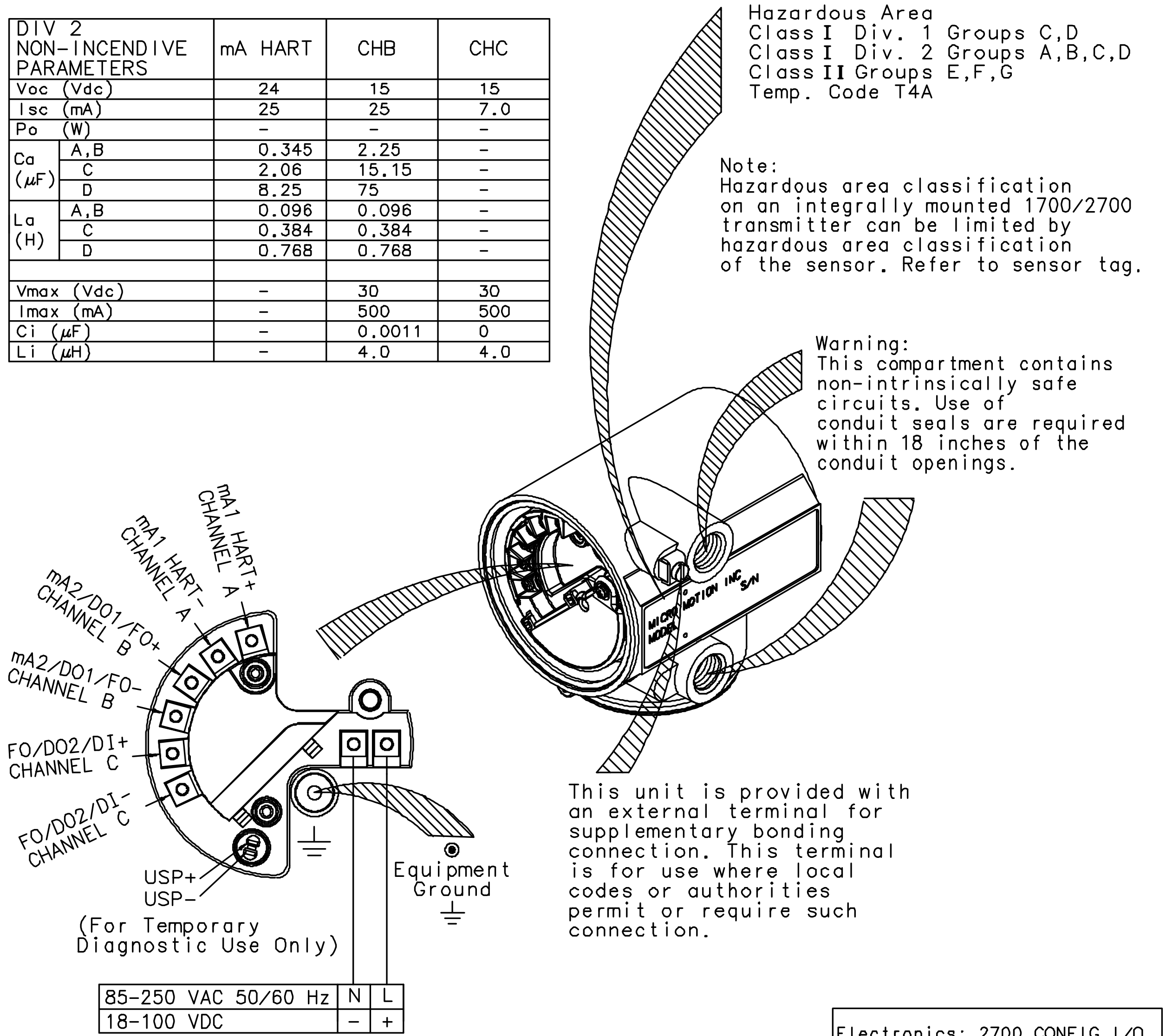
Transmitter Output Installation

Model 2700 with configurable inputs and outputs

MODEL 2700 WITH CONFIG I/O IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

DIV 2 NON-INCENDIVE PARAMETERS		mA HART	CHB	CHC
Voc (Vdc)		24	15	15
Isc (mA)		25	25	7.0
Po (W)		-	-	-
Ca (μF)	A,B	0.345	2.25	-
	C	2.06	15.15	-
	D	8.25	75	-
La (H)	A,B	0.096	0.096	-
	C	0.384	0.384	-
	D	0.768	0.768	-
Vmax (Vdc)		-	30	30
Imax (mA)		-	500	500
Ci (μF)		-	0.0011	0
Li (μH)		-	4.0	4.0



Electronics: 2700 CONFIG I/O

EB-3600667 Rev. B
SHT 1 OF 1

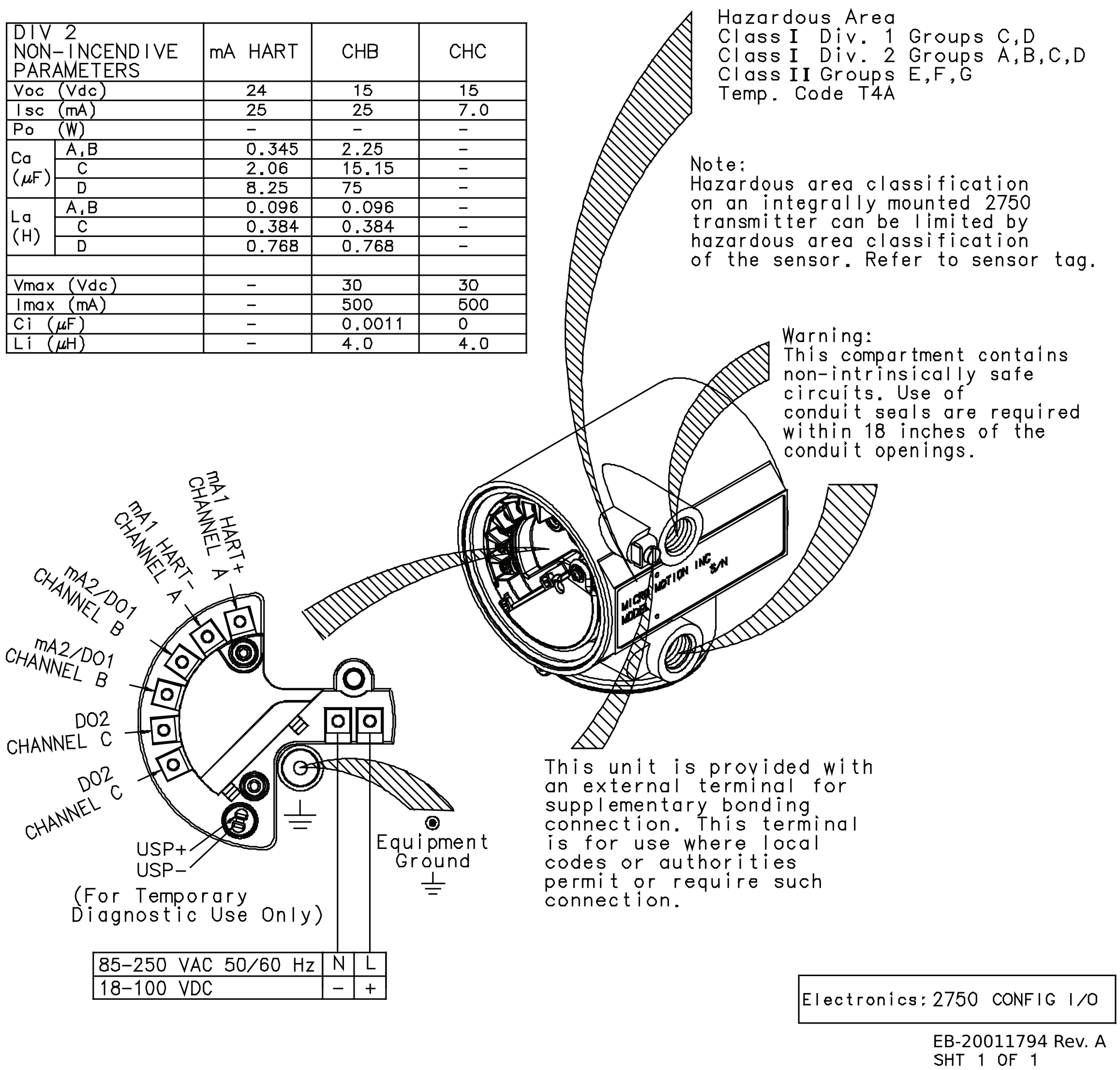
Transmitter Output Installation

Model 2750 with configurable inputs and outputs

MODEL 2750 WITH CONFIG I/O IN HAZARDOUS LOCATION

(WARNING; SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

DIV 2 NON-INCENDIVE PARAMETERS		mA HART	CHB	CHC
Voc (Vdc)		24	15	15
Isc (mA)		25	25	7.0
Po (W)		-	-	-
Ca (µF)	A,B	0.345	2.25	-
	C	2.06	15.15	-
	D	8.25	75	-
La (H)	A,B	0.096	0.096	-
	C	0.384	0.384	-
	D	0.768	0.768	-
Vmax (Vdc)		-	30	30
Imax (mA)		-	500	500
Ci (µF)		-	0.0011	0
Li (µH)		-	4.0	4.0



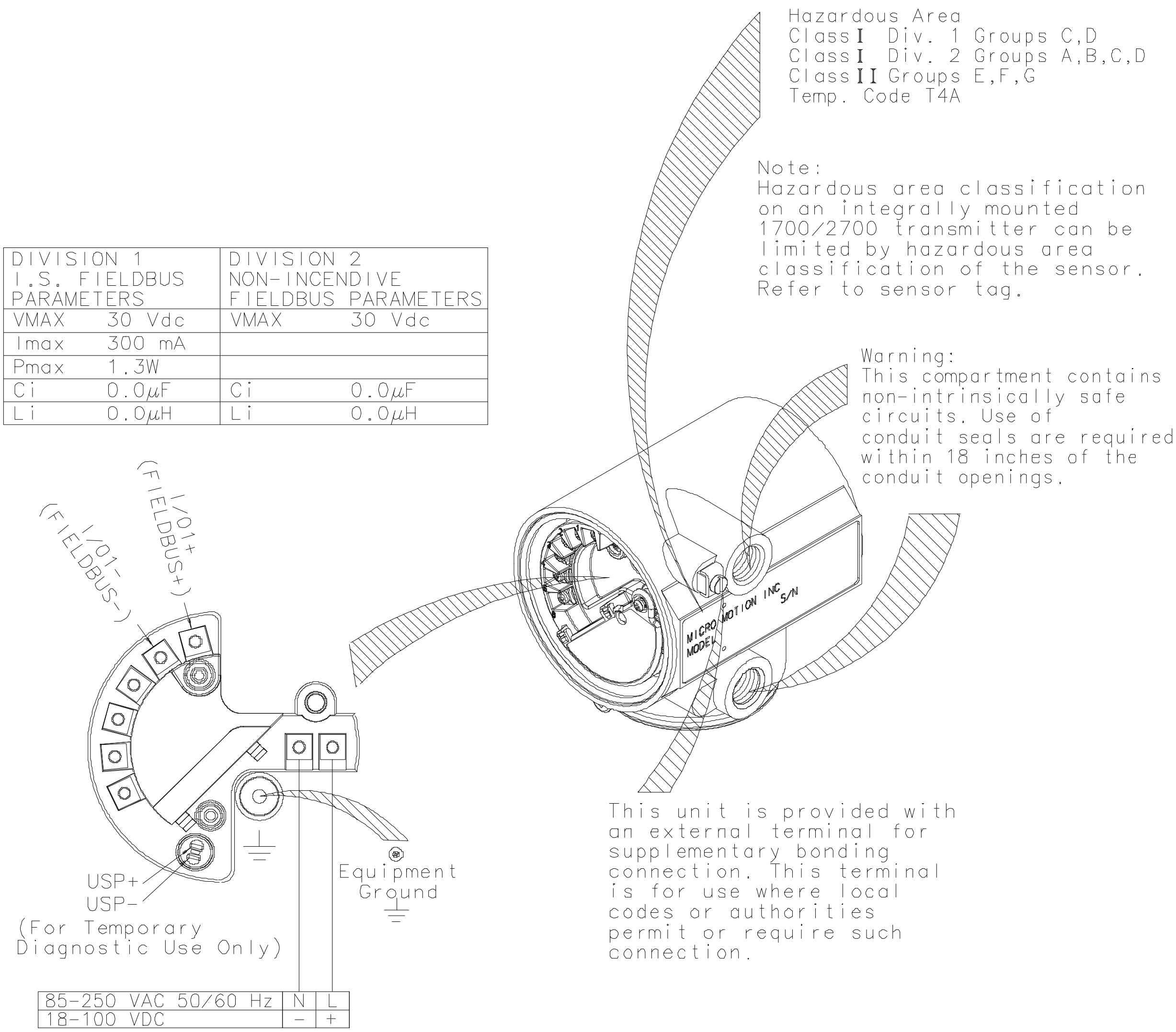
Transmitter Output Installation

FOUNDATION fieldbus™ outputs

MODEL 1700/2700 WITH FIELDBUS IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

DIVISION 1 I.S. FIELDBUS PARAMETERS		DIVISION 2 NON-INCENDIVE FIELDBUS PARAMETERS	
VMAX	30 Vdc	VMAX	30 Vdc
Imax	300 mA		
Pmax	1.3W		
Ci	0.0μF	Ci	0.0μF
Li	0.0μH	Li	0.0μH



Electronics: 1700/2700 FIELDBUS

EB-3600476 Rev. D
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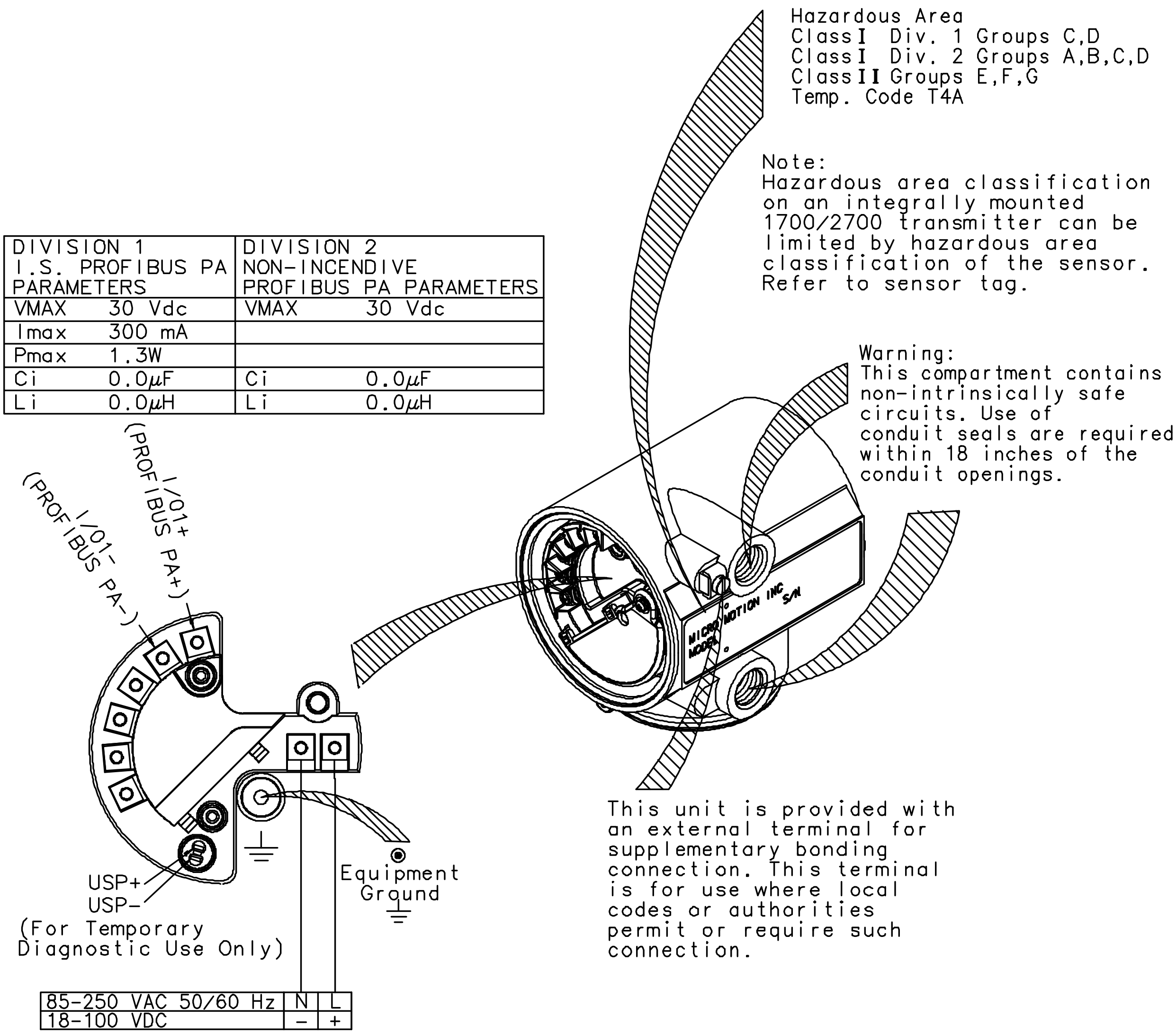
Transmitter Output Installation

Profibus-PA outputs

MODEL 1700/2700 WITH PROFIBUS PA IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

DIVISION 1 I.S. PROFIBUS PA PARAMETERS		DIVISION 2 NON-INCENDIVE PROFIBUS PA PARAMETERS	
VMAX	30 Vdc	VMAX	30 Vdc
Imax	300 mA		
Pmax	1.3W		
Ci	0.0μF	Ci	0.0μF
Li	0.0μH	Li	0.0μH



Electronics: 1700/2700 PROFIBUS PA

EB-3600473 Rev. D
SHT 1 OF 1

Model 1700/2700 4-Wire Installation

Remote transmitter to enhanced core processor mounted on sensor

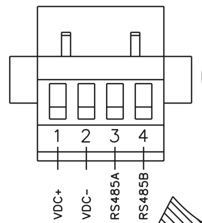
REMOTE MOUNT MODEL 1700/2700 IN HAZARDOUS LOCATION

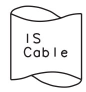
(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

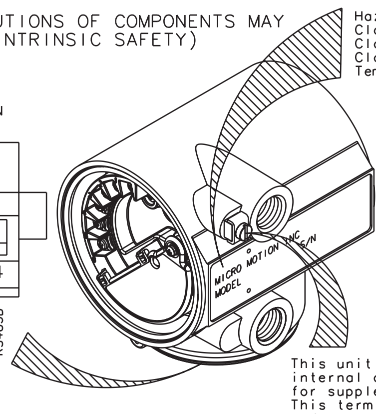
Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G
Temp. Code T4A

For proper installation including I/O, power, gland and hazardous area location, refer to appropriate 1700/2700 output option CSA-D-IS installation instructions

REMOTE INSTALLATION







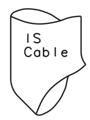
		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

Note:
Hazardous area classification on an integrally mounted 1700/2700 transmitter can be limited by hazardous area classification of the sensor. Refer to sensor tag.

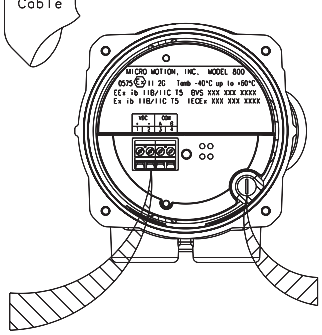
This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

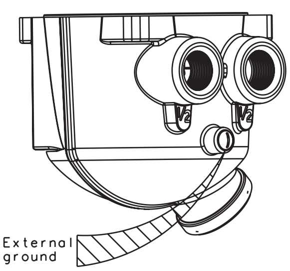
Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G

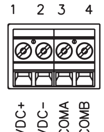
Refer to sensor tag for complete hazardous area classification.



I.S. AND NON-INCENDIVE ENHANCED CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH







INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci[1] + Ci[2] + ... + Cin
*La > = Lcable + Li[1] + Li[2] + ... + Li[n]

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Micro Motion mass flowmeter system connection for Intrinsically safe operation

Electronics: 1700/2700

EB-20003010 Rev. A
SHT 1 OF 1

Model 1700/2700 4-Wire Installation

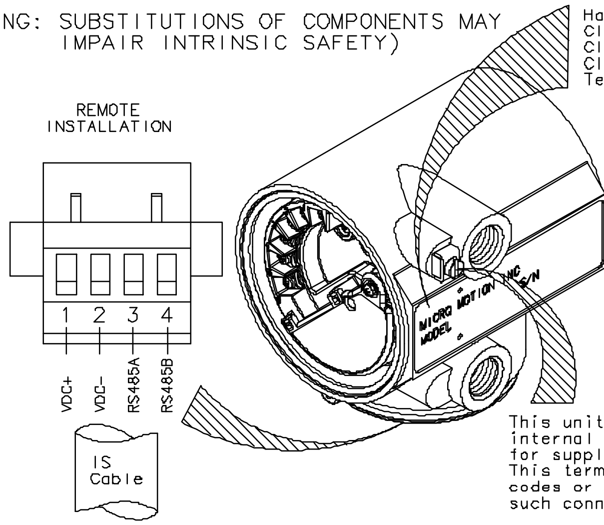
Remote transmitter to core processor mounted on sensor (except D600 and CMF400 with booster amplifier)

REMOTE MOUNT MODEL 1700/2700 IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G
Temp. Code T4A

For proper installation including I/O, power, gland and hazardous area location, refer to appropriate 1700/2700 output option CSA-D-IS installation instructions



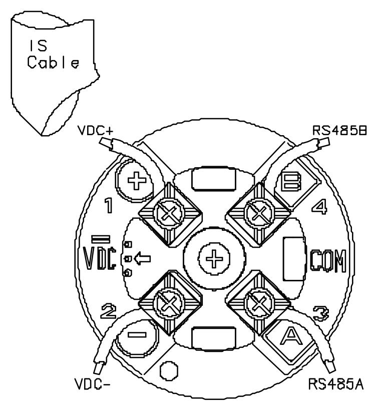
		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

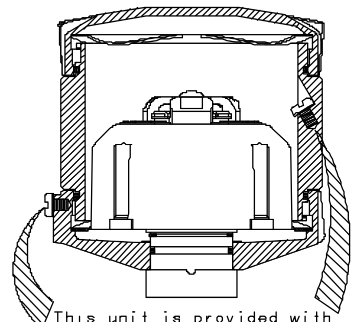
Note:
Hazardous area classification on an integrally mounted 1700/2700 transmitter can be limited by hazardous area classification of the sensor. Refer to sensor tag.

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

Hazardous Area
Class I Div. 1 Groups C,D
Class I Div 2 Groups A,B,C,D
Class II Groups E,F,G

Refer to sensor tag for complete hazardous area classification.





This unit is provided with an internal and external terminal for supplementary bonding connection This terminal is for use where local codes or authorities permit or require such connection.

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li^1 + Li^2 + . + Li^n

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

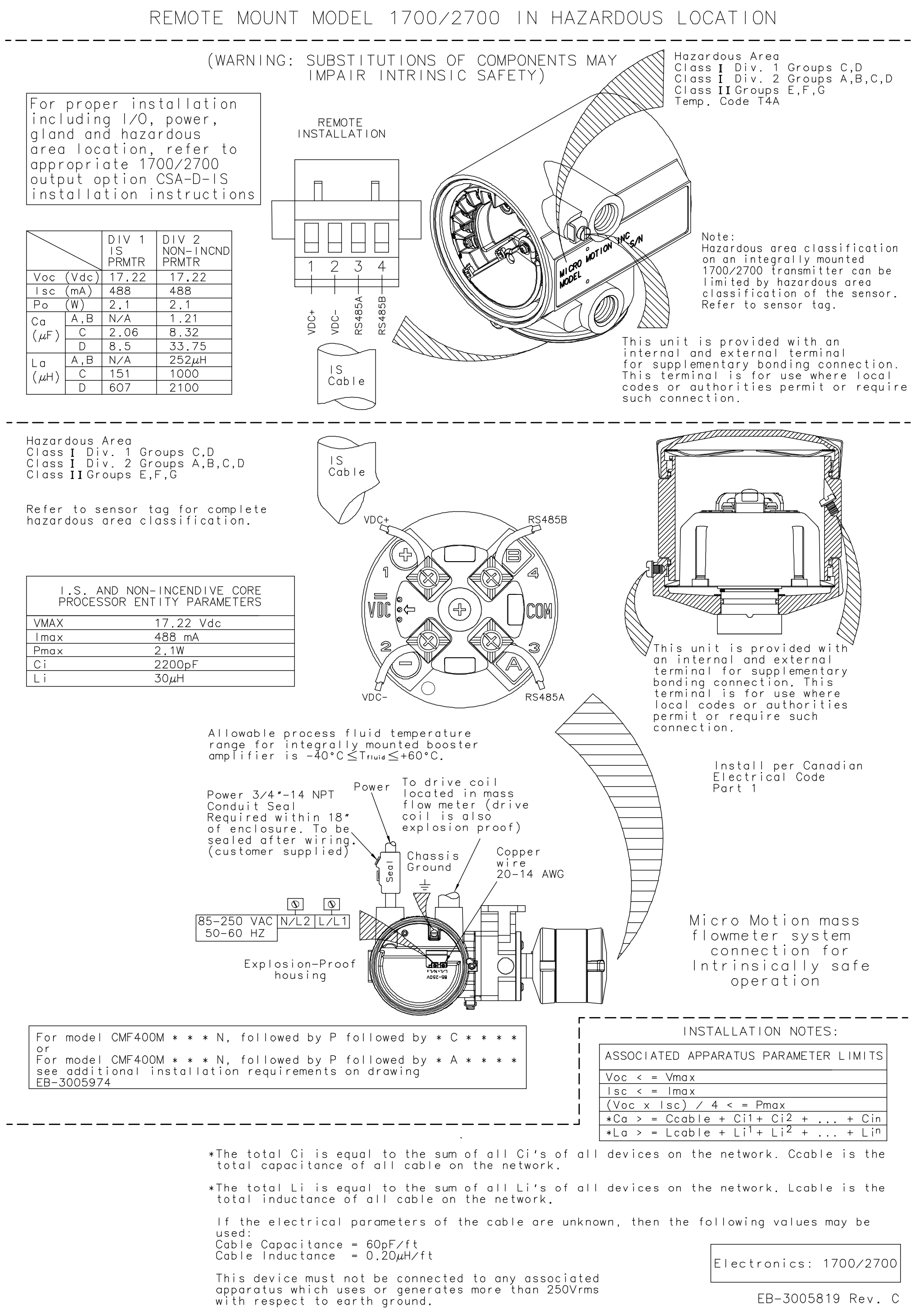
Micro Motion mass flowmeter system connection for Intrinsically safe operation

Electronics: 1700/2700

EB-3600482 Rev. B
SHT 1 OF 1

Model 1700/2700 4-Wire Installation

Remote transmitter to core processor mounted on CMF400 sensor with booster amplifier



		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		488	488
Po (W)		2.1	2.1
Ca (µF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (µH)	A,B	N/A	252µH
	C	151	1000
	D	607	2100

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.22 Vdc
Imax	488 mA
Pmax	2.1W
Ci	2200pF
Li	30µH

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

Model 1700/2700 4-Wire Installation

Remote transmitter to core processor mounted on D600 sensor

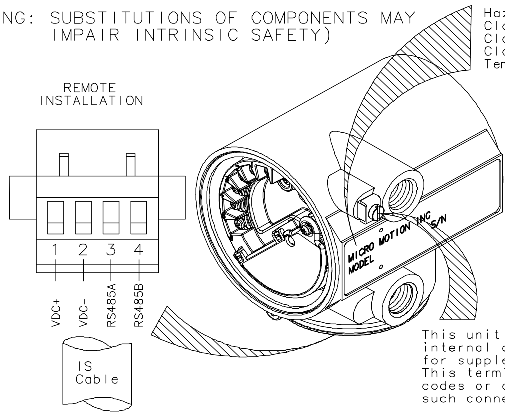
REMOTE MOUNT MODEL 1700/2700 IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G
Temp. Code T4A

For proper installation including I/O, power, gland and hazardous area location, refer to appropriate 1700/2700 output option CSA-D-IS installation instructions

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		488	488
Po (W)		2.1	2.1
Ca (µF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (µH)	A,B	N/A	252µH
	C	151	1000
	D	607	2100

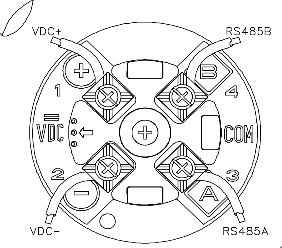


Note:
Hazardous area classification on an integrally mounted 1700/2700 transmitter can be limited by hazardous area classification of the sensor. Refer to sensor tag.

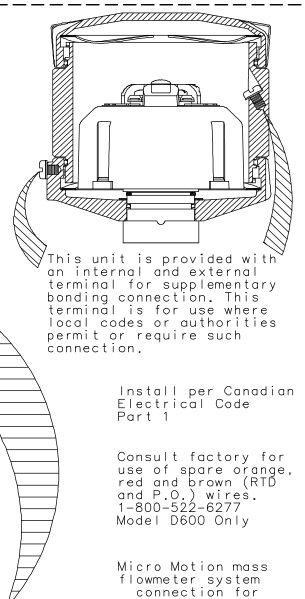
This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G

Refer to sensor tag for complete hazardous area classification.



I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.22 Vdc
Imax	488 mA
Pmax	2.1W
Ci	2200pF
Li	30µH



This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

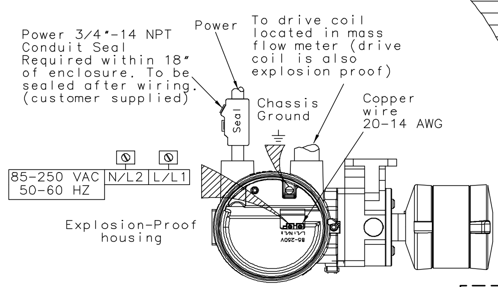
Allowable process fluid temperature range for integrally mounted booster amplifier is $-40°C \leq T_{fluid} \leq +60°C$.

Install per Canadian Electrical Code Part 1

Consult factory for use of spare orange, red and brown (RTD and P.O.) wires. 1-800-522-6277 Model D600 Only

Micro Motion mass flowmeter system connection for Intrinsically safe operation

Power 3/4"-14 NPT Conduit Seal Required within 18" of enclosure. To be sealed after wiring. (customer supplied)



For model D600S * * * S, followed by N followed by * C * * * * *
or
For model D600S * * * S, followed by N followed by * A * * * * *
see additional installation requirements on drawing EB-1005084

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20µH/ft

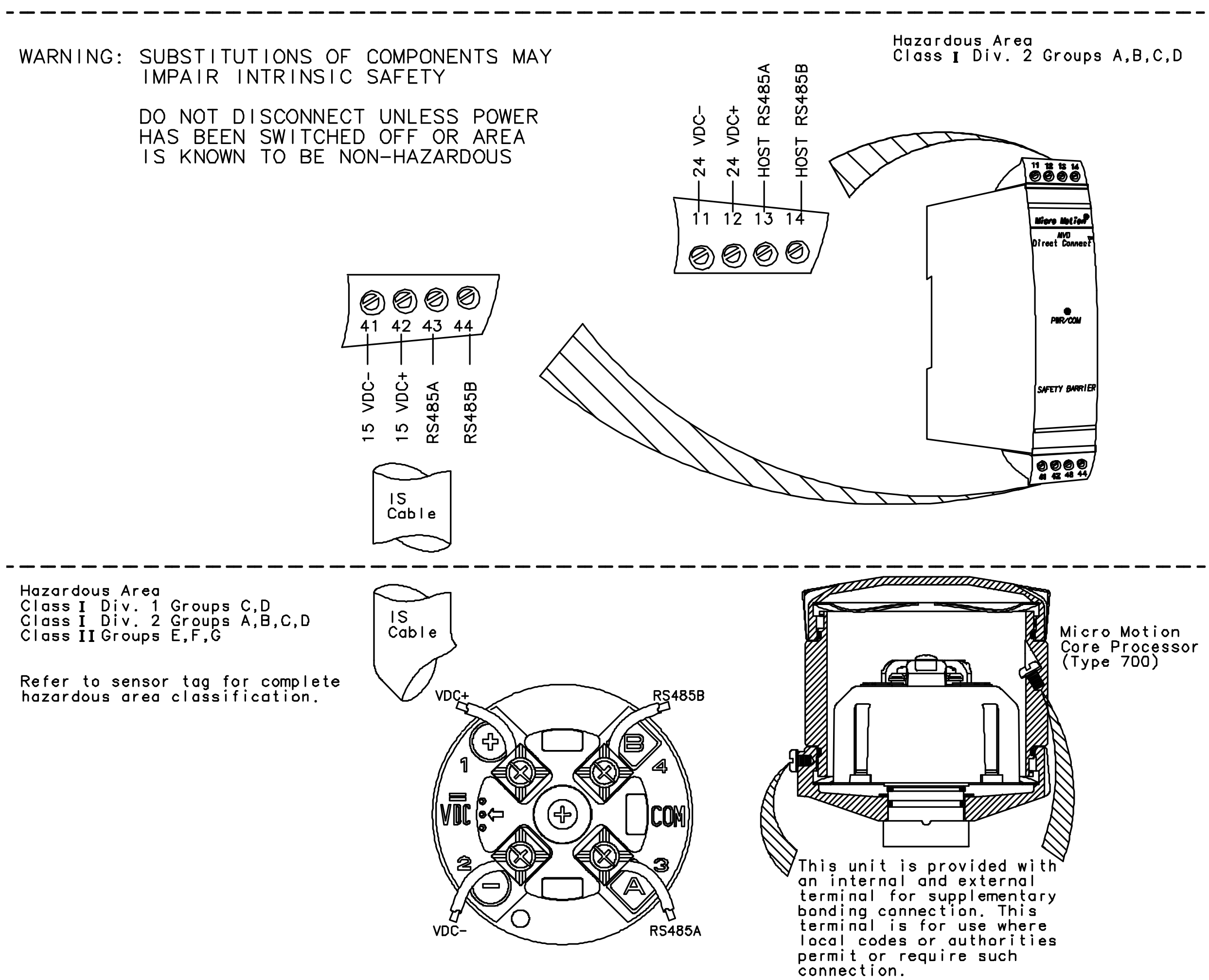
This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Electronics: 1700/2700

EB-1005083 Rev. B

Direct Host 4-Wire Installation

Core processor to direct host through safety barrier



Maximum Cable Capacitance = 60pF/ft
Maximum Cable Inductance = 0.20µH/ft

Maximum cable length from core processor to safety barrier is 500 feet.
For cable runs greater than 500 feet, please contact Micro Motion.

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

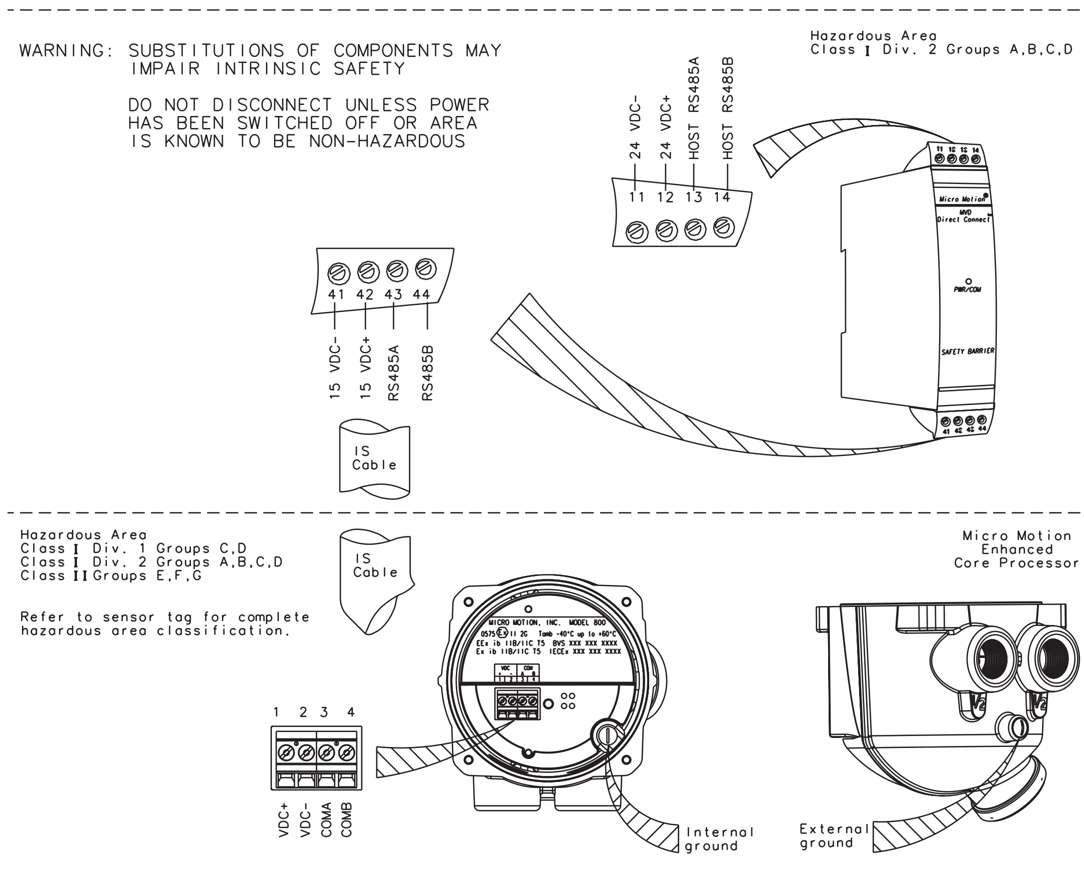
Micro Motion mass flowmeter system connection for Intrinsically safe operation

Electronics: SAFETY BARRIER

EB-3600799 Rev. C
SHT 1 OF 1

Direct Host 4-Wire Installation

Enhanced core processor to direct host through safety barrier



Maximum Cable Capacitance = 60pF/ft
Maximum Cable Inductance = 0.20μH/ft

Maximum cable length from core processor to safety barrier is 500 feet.
For cable runs greater than 500 feet, please contact Micro Motion.

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Micro Motion mass flowmeter system connection for Intrinsically safe operation

Electronics: SAFETY BARRIER

EB-20003013 Rev. A
SHT 1 OF 1

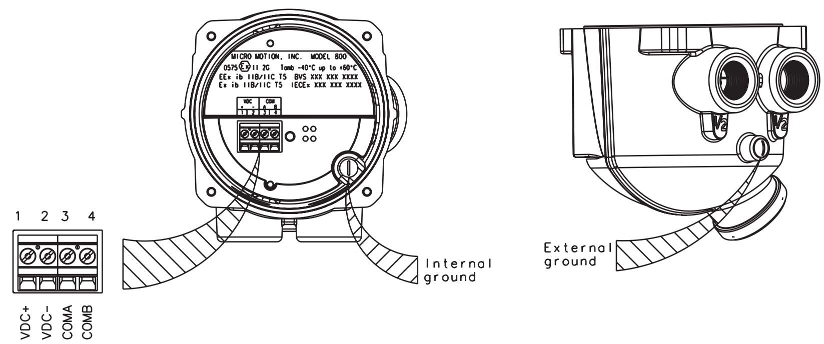
Model 800 Enhanced Core Processor

800 ENHANCED CORE PROCESSOR IN HAZARDOUS LOCATION

Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G

I.S. AND NON-INCENDIVE 800 ENHANCED CORE PROCESSOR(INPUT) ENTITY PRMTRS / 4-WIRE TERMINAL	
VMAX	17.22 Vdc
Imax	488 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

ENHANCED CORE PROCESSOR



This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci^1 + Ci^2 + ... + Cin
*La > = Lcable + Li^1 + Li^2 + ... + Li^n

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Electronics: ENHANCED CORE PROCESSOR

EB-20003427 Rev. A
SHT 1 OF 1

Model 2750 4-Wire Installation

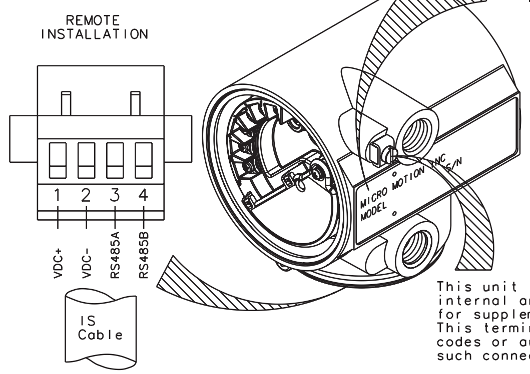
Remote transmitter to enhanced core processor mounted on sensor

REMOTE MOUNT MODEL 2750 IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

For proper installation including I/O, power, gland and hazardous area location, refer to appropriate 2750 output option CSA-D-IS installation instructions

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (µF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (µH)	A,B	N/A	252µH
	C	151	1000
	D	607	2100



Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G
Temp. Code T4A

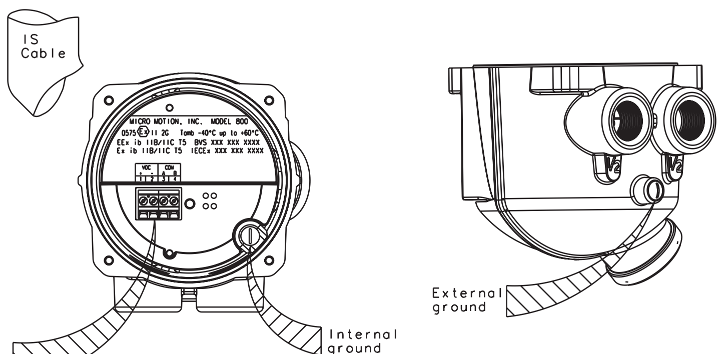
Note:
Hazardous area classification on an integrally mounted 2750 transmitter can be limited by hazardous area classification of the sensor. Refer to sensor tag.

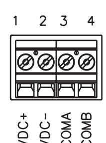
This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G

Refer to sensor tag for complete hazardous area classification.

I.S. AND NON-INCENDIVE ENHANCED CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30µH





This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci^1 + Ci^2 + ... + Ci^n
*La > = Lcable + Li^1 + Li^2 + ... + Li^n

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20µH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Micro Motion mass flowmeter system connection for Intrinsically safe operation

Electronics: 2750

EB-20011795 Rev. A
SHT 1 OF 1

Model 1500/2500 4-Wire Installation

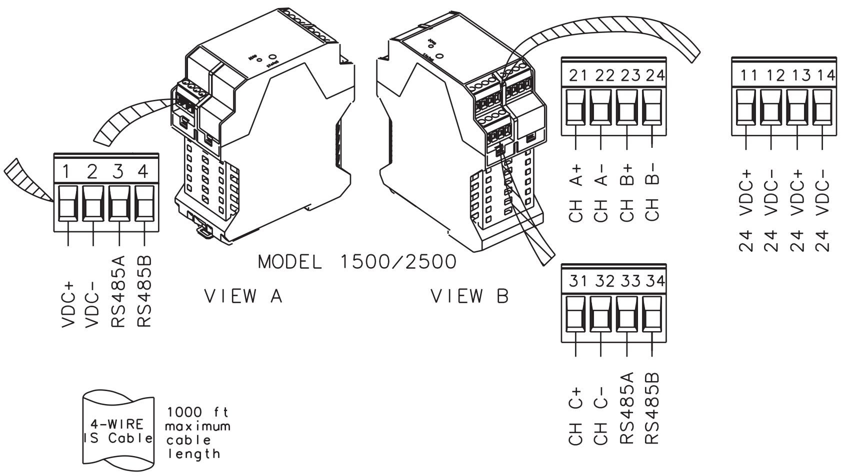
Remote transmitter to enhanced core processor mounted on sensor

MODEL 1500/2500 IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I Div. 2 Groups A,B,C,D

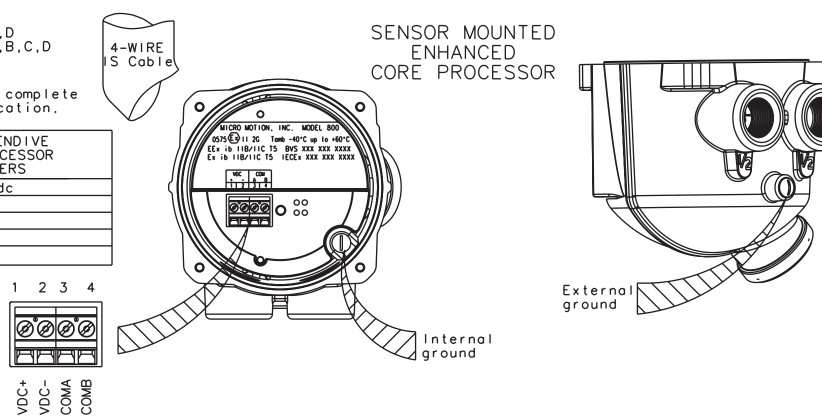
		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G

Refer to sensor tag for complete hazardous area classification.

I.S. AND NON-INCENDIVE ENHANCED CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH



INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci^1 + Ci^2 + ... + Ci^n
*La > = Lcable + Li^1 + Li^2 + ... + Li^n

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Micro Motion mass flowmeter system connection for Intrinsically safe operation

Electronics: 1500/2500

EB-20003009 Rev. A

Model 1500/2500 4-Wire Installation

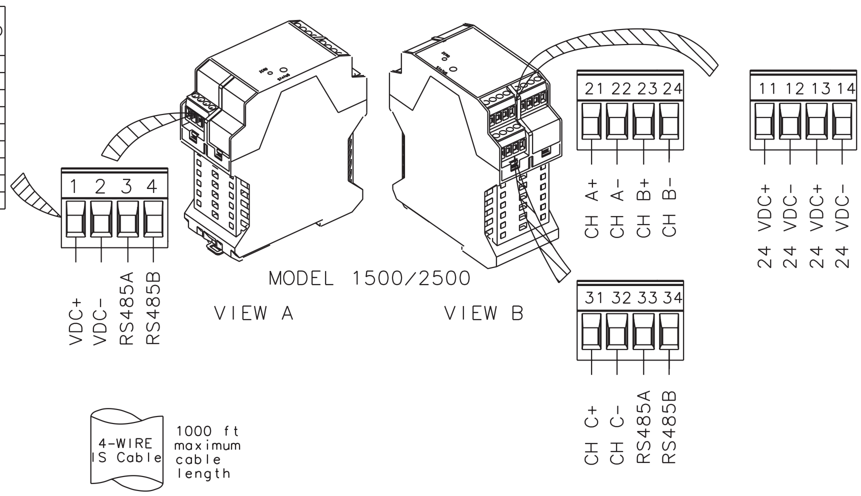
Remote transmitter to core processor mounted on CMF, F, H, R, CNG, and T sensor

MODEL 1500/2500 IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I Div. 2 Groups A,B,C,D

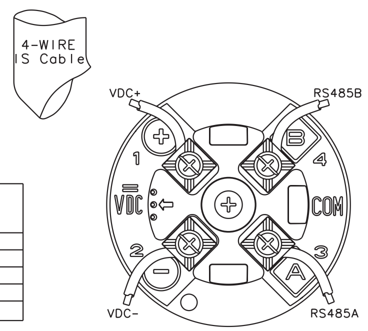
		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



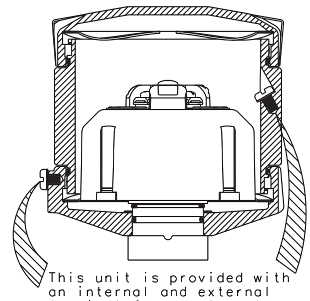
Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G

Refer to sensor tag for complete hazardous area classification.

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH



SENSOR MOUNTED CORE PROCESSOR



This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

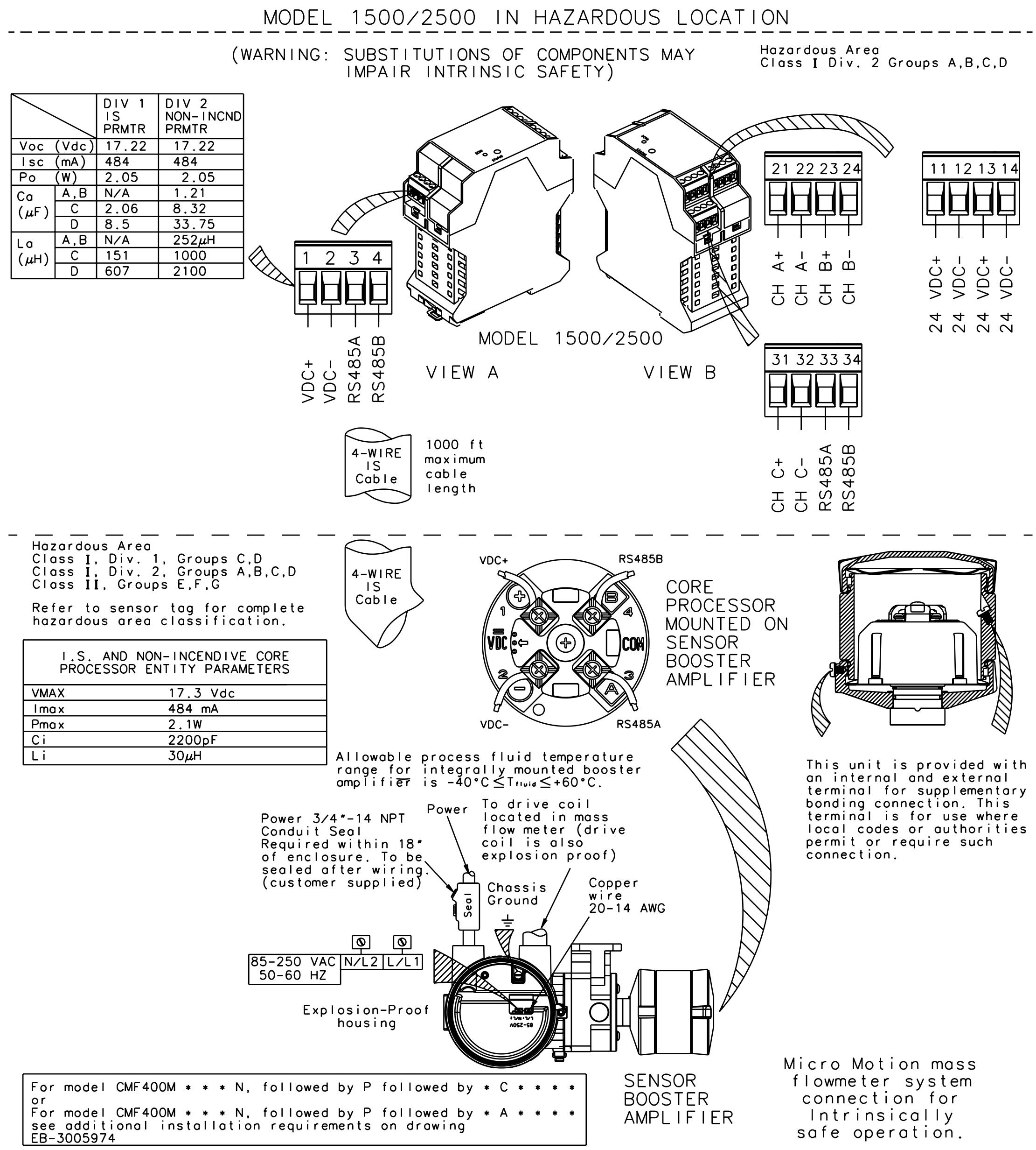
Micro Motion mass flowmeter system connection for Intrinsically safe operation

Electronics: 1500/2500

EB-20001220 Rev. A

Model 1500/2500 4-Wire Installation

Remote transmitter to core processor mounted on CMF400 sensor with booster amplifier



		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

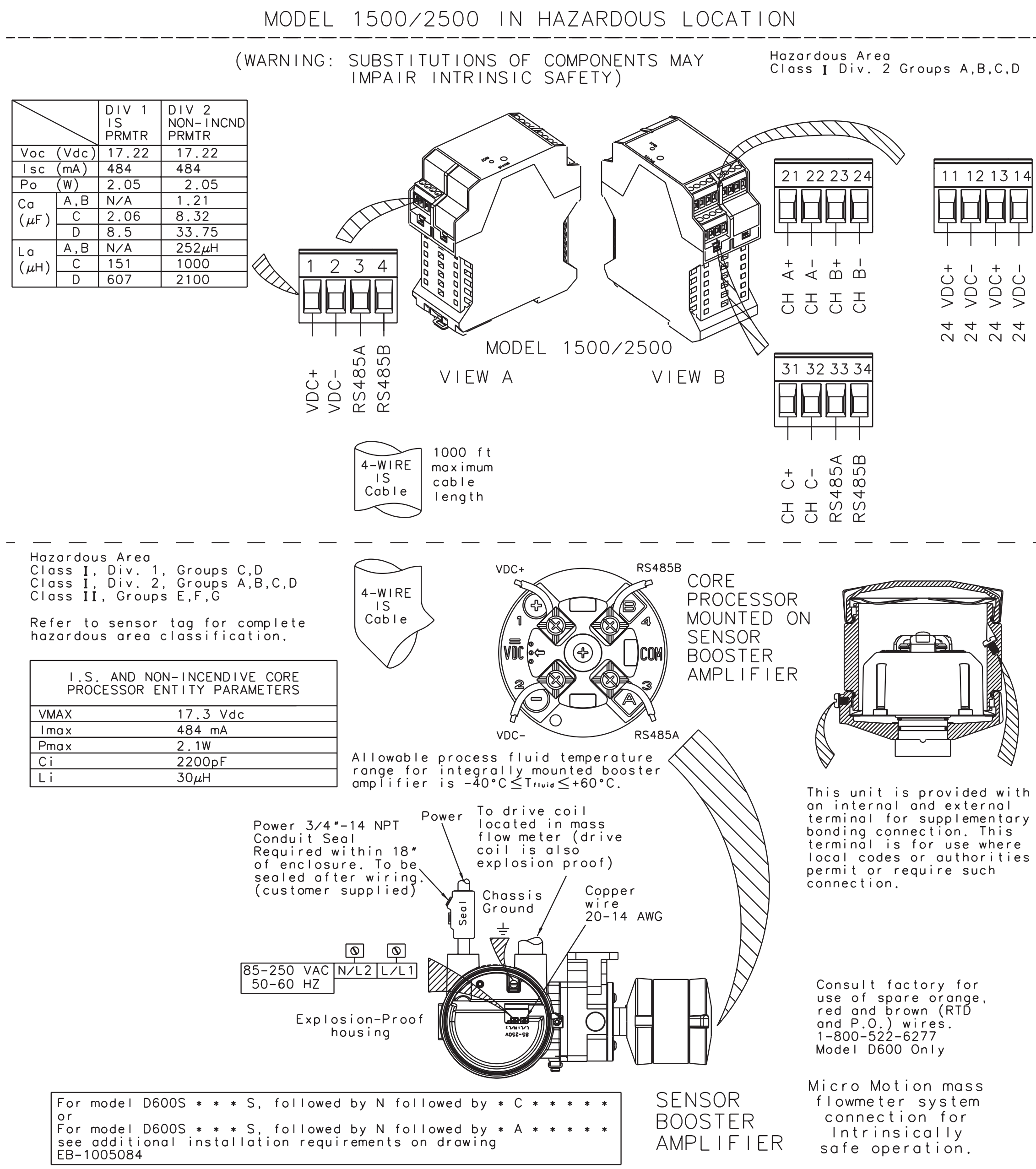
This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Electronics: 1500/2500
Sensor: CMF400

EB-20001219 Rev. A

Model 1500/2500 4-Wire Installation

Remote transmitter to core processor mounted on D600 sensor



		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci[1] + Ci[2] + ... + Cin
*La > = Lcable + Li[1] + Li[2] + ... + Li[n]

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Electronics: 1500/2500
Sensor: D600

EB-20001218 Rev. A

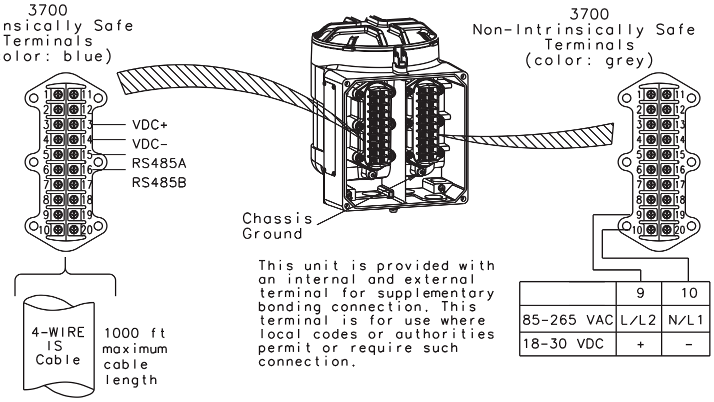
Model 3700 4-Wire Installation

Remote transmitter to enhanced core processor mounted on sensor

3700 IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I, Div. 2, Groups A,B,C,D
Class II, Div. 2, Groups F,G



	DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)	17.22	17.22
Isc (mA)	484	484
Po (W)	2.05	2.05
Ca (µF) A,B	N/A	1.21
Ca (µF) C	2.04	8.32
Ca (µF) D	8.5	33.75
La (µH) A,B	N/A	252µH
La (µH) C	151	1000
La (µH) D	607	2100

	9	10
85-265 VAC	L/L2	N/L1
18-30 VDC	+	-

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

NOTE: Prepare cable per the instructions provided with the cable.

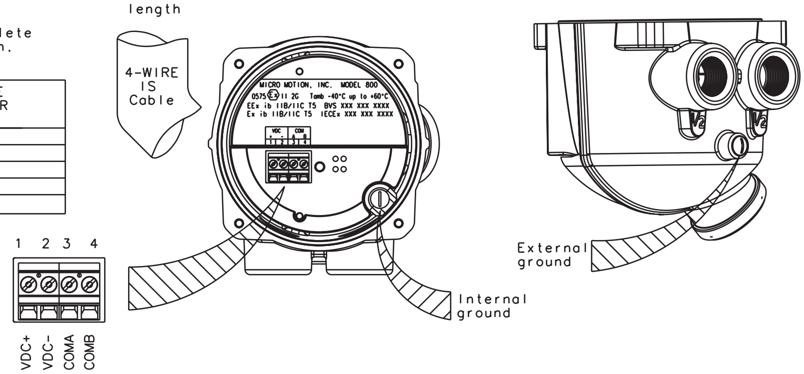
MODEL 3700

Hazardous Area
Class I, Div. 1, Groups C,D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

Refer to sensor tag for complete hazardous area classification.

I.S. AND NON-INCENDIVE ENHANCED CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30µH

SENSOR MOUNTED
ENHANCED CORE PROCESSOR



INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci^1 + Ci^2 + ... + Cin
*La > = Lcable + Li^1 + Li^2 + ... + Li^n

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20µH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Micro Motion mass flowmeter system connection for Intrinsically safe operation.

Electronics: 3700

EB-20003012 Rev. A
SHT 1 OF 1

Model 3700 4-Wire Installation

Remote transmitter to core processor mounted on CMF, F, H, R, CNG, and T sensors

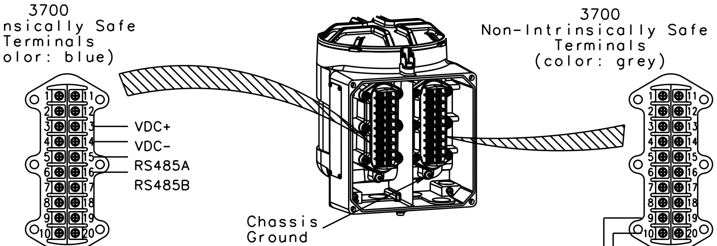
3700 IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

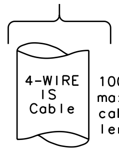
Hazardous Area
Class I, Div. 2, Groups A,B,C,D
Class II, Div. 2, Groups F,G

3700
Intrinsically Safe
Terminals
(color: blue)

3700
Non-Intrinsically Safe
Terminals
(color: grey)



	DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)	17.22	17.22
Isc (mA)	484	484
Po (W)	2.05	2.05
Ca (µF) A,B	N/A	1.21
Ca (µF) C	2.04	8.32
Ca (µF) D	8.5	33.75
La (µH) A,B	N/A	252µH
La (µH) C	151	1000
La (µH) D	607	2100



1000 ft maximum cable length

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

	9	10
85-265 VAC	L/L2	N/L1
18-30 VDC	+	-

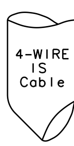
NOTE: Prepare cable per the instructions provided with the cable.

MODEL 3700

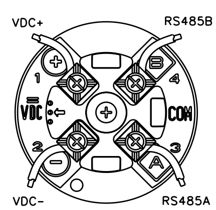
Hazardous Area
Class I, Div. 1, Groups C,D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

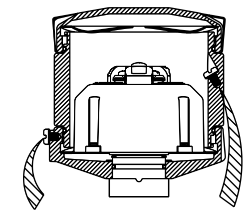
Refer to sensor tag for complete hazardous area classification.

1000 ft maximum cable length



I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30µH





This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

SENSOR MOUNTED CORE PROCESSOR

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20µH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

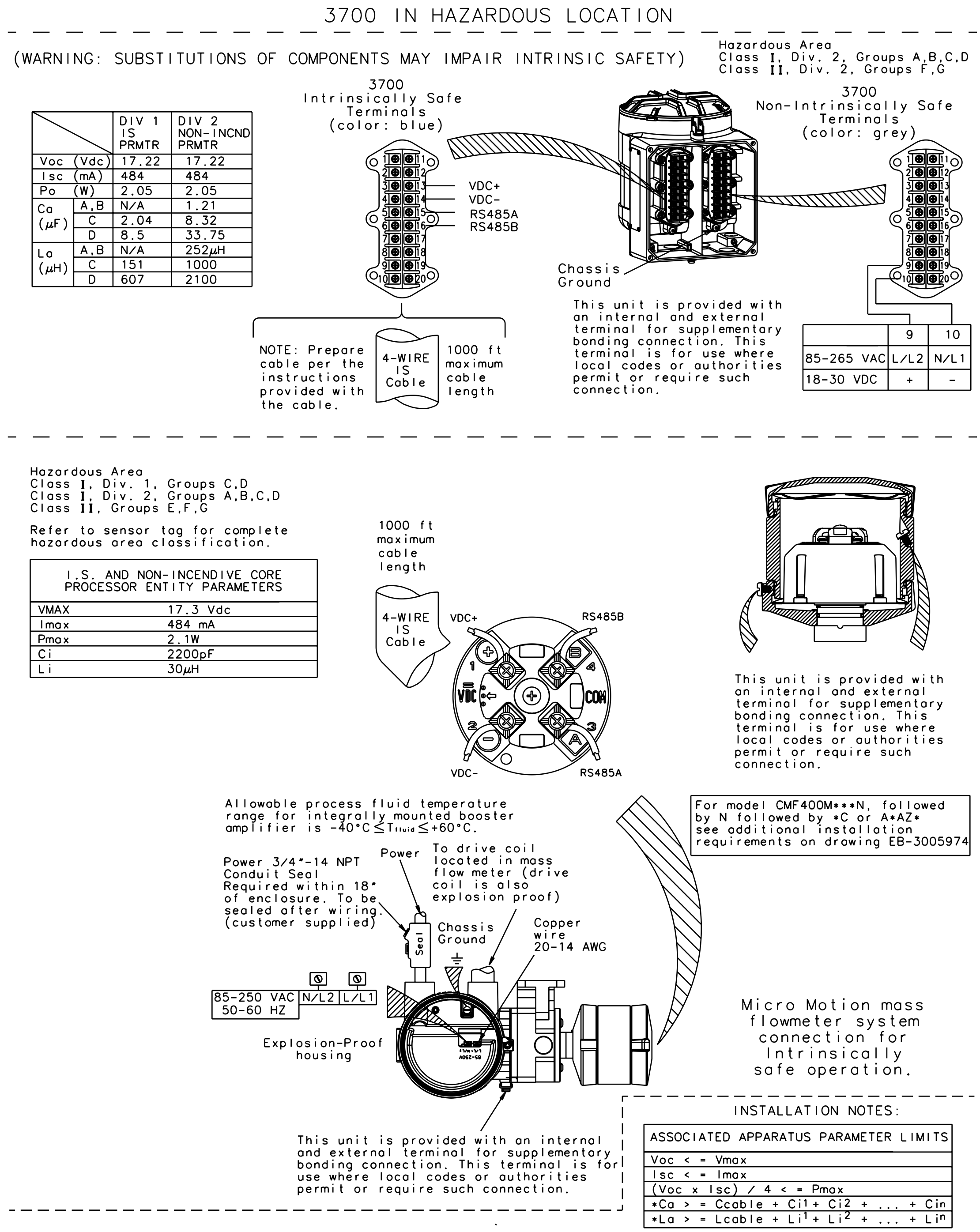
Micro Motion mass flowmeter system connection for Intrinsically safe operation.

Electronics: 3700

EB-20000224 Rev. B
SHT 1 OF 1

Model 3700 4-Wire Installation

Remote transmitter to core processor mounted on CMF400 sensor with booster amplifier



		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

	9	10
85-265 VAC	L/L2	N/L1
18-30 VDC	+	-

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci[1] + Ci[2] + ... + Cin
*La > = Lcable + Li[1] + Li[2] + ... + Li[n]

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Electronics: 3700
Sensor: CMF400

EB-20000218 Rev. B
SHT 1 OF 1

Model 3700 4-Wire Installation

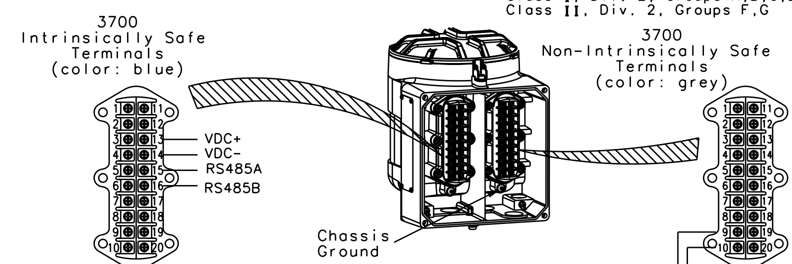
Remote transmitter to core processor mounted on D600 sensor

3700 IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I, Div. 2, Groups A,B,C,D
Class II, Div. 2, Groups F,G

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



NOTE: Prepare cable per the instructions provided with the cable.

4-WIRE IS Cable

1000 ft maximum cable length

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

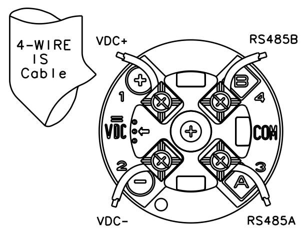
	9	10
85-265 VAC	L/L2	N/L1
18-30 VDC	+	-

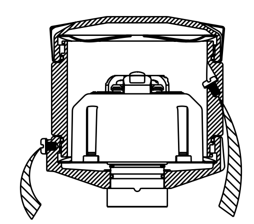
Hazardous Area
Class I, Div. 1, Groups C,D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

Refer to sensor tag for complete hazardous area classification.

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

1000 ft maximum cable length



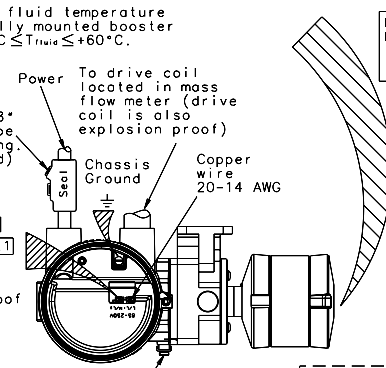


This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

Allowable process fluid temperature range for integrally mounted booster amplifier is -40°C ≤ T_{fluid} ≤ +60°C.

For model D600S***S, followed by N followed by *C or A*AZ* see additional installation requirements on drawing EB-1005084

Power 3/4"-14 NPT Conduit Seal Required within 18" of enclosure. To be sealed after wiring. (customer supplied)



85-250 VAC 50-60 HZ	N/L2	L/L1

Explosion-Proof housing

Micro Motion mass flowmeter system connection for Intrinsically safe operation.

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Electronics: 3700
Sensor: D600

EB-20000221 Rev. B
SHT 1 OF 1

Model 3500 4-Wire Installation

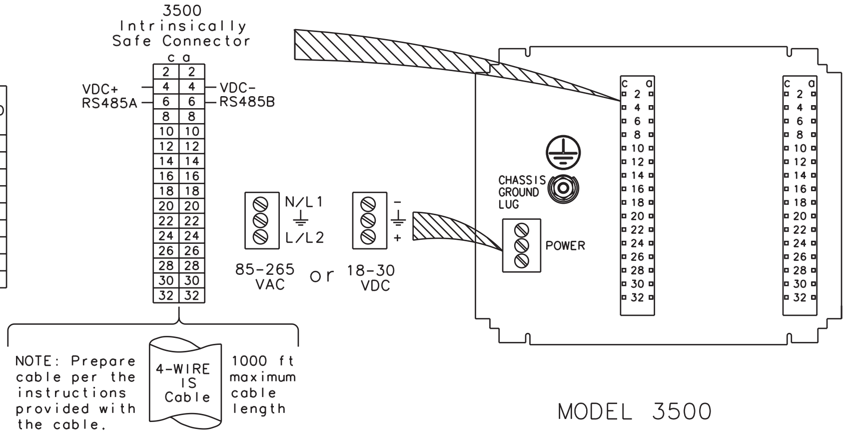
Remote transmitter to enhanced core processor mounted on sensor

3500 IN HAZARDOUS LOCATION TO SENSOR IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I, Div. 2, Groups A,B,C,D

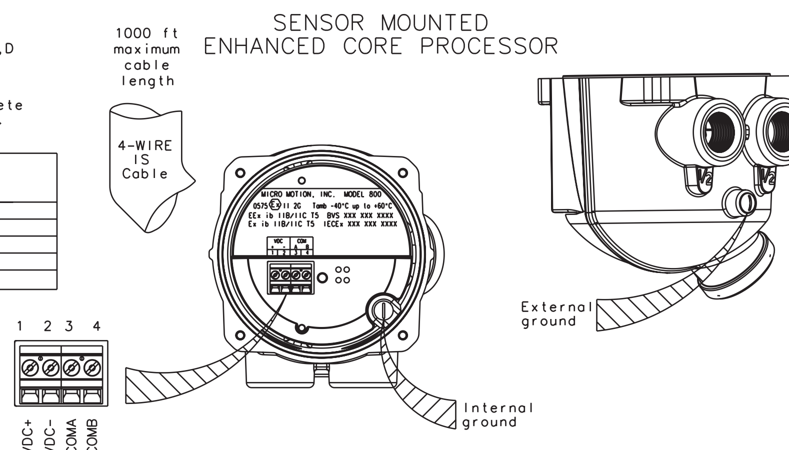
		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



Hazardous Area
Class I, Div. 1, Groups C,D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

Refer to sensor tag for complete hazardous area classification.

I.S. AND NON-INCENDIVE ENHANCED CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH



INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci^1 + Ci^2 + ... + Ci^n
*La > = Lcable + Li^1 + Li^2 + ... + Li^n

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Micro Motion mass flowmeter system connection for Intrinsically safe operation.

Electronics: 3500

EB-20003011 Rev. A
SHT 1 OF 1

Model 3500 4-Wire Installation

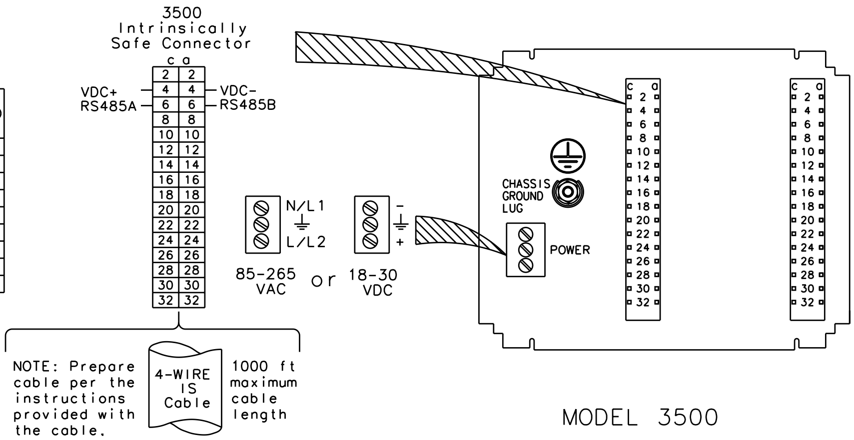
Remote transmitter to core processor mounted on CMF, F, H, R, CNG, and T sensors

3500 IN HAZARDOUS LOCATION TO SENSOR IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I, Div. 2, Groups A,B,C,D

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

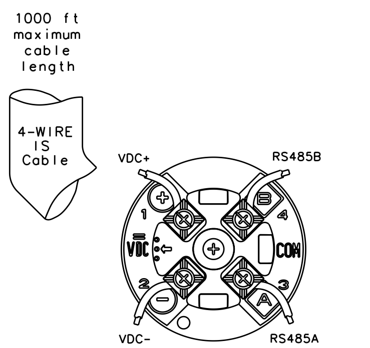


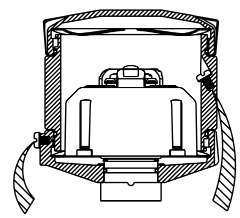
MODEL 3500

Hazardous Area
Class I, Div. 1, Groups C,D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

Refer to sensor tag for complete hazardous area classification.

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH





This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

SENSOR MONTED CORE PROCESSOR

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

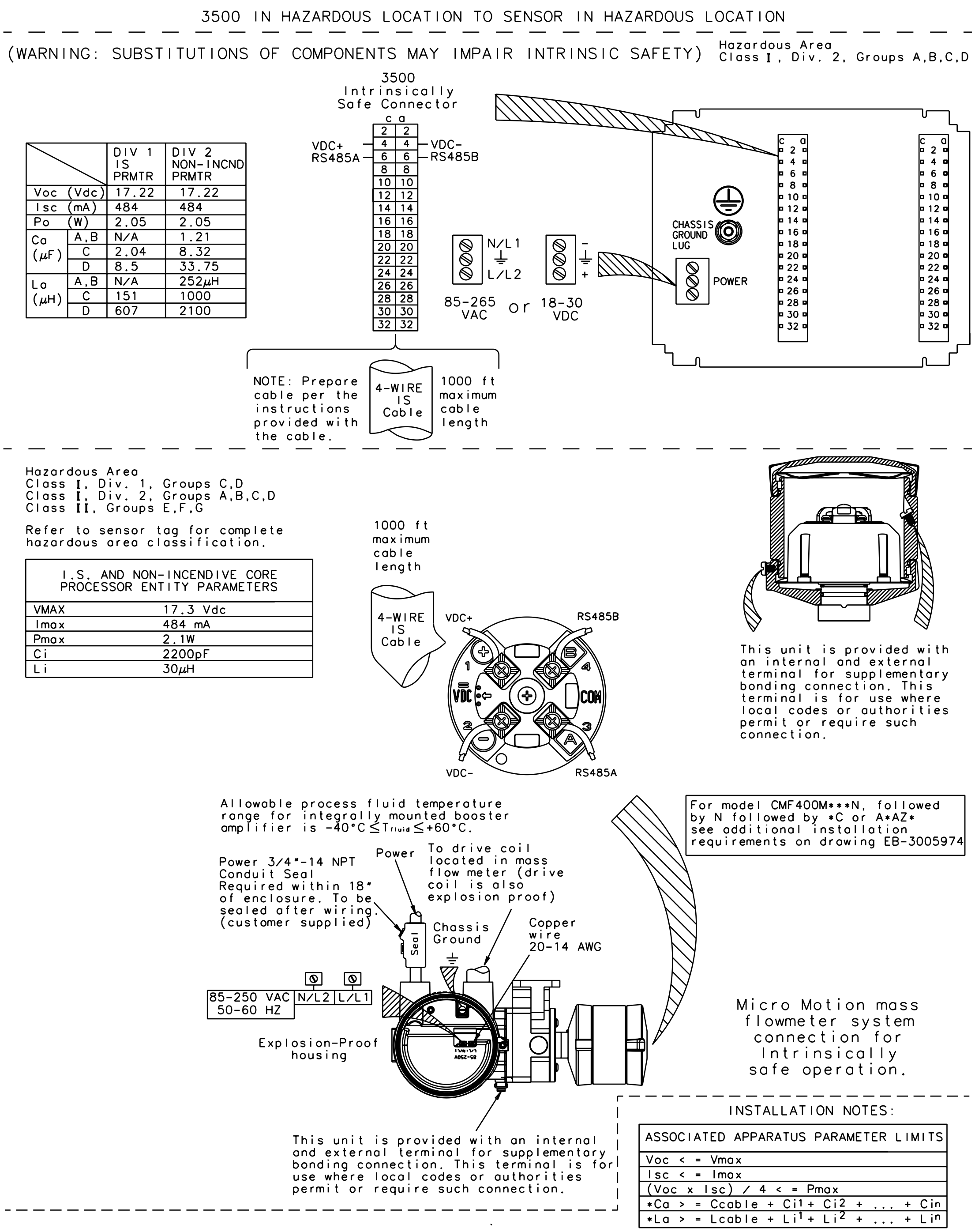
Micro Motion mass flowmeter system connection for Intrinsically safe operation.

Electronics: 3500

EB-20000250 Rev. B
SHT 1 OF 1

Model 3500 4-Wire Installation

Remote transmitter to core processor mounted on CMF400 sensor with booster amplifier



		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci^1 + Ci^2 + ... + Cin
*La > = Lcable + Li^1 + Li^2 + ... + Li^n

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Electronics: 3500
Sensor: CMF400

EB-20000244 Rev. B
SHT 1 OF 1

Model 3500 4-Wire Installation

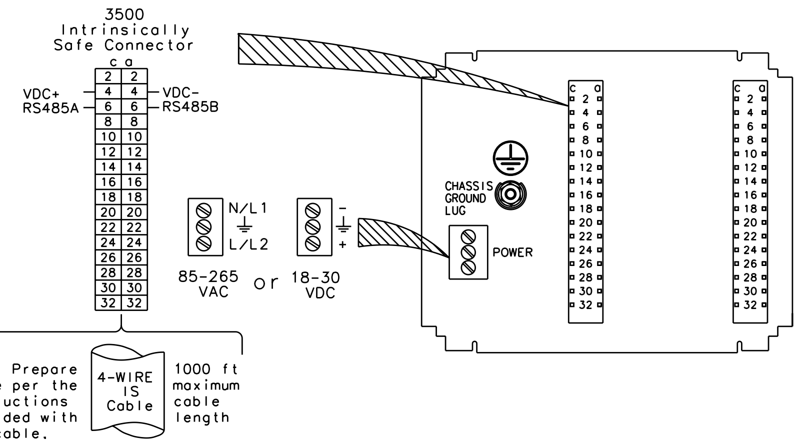
Remote transmitter to core processor mounted on D600 sensor

3500 IN HAZARDOUS LOCATION TO SENSOR IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I, Div. 2, Groups A,B,C,D

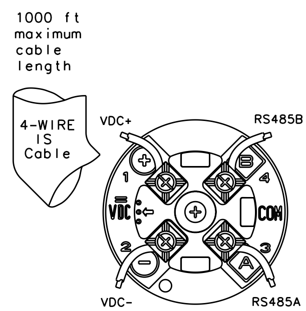
		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

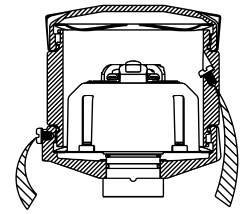


Hazardous Area
Class I, Div. 1, Groups C,D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

Refer to sensor tag for complete hazardous area classification.

I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

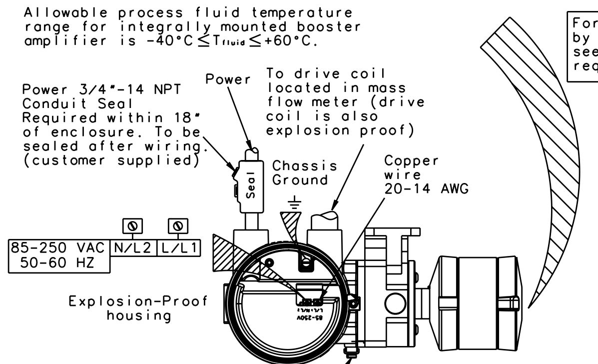




This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

Allowable process fluid temperature range for integrally mounted booster amplifier is -40°C $\leq T_{fluid} \leq$ +60°C.

For model D600S***S, followed by N followed by *C or A*AZ* see additional installation requirements on drawing EB-1005084



Micro Motion mass flowmeter system connection for Intrinsically safe operation.

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft
Cable Inductance = 0.20μH/ft

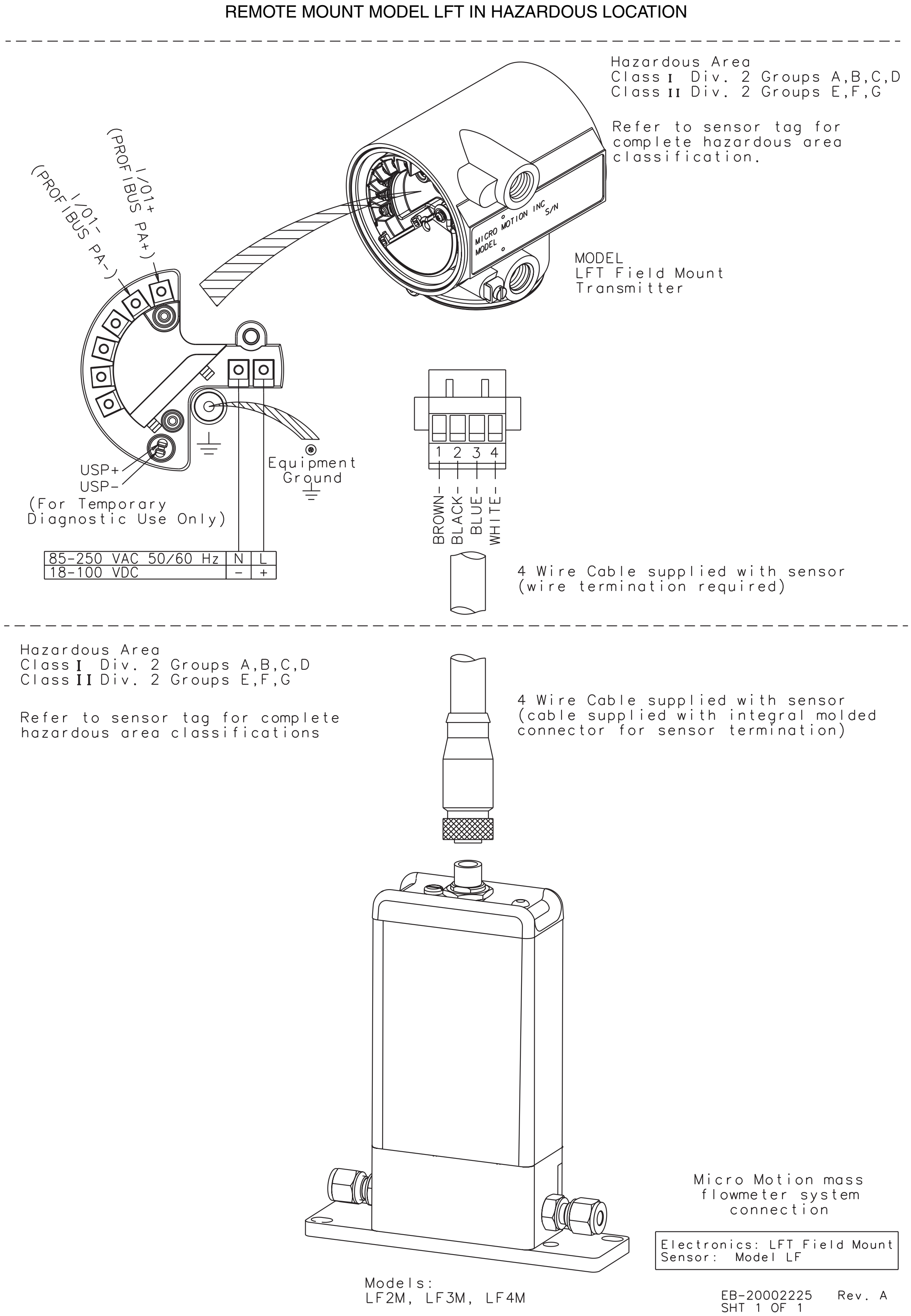
This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Electronics: 3500
Sensor: D600

EB-20000247 Rev. B
SHT 1 OF 1

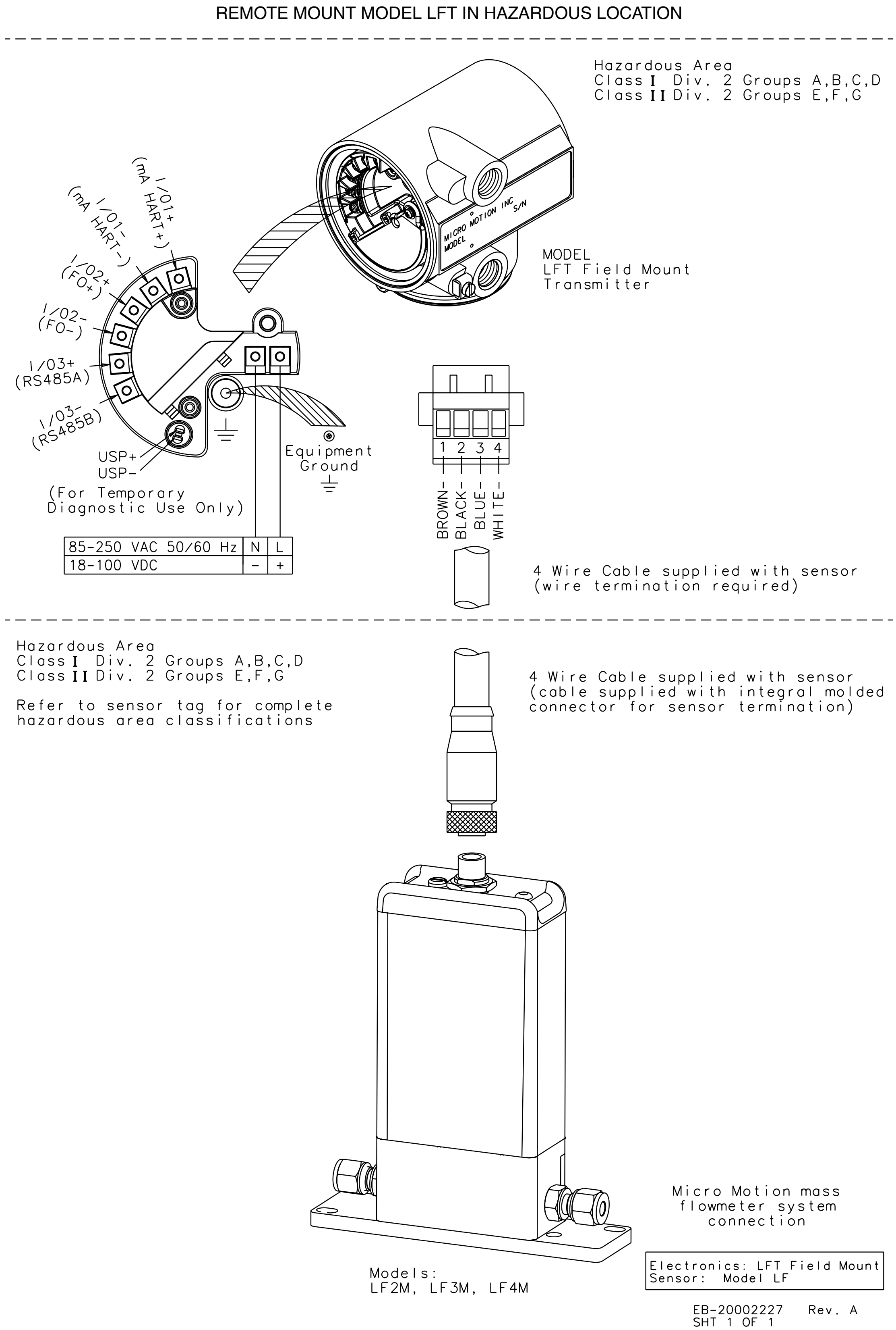
Model LFT 4-Wire Installation to LF

Profibus-PA transmitter remotely mounted to LF sensor



Model LFT 4-Wire Installation to LF

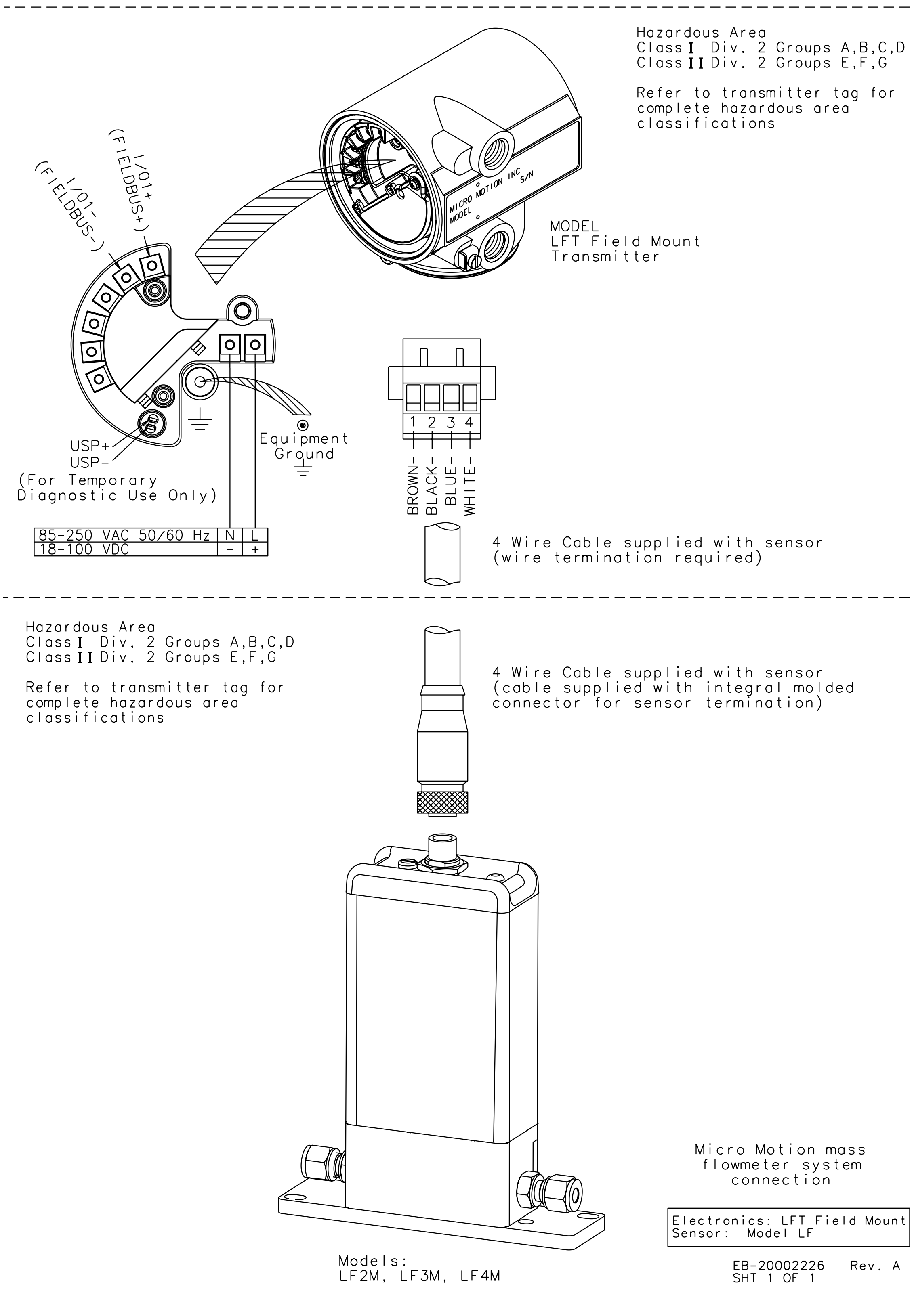
mA/FO transmitter remotely mounted to LF sensor



Model LFT 4-Wire Installation to LF

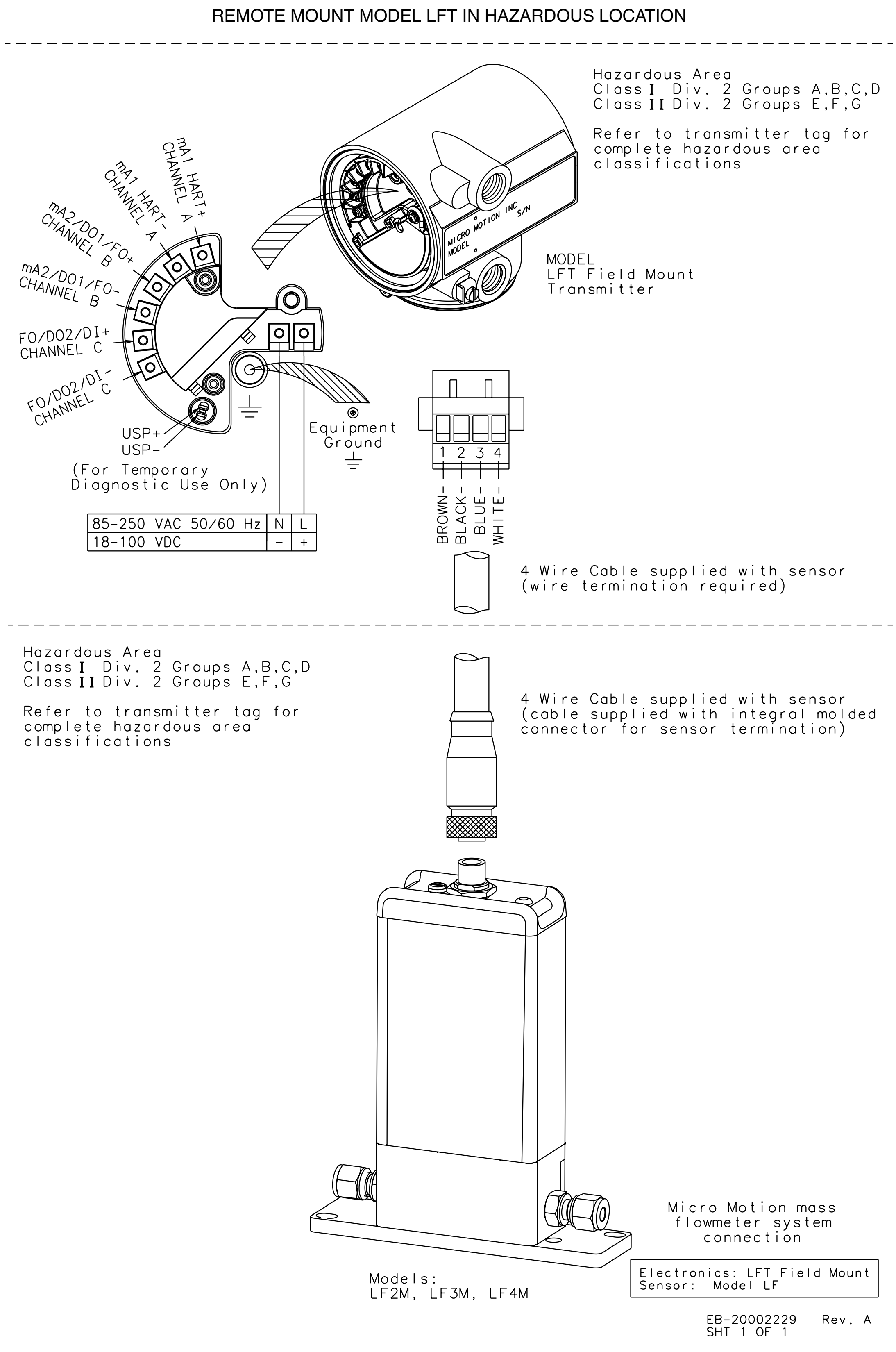
FOUNDATION fieldbus™ transmitter remotely mounted to LF sensor

REMOTE MOUNT MODEL LFT IN HAZARDOUS LOCATION



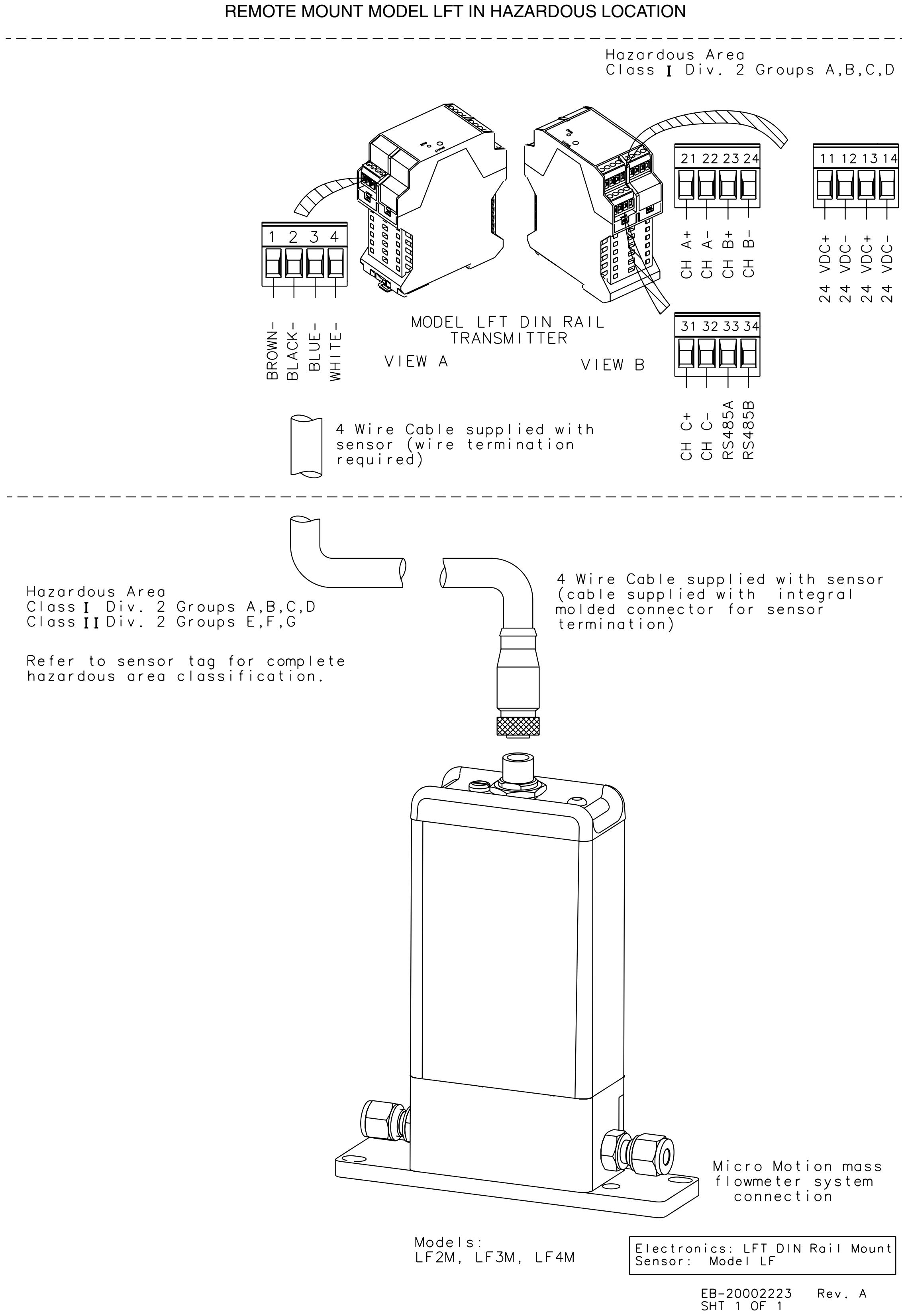
Model LFT 4-Wire Installation to LF

Config I/O transmitter remotely mounted to LF sensor



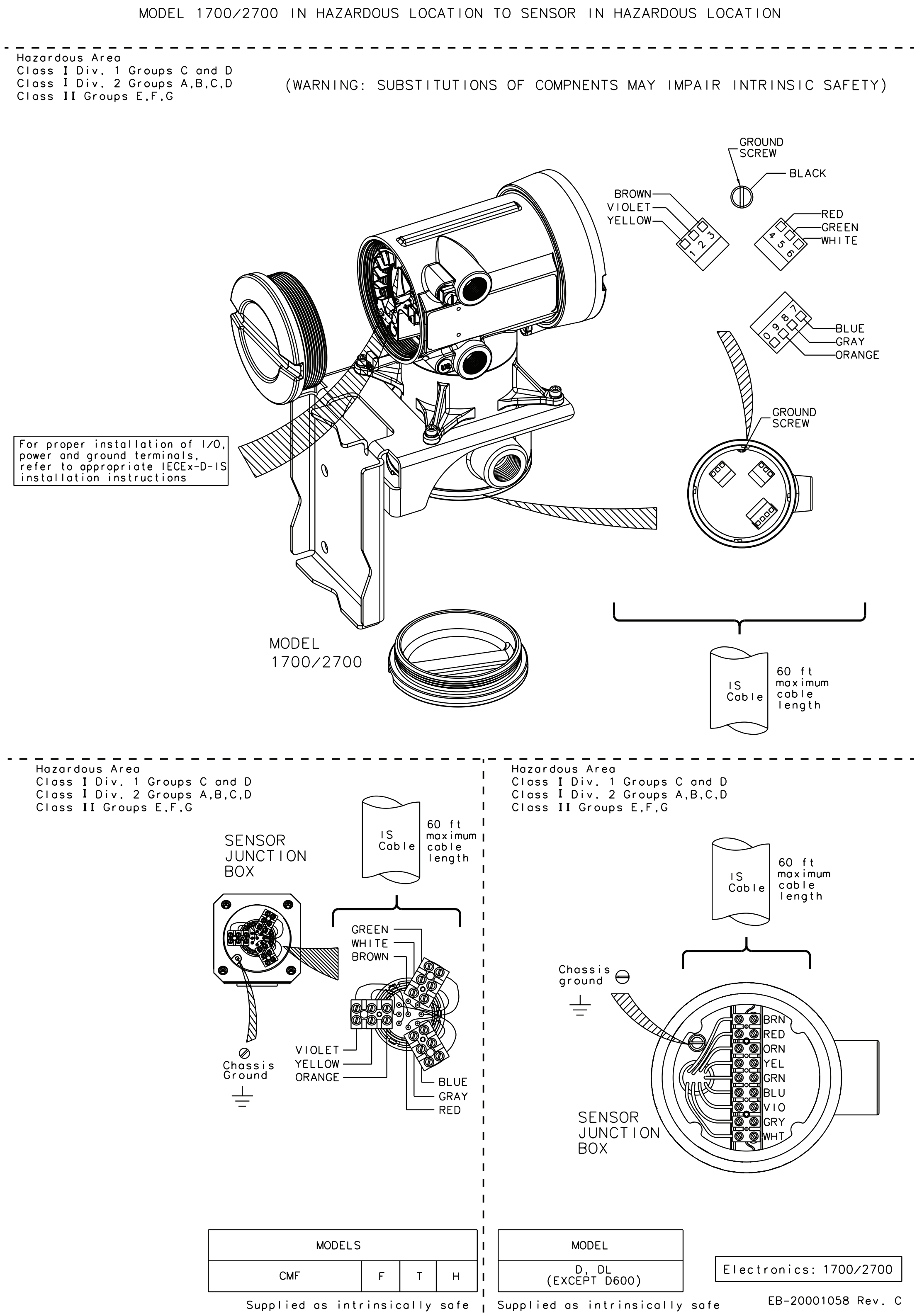
Model LFT 4-Wire Installation to LF

DIN rail transmitter remotely mounted to LF sensor



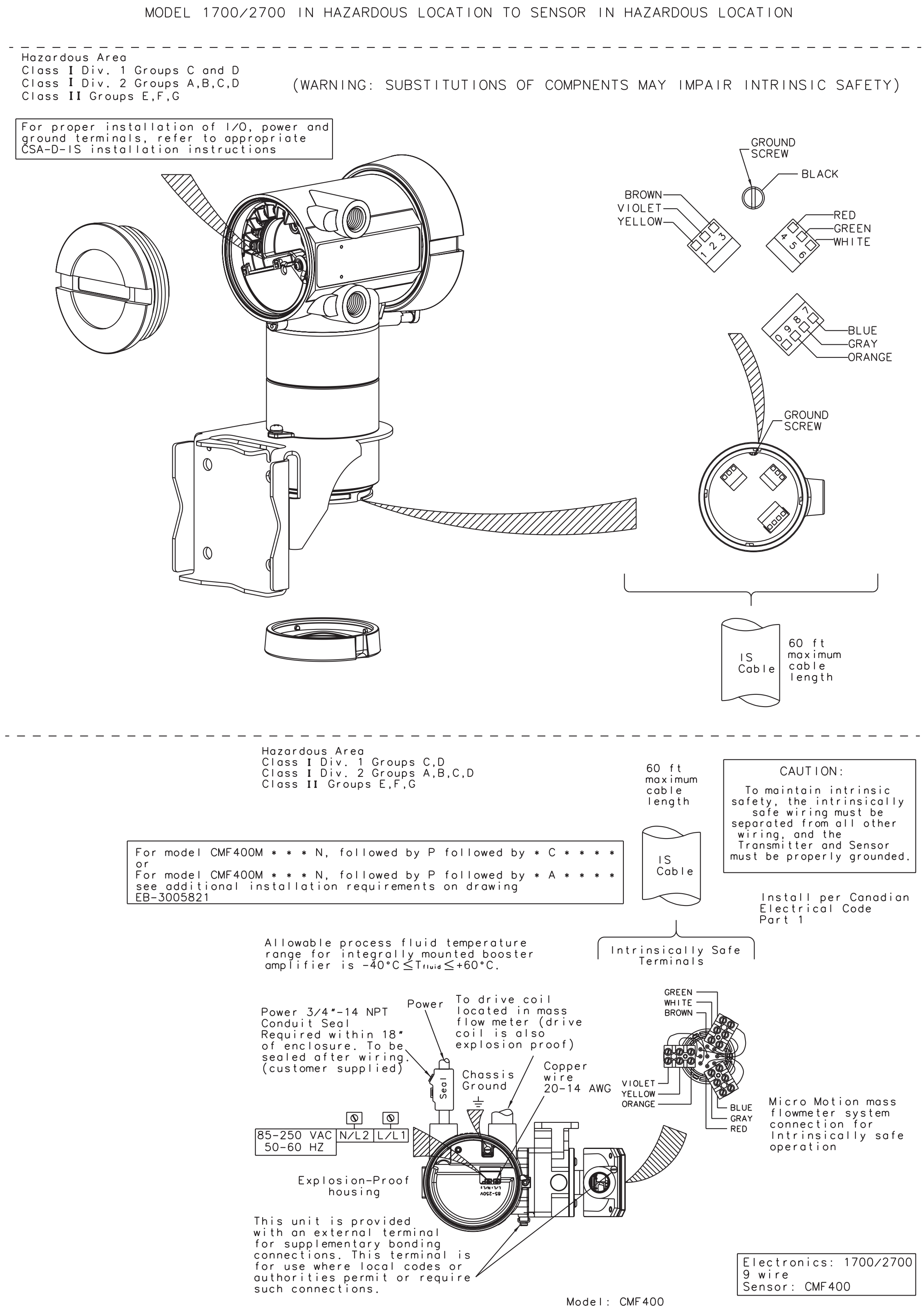
Model 1700/2700 9-Wire Installation

Transmitter with integrally mounted core processor to junction box on CMF (except CMF400 with booster amplifier), F, H, T, D (except D600), and DL sensors



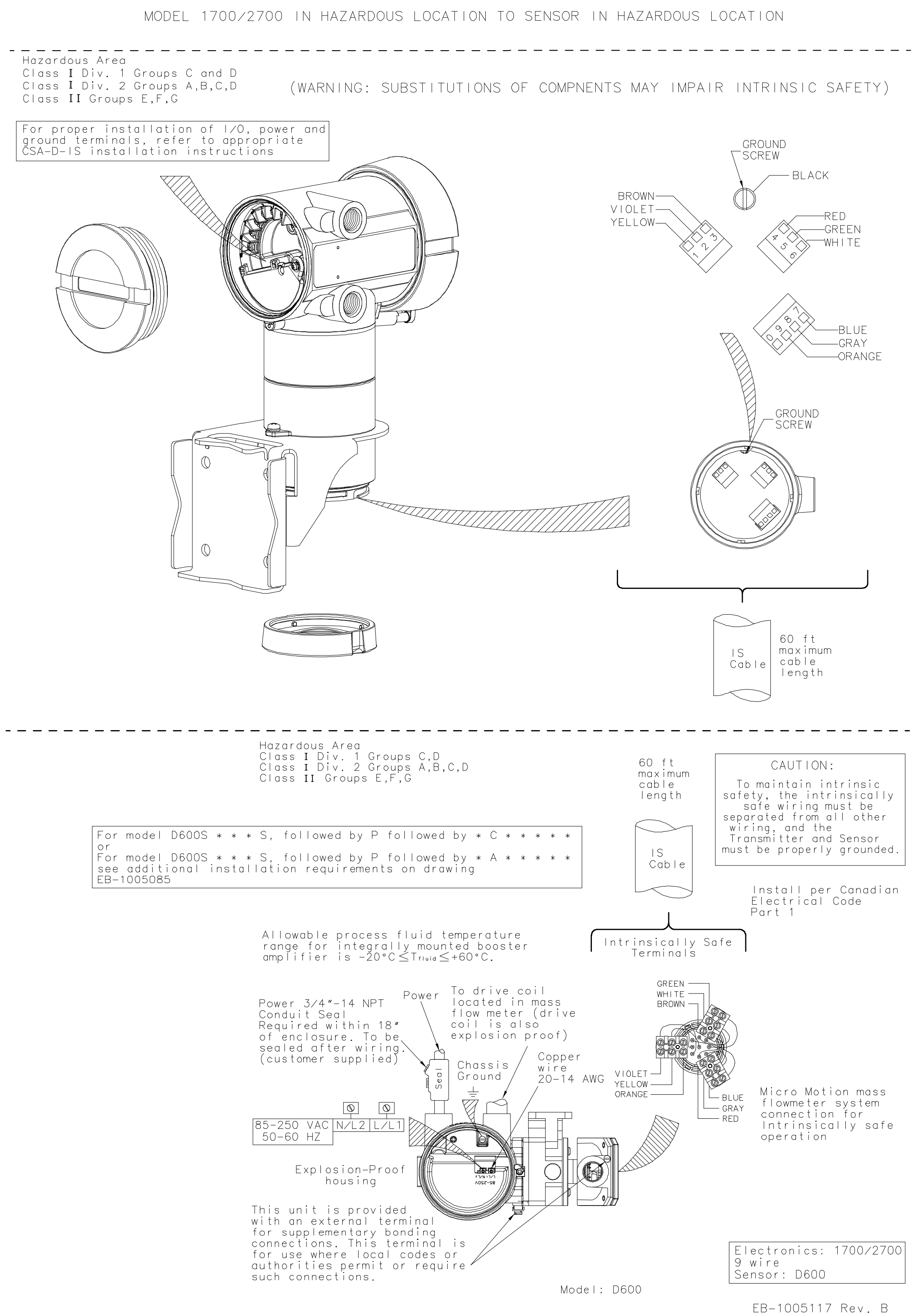
Model 1700/2700 9-Wire Installation

Transmitter with integrally mounted core processor to junction box on CMF400 sensor with booster amplifer



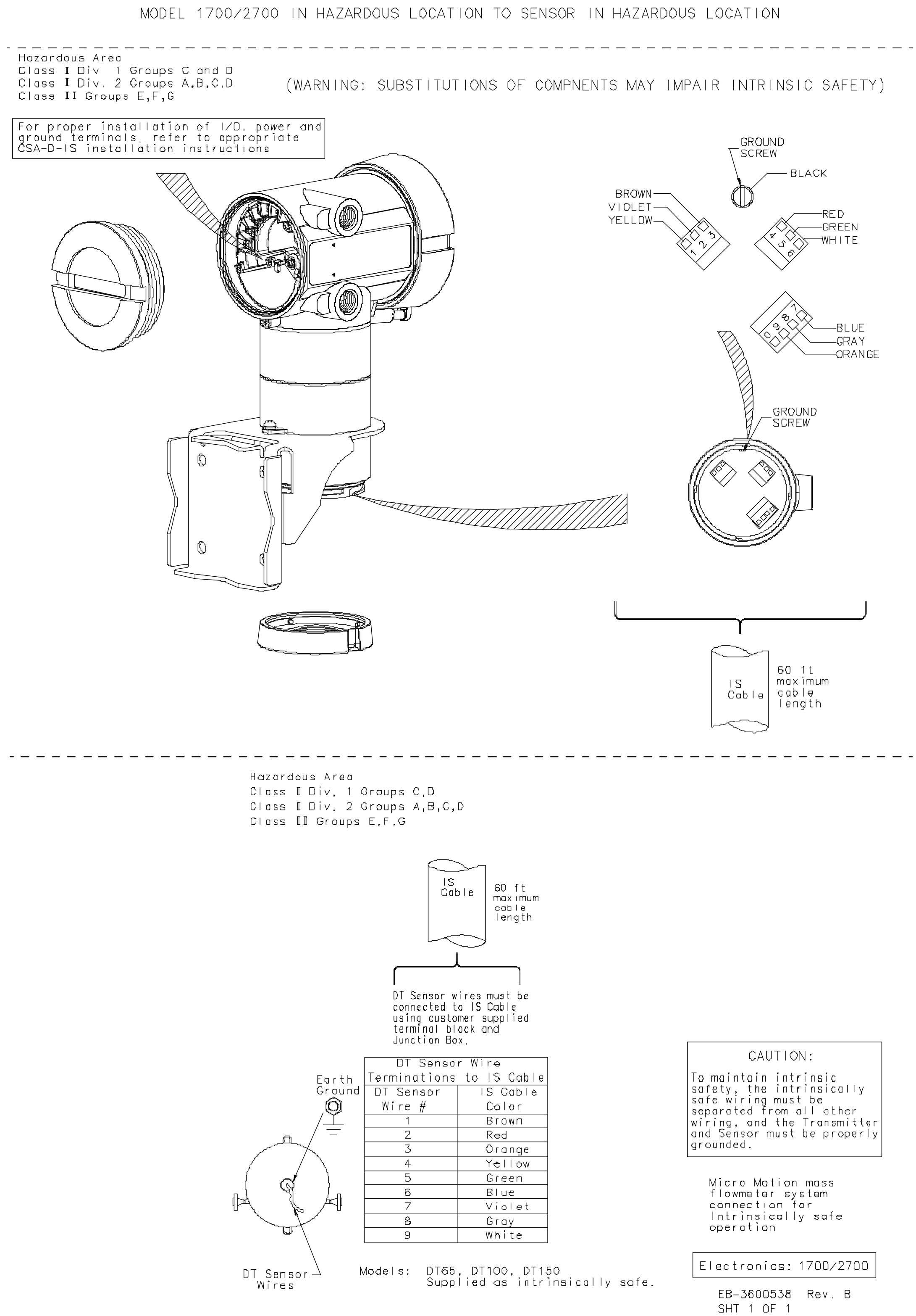
Model 1700/2700 9-Wire Installation

Transmitter with integrally mounted core processor to junction box on D600 sensor



Model 1700/2700 9-Wire Installation

Transmitter with integrally mounted core processor to junction box on DT sensor

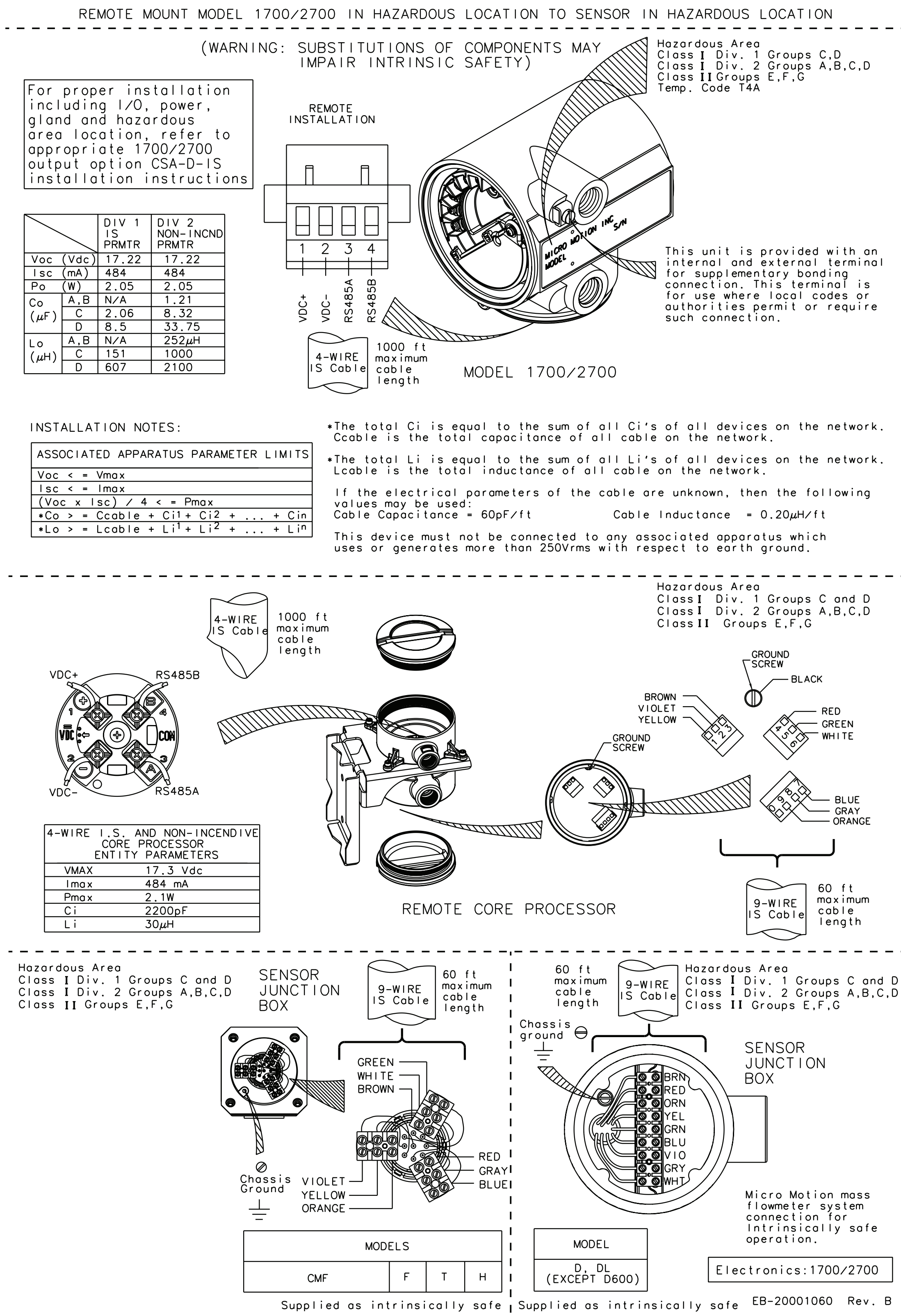


DT Sensor Wire Terminations to IS Cable

DT Sensor Wire #	IS Cable Color
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White

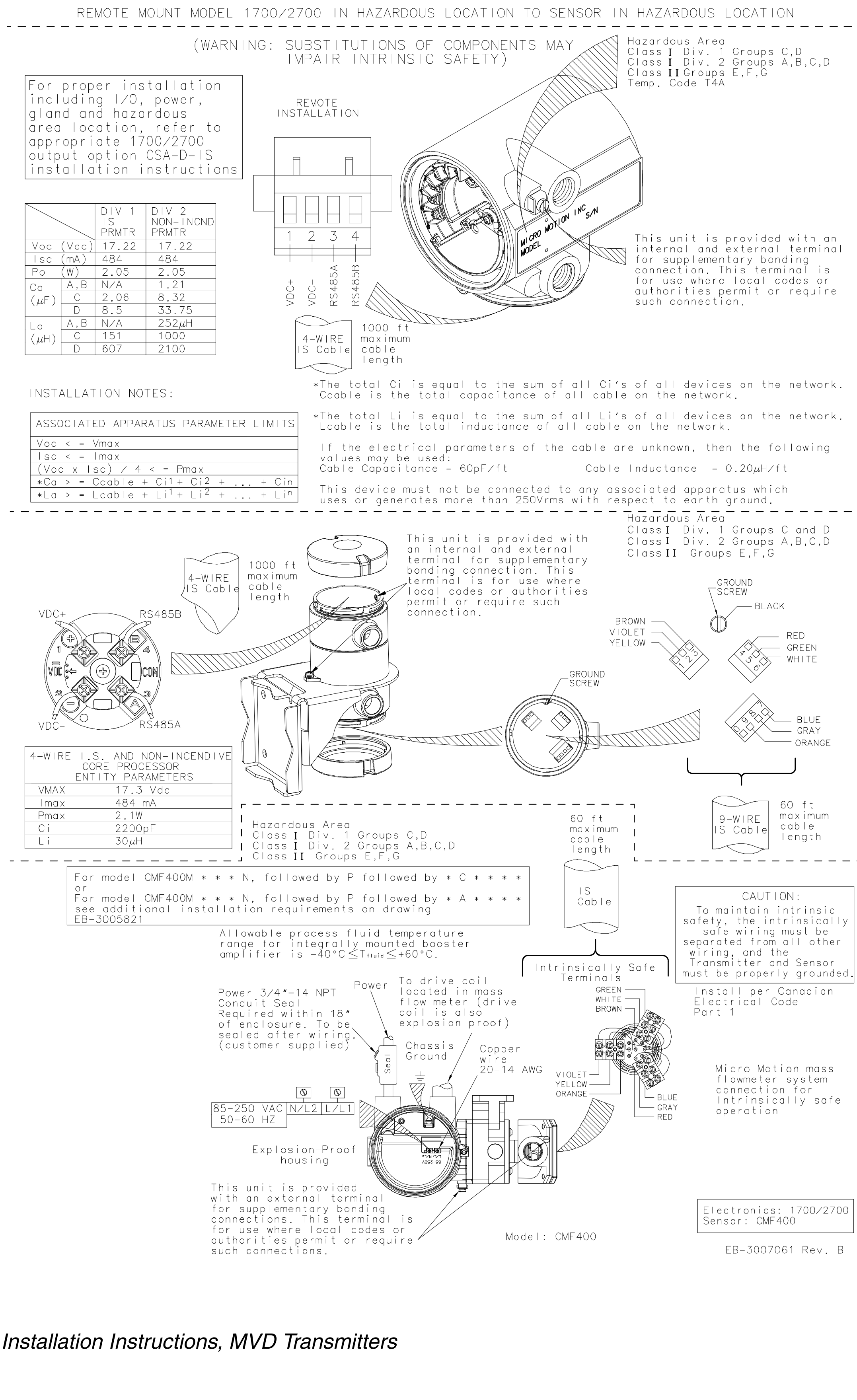
Model 1700/2700 9-Wire Installation

Transmitter to remote core processor to 9-wire junction box on CMF (except CMF400 with booster amplifier), F, H, T, D (except D600), and DL sensors



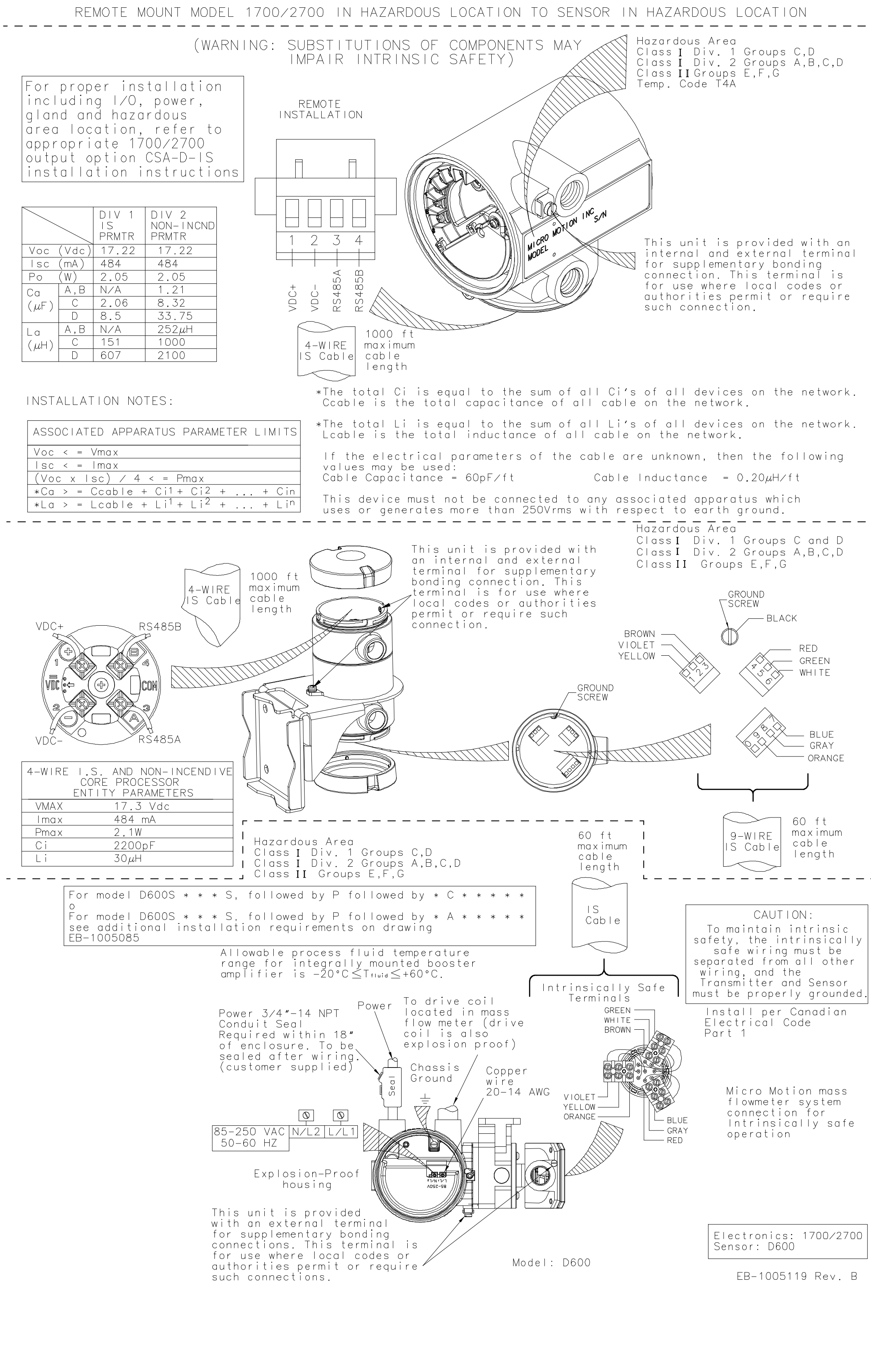
Model 1700/2700 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on CMF400 sensor with booster amplifier sensor



Model 1700/2700 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on D600 sensor



		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

Model 1700/2700 9-Wire Installation

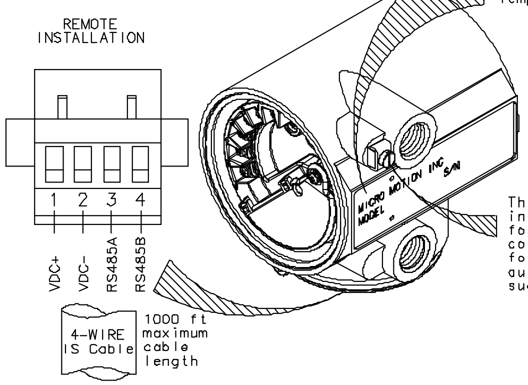
Transmitter to remote core processor to 9-wire junction box on DT sensor

REMOTE MOUNT MODEL 1700/2700 IN HAZARDOUS LOCATION TO SENSOR IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

For proper installation including I/O, power, gland and hazardous area location, refer to appropriate 1700/2700 output option CSA-D-IS installation instructions

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G
Temp. Code T4A

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

INSTALLATION NOTES:

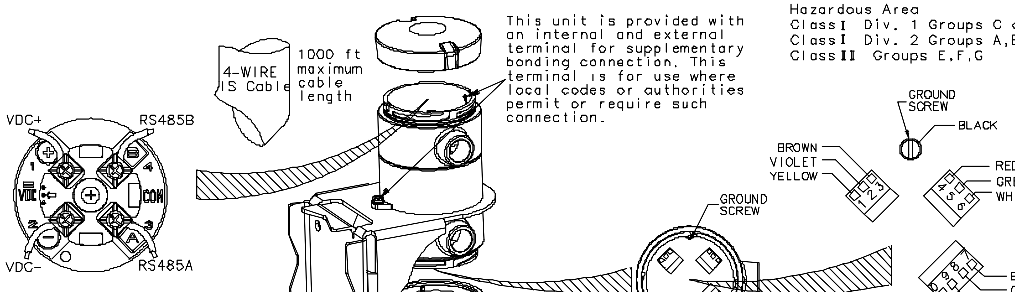
ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft   Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

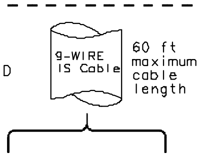


This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

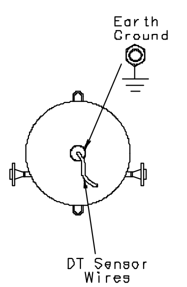
Hazardous Area
Class I Div. 1 Groups C and D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G

4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G



DT Sensor wires must be connected to IS Cable using customer supplied terminal block and Junction Box.



DT Sensor Wire Terminations to 9-Wire IS Cable	
DT Sensor Wire #	IS Cable Color
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White

Models:
DT65, DT100, DT150
Supplied as intrinsically safe.

CAUTION:
To maintain intrinsic safety, the intrinsically safe wiring must be separated from all other wiring, and the Transmitter and Sensor must be properly grounded.

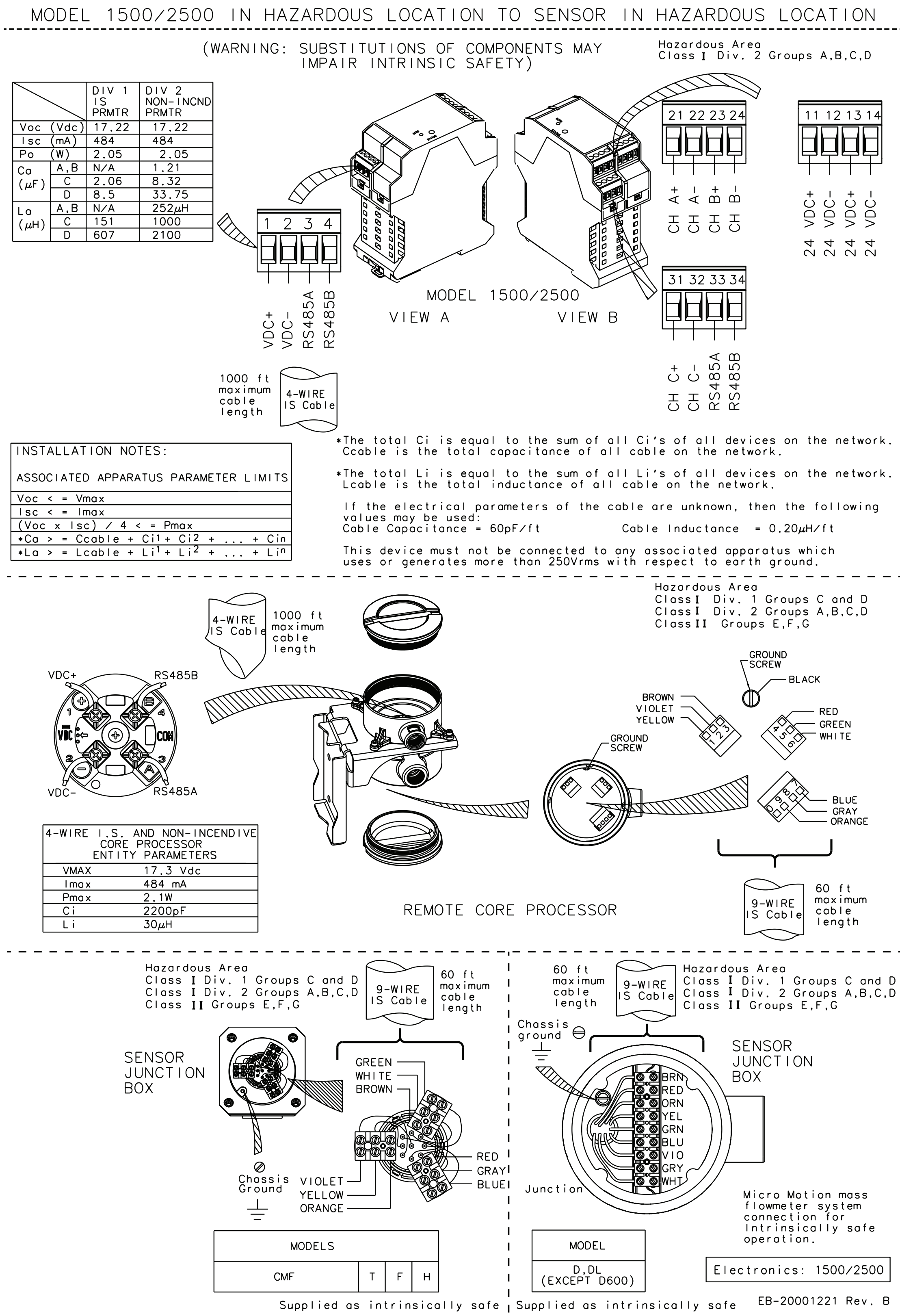
Micro Motion mass flowmeter system connection for Intrinsically safe operation.

Electronics:1700/2700

EB-3600674 Rev. C
SHT 1 OF 1

Model 1500/2500 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on CMF, D (except D600), DL, F, H, and T sensors



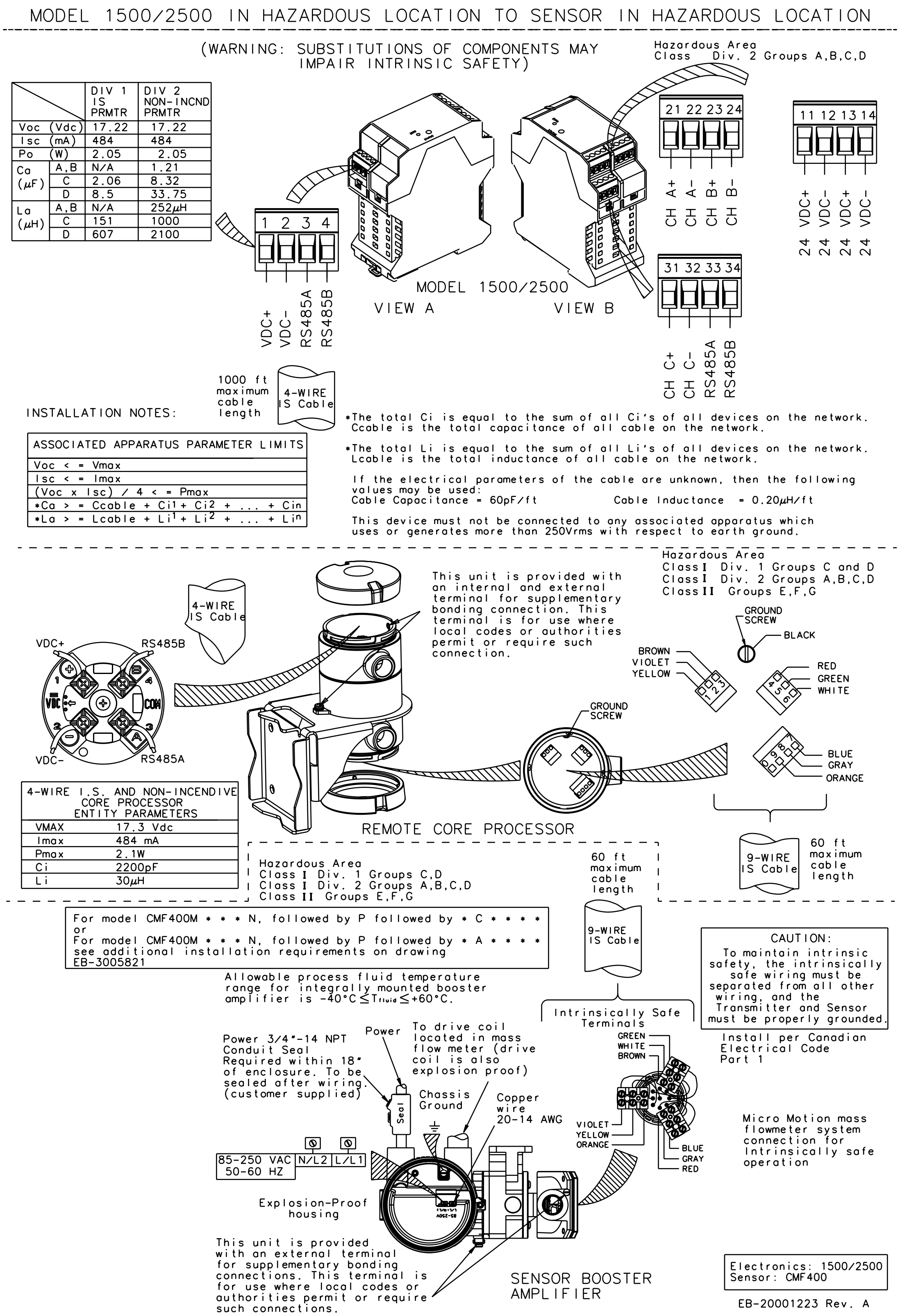
		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (µF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (µH)	A,B	N/A	252µH
	C	151	1000
	D	607	2100

INSTALLATION NOTES:
ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30µH

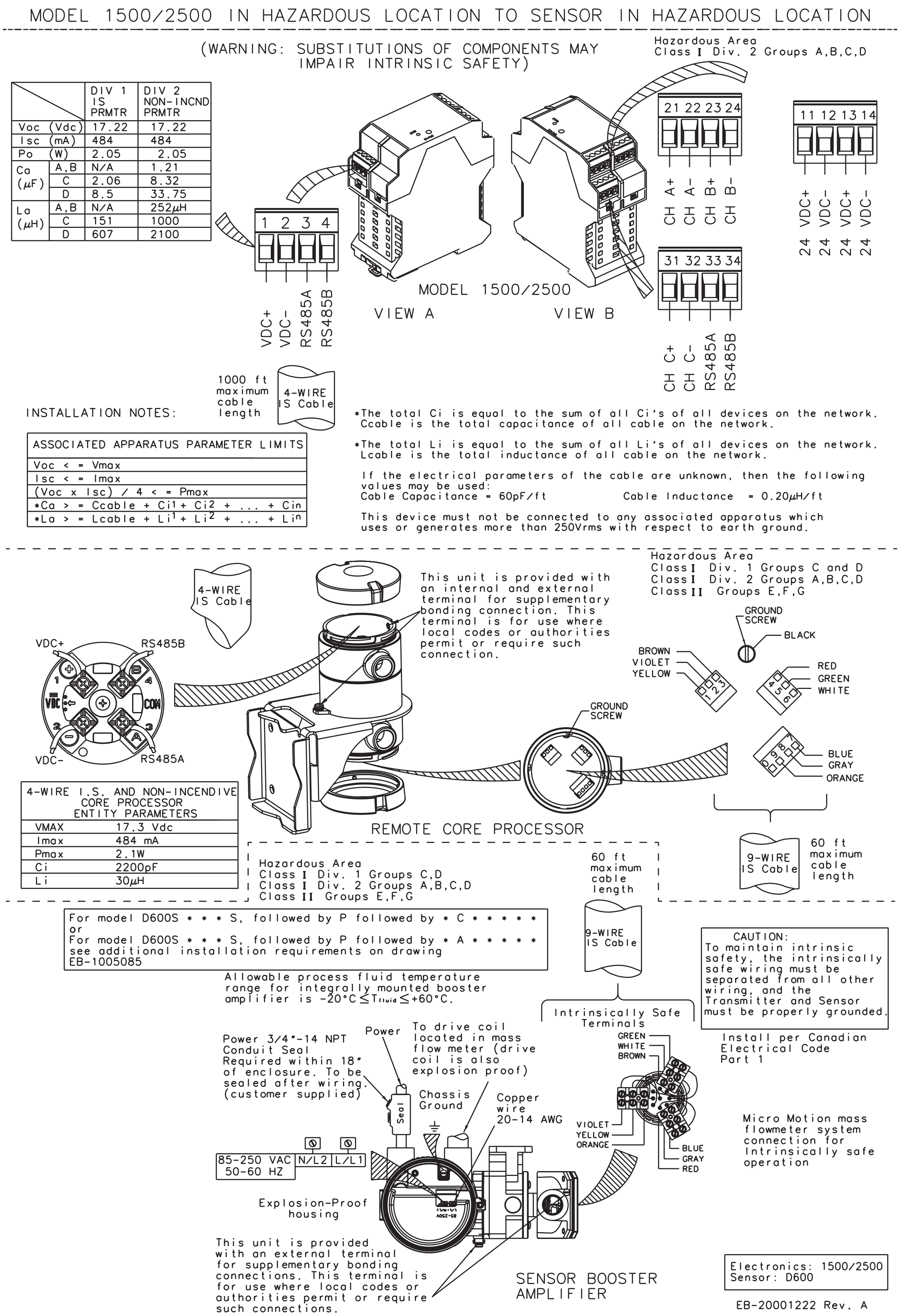
Model 1500/2500 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on CMF400 sensor with booster amplifier



Model 1500/2500 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on D600 sensor



Model 1500/2500 9-Wire Installation

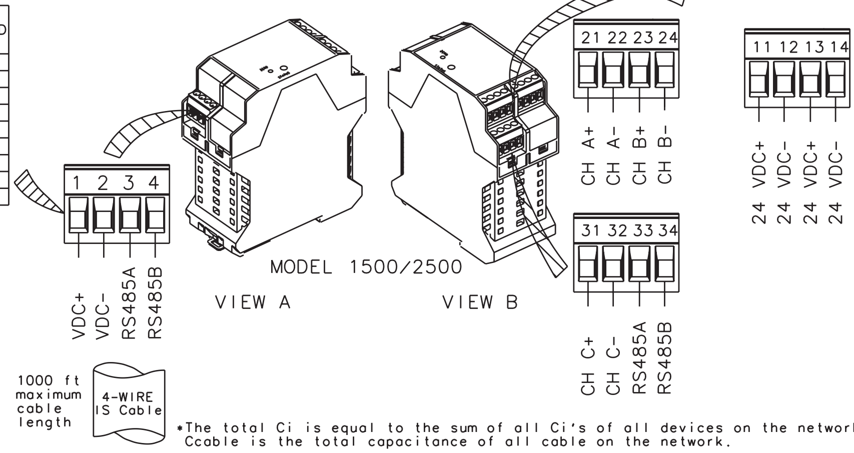
Transmitter to remote mount core processor to 9-wire junction box on DT sensor

MODEL 1500/2500 IN HAZARDOUS LOCATION TO SENSOR IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class Div. 2 Groups A,B,C,D

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.06	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



INSTALLATION NOTES:

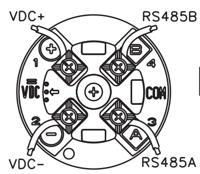
ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

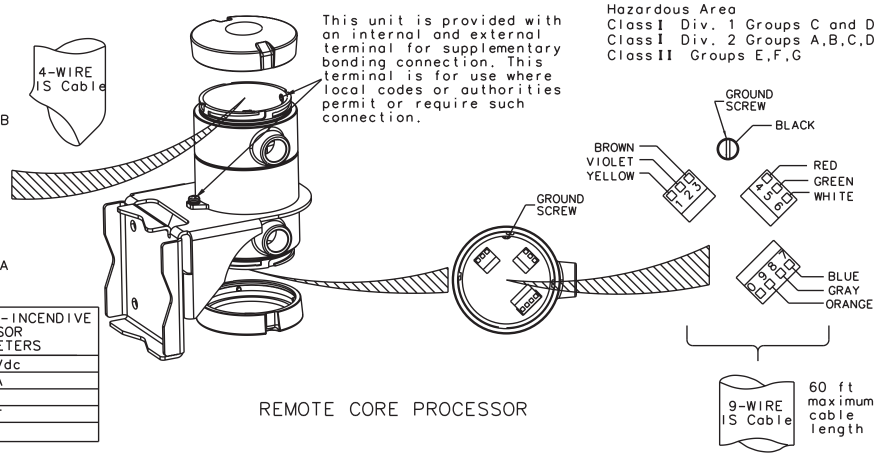
*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.



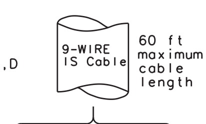


Hazardous Area
Class I Div. 1 Groups C and D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G

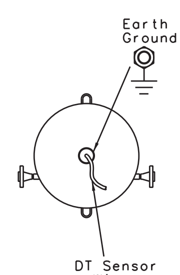
4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

REMOTE CORE PROCESSOR

Hazardous Area
Class I Div. 1 Groups C,D
Class I Div. 2 Groups A,B,C,D
Class II Groups E,F,G



CAUTION:
To maintain intrinsic safety, the intrinsically safe wiring must be separated from all other wiring, and the Transmitter and Sensor must be properly grounded.



DT Sensor wires must be connected to IS Cable using customer supplied terminal block and Junction Box.

DT Sensor Wire Terminations to 9-Wire IS Cable	
DT Sensor Wire #	IS Cable Color
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White

Micro Motion mass flowmeter system connection for Intrinsically safe operation.

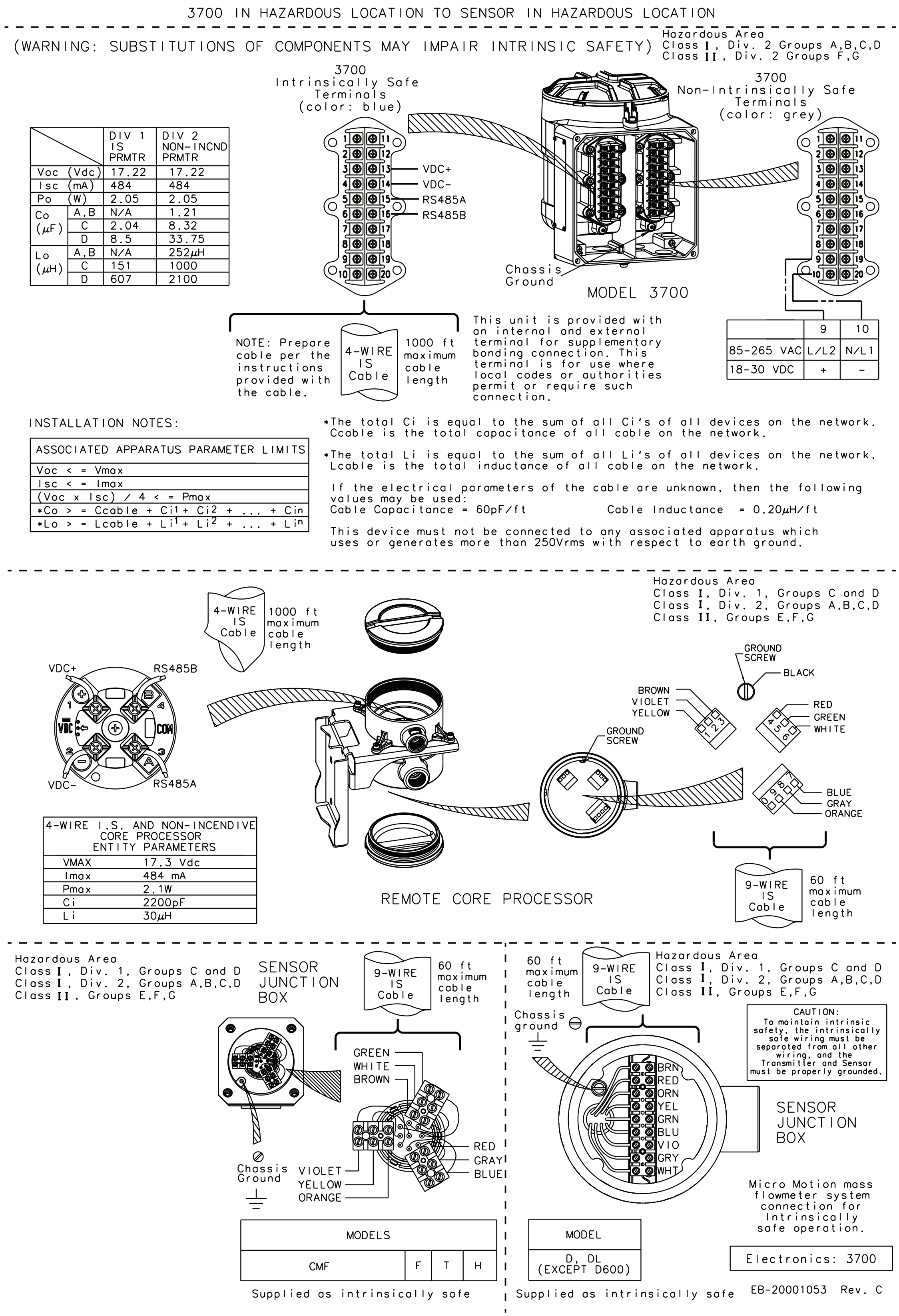
Models:
DT65, DT100, DT150
Supplied as intrinsically safe.

Electronics: 1500/2500
Sensor: DT

EB-20001225 Rev. A

Model 3700 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on CMF, D (except D600), DL, F, H, and T sensors



	DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)	17.22	17.22
Isc (mA)	484	484
Po (W)	2.05	2.05
Co (μF) A,B	N/A	1.21
Co (μF) C	2.04	8.32
Co (μF) D	8.5	33.75
Lo (μH) A,B	N/A	252μH
Lo (μH) C	151	1000
Lo (μH) D	607	2100

	9	10
85-265 VAC	L/L2	N/L1
18-30 VDC	+	-

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Co > = Ccable + Ci1 + Ci2 + ... + Cin
*Lo > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft   Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

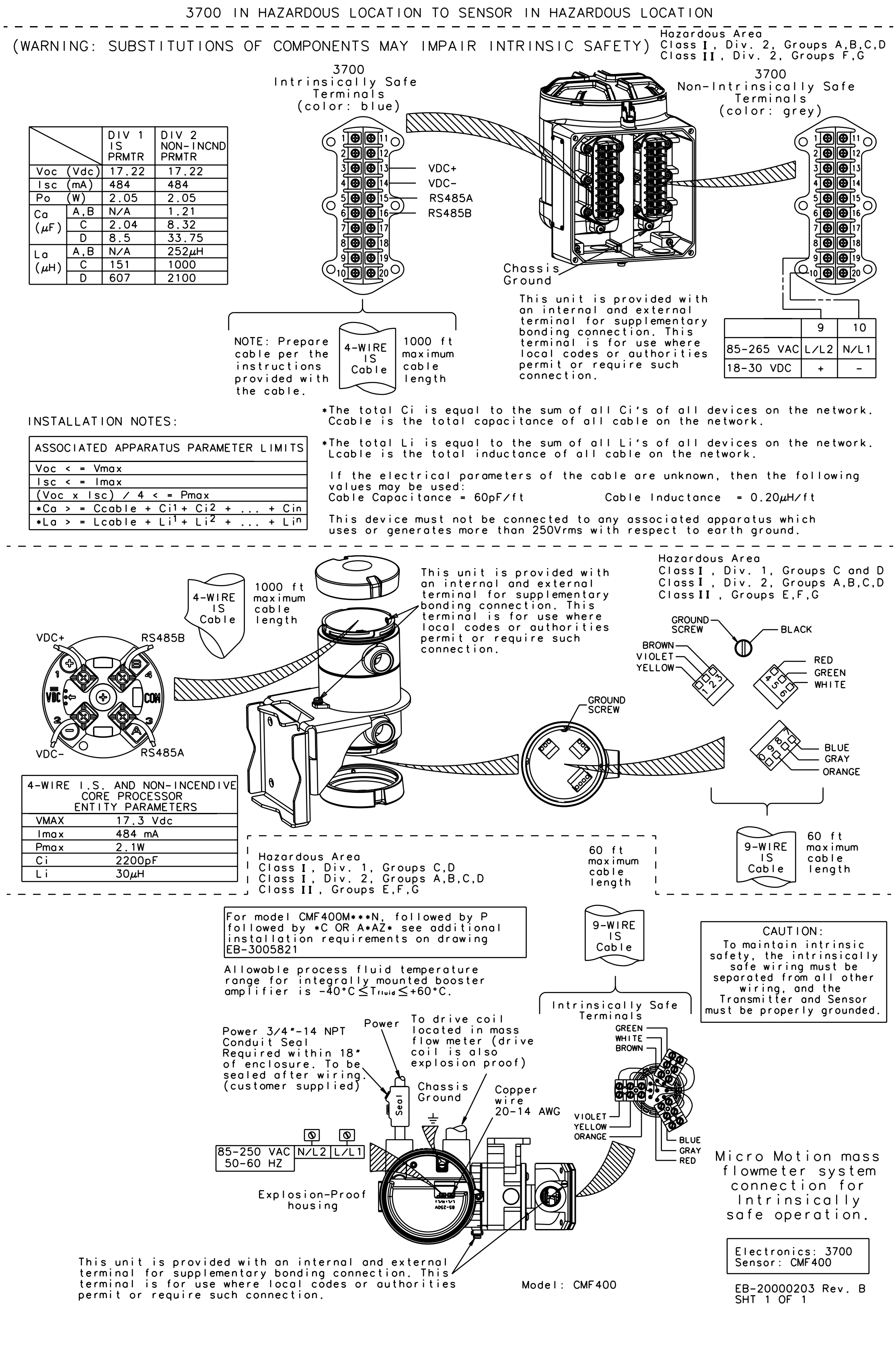
4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

MODELS			
CMF	F	T	H

MODEL
D, DL (EXCEPT D600)

Model 3700 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on CMF400 sensor with booster amplifier



		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (µF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (µH)	A,B	N/A	252µH
	C	151	1000
	D	607	2100

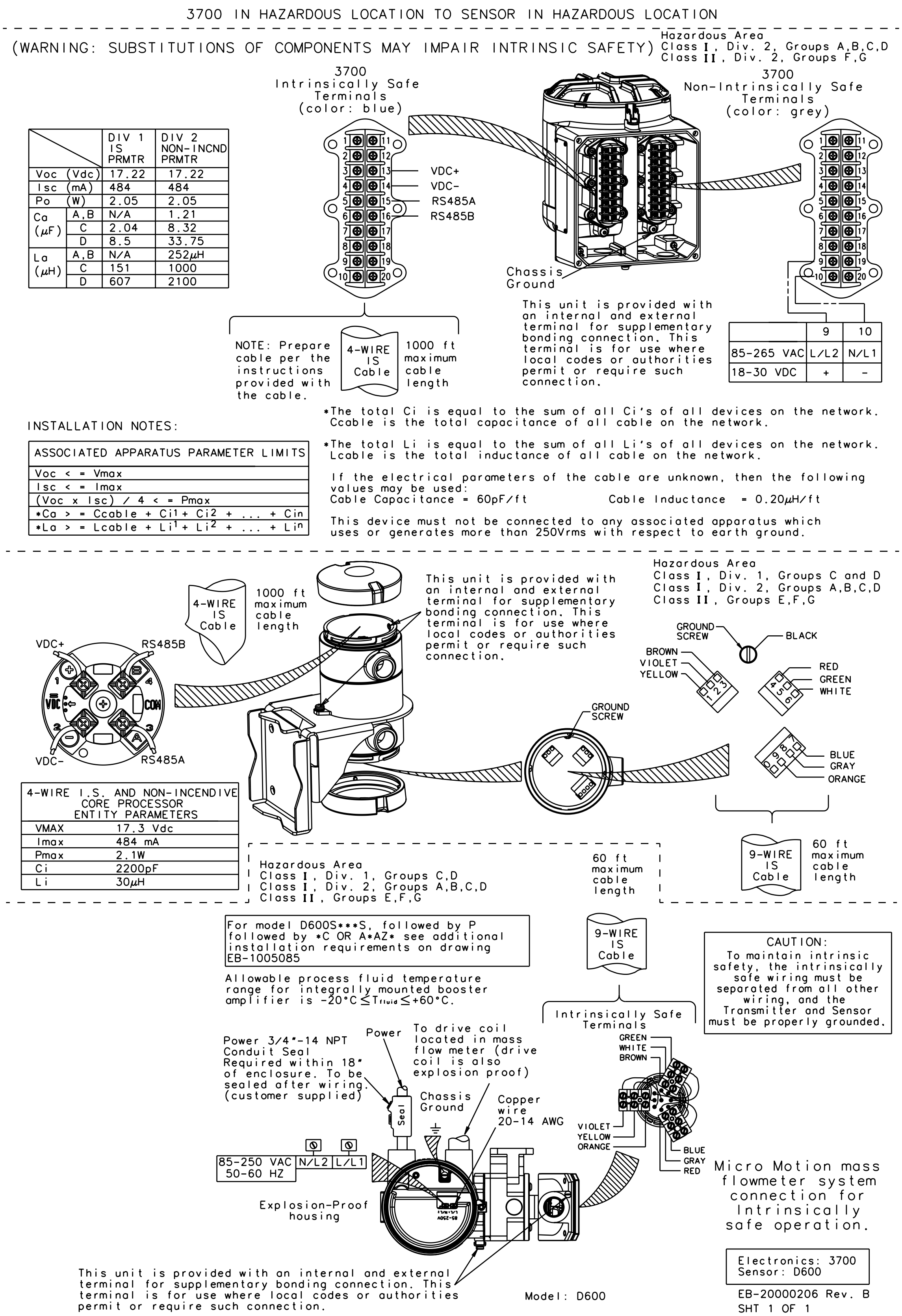
	9	10
85-265 VAC	L/L2	N/L1
18-30 VDC	+	-

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30µH

Model 3700 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on D600 sensor



Model 3700 9-Wire Installation

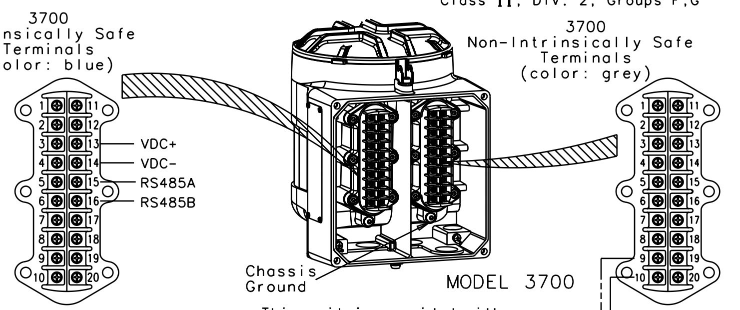
Transmitter to remote mount core processor to 9-wire junction box on DT sensor

3700 IN HAZARDOUS LOCATION TO SENSOR IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I, Div. 2, Groups A,B,C,D
Class II, DIV. 2, Groups F,G

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



	9	10
85-265 VAC	L/L2	N/L1
18-30 VDC	+	-

NOTE: Prepare cable per the instructions provided with the cable.

4-WIRE IS Cable — 1000 ft maximum cable length

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.

INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

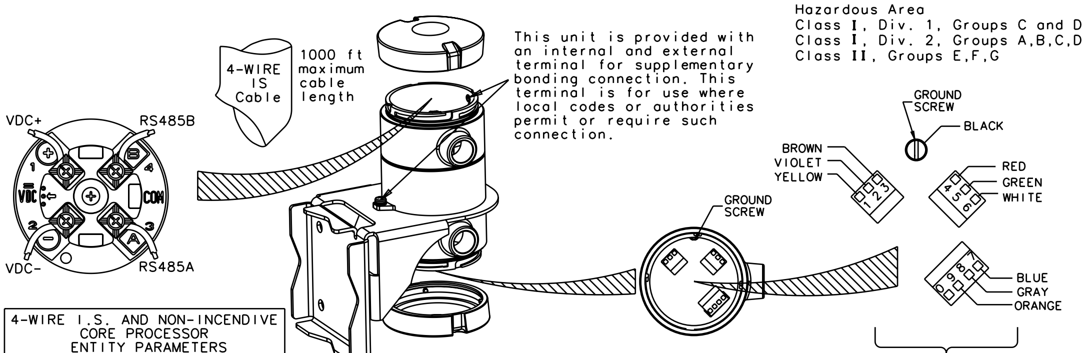
If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft   Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

Hazardous Area
Class I, Div. 1, Groups C and D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

4-WIRE IS Cable — 1000 ft maximum cable length

This unit is provided with an internal and external terminal for supplementary bonding connection. This terminal is for use where local codes or authorities permit or require such connection.



4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

REMOTE CORE PROCESSOR

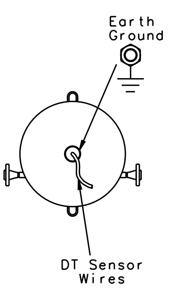
9-WIRE IS Cable — 60 ft maximum cable length

Hazardous Area
Class I, Div. 1, Groups C,D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

9-WIRE IS Cable — 60 ft maximum cable length

CAUTION:
To maintain intrinsic safety, the intrinsically safe wiring must be separated from all other wiring, and the Transmitter and Sensor must be properly grounded.

DT Sensor wires must be connected to IS Cable using customer supplied terminal block and Junction Box.



Models:
DT65, DT100, DT150
Supplied as intrinsically safe.

DT Sensor Wire Terminations to 9-Wire IS Cable	
DT Sensor Wire #	IS Cable Color
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White

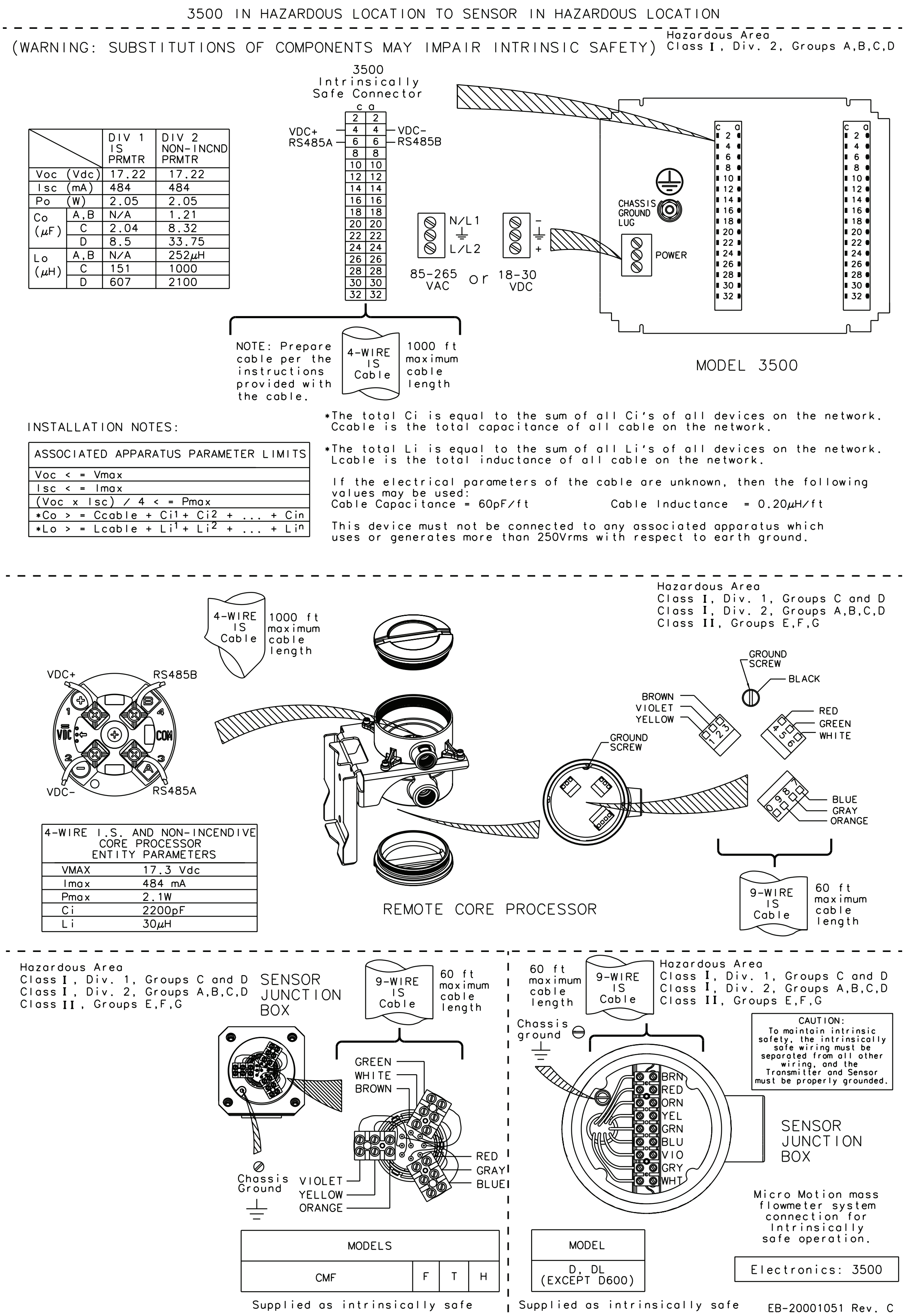
Micro Motion mass flowmeter system connection for Intrinsically safe operation.

Electronics: 3700
Sensor: DT

EB-20000215 Rev. B
SHT 1 OF 1

Model 3500 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on CMF, D (except D600), DL, F, H, and T sensors



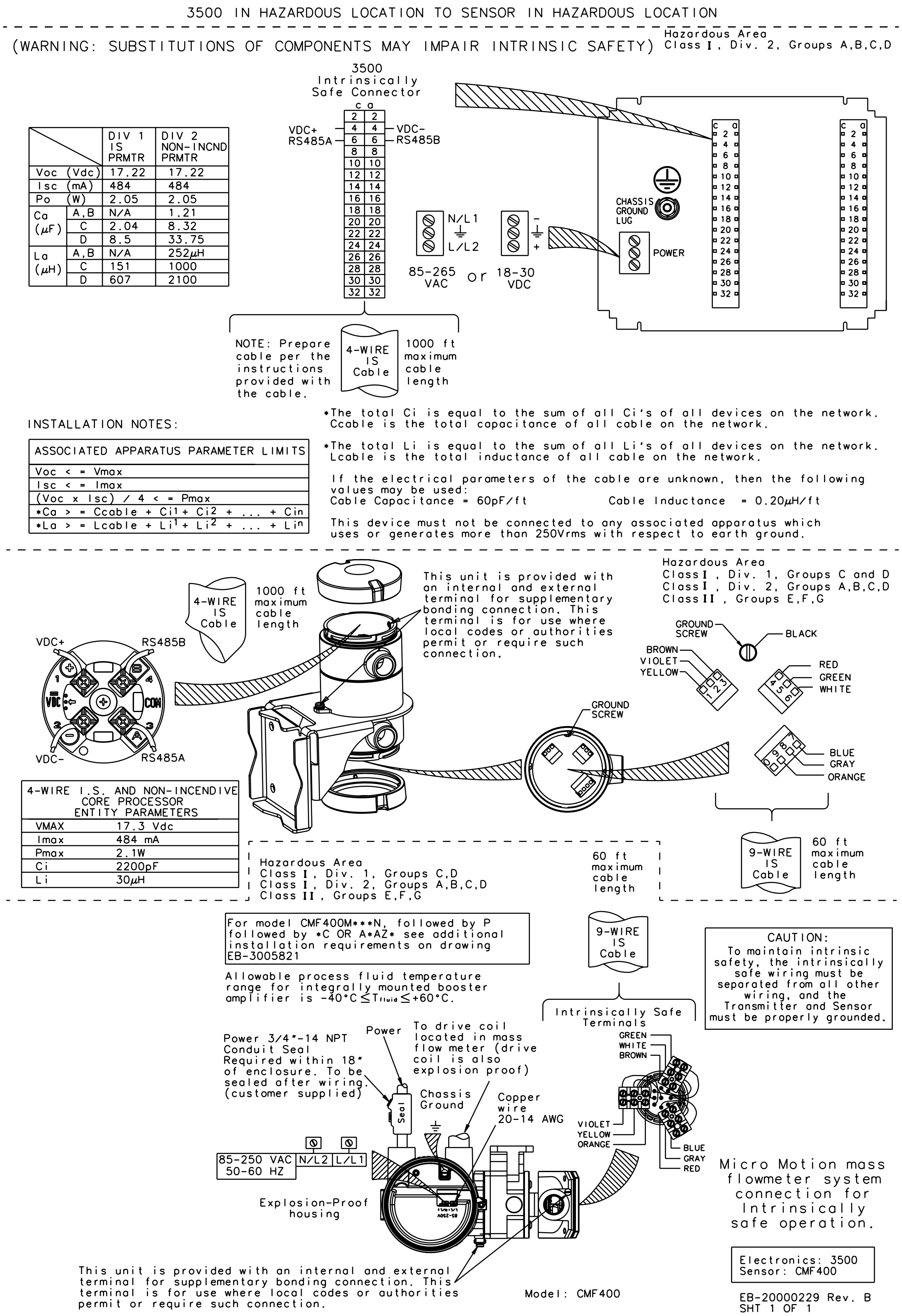
		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Co (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
Lo (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Co > = Ccable + Ci1 + Ci2 + ... + Cin
*Lo > = Lcable + Li1 + Li2 + ... + Lin

4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

Model 3500 9-Wire Installation

Transmitter to remote mount core processor to 9-wire junction box on CMF400 sensor with booster amplifier



Model 3500 9-Wire Installation

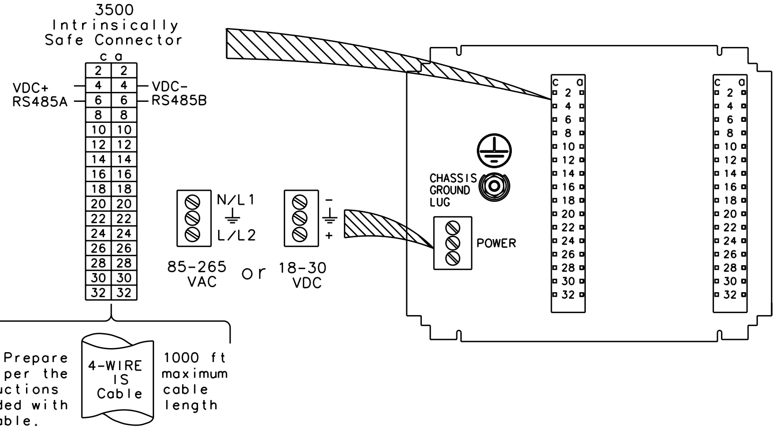
Transmitter to remote mount core processor to 9-wire junction box on D600 sensor

3500 IN HAZARDOUS LOCATION TO SENSOR IN HAZARDOUS LOCATION

Hazardous Area
Class I, Div. 2, Groups A,B,C,D

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



INSTALLATION NOTES:

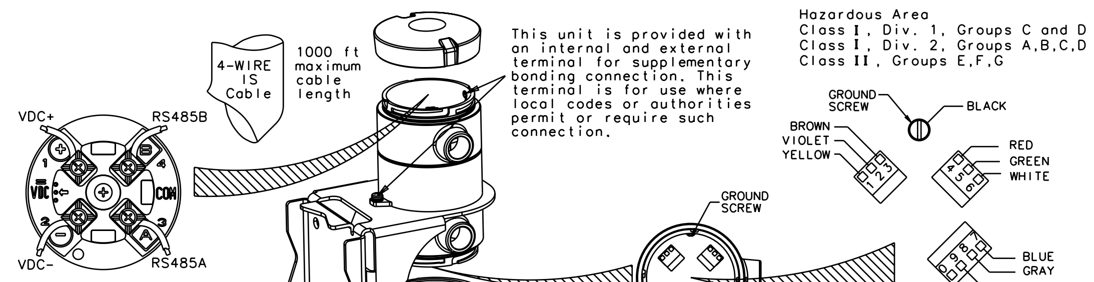
ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft   Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

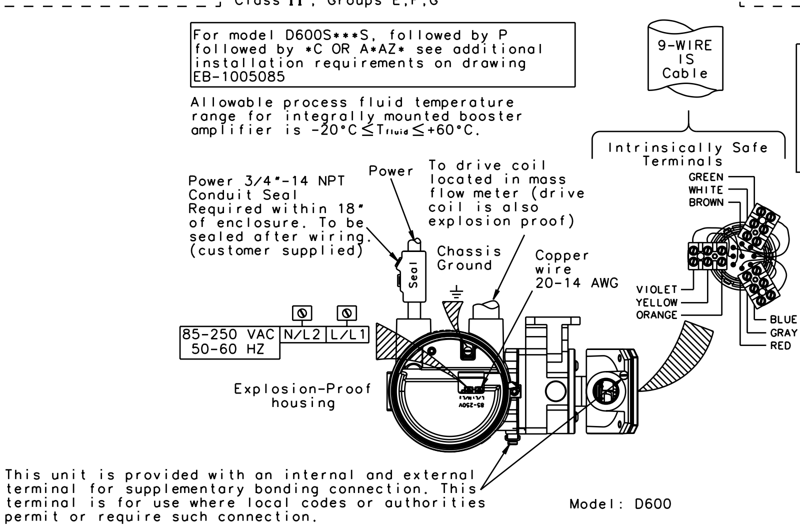


4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

For model D600S***S, followed by P followed by *C OR A*AZ* see additional installation requirements on drawing EB-1005085

Allowable process fluid temperature range for integrally mounted booster amplifier is -20°C ≤ T_{fluid} ≤ +60°C.

CAUTION:
To maintain intrinsic safety, the intrinsically safe wiring must be separated from all other wiring, and the Transmitter and Sensor must be properly grounded.



Micro Motion mass flowmeter system connection for Intrinsically safe operation.

Electronics: 3500
Sensor: D600

EB-20000232 Rev. B
SHT 1 OF 1

Model 3500 9-Wire Installation

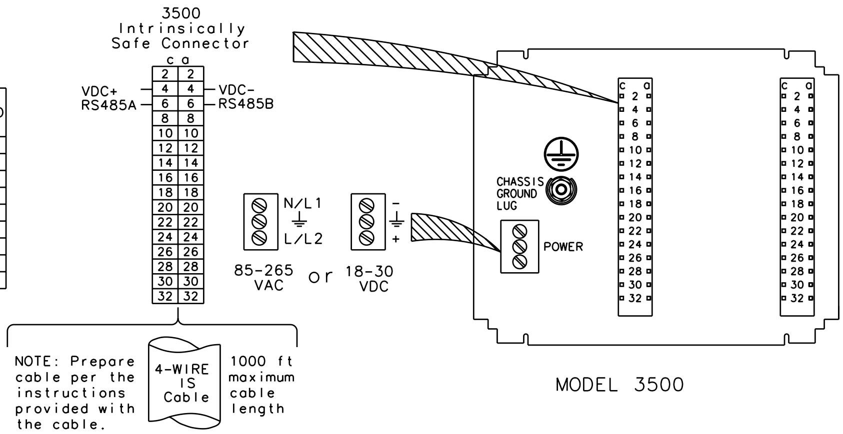
Transmitter to remote mount core processor to 9-wire junction box on DT sensor

3500 IN HAZARDOUS LOCATION TO SENSOR IN HAZARDOUS LOCATION

(WARNING: SUBSTITUTIONS OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY)

Hazardous Area
Class I, Div. 2, Groups A,B,C,D

		DIV 1 IS PRMTR	DIV 2 NON-INCND PRMTR
Voc (Vdc)		17.22	17.22
Isc (mA)		484	484
Po (W)		2.05	2.05
Ca (μF)	A,B	N/A	1.21
	C	2.04	8.32
	D	8.5	33.75
La (μH)	A,B	N/A	252μH
	C	151	1000
	D	607	2100



INSTALLATION NOTES:

ASSOCIATED APPARATUS PARAMETER LIMITS
Voc < = Vmax
Isc < = Imax
(Voc x Isc) / 4 < = Pmax
*Ca > = Ccable + Ci1 + Ci2 + ... + Cin
*La > = Lcable + Li1 + Li2 + ... + Lin

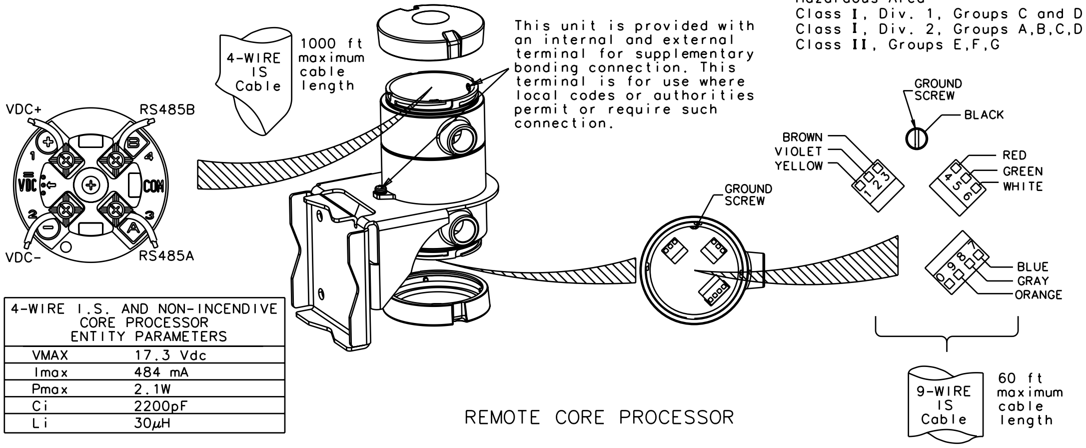
*The total Ci is equal to the sum of all Ci's of all devices on the network. Ccable is the total capacitance of all cable on the network.

*The total Li is equal to the sum of all Li's of all devices on the network. Lcable is the total inductance of all cable on the network.

If the electrical parameters of the cable are unknown, then the following values may be used:
Cable Capacitance = 60pF/ft Cable Inductance = 0.20μH/ft

This device must not be connected to any associated apparatus which uses or generates more than 250Vrms with respect to earth ground.

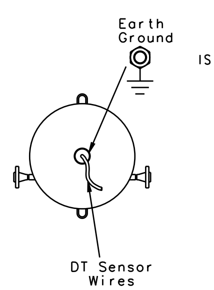
Hazardous Area
Class I, Div. 1, Groups C and D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G



4-WIRE I.S. AND NON-INCENDIVE CORE PROCESSOR ENTITY PARAMETERS	
VMAX	17.3 Vdc
Imax	484 mA
Pmax	2.1W
Ci	2200pF
Li	30μH

Hazardous Area
Class I, Div. 1, Groups C,D
Class I, Div. 2, Groups A,B,C,D
Class II, Groups E,F,G

9-WIRE IS Cable — 60 ft maximum cable length



DT Sensor wires must be connected to IS Cable using customer supplied terminal block and Junction Box.

DT Sensor Wire Terminations to 9-Wire IS Cable	
DT Sensor Wire #	IS Cable Color
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White

Models:
DT65, DT100, DT150
Supplied as intrinsically safe.

CAUTION:
To maintain intrinsic safety, the intrinsically safe wiring must be separated from all other wiring, and the Transmitter and Sensor must be properly grounded.

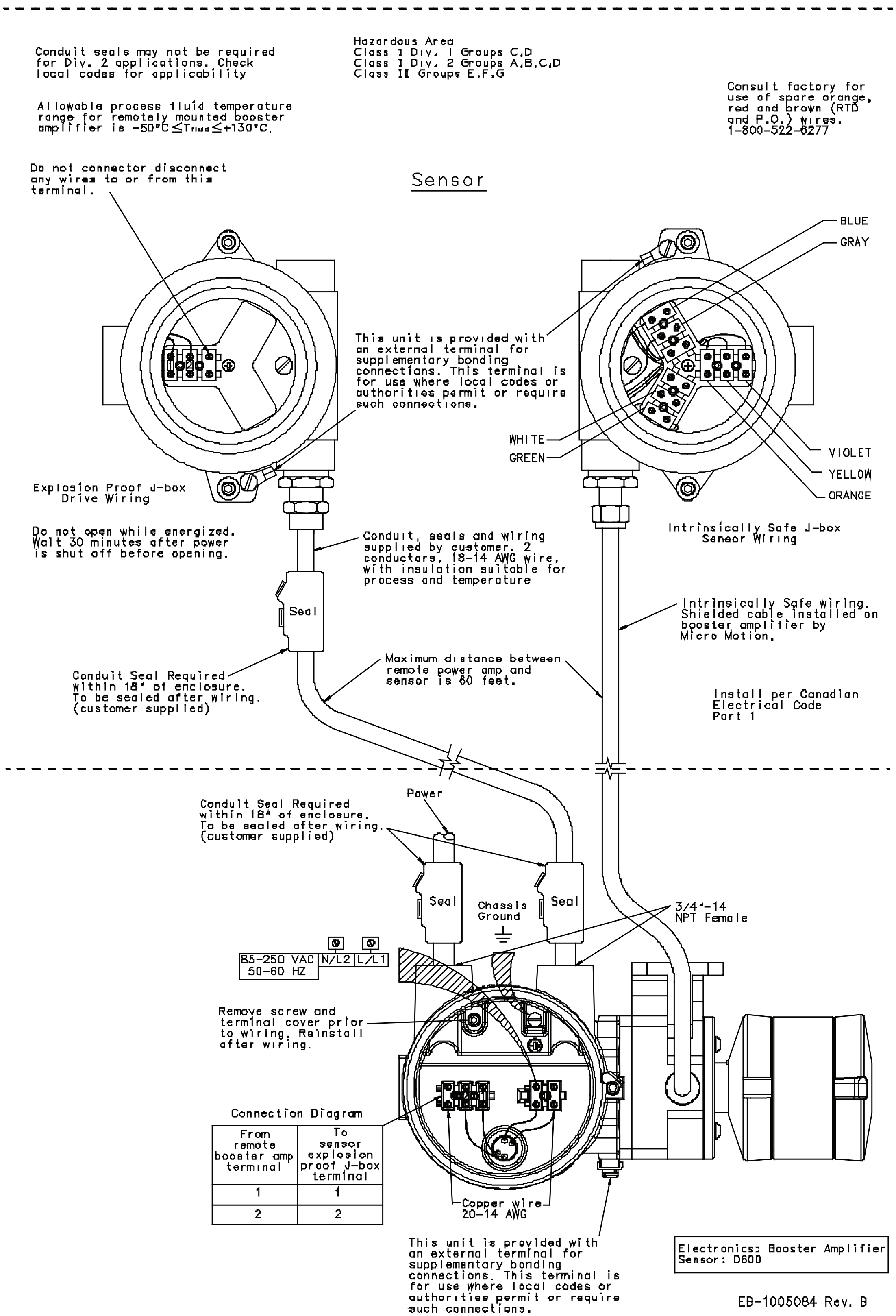
Micro Motion mass flowmeter system connection for Intrinsically safe operation.

Electronics: 3500
Sensor: DT

EB-20000241 Rev. B
SHT 1 OF 1

D600 Remote Booster Amplifier Installation

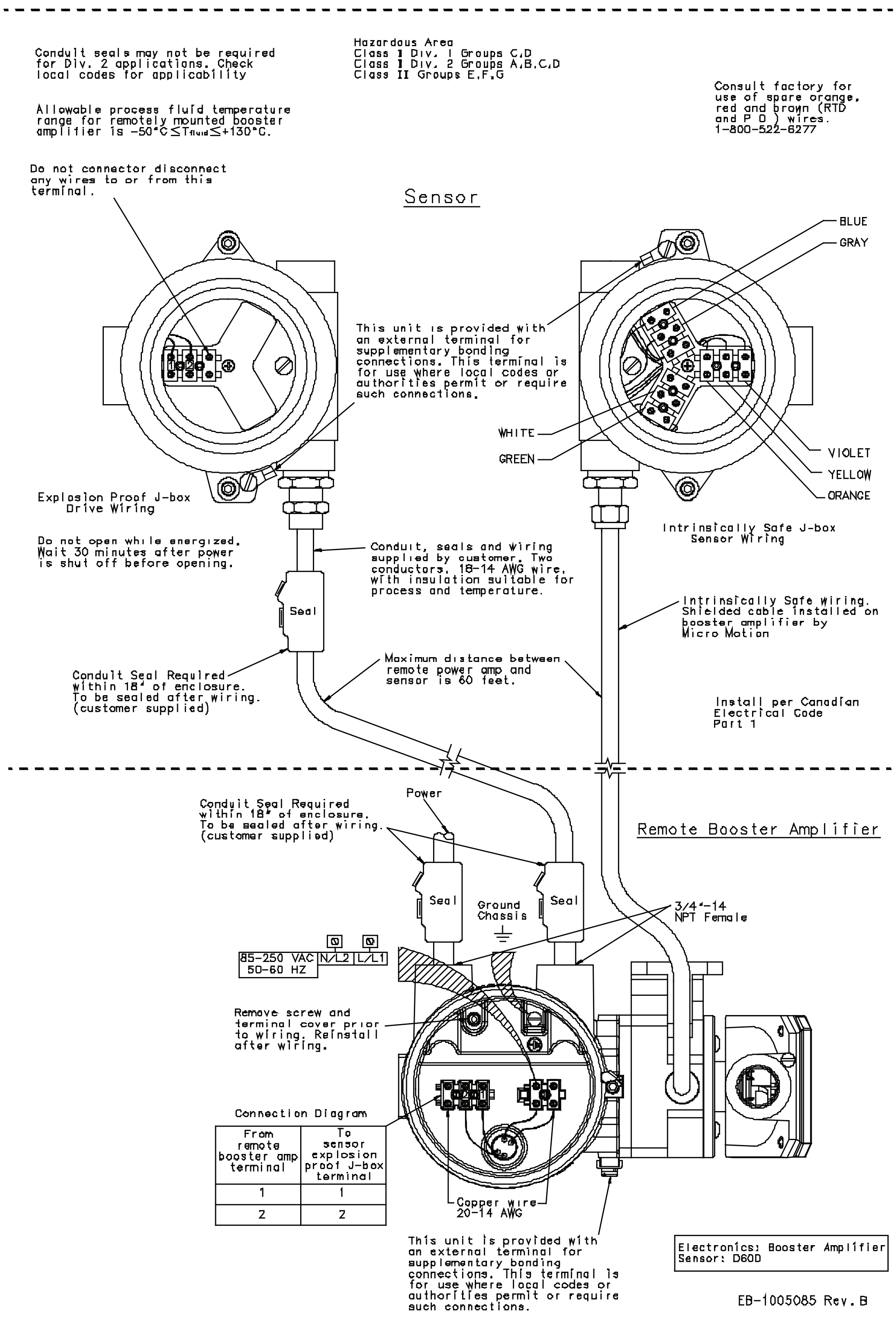
Booster amplifier with core processor remotely mounted from sensor and transmitter



From remote booster amp terminal	To sensor explosion proof J-box terminal
1	1
2	2

D600 Remote Booster Amplifier Installation

Booster amplifier with junction box remotely mounted from sensor and transmitter



From remote booster amp terminal	To sensor explosion proof J-box terminal
1	1
2	2

Instruction Manual
P/N 20002273, Rev. A
August 2005

Micro Motion®
MVD™ Direct Connect™
Meters

Installation Manual

Micro Motion®

EMERSON.
Process Management

Before You Begin

This manual provides installation information for Micro Motion® MVD™ Direct Connect™ meters. MVD Direct Connect meters may or may not include the MVD Direct Connect I.S. barrier. Both installation types are discussed here.

Additionally, this manual provides basic information for establishing communication between the MVD Direct Connect meter and the remote host system.

Product Overview and Architecture . . . . page 3
Installation . . . . page 6
- Supplying power . . . . page 6
- Locating the components . . . . page 7
- Installing the core processor . . . . page 8
- Wiring the core processor to the sensor . . . . page 10
- 4-wire cable preparation and core processor wiring . . . . page 11
- Installing the MVD Direct Connect I.S. barrier . . . . page 14
- Wiring at the MVD Direct Connect I.S. barrier . . . . page 14
- Wiring to the remote host . . . . page 15
- Wiring to the power supply . . . . page 16
- Grounding . . . . page 16

MVD Direct Connect Communications . . . . page 17
Return Policy . . . . page 18

European installations

This Micro Motion product complies with all applicable European directives when properly installed in accordance with the instructions in this manual. Refer to the EC declaration of conformity for directives that apply to this product.

Safety

For information on I.S. applications, refer to Micro Motion ATEX, UL, or CSA installation instructions.

> **⚠ WARNING**
>
> **Improper installation in a hazardous area can cause an explosion.**
>
> For information about hazardous applications, refer to the appropriate Micro Motion approval documentation, shipped with the meter or available from the Micro Motion web site.

> **⚠ CAUTION**
>
> **Excess voltage can damage the core processor.**
>
> To avoid damaging the core processor, use only low-voltage DC power.

Product Overview and Architecture

MVD Direct Connect meters are used to supply Micro Motion sensor data directly to a remote Modbus-capable host, rather than to a Micro Motion transmitter. Because there is no transmitter component, MVD Direct Connect systems are not intrinsically safe unless the MVD Direct Connect I.S. barrier is included in the installation.

> **⚠ WARNING**
>
> **MVD Direct Connect systems without the MVD Direct Connect I.S. barrier are not intrinsically safe.**

Installation options

All MVD Direct Connect systems include a sensor and a core processor. Either the standard core processor or the enhanced core processor may be installed.

- The standard core processor may be mounted integrally with the sensor, or remotely.
- The enhanced core processor must be mounted integrally with the sensor; it cannot be mounted remotely.

If the MVD Direct Connect I.S. barrier is installed, a separate barrier is required for each core processor.

See Figures 1 and 2 for illustrations of MVD Direct Connect installations without the MVD Direct Connect I.S. barrier. See Figures 3 and 4 for illustrations of MVD Direct Connect installations with the MVD Direct Connect I.S. barrier.

Figure 1 MVD Direct Connect installations – Integral core processor, no I.S. barrier

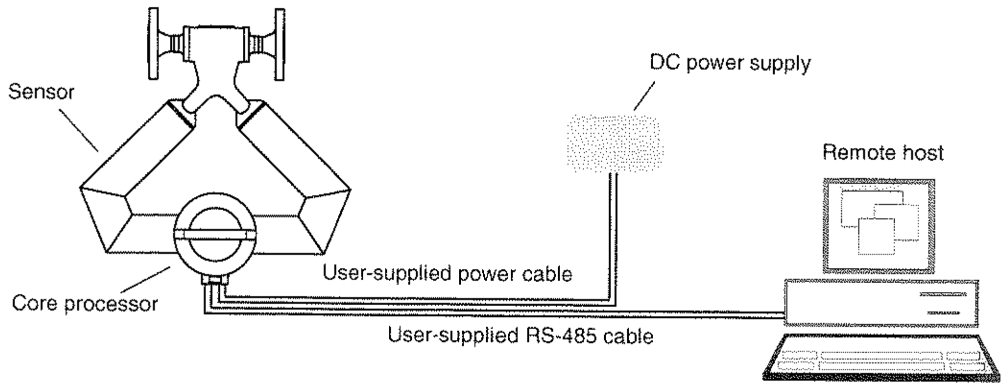


Figure 2 MVD Direct Connect installations – Remote core processor, no I.S. barrier

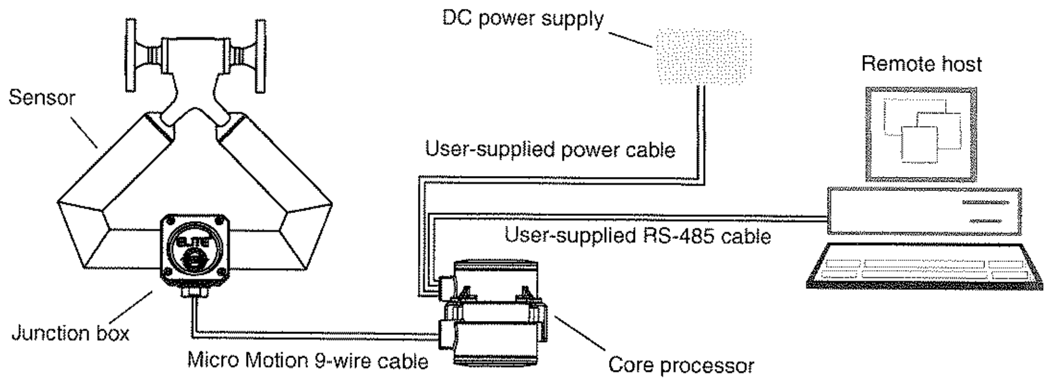


Figure 3 MVD Direct Connect installations – Integral core processor, I.S. barrier

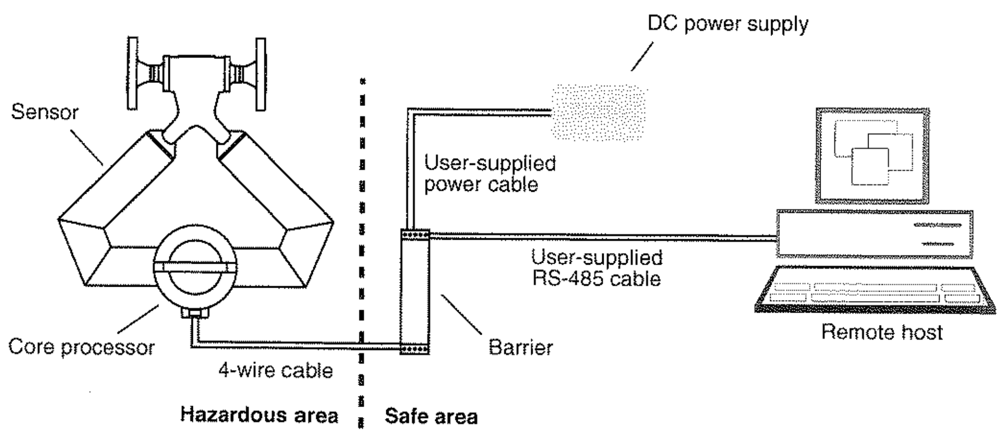
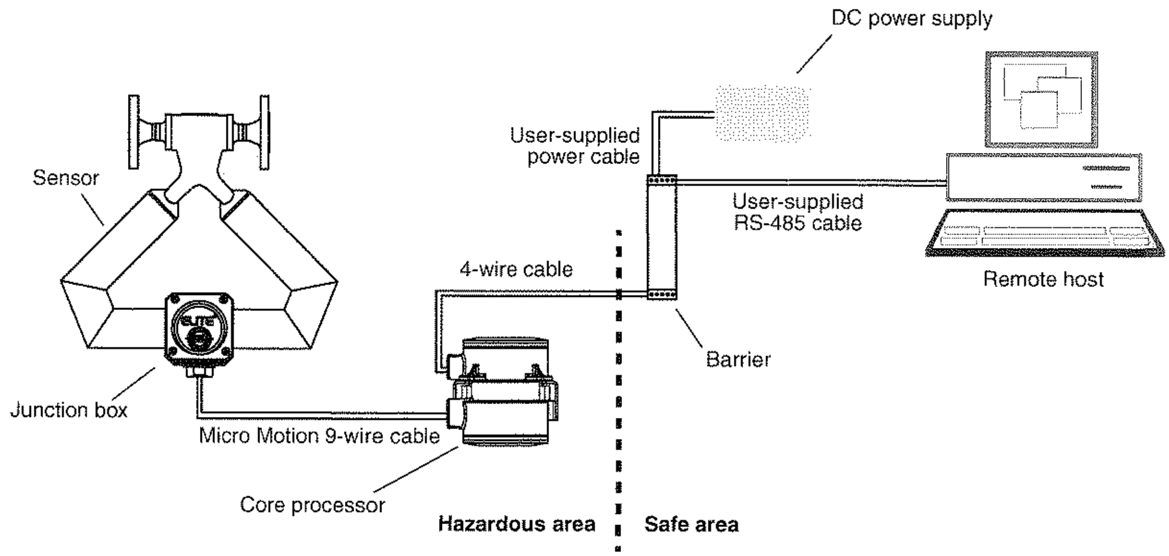


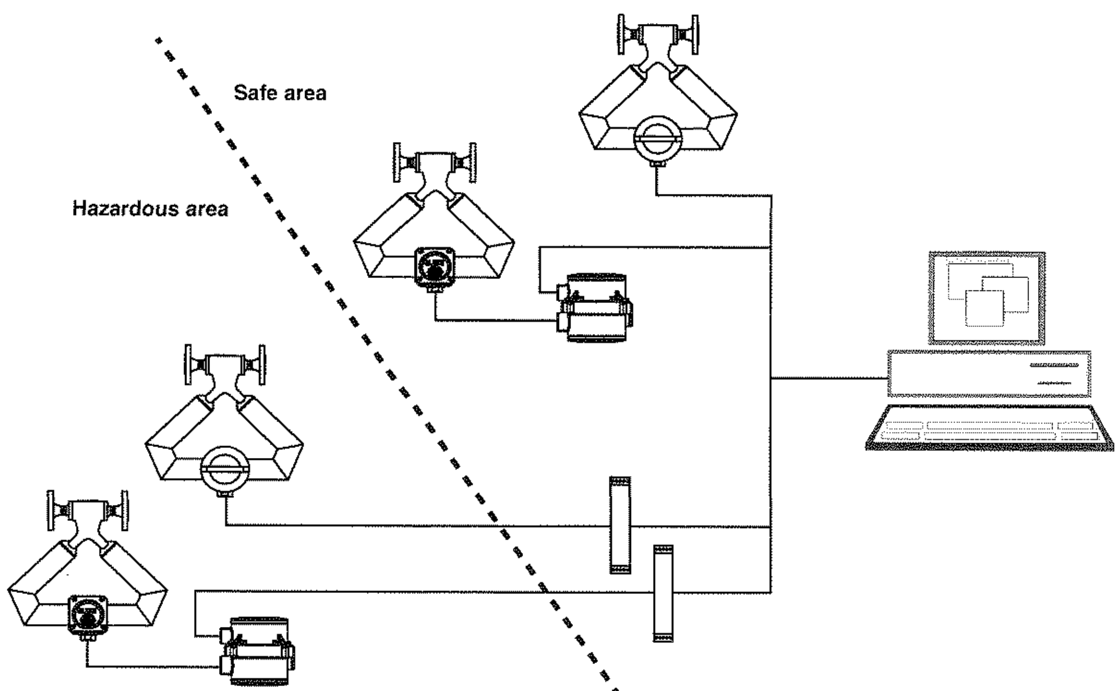
Figure 4 **MVD Direct Connect installations – Remote core processor, I.S. barrier**



Multidrop installation

Up to fifteen MVD Direct Connect installations can be networked to a single remote host. If I.S. barriers are used, one barrier is required for each core processor. Figure 5 shows the four options for a multidrop installation.

Figure 5 **Multidrop installation options**



Installation

Supplying power

Power supply requirements depend on your installation type:

- MVD Direct Connect without the MVD Direct Connect I.S. barrier (see Figures 1 and 2)
- MVD Direct Connect with the MVD Direct Connect I.S. barrier (see Figures 3 and 4)

MVD Direct Connect installations without the MVD Direct Connect I.S. barrier

In MVD Direct Connect installations without the I.S. barrier, power is supplied directly to the core processor. The core processor supplies power to the sensor. The power supply must meet the following requirements:

- Power must be supplied from a common floating regulated power supply with the correct voltage.
- The voltage requirement for a single core processor is 15–26 VDC. The maximum power consumption of a single core processor is approximately 3 W.
- The power supply may be used to power any number of core processors, but must not be used to power other devices.
- Use shielded wiring.
- The power supply must not allow power surges or conducted radio frequency interference (RFI) to propagate through to its output.
- The power supply must not be grounded.

⚠ CAUTION

Grounding the power supply to the core processor can cause damage to the core processor or the remote host.

To avoid damaging the core processor or the remote host, ensure that the power supply to the core processor is not grounded.

- In EU countries, the power supply must meet the requirements of the EMC directive.
- The power supply cable must comply with the size and length requirements listed in Table 2. A minimum DC input of 15 V is required for each core processor. At startup, the power source must provide a minimum of 0.2 A of short-term current per core processor. The maximum steady state current is 0.15 A. For assistance in sizing the power supply cable, refer to Table 1 and use the equation below:

$$\text{MinimumSupplyVoltage} = 15\text{V} + (\text{CableResistance} \times \text{CableLength} \times 0.15\text{A})$$

Example The core processor is mounted 350 feet from a DC power supply. If you want to use 18 AWG cable, calculate the required voltage at the DC power supply as follows:

$$\text{MinimumSupplyVoltage} = 15\text{V} + (\text{CableResistance} \times \text{CableLength} \times 0.15\text{A})$$

$$\text{MinimumSupplyVoltage} = 15\text{V} + (0.0128\ \text{ohms/ft} \times 350\ \text{ft} \times 0.15\text{A})$$

$$\text{MinimumSupplyVoltage} = 15.7\text{V}$$

Table 1 Typical power cable resistances at 68 °F (20 °C)

Gauge	Resistance[1]
14 AWG	0.0050 Ω/foot
16 AWG	0.0080 Ω/foot
18 AWG	0.0128 Ω/foot
20 AWG	0.0204 Ω/foot
22 AWG	0.0328 Ω/foot
2,5 mm^2	0,0136 Ω/meter
1,5 mm^2	0,0228 Ω/meter
1 mm^2	0,0340 Ω/meter
0,75 mm^2	0,0460 Ω/meter
0,5 mm^2	0,0680 Ω/meter

(1) These values include the resistance of both high and low conductors in a cable.

MVD Direct Connect installations with the MVD Direct Connect I.S. barrier

In MVD Direct Connect installations with the I.S. barrier, power is supplied to the barrier. The barrier supplies power to the core processor, and the core processor supplies power to the sensor. The power supply must meet the following requirements:

- The power supply can be either floating or grounded.
- The voltage requirement for a single barrier is 24 VDC ±20%. The maximum power consumption of a single barrier plus core processor is approximately 3.5 W.
- The power supply cable must comply with the size and length requirements listed in Table 3. A minimum DC input of 19.2 V is required at the barrier terminals. At startup, the power source must provide a minimum of 0.2 A of short-term current per core processor. The maximum steady state current is 0.15 A. For assistance in sizing the power supply cable, refer to Table 1 and use the equation below:

$$\text{MinimumSupplyVoltage} = 19.2\text{V} + (\text{CableResistance} \times \text{CableLength} \times 0.15\text{A})$$

Example A single MVD Direct Connect I.S. barrier is mounted 350 feet from a DC power supply. If you want to use 18 AWG cable, calculate the required voltage at the DC power supply as follows:

$$\text{MinimumSupplyVoltage} = 19.2\text{V} + (\text{CableResistance} \times \text{CableLength} \times 0.15\text{A})$$

$$\text{MinimumSupplyVoltage} = 19.2\text{V} + (0.0128\ \text{ohms/ft} \times 350\ \text{ft} \times 0.15\text{A})$$

$$\text{MinimumSupplyVoltage} = 19.9\text{V}$$

Locating the components

See the sensor installation manual for information on locating the sensor or the sensor/core processor assembly. If the core processor is installed remotely from the sensor, see the sensor installation manual for information on the maximum distance between these two components.

Maximum distance between the core processor, the power supply, the remote host, and the I.S. barrier (if your installation includes the barrier) depends on the wire size and type. Ensure that your installation complies with these requirements.

- Table 2 lists the wire size and length requirements for MVD Direct Connect installations without the I.S. barrier.
- Table 3 lists the wire size and length requirements for MVD Direct Connect installations with the I.S. barrier.

Table 2 Wire sizes and lengths – MVD Direct Connect installations without I.S. barrier

Span	Cable type	Wire size	Max length
Core processor to remote host	RS-485	22 AWG (0,35 mm^2) or larger	500 feet (150 meters)
Core processor to power supply	Power(1)	22 AWG (0,35 mm^2)	300 feet (90 meters)
		20 AWG (0,5 mm^2)	500 feet (150 meters)
		18 AWG (0,8 mm^2)	500 feet (150 meters)

(1) Wire must be sized to provide a minimum of 15 V at the core processor. See the discussion in the preceding section.

Table 3 Wire sizes and lengths – MVD Direct Connect installations with I.S. barrier

Span	Cable type	Wire size	Max length
Core processor to barrier	RS-485	22 AWG (0,35 mm^2) or larger	500 feet (150 meters)
	Power(1)	22 AWG (0,35 mm^2)	300 feet (90 meters)
		20 AWG (0,5 mm^2)	500 feet (150 meters)
		18 AWG (0,8 mm^2)	500 feet (150 meters)
Barrier to host	RS-485	22 – 18 AWG (0,35 – 0,8 mm^2)	1000 ft (300 meters)
Barrier to power supply	Power(2)	22 AWG (0,35 mm^2)	300 feet (90 meters)
		20 AWG (0,5 mm^2)	500 feet (150 meters)
		18 AWG (0,8 mm^2)	500 feet (150 meters)

(1) Wire must be sized to provide a minimum of 15 V at the core processor. See the discussion in the preceding section.

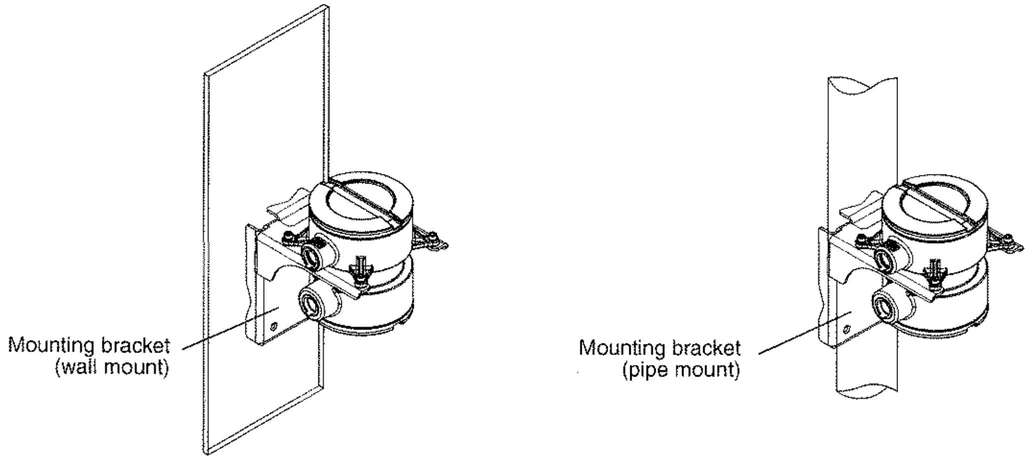
(2) Wire must be sized to provide a minimum of 19.2 V at the barrier. See the discussion in the preceding section.

Installing the core processor

Note: This step is required only if the core processor is mounted separately from the sensor. Refer to Figures 2 and 4.

See Figure 6 for a diagram of the mounting bracket supplied with the core processor. Both pipe mounting and wall mounting are shown.

Figure 6 Remote core processor – Wall mount or pipe mount



To mount the core processor:

1. Identify the components shown in Figure 7. For dimensions, see Figure 8.
2. If desired, reorient the core processor housing on the bracket.
   a. Loosen each of the four cap screws (4 mm).
   b. Rotate the bracket so that the core processor is oriented as desired.
   c. Tighten the cap screws, torquing to 30 to 38 in-lbs (3 to 4 N-m).
3. Attach the mounting bracket to an instrument pole or wall. For pipe mount, two user-supplied U-bolts are required. Contact Micro Motion to obtain a pipe-mount installation kit if required.

Figure 7 Remote core processor components

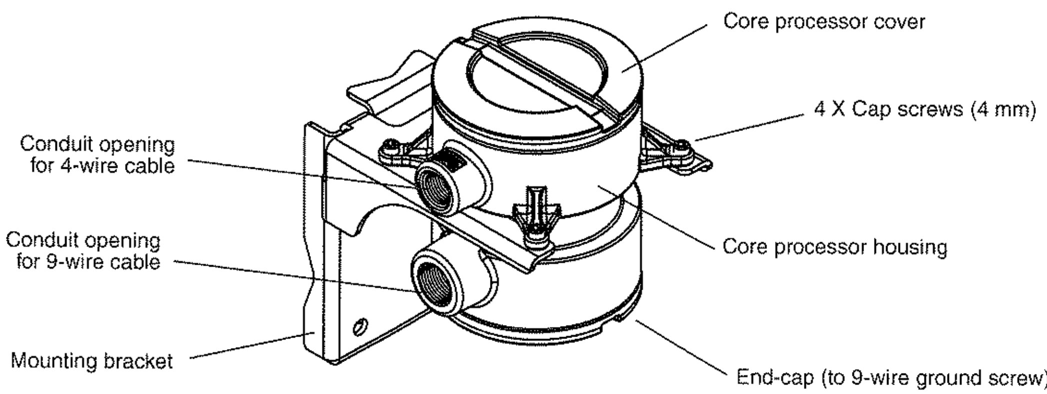
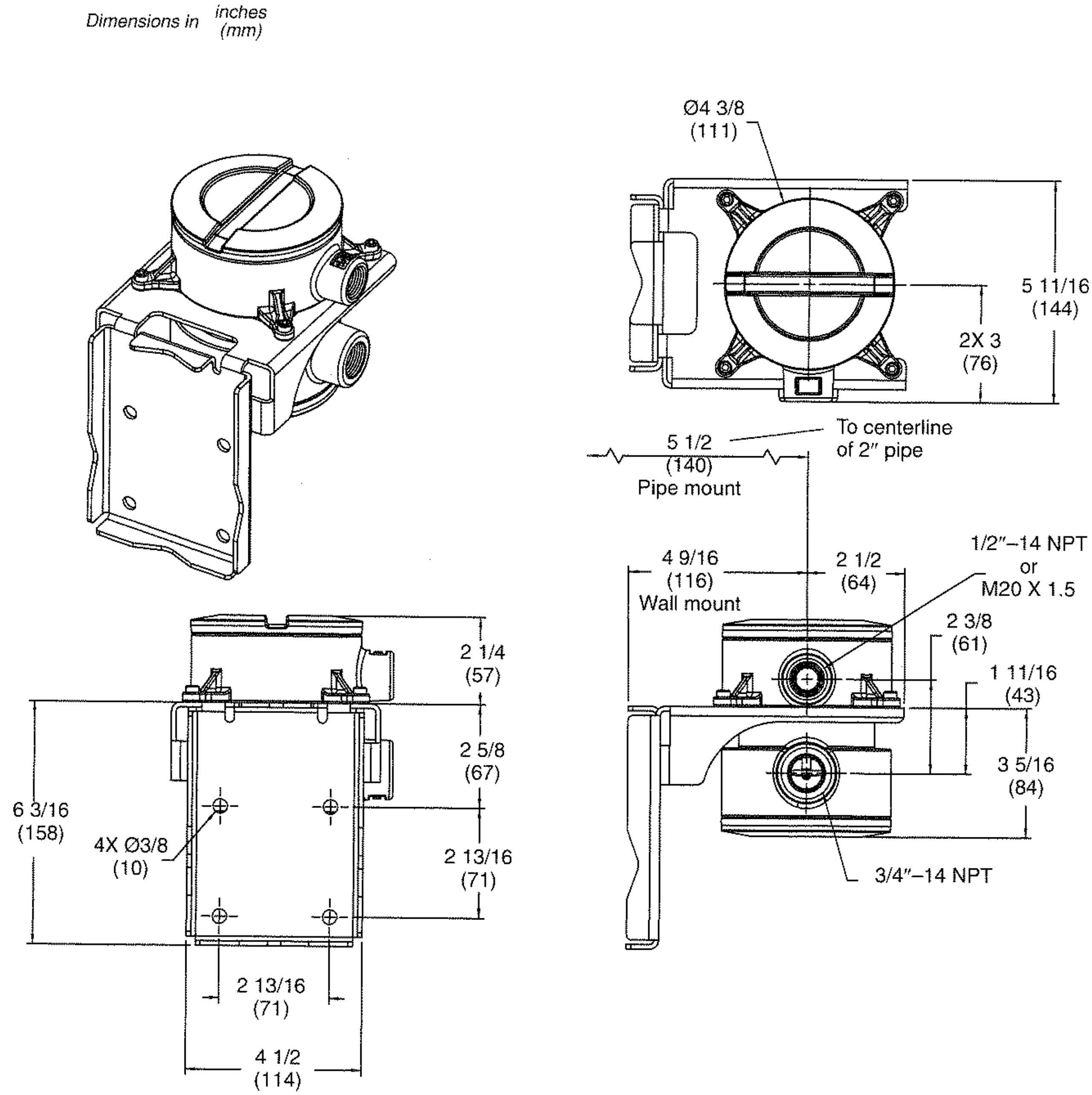


Figure 8 Dimensions – Remote core processor



Wiring the core processor to the sensor

Note: This step is required only if the core processor is mounted separately from the sensor. Refer to Figures 2 and 4.

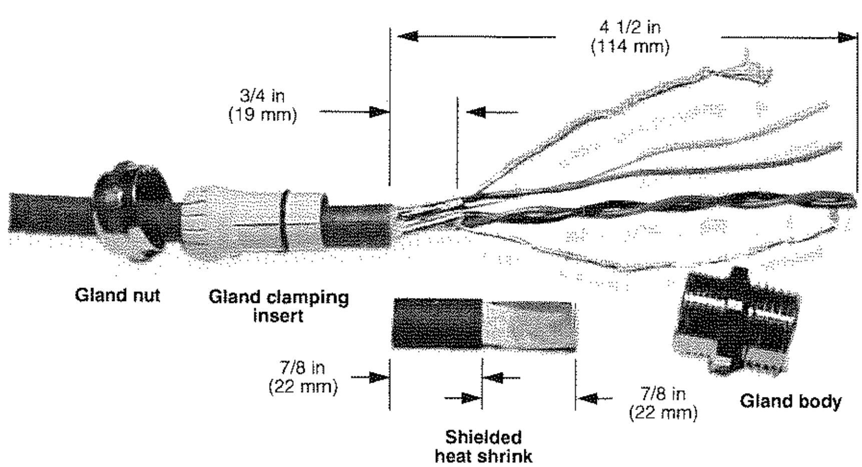
Wire the core processor to the sensor using a Micro Motion 9-wire cable. See the sensor installation manual for instructions.

4-wire cable preparation and core processor wiring

Note: This step is required for all MVD Direct Connect installations.

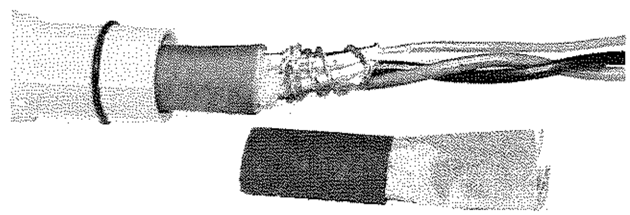
1. Ensure that the cables meet the following requirements:
   - Twisted-pair construction
   - The size and length requirements described in the preceding sections
2. Use one of the following methods to shield the wiring from the core processor:
   - If you are installing unshielded cable, the cable must be installed in continuous metallic conduit that provides 360° termination shielding for the enclosed wiring. Go to Step 7.
   - If you are installing shielded or armored cable with a user-supplied cable gland, terminate the shield or braid and drain wires in the cable gland. Never connect the drain wires to the internal ground screw of the core processor. Go to Step 7.
   - If you are installing shielded or armored cable with a Micro Motion-supplied cable gland:
     - With shielded cable (where the shield consists of foil), prepare the cable and apply shielded heat shrink as described in Steps 3 through 6. The shielded heat shrink provides a shield termination suitable for use in the gland.
     - With armored cable (where the shield consists of braid), prepare the cable as described as described in Steps 3 through 6. Do not apply heat shrink (omit Steps 5d through 5g).
3. Remove the cover from the core processor.
4. Slide the gland nut and the clamping insert over the cable.

Figure 9 Micro Motion cable gland and heat shrink



5. For connection at the core processor housing, prepare cable as follows (for armored cable, omit Steps 5d through 5g):
   a. Strip 4 1/2 inches (114 mm) of cable jacket.
   b. Remove the clear wrap that is inside the cable jacket, and remove the filler material between the wires.
   c. Remove the foil shield that is around the insulated wires, leaving 3/4 inch (19 mm) of foil or braid and drain wires exposed, and separate the wires.
   d. Wrap the shield drain wire(s) around the exposed foil twice. Cut off the excess wire.

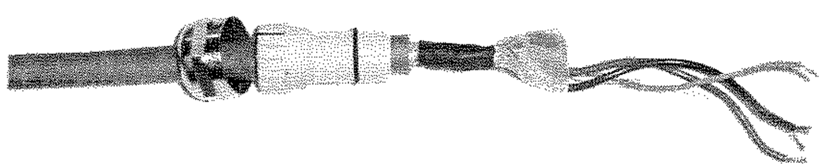
Figure 10 Wrapping the shield drain wires



e. Place the shielded heat shrink over the exposed shield drain wire(s). The tubing should completely cover the drain wires.

f. Without burning the cable, apply heat (250 °F or 120 °C) to shrink the tubing.

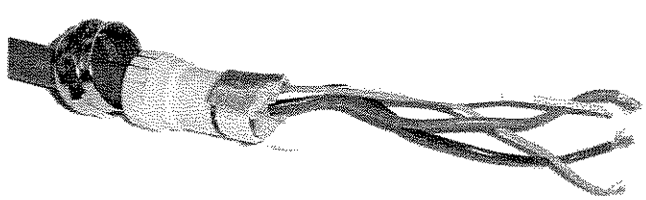
Figure 11 Applying the heat shrink



g. Position gland clamping insert so the interior end is flush with the heat shrink.

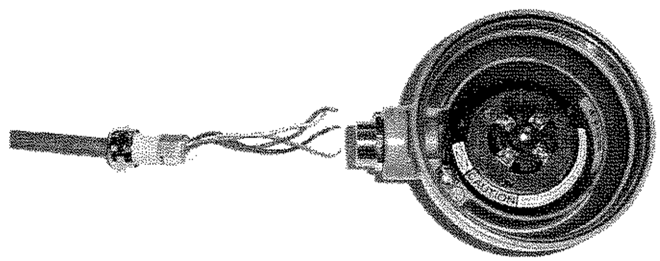
h. Fold the cloth shield or braid and drain wires over the clamping insert and approximately 1/8 inch (3 mm) past the O-ring.

Figure 12 Folding the cloth shield



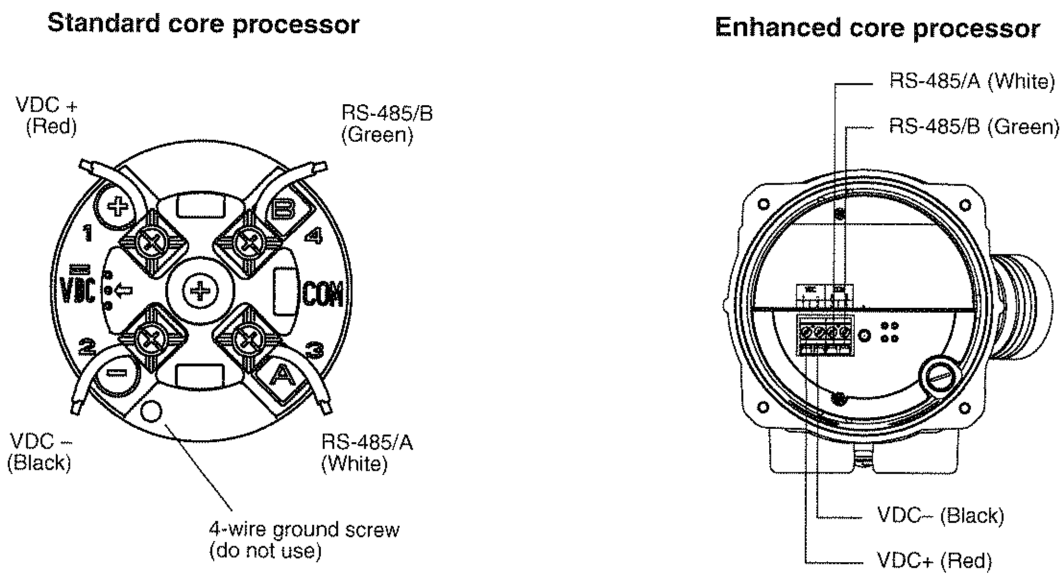
i. Install the gland body into the core processor housing conduit opening.

Figure 13 **Gland body and core processor housing**



6. Insert the wires through the gland body and assemble the gland by tightening the gland nut.
7. Connect signal wires to the RS-485 terminals on the core processor (see Figure 14). If you are using Micro Motion 4-wire cable, use the green and white wires.

Figure 14 **Connecting the wires at the core processor**



8. Connect power supply wires to the VDC terminals on the core processor (see Figure 14). If you are using Micro Motion 4-wire cable, use the red and black wires.
9. Reattach the core processor cover.

⚠ CAUTION

If the core processor is mounted integrally with the sensor, twisting the core processor will damage the sensor.

To avoid damaging the sensor, do not twist the core processor.

⚠ CAUTION

Damaging the RS-485 wires can cause measurement error or meter failure. Damaging the power supply wires can cause meter failure.

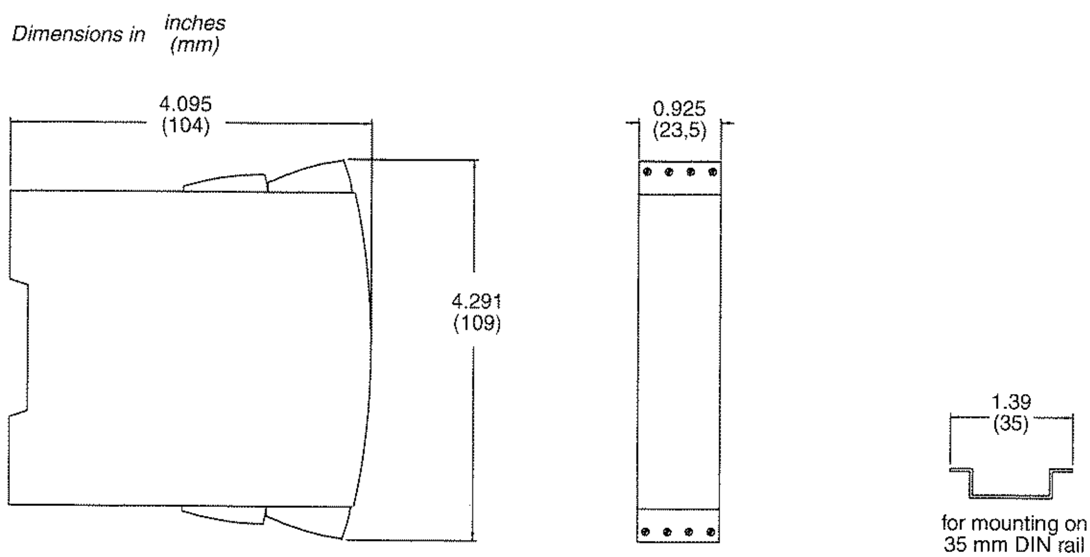
When replacing the core processor cover, make sure that the wires are not caught or pinched.

Installing the MVD Direct Connect I.S. barrier

Note: This step is required only for installations that include the MVD Direct Connect I.S. barrier. Refer to Figures 3 and 4.

The barrier is designed to snap onto a 35 mm DIN rail. Dimensions are shown in Figure 15. To remove the barrier from the rail, lift the bottom lock.

Figure 15 Barrier dimensions



Wiring at the MVD Direct Connect I.S. barrier

Note: This step applies only to installations that include the MVD Direct Connect I.S. barrier. Refer to Figures 3 and 4.

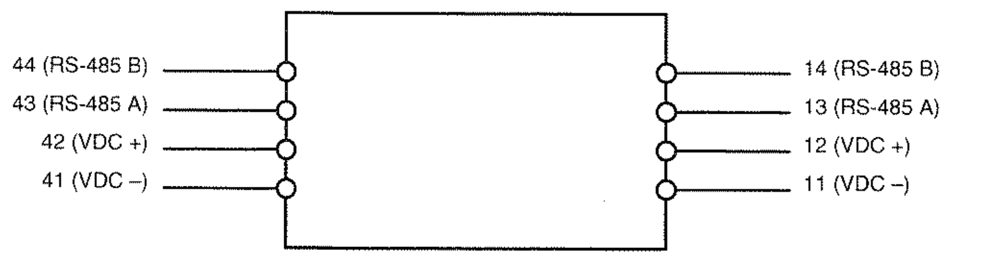
1. Connect the core processor to the barrier:
   a. Connect the RS-485 wires from the core processor to the I.S. RS-485 terminals at the barrier (terminals 43 and 44), matching A and B. See Table 4 and Figure 16. If you are using Micro Motion 4-wire cable, you can identify the wires by color.
   b. Connect the power supply wires from the core processor to the I.S. VDC terminals at the barrier (terminals 42 and 41), matching positive and negative (+ and –). See Table 4 and Figure 16. Do not terminate the shields at the barrier.

Table 4 Core processor terminals and barrier I.S. terminals

Function	Wire color (Micro Motion 4-wire cable)	Core processor terminals	Barrier I.S. terminals
RS-485 A	White	3	43
RS-485 B	Green	4	44
VDC +	Red	1	42
VDC –	Black	2	41

2. Connect RS-485 wires to the non-I.S. RS-485 terminals at the barrier (terminals 13 and 14). See Figure 16. These wires will be used in the next step to connect the barrier to the remote host. Do not terminate the shields at the barrier.
3. Connect power supply wires to the non-I.S. VDC terminals at the barrier (terminals 11 and 12). See Figure 16. These wires will be used in the next step to connect the barrier to the power supply.

Figure 16 Barrier terminals



Wiring to the remote host

Note: This step is required for all MVD Direct Connect installations.

1. At the remote host, open the wiring compartment and identify the RS-485 terminals. Refer to the vendor documentation if required.
2. If you are connecting the RS-485 wires directly from the core processor (see Figures 1 and 2):
   a. Connect the RS-485 wires from the core processor (see Figure 14) to the RS-485 terminals at the remote host.
   b. Do not terminate the shield, braid, or drain wire(s) at the remote host.
   c. Do not terminate the RS-485 lines using the standard 60-ohm termination resistor. If possible, do not terminate the RS-485 lines at all. If the RS-485 cable is 1000 feet (300 meters) long or longer, and termination is required, the total termination must be 175 ohm or above.

   If you are connecting the RS-485 wires from the I.S. barrier (see Figures 3 and 4):
   a. Connect the RS-485 wires from the barrier (see Figure 16) to the RS-485 terminals at the remote host.
   b. Terminate the shields at the remote host.
   c. The barrier contains internal pull-up/pull-down and termination resistors. Do not add external resistors.
3. Close the wiring compartment.

Wiring to the power supply

Note: This step is required for all MVD Direct Connect installations.

1. You may connect multiple MVD Direct Connect installations to a single power supply, as long as each installation receives sufficient power.
2. If you are connecting the power supply wires directly from the core processor (see Figures 1 and 2):
   a. Do not connect any other equipment to the power supply used for MVD Direct Connect installations.
   b. Connect the power supply wires from the core processor (see Figure 14), matching positive and negative (+ and –).

   If you are connecting the power supply wires from the I.S. barrier (see Figures 3 and 4):
   a. The power supply may be used to power other equipment.
   b. Connect the power supply wires from the barrier (see Figure 16), matching positive and negative (+ and –).

Grounding

Note: This step is required for all MVD Direct Connect installations.

⚠ CAUTION

Improper grounding could cause measurement error.

To reduce the risk of measurement error:

- Ground the meter to earth, or follow ground network requirements for the facility.
- For installation in an area that requires intrinsic safety, refer to the appropriate Micro Motion approval documentation.
- For hazardous area installations in Europe, refer to standard EN 60079-14 if national standards do not apply.

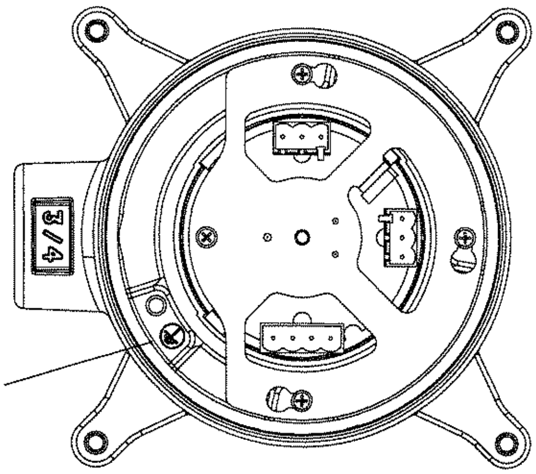
The sensor/core processor assembly (see Figures 1 and 3) or the sensor alone (see Figures 2 and 4) must be grounded. To ground these components, see the sensor installation manual.

If your installation includes a remote core processor (see Figures 2 and 4), it must be grounded. To ground the remote core processor:

- The core processor has two internal ground screws: one 4-wire ground screw and one 9-wire ground screw. Do not use the 4-wire ground screw. The 9-wire ground screw may be used (see Figure 17). To access the 9-wire ground screw, remove the core processor end-cap (see Figure 7).
- Use copper wire, 14 AWG (2,0 mm^2) or larger, for grounding.
- Keep all ground leads as short as possible, less than 1 ohm impedance.
- Connect ground leads directly to earth, or follow plant standards.

If your installation includes the MVD Direct Connect I.S. barrier (see Figures 3 and 4), the barrier is not grounded. Do not ground the barrier.

Figure 17 **Core processor 9-wire ground screw**



MVD Direct Connect Communications

For communication with the remote host, the core processor uses an industry-standard RS-485 half-duplex communication line driver. Supported communication settings are described in Table 5. The remote host can use any supported setting and the core processor will automatically detect and switch.

Table 5 **Supported communication settings**

Parameter	Option
Protocol	Modbus RTU (8-bit) Modbus ASCII (7-bit)
Baud rate	Standard rates between 1200 and 38,400
Parity	Even, odd, none
Stop bits	1, 2

Addresses

When addressing specific registers in the core processor, certain remote hosts require the program to subtract 1 from the address. For more information, see the manual entitled *Modbus Mapping Assignments for Micro Motion Transmitters*.

Response time

The core processor's default response time to a valid query is 1.2 milliseconds. If required, a delay may be programmed into the core processor (see the manual entitled *Modbus Mapping Assignments for Micro Motion Transmitters*).

The core processor may be queried as often as once every 10 milliseconds. If you are sending queries at this rate at 38,400 baud, a maximum of three floating-point values can be returned per query.

Core processors may be multidropped, with a maximum of 15 per segment. Communication throughput is improved with fewer units per segment.

Byte order in floating-point values

Four bytes are used to transmit floating-point values. When the core processor leaves the Micro Motion factory, its default byte order is either 1–2–3–4 (typical) or 3–4–1–2. For contents of bytes, see Table 6.

Table 6 **Byte contents in Modbus commands and responses**

Byte	Bits	Definitions
1	S E E E E E E E	S = Sign E = Exponent
2	E M M M M M M M	E = Exponent M = Mantissa
3	M M M M M M M M	M = Mantissa
4	M M M M M M M M	M = Mantissa

If the core processor is attached to a transmitter for any reason (for example, for field testing), the byte order is automatically set to 1–2–3–4. It may be necessary to reset the byte order before resuming MVD Direct Connect operation. Byte order is controlled by the value in register 521. The byte order codes and associated byte orders are listed in Table 7.

Table 7 **Byte order codes and byte orders**

Byte order code	Byte order
0	1–2–3–4
1	3–4–1–2
2	2–1–4–3
3	4–3–2–1

Additional information

For more information on programming a remote host for use with MVD Direct Connect systems, see the manual entitled *Modbus Mapping Assignments for Micro Motion Transmitters*.

Return Policy

Micro Motion procedures must be followed when returning equipment. These procedures ensure legal compliance with government transportation agencies and help provide a safe working environment for Micro Motion employees.

New and unused equipment

Only equipment that has not been removed from the original shipping package will be considered new and unused. New and unused equipment requires a completed Return Materials Authorization form.

Used equipment

All equipment that is not classified as new and unused is considered used. This equipment must be completely decontaminated and cleaned before being returned.

Used equipment must be accompanied by a completed Return Materials Authorization form and a Decontamination Statement for all process fluids that have been in contact with the equipment. If a Decontamination Statement cannot be completed (e.g., for food-grade process fluids), you must include a statement certifying decontamination and documenting all foreign substances that have come in contact with the equipment.

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Process Management

ModBus Register Mapping Manual

ANGI Series II Dispenser

Rev. 04

WARNING

1. SAFETY

- Read this entire manual before operating, servicing, adjusting, repairing or maintaining this Equipment.
- Never adjust or repair machinery while it is in operation. Always stop the engine or electric motor before cleaning, servicing or repairing. Place all controls in the off position to prevent accidental restarting. Before restarting, make sure that all tools and other materials are removed from the equipment.
- Do not wear loose clothing around machinery. Loose clothing: neckties, rings, wristwatch, bracelets, hand rags, etc. are potential hazards.
- Do not smoke within 50 feet of the unit
- Make sure you are equipped with all required safety equipment: hearing protection, safety glasses, hard hats, safety shoes and fire extinguisher.
- Do not modify the fuel station or its systems.
- Do not tamper with, modify, or bypass fuel station safety and shutdown equipment.
- Do not exceed maximum allowable fuel station pressures and temperatures.
- Record operating hours, maintenance work, and repairs etc. in a logbook.
- ANGI Energy Systems, Inc. reserves the right to make changes or modifications to the equipment designs without notice.
- ANGI must authorize all modification to this equipment. Any unauthorized modification to this equipment and or software will void the warranty. Modification may damage the equipment and cause bodily injury.
- ANGI disclaims any responsibilities whatsoever to the customer or to any person for injury or damage to, or loss of, property or value resulting from the use of its products which have been subjected to misuse, accidents, misapplied, repaired by unauthorized person, or improperly installed.
- EXPLOSIVE HAZARD DO NOT DISCONNECT WHILE THE CIRCUIT IS LIVE OR UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITABLE CONCENTRATIONS.

NOTICE

This manual is as current as possible at the time of printing and is subject to change without notice. For information not covered in this manual or further clarification, contact ANGI Customer Service at 1-800-934-5219

- CONTRACTOR OR INSTALLER: Leave this manual with the Unit station after installation is complete.

- CUSTOMER: Retain this manual for future reference.

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1. Introduction

The ANGI Series II dispenser supports the ModBus protocol on its half-duplex RS485 serial communication port COMM 5 as a slave device with dispenser program revisions 3.960 and greater. This port is found on the Series II Interface board 403-07263 TB6. It is electrically isolated from the dispenser circuitry by opto-couplers and an isolated DC-DC power converter. The port is powered from the interface board. An on-board terminating resistor/capacitor is integrated on the interface board and is brought out on the terminal strip TB6. The provided terminating resistor can be wired in to the end of the transmission cable. The ModBus protocol is enabled by turning switch SW1-8 on (up) on the dispenser interface board. The dispenser will revert to the proprietary Series II Monitor protocol if this switch is off. Swiches SW1-2 through SW1-6 and a parameter establish the ModBus node ID (see section 10).

2. Supported ModBus functions

The dispenser supports these ModBus functions

1) Function 3: read holding registers.
2) Function 4: read input registers.
3) Function 16: write multiple registers.
4) Function 22: mask write single register.
5) Function 23: write/read multiple registers (Write before read).
6) Function 43: read device identification.

All other functions are not supported and, if called for, will return an error. Function 3 and 4 are identical. The terms “holding” and “input” that apply to a Modicon PLC do not apply to the Series II dispenser. Both functions are simplified to just being read-register functions. There are no “coils” defined in the Series II dispenser controller. Those coil functions are not supported.

3. ModBus addressing, Series II dispenser register set

The Series II control uses a field of 32-bit registers exclusively to hold long and floating point words. All the register words are aliened to the ModBus odd address: word at memory address 0 is at ModBus address 1. All the register words must be read or written as two consecutive ModBus integer address starting with the odd address. Registers addressed on the even ModBus address or in amounts not in sets of two integers will return an exception error. This rule does not apply to function 22 mask write single register. Function 22 will mask write the upper or lower 16 bits of the 32-bit register based on the Modbus address.

The value in the dispenser’s 32-bit register can be placed in the two consecutive ModBus integers in either a big-endian or little-endian format. The desired format is selected by the parameter configuration bit “extra_configuration / use_little_endian” in the dispenser. A ‘1’ in this bit puts the ModBus communication in the little-endian format mode, a ‘0’ big-endian. With the big-endian format the odd address holds the most significant half and the even (higher) address holds the least significant half of the dispenser’s 32-bit register value. The little-endian format is reversed, the odd address holds the least significant half and the even (higher) address holds the most significant half. The lower address is always sent first in the response packet. The byte order of the ModBus integer values is always big-endian: the most significant half (byte) of the integer is sent first. In function 22 mask write register, the big or little endian format will apply to which half of the dispenser's 32-bit register is mask written. In big endian mode the odd Modbus address mask writes the most significant half of the dispenser's 32-bit register. Visa versa for little endian mode. This option exists to allow the dispenser to conform to how the host system, using the ModBus protocol, may order it's register values.

The Series II dispenser's register set is divided into blocks containing 64 long words (long word = 32 bits). Each block is dedicated to a specific dispenser function. Sets of blocks are, in turn, assembled into groups. The individual registers are ModBus addressed in a block from 1 to 128 (1 to 80 hex). The blocks are ModBus addressed in values of 128 (80 hex) added to the ModBus address. The ModBus protocol subtracts a 1 from the address and sends the values 0 to 127 to the dispenser for addressing the registers in the blocks. The dispenser will align the ModBus address to the dispenser memory point by dividing it by 2. Examples:

Input Modbus address 51 (33 hex) - 1 = 50 (32 hex) sent in the master packet. In the dispenser 50 / 128 = 0 block, 50 / 2 = 25, the 25th register in the dispenser is addressed in block 0.

Input Modbus address 407 (197 hex) - 1 = 406 (196 hex) sent in the master packet. In the dispenser 406 / 128 = 3 block, 406 remainder 128 = 22 (17 hex) the 22th register in the dispenser is addressed in block 3.

A formulas for dispenser to ModBus addressing would be:

Block# * 128 + register# x 2 + 1 = ModBus address.

(ModBus address – 1) / 128 = block# (truncate decimal fraction)

((ModBus address – 1) logical-and 127) / 2 = register#

Addressing registers not defined in the dispenser program will not return a traditional ModBus exception error. The dispenser will return a zero if read and do nothing if written. An exception error will also not be generated by a ModBus write command if the register is write protected. The register will simply not be written.

The function 23 multiple read/write will write the registers first then read. If the same register is written and read with the register being write protected, the write will be denied and the original unmodified value will be read.

The write protect on the dispenser registers can be unlocked by writing a password number to a register. There are two password registers, one unlocks the write protect according to the protection level given to the password value and the other unlocks the write protect only during the reception of a packet. The first password register value will unlock the write protect and set-up a ten second time-out timer. The write protect will lock-up after ten seconds if another transmission from the master is not sent. The unlock timer will be reset every time the ModBus master poles the dispenser with any function. The use of second password register is not practical with the ModBus protocol since registers cannot be arbitrarily addressed but are read or written as a contiguous block. The registers are write protected at the end of processing the ModBus command reception using password #2.

The ModBus communication can be forced to be read-only be selected by the parameter configuration bit "extra_configuration / MB_read_only" set to 1 in the dispenser. Sending a valid password number will not unlock the write protect with this configuation bit set.

4. The Series II dispenser register set: block definitions

Note: GTI: Gas Technology Institute
All register values are long words, registers containing floating point values are noted as "float" in their decimal point declaration.
All control addresses are stated as "block.register" in decimal.
ModBus addresses are stated as decimal value and hex value – 1.
The item list number given to the defined registers in sequential order.
For more information on the function of these register consult the ANGI Series II Dispenser Technical Function manual.
An asterisk by the control address thus x.x* indicates the register is a set of Boolean bits.

Block 0: Directory. The register value provides a list item index to the base register in the named block. Note: the listing item number is not the control address used in the ModBus addressing.

Item Numb	Control Address	ModBus Address		Description / Name
0	0.0	1	0h	Total items
1	0.1	3	2h	Common parameters (shared by both hoses)
2	0.2	5	4h	'A' Hose variables
3	0.3	7	6h	'A' Hose Flow meter variables (floating point)
4	0.4	9	8h	'A' Hose parameters
5	0.5	11	Ah	'A' Hose fill monitor variables
6	0.6	13	Ch	'A' Hose totalizer variables
7	0.7	15	Eh	'B' Hose variables
8	0.8	17	10h	'B' Hose Flow meter variables (floating point)
9	0.9	19	12h	'B' Hose parameters
10	0.10	21	14h	'B' Hose fill monitor variables
11	0.11	23	16h	'B' Hose totalizer variables
12	0.12	25	18h	Program control variables
13	0.13	27	1Ah	Analog input variables
14	0.14	29	1Ch	GTI 'A' Hose control variables
15	0.15	31	1Eh	GTI 'A' Hose signal variables (floating point)
16	0.16	33	20h	GTI 'A' Hose fill variables (floating point)
17	0.17	35	22h	GTI 'A' Hose fill monitor variables
18	0.18	37	24h	GTI 'A' Hose parameters (floating point)
19	0.19	39	26h	GTI 'A' Hose parameters
20	0.20	41	28h	GTI 'B' Hose control variables
21	0.21	43	2Ah	GTI 'B' Hose signal variables (floating point)
22	0.22	45	2Ch	GTI 'B' Hose fill variables (floating point)
23	0.23	47	2Eh	GTI 'B' Hose fill monitor variables
24	0.24	49	30h	GTI 'B' Hose parameters (floating point)
25	0.25	51	32h	GTI 'B' Hose parameters
26	0.26	53	34h	'A' Hose price
27	0.27	55	36h	'B' Hose price
28	0.28	57	38h	'A' Hose process
29	0.29	59	3Ah	'B' Hose process
30	0.30	61	3Ch	'A' Hose Gilbarco communication variables
31	0.31	63	3Eh	'B' Hose Gilbarco communication variables
32	0.32	65	40h	'A' Hose test variables

Item Numb	Control Address	ModBus Address		Description / Name
33	0.33	67	42h	'B' Hose test variables
34	0.34	69	44h	Extra parameters (see note 1)
none	0.36	73	48h	Not defined
…				
none	0.63	128	7Fh	Not defined

Block 1: Common parameters. Shared by both hoses. Write protected. Items with * write protected by switch 1-1.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
35	1.0	129	80h	Sdpmax	%	0.0
36	1.1	131	82h	Smmfactor	g/pls	0.0000
37	1.2	133	84h	SPcrit	Mpa	0.00
38	1.3	135	86h	STcrit	K	0.0
39	1.4	137	88h	underfill_factor	%	0
40	1.5	139	8Ah	Smax	%	0.0
41	1.6	141	8Ch	Sdelay	sec	0.00
42	1.7	143	8Eh	Stank_dwell	sec	0.00
43	1.8	145	90h	press_settle	Mpa	0.00
44	1.9*	147	92h	test_bits	#	0
45	1.10	149	94h	Smass_unit	#	0
46	1.11	151	96h	Smassconv	g / 'unit'	0.0
47	1.12	153	98h	mass_decimal	#	0
48	1.13	155	9Ah	Ssale_decimal	#	0
49	1.14	157	9Ch	pulses_per_qty	pls / 'unit'	0
50	1.15	159	9Eh	pulses_per_sale	pls / 'unit'	0
51	1.16	161	A0h	qty_frequency	Hz	0
52	1.17	163	A2h	sale_frequency	Hz	0
53	1.18	165	A4h	temperature_sim	K	0.0
54	1.19	167	A6h	tank_size	feet^3	0.000
55	1.20	169	A8h	resist_sim	Pa s^2 / g^2	0.0
56	1.21	171	AAh	low_sim	Mpa	0.00
57	1.22	173	ACh	mid_sim	Mpa	0.00
58	1.23	175	AEh	high_sim	Mpa	0.00
59	1.24	177	B0h	time_zone	#	0
60	1.25	179	B2h	serial_number*	#	0
61	1.26	181	B4h	spc_baud	#	0
62	1.27	183	B8h	Sprice_decimal	#	0
63	1.28	185	BAh	spc_com_timeout	#	0
64	1.29	187	BCh	overfill_factor	%	0
none	1.30	189	BEh	Not defined		
…						
none	1.63	128	FFh	Not defined		

Block 2: 'A' Hose variables. All write protected by password and switch 1-1.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
65	2.0	257	100h	Astatus	#	0
66	2.1	259	102h	Await	sec	0.0
67	2.2	261	104h	Amass	g	0
68	2.3	263	106h	Apressure	Mpa	0.00
69	2.4	265	108h	Apreslow	Mpa	0.00
70	2.5	267	10Ah	Aflow	g / s	0.00
71	2.6	269	10Ch	Atemperature	K	0.0
72	2.7	271	10Eh	Apress_stored	Mpa	0.00
73	2.8	273	110h	Atemp_stored	K	0.0
74	2.9	275	112h	Apmax	Mpa	0.00
75	2.10	277	114h	Apmax_calc	Mpa	0.00
76	2.11	279	116h	Atankpress	Mpa	0.00
77	2.12	281	118h	Aflow_max	g / s	0.00
78	2.13	283	11Ah	Apress_test	Mpa	0.00
79	2.14	285	11Ch	Aresist	Pa s^2 / g^2	0.0
80	2.15	287	11Eh	Apress_mem	Mpa	0.00
81	2.16	289	120h	Arestrict	Pa^-2 s / g	0.000
82	2.17*	291	122h	Aflags	#	0
83	2.18*	293	124h	Acontrol_bits	#	0
84	2.19	295	126h	Apchange	Mpa	0.00
85	2.20	297	128h	Aflow_analog	#	0
86	2.21	299	12Ah	Aabs_press	Mpa	0.00
87	2.22	301	12Ch	Amax_moles	moles	0.00
88	2.23	303	12Eh	Asim_press_preset	Mpa	0.00
89	2.24	305	130h	Asim_dpmax	%	0.0
90	2.25	307	132h	Apress_delta	Mpa	0.00
91	2.26*	309	134h	Aerror_reg	#	0
92	2.27	311	136h	Aerror_code	#	0
93	2.28	313	138h	Apressure2_in	Mpa	0.00
94	2.29	315	13Ah	Apsim	Mpa	0.00
95	2.30	317	13Ch	Atemp_analog	K	0.0
96	2.31	319	14Eh	Asonic_pressure	Mpa	0.00
97	2.32	321	140h	Apress_display	Mpa	0.00
98	2.33	323	142h	Aresist_temp	Pa s^2 / g^2	0.0
99	2.34	325	144h	Apress_target	Mpa	0.00
100	2.35	327	146h	Amass_ran	g	0
101	2.36	329	148h	Aqty_pulses	pls	0
102	2.37	331	14Ah	Asale_pulses	pls	0
103	2.38	333	14Ch	Aqty_pulses_sent	pls	0
104	2.39	335	14Eh	Asale_pulses_sent	pls	0

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
105	2.40	337	150h	Atotal_sale	$	note 1
106	2.41	339	152h	Atotal_qty	‘units’	note 2
107	2.42	341	154h	Aprice_per_unit	$	note 3
108	2.43	343	156h	Apmax_used	Mpa	0.00
109	2.44	345	158h	Ameter_mass_flow_unit	#	0
110	2.45	347	15Ah	Ameter_mass_unit	#	0
111	2.46	349	15Ch	Ameter_temp_unit	#	0
112	2.47	351	15Eh	Afull_mass	g	0
113	2.48	353	160h	Atank_mass	g	0
114	2.49	355	162h	Afinal_process_count	#	0
115	2.50	357	164h	Afinal_process_mod	#	0
116	2.51	359	166h	Aprocess_mod	#	0
117	2.52	361	168h	Agas_temperature	K	0
118	2.53	363	16Ah	Atotalizer_pulses	pls	0
119	2.54	365	16Ch	Atotl_pulses_sent	pls	0
120	2.55	367	16Eh	Apast_mons_page	#	0
121	2.56	369	170h	Acurrent_mons_page	#	0
122	2.57	371	172h	Amon_ROM_address	#	0
123	2.58*	373	174h	Ameter_status	#	0

Block 3: ‘A’ Hose Flow meter variables. All write protected by switch 1-1. All IEEE real.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
124	3.0	385	180h	Ameter_temp	C	float
125	3.1	387	182h	Ameter_flow	Kg / s	float
126	3.2	389	184h	Ameter_mass	Kg	float
127	3.3	391	186h	Ameter_vol	Liter	float
128	3.4	393	188h	Ameter_mass_inv	Kg	float
none	3.5	395	18Ah	not defined		
…						
none	3.5	511	1FEh	not defined		

Block 4: ‘A’ Hose parameters. All write protected by password. * indicates switch 1-1.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
129	4.0	513	200h	ASlowflo	g / s	0.00
130	4.1	515	202h	ASmidflo	g / s	0.00
131	4.2	517	204h	Ashiflo	g / s	0.00
132	4.3	519	206h	Astopflo	g / s	0.00
133	4.4	521	208h	ASdrop	Mpa	0.00
134	4.5	523	20Ah	ASlow	g / s	0.00
135	4.6	525	20Ch	ASburst	g / s	0.00
136	4.7	527	20Eh	AStartdel	s	0.00
137	4.8	529	210h	ASmode	#	0
138	4.9	531	212h	Aanalog_temp_cal	C	0.0
139	4.10	533	214h	Adac_freeze	adc#	0
140	4.11	535	216h	Ano_flow_time	s	0.00
141	4.12	537	218h	Apress_dac_offset	adc#	0
142	4.13	539	21Ah	Apress_dac_range	adc#	0
143	4.14	541	21Ch	Aflow_dac_zero	adc#	0
144	4.14	543	21Eh	Aflow_dac_max	adc#	0
145	4.16	545	220h	Aflow_cal	g / s	0.00
146	4.17	547	222h	Ameter_temp_cal	#	0
147	4.18	549	224h	Ameter_flow_cal	#	0
148	4.19	551	226h	Ameter_mass_cal	#	0
149	4.20	553	228h	Apress_unit	#	0
150	4.21*	555	22Ah	Asignal_config *	#	0
151	4.22	557	22Ch	ASlowtarget	%	0
152	4.23	559	22Eh	ASmidtarget	%	0
153	4.24	561	230h	AShightarget	%	0
154	4.25	563	232h	Ato_mid	Mpa	0.00
155	4.26	565	234h	Ato_high	Mpa	0.00
156	4.27	567	236h	Ato_full	Mpa	0.00
157	4.28	569	238h	Avalve_off_dwell	s	0.00
158	4.29	571	23Ah	Apress2_dac_offset	adc#	0
159	4.30	573	23Ch	Apress2_dac_range	adc#	0
160	4.31	575	23Eh	Apress2_trip	Mpa	0.00
161	4.32	577	240h	Abank_time_limit	s	0
162	4.33	579	242h	Amass_calibrate	#	0.0000
163	4.34	581	244h	Apressure_trip	Mpa	0.00
164	4.35	583	246h	Adelay_adj_limit	Mpa	0.00
165	4.36	585	248h	Apmax_fixed	Mpa	0.00
166	4.37	587	24Ah	Amin_resist	Pa s^2 / g^2	0.0
167	4.38	589	24Ch	Ahose_mass	g	0
168	4.39	591	24Eh	Apress_dip	Mpa	0.00
none	4.40	593	250h	not defined		
…						
none	4.63	639	27Eh	not defined		

Block 5: 'A' Hose fill monitor variables. Read only

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
169	5.0	641	280h	Alow_target	Mpa	0.00
170	5.1	643	282h	Alow_tank	Mpa	0.00
171	5.2	645	284h	Amid_target	Mpa	0.00
172	5.3	647	286h	Amid_tank	Mpa	0.00
173	5.4	649	288h	Ahigh_target	Mpa	0.00
174	5.5	651	28Ah	Ahigh_tank	Mpa	0.00
175	5.6	653	28Ch	Alow_adjust	%	0.00
176	5.7	655	28Eh	Amid_adjust	%	0.00
177	5.8	657	290h	Apress_max	Mpa	0.00
178	5.9	659	292h	Asubsonic_press	Mpa	0.00
179	5.10	661	294h	Ainit_flow_max	g / s	0.00
180	5.11	663	296h	Ainit_ib_pressure	Mpa	0.00
181	5.12	665	298h	Ainitial_resist	Pa s^2 / g^2	0.0
182	5.13	667	29Ah	Amid_resist	Pa s^2 / g^2	0.0
183	5.14	669	29Ch	Ahigh_resist	Pa s^2 / g^2	0.0
184	5.15	671	29Eh	Afinal_resist	Pa s^2 / g^2	0.0
185	5.16	673	2A0h	Ainit_tank_press	Mpa	0.00
186	5.17	675	2A2h	Alow_ib_pressure	Mpa	0.00
187	5.18	677	2A4h	Alow_tank_target	Mpa	0.00
188	5.19	679	2A6h	Alow_time	s	0.00
189	5.20	681	2A8h	Amid_ib_pressure	Mpa	0.00
190	5.21	683	2AAh	Amid_tank_target	Mpa	0.00
191	5.22	685	2ACh	Amid_time	s	0.00
192	5.23	687	2AEh	Ahigh_ib_pressure	Mpa	0.00
193	5.24	689	2B0h	Ahigh_tank_target	Mpa	0.00
194	5.25	691	2B2h	Ahigh_time	s	0.00
195	5.26	693	2B4h	Afinal_mass	g	0.00
196	5.27	695	2B6h	Afinal_press	Mpa	0.00
197	5.28	697	2B8h	ATcomp_press	Mpa	0.00
198	5.29	699	2BAh	Alow_hose_mass	g	0
199	5.30	701	2BCh	Amid_hose_mass	g	0
200	5.31	703	2BEh	Ahigh_hose_mass	g	0
201	5.32	705	2C0h	Alow_stop_flow	g / s	0.00
202	5.33	707	2C2h	Amid_stop_flow	g / s	0.00
203	5.34	709	2C4h	Ahigh_stop_flow	g / s	0.00
204	5.35	711	2C6h	Alow_off_adj	Mpa	0.00
205	5.36	713	2C8h	Amid_off_adj	Mpa	0.00
206	5.37	715	2CAh	Ahigh_off_adj	Mpa	0.00
207	5.38*	717	2CCh	Aave_gas_temp	K	0.0
208	5.39	719	2CEh	Atemperature_ran	K	0.0
209	5.40*	721	2D0h	Aaccount_1	#	0
210	5.41*	723	2D2h	Aaccount_2	#	0
211	5.42*	725	2D4h	Aaccount_3	#	0
212	5.43*	727	2D6h	Aaccount_4	#	0
213	5.44	729	2D8h	Afill_time	sec	0.00
214	5.45	731	2DAh	Atime	time	n.a.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
215	5.46	733	2DCh	Adate	date	n.a.
216	5.47	735	2DEh	Alast_ib_pressure	Mpa	0.00
217	5.48	737	2E0h	Alast_tank_target	Mpa	0.00
218	5.49	739	2E2h	Alast_tank_pressure	Mpa	0.00
219	5.50	741	2E4h	Ainit_restrict	Pa^-2 s / g	0.000
220	5.51	743	2E6h	Amid_restrict	Pa^-2 s / g	0.000
221	5.52	745	2E8h	Ahigh_restrict	Pa^-2 s / g	0.000
222	5.53	747	2EAh	Afinal_restrict	Pa^-2 s / g	0.000
223	5.54	749	2ECh	Alow_adj_restrict	%	0.00
224	5.55	751	2EEh	Amid_adj_restrict	%	0.00
225	5.56	753	2F0h	Ahi_adj_restrict	%	0.00
none	5.57	755	2F2h	not defined		
…						
none	5.63	767	2FEh	not defined		

Block 6: ‘A’ Hose totalizer variables. Read only

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
226	6.0	769	300h	Atotal_save_count	#	0
227	6.1	771	302h	Alog_count	#	0
228	6.2	773	303h	Atime_stamp	time	n.a.
229	6.3	775	306h	Adate_stamp	date	n.a.
230	6.4	777	308h	Ahose_id	#	0
231	6.5	779	30Ah	Atotal_extend	g	note 4
232	6.6	781	30Ch	Atotal_sale_tier1	$	0
233	6.7	783	30Eh	Atotal_mass_tier1	g	0
234	6.8	785	310h	Atotal_sale_tier2	$	0
235	6.9	787	312h	Atotal_mass_tier2	g	0
236	6.10	789	314h	Atotal_mass_ran	g	note 6
237	6.11	791	316h	Atotal_sale_ran	$	0
238	6.12	793	318h	Atotal_qty_ran	‘unit’	0
239	6.13	795	31Ah	Aprice_ran	$	0
240	6.14	797	31Ch	Aprice_tier_ran	#	0
241	6.15	799	31Eh	Asale_ran_decimal	#	0
242	6.16	801	320h	Aqty_ran_decimal	#	0
243	6.17	803	322h	Aprice_ran_decimal	#	0
244	6.18	805	324h	Alow_cycle_total	#	0
245	6.19	807	326h	Amid_cycle_total	#	0
246	6.20	809	328h	Ahigh_cycle_total	#	0
247	6.21	811	32Ah	Atotal_fault	#	0
248	6.22	813	32Ch	Ashift_sale_tier1	$	0
249	6.23	815	32Eh	Ashift_mass_tier1	g	0
250	6.24	817	330h	Ashift_sale_tier2	$	0
251	6.25	819	332h	Ashift_mass_tier2	g	0
252	6.26	821	334h	Ashift_time_stamp1	time	n.a.
253	6.27	823	336h	Ashift_date_stamp1	date	n.a.
254	6.28	825	338h	Ashift_time_stamp2	time	n.a.
255	6.29	827	33Ah	Ashift_date_stamp2	date	n.a.
256	6.30	829	33Ch	Aqty_remainder	‘unit’	0
257	6.31	831	33Eh	Atotal_sale_spc_ran	$	0
none	6.32	833	340h	not defined		
…						
none	6.63	895	37Eh	not defined		

Block 7: 'B' Hose variables. All write protected by switch 1-1.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
258	7.0	897	380h	Bstatus	#	0
259	7.1	899	382h	Bwait	sec	0.0
260	7.2	901	384h	Bmass	g	0
261	7.3	903	386h	Bpressure	Mpa	0.00
262	7.4	905	388h	Bpreslow	Mpa	0.00
263	7.5	907	38Ah	Bflow	g / s	0.00
264	7.6	909	38Ch	Btemperature	K	0.0
265	7.7	911	38Eh	Bpress_stored	Mpa	0.00
266	7.8	913	390h	Btemp_stored	K	0.0
267	7.9	915	392h	Bpmax	Mpa	0.00
268	7.10	917	394h	Bpmax_calc	Mpa	0.00
269	7.11	919	396h	Btankpress	Mpa	0.00
270	7.12	921	398h	Bflow_max	g / s	0.00
271	7.13	923	39Ah	Bpress_test	Mpa	0.00
272	7.14	925	39Ch	Bresist	Pa s^2 / g^2	0.0
273	7.15	927	39Eh	Bpress_mem	Mpa	0.00
274	7.16	929	3A0h	Brestrict	Pa^-2 s / g	0.000
275	7.17*	931	3A2h	Bflags	#	0
276	7.18*	933	3A4h	Bcontrol_bits	#	0
277	7.19	935	3A6h	Bpchange	Mpa	0.00
278	7.20	937	3A8h	Bflow_analog	#	0
279	7.21	939	3AAh	Babs_press	Mpa	0.00
280	7.22	941	3ACh	Bmax_moles	moles	0.00
281	7.23	943	3AEh	Bsim_press_preset	Mpa	0.00
282	7.24	945	3B0h	Bsim_dpmax	%	0.0
283	7.25	947	3B2h	Bpress_delta	Mpa	0.00
284	7.26	949	3B4h	Berror_reg	#	0
285	7.27	951	3B6h	Berror_code	#	0
286	7.28	953	3B8h	Bpressure2_in	Mpa	0.00
287	7.29	955	3BAh	Bpsim	Mpa	0.00
288	7.30	957	3BCh	Btemp_analog	K	0.0
289	7.31	959	3BEh	Bsonic_pressure	Mpa	0.00
290	7.32	961	3C0h	Bpress_display	Mpa	0.00
291	7.33	963	3C2h	Bresist_temp	Pa s^2 / g^2	0.0
292	7.34	965	3C4h	Bpress_target	Mpa	0.00
293	7.35	967	3C6h	Bmass_ran	g	0
294	7.36	969	3C8h	Bqty_pulses	pls	0
295	7.37	971	3CAh	Bsale_pulses	pls	0
296	7.38	973	3CCh	Bqty_pulses_sent	pls	0
297	7.39	975	3CEh	Bsale_pulses_sent	pls	0
298	7.40	977	3D0h	Btotal_sale	$	note 1
299	7.41	979	3D2h	Btotal_qty	'units'	note 2
300	7.42	981	3D4h	Bprice_per_unit	$	note 3
301	7.43	983	3D6h	Bpmax_used	Mpa	0.00
302	7.44	985	3D8h	Bmeter_mass_flow_unit	#	0
303	7.45	987	3DAh	Bmeter_mass_unit	#	0
List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal

304	7.46	989	3DCh	Bmeter_temp_unit	#	0
305	7.47	991	3DEh	Bfull_mass	g	0
306	7.48	993	3E0h	Btank_mass	g	0
307	7.49	995	3E2h	Bfinal_process_count	#	0
308	7.50	997	3E4h	Bfinal_process_mod	#	0
309	7.51	999	3E6h	Bprocess_mod	#	0
310	7.52	1001	3E8h	Bgas_temperature	K	0
311	7.53	1003	3EAh	Btotalizer_pulses	pls	0
312	7.54	1005	3ECh	Btotl_pulses_sent	pls	0
313	7.55	1007	3EEh	Bpast_mons_page	#	0
314	7.56	1009	3F0h	Bcurrent_mons_page	#	0
315	7.57	1011	3F2h	Bmon_ROM_address	#	0
316	7.58*	1013	3F4h	Bmeter_status	#	0

Block 8: 'B' Hose Flow meter variables. All write protected by switch 1-1.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
317	8.0	1025	400h	Bmeter_temp	C	float
318	8.1	1027	402h	Bmeter_flow	Kg / s	float
319	8.2	1027	404h	Bmeter_mass	Kg	float
320	8.3	1031	406h	Bmeter_vol	Liter	float
321	8.4	1033	408h	Bmeter_mass_inv	Kg	float
none	8.5	1035	40Ah	not defined		
…						
none	8.63	1151	47Eh	not defined		

Block 9: 'B' Hose parameters. All write protected by password. * indicates switch 1-1.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
322	9.0	1153	480h	BSlowflo	g / s	0.00
323	9.1	1155	482h	BSmidflo	g / s	0.00
324	9.2	1157	484h	Bshiflo	g / s	0.00
325	9.3	1159	486h	Bstopflo	g / s	0.00
326	9.4	1161	488h	BSdrop	Mpa	0.00
327	9.5	1163	48Ah	BSlow	g / s	0.00
328	9.6	1165	48Ch	BSburst	g / s	0.00
329	9.7	1167	48Eh	BStartdel	s	0.00
330	9.8	1169	490h	BSmode	#	0
331	9.9	1171	492h	Banalog_temp_cal	C	0.0
332	9.10	1173	494h	Bdac_freeze	adc#	0
333	9.11	1175	496h	Bno_flow_time	s	0.00
334	9.12	1177	498h	Bpress_dac_offset	adc#	0
335	9.13	1179	49Ah	Bpress_dac_range	adc#	0
336	9.14	1181	49Ch	Bflow_dac_zero	adc#	0
337	9.14	1183	49Eh	Bflow_dac_max	adc#	0
338	9.16	1185	4A0h	Bflow_cal	g / s	0.00
339	9.17	1187	4A2h	Bmeter_temp_cal	#	0
340	9.18	1189	4A4h	Bmeter_flow_cal	#	0
341	9.19	1191	4A6h	Bmeter_mass_cal	#	0
342	9.20	1193	4A8h	Bpress_unit	#	0
343	9.21*	1195	4AAh	Bsignal_config *	#	0
344	9.22	1197	4ACh	BSlowtarget	%	0
345	9.23	1199	4AEh	BSmidtarget	%	0
346	9.24	1201	4B0h	BShightarget	%	0
347	9.25	1203	4B2h	Bto_mid	Mpa	0.00
348	9.26	1205	4B4h	Bto_high	Mpa	0.00
349	9.27	1207	4B6h	Bto_full	Mpa	0.00
350	9.28	1209	4B8h	Bvalve_off_dwell	s	0.00
351	9.29	1211	4BAh	Bpress2_dac_offset	adc#	0
352	9.30	1213	4BCh	Bpress2_dac_range	adc#	0
353	9.31	1215	4BEh	Bpress2_trip	Mpa	0.00
354	9.32	1217	4C0h	Bbank_time_limit	s	0
355	9.33	1219	4C2h	Bmass_calibrate	#	0.0000
356	9.34	1221	4C4h	Bpressure_trip	Mpa	0.00
357	9.35	1223	4C6h	Bdelay_adj_limit	Mpa	0.00
358	9.36	1225	4C8h	Bpmax_fixed	Mpa	0.00
359	9.37	1227	4CAh	Bmin_resist	Pa s^2 / g^2	0.0
360	9.38	1229	4CCh	Bhose_mass	g	0
361	9.39	1231	4CEh	Bpress_dip	Mpa	0.00
none	9.40	1233	4D0h	not defined		
…						
none	9.63	1279	4FEh	not defined		

Block 10: ‘B’ Hose fill monitor variables. Read only

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
362	10.0	1281	500h	Blow_target	Mpa	0.00
363	10.1	1283	502h	Blow_tank	Mpa	0.00
364	10.2	1285	504h	Bmid_target	Mpa	0.00
365	10.3	1287	506h	Bmid_tank	Mpa	0.00
366	10.4	1289	508h	Bhigh_target	Mpa	0.00
367	10.5	1291	50Ah	Bhigh_tank	Mpa	0.00
368	10.6	1293	50Ch	Blow_adjust	%	0.00
369	10.7	1295	50Eh	Bmid_adjust	%	0.00
370	10.8	1297	510h	Bpress_max	Mpa	0.00
371	10.9	1299	512h	Bsubsonic_press	Mpa	0.00
372	10.10	1301	514h	Binit_flow_max	g / s	0.00
373	10.11	1303	516h	Binit_ib_pressure	Mpa	0.00
374	10.12	1305	518h	Binitial_resist	Pa s^2 / g^2	0.0
375	10.13	1307	51Ah	Bmid_resist	Pa s^2 / g^2	0.0
376	10.14	1309	51Ch	Bhigh_resist	Pa s^2 / g^2	0.0
377	10.15	1311	51Eh	Bfinal_resist	Pa s^2 / g^2	0.0
378	10.16	1313	520h	Binit_tank_press	Mpa	0.00
379	10.17	1315	522h	Blow_ib_pressure	Mpa	0.00
380	10.18	1317	524h	Blow_tank_target	Mpa	0.00
381	10.19	1319	526h	Blow_time	s	0.00
382	10.20	1321	528h	Bmid_ib_pressure	Mpa	0.00
383	10.21	1323	52Ah	Bmid_tank_target	Mpa	0.00
384	10.22	1325	52Ch	Bmid_time	s	0.00
385	10.23	1327	52Eh	Bhigh_ib_pressure	Mpa	0.00
386	10.24	1329	530h	Bhigh_tank_target	Mpa	0.00
387	10.25	1331	532h	Bhigh_time	s	0.00
388	10.26	1333	534h	Bfinal_mass	g	0
389	10.27	1335	536h	Bfinal_press	Mpa	0.00
390	10.28	1337	538h	BTcomp_press	Mpa	0.00
391	10.29	1339	53Ah	Blow_hose_mass	g	0
392	10.30	1341	53Ch	Bmid_hose_mass	g	0
393	10.31	1343	53Eh	Bhigh_hose_mass	g	0
394	10.32	1345	540h	Blow_stop_flow	g / s	0.00
395	10.33	1347	542h	Bmid_stop_flow	g / s	0.00
396	10.34	1349	544h	Bhigh_stop_flow	g / s	0.00
397	10.35	1351	546h	Blow_off_adj	Mpa	0.00
398	10.36	1353	548h	Bmid_off_adj	Mpa	0.00
399	10.37	1355	54Ah	Bhigh_off_adj	Mpa	0.00
400	10.38*	1357	54Ch	Bave_gas_temp	K	0.0
401	10.39	1359	54Eh	Btemperaure_ran	K	0.0
402	10.40*	1361	550h	Baccount_1	#	0
403	10.41*	1363	552h	Baccount_2	#	0
404	10.42*	1365	554h	Baccount_3	#	0
405	10.43*	1367	556h	Baccount_4	#	0
406	10.44	1369	558h	Bfill_time	sec	0.00
407	10.45	1371	55Ah	Btime	time	n.a.
List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal

408	10.46	1373	55Ch	Bdate	date	n.a.
409	10.47	1375	55Eh	Blast_ib_pressure	Mpa	0.00
410	10.48	1377	560h	Blast_tank_target	Mpa	0.00
411	10.49	1379	562h	Blast_tank_pressure	Mpa	0.00
412	10.50	1381	564h	Binit_restrict	Pa^-2 s / g	0.000
413	10.51	1383	566h	Bmid_restrict	Pa^-2 s / g	0.000
414	10.52	1385	568h	Bhigh_restrict	Pa^-2 s / g	0.000
415	10.53	1387	56Ah	Bfinal_restrict	Pa^-2 s / g	0.000
416	10.54	1389	56Ch	Blow_adj_restrict	%	0.00
417	10.55	1391	56Eh	Bmid_adj_restrict	%	0.00
418	10.56	1393	570h	Bhi_adj_restrict	%	0.00
none	10.57	1395	572h	not defined		
…						
none	10.63	1407	57Eh	not defined		

Block 11: ‘B’ Hose totalizer variables. Read only

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
419	11.0	1409	580h	Btotal_save_count	#	0
420	11.1	1411	582h	Blog_count	#	0
421	11.2	1413	583h	Btime_stamp	time	n.a.
422	11.3	1415	586h	Bdate_stamp	date	n.a.
423	11.4	1417	588h	Bhose_id	#	0
424	11.5	1419	58Ah	Btotal_extend	g	note 4
425	11.6	1421	58Ch	Btotal_sale_tier1	$	0
426	11.7	1423	58Eh	Btotal_mass_tier1	g	0
427	11.8	1425	590h	Btotal_sale_tier2	$	0
428	11.9	1427	592h	Btotal_mass_tier2	g	0
429	11.10	1429	594h	Btotal_mass_ran	g	0
430	11.11	1431	596h	Btotal_sale_ran	$	0
431	11.12	1433	598h	Btotal_qty_ran	‘unit’	0
432	11.13	1435	59Ah	Bprice_ran	$	0
433	11.14	1437	59Ch	Bprice_tier_ran	#	0
434	11.15	1439	59Eh	Bsale_ran_decimal	#	0
435	11.16	1441	5A0h	Bqty_ran_decimal	#	0
436	11.17	1443	5A2h	Bprice_ran_decimal	#	0
437	11.18	1445	5A4h	Blow_cycle_total	#	0
438	11.19	1447	5A6h	Bmid_cycle_total	#	0
439	11.20	1449	5A8h	Bhigh_cycle_total	#	0
440	11.21	1451	5AAh	Btotal_fault	#	0
441	11.22	1453	5A4h	Bshift_sale_tier1	$	0
442	11.23	1455	5AEh	Bshift_mass_tier1	g	0
443	11.24	1457	5B0h	Bshift_sale_tier2	$	0
444	11.25	1459	5B2h	Bshift_mass_tier2	g	0
445	11.26	1461	5B4h	Bshift_time_stamp1	time	n.a.
446	11.27	1463	5B6h	Bshift_date_stamp1	date	n.a.
447	11.28	1465	5B8h	Bshift_time_stamp2	time	n.a.
448	11.29	1467	5BAh	Bshift_date_stamp2	date	n.a.
449	11.30	1469	5BCh	Bqty_remainder	‘unit’	0
450	11.31	1471	5BEh	Btotal_sale_spc_ran	$	0
none	11.32	1473	5C0h	not defined		
…						
none	11.63	1535	5FEh	not defined		

Block 12: Program control variables.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
451	12.0	1537	600h	action_command	#	0
452	12.1	1539	602h	action_commanded	#	0
453	12.2*	1541	604h	io_inputs	#	0
454	12.3*	1543	606h	io_outputs	#	0
455	12.4	1545	608h	force_out_off	#	0
456	12.5	1547	60Ah	force_out_on	#	0
457	12.6	1549	60Ch	keyset_0	#	0
458	12.7	1551	60Eh	keyset_1	#	0
459	12.8*	1553	610h	main_loop_boolean	#	0
460	12.9	1555	612h	keyset_2	#	0
461	12.10	1557	614h	keyset_3	#	0
462	12.11	1559	616h	RTC_time	time	n.a.
463	12.12	1561	618h	RTC_date	date	n.a.
464	12.13	1563	61Ah	time_control	#	0
465	12.14	1565	61Ch	average_scan	usec	0
466	12.15	1567	61Eh	maximum_scan	usec	0
467	12.16	1569	620h	minimum_scan	usec	0
468	12.17	1571	622h	key_mode	#	0
469	12.18	1573	624h	revision	#	0.000
470	12.19	1575	626h	totals_page	#	0
471	12.20	1577	628h	totals_ROM	#	0
472	12.21	1579	62Ah	rom_save_addr	#	0
473	12.22	1581	62Ch	key_pad	#	0
474	12.23	1583	62Eh	key_set	#	0
475	12.24	1585	630h	audit_find	#	0
476	12.25	1587	632h	trail_list_base	#	0
477	12.26	1589	634h	data_trail_base	#	0
478	12.27	1591	636h	pass_number_1	#	0
479	12.28	1593	638h	pass_number_2	#	0
480	12.29	1595	63Ah	access_level	#	0
481	12.30	1597	63Ch	backup_ROM	#	0
none	11.31	1599	63Eh	not defined		
…						
none	11.63	1663	67Eh	not defined		

Block 13: Analog input variables.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
482	13.0	1665	680h	AN_0	adc#	0
483	13.1	1667	682h	AN_1	adc#	0
484	13.2	1669	684h	AN_2	adc#	0
485	13.3	1671	686h	AN_3	adc#	0
486	13.4	1673	688h	AN_4	adc#	0
487	13.5	1675	68Ah	AN_5	adc#	0
488	13.6	1677	68Ch	AN_6	adc#	0
489	13.7	1679	68Eh	AN_7	adc#	0
none	13.8	1681	690h	not defined		
…						
none	13.63	1791	6FEh	not defined		

Block 14: GTI 'A' Hose control variables.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
490	14.0	1793	700h	AGTI_page	#	0
491	14.1	1795	702h	AGTI_step	#	0
492	14.2*	1797	704h	AGTI_flags	#	0
493	14.3*	1799	706h	AGTI_flags2	#	0
494	14.4	1801	708h	AGTI_wait	s	0.000
495	14.5	1803	70Ah	AGTI_mass_ran	g	0
496	14.6*	1805	70Ch	AGTI_error_reg	#	0
497	14.7	1807	70Eh	AGTI_meter_status	#	0
498	14.8	1809	710h	AGTI_init_hose_press	PSI	0
499	14.9	1811	712h	AGTI_hose_press_theory	PSI	0
none	14.10	1813	714h	not defined		
…						
none	14.63	1919	77Eh	not defined		

Block 15: GTI 'A' Hose signal variables (floating point)

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
500	15.0	1921	780h	Aflow	lbs / min	float
501	15.1	1923	782h	Apr	PSI	float
502	15.2	1925	784h	Ats	F	float
503	15.3	1927	786h	Asum_ps0	PSI	float
504	15.4	1929	788h	Asum_ts0	F	float
505	15.5	1931	78Ah	Apsm	PSI	float
506	15.6	1933	78Ch	Atsm	F	float
507	15.7	1935	78Eh	Asim_tank_mass	g	float
508	15.8	1937	790h	Atank_psim_f	PSI	float
509	15.9	1939	792h	Adelmr	lbs	float
510	15.10	1941	794h	Arhorat	lbs / ft^3	float
511	15.11	1941	794h	Arhorat36	lbs / ft^3	float
none	15.12	1943	796h	not defined		
…						
none	15.63	2047	7FEh	not defined		

Block 16: GTI 'A' Hose fill variables (floating point).

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
512	16.0	2049	800h	Aprim	PSI	float
513	16.1	2051	802h	Atrim	F	float
514	16.2	2053	804h	Adelmrle250	lbs	float
515	16.3	2055	806h	Aps1	PSI	float
516	16.4	2057	808h	Ats1	F	float
517	16.5	2059	80Ah	Adelmr1m_1	lbs	float
518	16.6	2061	80Ch	Apr1m_1	PSI	float
519	16.7	2063	80Eh	Avr1e	ft^3	float
520	16.8	2065	810h	Adelmr1m	lbs	float
521	16.9	2067	812h	Apr1m	PSI	float
522	16.10	2069	814h	Avr1water	ft^3	float
523	16.11	2071	816h	Amrie1	lbs	float
524	16.12	2073	818h	Amrrat1	lbs	float
525	16.13	2075	81Ah	Adelmrito90	lbs	float
526	16.14	2077	81Ch	Avrwater500	ft^3	float
527	16.15	2079	81Eh	Amrie500	lbs	float
528	16.16	2081	820h	Amrrat500	lbs	float
529	16.17	2083	822h	Adelmrito90500	lbs	float
530	16.18	2085	824h	Adelmrout500	lbs	float
531	16.19	2087	826h	Apr2e	PSI	float
532	16.20	2089	828h	Adelmr2e	lbs	float
533	16.21	2091	82Ah	Aps2	PSI	float
534	16.22	2093	82Ch	Ats2	F	float
535	16.23	2095	82Eh	Adelmr2m	lbs	float

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
536	16.24	2097	830h	Apr2m	PSI	float
537	16.25	2099	832h	Avr2water	ft^3	float
538	16.26	2101	834h	Amrie2	lbs	float
539	16.27	2103	836h	Amrrat2	lbs	float
540	16.28	2105	838h	Apr3e	PSI	float
541	16.29	2107	83Ah	Adelmr3e	lbs	float
542	16.30	2109	83Ch	Adelmr3m	lbs	float
543	16.31	2111	83Eh	Aslope3	#	float
544	16.32	2113	840h	Arhorim	lbs / ft^3	float
545	16.33	2115	842h	Adadj	lbs	float
546	16.34	2117	844h	Arho_ratio	%	float
none	16.35	2119	846h	not defined		
…						
none	16.63	2175	87Eh	not defined		

Block 17: GTI ‘A’ Hose fill monitor variables.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
547	17.0*	2177	880h	AGTI_final_flag1	#	0
548	17.1*	2179	882h	AGTI_final_flag2	#	0
549	17.2*	2181	884h	AGTI_account1	#	0
550	17.3*	2183	886h	AGTI_account2	#	0
551	17.4*	2185	888h	AGTI_account3	#	0
552	17.5*	2187	88Ah	AGTI_account4	#	0
none	17.6	2189	88Ch	not defined		
…						
none	17.63	2559	9FEh	not defined		

Block 18: GTI 'A' Hose parameters (floating point).

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
553	18.0	2177	A00h	Aprat	PSI	float
554	18.1	2179	A02h	Aprlim	PSI	float
555	18.2	2181	A04h	Arhostd	lbs / ft^3	float
556	18.3	2183	A06h	Apr36	PSI	float
557	18.4	2185	A08h	Atr36	F	float
558	18.5	2187	A0Ah	Adelmr250	lbs	float
559	18.6	2189	A0Ch	Astep3_delay	sec	float
560	18.7	2191	A0Eh	Astep8_delay	sec	float
561	18.8	2193	A10h	AGTI_drop_timeout	sec	float
562	18.9	2195	A12h	AGTI_drop_threshold	PSI	float
563	18.10	2197	A14h	AGTI_temp_offset	#	float
564	18.11	2199	A16h	AGTI_temp_cal	#	float
565	18.12	2201	A18h	AGTI_mass_cal	#	float
566	18.13	2203	A1Ah	AGTI_press_cal	#	float
567	18.14	2205	A1Ch	AGTI_flow_cal	#	float
568	18.15	2207	A1Eh	Apr_settle	PSI	float
569	18.16	2209	A20h	AGTI_low_flow	lbs / min	float
570	18.17	2211	A22h	AGTI_burst_flow	lbs / min	float
571	18.18	2213	A24h	Alow_flow_change	lbs / min	float
572	18.19	2215	A26h	Amid_flow_change	lbs / min	float
573	18.20	2217	A28h	Ahigh_flow_change	lbs / min	float
574	18.21	2219	A2Ah	AGTI_hose_mass	lbs	float
none	18.22	2221	A2Ch	not defined		
…						
none	18.63	2559	A7Eh	not defined		

Block 19: GTI 'A' Hose parameters

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
575	19.0*	2561	A80h	AGTI_signal_config	#	0
576	19.1	2563	A82h	Amin_vrnew	ft^3	0
577	19.2	2565	A84h	AGTI_spare2_pl	#	0
578	19.3	2567	A86h	AGTI_spare3_pl	#	0
579	19.5	2569	A88h	AGTI_spare4_pl	#	0
none	19.6	2571	A8Ah	not defined		
…						
none	19.63	2815	AFEh	not defined		

Block 20: GTI 'B' Hose control variables.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
580	20.0	2817	B00h	BGTI_page	#	0
581	20.1	2810	B02h	BGTI_step	#	0
582	20.2*	2821	B04h	BGTI_flags	#	0
583	20.3*	2823	B06h	BGTI_flags2	#	0
584	20.4	2825	B08h	BGTI_wait	s	0.000
585	20.5	2827	B0Ah	BGTI_mass_ran	g	0
586	20.6	2829	B0Ch	BGTI_error_reg	#	0
587	20.7	2831	B0Eh	BGTI_meter_status	#	0
588	20.8	2833	B10h	BGTI_init_hose_press	PSI	0
589	20.9	2835	B12h	BGTI_hose_press_theory	PSI	0
none	20.10	2837	B14h	not defined		
…						
none	20.63	2943	B7Eh	not defined		

Block 21: GTI 'B' Hose signal variables (floating point)

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
590	21.0	2945	B80h	Bflow	lbs / min	float
591	21.1	2947	B82h	Bpr	PSI	float
592	21.2	2949	B84h	Bts	F	float
593	21.3	2951	B86h	Bsum_ps0	PSI	float
594	21.4	2953	B88h	Bsum_ts0	F	float
595	21.5	2955	B8Ah	Bpsm	PSI	float
596	21.6	2957	B8Ch	Btsm	F	float
597	21.7	2959	B8Eh	Bsim_tank_mass	g	float
598	21.8	2961	B30h	Btank_psim_f	PSI	float
599	21.9	2963	B32h	Bdelmr	lbs	float
600	21.10	2965	B34h	Brhorat	lbs / ft^3	float
601	21.11	2967	B36h	Brhorat36	lbs / ft^3	float
none	21.12	2969	B38h	not defined		
…						
none	21.63	3071	BFEh	not defined		

Block 22: GTI ‘B’ Hose fill variables (floating point).

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
602	22.0	3073	C00h	Bprim	PSI	float
603	22.1	3075	C02h	Btrim	F	float
604	22.2	3077	C04h	Bdelmrle250	lbs	float
605	22.3	3079	C06h	Bps1	PSI	float
606	22.4	3081	C08h	Bts1	F	float
607	22.5	3083	C0Ah	Bdelmr1m_1	lbs	float
608	22.6	3085	C0Ch	Bpr1m_1	PSI	float
609	22.7	3087	C0Eh	Bvr1e	ft^3	float
610	22.8	3089	C10h	Bdelmr1m	lbs	float
611	22.9	3091	C12h	Bpr1m	PSI	float
612	22.10	3091	C14h	Bvr1water	ft^3	float
613	22.11	3091	C16h	Bmrie1	lbs	float
614	22.12	3091	C18h	Bmrrat1	lbs	float
615	22.13	3091	C1Ah	Bdelmrito90	lbs	float
616	22.14	3101	C1Ch	Bvrwater500	ft^3	float
617	22.15	3101	C1Eh	Bmrie500	lbs	float
618	22.16	3101	C20h	Bmrrat500	lbs	float
619	22.17	3101	C22h	Bdelmrito90500	lbs	float
620	22.18	3101	C24h	Bdelmrout500	lbs	float
621	22.19	3111	C26h	Bpr2e	PSI	float
622	22.20	3111	C28h	Bdelmr2e	lbs	float
623	22.21	3111	C2Ah	Bps2	PSI	float
624	22.22	3111	C2Ch	Bts2	F	float
625	22.23	3111	C2Eh	Bdelmr2m	lbs	float
626	22.24	3121	C30h	Bpr2m	PSI	float
627	22.25	3121	C32h	Bvr2water	ft^3	float
628	22.26	3121	C34h	Bmrie2	lbs	float
629	22.27	3121	C36h	Bmrrat2	lbs	float
630	22.28	3121	C38h	Bpr3e	PSI	float
631	22.29	3131	C3Ah	Bdelmr3e	lbs	float
632	22.30	3131	C3Ch	Bdelmr3m	lbs	float
633	22.31	3131	C3Eh	Bslope3	#	float
634	22.32	3131	C40h	Brhorim	lbs / ft^3	float
635	22.33	3131	C42h	Bdadj	lbs	float
636	22.34	3141	C44h	Brho_ratio	%	float
none	22.35	3143	C46h	not defined		
…						
none	22.63	3199	C7Eh	not defined		

Block 23: GTI ‘B’ Hose fill monitor variables.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
637	23.0*	3201	C80h	BGTI_final_flag1	#	0
638	23.1*	3203	C82h	BGTI_final_flag2	#	0
639	23.2*	3205	C84h	BGTI_account1	#	0
640	23.3*	3207	C86h	BGTI_account2	#	0
641	23.4*	3209	C88h	BGTI_account3	#	0
642	23.5*	3211	C8Ah	BGTI_account4	#	0
none	23.6	3213	C8Ch	not defined		
…						
none	23.63	3327	CFEh	not defined		

Block 24: GTI ‘B’ Hose parameters (floating point).

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
643	24.0	3329	D00h	Bprat	PSI	float
644	24.1	3331	D02h	Bprlim	PSI	float
645	24.2	3333	D04h	Brhostd	lbs / ft^3	float
646	24.3	3335	D06h	Bpr36	PSI	float
647	24.4	3337	D08h	Btr36	F	float
648	24.5	3339	D0Ah	Bdelmr250	lbs	float
649	24.6	3341	D0Ch	Bstep3_delay	sec	float
650	24.7	3343	D0Eh	Bstep8_delay	sec	float
651	24.8	3345	D10h	BGTI_drop_timeout	sec	float
652	24.9	3347	D12h	BGTI_drop_threshold	PSI	float
653	24.10	3349	D14h	BGTI_temp_offset	#	float
654	24.11	3351	D16h	BGTI_temp_cal	#	float
655	24.12	3353	D18h	BGTI_mass_cal	#	float
656	24.13	3355	D1Ah	BGTI_press_cal	#	float
657	24.14	3357	D1Ch	BGTI_flow_cal	#	float
658	24.15	3359	D1Eh	Bpr_settle	PSI	float
659	24.16	3361	D20h	BGTI_low_flow	lbs / min	float
660	24.17	3363	D22h	BGTI_burst_flow	lbs / min	float
661	24.18	3365	D24h	Blow_flow_change	lbs / min	float
662	24.19	3367	D26h	Bmid_flow_change	lbs / min	float
663	24.20	3369	D28h	Bhigh_flow_change	lbs / min	float
664	24.21	3371	D2Ah	BGTI_hose_mass	lbs	float
none	24.22	3373	D2Ch	not defined		
…						
none	24.63	3455	D7Eh	not defined		

Block 25: GTI 'B' Hose parameters

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
665	25.0*	3713	E80h	BGTI_signal_config	#	0
666	25.1	3715	E82h	Bmin_vrnew	ft^3	0
667	25.2	3717	E84h	BGTI_spare2_pl	#	0
668	25.3	3719	E86h	BGTI_spare3_pl	#	0
669	25.5	3721	E88h	BGTI_spare4_pl	#	0
none	25.6	3723	E8Ah	not defined		
…						
none	25.63	3839	EFEh	not defined		

Block 26: 'A' Hose price

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
670	26.0	3841	F00h	Aprice_per_unit_t1	$	note 5
671	26.1	3843	F00h	Aprice_per_unit_t2	$	note 5
672	26.2	3845	F00h	Aprice_decimal_t1	#	0
673	26.3	3847	F00h	Aprice_decimal_t2	#	0
674	26.4	3849	F00h	Atier_select_mem	#	0
none	26.5	3851	E8Ah	not defined		
…						
none	26.63	3839	EFEh	not defined		

Block 27: 'B' Hose price

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
675	27.0	4097	1000h	Bprice_per_unit_t1	$	note 5
676	27.1	4099	1002h	Bprice_per_unit_t2	$	note 5
677	27.2	4101	1004h	Bprice_decimal_t1	#	0
678	27.3	4102	1006h	Bprice_decimal_t2	#	0
679	27.4	4103	1008h	Btier_select_mem	#	0
none	27.5	4104	100Ah	not defined		
…						
none	27.63	4223	107Eh	not defined		

Block 28: 'A' Hose process

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
680	28.0	4225	1080h	Aprocess_1	#	0
681	28.1	4227	1082h	Aprocess_2	#	0
682	28.2	4229	1084h	Aprocess_3	#	0
683	28.3	4231	1086h	Aprocess_4	#	0
684	28.4	4233	1088h	Aprocess_5	#	0
685	28.5	4235	108Ah	Aprocess_6	#	0
686	28.6	4237	108Ch	Aprocess_7	#	0
687	28.7	4239	108Eh	Aprocess_8	#	0
688	28.8	4241	1090h	Aprocess_9	#	0
689	28.9	4243	1092h	Aprocess_10	#	0
none	28.10	4245	1094h	not defined		
…						
none	28.63	4351	10FEh	not defined		

Block 29: 'B' Hose process

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
690	29.0	4353	1100h	Bprocess_1	#	0
691	29.1	4357	1102h	Bprocess_2	#	0
692	29.2	4359	1104h	Bprocess_3	#	0
693	29.3	4361	1106h	Bprocess_4	#	0
694	29.4	4363	1108h	Bprocess_5	#	0
695	29.5	4365	110Ah	Bprocess_6	#	0
696	29.6	4367	110Ch	Bprocess_7	#	0
697	29.7	4369	110Eh	Bprocess_8	#	0
698	29.8	4371	1110h	Bprocess_9	#	0
699	29.9	4373	1112h	Bprocess_10	#	0
none	29.10	4375	1114h	not defined		
…						
none	29.63	4479	117Eh	not defined		

Block 30: ‘A’ Hose Gilbarco communication variables

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
700	30.0	4481	1180h	Apump_node	#	0
701	30.1	4483	1182h	Apump_status	#	0
702	30.2*	4485	1184h	Aspc_ident	#	0
703	30.3	4487	1186h	Aspc_error	#	0
704	30.4	4489	1188h	Aspc_grade	#	0
705	30.5	4491	118Ah	Aspc_price1_g1	$	0.000
706	30.6	4493	118Ch	Aspc_price2_g1	$	0.000
707	30.7	4495	118Eh	Aspc_tier_g1	#	0
708	30.8	4497	1190h	Aspc_price_g1	$	0.000
709	30.9	4499	1192h	Aspc_vol_g1	‘units’	0.000
710	30.10	4501	1194h	Aspc_money_g1	$	0.00
711	30.11	4503	1196h	Aspc_vol_total_g1	‘units’	0.000
712	30.12	4505	1198h	Aspc_mon_total_g1	$	0.00
713	30.13	4507	119Ah	Aspc_price1_g2	$	0.000
714	30.14	4509	119Ch	Aspc_price2_g2	$	0.000
715	30.15	4511	119Eh	Aspc_tier_g2	#	0
716	30.16	4513	11A0h	Aspc_price_g2	$	0.000
717	30.17	4515	11A2h	Aspc_vol_g2	‘units’	0.000
718	30.18	4517	11A4h	Aspc_money_g2	$	0.00
719	30.19	4519	11A6h	Aspc_vol_total_g2	‘units’	0.000
720	30.20	4521	11A8h	Aspc_mon_total_g2	$	0.00
721	30.21	4523	11Aah	Aspc_price1_g3	$	0.000
722	30.22	4525	11Ach	Aspc_price2_g3	$	0.000
723	30.23	4527	11Aeh	Aspc_tier_g3	#	0
724	30.24	4529	11B0h	Aspc_price_g3	$	0.000
725	30.25	4531	11B2h	Aspc_vol_g3	‘units’	0.000
726	30.26	4533	11B4h	Aspc_money_g3	$	0.00
727	30.27	4535	11B6h	Aspc_vol_total_g3	‘units’	0.000
728	30.28	4537	11B8h	Aspc_mon_total_g3	$	0.00
729	30.29	4539	11Bah	Aspc_price1_g4	$	0.000
730	30.30	4541	11BCh	Aspc_price2_g4	$	0.000
731	30.31	4543	11BEh	Aspc_tier_g4	#	0
732	30.32	4545	11C0h	Aspc_price_g4	$	0.000
733	30.33	4547	11C2h	Aspc_vol_g4	‘units’	0.000
734	30.34	4549	11C4h	Aspc_money_g4	$	0.00
735	30.35	4551	11C6h	Aspc_vol_total_g4	‘units’	0.000
736	30.36	4553	11C8h	Aspc_mon_total_g4	$	0.00
737	30.37	4555	11CAh	Aspc_price1_g5	$	0.000
738	30.38	4557	11CCh	Aspc_price2_g5	$	0.000
739	30.39	4559	11CEh	Aspc_tier_g5	#	0
740	30.40	4561	11D0h	Aspc_price_g5	$	0.000
741	30.41	4563	11D2h	Aspc_vol_g5	‘units’	0.000
742	30.42	4565	11D4h	Aspc_money_g5	$	0.00
743	30.43	4567	11D6h	Aspc_vol_total_g5	‘units’	0.000
744	30.44	4569	11D8h	Aspc_mon_total_g5	$	0.00
745	30.45	4571	11DAh	Aspc_price1_g6	$	0.000

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
746	30.46	4573	11DCh	Aspc_price2_g6	$	0.000
747	30.47	4575	11DEh	Aspc_tier_g6	#	0
748	30.48	4577	11E0h	Aspc_price_g6	$	0.000
749	30.49	4579	11E2h	Aspc_vol_g6	‘units’	0.000
750	30.50	4581	11E4h	Aspc_money_g6	$	0.00
751	30.51	4583	11E6h	Aspc_vol_total_g6	‘units’	0.000
752	30.52	4585	11E8h	Aspc_mon_total_g6	$	0.00
753	30.53*	4587	11EAh	pumps_scanned	#	0
none	30.54	4589	11ECh	not defined		
…						
none	30.63	4607	11FEh	not defined		

Block 31: ‘B’ Hose Gilbarco communication variables

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
754	31.0	4609	1200h	Bpump_node	#	0
755	31.1	4611	1202h	Bpump_status	#	0
756	31.2*	4613	1204h	Bspc_ident	#	0
757	31.3	4615	1206h	Bspc_error	#	0
758	31.4	4617	1208h	Bspc_grade	#	0
759	31.5	4619	120Ah	Bspc_price1_g1	$	0.000
760	31.6	4621	120Ch	Bspc_price2_g1	$	0.000
761	31.7	4623	120Eh	Bspc_tier_g1	#	0
762	31.8	4625	1210h	Bspc_price_g1	$	0.000
763	31.9	4627	1212h	Bspc_vol_g1	‘units’	0.000
764	31.10	4629	1214h	Bspc_money_g1	$	0.00
765	31.11	4631	1216h	Bspc_vol_total_g1	‘units’	0.000
766	31.12	4633	1218h	Bspc_mon_total_g1	$	0.00
767	31.13	4635	121Ah	Bspc_price1_g2	$	0.000
768	31.14	4637	121Ch	Bspc_price2_g2	$	0.000
769	31.15	4639	121Eh	Bspc_tier_g2	#	0
770	31.16	4641	1220h	Bspc_price_g2	$	0.000
771	31.17	4643	1222h	Bspc_vol_g2	‘units’	0.000
772	31.18	4645	1224h	Bspc_money_g2	$	0.00
773	31.19	4647	1226h	Bspc_vol_total_g2	‘units’	0.000
774	31.20	4649	1228h	Bspc_mon_total_g2	$	0.00
775	31.21	4651	122Ah	Bspc_price1_g3	$	0.000
776	31.22	4653	122Ch	Bspc_price2_g3	$	0.000
777	31.23	4655	122Eh	Bspc_tier_g3	#	0
778	31.24	4657	1230h	Bspc_price_g3	$	0.000
779	31.25	4659	1232h	Bspc_vol_g3	‘units’	0.000
780	31.26	4661	1234h	Bspc_money_g3	$	0.00
781	31.27	4663	1236h	Bspc_vol_total_g3	‘units’	0.000
782	31.28	4665	1238h	Bspc_mon_total_g3	$	0.00
783	31.29	4667	123Ah	Bspc_price1_g4	$	0.000
784	31.30	4669	123Ch	Bspc_price2_g4	$	0.000
785	31.31	4671	123Eh	Bspc_tier_g4	#	0
786	31.32	4673	1240h	Bspc_price_g4	$	0.000
787	31.33	4675	1240h	Bspc_vol_g4	‘units’	0.000
788	31.34	4677	1242h	Bspc_money_g4	$	0.00
789	31.35	4679	1244h	Bspc_vol_total_g4	‘units’	0.000
790	31.36	4681	1246h	Bspc_mon_total_g4	$	0.00
791	31.37	4683	1248h	Bspc_price1_g5	$	0.000
792	31.38	4685	124Ah	Bspc_price2_g5	$	0.000
793	31.39	4687	124Ch	Bspc_tier_g5	#	0
794	31.40	4689	124Eh	Bspc_price_g5	$	0.000
795	31.41	4691	1250h	Bspc_vol_g5	‘units’	0.000
796	31.42	4693	1252h	Bspc_money_g5	$	0.00
797	31.43	4695	1254h	Bspc_vol_total_g5	‘units’	0.000
798	31.44	4697	1256h	Bspc_mon_total_g5	$	0.00
799	31.45	4699	1258h	Bspc_price1_g6	$	0.000

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
800	31.46	4701	125Ah	Bspc_price2_g6	$	0.000
801	31.47	4703	125Ch	Bspc_tier_g6	#	0
802	31.48	4705	125Eh	Bspc_price_g6	$	0.000
803	31.49	4707	1260h	Bspc_vol_g6	'units'	0.000
804	31.50	4709	1262h	Bspc_money_g6	$	0.00
805	31.51	4711	1264h	Bspc_vol_total_g6	'units'	0.000
806	31.52	4713	1266h	Bspc_mon_total_g6	$	0.00
807	31.53*	4715	1268h	pumps_scanned	#	0
none	31.54	4717	126Ah	not defined		
…						
none	31.63	4735	127Eh	not defined		

Block 32: ‘A’ Hose test variables

Note: test variables are subject to be different between program revisions.

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
808	32.0	4737	1280h	Ap_ave	Mpa	0.000
809	32.1	4739	1282h	Af_dip	g / s	0.0
810	32.2	4741	1284h	Af_dip_prev	g / s	0.0
811	32.3	4743	1286h	Ap_derivative	Mpa	0.00
812	32.4	4745	1288h	Ap_dip_rate	Mpa	0.00
813	32.5	4747	128Ah	Ap_dip_sim	Mpa	0.00
814	32.6	4749	128Ch	Aset_dip_rate	#	0
815	32.7*	4751	128Eh	Amisc-bits	#	0
816	32.8	4753	1290h	Asale_preset	$	0.00
817	32.9	4755	1292h	Asale_stop	#	0
818	32.10	4757	1294h	Acoast_mass	g	0
819	32.11	4759	1296h	Astop_mass	g	0
820	32.12	4761	1298h	Aactual_mass	g	0
821	32.13	4763	129Ah	Aheat_pressure	MPa	0.00
822	32.14	4765	129Ch	Amin_restrict	Pa^-2 s / g	0.000
823	32.15	4767	129Eh	Amax_restrict	Pa^-2 s / g	0.000
none	32.16	4769	12A0h	not defined		
…						
none	32.63	4863	12FEh	not defined		

Block 33: ‘B’ Hose test variables

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
824	33.0	4865	1300h	Bp_ave	Mpa	0.000
825	33.1	4867	1302h	Bf_dip	g / s	0.0
826	33.2	4869	1304h	Bf_dip_prev	g / s	0.0
827	33.3	4871	1306h	Bp_derivative	Mpa	0.00
828	33.4	4873	1308h	Bp_dip_rate	Mpa	0.00
829	33.5	4875	130Ah	Bp_dip_sim	Mpa	0.00
830	33.6	4877	130Ch	Bset_dip_rate	#	0
831	33.7*	4979	130Eh	Bmisc-bits	#	0
832	33.8	4981	1310h	Bsale_preset	$	0.00
833	33.9	4983	1312h	Bsale_stop	#	0
834	33.10	4985	1314h	Bcoast_mass	g	0
835	33.11	4987	1316h	Bstop_mass	g	0
836	33.12	4989	1318h	Bactual_mass	g	0
837	33.13	4991	131Ah	Bheat_pressure	MPa	0.00
838	33.14	4993	131Ch	Bmin_restrict	Pa^-2 s / g	0.000
839	33.15	4995	131Eh	Bmax_restrict	Pa^-2 s / g	0.000
none	33.16	4997	1320h	not defined		
…						
none	33.63	4991	137Eh	not defined		

Block 34: Extra parameters

List Numb	Control Address	ModBus Address		Description / Name	Units	Decimal
840	34.0	4993	1380h	Spc_grade	#	0
841	34.1	4995	1382h	Force_tier	#	0
842	34.2	4997	1384h	Spc_money_mode	#	0
843	34.3	4999	1386h	Hose_A_number	#	0
844	34.4	5001	1388h	Hose_B_number	#	0
845	34.5	5003	138Ah	ModBus_node_base	#	0
846	34.6*	5005	138Ch	extra_configuration	#	0
847	34.7	5007	138Eh	control_air_thres	MPa	0.00
848	34.8	5009	1390h	control_air_cal	MPa	0.00
849	34.9	5011	1392h	extra_param_9	#	0
850	34.10	5013	1394h	A_coast_factor	sec	0.00
851	34.11	5015	1396h	A_coast_adder	g	0
852	34.12	5017	1398h	A_stop_qty	‘units’	0.000
853	34.13	5019	139Ah	A_Compression_pressure	MPa	0.00
854	34.14	5021	139Ch	A_boost_mass	grams	0
855	34.15	5023	139Eh	A_boost_factor	#	0.000
856	34.16	5025	13A0h	A_sim_boost	#	0.00
857	34.17	5027	13A2h	A_tank_qty	GGE	0.000
858	34.18	5029	13A4h	A_extra_spare18	#	0
859	34.19	5031	13A6h	A_extra_spare19	#	0
860	34.20	5033	13A8h	B_coast_factor	sec	0.00
861	34.21	5035	13AAh	B_coast_adder	g	0
862	34.22	5037	13ACh	B_stop_qty	‘units’	0.000
863	34.23	5039	13AEh	B_Compression_pressure	MPa	0.00
864	34.24	5041	13B0h	B_ boost_mass	grams	0
865	34.25	5043	13B2h	B_ boost_factor	#	0.000
866	34.26	5045	13B4h	B_ sim_boost	#	0.00
867	34.27	5047	13B6h	B_ tank_qty	GGE	0.000
868	34.28	5049	13B8h	B_extra_spare28	#	0
869	34.29	5051	13BAh	B_extra_spare29	#	0
870	34.30	5053	13BCh	A_meter_history	#	0
871	34.31	5055	13BEh	B_meter_history	#	0
872	34.32	5057	13C0h	low_sorage	feet^3	0.000
873	34.33	5059	13C2h	mid_sorage	feet^3	0.000
874	34.34	5061	13C4h	high_sorage	feet^3	0.000
875	34.35	5063	13C6h	BSmass_unit	#	0
876	34.36	5065	13CAh	BSmassconv	g/”unit”	0.0
877	34.37	5067	13CCh	Bmass_decimal	#	0
878	34.38	5069	13CEh	Bsale_decimal	#	0
879	34.39	5071	13D0h	Bprice_decimal	#	0
880	34.40	5073	13D2h	Bpulses_per_qty	#	0
881	34.41	5074	13D4h	Bpulses_per_sale	#	0
882	34.42	5073	13D2h	Bqty_fequency	Hz	0
883	34.43	5075	13D4h	Bsale_fequency	Hz	0
884	34.44	5077	13D6h	Spare45	#	0

none	34.45	5079	13D8h	not defined
…				
none	34.63	5119	13FEh	not defined

Note 1: decimal point is set by the value of parameter Ssale_decimal.
Note 2: decimal point is set by the value of parameter mass_decimal.
Note 3: decimal point is set by the value of parameter Sprice_decimal.
Note 4: Holds 4 bytes that extend the totalizers beyond 32-bit values. Decimal not applicable.
Note 5: decimal point is set by with the value of parameters
'Hose'price_decimal_t'tier#'

5. Decimal point and engineering unit look-up registers.

Accompanying the variable and parameter register set is a range of ModBus addresses that hold code values for the engineering unit and decimal point that go with the variable and parameter register values. This register range from 8193 to 16286 (2000h to 3FFFh) and is read only. These registers are laid out in matching order to the variable and parameter range. Addresses for the registers are obtained by adding 8192 (2000 hex) to the ModBus address for the variable or parameter. The value returned would be a 32-bit value with the decimal point number in the LSW and the engineering unit code in the MSW.

Example:

To get the decimal point and engineering unit for the 'A' hose pressure from the sensor below

68	2.3	263	106h	Apressure	Mpa	0.00

add 8192 to 263 (2000h to 106h) for a ModBus address of 8297 (2106h). A read of this register will return 1966082 (001E0002 hex). The LSW of 0002 hex is the placement of 2 decimal points and the MSW of 1E hex is engineering unit code of 30 for MPa (MegaPascals).

A read if the 'A' hose pressure register at 263 (106 hex) of 2069 with the above information means this value is 20.69 Mpa. This converts to 3000 PSI (145 PSI / Mpa).

6. Engineering unit code table

Engineering units of variables and parameters used in the dispenser control and their number code read from the decimal point and engineering unit address range.

#	0	unitless number	displayed as decimal
#	1	unitless number	displayed as hex
#	2	unitless number	displayed as ASCII characters
sec or s	10	time	seconds
g	20	mass	grams
lbs	21	mass	pounds mass (slugs)
Kg	22	mass	Kilograms
EGal	23	mass	equivalent gallons of gasoline
ELiter	24	mass	equivalent liters of gasoline
SCM	25	mass	standard cubic meters at 68F 14.5 PSI
MPa	30	pressure	MegaPascals
Bar	31	pressure	Barometric
PSI	32	pressure	Pounds force per square inch
g / sec or g / s	40	mass flow	grams per second
Lbs / min	41	mass flow	pounds mass per minute
SCFM	42	mass flow	standard cubic feet per minute
K	50	temperature	Kelvin
C	51	temperature	Celsius
F	52	temperature	Fahrenheit
Pa_s^2 / g^2	60	hose resistance	Pascals per mass-flow squared metric
Bar_s^2 / g^2	61	hose resistance	Bars per mass-flow squared metric
PSI_s^2 / lbs^2	62	hose resistance	PSI per mass-flow squared imperial
moles	80	mass	
adc#	90	number	analog to digital conversion 0-1023
grams / pls	100	mass count	mass per meter pulse
lbs / pls	101	mass count	mass per meter pulse
Hz	110	frequency	Hertz
Kg / sec	120	mass flow	Kilograms per second (meter use)
Lbs / min	121	mass flow	Pounds mass per second (meter use)
nd	130	not defined	
$	140	money	Dollars or other
%	150	percent	
pls	160	pulses	Any: mass, penny, liters, etc.
mol / l	170	density	moles per liter
g / unit	180	conversion	grams per custom mass unit
g / lbs	181	conversion	grams per pound mass
g / Kg	182	conversion	grams per Kilogram
g / EGal	183	conversion	grams per Equivalent Gallon
g / ELiter	184	conversion	grams per Equivalent liter
g / SCM	185	conversion	grams per standard cubic meters
ppu	190	pulses	pulses per unit
liter	200	volume	liter
feet^3	201	volume	cubic feet
in^3	202	volume	cubic inches
Kg / liter	210	density	Kilograms per liter
Lbs / feet3	211	density	pound mass per cubic feet

Engineering unit code table (continued)

time	220	clock time	hours, minute, second
date	230	calendar date	day-of-week, month, day, year
passw	240	number	password
error	250	number	
Pa^-2 s / g	260	hose restrictance	square root Pascals per mass-flow metric

7. Audit trail register range.

The range of registers from 16287 to 24576 (4000 hex to 5FFF hex) is the sorted audit trail log of parameter changes through the life of the dispenser. The dispenser records any new parameter value with a time and date stamp and change counter. Each of these fields is a 32-bit long word so each change record item is four 32-bit words: count-address, new value, time, and date. The audit trail contains 1024 possible records. The audit trail is kept in the dispenser's nonvolatile flash memory for permanent storage. A sorting routine reads the trail, orders the records according to their control addresses, and put the sorted result in the dispenser's volatile memory. This sorted result is mapped to these ModBus addresses and are read only.

Each record is placed in this range in groups of four 32-bit words starting at address 16287 (4000 hex) and taking up 8 ModBus addresses so the first record lies in addresses 16287 to 16294 (4000 hex to 4007 hex). The next record starts at the next ModBus address 16295 (4008 hex), the next 8 at 16303 (4010h), and so on (A reminder: hex values shown are official ModBus addresses minus one). A read of 8 addresses for the first record would return:

16287 94000h): control address word
16289 (4002h): new parameter value
16291 (4004h): time stamp
16293 (4006h): date stamp

The first 32-bit word is encoded with the change count and control address. The audit change count is stored in the MSW (upper 16-bits) and the parameter control address is stored in the LSW (lower 16-bits) of this 32-bit word. The LSW is further encoded: this word is divided into two sections: bits 0 – 13 are the dispenser control address or flow-meter address, bits 14 and 15 are indicators for a meter parameter change. Bit 14 = 1 indicates a parameter change on the 'A' hose meter. Bit 15 = 1 indicates a parameter change on the 'B' hose meter. If the parameter change was a meter value change through the dispenser controller, bits 0 – 13 holds the ModBus address of the MicroMotion meter parameter. Bits 14 and 15 can never be 1 at the same time. With bit bits 14 and 15 = 0, bits 0 – 13 holds the dispenser control address for the dispenser parameter. Bits 0 – 13 are, in turn, divided into 2 sections, bits 8 – 13 hold the block address and bits 0 – 7 hold the control register number ranging 0-63 for that block.

The time word is encoded as value = seconds + minutes * 100 + hours * 10000 where the hours are military 24 hours The date word is encoded as value = year + day * 100 + month * 10000 + day-of-week * 1000000. The year is 0-99. The day-of-week is 0 - 6 for Sunday through Saturday respectively. Example:

The fifth change to parameter Apmax_fixed at control address 4.36 (ModBus address 585 248h) to 26.20 MPa made at 1:47:35pm on a Thurdsday the 15th of March 2007 would be recorded as:

control address word = 328740 (00050424 hex) -> 5th change, 4th block, 36th word (24 hex)
new parameter value = 2620
time stamp = 134735 (20E4F hex) -> 13th hour,47 minutes, 35 seconds
date stamp = 4031507 (3D8413 hex) -> 4 = Thursday, 03 = March, 15th day, year = 2007.

8. Monitor fill result history log range.

The ranges 24577 to 40959 (6000 hex to 9FFF hex) and 40961 to 57344 (A000 hex to DFFF hex) are 128 blocks of 64 fill result register for the 'A' and 'B' hose respectively. The monitor fill result variable blocks 5 and 10 ('A' and 'B' hose respectively) are copied to flash memory in a circular buffer at the end of a fill. This buffer is addressed in these ranges. The variables are laid out in the same order in each 64 32-bit registers as the variable block. Each block spans 128 ModBus addresses.

Example:
A read of ModBus address 24581 (6002 hex) will return a recording of the variable Amid_target at control address 5.2. A read of ModBus address 24709 (6082 hex) will return a recording of the variable Amid_target of another fill.

The variables 2.56 Acurrent_mons_page and 7.56 Bcurrent_mons_page points to the latest block recorded for their respective hoses. The ModBus address for the latest record for the 'A' hose would be: ModBus address = Acurrent_mons_page * 128 + 24577.

9. Dispenser interface terminal connections

The RS485 communication is connected to the dispenser interface board 403-07263 by a low capacitance shielded cable to the terminal strip TB6. An on board terminating resistor-capacitor network is provided for the end termination of the cable. Jumper terminals 56 to 54 and 55 to 53 on the last dispenser. Dispensers daisy-changed in the midst of the cable do not get jumpered to the terminating network

Signal	Terminal
Shield	57
RS484-A (+)	56
RS484-B (-)	55
RS484-A (+) Terminating RC	54
RS484-B (-) Terminating RC	53

10. ModBus node set-up

The ModBus node number is set by 5 DIP switches on the dispenser interface board SW1-2 through SW1-6 for with a binary value of 0 to 31 and a parameter ModBus_node_base 34.5. The ModBus node value is the sum of the switch value and the parameter value. The valid range for a ModBus node number ID is 1 – 255, ID 0 is a master broadcast to all slaves. Slaves do not send a response to a node 0 command. The ModBus communication will be disabled if the sum of the switch and parameter values are out of the valid node range. The switch "weight" values for the SW1-2 through SW1-6 is SW1-2 = 1, SW1-3 = 2, SW1-4 = 4, SW1-5 = 8, and SW1-6 = 16.

11. Bit definitions for registers with Booleans

Bits definitions Aflags 2.17 and Bflags 7.17

Bit	Name
0	drop_flag
1	lost_authorize
2	quit_flag
3	bursted
4	no_zero_flow
5	flowing
6	lowb4full
7	p3high
8	mass_changing
9	p3ibhigh
10	press_error
11	filling
12	rate_low
13	rate_mid
14	rate_high
15	pressure_dip
16	authorized
17	p1high
18	p2high
19	abort_fill
20	drop_time_out
21	temperror
22	handl_inhb
23	power_loss
24	display_updated
25	fill_request
26	lowbank_flag
27	midbank_flag
28	highbank_flag
29	fill_done
30	sonic_flow
31	meter_updated

Bits definitions Acontrol_bits 2.18 and Bcontrol_bits 7.18

Bit	Name
0	force_mass_freq
1	force_sale_freq
2	force_comp_bit
3	force_screen_bit
4	blank_screen_bit
5	simulate_fill
6	sim_preset
7	first_resist_bit
8	error_bit
9	sim_handle
10	wait_enable
11	flow_settled_bit
12	handles_off
13	resist_calculated
14	other_Left
15	other_Right
16	handleL_fill
17	handleR_fill
18	send_authorize
19	burst
20	fill_data_recvd
21	power_on_dwel_bit
22	comm_authorize
23	tank_measured_bit
24	choke_bit
25	pressure_broken
26	pressure2_broken
27	save_log
28	fill_acknowlage
29	qty_enable
30	pressure_short
31	pressure2_short

Bits definitions Aerror_reg 2.26 and Berror_reg 7.26

Bit	Name
0	Change_on_flow
1	Press_over_trip
2	Press_over_Smax
3	Tank_over_target_press
4	Abort_fill
5	Lost_authorize
6	Hose_burst_flow
7	Flow_valve_off
8	Nozzle_open_timeout
9	Meter_busy
10	Switch_1_up
11	Flow_when_idle
12	Temp_out_range
13	Press_signal_loss
14	Meter_Comm_loss
15	Display_Comm_loss
16	Press_conflict
17	Comm_overrun
18	Comm_parity
19	Comm_framing
20	Comm_checksum
21	Comm_data_length
22	Comm_bad_command
23	Comm_invalid_grade
24	Parameter_changed
25	Wrong_flow_unit
26	Wrong_mass_unit
27	Press2_sig_loss
28	Press2_sig_short
29	Press_sig_short
30	Gilbarco_off_line
31	Fill_press_dip

Bits definitions Ameter_status 2.58 and Bmeter_status 7.58

Bit	Name
0	not defined
1	not defined
2	not defined
3	not defined
4	not defined
5	not defined
6	not defined
7	not defined
8	not defined
9	not defined
10	checksum_fail
11	RAM_fail
12	sensor_fail
13	temp_sensor_fail
14	input_overrange
15	pulse_saturated
16	not_configured
17	interrupt_fail
18	primary_saturated
19	secondary_saturated
20	primary_fixed
21	secondary_fixed
22	density_overrange
23	zero_fail
24	zero_to_low
25	zero_to_high
26	electronics_fail
27	zeroing
28	slug_flow
29	power_reset
30	config_changed
31	initializing

Bits definitions Asignal_config 4.21 and Bsignal_config 9.21

Bit	Name
0	use_meter_mass_flow
1	use_meter_vol_flow
2	use_analog_mass_flow
3	use_meter_vol_total
4	use_meter_mass_total
6	use_meter_temperature
7	use_analog_temperature
8	use_right_handle
9	use_left_handle
10	use_dual_display
11	use_total_pushbutton
12	use_auth1_input
13	use_auth2_input
14	use_auth3_input
15	use_tier_input
16	use_pmax_fixed
17	use_price_decimal
18	spc_com_enable
19	use_ored_authorize
20	use_redundant_pressure
21	use_early_check
22	use_resist_ave
23	use_comm_authorize
24	limit_pmax
25	disable_flow_max
26	use_restrict
27	share_display
28	use_totalizer
29	use_remote_valves
30	single_bank_valve
31	meter_9739_type

Bits definitions io_inputs 12.2

Bit	Name
0	A_handle_left
1	A_handle_right
2	A_handle_hose_seated
3	A_spare_input
4	B_handle_left
5	B_handle_right
6	B_handle_hose_seated
7	B_spare_input
8	A_authorization_1
9	A_authorization_2
10	A_authorization_3
11	A_tier_2
12	B_authorization_1
13	B_authorization_2
14	B_authorization_3
15	B_tier_2
16	SW1_1
17	SW1_2
18	SW1_3
19	SW1_4
20	SW1_5
21	SW1_6
22	SW1_7
23	SW1_8
24	spare_24
25	spare_25
26	spare_26
27	spare_27
28	spare_28
29	spare_29
30	spare_30
31	spare_31

Bits definitions io_outputs 12.3, force_out_off 12.4, and force_out_on 12.5

Bit	Name
0	not_defined_0
1	not_defined_1
2	not_defined_2
3	not_defined_3
4	not_defined_4
5	not_defined_5
6	not_defined_6
7	not_defined_7
8	ESD_Active
9	ESD_Active
10	A_lowbank_valve
11	A_midbank_valve
12	A_highbank_valve
13	B_lowbank_valve
14	B_midbank_valve
15	B_highbank_valve
16	A_choke
17	A_demand
18	A_filling
19	A_authorize
20	A_complete
21	A_error
22	B_choke
23	B_demand
24	B_filling
25	B_authorized
26	B_complete
27	B_error
28	A_sale_pulse_output
29	A_mass_pulse_output
30	B_sale_pulse_output
31	B_mass_pulse_output

Bits definitions main_loop_boolean 12.8

Bit	Name
0	comm0_connected
1	not_writing_flash
2	one_sec_os
3	use_modbus5
4	single_meter
5	calibrate_enable
6	sw1_1_on
7	mon_override
8	display_0_ok
9	display_1_ok
10	audit_sorted
11	single_step
12	supply_above_22v
13	supply_below_21v
14	supply_was_ok
15	supply_loss
16	supply_loss_ack
17	param_changed
18	param_scanned
19	quick_scan
20	fill_A_right
21	fill_A_left
22	fill_B_right
23	fill_B_left
24	display_2_ok
25	display_3_ok
26	totals_ready
27	simulating_fill
28	display_totals_bit
29	comm_connected
30	meter_data_force
31	tier_display_bit

Bits definitions extra_configuration 34.6

Bit	Name
0	MB_little_endian
1	Comm5_read_only
2	MB_ASCII
3	MB_rcv_refresh
4	Roseman_protocol
5	extra_config5
6	extra_config6
7	extra_config7
8	A_momentary_btn
9	B_momentary_btn
10	disable_short_stop
11	use_independent_qty
12	comm_refresh_off
13	no_check_off
14	disable_freq_calc
15	disable_autozero
16	Atwo_step_single
17	Btwo_step_single
18	use_prev_adjust
19	Control_air_enbl
20	Amid_with_low
21	Bmid_with_low
22	extra_config22
23	extra_config23
24	extra_config24
25	extra_config25
26	extra_config26
27	extra_config27
28	extra_config28
29	extra_config29
30	extra_config30
31	GTI_select

Bits definitions Aaccount_1 5.40 and Baccount_1 10.40

Bit	Status#	Description
0	27	process_started Right
1	27	process_started left
2	26	pressure_drop_detected
3	26	no_pressure_drop
4	24	waiting_short_delay
5	24	low_bank_on
6	24	waiting_motor_delay
7	24	motor_delay_time_out_bank_off
8	24	high_flow_flag_bank_off
9	22	high_bank_on_for_hose_check
10	22	high_bank_off_above_hose_mass
11	22	hose_check_time_out
12	22	abort_during_hose_check
13	22	lost_authorize_during hose_check
14	21	pressure_and_flow_settled_after_hose_check
15	21	mass_>_hose_mass_go_record_pressure
16	21	mass_<_hose_mass_wait_for_hose_drop
17	21	spare
18	20	waiting_for_hose_drop
19	20	abort_time_out_start_delay
20	20	detected pressure drop
21	20	pressure_and_flow_settled_after_hose_drop
22	19	waiting_for_pressure_and_flow_settle
23	19	pressure_settled
24	19	flow settled
25	19	flow_not_settled_10_sec_time_out_abort
26	19	initial_pressure_and_temperature_measured
27	19	spare
28	18	calculating_target mode 0
29	18	calculating_target mode 2
30	18	calculating_target mode 4
31	18	temperature compensation off

Bits definitions Aaccount_2 5.41 and Baccount_2 10.41

Bit	Status#	Description
0	18	using calculated pressure target
1	18	using fixed pressure target
2	18	spare
3	18	spare
4	18	target_pressure_exceeds_absolute
5	18	using given target
6	18	tank_already_>_95%_full_abort
7	18	spare
8	16	resist_measure
9	16	flow_maximum_during_resist_measure
10	16	pressure_differnce_sonic
11	16	pressure_differnce_subsonic
12	16	resistance_within_range
13	16	resistance_exceeds_maximum
14	16	resistance_below_minimum
15	6	spare
16	9	low bank fill all banks off
17	9	low bank fill flow_settled
18	9	low bank fill low bank on
19	9	low bank fill resistance_increased
20	9	low bank fill resistance_decreased
21	9	low bank fill waiting_Sdelay
22	9	low bank fill in process
23	9	low bank fill abort interbank_pressure_high
24	9	low bank fill change on pressure limit
25	9	low bank fill change on pressure target
26	9	low bank fill abort on pressure high
27	9	low bank fill change on low flow
28	9	low bank fill time out
29	9	low bank spare 1
30	9	low bank spare 2
31	8	mid bank fill all banks off

Bits definitions Aaccount_3 5.42 and Baccount_2 10.42

Bit	Status# - Description
0	8 mid bank fill flow_settled
1	8 mid bank fill mid bank on
2	8 mid bank fill resistance_increased
3	8 mid bank fill resistance_decreased
4	8 mid bank fill waiting_Sdelay
5	8 mid bank fill in process
6	8 mid bank fill abort interbank_pressure_high
7	8 mid bank fill change on pressure limit
8	8 mid bank fill change on pressure target
9	8 mid bank fill abort on pressure high
10	8 mid bank fill change on low flow
11	8 mid bank fill time out
12	8 mid bank spare 1
13	8 mid bank spare 2
14	7 high bank fill all banks off
15	7 high bank fill flow_settled
16	7 high bank fill high bank on
17	7 high bank fill resistance_increased
18	7 high bank fill resistance_decreased
19	7 high bank fill waiting_Sdelay
20	7 high bank fill in process
21	7 high bank fill abort interbank_pressure_high
22	7 high bank fill change on pressure limit
23	7 high bank fill change on pressure target
24	7 high bank fill abort on pressure high
25	7 high bank fill change on low flow
26	7 high bank fill time out
27	7 high bank spare 1
28	7 high bank spare 2
29	4 fill_complete wait for settle
30	4 fill_complete
31	2 abnormal shutdown

Bits definitions Aaccount_4 5.43 and Baccount_2 10.43

Bit	Status# Description
0	1 data_recorded wait for handle off
1	spare98
2	0 spare99
3	0 fill denied temperature error
4	0 drop flag time out
5	spare102
6	spare103
7	9 low bank burst_detect
8	8 mid bank burst_detect
9	7 high bank burst_detect
10	spare107
11	spare108
12	spare109
13	low bank pressure exceeds Smax
14	mid bank pressure exceeds Smax
15	high bank pressure exceeds Smax
16	low bank pressure exceeds absolute
17	mid bank pressure exceeds absolute
18	high bank pressure exceeds absolute
19	handle_shut_off_during_fill
20	redundant pressure error abort
21	lost authorize during fill
22	spare 119
23	spare 120
24	spare 121
25	spare 122
26	spare 123
27	spare 124
28	spare 125
29	spare 126
30	spare 127
31	spare 128

12. Document Revision History

Rev. 0: original release 7-28-2010

Rev. 1: release 6-72-2010: corrections to ModBus addresses.

Rev. 2: release 5-2-2012: added variables and parameters from program revisions 3.962 through 3.966.

Rev. 3: corrected B process addresses page 35. Changed parameter 207 and 400 to ave_gas_temp from final_flags for program revision 3.967 and higher. Added parameters 847 control_air_thres and 848 control_air_cal for program revision 3.968 and higher. Added extra_config bit 19 Conrol_air_enbl for program revision 3.968 and higher.

Rev 4: Logo Swap. Updated Safety Warning

BV 8

HOKE
6610MS4Y

PURGE VALVE - 7/16 - 20” MSAE 6000 PSI
STAINLESS STEEL

ANGI PART NUMBER - 330-07312

NO REBUILD KIT AVAILABLE

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6600 SERIES BLEED VALVE

Purpose:
- Hoke 6600 Series Bleed Valves allow for quick, easy manual bleed off of system pressure

Typical Applications:
- Air, Hydraulic Systems or Natural Gas

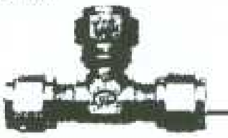
Technical Data: 6610, 6660, 6670, and 6680 Series Bleed Valves:
- Maximum Operating Pressure: 6000 PSIG @ 70°F (414 Bar @ 21°C)
- Operating Temperature Range: -40° to 600°F (-40° to 316°C)
- End Connections: 1/4, 3/8, 1/2 inch Gyrolok®

Technical Data: 6631 Series Bleed Valves:
- Maximum Operating Pressure: 5000 PSIG @ 70°F (345 Bar @ 21°C)
- Operating Temperature Range: -20° to 425°F (-29° to 218°C)
- Orifice: .125 in. (3.2mm)
- End Connections: 1/4" NPT, 1/4" Tube Stub

Features:
- Compact Installation
- 316 Stainless Steel Construction
- Straight, Union, Elbow or Tee Flow Configurations
- Integral Tube Ends

Benefits:
- Safe
- Reliable
- Gyrolok® Fitting Connections Eliminate Pipe Thread Leak Paths

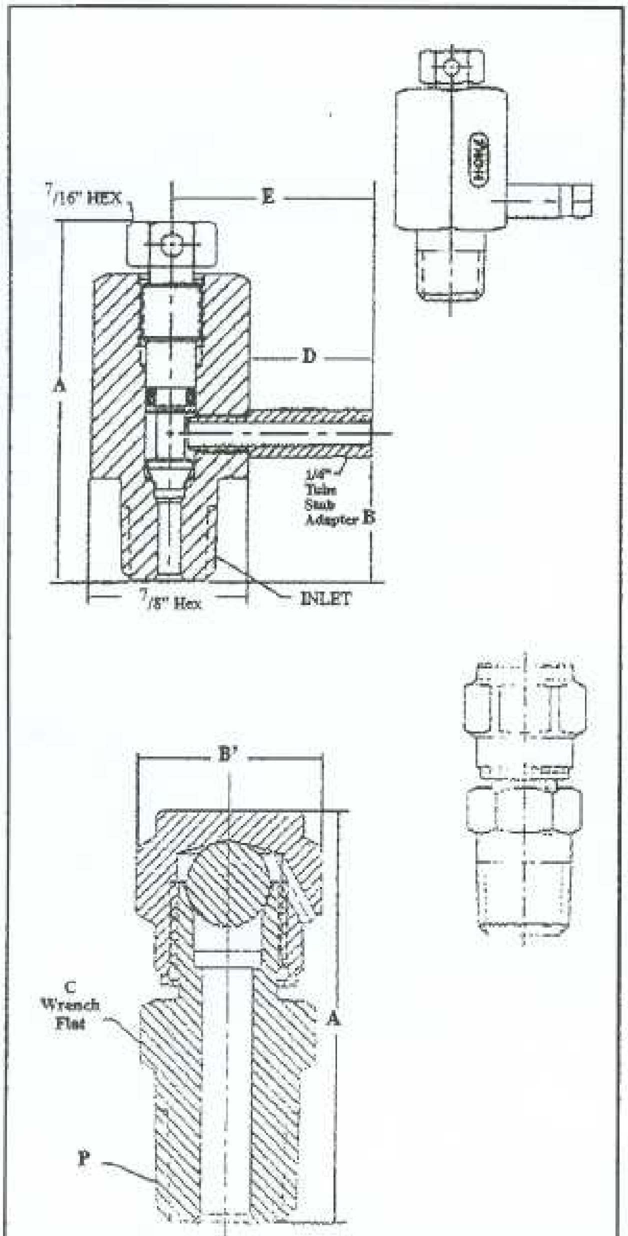
Operation Instructions: (For all but the 6631 Series Valves)
- Valve is operated by turning the bleed port nut with a wrench. Use appropriate back-up wrench to hold body, while turning bleed nut.
- As bleed nut is turned, pressure forces ball off seat. Pressure is vented through a hole drilled in the nut, angled back toward the body of the valve. Make sure flow is directed away from user.
- Those using the valves should wear protective clothing, especially goggles.
- No attempt should be made to repair or dismantle the valve.



6600 SERIES BLEED VALVE

Part Number/Ordering Chart:

Series Designation	Configuration	End Type	End Size	Material
66 - Bleed Valve	10-Straight 31-Directed 60-Elbow 70-Union 80-Tee	G-Gyrolok H-Male NPT x Tube Stub M-Male NPT	4-1/4 in. 6-3/8 in. 8-1/2 in.	Y-316SS



6631 Series Bleed Valves:

Hoke's 6631 Bleed Valve allows the user to direct the bled fluid as desired. To operate simply turn the 7/16" nut with a wrench or the optional loose fit handle, part number 96706-103.

Part Number	Inlet	A (open)	B	D	E
6631H4Y	1/4 Male NPT	2 (51mm)	3/4 (19mm)	11/16 (17mm)	1 1/8 (29mm)
6631H84Y	1/2 Male NPT	2 1/8 (54mm)	29/32 (23mm)	11/16 (17mm)	1 1/8 (29mm)

6610 6660, 6670, And 6680 Series Bleed Valves:

These Hoke Valves come in a variety of configurations including Straight, Elbow, Union, and Tee. See operating instructions and technical data on front cover.

Part Number	P Thread NPT	A Open	B' Hex	C Wrench Flat
6610M4Y	1/4	1 17/32 (39mm)	5/8	9/16
6610MGY	3/8	1 19/32 (40mm)	5/8	11/16
6610M8Y	1/2	1 13/16 (46mm)	5/8	7/8

• Dimensions for reference only and are subject to change without notice.

CV 2

HOKE
6133M4Y3
1/4" MNPT CHECK VALVE 6000 PSI,
2 PSI CRACKING PRESSURE SPRING

ANGI PART NUMBER 336-02419

REBUILD KIT ASSY - 804-06816

BALL CHECK VALVE 1/4 SS 6130 SERIES – 339-06818

O’RING CHECK VALVE 6130 SERIES – 710-07377

GASKET CHECK VALVE 6130 & 6230 SERIES – 260-06819

SPRING CHECK VALVE 6100 & 6230 SERIES SS & BRASS 2 PSI – 650-06820

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Check Valves—Ball and Poppet Designs 6100–6200 Series

6133G4Y

6253F8Y

FEATURES:

- O-ring seat provides leak-tight shut-off.
- Internal design guides flow around or inside spring, not through coils, when valve is open.
- All models are tested in production to assure a leak-tight body joint and seat.
- Ball & Poppet designs are available as standard.
- Ball type provides effective leak-tight closure with minimum flow resistance.
- Poppet models provide large flows with a minimum of chatter and fluctuation.
- Valves are available with various cracking pressures, from 1/3 to 25 PSI.
- 2-piece body permits interchangeability of end connections.

APPLICATIONS:

- Prevents reversed flow to protect solenoids, regulators and pumps
- Locks pressure in hydraulic cylinders
- Low pressure inline relief valve
- Vent valve to purge a system

Maximum Operating Pressure:
Brass Valves: 3000 PSIG @ 70°F (211 Kg/Cm^2 @ 21°C)
SS Valves: 6000 PSIG @ 70°F (423Kg/Cm^2 @ 21°C)
Operating Temperature Range:
Buna N O-ring: –40° to 200°F (–40° to 93°C)
Viton O-ring: –20° to 350°F (–29° to 177°C)
Cracking Pressure Standard: 2 PSI (.14 Kg/Cm^2)
Orifice Sizes: .187" (4.75mm), .422" (10.7mm)
Cv Factor: 0.3, 2.4

MATERIALS OF CONSTRUCTION

	Ball Type			Poppet Type
	Brass Valves	316SS Valves	Monel	316SS
Body	Brass	316SS	Monel	316SS
Ball or Poppet	302SS	316SS	Monel	316SS
Spring	302SS	316SS	Monel	316SS
O-ring seat	Buna N	Viton	Viton	Viton Buna N*
Gasket (Body)	Mylar	Teflon	Teflon	Teflon Buna N*

**For poppet check valves with ⅜ and ½ NPT female connections.*

BALL CHECK VALVES

A & B Connections	ORDER BY NUMBER Brass Valves	Monel	316 SS Valves	Orifice
1/8 NPT Female	6113F2B	—	6133F2Y	.187
1/8 NPT Male	6113M2B	—	6133M2Y	.187
1/4 NPT Female	6113F4B	—	6133F4Y	.187
1/4 NPT Male	6113M4B	—	6133M4Y	.187
1/4 Gyrolok	6113G4B	6133G4M	6133G4Y	.187
3/8 Gyrolok	6113G6B	6133G6M	6133G6Y	.187
1/4 NPT Male x 1/4 Gyrolok	6113H4B	—	—	.187
6MM Gyrolok	—	—	6133G6Y/MM	.187

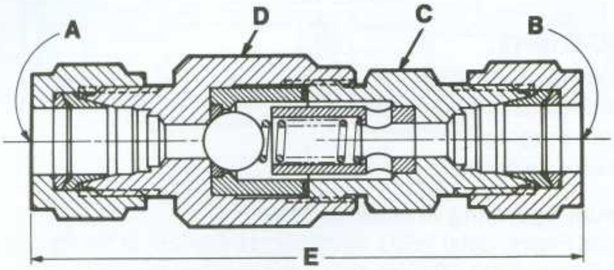
POPPET CHECK VALVES

A & B Connections	ORDER BY NUMBER 316 SS Valves	Orifice
1/4 NPT Female	6233F4Y	.187
1/4 NPT Male	6233M4Y	.187
1/4 Gyrolok	6233G4Y	.187
3/8 Gyrolok	6233G6Y	.187
1/2 NPT Female	6253F8Y	.422
1/2 Gyrolok	6253G8Y	.422

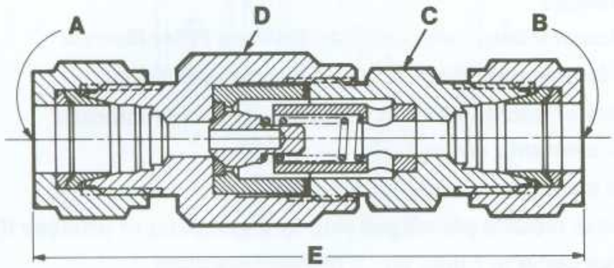
OTHER DIFFERENTIAL CRACKING PRESSURES

All check valves except 3/8 and 1/2 NPT female models can be furnished with other than 2 PSI cracking pressures. To order, change the fourth digit (3) of the desired valve part number as follows: Example: 6115G4B would have 10 PSI cracking pressure.

Cracking Pressure	Fourth Digit
1/3 PSI	"1"
10 PSI	"5"
25 PSI	"6"



6133G4Y
BALL TYPE

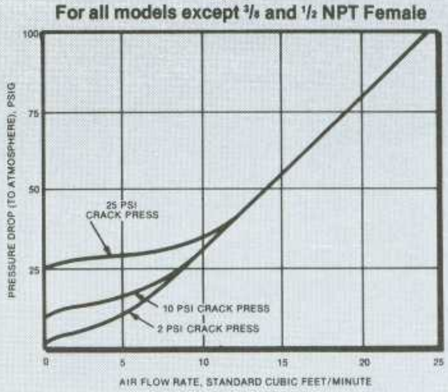


6233G4Y
POPPET TYPE

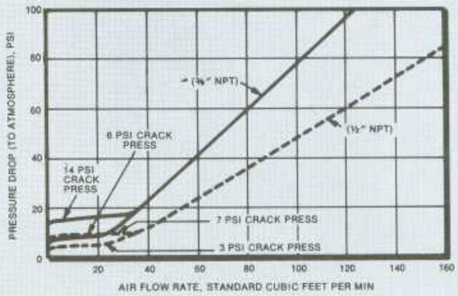
DIMENSIONS

Type	A & B Connections		C (Hex)	D (Hex)	E
Ball	1/8 NPT Female	mm	17	19	60
		inch	11/16	3/4	2 3/8
	1/8 NPT Male	mm	17	19	60
		inch	11/16	3/4	2 3/8
	1/4 NPT Female	mm	19	19	64
		inch	3/4	3/4	2 1/2
	1/4 NPT Male	mm	17	19	60
		inch	11/16	3/4	2 3/8
	1/4 NPT Male 1/4 Gyrolok	mm	17	19	70
		inch	11/16	3/4	2 3/4
	6MM Gyrolok	mm	17	19	76
		inch	11/16	3/4	3
	1/4 Gyrolok	mm	17	19	76
		inch	11/16	3/4	3
	3/8 Gyrolok	mm	25	19	79
		inch	1	3/4	3 1/8
Poppet	1/4 NPT Female	mm	19	19	64
		inch	3/4	3/4	2 1/2
	1/4 NPT Male	mm	17	19	60
		inch	11/16	3/4	2 3/8
	1/4 Gyrolok	mm	17	19	76
		inch	11/16	3/4	3
	3/8 Gyrolok	mm	25	19	79
		inch	1	3/4	3 1/8
	1/2 Female	mm	32	32	89
		inch	1 1/4	1 1/4	3 1/2

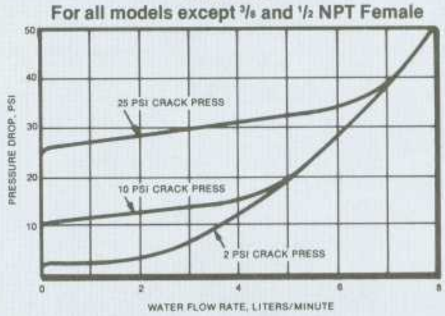
AIR
For all models except 3/8 and 1/2 NPT Female



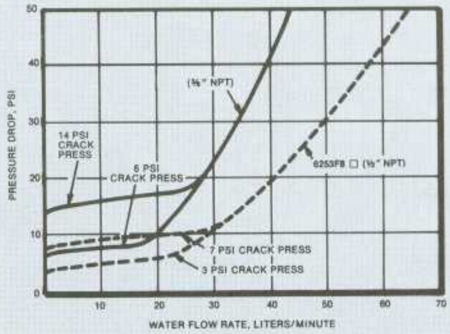
AIR



WATER
For all models except 3/8 and 1/2 NPT Female



WATER



CV 92

HOKE
CVH-080

CHECK VALVE 1 FSAE (SAE-16) 6000#
W/20# CRACKING SPRING

ANGI PART NUMBER – 336-07321

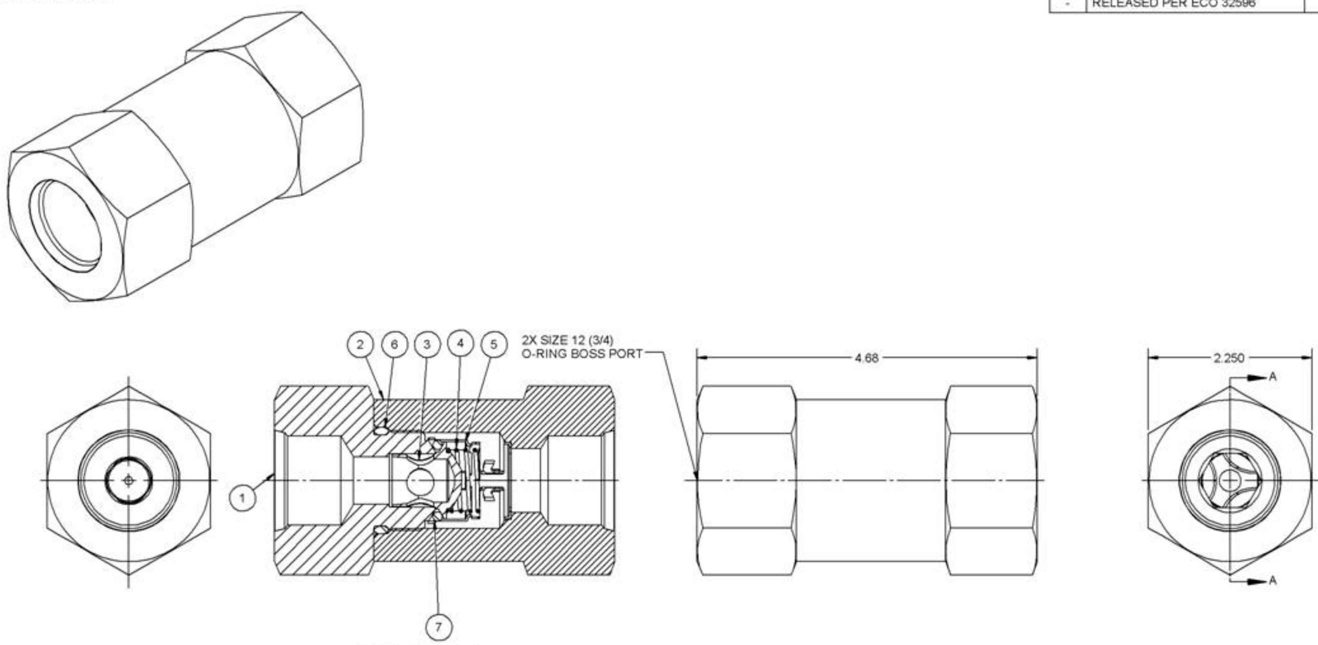
O'RING – 761-07418

SPRING – 650-07358

DWG NO.	CVH-080	SHT 1

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
-	RELEASED PER ECO 32596	1/12/2012	MSS



SECTION A-A

NOTE:

FOR ASSEMBLY, TEST & MARKING INSTRUCTIONS SEE CVH SERIES DRAWING.

QTY.	PART NUMBER	DESCRIPTION	MATERIAL	ITEM NO.
1	58-211-59	O-RING	VITON	7
1	58-218-50	O-RING	VITON	6
1	121348	SPRING GUIDE, CVH (LARGE)	316 SST	5
1	121345-20	SPRING	302 SST	4
1	121342-103	POPPET, CVH (LARGE)	316 SST	3
1	121746-16-103	BODY, FEMALE SAE	316 SST	2
1	121745-16-103	END, FEMALE SAE	316 SST	1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE ALL BURRS
BREAK EDGES .005-.010
DRILL POINTS STANDARD
DEFAULT TOLERANCES ARE:
DECIMALS: .XXX = ±.005
.XX = ±.010
ANGLES ±1°
CONCENTRICITY ⌀.010
MACHINE FINISH 63 RMS
DO NOT SCALE DRAWING

APPROVALS		DATE
DRAWN	LJB	1/13/2012
CHECKED	MSS	1/18/2012
APPROVED	KDJ	1/19/2012
INITIAL USAGE (REF ONLY)		
CAD FILE NAME	CVH-080	

HOKE
SPARTANBURG, SOUTH CAROLINA 29303

TITLE: CHECK VALVE
SIZE 16 FEMALE SAE
1 PSI, 316 SST, VITON SEALS

SIZE	CAGE CODE	DWG NO.	REV
C	28968	CVH-080	-

SCALE 1:1 | CALC. WT | ACT. WT | SHEET 1 OF 1

DM 9

MICRO MOTION
CNG50S291NWCAEZZZ
MASS FLOW METER CNG50

ANGI PART NUMBER 902-07240

***FOR MORE INFORMATION,
PLEASE SEE THE MICROMOTION SECTION
IN THIS MANUAL***

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Product Data Sheet
PS-00408, Rev. B
October 2004

Micro Motion® CNG050
Compressed Natural Gas Flowmeter

With MVD™ Technology

Micro Motion™

EMERSON™
Process Management

Micro Motion® CNG050 flowmeters

The first full-range CNG flowmeter designed and tested specifically for compressed natural gas, resulting in better performance in CNG applications.

The CNG050 meter was specifically designed for the CNG industry to meet the challenges of measuring compressed natural gas. The meter's increased rangeability allows customers the flexibility to use the sensor for automobile or light- or heavy-duty vehicle dispenser designs.

Micro Motion CNG050 meters feature integral transmitters, making them easy to install. Offered with Series 1000 and 2000 transmitters with MVD™ Technology, customers can choose either single or multivariable output configurations with milliamp, pulse, dual pulse, digital outputs, and an integral display.

Micro Motion MVD™ Direct Connect™ Technology is making Coriolis flowmeters from Micro Motion even more suitable for CNG applications. OEMs can benefit from MVD Direct Connect Technology, which allows smart sensors to communicate directly with dispenser head electronics via Modbus — no transmitter is required!

Like all Micro Motion flowmeters, CNG050 meters offer highly accurate direct mass and volume flow measurement.

Micro Motion CNG050 meters are designed to perform in even the most harsh operating environments, and carry hazardous area approvals for the U.S.A., Canada, and Europe.

Easy to use

CNG050 meters have no moving parts, no need for periodic recalibration, non-intrusive design, and no regular maintenance requirements.

Wide rangeability

The CNG050 meter is used for both car and bus dispenser designs alike. With a 1–100 kg/min flow range, the CNG050 is truly a one-size-fits-all CNG flowmeter.

CNG station reconciliation

The AGA 11 guidelines recently published by the American Gas Association allow for the use of Coriolis meters like the Micro Motion CNG050 in the custody transfer of natural gas. Combining a low pressure check meter (such as a Micro Motion ELITE® or F-Series sensor) on the natural gas inlet with a CNG050 dispensing meter allows for true mass balancing of CNG stations.

MVD™ technology

Reduced fill times

Having a higher flow rate capacity means that vehicles can get back on the road faster than ever.

Proven technology

Micro Motion is known worldwide for increasing plant efficiency, production, and profitability. More than 400,000 Micro Motion meters are installed in applications worldwide, including 15,000 CNG applications.

Greater accuracy and versatility

Micro Motion CNG050 meters have a CNG accuracy of 0.5% of delivered batch over a flow range of 2 to 220 lbs/min (1 to 100 kg/min). This translates to reduced dispenser losses and is approved worldwide by weights and measures authorities.

Weights and measures approvals

Country	Approval
U.S.A.	NTEP
Germany	PTB
Netherlands	NMI
China	Pattern approval
Malaysia	SIRIM
India	Ministry of Consumer Affairs
Italy	Ufficio Metrico Italiano
Canada	Measurement Canada (pending)
Brazil	Inmetro (pending)

Vehicle filling

Because of its clean combustion, CNG is increasingly used as a vehicle fuel in many parts of the world. Micro Motion CNG050 meters used in dispenser stations are routinely verified (proved) against a gravimetric standard, the highest performance rating possible. In addition, the CNG050 meter can be used as a Master Meter standard, thus providing increased safety and eliminating cumbersome scale setup and venting of gas.

Micro Motion CNG050 flowmeters *continued*

Software functionality

The CNG050 sensor can be used with Micro Motion transmitter with MVD Technology. The standard software option of the Series 1000 or 2000 is most common.

A Micro Motion MVD Direct Connect pass-through I.S. barrier can also be used in public stations if it is installed in a separate, sealable housing.

Weights and measures configuration lockout

For applications that require weights and measures approval for legal trade (i.e., public CNG stations), the weights and measures configuration lockout software option for Model 2500 and 2700 transmitters should be ordered with the CNG050 sensor. The configuration lockout software option allows the transmitter to be changed from operating (secure) mode to configuration mode (and back again) using ProLink® II software. The transmitter will register flow only when in the operating (secure) mode. The transmitter will allow configuration changes and zeroing of the meter only when in configuration mode.

When the configuration lockout option is ordered, a means is provided for physically sealing the transmitter housing.

The configuration lockout software option may not be required by certain world area weights and measures authorities. The performance of the CNG050 sensor is not affected by configuration lockout, and the sensor meets batch and accuracy specifications with standard features.

Flow specifications

	Mass		Standard volume[1]	
	lb/min	kg/min	SCFM	Nm^3/hr
Flow range	2 to 220	1 to 100	40 to 4444	68 to 7550
Batch accuracy[2][3]	±0.50% of batch			
Repeatability[2]	±0.30% of rate			
	lb/min	kg/min		
Zero stability	0.02	0.009		

(1) CNG with SG = 0.66 at 60 °F (15.5 °C) and 14.73 psia (1 bar-a).

(2) In terms of percent of total batch delivered on CNG.

(3) Accuracy is under typical CNG batch/dispensing conditions. Typical batch/dispensing conditions are defined as those where the flow rate is greater than 4 lbs/min (109 kg/hr).

Pressure ratings

	psi	bar
Flow tube rating	5000	345
Pressure limits[1]	5000	345
Union to NPT adapter piece rating[2]	4600	317
Housing rating	Housing is not rated for pressure containment.	
PED compliance	Sensor complies with council directive 97/23/EC of 29 May 1997 on Pressure Equipment	

(1) All fittings are rated to 5000 psi (345 bar) — the Union SWG type fitting according to ASME B31.3, and the SAE fitting according to SAE J1453.

(2) Pressure rating of the additional adapter piece (#12 O-ring face seal to female NPT) that is provided with process connection option 239.

Environmental limits

		°F	°C
Process fluid temperature limits		–40 to +257	–40 to +125
Ambient temperature limits	CSA and MMI standard (no approval)	–40 to +140	–40 to +60
	ATEX	Refer to the graph below.	
Humidity limits	5 to 95% relative humidity, non-condensing at 140 °F (60 °C)		
Vibration limits	Meets IEC 68.2.6, endurance sweep, 5 to 2000 Hz, 50 sweep cycles at 1.0 g		

Hazardous area classifications

CSA is a Canadian approvals agency that provides approvals accepted both in the U.S.A (C-US) and in Canada. ATEX is a European directive.

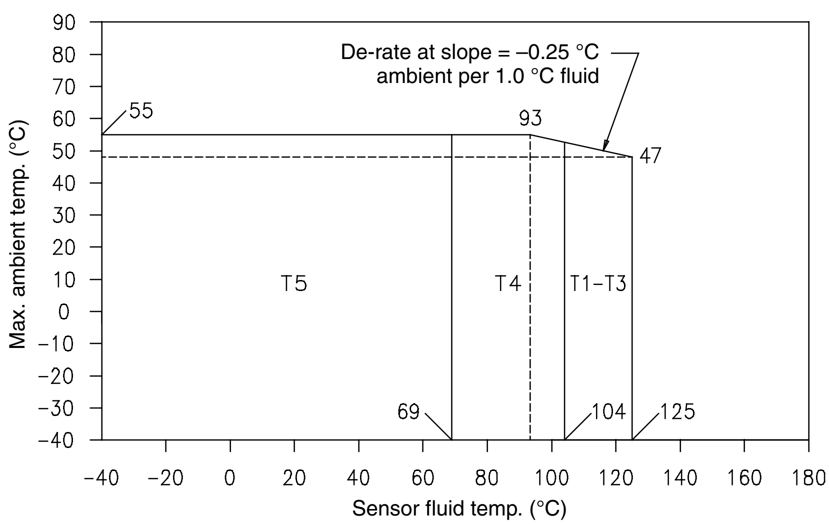
CSA

Class I, Div. 1, Groups C and D
Class I, Div. 2, Groups A, B, C, and D
Class II, Div. 1, Groups E, F, and G

ATEX

EEx ib IIC T1–T5(1)

Allowable CNG050 sensor temperature rating with core processor or integrally mounted transmitter



(1) *The "T" rating is defined as the maximum surface temperature of the flowmeter. The "T" rating of the hazardous area, and ambient temperatures above 47 °C, restrict the allowable temperature of the process fluid as shown in the graph above.*

Materials of construction

Wetted parts[1]	316L stainless steel
Sensor housing	304L stainless steel
Core processor housing	CF-3M stainless steel or epoxy-painted aluminum; NEMA 4X (IP65)

(1) General corrosion guidelines do not account for cyclical stress, and therefore should not be relied upon when choosing a wetted material for your Micro Motion flowmeter. Please refer to Micro Motion's corrosion guide for material compatibility information.

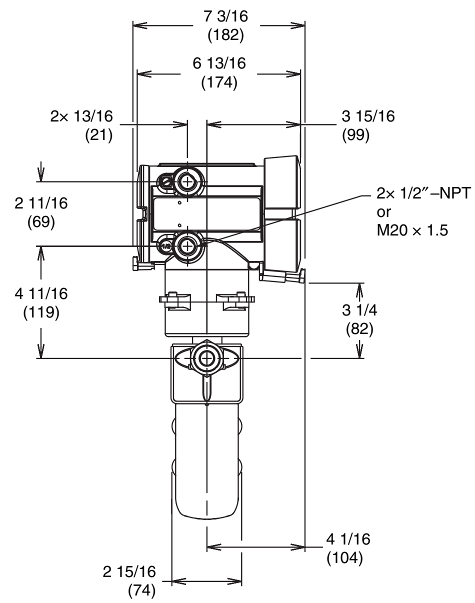
Weight

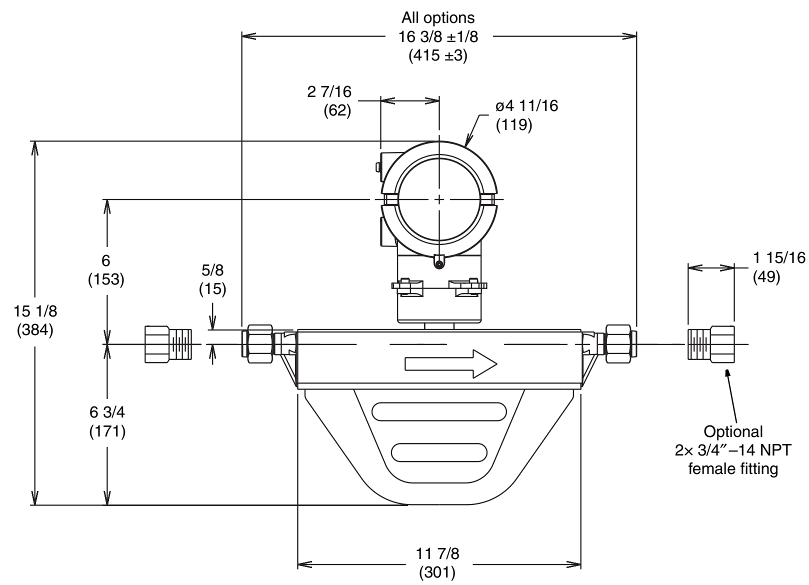
Sensor with core processor	16 lbs (7 kg)
Sensor with integrally mounted transmitter	18 lbs (8 kg)

Dimensions

CNG050 sensor with integrally mounted Model 1700/2700 transmitter

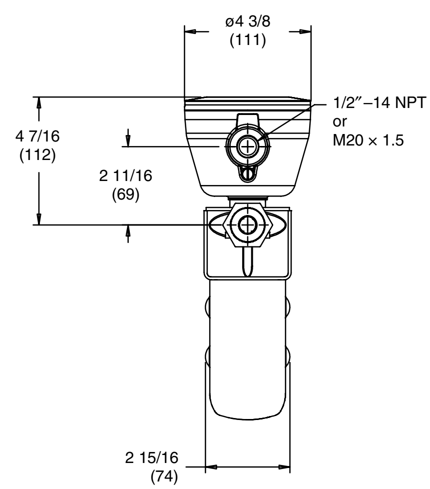
Dimensions in *inches (mm)*

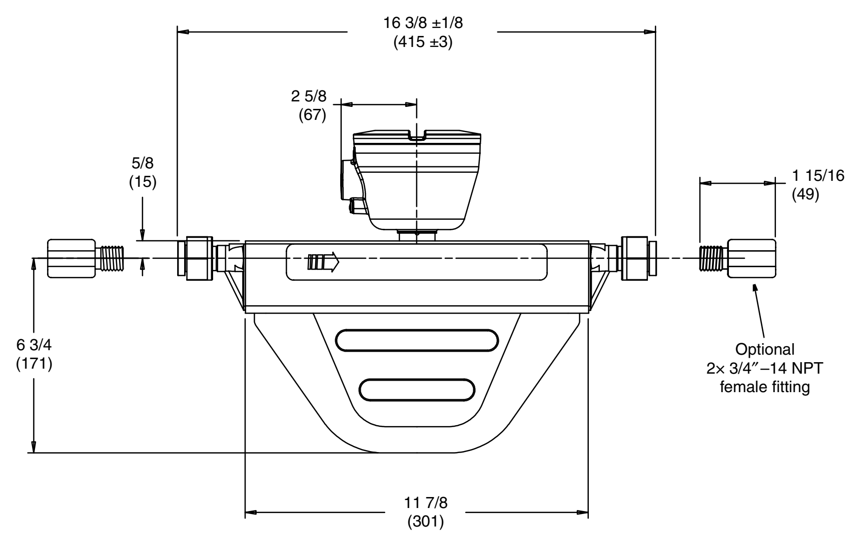




CNG050 sensor with core processor

Dimensions in *inches (mm)*





Ordering information

Model	Product Description
CNG050S	Micro Motion Coriolis CNG-Series sensor; 1/2-inch; 316L stainless steel
Code	**Process Connections**
239(1)	3/4-inch NPT-female adapter; CAJON compatible size 12 VCO union fitting
290(2)	CAJON compatible size 12 VCO union fitting
291(2)	Union size 12 SAE fitting (universal thread)
Code	**Case Options**
N	Standard
Code	**Electronics Interface**
Q	4-wire epoxy-painted aluminum integral core processor for remote mount transmitters
A	4-wire stainless steel integral core processor for remote mount transmitters
C	For integrally mounted 1700/2700 transmitter
W(3)	Epoxy-painted aluminum integral core processor for MVD Direct Connect installation
D(3)	Stainless steel integral core processor for MVD Direct Connect installation
Code	**Conduit Connections**
	Electronics Interface Codes Q, A, W and D
B	1/2-inch NPT — no gland
E	M20 — no gland
F	Brass/nickel cable gland (cable diameter 0.335 to 0.394 inches [8.5 to 10.0 mm])
G	Stainless steel cable gland (cable diameter 0.335 to 0.394 inches [8.5 to 10.0 mm])
	Electronics interface Code C (Integrally mounted 1700/2700)
A	No gland
Code	**Approvals(3)**
M	Micro Motion Standard (no approval)
N	Micro Motion Standard / PED compliant
C	CSA (Canada only)
A	CSA C-US (U.S.A. and Canada)
Z	ATEX - Equipment Category 2 (Zone 1) / PED compliant
Continued on next page	

(1) 3/4-inch NPT female adapter to O-ring face seal adapter rated to 4600 psi (317 bar).

(2) Ready for face seal O-ring (not included).

(3) When electronics interface W or D is ordered with approval codes C, A, or Z, an MVD Direct Connect I.S. barrier is supplied. No barrier is supplied when ordered with approval codes M or N.

Ordering information *continued*

Code	Language
A	Danish Quick Reference Guide and English Manual
D	Dutch Quick Reference Guide and English Manual
E	English Quick Reference Guide and English Manual
F	French Quick Reference Guide and French Manual
G	German Quick Reference Guide and German Manual
H	Finnish Quick Reference Guide and English Manual
I	Italian Quick Reference Guide and English Manual
J	Japanese Quick Reference Guide and English Manual
N	Norwegian Quick Reference Guide and English Manual
O	Polish Quick Reference Guide and English Manual
P	Portuguese Quick Reference Guide and English Manual
S	Spanish Quick Reference Guide and Spanish Manual
W	Swedish Quick Reference Guide and English Manual
Code	**Future Option 1**
Z	Reserved for future use
Code	**Future Option 2**
Z	Reserved for future use
Code	**Factory Options**
Z	Standard product
R	Restocked product (if available)
Typical Model Number:	**CNG050S 290 N C A A E Z Z Z**

F 177

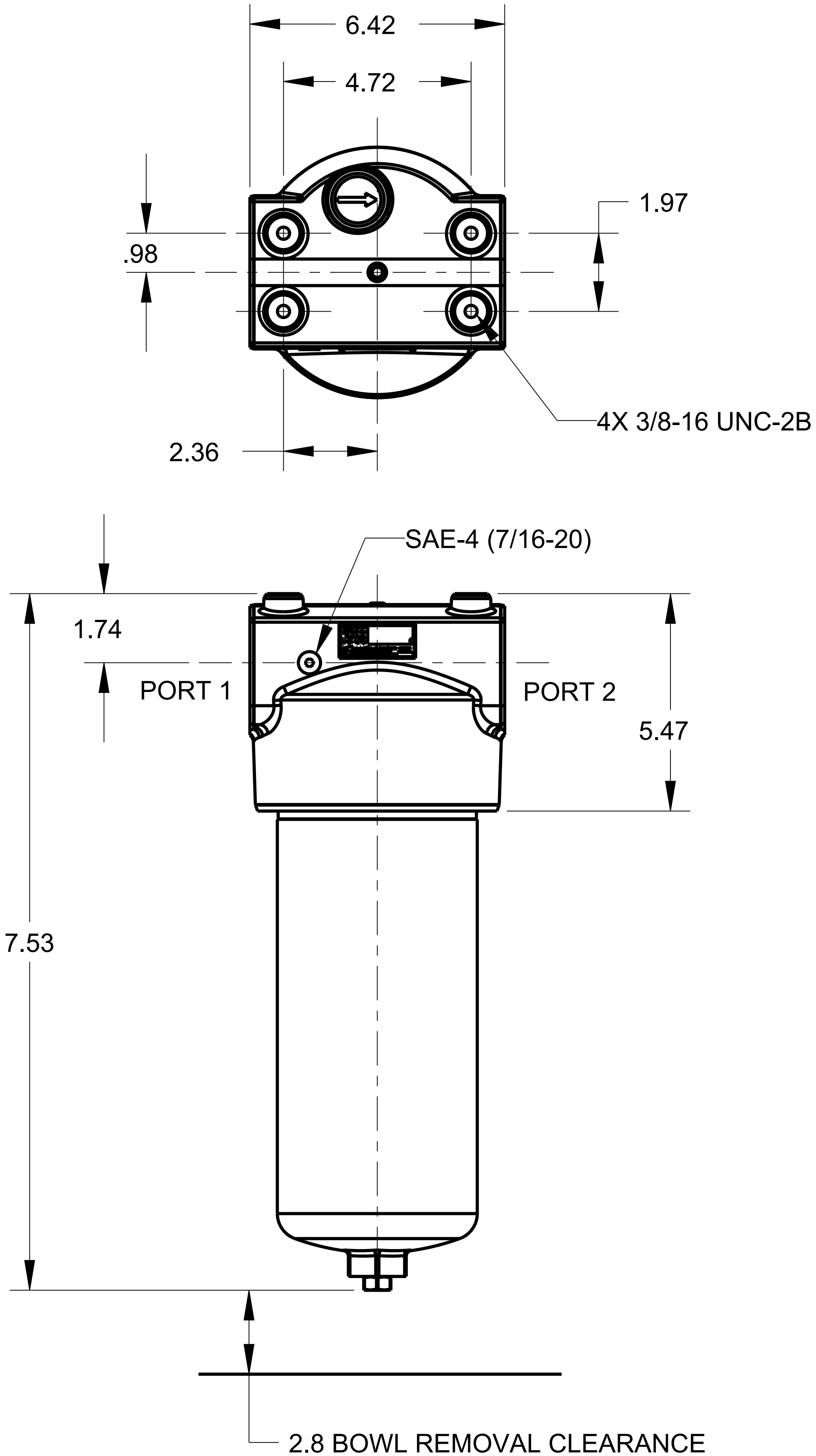
ANGI
JS6D-10CN

FILTER - SAE-24 GR10 COALESCING
ELEMENT 5500 PSI

ANGI PART NUMBER – 772-07307

ELEMENT – 772-07327

SEAL KIT – 760-07384



ASSEMBLY NUMBER: JS6D

PORT TYPE & SIZE

FLOW PORTS 1 & 2: SAE-24 (1-7/8-12)
PRESSURE TAP: SAE-4 (7/16-20), PLUG INCLUDED
DRAIN: SAE-6 (9/16-18), PLUG INCLUDED
MAXIMUM PRESSURE: 5,500 PSIG
MAXIMUM TEMPERATURE (HOUSING ONLY): 350° F
MAX. DIFFERENTIAL PRESSURE AT ELEMENT REPLACEMENT: 10 PSID
SUMP CAPACITY: 500ML
MOUNTING: LINE MOUNTED, VERTICAL AS SHOWN, MOUNTING HOLES PROVIDED
ASSEMBLY WEIGHT: 45.0 LBS

MATERIALS

HEAD: NICKEL-PLATED SG IRON, POWDER PAINTED WHITE
BOWL: NICKEL-PLATED STEEL, POWDER PAINTED WHITE
PRESSURE PLUG: ZINC-PLATED STEEL
DRAIN PLUG: ZINC-PLATED STEEL
SEALS: FLUOROCARBON
NON-WETTED BACKING RING: NITRILE RUBBER
FILTER ELEMENT: SEE TABLE

FILTER ASSEMBLY P/N	REPLACEMENT ELEMENT P/N	MEDIA TYPE	RATED FLOW at 100 PSIG	RATED FLOW at 3000 PSIG	RATED FLOW at 5000 PSIG
772-07307	772-07327	PRE-COALESCER	400 SCFM	10515 SCFM	17490 SCFM

REV	DATE/BY	DESCRIPTION
B	09/10/2012 MDP	UPDATED

ANGI ENERGY SYSTEMS

ANGI ENERGY SYSTEMS
15 PLUMB STREET
MILTON, WI 53563
PH: 608-868-4626
FX: 608-868-2723

UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES
ALL DIMENSIONS IN INCHES

FRACTIONAL	±.125
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE: FILTER-ANGI SAE-24 JS6D GR10 (F177)
CUSTOMER:
PROJECT NO.:
SHEET: 1 of 1
SCALE: 0.250
DRAWN BY: MDP
DATE: 11/12/2010
DRAWING NO.: 772-07307
REV.: B

F 178

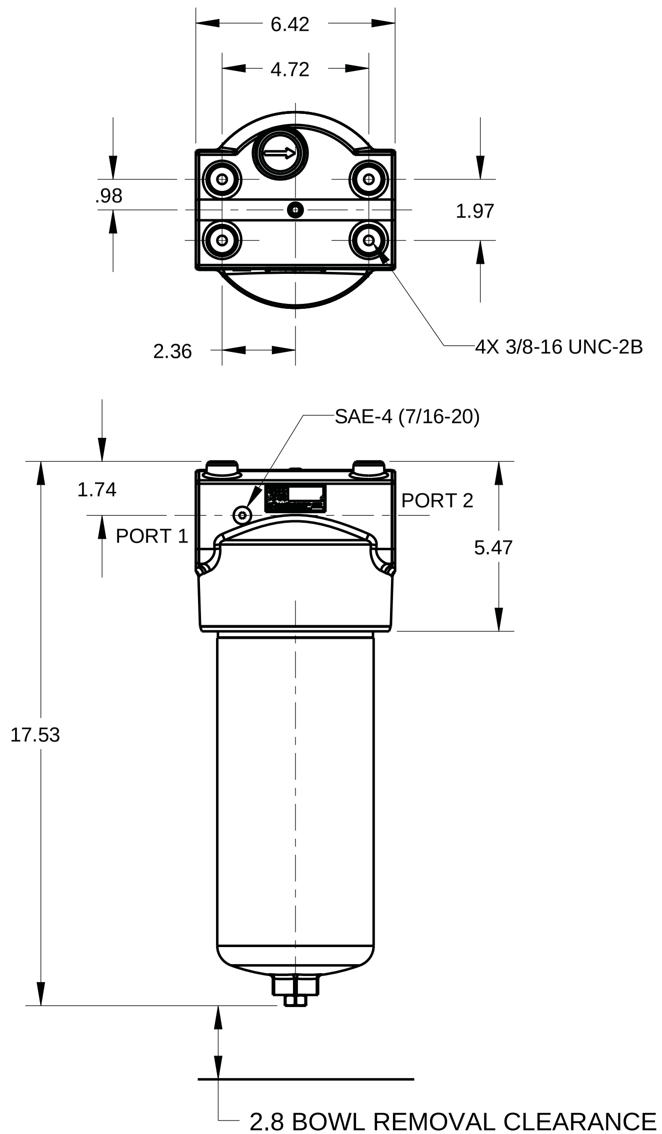
ANGI
JS6D-4CN

FILTER - SAE-24 GR4 COALESCING
ELEMENT 5500 PSI

ANGI PART NUMBER – 772-07308

ELEMENT – 772-07328

SEAL KIT – 760-07384



ASSEMBLY NUMBER: JS6D

PORT TYPE & SIZE

FLOW PORTS 1 & 2: SAE-24 (1-7/8-12)
PRESSURE TAP: SAE-4 (7/16-20), PLUG INCLUDED
DRAIN: SAE-6 (9/16-18), PLUG INCLUDED
MAXIMUM PRESSURE: 5,500 PSIG
MAXIMUM TEMPERATURE (HOUSING ONLY): 350° F
MAX. DIFFERENTIAL PRESSURE AT ELEMENT REPLACEMENT: 10 PSID
SUMP CAPACITY: 500ML
MOUNTING: LINE MOUNTED, VERTICAL AS SHOWN, MOUNTING HOLES PROVIDED
ASSEMBLY WEIGHT: 45.0 LBS

MATERIALS

HEAD: NICKEL-PLATED SG IRON, POWDER PAINTED WHITE
BOWL: NICKEL-PLATED STEEL, POWDER PAINTED WHITE
PRESSURE PLUG: ZINC-PLATED STEEL
DRAIN PLUG: ZINC-PLATED STEEL
SEALS: FLUOROCARBON
NON-WETTED BACKING RING: NITRILE RUBBER
FILTER ELEMENT: SEE TABLE

FILTER ASSEMBLY P/N	REPLACEMENT ELEMENT P/N	MEDIA TYPE	RATED FLOW at 100 PSIG	RATED FLOW at 3000 PSIG	RATED FLOW at 5000 PSIG
772-07308	772-07328	COALESCER	180 SCFM	4730 SCFM	7870 SCFM

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION
B	09/10/2012 MDP	UPDATED			

ANGI ENERGY SYSTEMS
15 PLUMB STREET
MILTON, WI 53563
PH: 608-868-4626
FX: 608-868-2723

UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES
ALL DIMENSIONS IN INCHES
FRACTIONAL ±.125
TWO PLACE DECIMAL ±.010
THREE PLACE DECIMAL ±.005
ANGLES ±1°

TITLE: FILTER-ANGI SAE-24 JS6D GR4 (F178)
CUSTOMER:
PROJECT NO.:
SHEET: 1 of 1
SCALE: 0.250
DRAWN BY: MDP
DATE: 11/12/2010
DRAWING NO.: 772-07308
REV.: B

G 22

WIKA
50394771

0-200 PSI/BAR PRESSURE GAUGE

ANGI PART NUMBER 741-07240

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WIKA

Industrial Gauges

Type 23X.53

- Stainless Steel Case & Crimp Ring
- Welded Case-to-Socket Connection
- Field Liquid-Fillable

Liquid Fillable

Type 232.53 - Dry case
Type 233.53 - Liquid filled case

The rugged construction of WIKA Type 23X.53 stainless steel gauges provides resistance to the most corrosive media and environments. These gauges feature 316 stainless steel wetted parts and a 304 stainless steel case and crimped ring, and can be liquid-filled in the field.

Standard Features

- **Nominal Case Size:** 2" (53 mm), 2½" (68 mm), 4" (100 mm)
- **Case Material:** 304 stainless steel
- **Wetted Parts:** 316 SS
- **Window Type & Material:** 2½" Polycarbonate; 4" Acrylic
- **Removable Window:** No
- **Dial Material:** White aluminum
- **Bezel Ring Type & Material:** Crimp on SS polished
- **Liquid Fillable Gauge:** Yes
- **Case-to-Socket O-ring Material:** Welded
- **"Other" Gaskets/O-ring Types & Materials:** Window gasket, BUNA-N
- **Pointer Material/Type:** Black aluminum
- **Adjustable Pointer:** No
- **Accuracy:** ±1.5% of span (2" & 2½"); (4") ± 1.0% of span-ASME B40.100 Grade 1A
- **Connection locations:** LM (Lower Mount), CBM (Center Back Mount) & LBM (Lower Back Mount) (4" only)
- **Media Operating Temperature:** 212°F
- **Ambient Operating Temperature:** -40°F to 140°F dry; -4°F to 140°F glycerine case fill; -40°F to 140°F silicone case fill

Available Options

"Dampened Movement" Option: Yes, (N/A on 2½" CBM or 2" LM/CBM) & LBM
U-Clamp Bracket: Yes (CBM only)
Front Flange: Yes (CBM & LBM only)
Rear Flange: Yes (LM, CBM & LBM)
Restrictor: Yes
Safety Glass Window: No
Instrument Glass Window (flat glass): No
Drag Pointer (maximum reading indicator): Yes
Cleaned for Use in Oxygen Service: Yes
Panel Mount Kit: Yes (see front flange or u-clamp option)
Magnetic or Inductive Contact Switches: No
Receiver Gauge Scales: Yes
Special Connection: Limited to wrench flat area

Type	232.53				
Connection	LM	CBM			
Conn. Size	1/4" NPT				
Size	2½"				
Pressure Scale[1]	PSI	PSI	PSI/BAR	PSI/KPA	PSI/KG/CM²
30" Hg	9768777	9768394			
30"-0-15 PSI					
30"-0-30 PSI	9768769	9768386			
30"-0-60 PSI	9768750	9768378			
30"-0-100 PSI					
30"-0-160 PSI	9768742	9768360			
30"-0-200 PSI					
15 PSI	9768734	9768351			
30 PSI	9768726	9768343			
60 PSI	9768718	9768335	8992848	8993089	8992962
100 PSI	9768700	9768327	8992856	8993097	8992970
160 PSI	9768696	9768319	8992865	8993101	8992988
200 PSI	9768688	9768300	8992873	8993119	8992996
300 PSI	9768670	9768297	8992881	8993127	8993004
400 PSI	9768661	9768289			
600 PSI	9768653	9768270	9779685	9779693	
800 PSI					
1,000 PSI	9768645	9768262	8992899	8993135	8993012
1,500 PSI	9768637	9768254	8992903	8993144	8993020
2,000 PSI	9768629	9768246	8992911	8993152	8993038
3,000 PSI	9768610	9768238	8992929	8993160	8993046
5,000 PSI	9768602	9768220	8992937	8993178	8993055
6,000 PSI		8993208	8992945	8993186	8993063
10,000 PSI	9768599	9768211	8992954	8993195	8993071
15,000 PSI		9779715	9776715		9779731

[1] "PSI/BAR" denotes dual scale; PSI outside in black, BAR inside in red; "PSI/KPA" denotes dual scale; PSI outside in black, KPA inside in red; "PSI/KG/CM²" denotes dual scale; PSI outside in black, KG/CM² inside in red. Note: Vacuum scale: 30" Hg outside in black; 760 mm Hg inside in red. [2]

Note: For options not shown - consult your WIKA Distributor or the Factory.

Data sheet: 23X.53

For liquid filled gauges, add "-829" to part numbers above for 2½" size or "-834" for 4" size.

Items shown with part numbers indicate readily available standard WIKA products. Items shown without part numbers are available on special order.

Type	232.53- liquid fillable		
Connection	LM	LM	LBM
Conn. Size	1/4" NPT	1/2" NPT	
Size	4"		
Pressure Scale	PSI	PSI	PSI
30" Hg	9767576	9768459	9737057
30"-0-15 PSI	9737910	9768467	9737065
30"-0-30 PSI	9767398	9768475	9737073
30"-0-60 PSI	9767401	9768483	9737081
30"-0-100 PSI	9737898	9737880	9737090
30"-0-160 PSI	9767410	9768491	9737103
30"-0-200 PSI	9737901	9768505	9737111
30"-0-300 PSI	4260147		
30"-0-400 PSI	4260155		
15 PSI	9767428	9768513	9737120
30 PSI	9767436	9768521	9737138
60 PSI	9767444	9768530	9737146
100 PSI	9767452	9768548	9737154
160 PSI	9767460	9768556	9737162
200 PSI	9767479	9768564	9737170
300 PSI	9767487	9768572	9737189
400 PSI	9767495	9768580	9737197
600 PSI	9767509	9768963	9737200
800 PSI			9737219
1,000 PSI	9767517	9768858	9737227
1,500 PSI		9768866	9737235
2,000 PSI		9768807	9737243
3,000 PSI		9768874	9737251
5,000 PSI		9768823	9737260
10,000 PSI		9768831	9737278
15,000 PSI		9768840	9737286

Type	233.53- glycerine filled				
Connection	LM		LM	LBM	CBM
Conn. Size	1/4" NPT		1/2" NPT		1/4" NPT
Size	2½"	4"	4"		2½"
Pressure Scale	PSI	PSI	PSI	PSI	PSI
30" Hg	9833646	9833124	9833328	9831504	9833310
30"-0-15 PSI		9831775	9833336	9831512	
30"-0-30 PSI	9833638	9832993	9833345	9831520	9833302
30"-0-60 PSI	9833620	9833000	9833353	9831538	9833298
30"-0-100 PSI		9831759	9831741	9831546	
30"-0-160 PSI	9833612	9833018	9833361	9831555	9833280
30"-0-200 PSI		9831767	9833379	9831563	
30"-0-300 PSI					
30"-0-400 PSI					
15 PSI	9833604	9833026	9833387	9831571	9833272
30 PSI	9833590	9833035	9833395	9831589	9833264
60 PSI	9833582	9833043	9833409	9831597	9833255
100 PSI	9833574	9833051	9833417	9831601	9833247
160 PSI	9833565	9833069	9833425	9831619	9833239
200 PSI	9833557	9833077	9833434	9831627	9833221
300 PSI	9833549	9833085	9833442	9831635	9833213
400 PSI	9833531	9833094	9833450	9831644	9833205
600 PSI	9833523	9833107	9833727	9831652	9833191
800 PSI					
1,000 PSI	9833515	9833115	9833697	9831678	9833183
1,500 PSI	9833506		9833701	9831686	9833175
2,000 PSI	9833493		9833655	9831695	9833166
3,000 PSI	9833485		9833719	9831708	9833158
5,000 PSI	9833476		9833663	9831716	9833140
10,000 PSI	9833468		9833671	9831725	9833132
15,000 PSI			9833689	9831733	

Type	232.53- Stock Gauges with Ammonia Scales	
Size	2 ½"	4"
Connection	LM	
Conn. Size	1/4" NPT	
30"-0-150 PSI / 84°F	9797144	9797127
30"-0-300 PSI / 126°F	9797152	9797135

G 57

WIKA
4272016
0-10,000 PSI/BAR PRESSURE GAUGE

ANGI PART NUMBER 741-07289

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WIKA

Industrial Gauges

Type 23X.53

- Stainless Steel Case & Crimp Ring
- Welded Case-to-Socket Connection
- Field Liquid-Fillable

Liquid Fillable

Type 232.53 - Dry case
Type 233.53 - Liquid filled case

The rugged construction of WIKA Type 23X.53 stainless steel gauges provides resistance to the most corrosive media and environments. These gauges feature 316 stainless steel wetted parts and a 304 stainless steel case and crimped ring, and can be liquid-filled in the field.

Standard Features

- **Nominal Case Size:** 2" (53 mm), 2½" (68 mm), 4" (100 mm)
- **Case Material:** 304 stainless steel
- **Wetted Parts:** 316 SS
- **Window Type & Material:** 2½" Polycarbonate; 4" Acrylic
- **Removable Window:** No
- **Dial Material:** White aluminum
- **Bezel Ring Type & Material:** Crimp on SS polished
- **Liquid Fillable Gauge:** Yes
- **Case-to-Socket O-ring Material:** Welded
- **"Other" Gaskets/O-ring Types & Materials:** Window gasket, BUNA-N
- **Pointer Material/Type:** Black aluminum
- **Adjustable Pointer:** No
- **Accuracy:** ±1.5% of span (2" & 2½"); (4") ± 1.0% of span-ASME B40.100 Grade 1A
- **Connection locations:** LM (Lower Mount), CBM (Center Back Mount) & LBM (Lower Back Mount) (4" only)
- **Media Operating Temperature:** 212°F
- **Ambient Operating Temperature:** -40°F to 140°F dry; -4°F to 140°F glycerine case fill; -40°F to 140°F silicone case fill

Available Options
"Dampened Movement" Option: Yes, (N/A on 2½" CBM or 2" LM/CBM) & LBM
U-Clamp Bracket: Yes (CBM only)
Front Flange: Yes (CBM & LBM only)
Rear Flange: Yes (LM, CBM & LBM)
Restrictor: Yes
Safety Glass Window: No
Instrument Glass Window (flat glass): No
Drag Pointer (maximum reading indicator): Yes
Cleaned for Use in Oxygen Service: Yes
Panel Mount Kit: Yes (see front flange or u-clamp option)
Magnetic or Inductive Contact Switches: No
Receiver Gauge Scales: Yes
Special Connection: Limited to wrench flat area

Type	232.53				
Connection	LM	CBM			
Conn. Size	1/4" NPT				
Size	2½"				
Pressure Scale[1]	PSI	PSI	PSI/BAR	PSI/KPA	PSI/KG/CM²
30" Hg	9768777	9768394			
30"-0-15 PSI					
30"-0-30 PSI	9768769	9768386			
30"-0-60 PSI	9768750	9768378			
30"-0-100 PSI					
30"-0-160 PSI	9768742	9768360			
30"-0-200 PSI					
15 PSI	9768734	9768351			
30 PSI	9768726	9768343			
60 PSI	9768718	9768335	8992848	8993089	8992962
100 PSI	9768700	9768327	8992856	8993097	8992970
160 PSI	9768696	9768319	8992865	8993101	8992988
200 PSI	9768688	9768300	8992873	8993119	8992996
300 PSI	9768670	9768297	8992881	8993127	8993004
400 PSI	9768661	9768289			
600 PSI	9768653	9768270	9779685	9779693	
800 PSI					
1,000 PSI	9768645	9768262	8992899	8993135	8993012
1,500 PSI	9768637	9768254	8992903	8993144	8993020
2,000 PSI	9768629	9768246	8992911	8993152	8993038
3,000 PSI	9768610	9768238	8992929	8993160	8993046
5,000 PSI	9768602	9768220	8992937	8993178	8993055
6,000 PSI		8993208	8992945	8993186	8993063
10,000 PSI	9768599	9768211	8992954	8993195	8993071
15,000 PSI		9779715	9776715		9779731

[1]"PSI/BAR" denotes dual scale; PSI outside in black, BAR inside in red; "PSI/KPA" denotes dual scale; PSI outside in black, KPA inside in red; "PSI/KG/CM²" denotes dual scale; PSI outside in black, KG/CM² inside in red. Note: Vacuum scale: 30" Hg outside in black; 760 mm Hg inside in red. [2]

Note: For options not shown - consult your WIKA Distributor or the Factory.

Data sheet: 23X.53

For liquid filled gauges, add "-829" to part numbers above for 2½" size or "-834" for 4" size.

Items shown with part numbers indicate readily available standard WIKA products. Items shown without part numbers are available on special order.

Type	232.53- liquid fillable		
Connection	LM	LM	LBM
Conn. Size	1/4" NPT	1/2" NPT	
Size	4"		
Pressure Scale	PSI	PSI	PSI
30" Hg	9767576	9768459	9737057
30"-0-15 PSI	9737910	9768467	9737065
30"-0-30 PSI	9767398	9768475	9737073
30"-0-60 PSI	9767401	9768483	9737081
30"-0-100 PSI	9737898	9737880	9737090
30"-0-160 PSI	9767410	9768491	9737103
30"-0-200 PSI	9737901	9768505	9737111
30"-0-300 PSI	4260147		
30"-0-400 PSI	4260155		
15 PSI	9767428	9768513	9737120
30 PSI	9767436	9768521	9737138
60 PSI	9767444	9768530	9737146
100 PSI	9767452	9768548	9737154
160 PSI	9767460	9768556	9737162
200 PSI	9767479	9768564	9737170
300 PSI	9767487	9768572	9737189
400 PSI	9767495	9768580	9737197
600 PSI	9767509	9768963	9737200
800 PSI			9737219
1,000 PSI	9767517	9768858	9737227
1,500 PSI		9768866	9737235
2,000 PSI		9768807	9737243
3,000 PSI		9768874	9737251
5,000 PSI		9768823	9737260
10,000 PSI		9768831	9737278
15,000 PSI		9768840	9737286

Type	233.53- glycerine filled				
Connection	LM		LM	LBM	CBM
Conn. Size	1/4" NPT		1/2" NPT		1/4" NPT
Size	2½"	4"	4"		2½"
Pressure Scale	PSI	PSI	PSI	PSI	PSI
30" Hg	9833646	9833124	9833328	9831504	9833310
30"-0-15 PSI		9831775	9833336	9831512	
30"-0-30 PSI	9833638	9832993	9833345	9831520	9833302
30"-0-60 PSI	9833620	9833000	9833353	9831538	9833298
30"-0-100 PSI		9831759	9831741	9831546	
30"-0-160 PSI	9833612	9833018	9833361	9831555	9833280
30"-0-200 PSI		9831767	9833379	9831563	
30"-0-300 PSI					
30"-0-400 PSI					
15 PSI	9833604	9833026	9833387	9831571	9833272
30 PSI	9833590	9833035	9833395	9831589	9833264
60 PSI	9833582	9833043	9833409	9831597	9833255
100 PSI	9833574	9833051	9833417	9831601	9833247
160 PSI	9833565	9833069	9833425	9831619	9833239
200 PSI	9833557	9833077	9833434	9831627	9833221
300 PSI	9833549	9833085	9833442	9831635	9833213
400 PSI	9833531	9833094	9833450	9831644	9833205
600 PSI	9833523	9833107	9833727	9831652	9833191
800 PSI					
1,000 PSI	9833515	9833115	9833697	9831678	9833183
1,500 PSI	9833506		9833701	9831686	9833175
2,000 PSI	9833493		9833655	9831695	9833166
3,000 PSI	9833485		9833719	9831708	9833158
5,000 PSI	9833476		9833663	9831716	9833140
10,000 PSI	9833468		9833671	9831725	9833132
15,000 PSI			9833689	9831733	

Type	232.53- Stock Gauges with Ammonia Scales	
Size	2 ½"	4"
Connection	LM	
Conn. Size	1/4" NPT	
30"-0-150 PSI / 84°F	9797144	9797127
30"-0-300 PSI / 126°F	9797152	9797135

MLV 15

ANDERSON-GREENWOOD
H5RDS-2

NEEDLE VALVE - ¼” FNPT 6000 PSI SS STEEL MINI VALVE
COMPACT DESIGN IS 2" LONG AT MAX OPEN

ANGI PART NUMBER – 330-07385

NO REBUILD KIT AVAILABLE

Mini Valves – H5

6000 psig [414 barg]

Product Overview

The H5 Mini Valves facilitate safe, compact, and economical installations. They are excellent for both throttling and straight isolation.

Valve seating is interchangeable between 'Hard' or 'Soft' without changing the bonnet assembly or removing valve from the installation. This feature of the H5 greatly extends the valve life.

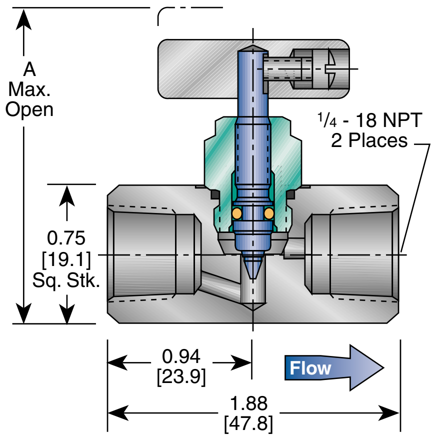
Features and Benefits

- **Packing below threads (O-ring bonnet)** prevents lubricant washout, thread corrosion, and keeps solids from entering thread area, which can cause galling. It also prevents process contamination.
- **Adjustable packing** – Teflon® and GRAFOIL® packed bonnets adjust easily, decreasing packing replacement downtime and increasing valve life.
- **Safety back seating** prevents stem blowout or accidental removal while in operation and provides a metal-to-metal secondary stem seal while in the full open position.
- **Chrome plating of 316 SS stem** prevents galling or freezing of stem threads when similar metals mate. CS valves use a 303 SS stem.
- **Rolled threads** provide additional thread strength. The stem, bonnet, and male NPT threads are rolled, not cut.
- **Mirror stem finish** burnished to a 16 RMS finish in the packing area enables smooth stem operation and extending packing life.
- **One-piece handle design** prevents loss of the valve handle due to vibration or during maintenance.
- **Soft or metal seat for bubble-tight shutoff** is field replaceable for easy maintenance. The V-tipped stem provides accurate flow control.
- **Extended valve life:** if soft seat becomes damaged it can be removed, leaving a metal seated valve.

H5 Specifications

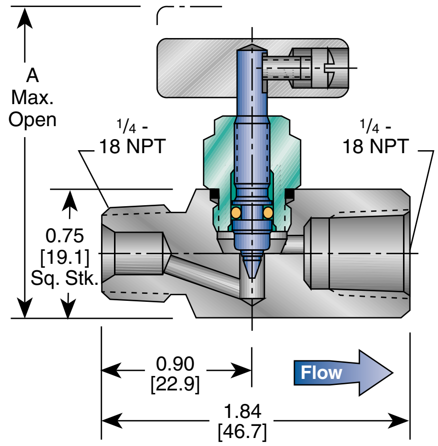
6000 psig [414 barg]

Dimensions, inches [mm]



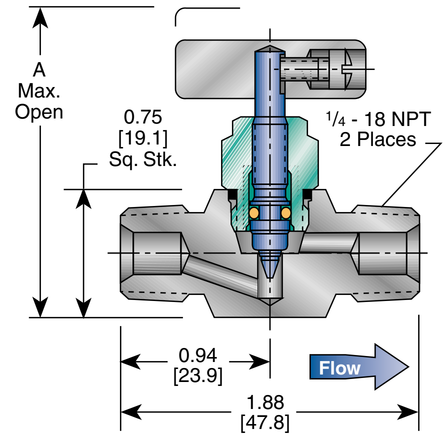
Maximum Open – Dimension A

O-ring	Teflon®	GRAFOIL®
2.00 [50.8]	2.60 [66.0]	3.07 [78.0]



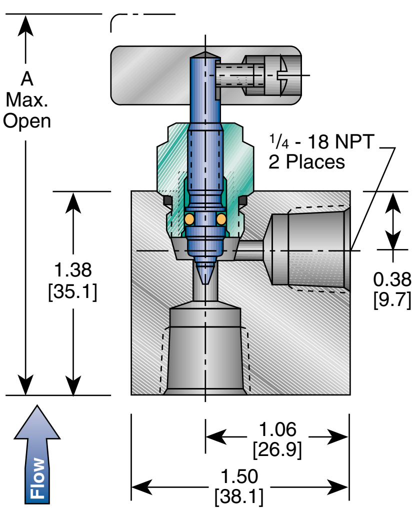
Maximum Open – Dimension A

O-ring	Teflon®	GRAFOIL®
2.00 [50.8]	2.60 [66.0]	3.07 [78.0]



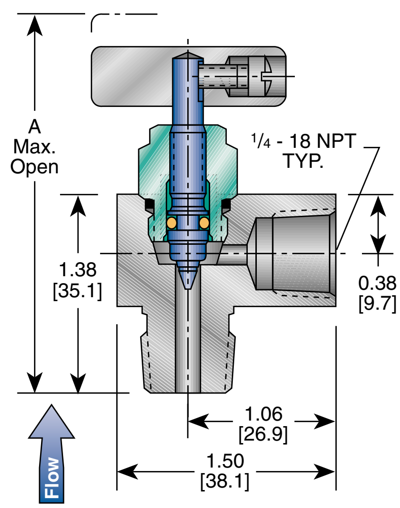
Maximum Open – Dimension A

O-ring	Teflon®	GRAFOIL®
2.00 [50.8]	2.60 [66.0]	3.07 [78.0]



Maximum Open – Dimension A

O-ring	Teflon®	GRAFOIL®
2.64 [67.1]	3.23 [82.0]	3.71 [94.2]



Maximum Open – Dimension A

O-ring	Teflon®	GRAFOIL®
2.66 [67.6]	3.26 [82.8]	3.73 [94.7]

Notes

1. Approximate valve weight: 0.5 lb [.23 kg]. Seat orifice size 0.136-inch [3.5 mm] diameter.
2. Valve C_v Soft Seat 0.27 maximum.
   Valve C_v Hard Seat 0.31 maximum.

H5 Specifications

6000 psig [414 barg]

Standard Materials – Hard Seat

Valve	Body	Bonnet	Stem	Packing	Seat	Handle[2]
CS[1]	A108	A108	A581-303	Teflon® or BUNA-N O-ring	Integral	Round
SS	A479-316	A479-316	A276-316	Teflon® or Viton® O-ring	Integral	Tee
Brass	B16	B16	A581-303	Teflon® or BUNA-N O-ring	Integral	Round
SG[3]	A479-316	A479-316	Monel® R405	Teflon® or Viton® O-ring	Integral	Tee

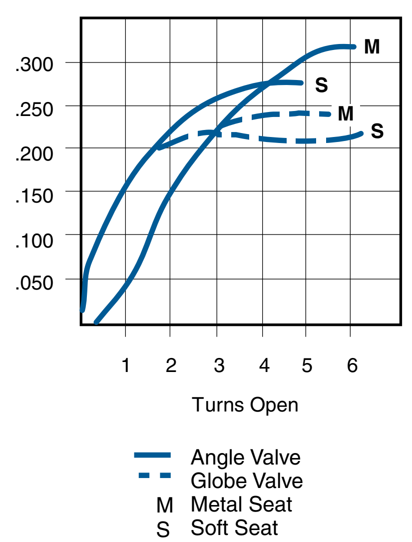
Standard Materials – Soft Seat

Valve	Body	Bonnet	Stem	Packing	Flow Washer	Seat	Handle[2]
CS[1]	A108	A108	A581-303	Teflon® or BUNA-N O-ring	A479-316	Delrin®[4]	Round
SS	A479-316	A479-316	A276-316	Teflon® or Viton® O-ring	A479-316	PCTFE[5]	Tee
Brass	B16	B16	A581-303	Teflon® or BUNA-N O-ring	A479-316	Delrin®[4]	Round
SG[3]	A479-316	A479-316	Monel® R405	Teflon® or Viton® O-ring	A479-316	PCTFE[5]	Tee

Notes

1. CS is zinc cobalt plated to prevent corrosion.
2. Tee handle is SS; Round handle is CS.
3. SG (Sour Gas) meets the requirements of NACE MR0175-latest revision.
4. PEEK available.
5. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

H5 Metal and Soft Seated Flow Characteristics



Formula

Liquids

$$C_V = Q_L \sqrt{\frac{(P_1 - P_2)\,(62.4)}{\rho}}$$

Where:

Q_L = Flow (gpm)

ρ = Density of Liquid (lb/ft³)

P_1 = Upstream Pressure (psia)

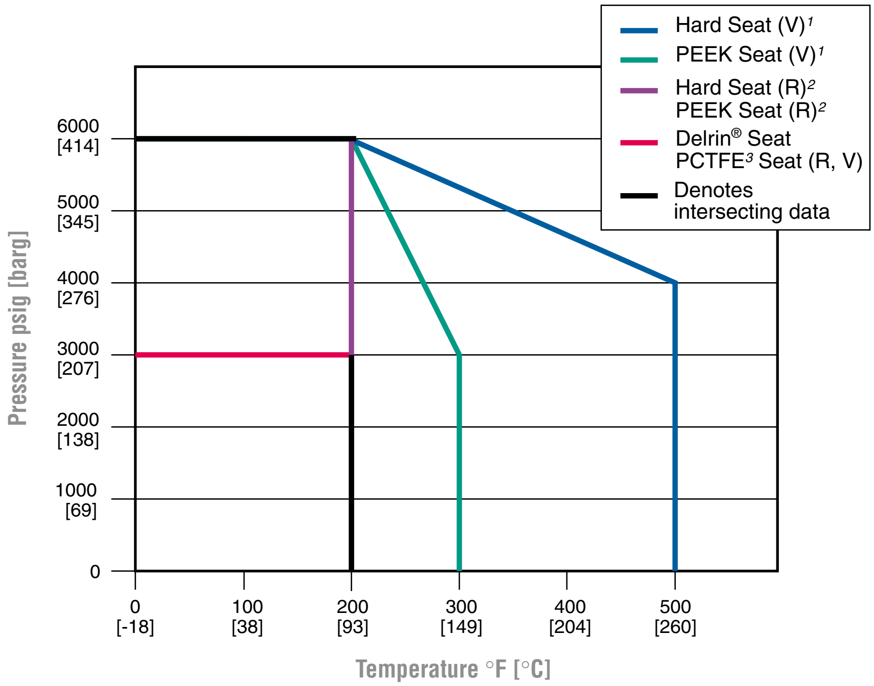
P_2 = Downstream Pressure (psia)

ρ (water) = 62.4 lb/ft³ @ 60°F [16°C]

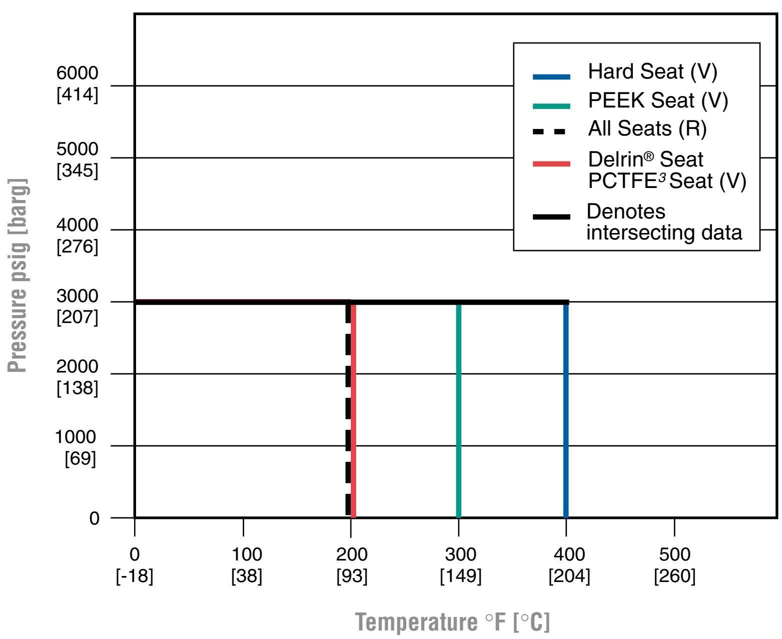
H5 Specifications

6000 psig [414 barg]

Pressure vs. Temperature – CS and SS Valves



Pressure vs. Temperature – Brass Valves



Notes

1. (V) = with Teflon® or GRAFOIL® bonnet assemblies.
2. (R) = with O-ring bonnet assembly.
3. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

H5 Specifications

6000 psig [414 barg]

Pressure and Temperature Ratings[1]

Seat	Teflon® or GRAFOIL® Bonnet[2] CS and SS Valves		Brass Valves	
Hard	6000 psig @ 200°F 4000 psig @ 500°F	[414 barg @ 93°C] [276 barg @ 260°C]	3000 psig @ 400°F	[207 barg @ 204°C]
Delrin® and PCTFE[3]	3000 psig @ 200°F	[207 barg @ 93°C]	3000 psig @ 200°F	[207 barg @ 93°C]
PEEK	6000 psig @ 200°F 3000 psig @ 300°F	[414 barg @ 93°C] [207 barg @ 149°C]	3000 psig @ 300°F	[207 barg @ 149°C]

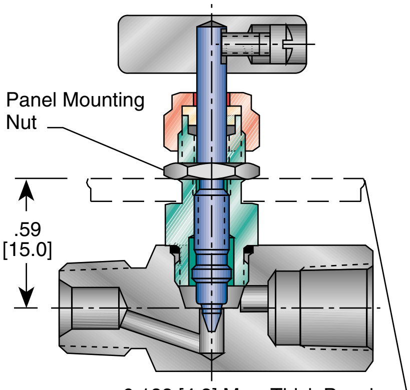
Seat	O-ring Bonnet CS and SS Valves		Brass Valves	
Hard	6000 psig @ 200°F	[414 barg @ 93°C]	3000 psig @ 200°F	[207 barg @ 93°C]
Delrin® and PCTFE[3]	3000 psig @ 200°F	[207 barg @ 93°C]	3000 psig @ 200°F	[207 barg @ 93°C]
PEEK	6000 psig @ 200°F	[414 barg @ 93°C]	3000 psig @ 200°F	[207 barg @ 93°C]

Notes

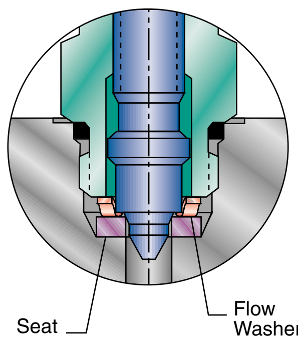
1. Pressure and temperature ratings are not shown on valve body.
2. GRAFOIL® packed bonnet comes complete with ball end stem; SS only.
3. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

H5 Options

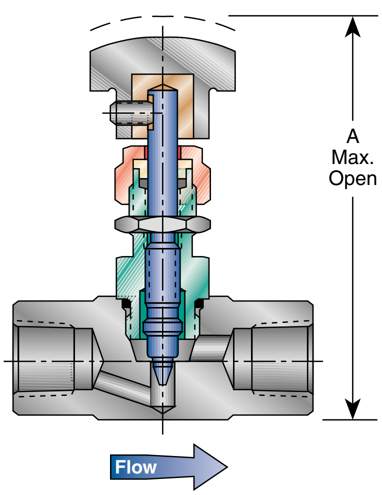
Optional Panel Mounting Nut[1], inches [mm]



Optional Soft Seat[2]



Optional Phenolic Handles[2]



Phenolic Handles are available in 1-inch [25 mm] diameter. Colors available are green, red, and black.

Phenolic Handles facilitate repeatable flow control as well as enhance the appearance of panels, sample cylinders, and other associated products requiring premium performance throttling and/or isolation valves.

Maximum open dimension of any H5 with Phenolic Handles is calculated by adding 0.4-inch [10.2 mm] to the 'A' reference dimension for Teflon® Stem Seal on page 28.

Notes

1. Available with Teflon® packed bonnet.
2. Available on all H5 products.

H5 Specifications

Ordering Information

H5	V	D	S	– 22	– SG

Packing

V – Teflon® (standard for SS)
R – O-ring
H – GRAFOIL® (SS only)

Seat

I – Integral
D – Delrin®
E – PEEK
K – PCTFE[1] (standard for SS)

Material

B – Brass
C – CS
S – SS

Connections (Inlet/Outlet)

2 – 1/4-inch F x 1/4-inch F
2A – 1/4-inch F x 1/4-inch F (Angle)
2M – 1/4-inch M x 1/4-inch M
22 – 1/4-inch M x 1/4-inch F
22A – 1/4-inch M x 1/4-inch F (Angle)

Options

CLC – Chlorine Cleaning
HD – Hydrostatic Testing (100%) (MSS-SP-61)
MS – Monel® Stem
OC – Oxygen Cleaning
PHB – Phenolic Black Handle (page 32)
PHG – Phenolic Green Handle (page 32)
PHR – Phenolic Red Handle (page 32)
PM – Panel Mount (Teflon® packed only) (page 32)
SG – Sour Gas meets the requirements of NACE MR0175-latest revision (SS only)
SP – Special Requirement - please specify

Note

1. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

MV305

SVF/SVF
1H7666MDBSAE10/A2S-110-
10-NC

VALVE/ACT-ASSY SVF SAE-16 S.P. 6000# SS W/A2S-110-10-NC ACT 3-PIECE 6-BOLT

ANGI PART NUMBER-
334-07515

VALVE REBUILD KIT - 761-07287

ACTUATOR REBUILD KIT (VITON) - 761-07461

ACTUATOR REBUILD KIT (BUNA) *FOR COLD WEATHER* TEMP. RANGE 15-20 TO 212 DEGREES FAHRENHEIT- 761-07591

SVF Flow Controls INCORPORATED

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Series H7 Ball Valve

Three-Piece High Pressure Ball Valve

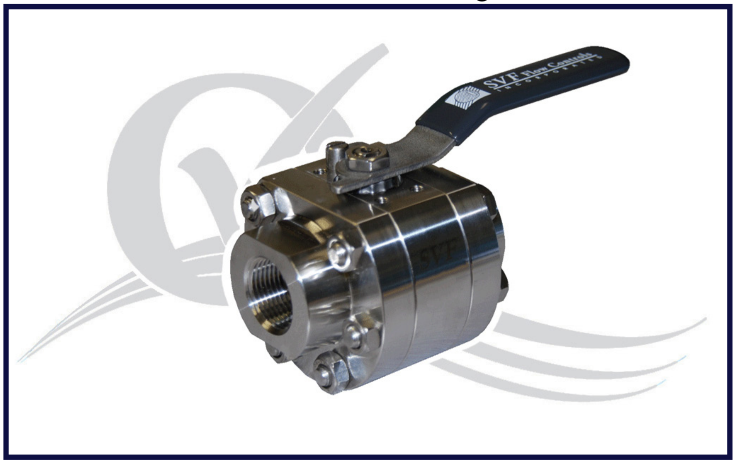
Sizes 1/2" ~ 2"

H7

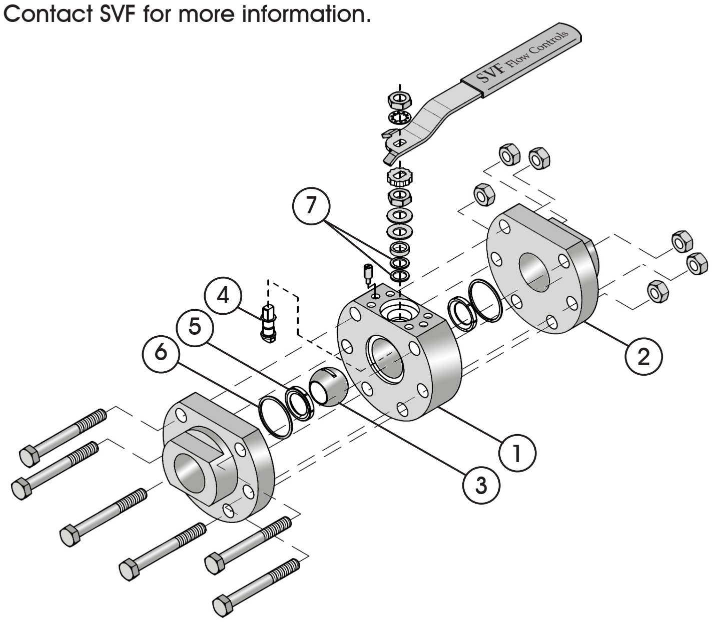
The SVF Series H7 Standard Port high pressure ball valve is designed to meet applications up to 6000 psi. This engineered valve features a Carbon or Stainless Steel Body and is available in a variety of alloy materials. The H7 adds safety and reliability to high pressure systems and applications in Offshore, Oil & Gas, Petrochemical, Power and Refining.

SERIES H7 DESIGN FEATURES

- ✓ High pressure to 6000 psi
- ✓ Live-loaded stem packing ensures seal-tight pressure containment even under thermal cycling
- ✓ Three-piece "swing out" design offers easy access for in-line maintenance
- ✓ Standard seat material is Delrin®
- ✓ Blowout proof stem adds safety & reliability
- ✓ Stainless Steel fasteners and handle



The Series H7 Ball Valve is available with additional options. Contact SVF for more information.



MATERIALS OF CONSTRUCTION

ITEM #	DESCRIPTION	MATERIALS SPECIFICATIONS (Additional options available)
1	Body	Carbon Steel (ASTM A216 WCB), 316 Stainless Steel (ASTM A351 CF8M)
2	End Connector	Carbon Steel (ASTM A216 WCB), 316L Stainless Steel (ASTM A351 CF3M)
3	Ball	316 Stainless Steel (ASTM A351 CF8M)
4	Stem	Stainless Steel 17-4 ph (ASTM A564 630)
5	Seat	Delrin®, PEEK
6	Body Seal	Buna "N", Viton®, EPDM
7	Stem Seal	SupraLon™

SPECIFICATION STANDARDS OF COMPLIANCE

SVF Series H7 Ball Valves are available in designs that meet the following Industry Standards:

- ANSI
- DIN
- BPE
- ASME
- ISO
- NACE
- API
- MSS
- ASTM

Contact SVF for specific applications

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Series H7 Ball Valve

SVF Flow Controls INCORPORATED

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Three-Piece High Pressure Ball Valve

Sizes 1/2” ~ 2”

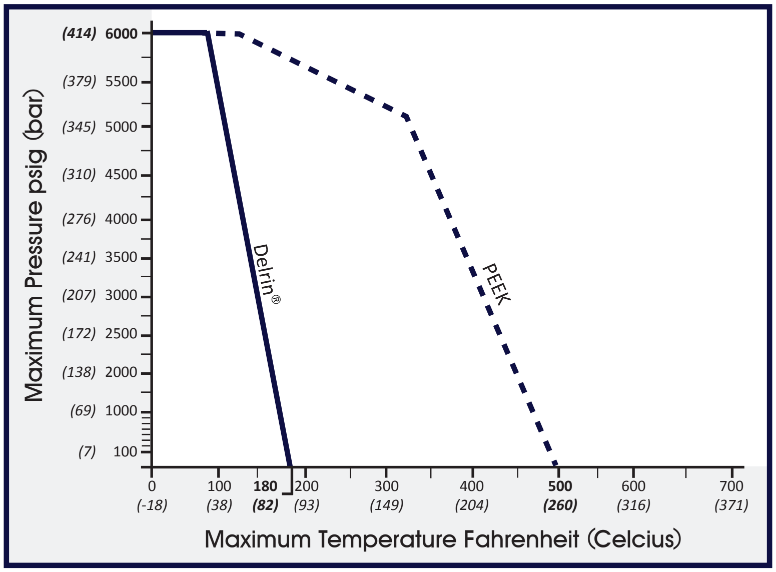
H7

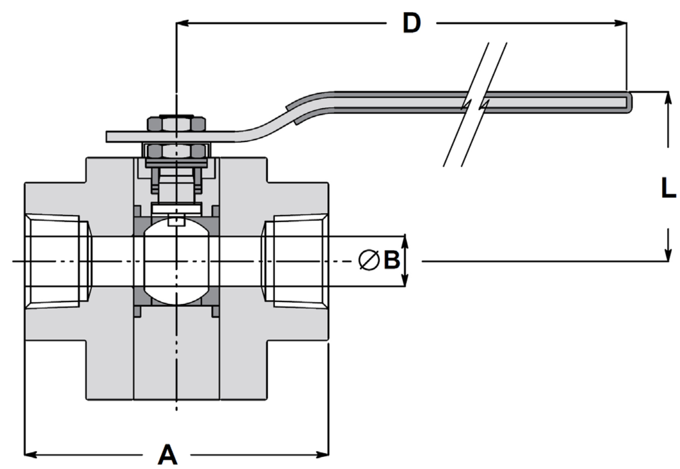
DIMENSIONS, WEIGHT, Cv, TORQUE

Size	A in.	A mm	B in.	B mm	D in.	D mm	L in.	L mm	Weight lbs	Weight kg	Cv	Torque* in-lbf	Torque* Nm
1/2”	2.78	71	0.44	11	5	127	1.8	46	3.5	1.6	8	60	7
3/4”	3.48	88	0.56	14	5	127	1.9	48	5.3	2.4	12	200	23
1”	3.69	94	0.81	21	6	152	2.4	61	9.9	4.5	32	300	34
1-1/2”	5.04	128	1.25	32	11	279	3.2	81	20.9	9.5	80	550	62
2”	6.14	156	1.50	38	11	279	3.3	84	28.9	13.1	104	1100	124

* At full differential pressure for clean fluids with Delrin® Seats

H7 - PRESSURE/TEMPERATURE CHART





HOW TO ORDER SERIES H7 BALL VALVES

SERIES	BODY & END MATERIAL	BALL & STEM MATERIAL	SEAT	BODY SEAL	ENDS	SIZE
H7 = Standard Port	**44** = Carbon Steel ASTM A216 WCB **66** = Body: 316 Stainless Steel ASTM A351 CF8M Ends: 316L Stainless Steel ASTM A351 CF3M	**6M** = Ball: 316 Stainless Steel ASTM A351 CF8M Stem: 17-4ph ASTM A564 630	**D** = Delrin® **K** = PEEK	**B** = Buna “N” **V** = Viton® **E** = EPDM	**SE** = Screwed Ends (FNPT) **SW** = Socket Weld Ends	**05** = 1/2” **07** = 3/4” **10** = 1” **15** = 1-1/2” **20** = 2”

Order Example:* *(H7666MDBSE05)

Example Description:
316 Stainless Steel Body, 316L Stainless Steel Ends, 316 Stainless Steel Ball, 17-4ph Stem, Delrin® Seat, Buna “N” Body Seal, Screwed Ends (FNPT), ½” Size

H7	66	6M	D	B	SE	05

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MV 333

SVF
1"H7666MDBSAE10 W/LKG HANDLE

VALVE-BALL SVF SAE-16 6000# W/LKG HDL SS
STANDARD PORT 3-PIECE, 6-BOLT

ANGI PART NUMBER-
334-07544

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SVF Flow Controls INCORPORATED

Series H7 Ball Valve

Three-Piece High Pressure Ball Valve

Sizes 1/2" ~ 2"

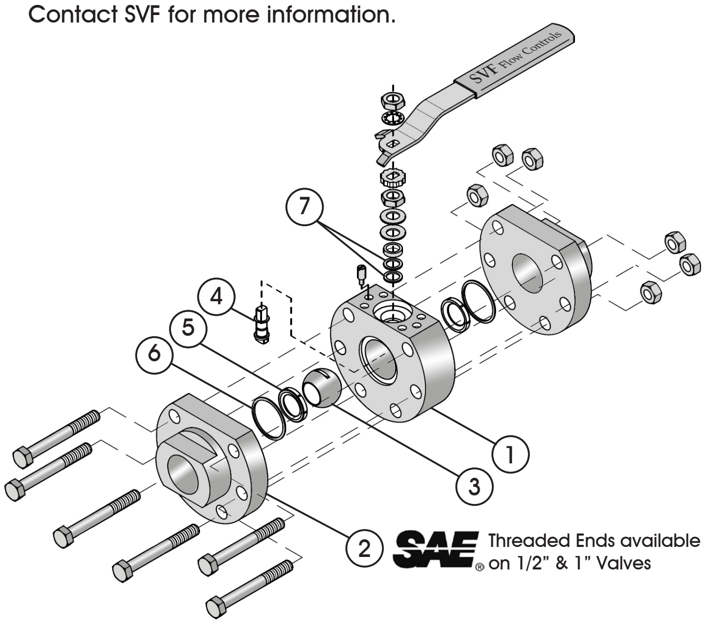
H7

The SVF Series H7 Standard Port high pressure ball valve is designed to meet applications to 6000 psi. This engineered valve features a Carbon or Stainless Steel Body and is available in a variety of alloy materials. The H7 adds safety and reliability to high pressure systems and applications in Offshore, Oil & Gas, Petrochemical, Power, CNG and Refining.

SERIES H7 DESIGN FEATURES

- ✓ High pressure to 6000 psi
- ✓ Live-loaded stem packing ensures seal-tight pressure containment even under thermal cycling
- ✓ Three-piece "swing out" design offers easy access for in-line maintenance
- ✓ Standard seat material is Delrin®
- ✓ Blowout proof stem adds safety & reliability
- ✓ Stainless Steel fasteners and handle
- ✓ SAE Threaded Ends available (SAE Specification J1926)*
  *Available in Valve Sizes 1/2" and 1"

The Series H7 Ball Valve is available with additional options. Contact SVF for more information.



MATERIALS OF CONSTRUCTION

ITEM #	DESCRIPTION	MATERIALS SPECIFICATIONS (Additional options available)
1	Body	Carbon Steel (A105), Carbon Steel (ASTM A216 WCB), 316 Stainless Steel (ASTM A351 CF8M), 316L Stainless Steel (A-479)
2	End Connector	Carbon Steel (A105), Carbon Steel (ASTM A216 WCB), 316L Stainless Steel (A-479) 316L Stainless Steel (ASTM A351 CF3M)
3	Ball	316 Stainless Steel (ASTM A351 CF8M)
4	Stem	Stainless Steel 17-4 ph (ASTM A564 630)
5	Seat	Delrin®, PEEK
6	Body Seal	Buna "N", Viton®, EPDM
7	Stem Seal	SupraLon™

SERIES H7 NFPA-52 COMPLIANCE

SVF Series H7 Ball Valves have been third party pressure tested to 4X according to NFPA-52

Contact SVF for specific applications

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HIGH PURITY VALVES CleanFLOW™ · PRO-SPEC PROCESS SPECIFIC WWW.PRO-SPEC.NET · QUALITY FLOWS THROUGH US

Series H7 Ball Valve

SVF Flow Controls INCORPORATED

Three-Piece High Pressure Ball Valve

Sizes 1/2" ~ 2"

H7

DIMENSIONS, WEIGHT, Cv, TORQUE

Size	A		B		D		L		Weight		Cv	Torque*	
	in.	mm	in.	mm	in.	mm	in.	mm	lbs	kg		in-lbf	Nm
1/2"	2.78	71	0.44	11	5	127	1.8	46	3.5	1.6	8	60	7
3/4"	3.48	88	0.56	14	5	127	1.9	48	5.3	2.4	12	200	23
1"	3.69	94	0.81	21	6	152	2.4	61	9.9	4.5	32	300	34
1-1/2"	5.04	128	1.25	32	11	279	3.2	81	20.9	9.5	80	550	62
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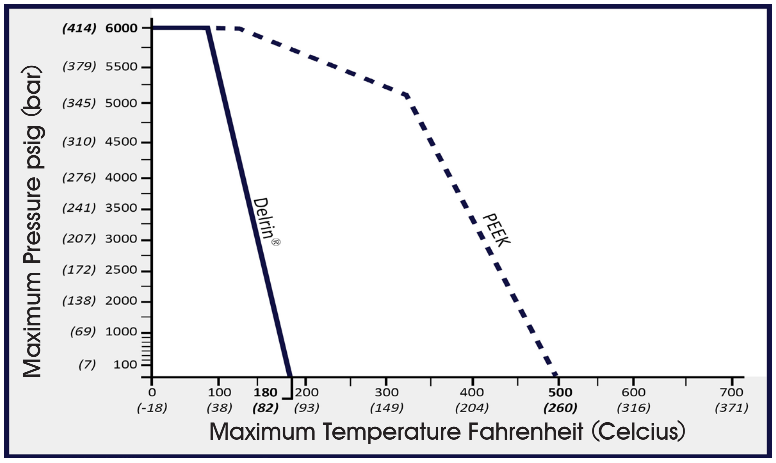
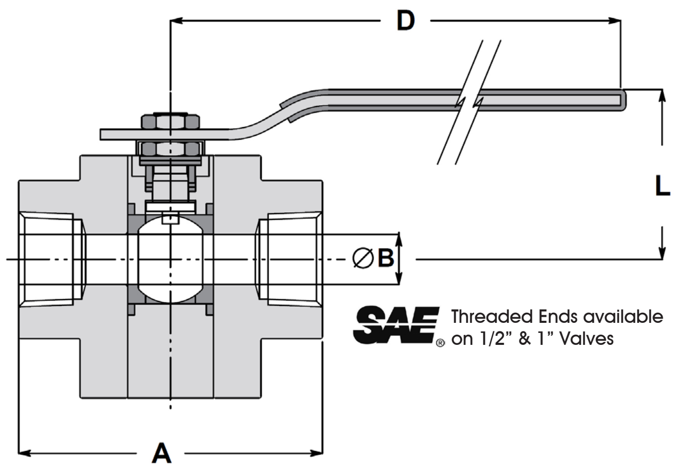
* At full differential pressure for clean fluids with Delrin® Seats

H7 - PRESSURE/TEMPERATURE CHART





HOW TO ORDER SERIES H7 BALL VALVES

Please refer to the next page for our comprehensive How to Order Guide for Series H7 Ball Valves.

SVF Flow Controls INCORPORATED

How to Order Series H7 Ball Valves

Three-Piece High Pressure Ball Valve, Sizes 1/2" ~ 2"

Ordering Code Sequence (Columns 1 thru 11)

1	2	3	4	5	6
SERIES	***BODY***	***ENDS***	***BALL***	***STEM***	***SEAT MATERIAL***
H700 = Series H7	**4** = Carbon Steel ASTM A216 WCB or ASTM A105 **6** = 316 Stainless Steel ASTM A351 CF8M or ASTM A479 316L	**4** = Carbon Steel ASTM A216 WCB or ASTM A105 **6** = 316L Stainless Steel ASTM A351 CF3M or ASTM A479 316L	**6** = 316 Stainless Steel ASTM A351 CF8M	**M** = Stainless Steel 17-4 pH ASTM A564 630	**D** = Delrin** **K** = PEEK

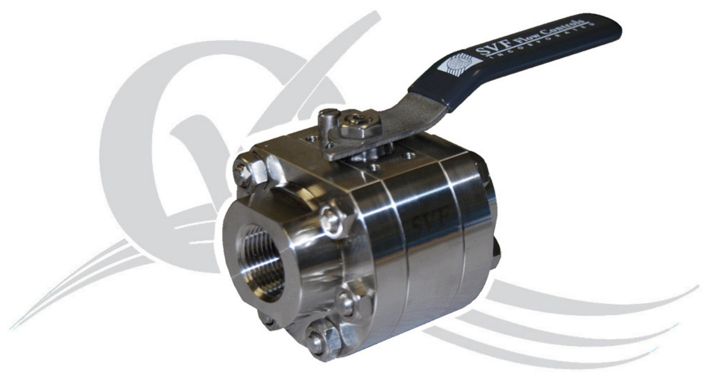
7	8	9	10	11
BODY SEAL	***END CONNECTIONS***	***VALVE SIZE***	***OPTIONS****	***SPECIAL SERVICES****
B = Buna "N" **V** = Viton **E** = EPDM	**SE0** = Screwed Ends (FNPT) **SW0** = Socket Weld Ends **SAE** = Screwed Ends per SAE Specification J1926 (1/2" & 1" Size Valves) **AAA** = Screwed End (FNPT) X Socket Weld End **AAP** = Screwed End (SAE) X Socket Weld End (1/2" & 1" Size Valves)	**005** = 1/2" **007** = 3/4" **010** = 1" **015** = 1-1/2" **020** = 2"	**00** = None **LK** = Locking Device **AD** = Anti-Static Device **AC** = Locking Device & Anti-Static Device	**00** = None **HC** = High Cycle Stem Kit **UH** = Vent/Relief Hole (Upstream Side) **EP** = Electropolished

Order Example: (H700666MDBSE00050000) The Part Number will contain 20 digits.

Ordering Code Sequence >>	1	2	3	4	5	6	7	8	9	10	11
Sample Part Number >>	*H700*	*6*	*6*	*6*	*M*	*D*	*B*	*SE0*	*005*	*00*	*00*
	Valve Series	Body Material	End Material	Ball	Stem	Seat Material	Seal Material	End Connections	Valve Size	Options*	Special Services*

* Not all Options or Special Services available on all ball valves. Consult SVF for additional information.
** Delrin Seats <u>**cannot**</u> be used for Oxygen Service

INSTALLATION, OPERATION & MAINTENANCE FOR SVF SERIES H7 BALL VALVES



GENERAL

SVF Ball valves have been designed and engineered to provide long lasting and trouble free service when used in accordance with the instructions and specifications herein.

The following instructions refer only to SVF Series H7 Ball Valves.

Keep protective cover in place until moment of installation. Valve performance depends upon preventing of damage to ball surface. Upon removal of cover, make sure that the valve is completely open and free of obstruction.

If requested, valves can be shipped from the factory containing a silicon based lubricant which aids in the assembly of the valve. This may be removed with a solvent if found intolerable.

Certain ferrous valves are phosphate and oil dipped during the course of manufacture, but they are completely non-toxic and the valves are quite safe to use for edible or potable products.

STORAGE:

All manual valves are shipped in the fully open position with protective end caps (covers). Keep all protective packaging, flange covers, or end caps attached to the valves during storage. To avoid damage to the seat due to contact with the balls edge, leave the valve in the fully open or closed position during storage. It is recommended to keep the valves in a clean and dry environment until ready for use.

!!!CAUTION! Safety Precautions!!!

Before removing valve from pipeline NOTE that:

Media flowing through a valve may be corrosive, toxic, flammable, a contaminant or harmful nature. Where there is evidence of harmful fluids having flowed through the valve, the utmost care must be taken. It is suggested that the following minimal safety precautions be taken when handling valves.

1. Always wear eye shields.
2. Always wear gloves and overalls.
3. Wear protective footwear.
4. Wear protective headgear.
5. Ensure that running water is readily accessible.
6. Have a suitable fire extinguisher ready if media is flammable.
7. Be sure that you are aware of the fluid that has been passing through the valve before opening or dismantling any valve. Require MSDS information.

By checking line gauges ensure that no pressure is present at the valve.
Ensure that any media is released by operating valve slowly to half open position. Ideally, the valve should be decontaminated when the ball is in the half open position.

These valves, when installed, have body connectors which form an integral part of the pipeline and the valve cannot be removed from the pipeline without being dismantled.

Valves and accessories must not be used as a sole support of piping or human weight. Safety accessories such as safety relief (overpressure) valves are the responsibility of the system designer.

It is the user/system designer's responsibility to use insulation in high temperature applications. Refer to OSHA documents for more details.

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INSTALLATION, OPERATION & MAINTENANCE FOR SVF SERIES H7 BALL VALVES

INSTALLATION
The valve may be installed for flow or vacuum in either direction. Carefully exclude pipe sealants from the valve cavity. When installing, use standard gaskets suitable for the specific service. Tighten flange bolts or studs evenly.

WELDING ENDS
Welding of valves shall be performed by a qualified person according to the ASME Boiler Construction Code, Section IX. Socket Weld End valves must be partially disassembled to prevent heat damage during welding of the soft plastic Seats and Seals in the valve. Prior to disassembly, the valve may be temporarily fitted in-line, and the ends tack-welded to the piping for alignment purposes.

1. With the valve in the OPEN position, remove Body Bolts (#15) and Body Bolt Nuts (#16).
2. Remove the End Connectors (#2) from the Body (#1) and carefully remove the Seats (#5), Body Seals (#6) and Ball (#3), avoiding damage to them.
3. With the soft components and Ball (#3) removed from the Body (#1), loosely reassemble the End Connectors (#2) to the valve Body (#1).
4. Tack-weld the End Connectors (#2) to the pipeline, then remove the valve Body (#1).
5. Complete the welding, being careful to avoid weld splatter on the exposed end faces.
6. When cooled, clean the faces of the ends before reassembling the valve (See Reassembly Procedure).

OPERATION
SVF valves provide tight shut off when used under normal conditions and in accordance with SVF's published pressure/temperature chart. If these valves are used in a partially open (throttled) position seat life may be reduced.

SVF valves have ¼ turn operation closing in a clockwise direction. It is possible to see when the valve is open or closed by the position of the wrench handle. When the wrench is in line with the pipeline, the valve is open.

Any media which might solidify, crystallize or polymerize should not be allowed to stand in the ball valve cavities unless regular maintenance is provided.

TORQUE REQUIREMENTS
Torque ratings are subject to variations depending on the length of time between cycles and the media in the system.

Breakaway torque is that force which must be exerted to cause the ball to begin to open. Operating torque requirements will vary depending on the length of time between cycles, media in the system, line pressure and type of valve seat.

MAINTENANCE
With self-wiping ball/seats, SVF valves have a long, trouble free life, and maintenance is seldom required. But, when necessary, valves may be refurbished, using a small number of components, none of which require machining.

SVF valves are designed for easy service and assembly in the field. The following checks will help to extend valve life, or reduce plant problems.

SVF ball valves utilize live-loaded stem seals featuring Belleville washers (disk springs) that maintain constant pressure on the Stem Seal area even under a wide range of pressure and temperature fluctuations. If stem leakage is evident proceed as follows:

STEM LEAKAGE
Examine the disk springs (Belleville washers) for damage. If in good condition tighten the gland nut until disk springs are firmly compressed, then back nut off 1/16th of a turn. If damaged, dismantle the stem down to the gland, fit new disk springs with their outer edges touching, replace and retighten using gland nut. Further maintenance necessitates dismantling of the valve.

LEAKAGE AT BODY JOINT
Check for tightness at the body connector bolts. If loose, tighten body bolts. Excessive force will damage the bolts (See Table A).
If there is still leakage it will be necessary to dismantle the valve and replace the body seals.

IN-LINE LEAKAGE
Check that the valve is fully closed. If leakage occurs while the valve is in the closed position, a seat or ball sealant surface may be damaged and it will be necessary to disassemble the valve.

NOTE: If Stem leakage and leakage at body joint are not cured by the simple means described above, it will be necessary to dismantle the valve. If there is no stem leakage the stem assembly should not be touched.

INSTALLATION, OPERATION & MAINTENANCE FOR SVF SERIES H7 BALL VALVES

REBUILDING

Before rebuilding, check that all the correct components are available and that they are fit for reassembly. When rebuilding, cleanliness is essential to allow long valve life and provide cost effective maintenance. CAUTION: NO BODY OR STEM SEALS ARE REUSABLE. Care must be taken to avoid scratching the seats and seals during installation.

NOTE: Caution must be taken with valves that have been in hazardous media. They must be decontaminated before disassembly by relieving the line pressure and flushing the line with the valve in the partially open position. Protective clothing, face shields, gloves, etc., MUST BE USED for this operation.

A **DISASSEMBLY OF VALVE** (Removed from line)

1.) Remove the End Connectors (#2) by removing the Body Bolts (#15) and Body Bolt Nuts (#16).
2.) Once the End Connectors (#2) have been separated from the Body (#1), remove the Body Seals (#6) and Seats (#5).
3.) Make sure the Ball is in the closed position, thus the Ball (#3) can be taken out easily from the Body (#1).

B **REMOVING STEM ASSEMBLY**

1.) Remove Handle (#12) by removing Handle Nut (#14) along with the Lock Washer (#13).
2.) Remove the Tab Lock (#11), Stem Nut (#10), Belleville Washers (#9), Gland (#8), Thrust Washer (#17) and Stem Seals (#7).
3.) Push the Stem (#4) down into the Body cavity to remove, and take off Thrust Washer (#17).

C **INSPECTION**

1.) The Ball and the surfaces against which the Seats wipe and make contact should be free of pit marks and scratches. Light marring from the action of the Ball against the Seats is normal and will not affect the operation of the valve.
2.) The Stem and Body surfaces, which the Thrust Washers and Stem Seals make contact with, should be free of pit marks and scratches.

D **REASSEMBLY**

1.) Apply an adequate amount of lubricant compatible with the media being handled around the Ball (#3), Seats (#5), Body Seals (#6), Stem (#4), and Thrust Washers (#17).
2.) For Stem reassembly, disassembly procedure should be followed in reverse order.
3.) When Stem assembly is complete, tighten Stem Nut (#10) according to the values in Table A.
4.) With the Stem (#4) in the close position, insert the Ball (#3) into Body (#1) so that Stem slot engages with the tang at the base of the Stem.
5.) Make sure Body Seals (#6) rests squarely on center seal surface of the Body.
6.) Insert Seats (#5) in Body (#1). Make sure Seats rest firmly on back surface of each recess.
7.) Merge the End Connectors (#2) with the Body (#1).
8.) Insert and tighten Body Bolts (#15) and Body Nuts (#16) diagonally, in accordance to the cross pattern procedure shown on the following page.
9.) In the final assembly step ensure that the Body Bolts (#15) and Body Bolt Nuts (#16) are tightened to torque values according to Table A.

INSTALLATION, OPERATION & MAINTENANCE FOR SVF SERIES H7 BALL VALVES

TORQUE SPECS

Certain precautions need to be followed when tightening bolts down to their corresponding torques to help prevent bolt galling. There are two passes each bolt has to undergo during the process, first pass and the final pass. Once every bolt has met the first pass requirement, the final pass can be initiated. When tightening down bolts it is necessary to follow the corresponding bolt pattern shown below.

TABLE A: TORQUE REQUIREMENTS (in-lbs)

Valve Size	Bolt Pattern	Body Bolts: Stainless Steel or Carbon Steel First Pass	Body Bolts: Stainless Steel or Carbon Steel Final Pass	Stem Nuts
1/2"	6	156	260	35
3/4"	6	156	260	35
1"	6	213	355	80
1-1/2"	8	450	750	120
2"	8	450	750	120

REPAIR KITS

Repair Kits are available from SVF Flow Controls, Inc. Table B below shows what the kits consist of. When ordering a Repair Kit, please be sure to specify the type, size and seating material of the valve.

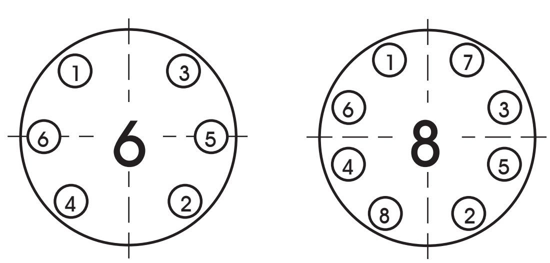
When repairing a valve use only SVF Flow Controls, Inc. authorized spare parts including; bolts and nuts, etc. In addition to maintenance kits, spare parts are available from SVF Flow Controls, Inc. They are: balls, stems and glands. If additional parts are required (body and ends) it is normally recommended that the complete valve be replaced.

Components from a different valve series should not be used with the repair of any other valve. If the valve is altered in any way, no liability can be accepted by SVF Flow Controls, Inc.

TABLE B: GENERAL REPAIR KIT

Part	Quantity
Thrust Washers	2
Stem Seals	2
Belleville Washers	2
Seats	2
Body Seals	2

SERIES H7 BOLT PATTERNS - BOLT TIGHTENING SEQUENCE



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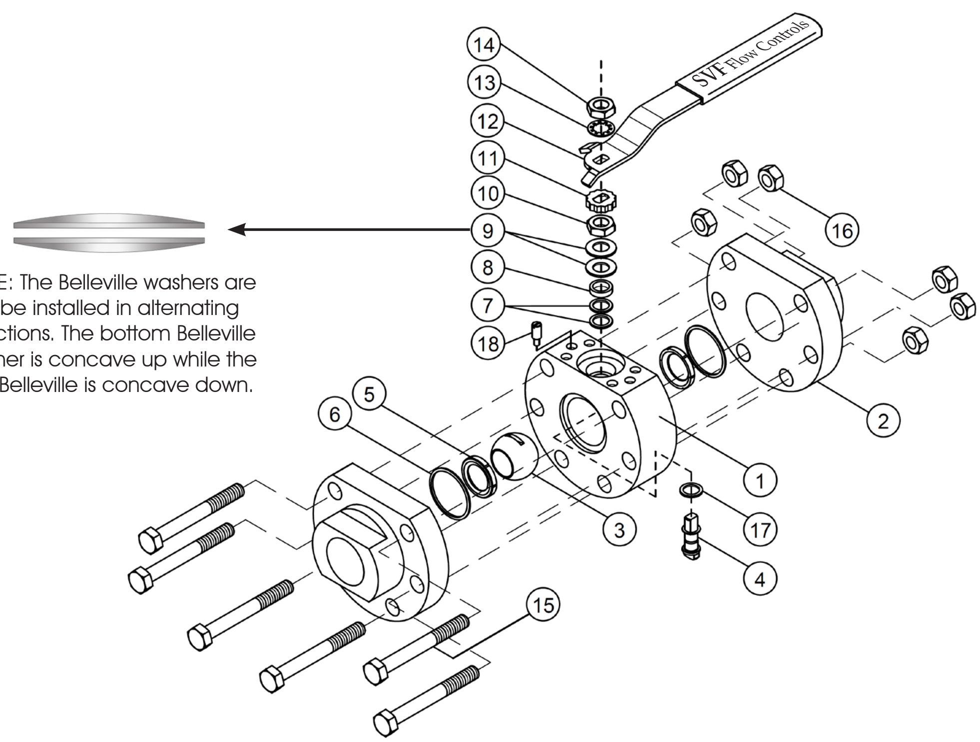
MATERIALS OF CONSTRUCTION FOR SVF SERIES H7 BALL VALVES

Item #	Part Name	Materials	Recommended Spare	Wetted
1	Body	Stainless Steel (ASTM A351 CF8M) Carbon Steel (ASTM A216 WCB)	-	X
2	End Connector	Stainless Steel (ASTM A351 CF3M) Carbon Steel (ASTM A216 WCB)	-	X
3	Ball	316 Stainless Steel A351-CF8M	-	X
4	Stem	Stainless Steel 17-7pH ASTM A564 630	-	X
5	Seat	Delrin®, PEEK	X	X
6	Body Seal	Buna "N", Viton®, EPDM	X	X
7	Stem Seal	SupraLon™	X	X
8	Gland	Stainless Steel	-	-
9	Belleville Washer	Stainless Steel	-	-
10	Stem Nut	Stainless Steel	-	-
11	Tab Lock	Stainless Steel	-	-
12	Handle	Stainless Steel	-	-
13	Lock Washer	Stainless Steel	-	-
14	Handle Nut	Stainless Steel	-	-
15	Body Bolt	Stainless Steel	-	-
16	Body Bolt Nut	Stainless Steel	-	-
17	Thrust Washer	Delrin®, PEEK	X	X
18	Stop Pin	304 Stainless Steel	-	-



NOTE: The Belleville washers are to be installed in alternating directions. The bottom Belleville washer is concave up while the top Belleville is concave down.

PR 13

MECO
5648-9717

PRESSURE REGULATOR

ANGI PART NUMBER 500-01674

REBUILD KIT ASSY - MECO PRIMARY REGULATOR – 840-04319

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NGV REGULATORS & ENVIRO-CAP®

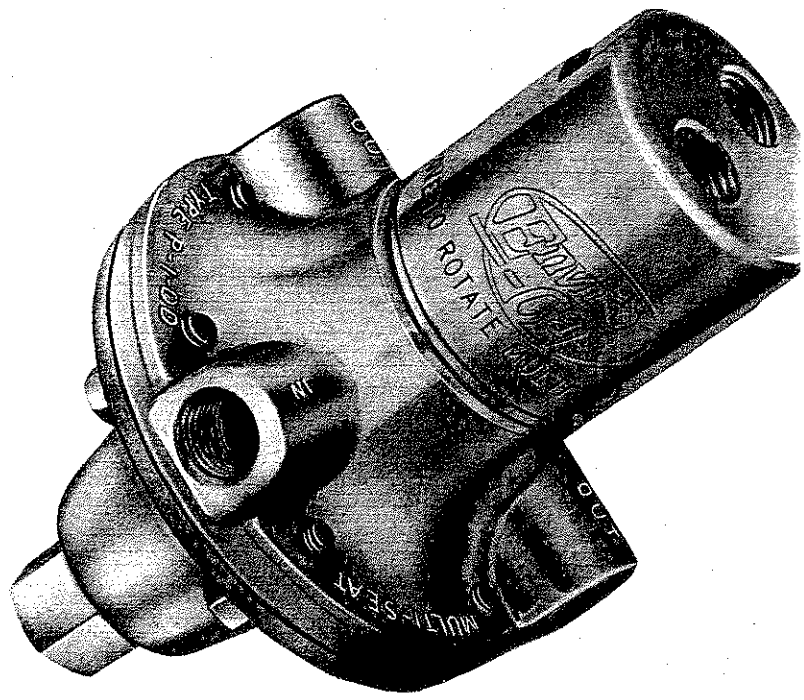
TYPE “P-NGV”

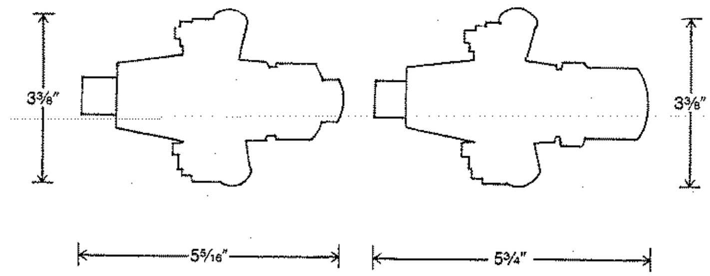
THE DEPENDABILITY OF THE “YOKE” TYPE REGULATOR IS IDEALLY SUITED AS THE HIGH PRESSURE REGULATOR IN POSITIVE PRESSURE NGV SYSTEMS. RATED FOR INLET PRESSURES TO 5,500 PSI, DELIVERY PRESSURES BETWEEN 2 AND 500 PSI ARE RELIABLY ACHIEVED.

A SPECIAL FEATURE IS THE DIA-BLOK CONSTRUCTION. THE DIAPHRAGM IS CONNECTED TO THE SEAT BLOCK BY MEANS OF A YOKE. THIS ONE PIECE ACTION PROVIDES INSTANT RESPONSE TO VARIATIONS IN DEMAND AND INSURES INSTANTANEOUS AND POSITIVE SHUTOFF.

THE ENVIRO-CAP CAN BE USED TO RETROFIT ANY MECO TYPE “P” REGULATOR WHERE FREEZING AND RESULTING ERRATIC GAS FLOW IS A PROBLEM.

ENGINE COOLANT IS CIRCULATED THROUGH THE BACK CAP TO PREVENT “FREEZE-UP” AND MAINTAIN A UNIFORM GAS FLOW. CONNECTIONS TO THE ENGINE COOLING SYSTEM ARE THROUGH ¼" NPT PORTS.





Standard Type P NGV Regulator

Type P NGV Regulator with ENVIRO-CAP

SPECIFICATIONS:

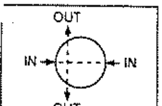
Maximum Inlet Pressure: 5,500 psi
Delivery Pressure Ranges:

Standard	Optional
0–125 psi	0–30 psi
0–150 psi	0–50 psi
0–225 psi	0–500 psi

Ports:
¼" NPT Female
Effective Diaphragm Size:
2⁹⁄₁₆" diameter
Materials of Construction:
Body........Forged Brass
Bonnet......Forged Brass
Diaphragm ..Stainless Steel
Seat........Nylon
Seals.......Teflon & SBR
Nozzle......Stainless Steel
Inlet Filter ...Sintered Bronze
Options: (at extra cost)
Mounting bolts and nuts

Ordering Information

PORTING STYLE P-1-DD



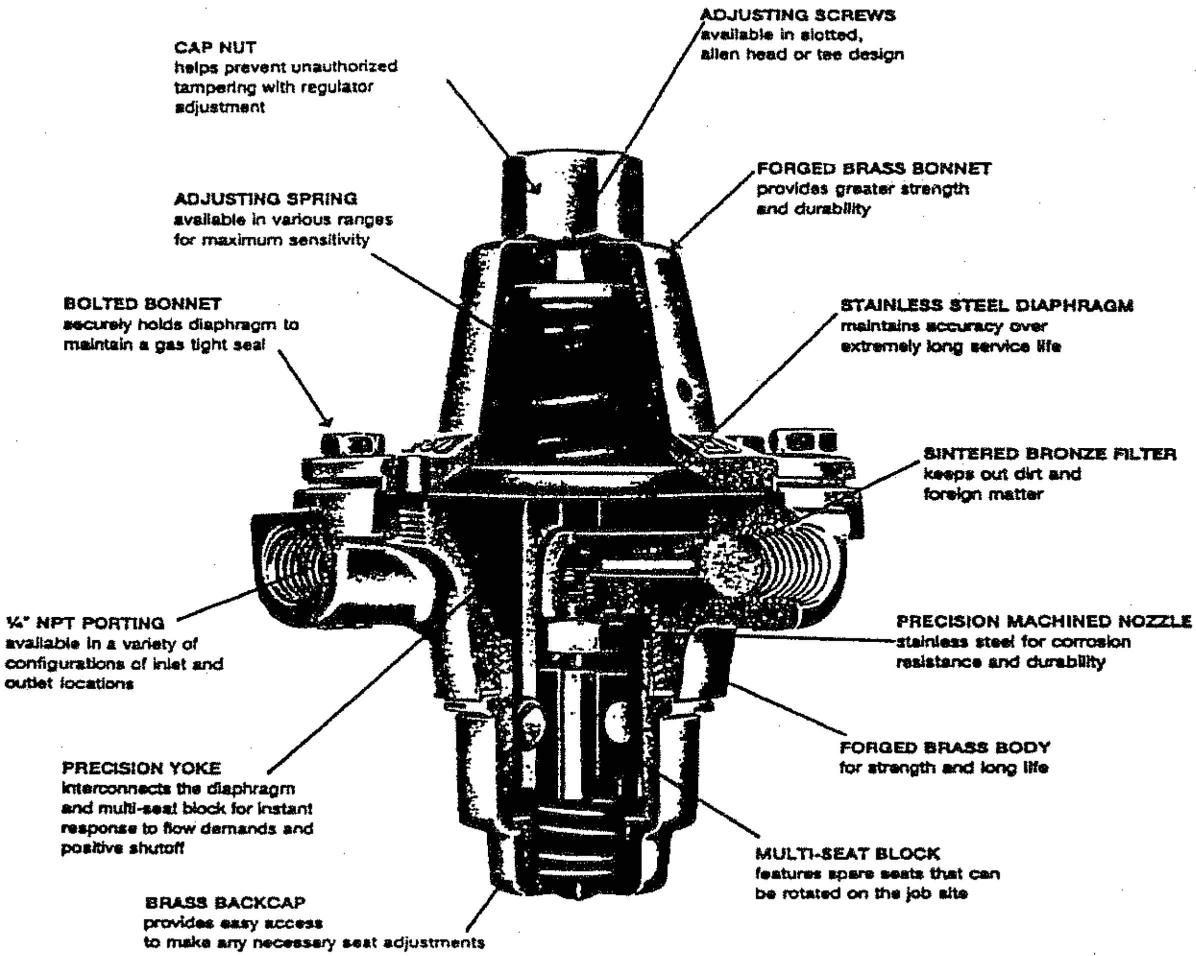
Stock No.	Max. Outlet Pressure	Connections Inlet	Connections Outlet	Enviro-Cap	Wt.
8429 8431 8433	125 psi 150 psi 225 psi	(2)¼"NPTF	(2)¼"NPTF	YES	3½ #
8440 8441 8442	125 psi 150 psi 225 psi	(2)¼"NPTF	(2)¼"NPTF	NO	3¼ #
4534	ENVIRO-CAP, WATER HEATED BACK CAP ONLY				

These are MECO's standard models. Additional models with other outlet pressure ranges, other porting and accessories are also available. Please consult with us on your custom regulator application.

MECO Regulators are included in kits certified by A.G.A. and C.A.R.B. MECO Regulators are approved by the Railroad Commission of Texas and are also available with Underwriters Laboratories (UL) Listing. Additional certifications may be applicable; please consult MECO for current listings.

Control Gas Regulator

Meco YOKE TYPE REGULATORS



THE TYPE P HIGH PRESSURE REGULATORS . . . fill numerous needs throughout industry. Time proven for reliability and service, these regulators are designed around the special DIA-BLOCK feature. The diaphragm and seat block are directly connected by a precision machined YOKE. Any action on the diaphragm is instantly transmitted to the seat. The results being a high degree of sensitivity and accuracy.

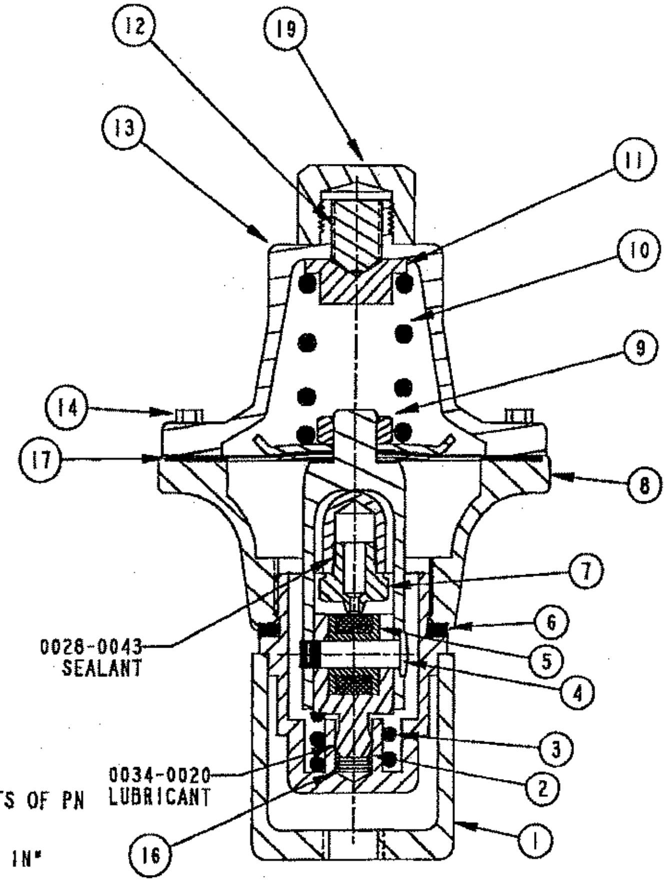
MULTI-SEAT BLOCK . . . contains four seating surfaces which can be easily revolved as needed. No special tools are required to make this change. Various seating materials are available

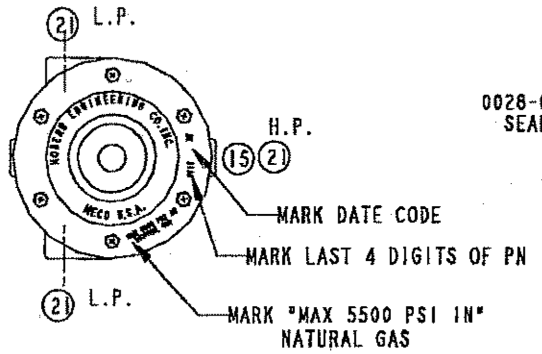
DWG. NO. 5648-9717 SH 1

NOTES
1. TEST REGULATOR PER 0090-0040, SHEET 2 PROCEDURE 11.2.
2. MARK REGULATOR PER DETAIL "A" BELOW.
3. SEE DWG 0093-0416 FOR TORQUE REQUIREMENTS.
4. USE 0034-0020 LUBRICANT AND 0028-0043 SEALANT WHERE SHOWN.

REVISIONS

SYM	REF.	DATE	SYM	REF.	DATE	SYM	REF.	DATE
	DWG RELEASE		B	E960	10-00			
EO	E542	11-99	C	F305B	12-01			
A	E675	8-00						





DETAIL A

ITEM NO.	DESCRIPTION	PART NO.	NO. REQ'D
28	LUBRICANT	0034-0020	A/R
27	SEALANT	0028-0043	A/R
26			
25	INSTRUCTION MANUAL A	0056-1625	1
24			
23			
22			
21	CAPLUG	1417-0005	3
20			
19	BONNET NUT	5213-5274	1
18			
17	DIAPHRAGM GASKET	5213-5269	1
16	O-RING	5199-2135	4
15	FILTER	5213-5215	1
14	BONNET SCREW	5213-5145	6
13	BONNET	5203-5419	1
12	ADJUSTING SCREW	5204-5279	1
11	SPRING BUTTON	5213-5259	1
10	BONNET SPRING (GREY)	5205-5400	1
9	DIAPH-YOKE ASSY	5232-4564	1
8	BODY	5202-5411	1
7	NOZZLE	5213-5161	1
6	BACK CAP GASKET	5213-5429	1
5	SEAT BLOCK ASSEMBLY	5233-4521	1
4	YOKE CLAMPING SCREW	5213-5181	1
3	BACK CAP SPRING	5205-5177	1
2	YOKE GUIDE	5213-5182	1
1	BACK CAP ASSEMBLY	5235-4534	1

BILL OF MATERIALS

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VICTOR®
VICTOR EQUIPMENT COMPANY
DENTON TEXAS

REF. DATA: 70420

MATERIAL

FINISH

UNLESS SPECIFIED
BREAK ALL EDGES .005-.015
MACHINED SURFACES 125
ALL FEATURES WITH A COMMON AXIS MUST BE COAXIAL WITHIN .005 F.I.M.
TOLERANCES .X ±.020
.XX ±.010
.XXX ±.005
ANGLES ±1°

	BY	DATE
DRAWN	D. BRADFORD	11-5-99
CHECKED	L.TURNEY	11-99
APVD	L.TURNEY	11-99

DIMENSIONS ARE IN INCHES UNLESS NOTED

TITLE: SPECIAL P REGULATOR NVG PRESET 125 PSI

SIZE B | DWG. NO. 5648-9717

PROJECTION | SCALE NTS | SHEET 1 OF 1

Printed 01/03/02

DWG. NO. 0090-0040 | SH 2

NOTES

REVISIONS								
STN	REF.	DATE	STN	REF.	DATE	STN	REF.	DATE
A	E514	9-99	C	E572	12/99			
	REV & REDWN		D	E605	01-00			
B	E516	10-99						

A TEST PRESSURE PSIG	H PRESSURE SETTING FOR TESTS	J PRESS. GAUGE FOR TEST	K LEAK TEST	L DROP TEST	M CREEP TEST	N FINAL PRESET	PROC. NUMBER
3600±200	225 PSIG	400 PSIG	10 SCC	15 PSIG	3 PSIG	225±5 PSIG	11.1
3600±200	125 PSIG	200 PSIG	10 SCC	10 PSIG	3 PSIG	125±5 PSIG	11.2
3600±200	50 PSIG	100 PSIG	10 SCC	5 PSIG	3 PSIG	50±3 PSIG	11.3
3600±200	150 PSIG	200 PSIG	10 SCC	10 PSIG	3 PSIG	150±5 PSIG	11.4
3600±200	40 PSIG	100 PSIG	10 SCC	5 PSIG	3 PSIG	40 ±5 PSIG	11.5
3600±200	35 PSIG	100 PSIG	10 SCC	5 PSIG	3 PSIG	35 ±5 PSIG	11.6 C
3600±200	60 PSIG	100 PSIG	10 SCC	5 PSIG	3 PSIG	60 ±3 PSIG	11.7 C

TEST PROCEDURE
MECO PRESET REGULATORS

1. INSTALL A TEST GUN WITH A #52 (.0635) ORIFICE TO REGULATOR OUTLET. USE A __J__ PSIG OUTLET GAUGE FOR TESTS.

2. PRESSURIZE THE REGULATOR WITH __A__ PSIG OF OIL FREE AIR OR DRY NITROGEN.

3. LEAK TEST: ADJUST THE REGULATOR TO DELIVER __H__ PSIG. CLOSE THE INLET VALVE AND TURN THE ADJUSTING SCREW ONE TURN COUNTER CLOCKWISE. OBSERVE BOTH GAUGES FOR 5 MINUTES. NO CHANGE IN EITHER GAUGE READING IS PERMITTED. A LEAK TEST MAY BE PERFORMED BY OTHER MEANS PROVIDED THE LEAK RATE USING AIR DOES NOT EXCEED __K__ PER MINUTE.

4. DROP TEST: ADJUST THE REGULATOR TO DELIVER __H__ PSIG STATIC. OPEN THE TEST GUN. THE DROP ON THE OUTLET TEST GAUGE MUST NOT EXCEED __L__ PSIG.

5. SLOW SHUT-OFF/CREEP TEST: ADJUST THE REGULATOR TO DELIVER __H__ PSIG FLOWING. CLOSE THE TEST GUN AND OBSERVE THE DELIVERY PRESSURE READING FOR 5 MINUTES. AN INITIAL SLOW SHUT-OFF INCREASE OF __M__ PSIG DURING THE FIRST MINUTE IS PERMISSIBLE. NO FURTHER CREEP IS PERMISSIBLE DURING THE NEXT 4 MINUTES.

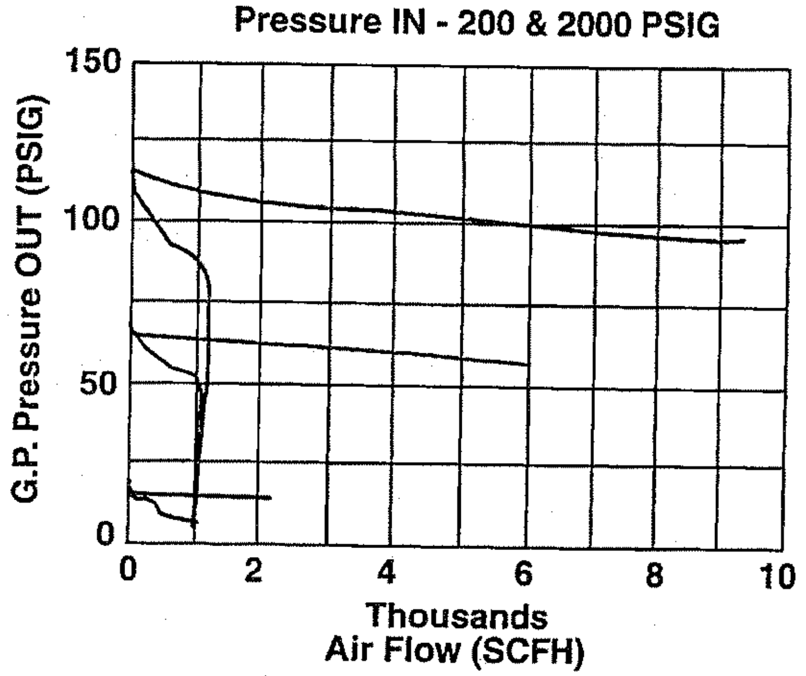
6. PRESET THE REGULATOR TO __N__ PSIG STATIC.

VICTOR®
VICTOR EQUIPMENT COMPANY
DENTON TEXAS

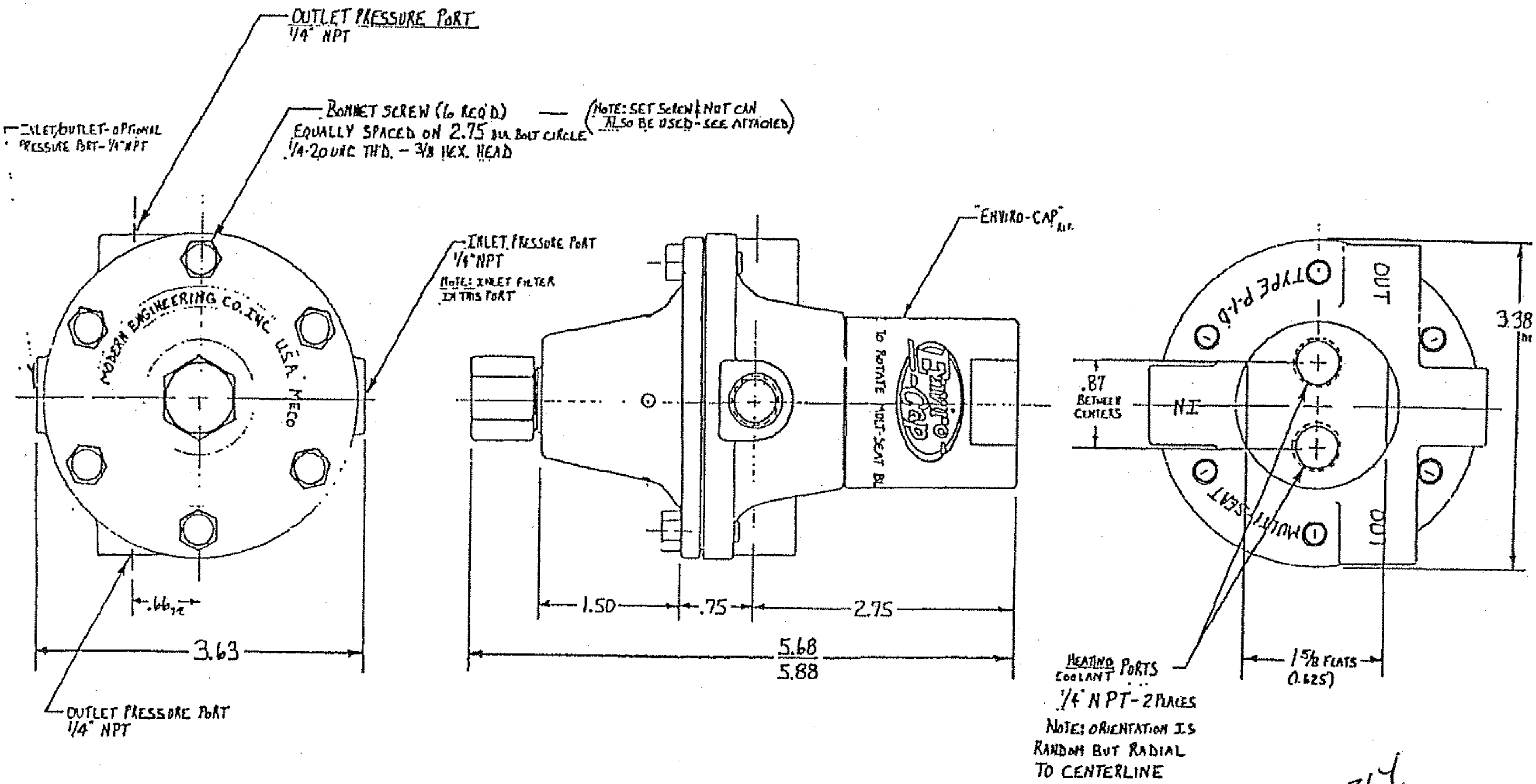
REF. DATA	MATERIAL	UNLESS SPECIFIED	DRAWN	BY	DATE	TITLE
70420	FINISH	BREAK ALL EDGES .005-.010 MACHINED SURFACES √125 ALL FEATURES WITH A COMMON AXIS MUST BE COAXIAL WITHIN .005 F.I.M. TOLERANCES .X ±.020 .XX ±.010 .XXX ±.005 ANGLES ±1°		E. BRADFORD	10-22-99	TEST PROCEDURE MECO PRESET REGULATORS
			CHECKED	L.TURNEY	11-99	
			APVD	L.TURNEY	11-99	SIZE B · DWG. NO. 0090-0040
			DIMENSIONS ARE IN INCHES UNLESS NOTED		PROJECTION	SCALE NTS · SHEET 2 OF 2

Flow Data (SCFH)

Meco "P" Series Cylinder Regulator
Single Stage/Heavy Duty



Reference: "P" Regulator Section A, Page 37



WEIGHT - 3.5 LB. APPROX.

NAME INSTALLATION DWG. ("P" NGV).

MATERIAL

DWG. NO. | STOCK NO.

ALL DIMENSIONS IN INCHES

TOLERANCE

1 PLACE DECIMAL AND FRACTIONAL DIMENSIONS + OR -.03 UNLESS OTHERWISE SPECIFIED.
3 PLACE DECIMAL DIMENSIONS + OR -. UNLESS OTHERWISE SPECIFIED.

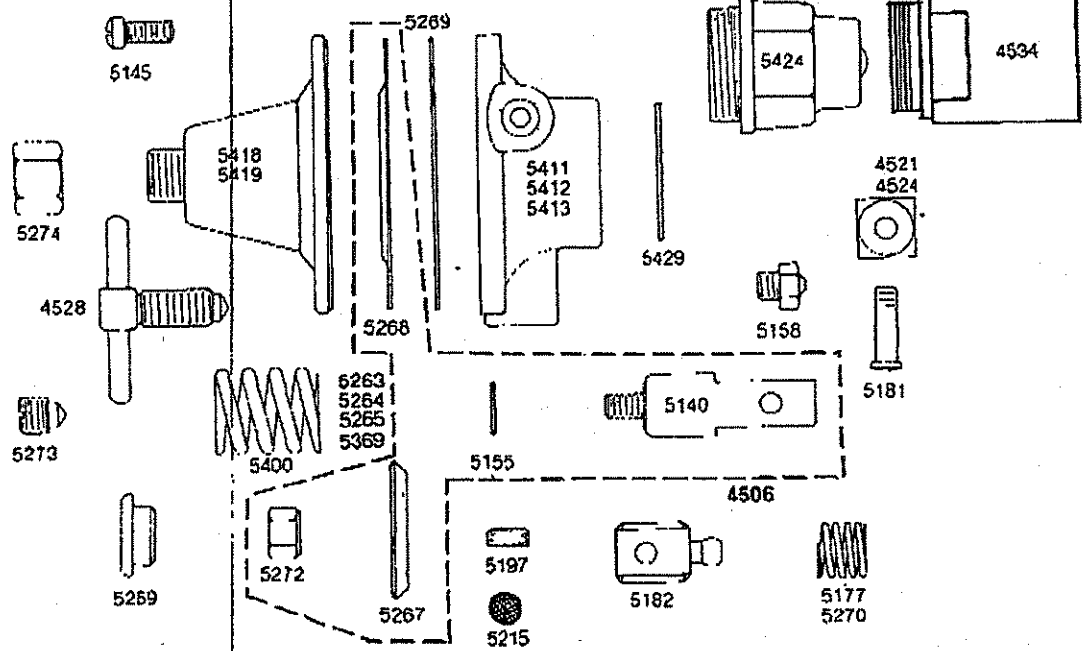
314
601

REVISED

MODERN ENGINEERING COMPANY
GALLMAN, MS • ST. LOUIS, MO U.S.A.

SUBJECT TYPE "P" NGV REGULATOR	
DRAWN WFF	DATE 6-25-91
CHK'D BY	SCALE FULL (APPROX)

TYPE P-30, P-50, P-125, P-150, & P-225 INDUSTRIAL MULTI-SEAT REGULATOR



Stock No.	Description
4506	Diaphram-Yoke Assembly
4521	Seat Block with White Nylon Seats
4524	Seat Block with Kel-F Seats for CO_2
4528	Adjusting Screw Assembly
4534	ENVIRO-CAP, Water Heated Back Cap Assembly
5140	Yoke (Part of 4506)
5145	Bonnet Screw 6 required, Pkg. 12
5155	Yoke Gasket, Teflon, Pkg. 12 (Part of 4506)
5158	Nozzle with 5/64″ Orifice, Pkg. 6
5177	Rear Spring, for over 500 PSI Inlet Pressure, Standard
5181	Yoke Clamping Screw, Pkg. 6
5182	Yoke Guide
5197	Filter Screen, pkg. 6
5215	Sintered Filter, pkg. 12, Standard
5259	Spring Button
5263	Compression Spring for 30 PSI Pressure (Red)
5264	Compression Spring for 125 PSI Pressure (Green)
5265	Compression Spring for 150 PSI pressure (Purple)
5267	Diaphragm Plate (Part of 4506)
5268	Stainless Steel Diaphragm (Part of 4506)
5269	Diaphragm Gasket, Pkg. 6
5272	Diaphragm Plate Nut (Part of 4506)
5273	Slot Type Adjusting Screw
5274	Protection Cap for Slot Adjusting Screw
5369	Compression Spring for 50 PSI pressure (Black)
5400	Compression Spring for 225 PSI pressure (Grey)
5411	Body, 1 inlet, 2 outlets P-1-DA
5412	Body, 1 inlet, 3 outlets P-1-DC
6413	Body, 2 inlets, 2 outlets P-1-DD
5418	Bonnet, for "T" Type Adjusting Screw
5419	Bonnet, for Slotted Type Adjusting Screw
5423	Allen Head Adj. Screw
5424	Back Cap
5429	Back Cap Gasket, Teflon, Pkg. 12

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ANGI™

PT 60

AMERICAN SENSOR TECHNOLOGIES
AST4400A06000P4Y0537

TRANSDUCER-AST 0-6000# IS/UL CL1 DIV2 GRPC&D 4-20mA 1/4MNPT SS M12x1 CONNECTION

ANGI PART NUMBER-
410-07298

AST4400 *Intrinsically Safe Pressure Transducer / Transmitter*

UL Approved for Hazardous Locations with Approved Barrier

Overview

The AST4400 is a media isolated stainless steel pressure sensor with a wide variety of options. With its rugged construction and best price-to-performance ratio in the industry, the AST4400 is the solution for pressure measurement in Intrinsically Safe areas.

Benefits

- **UL/cUL 913 (CSA 157)** Class 1 Div 1 Groups C, D when installed with an approved barrier
- High Strength Stainless Steel Construction
- No Oil, Welds or Internal O-rings
- Wide Operating Temperature
- Pressure up to 10,000 PSI
- Low Static and Thermal Errors
- Unparalleled Price and Performance
- Compatible with Various of Liquids and Gases
- EMI/RFI Protection

Applications

- Industrial OEM Equipment
- Water Management
- Pneumatics
- Data Loggers
- HVAC/R Equipment
- Control Panels
- Hydraulic Systems

Performance @ 25°C (77°F)

Accuracy*	< ±0.25% BFSL (< ±0.5% BFSL for 7,500 & 10,000 PSI)
Stability (1 year)	±0.25% FS, typical
Over Range Protection	2X Rated Pressure
Burst Pressure	5X or 20,000 PSI (whichever is less)
Pressure Cycles	> 100 Million

* Accuracy includes non-linearity, hysteresis & non-repeatability

Environmental Data

Temperature	
Operating	-40 to 85°C (-40 to 185°F)
Storage	-40 to 100°C (-40 to 212°F)
Thermal Limits	
Compensated Range	0 to 55°C (30 to 130°F)
TC Zero	<±1.5% of FS
TC Span	<±1.5% of FS
Other	
Shock	EN 60068-2-27
Vibration	EN 60068-2-6, 60068-2-64, and IEC 68-2-32
EMI/RFI Protection:	Yes
Rating:	IP-66

Electrical Data

Output	**4-20mA**	**1-5VDC, 1-6VDC**	**0.5-4.5V Ratiometric**
Excitation	10-28VDC	10-28VDC	5VDC, regulated
Output Impedance	>10k Ohms	<100 Ohms, Nominal	<100 Ohms, Nominal
Current Consumption:	20mA, typical	5mA, typical	5mA, typical
Bandwidth	(-3dB): DC to 250 Hz	(-3dB): DC to 1kHz	(-3dB): DC to 1kHz
Output Noise:	-	<2mV RMS	<2mV RMS
Zero Offset:	<±1% of FS	<±1% of FS	<±1% of FS
Span Tolerance:	<±2% of FS	<±1.5% of FS	<±1.5% of FS
Output Load:	0-800 Ohms@10-28VDC	10k Ohms, Min.	10K Ohms, Min.
Reverse Polarity Protection	Yes	Yes	Yes

American Sensor Technologies · 450 Clark Dr., Mt. Olive, NJ 07828 · phone (973) 448-1901 · fax (973) 448-1905 · email: *info@astsensors.com*

Ordering Information

AST4400	**A**	**00500**	**P**	**4**	**E**	**0**	**000**

Series Type

Process Connection
A= 1/4" NPT Male
B= 1/8" NPT Male*
C= 1/4" BSPP Male
F= 7/16" - 20 UNF Male*
I= 1/4" NPT Female
P = 1/2" NPT Male

Pressure Measurement
Insert pressure from chart

Pressure Unit
B= Bar K= kg/cm2r P= PSI

Outputs
1= 0.5-4.5V ratiometric 4= 4-20mA (2 wire loop powered)
3= 1-5V 6= 1-6V

Electrical**
A= 2 ft. (0.6 m)
B= 4 ft. (1.2 m)
C= 6 ft. (1.8 m)
D= 10 ft. (3.0 m)
E= Mini DIN 43650
F= Packard Metripack 150 3-Pin Conn.
Y= M12x1
I= DIN 43650A⁺
L= Conduit fitting, Cable 2 ft.⁺
M= Conduit fitting, Cable 4 ft.⁺
N= Conduit fitting, Cable 6 ft.⁺
P= Conduit fitting, Cable 10 ft.⁺
R= 6 Pin PT06A-10-6S Bendix

Wetted Material
0=17-4PH 1=316 L 2= Inconel 718 (consult factory on availability)

Options
000= No special options

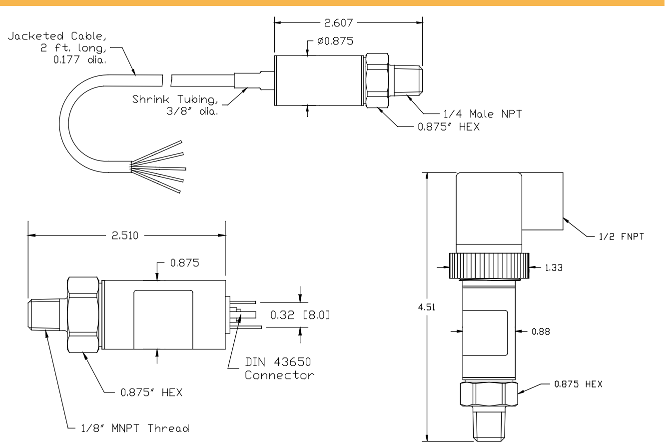
*Not available under 50PSI, or in 316L
**Wiring information available at: *http://www.astsensors.com/wiring.php*
⁺Also approved to UL/cUL 1604 Class I Div 2, Group A, B, C, D without requiring a barrier; contact AST for A11028 mating connector.

Pressure Ranges

PSIG Measurement	**Pressure Code**	**BARG Measurement**	**Pressure Code**
-14.7 to 30⁺⁺	V0030	-1 to 2⁺⁺	V0002
0-25	00025	0-2	00002
0-50	00050	0-5	00005
0-100	00100	0-10	00010
0-200	00200	0-20	00020
0-250	00250	0-50	00050
0-300	00300	0-100	00100
0-500	00500	0-250	00250
0-1,000	01000	0-350	00350
0-1,500	01500	0-500	00500
0-2,500	02500	0-700	00700
0-3,000	03000		
0-5,000	05000		
0-7,500	07500		
0-10,000	10000		

Typical ranges. All ranges between 0-25 PSI and 0-10,000 PSI available.
⁺⁺Compound ranges up to -14.7 to 500 PSI available. Please consult factory.

Dimensional Data



Warranty

Workmanship - AST, Inc. pressure transmitters have a limited one-year warranty to the original purchaser. AST, Inc. will replace or repair, free of charge, any defective transmitter. This warranty does not apply to any units that have been modified; misused, neglected or installed where the application exceeds published ratings. The AST4400 pressure sensor with 316L material is compatible with hydrogen, but does not carry the rating for Group B. For hydrogen applications, contact the factory for AST4300, AST4401, & AST4600 model information. AST's sensors are made with pride in New Jersey, USA. If in the area please feel free to stop by for a visit!

Installation/Applications - The purchaser is responsible for media compatibility, functional adequacy, and correct installation of the transmitter.

Barrier Installation

Class I, Div. 1, Groups C, D Hazardous Location

Nonhazardous Location

A01657

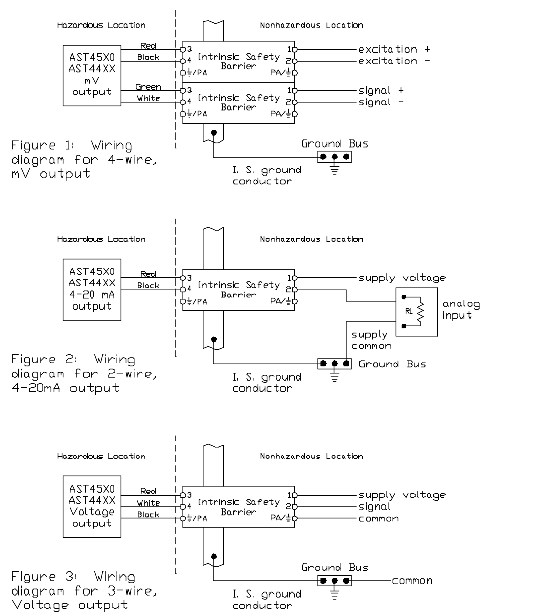


Figure 1: Wiring diagram for 4-wire, mV output

Figure 2: Wiring diagram for 2-wire, 4-20mA output

Figure 3: Wiring diagram for 3-wire, Voltage output

The transducers listed below are designed for installation in a Class I, Division 1, Groups C and D, Division 1 hazardous location when connected to Associated Apparatus as described in note 1.

Entity Parameters
Vmax = 28Vdc
Imax = 175mA
Ci = 0.44uf
Li = 0

Imax is the total current available from the Associated Apparatus under any condition.

Notes:
1. Associated Apparatus shall provide intrinsically safe connections which meet the following parameters.
Voc or Vt ≤ Vmax Ca ≥ Ci + Cleads
Isc or It ≤ Imax La ≥ Li + Lleads

2. Control Room aparatus shall not generate in excess of 250V (Umax).

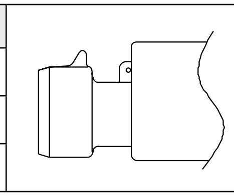
3. Installation should be in accordance with Article 504 in the National Electrical Code, ANSI/NFPA 70.

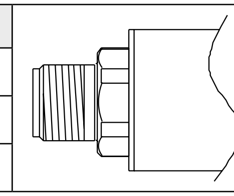
www.astsensors.com

American Sensor Technologies
Standard Electrical Connections For AST Pressure Products

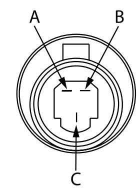
Packard Metripack 150
M12x / Eurofast

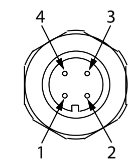
	Delphi : Packard Metripack 150	Turck : M12 4 Pin Eurofast
Electrical Connection option	“F”	“Y”
Mates with	Packard Delphi 1206 5287	N/A
Mating Connector Part Number	A04391	N/A





Output Type	Delphi : Packard Metripack 150 Pin A	Pin B	Pin C	Turck : M12 4 Pin Eurofast Pin 1	Pin 2	Pin 3	Pin 4
mV & 4-Wire Voltage	N/A	N/A	N/A	+V	+S	-S	GND
3 Wire Voltage	GND	+V	S	+V	N/C	GND	S
4-20mA (2 wire loop powered)	-V	+V	N/C	+V	N/C	-V	N/C
4-20mA (3 wire, available on the AST5400 only)	-	-	-	+V	N/C	GND	S





NOTICE FOR INTRINSICALLY SAFE SENSORS - *Refer to data sheet for barrier installation information*

+V	Voltage Supply
-V	4-20mA Electrical Ground / Signal [see schematic]
S	Voltage Output Signal
GND	Voltage Electrical Ground
Case	Case / Earth Ground ***(Do not connect or tie the case ground to the electrical ground)***
N/C	Not Connected

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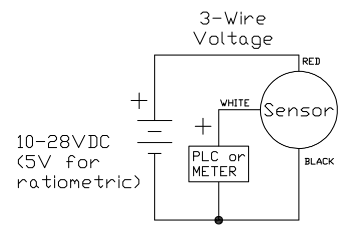
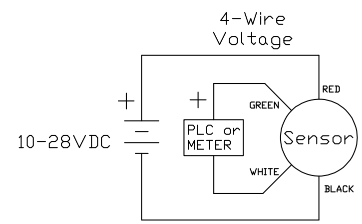
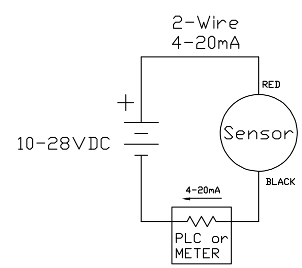
American Sensor Technologies
Standard Electrical Connections For AST Pressure Products

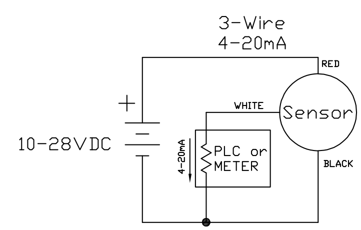
	mV	Voltage		
		0.5-4.5V ratiometric	1-5V, 1-6V, 0-5V	0-10V, 1-10V
Supply Voltage	5VDC typ., 10VDC max.	5VDC ± 0.01V	10-28VDC	15-28VDC
Output Load	>1 MΩ	>10 KΩ	>10 KΩ	>10 KΩ
Operating Temperature	-40 to 105°C	-40 to 85°C	-40 to 85°C	-40 to 85°C





	4-20mA
Supply Voltage	10-28VDC
Output Load	0-800Ω
Operating Temperature	-40 to 85°C





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SRV 37
CIRCLE SEAL
D559N2M-125ASME

VALVE-RELIEF 125# CIRCLE SEAL 1/4 ASME W/BUNA O'RINGS

ANGI PART NUMBER-
331-04522

CIRCLE SEAL CONTROLS

D500 Series
M5100 Series

ASME Safety Relief Valves
D500 Series: 15 to 150 psig (1 – 10 bar)
M5100 Series: 20 to 1200 psig (1 – 83 bar)

D500 Series

M5100 Series

Features

- D500 Series features cap design
- M5100 Series offered with ring or lift handle
- MD500 Series features cup design with manual override ring
- Zero leakage from 0 psi up to 70% of the marked set pressure

Technical Data

ASME	American Society of Mechanical Engineers
Body Construction Materials	Naval brass, 303 and 316 stainless steel
O-ring Materials	• D500 Series: Buna N, neoprene, PTFE, Viton®, EPDM, and silicone • M5100 Series: Buna N, neoprene, PTFE, Viton®, and EPDM
Set Pressure	• D500 Series: 15 to 150 psig (¼″) • M5100 Series: 20 to 1200 psig (⅛″, ¾, 1″); 50 to 1200 psig (¼″, ⅜″, ½″)
Temperature Range	–100° F to +400° F (–73° C to +204° F) *Based on O-ring & body material, see "How to Order"*
Connection Sizes	• D500 Series: ¼″ male pipe • M5100 Series: ⅛″ to 1″ male pipe

Note: Proper filtration is recommended to prevent damage to sealing surfaces.

Terminology for ASME Safety Relief Valves

Safety Relief Valves
An automatic pressure relieving device actuated by the static pressure upstream of the valve, which opens in proportion to the increase over the opening pressure.

Start-to-Leak Pressure
The pressure at the valve inlet where the relieved fluid is first detected (on the downstream side of the seat) before normal relieving action takes place

Opening Pressure (Set Pressure)
The valve inlet pop point pressure at which there is a measurable lift or discharge becomes continuous as determined by seeing, hearing or feeling. In the pop type of safety valve, it is the inlet pressure at which the valve opens, allowing a larger amount of fluid as compared with corresponding valve movements at higher or lower pressures
Note: A safety relief valve is not considered to open when it is simmering at a pressure just below the popping point even though the simmering may be audible. This set pressure distinguishes our ASME relief valves from our standard relief valves whose cracking pressure indicates initial flow.

Relieving Pressure
(Opening pressure plus overpressure) The pressure measured at the valve inlet at which the relieving capacity is determined.

Closing Pressure
(Reseat pressure) The pressure measured at the valve inlet, at which the valve closes, flow is substantially shut off, and there is no measurable lift.

Seal-off Pressure
The pressure (measured at the valve inlet) after closing at which no further gas is detected at the downstream side of the seat.

Operating Pressure
The actual pressure at which a vessel is maintained in normal operation.

Accumulation
Pressure buildup or overpressure beyond the set pressure of a safety relief valve, at which capacity flow is rated. Capacities are usually based on 10% accumulation.

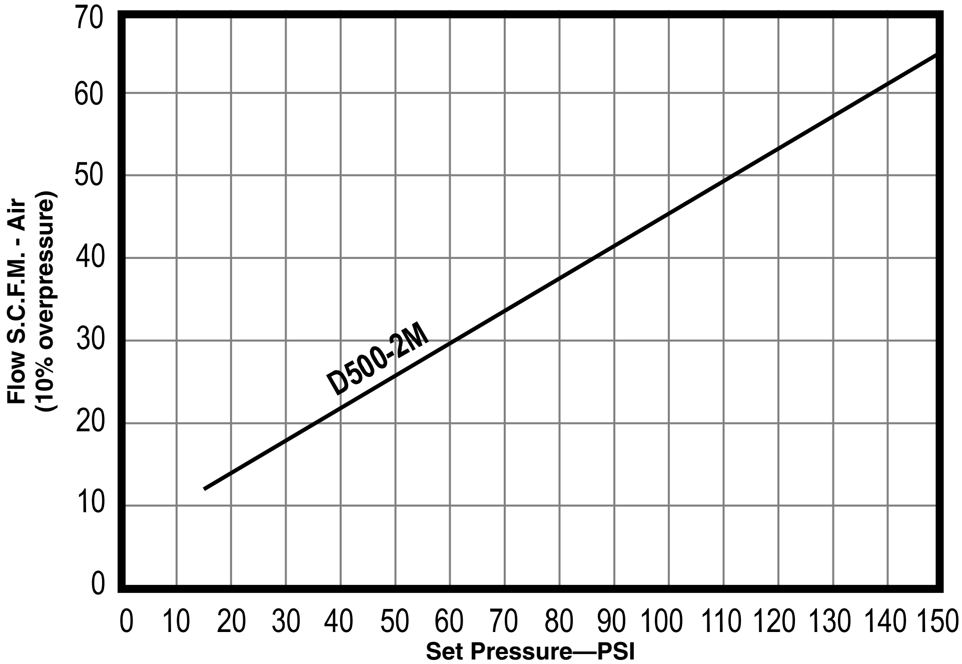
Note: Please specify 'ASME' when placing your order.

Circle Seal Controls
2301 Wardlow Circle • Corona, CA 92880
Phone (951) 270-6200 • Fax (951) 270-6201
www.circlesealcontrols.com

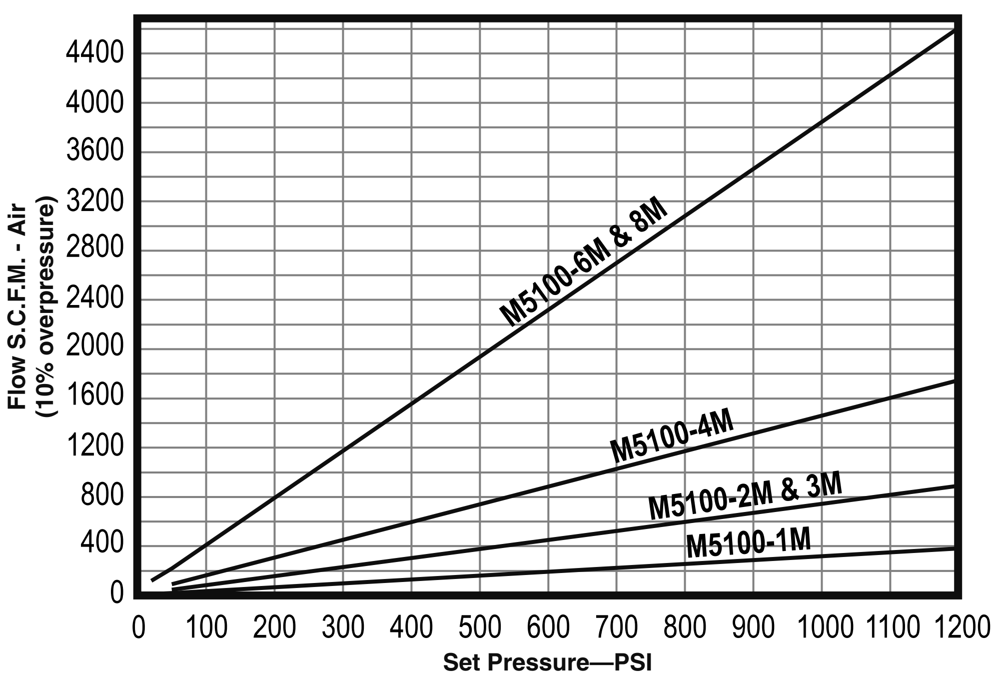
ASME Safety Relief Valves

Flow Curves

D500 Series



M5100 Series



ASME Safety Relief Valves

How to Order: D500 Series ASME Relief Valves (15 to 150 psig)

M D5 32 T1 – 2 M – 20

MANUAL OVERRIDE OPTION

O-RING MATERIAL & TEMPERATURE

20 PTFE, -100° F to +400° F (-73°C to +204°C)
24 Silicone, -65° F to +150° F (-54°C to +66°C)
32 Viton®, -20° F to +350° F (-29°C to +177°C)
33 Neoprene, -20° F to +240° F (-29°C to +116°C)
59 Buna N, -20° F to +250° F (-29°C to +121°C)
62 Ethylene propylene, -20° F to +250° F (-29°C to +121°C)

MATERIAL & OTHER PRESSURE BOUNDARY COMPONENTS

N Naval brass
T1 316 stainless steel

SET PRESSURE

Specify set pressure in psig
(15 – 150 psig) 125psig

CONNECTIONS—INLET

M Male pipe

VALVE SIZE

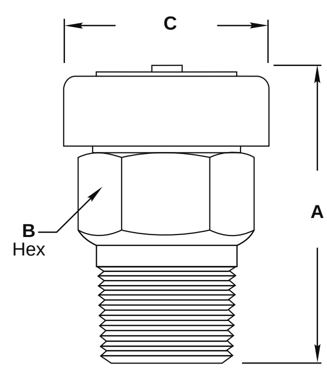
2 ¼″

Please specify 'ASME' when placing your order.

Please consult your Circle Seal Controls distributor or our factory for information on special connections, lubricants, operating pressures and temperature ranges.

Dimensions (inches)

Dash No.	Size	A	B Hex	C Dia.
–2M	¼″	1.1875	0.625	0.90



Recommended Installation

1. Before installing a new safety relief valve, we recommend that a pipe tap be used to assure clean-cut and uniform threads in the vessel opening and to allow for normal hand engagement followed by a half to one turn by wrench.
2. Avoid over-tightening as this can distort the valve seat.
3. Avoid excess "popping" of the valve. Safety relief valves should only be operated often enough to assure they are in good working order.
4. Apply only a moderate amount of pipe compound or tape to the threads, leaving the first thread clean parts.
5. Don't oversize the valve, as this may cause chatter resulting in rapid wear of the moving parts.
6. Avoid wire, cable, or chain pulls for attachments to levers that do not allow a vertical pull. The weight of these devices should not be applied to the safety relief valve.
7. Avoid having the operation pressure too near the valve set pressure. A minimum differential of 10% is recommended.

For Your Safety

It is solely the responsibility of the system designer and user to select products suitable for their specific application requirements and to ensure proper installation, operation, and maintenance of these products. Material compatibility, product ratings and application details should be considered in the selection. Improper selection or use of products described herein can cause personal injury or property damage.

Viton® is a registered trademark of DuPont Dow Elastomers.

ASME Safety Relief Valves

How to Order: M5100 Series ASME Relief Valves (20 to 1200 psig)

M51 59 N – 4 M(L) – 20

O-RING MATERIAL & TEMPERATURE

- **20** PTFE, –100° F to +300° F (-73°C to +149°C)
- **32** Viton®, –20° F to +400° F (-29°C to +204°C)
- **33** Neoprene, –40° F to +250° F (-40°C to +121°C)
- **59** Buna N, –40° F to +250° F (-40°C to +121°C)
- **62** Ethylene propylene, –20° F to +200° F (-29°C to +93°C)

BODY MATERIAL

- **N** Naval brass
- **T1** 316 stainless steel

* *Set Pressure*
⅛″, ¾″, 1″: 20 to 1200 psi (1 – 83 bar)
¼″, ⅜″, ½″: 50 to 1200 psi (3 – 83 bar)

Please specify 'ASME' when placing your order.

SET PRESSURE*

Specify set pressure in psig
(20 – 1200 psig)

CONNECTIONS—INLET

- **M** Male pipe
- **L** Lockwire

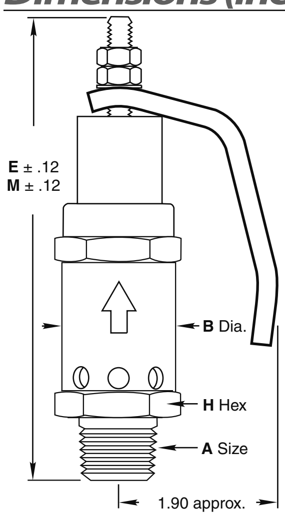
VALVE SIZE

Pipe sizes in ⅛″ increments

- **1** ⅛″
- **2** ¼″
- **3** ⅜″
- **4** ½″
- **6** ¾″
- **8** 1″

Please consult your Circle Seal Controls distributor or our factory for information on special connections, lubricants, operating pressures and temperature ranges.

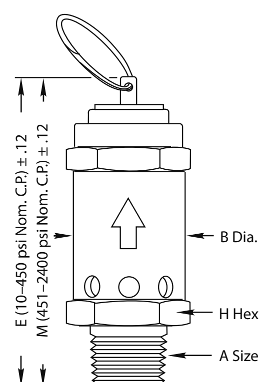
Dimensions (inches)



Dash No.	A Size	E	M	B Dia. H Hex
–1M	⅛″	2.84	3.45	0.71
–2M	¼″	3.16	4.06	1.00
–3M	⅜″	3.19	4.09	1.00
–4M	½″	3.86	5.51	1.25
–6M	¾″	5.41	7.54	1.50
–8M	1″	5.59	7.72	1.50

Lift Handle
For ½″, ¾″, and 1″ valve sizes with set pressure of 451–1200 psi.

Ring Handle
For set pressures to a maximum of 1200 psi in ⅛″ through ⅜″ valves sizes to a maximum of 450 psi in ½″ through 1″ sizes.



Important

Complete part number MUST INCLUDE set pressure in psi. The ASME requires that valves be set at a "pop point". The ASME refers to this as the set pressure. This point is higher than the traditional Circle Seal Controls definition of cracking pressure.

After a prolonged period of storage with no system pressure, these relief valves will evidence an apparent high set pressure on first pop; therefore, in receiving inspection tests, true set pressure should be determined after first pop.

The following Circle Seal Controls valves have been tested in accordance with procedures in Paragraph UG 131, Section V111 of the ASME Unified Pressure Vessel Code:

D500–2M	M5100–1M(L)	M5100–3M(L)	M5100–6M(L)
	M5100–2M(L)	M5100–4M(L)	M5100–8M(L)

ASME Certificate of Authorization, Number 4599

Note: These valves are not certified for steam or liquid service and are intended for air service applications only.

Viton® is a registered trademark of DuPont Dow Elastomers.

For Your Safety

It is solely the responsibility of the system designer and user to select products suitable for their specific application requirements and to ensure proper installation, operation, and maintenance of these products. Material compatibility, product ratings and application details should be considered in the selection. Improper selection or use of products described herein can cause personal injury or property damage.

SRV 149

MERCER
91-M2C61P1541/4500
4500 PSI C-ORIFICE, 3/4” MNPT IN, 1” FNPT OUT
4600 SCFM SAFETY RELIEF VALVE

ANGI PART NUMBER 331-08049

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MERCER VALVE CO., INC.
"Auto Seat Technology" ®

Post Office Box 270970
Oklahoma City, Oklahoma 73137
FAX # (405) 495-8728

MERCER VALVE COMPANY, INC.
9100 SERIES THREADED SAFETY RELIEF VALVES

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

INSTALLATION

The safety relief valve should always be installed on a tank or piping run in the vertical position with the valve outlet pointing in a horizontal direction. When screwing the valve into the inlet piping, always use the wrench flats on the inlet connection. Never put a wrench on the relief valve body.

One of the most common causes of early failure of relief valves is dirt trapped on the valve seat. Welding slag and/or piping Teflon tape are among the more common items that cause difficulty. It is recommended that all piping and tank systems be cleaned prior to installation of the relief valve.

A relief valve should be connected with the minimum amount of piping between the tank and valve. Further, all piping used must be equal or larger than the inlet pipe size of the relief valve, <u>never smaller</u>. Any restriction of the inlet to a relief valve may cause unusual valve chatter, which could result in <u>serious damage</u> to the valve. Piping restrictions can also can also cause the valve to not relieve its full capacity causing the valve not to be able to reduce the pressure increase. Outlet piping from the relief valve should be less than four (4) feet in length and never of a pipe size smaller than the outlet pipe size of the relief valve. Long runs of small diameter pipe on the outlet side of a relief valve will create valve chatter and a capacity reduction that can cause the system to not be protected.

Extreme caution is required in the outlet piping if installed where liquids, if present, could form an ice block in the piping of the relief valve body in below freezing conditions. Discharge lines must be "weathered capped" and provided with a drain hole to prevent any liquid collection in the relief valve body or outlet piping. This liquid can freeze and cause the valve to not open or reduce the capacity of the valve. If these precautions are not taken the valves will not protect the system.

Additional, important installation information is contained in Paragraph UG-135, Section VIII of the ASME Code.

OPERATION

For best performance in process work is usually obtained by setting the safety relief valve to open at least 15% above the operating pressure where possible. A greater margin is desirable. However, this setting must not exceed the maximum working pressure of the vessel. All Mercer 9100 Series Safety Relief Valves are checked for bubble-tight per API 527.

In Addition to checking the set pressure versus the maximum allowable working pressure of the vessel, also check to insure that back pressure and temperature limitations of the process are consistent with valve ratings. The fluid state, capacity, temperature, set pressure, and back pressure can all be found on the tag of the valve. Pressures and Temperatures outside the normal ranges require special materials. Further, carefully check the process fluid input capacities to insure that the relief valve capacity is greater than the process capacities.

DO NOT BREAK THE SEAL WIRE Breaking the seal wire invalidates the manufacture's warranty to repair or replace the valve. If resetting is required in a field emergency situation a qualified personnel with calibrated instrumentation should perform it. With a broken seal wire this valve will be considered a non ASME code valve until it has been repaired by a VR certified repair shop.

DISASSEMBLY: **The following general procedure is recommended in disassembly inspection and cleaning of the relief valve:**

1. **Cut the wire seal and unscrew the cap to expose the adjustment screw.**
2. **Loosen the lock nut and relieve the tension on the spring by turning the adjustment screw counter clockwise. This will relieve the spring tension.**
3. **Secure the valve body so that it will not move**
   For orifice sizes C to G, unscrew and remove the inlet base
   For orifice size of H, unscrew and remove the bonnet
   For orifice sizes J and K, unbolt and remove the bonnet
4. **Inspect the replaceable seat for cuts and abrasions. If there are only minor scratches or abrasions on the seat, polish the seat area lightly with Scotch-Brite #7447. Be careful not to damage the soft seat. If the seat is damaged with deep abrasions and cuts, replace the nozzle/seat subassembly.**
5. **Refer to Figure 1 and measure the diameter of Ds with a precision caliper. This diameter must be in the range of values listed in Table 1. If this is not the case, replace the nozzle/seat subassembly.**

TABLE 1

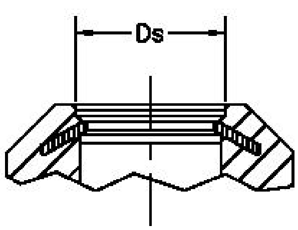


FIGURE 1

ORIFICE SIZE	DIAMETER Ds (INCHES) MINIMUM	MAXIMUM
"C"	.335	.337
"D"	.480	.482
"E"	.620	.622
"F"	.778	.780
"G"	.914	.916
"H"	1.242	1.2465
"J"	1.599	1.6025
"K"	1.899	1.903

6. **Remove and inspect the disk subassembly, especially the spherical surface portion that engages the seat. This surface must be clean and smooth. Polishing this surface with Scotch-Brite #7447 may restore the disk if it has only minor imperfections. If the spherical surface is damaged or scratched, replace the disk subassembly**

7. **Refer to Figure 2 and measure the diameter of Dd with a precision caliper. This diameter must be within the range of values listed in Table 2. If this is not the case, replace the disk subassembly.**

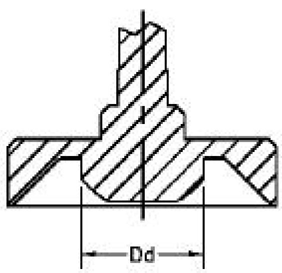


FIGURE 2

TABLE 2

ORIFICE SIZE	DIAMETER Dd (INCHES)	
	MINIMUM	MAXIMUM
"C"	.331	.333
"D"	.474	.477
"E"	.614	.616
"F"	.768	.771
"G"	.904	.906
"H"	1.228	1.231
"J"	1.580	1.583
"K"	1.876	1.880

8. **Check the disk stem of the disk subassembly to insure that the surface is smooth. Polish the stem if necessary with Scotch-Brite or fine emery. If the stem is galled, replace the disk subassembly.**
9. **Remove the spring and inspect for wear or damage. Clean and replace the spring if necessary. Be sure the spring is straight and square. If not replace the spring.**
10. **Remove the adjustment screw and guide bushing by tapping on the top of the adjustment screw with a "soft" drive rod. The guide bushing is designed to "slip fit" into the internal machined bore of the body. This "slip fit" must be maintained by cleaning the outside diameter of the guide bushing and internal bore of the valve body.**
11. **Replace the o-ring found on the adjustment screw stem.**
12. **DO NOT REMOVE THE CENTER NUT OR INDEX BRACKET SUBASSEMBLY. They are permanently installed at the factory. The purpose of the index bracket subassembly is to prevent rotation of the guide bushing. A body side pin is used in the 9100 "C" AND "D" orifices in place of the index bracket.**
13. **Lubricate the outside diameter of the adjustment screw thread, outside diameter of the guide bushing, the adjustment screw o-ring and the internal upper machined bore of the valve body with a good lubricating grease.**

REASSEMBLY: **The following general procedure is recommended in reassembly and setting of the valve:**

1. **Before reinstalling the adjustment screw and guide bushing, position the adjustment screw with the upper end of the thread protruding 1/8" from the end of the guide bushing. Carefully "slip fit" this assembly into the body, fitting the index bracket leg or body side pin into the slotted portion of the guide bushing. Note that the guide bushing must slip into the valve bore freely but with little radial play. Remove and reclean parts if the parts do not easy fit in. DO NOT FORCE THE GUIDE BUSHING INTO THE VALVE BODY. Forcing the parts may restrict valve lift and <u>cause serious malfunction.</u>**
2. **Swab out the internal bore of the adjustment screw to insure that is is clean and free from obstructions like dirt and grease.**
3. **Before reinstalling the spring, insert the disk subassembly into the bore of the adjustment screw and simulate the valve opening operation. The disk stem must slide freely within the bore of the adjustment screw.**
4. **Reinstall the spring and the disk subassembly. The spring should slide over the disk freely without sticking. Make sure the correct spring is installed.**
5. **Install the nozzle subassembly into the inlet base or body, for whichever applies.**
6. **For bottom entry valves reinstall the inlet base subassembly using a new base seal. Caution, the inlet base must be tight against the base seal and body.**
   For top entry valves reinstall the bonnet subassembly.
   Make sure the disk and nozzle are aligned.
7. **Check the lift of the valve by inhering a properly shaped drive rod in an arbor press into the internal bore of the inlet base and pressing on the nose of the disk subassembly. Apply a slight spring tension to the valve disk. Measure the "lift" of the valve with a dial indicator. The minimum lift can be found in NB-18 on the National Board website www.nationalboard.org.**
8. **Reinstall the lock nut and the valve is ready for setting. Valve setting at all pressures is dangerous. All eye and ear safety precautions should be observed.**
9. **Resetting should be performed on an air/gas test stand or a liquid test stand depending on the service of the valve. The test stand should have a volume under the valve of at least one (1) cubic foot capacity of the type recommended by the National Board. Test gauges should be a minimum of 6" dial with .25% accuracy. The gages should be dead weight verified for accuracy.**

10. **Repeated "popping" at set pressure is recommended. The valve should be popped approximately five (5) to ten (10) times during the setting process allowing full blowdowns.**
11. **A slight audible warning action is to be expected, starting approximately 5% below the set pressure.**
12. **All valves should be bubble tight at 10% below set pressure in accordance with API 527.**
13. **When the valve is set, tighten the lock nut securely so at least 1/4" of the stem is exposed above the lock nut. The adjustment screw must not turn when the lock nut is tightened. This will affect the set pressure. Pop the valve once more after the lock nut is tightened to verify the set pressure.**
14. **Reinstall the cap and a new lockwire. Close the lockwire and crimp the lead seal.**

<u>BACK PRESSURE TESTING</u> **The purpose of back pressure testing Mercer Safety Relief Valves is to check for leaks in the secondary pressure zone (the outlet side of the relief valve). This includes the body, bonnet, outlet flange and all parts included in the upper valve assembly. This is best performed before the valve seal wire has been attached.**

The back pressure test is performed after the valve has been assembled and set to the correct set pressure. The test is performed by attaching a pressure source to the outlet of the valve and submerging the valve in a solution of water treated with rust inhibitor. The pressure in the secondary pressure zone is then brought to 30 psig or to what the back pressure the valve will see. This is the pressure required by the ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII. PART UG-136(d) "Production Testing by Manufacturers and Assemblers". The valve is then visually inspected for any leaks by checking for bubbles coming from any part of the valve. If any part of the valve is producing bubbles, the valve is disassembled, repaired and the valve is reassembled and retested. If no leaks are detected, the valve is stamped with the appropriate set pressure, the valve then goes to the finishing department to be painted, tagged, and prepared for shipping.

MERCER VALVE COMPANY, INC.
9100 SERIES THREADED SAFETY RELIEF VALVES

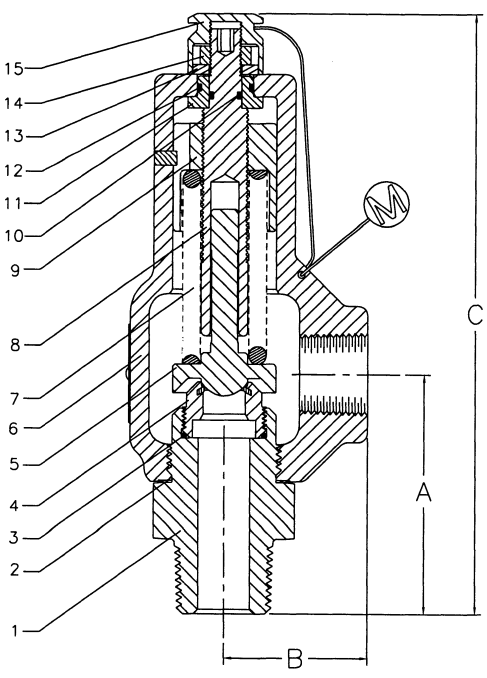
INSTALLATION, OPERATION AND MAINTENANCE MANUAL

“C”, “D”, AND “E” ORIFICE STANDARD BILL OF MATERIALS

“C” ORIFICE DIAMETER: .281 In.
“C” ORIFICE AREA: .062 Sq.In.
SET PRESSURE RANGE: 15-2999 PSI

“D” ORIFICE DIAMETER: .394 In.
“D” ORIFICE AREA: .122 Sq.In.
SET PRESSURE RANGE: 15-2999 PSI

“E” ORIFICE DIAMETER: .520 In.
“E” ORIFICE AREA: .212 Sq.In.
SET PRESSURE RANGE: 15-2400 PSI



"C", "D", and "E" Orifice

“C”, “D”, AND “E” ORIFICE				
ITEM NO.	PART NAME	“C” ORIFICE STD MTRLS “C” TRIM CODE	“D” & “E” STD MTRLS “I” TRIM CODE	“C”, “D”, “E” OPTIONS “U”, “L”, “N”, OR “B” CODE
1	Inlet Base	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel
2	Base Seal	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel
3	O’Ring	Viton	Viton	Viton
4	Nozzle Subassy	17-4 Stainless Steel with Soft Seat	17-4 Stainless Steel with Soft Seat	316 Stainless Steel with Soft Seat
5	Disk Subassy	440C Stainless Steel	17-4 Stainless Steel	316 Stainless Steel
6	Body	WCB Carbon Steel or CF3M Stainless Steel	WCB Carbon Steel or CF3M Stainless Steel	WCB Carbon Steel or CF3M Stainless Steel
7	Spring	17-7 Stainless Steel	17-7 Stainless Steel	17-7 Stainless Steel or Inconel X-750 (NACE)
8	Adjustment Screw	300 Series Stainless Steel	300 Series Stainless Steel	300 Series Stainless Steel
9	Adjustment Bushing	300 Series Stainless Steel	300 Series Stainless Steel	300 Series Stainless Steel
10	O’Ring	Buna N	Buna N	Buna N
11	Center Bushing	300 Series Stainless Steel	300 Series Stainless Steel	300 Series Stainless Steel
12	O’Ring	Buna N	Buna N	Buna N
13	Washer	Carbon Steel	Carbon Steel	Carbon Steel
14	Lock Nut	Carbon Steel	Carbon Steel	Carbon Steel
15	Cap	Anodized Aluminum	Anodized Aluminum	Anodized Aluminum

SV 9

ASCO
EF8320G184-120/60

1/4'' 3-WAY, 120V, 150 PSI SOLENOID VALVE

ANGI PART NUMBER 330-07243

REBUILD KIT- ASCO 3-WAY SOLENOID 120V 150 PSI – 761-07358

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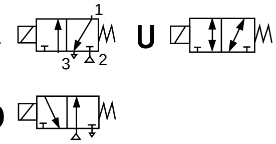
ASCO® Red-Hat®

Direct Acting
General Service Solenoid Valves
Brass or Stainless Steel Bodies
1/8" to 1/4" NPT

NC U NO



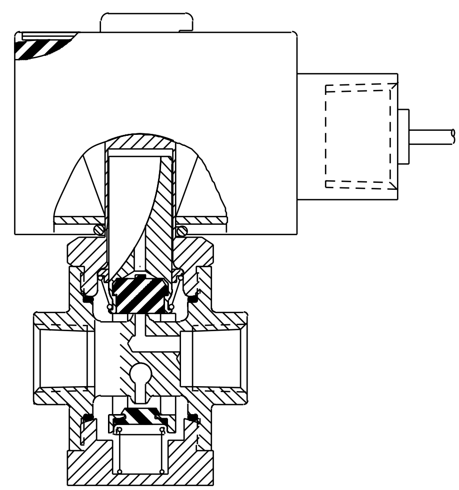
3/2
SERIES
8320

Features

- All NPT connections are in the valve body to allow in-line piping.
- No Minimum Operating Pressure Differential required.
- Sturdy design for long years of reliable service.
- Broadest range of applications.
- Mountable in any position.

Construction

Valve Parts in Contact with Fluids		
Body	Brass	303 Stainless Steel
Seals and Discs	NBR or Cast UR, as Listed	
Core Tube	305 Stainless Steel	
Core and Plugnut	430F Stainless Steel	
Core Springs	302 Stainless Steel	
Shading Coil	Copper	Silver
Disc-Holder	CA	
Core Guide	CA (10.1 and 17.1 Watt only)	



8320 1/4" NPT

Electrical

Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part No.			
	DC Watts	AC			General Purpose		Explosionproof	
		Watts	VA Holding	VA Inrush	AC	DC	AC	DC
F	10.6	6.1	16	30	238210	238310	238214	238314
F	-	9.1	25	40	238210	-	238214	-
F	11.6	10.1	25	50	238610	238710	238614	238714
F	-	17.1	40	70	238610	-	238614	-

Standard Voltages: 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220, volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering. Other voltages are available when required.

Nominal Ambient Temperature Ranges:

AC: 32˚F to 125˚F (0˚C to 52˚C)
DC: 32˚F to 104˚F (0˚C to 40˚C)
Refer to Engineering Section for details.

Solenoid Enclosures

Standard: Watertight, Types 1, 2, 3, 3S, 4, and 4X.

Optional: Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9. (To order, add prefix "EF" to the catalog number.)
See Optional Features Section for other available options.

Approvals:

CSA certified. UL listed General Purpose Valves.
Meets applicable CE directives.
Refer to Engineering Section for details.

Specifications (English units)

Pipe Size (ins.)	Orifice Size (ins.)	Cv Flow Factor	Operating Pressure Differential (psi) Max. AC Air-Inert Gas	Max. AC Water	Max. AC Lt. Oil @ 300 SSU	Max. DC Air-Inert Gas	Max. DC Water	Max. DC Lt. Oil @ 300 SSU	Max. Fluid Temp. °F AC	Max. Fluid Temp. °F DC	Brass Body Catalog Number	Brass Body Constr. Ref. No.	Stainless Steel Body Catalog Number	Stainless Steel Body Constr. Ref. No.	Watt Rating/ Class of Coil Insulation ② AC	Watt Rating/ Class of Coil Insulation ② DC
UNIVERSAL OPERATION (Pressure at any port)																
1/8	3/64	.06	175	175	175	125	125	125	140	120	8320G130 ①	1	8320G140 ①	1	9.1/F	10.6/F
1/8	1/16	.09	100	100	100	65	65	65	180	120	8320G1	1	8320G41	1	9.1/F	10.6/F
1/8	3/32	.12	50	50	50	50	50	50	180	120	8320G83	1	8320G87	1	6.1/F	10.6/F
1/8	1/8	.21	30	30	30	20	20	20	180	120	8320G3	1	8320G43	1	9.1/F	10.6/F
1/4	1/16	.09	125	130	130	75	75	75	200	150	8320G172	2	--	--	10.1/F	11.6/F
1/4	3/32	.12	100	100	100	60	60	60	200	150	8320G174	2	8320G200	3	17.1/F	11.6/F
1/4	1/8	.25	50	50	50	25	25	25	200	150	8320G176	2	8320G201	3	17.1/F	11.6/F
1/4	11/64	.35	20	20	20	12	12	12	200	150	8320G178	2	--	--	10.1/F	11.6/F
NORMALLY CLOSED (Closed when de-energized)																
1/8	3/64	.06	200	200	200	200	200	200	180	120	8320G132	1	8320G142	1	6.1/F	10.6/F
1/8	1/16	.09	150	125	125	125	125	125	180	120	8320G13	1	8320G45	1	6.1/F	10.6/F
1/8	3/32	.12	100	100	100	100	100	100	180	120	8320G15	1	8320G47	1	6.1/F	10.6/F
1/8	1/8	.21	40	40	40	40	40	40	180	120	8320G17	1	8320G49	1	6.1/F	10.6/F
1/4	1/16	.09	210	225	225	160	160	160	200	150	8320G182	2	--	--	17.1/F	11.6/F
1/4	3/32	.12	150	150	150	115	115	115	200	150	8320G184	2	8320G202	3	10.1/F	11.6/F
1/4	1/8	.25	85	85	85	60	60	60	200	150	8320G186	2	8320G203	3	10.1/F	11.6/F
1/4	11/64	.35	45	45	45	25	25	25	200	150	8320G188	2	--	--	10.1/F	11.6/F
NORMALLY OPEN (Open when de-energized)																
1/8	3/64	.06	200	200	200	200	200	200	180	120	8320G136	1	8320G146	1	6.1/F	10.6/F
1/8	1/16	.09	150	125	125	125	125	125	180	120	8320G27	1	8320G51	1	6.1/F	10.6/F
1/8	3/32	.12	100	100	100	100	100	100	180	120	8320G29	1	8320G53	1	6.1/F	10.6/F
1/8	1/8	.21	40	40	40	40	40	40	180	120	8320G31	1	8320G55	1	6.1/F	10.6/F
1/4	1/16	.09	250	250	250	160	160	160	200	150	8320G192	2	--	--	17.1/F	11.6/F
1/4	3/32	.12	150	140	140	100	100	100	200	150	8320G194	2	8320G204	3	10.1./F	11.6/F
1/4	1/8	.25	70	70	70	55	55	55	200	150	8320G196	2	8320G205	3	10.1/F	11.6/F
1/4	11/64	.35	40	40	40	30	30	30	200	150	8320G198	2	--	--	10.1/F	11.6/F

Notes: ① Supplied with cast UR disc.
② On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts; the watt rating for the 9.1/F solenoid is 11.1 watts.

Specifications (Metric units)

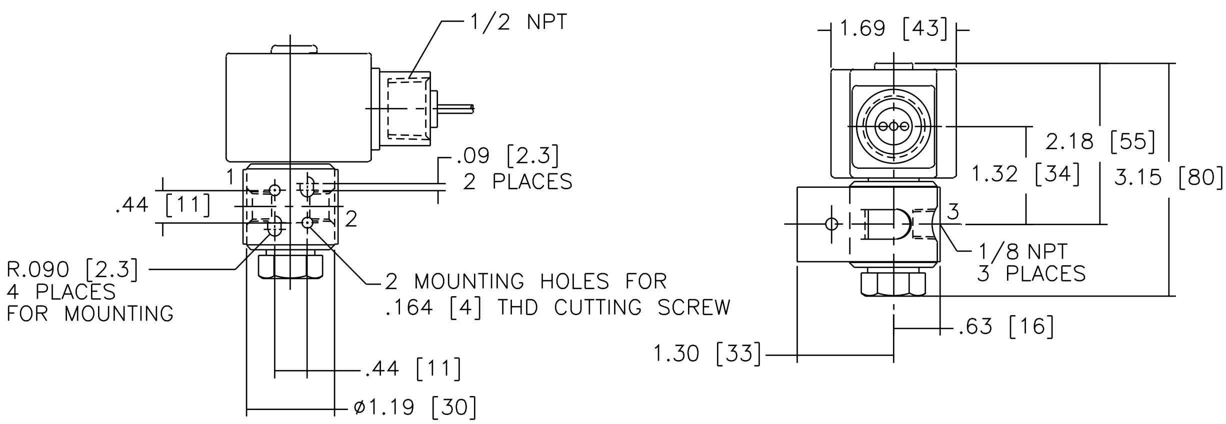
Pipe Size (ins.)	Orifice Size (mm)	Kv Flow Factor (m3/h)	Operating Pressure Differential (bar) Max. AC Air-Inert Gas	Water	Lt. Oil @ 300 SSU	Max. DC Air-Inert Gas	Water	Lt. Oil @ 300 SSU	Max. Fluid Temp. °C AC	DC	Brass Body Catalog Number	Constr. Ref. No.	Stainless Steel Body Catalog Number	Constr. Ref. No.	Watt Rating/ Class of Coil Insulation ② AC	DC
UNIVERSAL OPERATION (Pressure at any port)																
1/8	1.2	.05	12	12	12	9	9	9	59	48.4	8320G130 ①	1	8320G140 ①	1	9.1/F	10.6/F
1/8	1.6	.08	7	7	7	4	4	4	81	48.4	8320G1	1	8320G41	1	9.1/F	10.6/F
1/8	2.4	.10	3	3	3	3	3	3	81	48.4	8320G83	1	8320G87	1	6.1/F	10.6/F
1/8	3.2	.18	2	2	2	1	1	1	81	48.4	8320G3	1	8320G43	1	9.1/F	10.6/F
1/4	1.6	.08	9	9	9	5	5	5	92	64.9	8320G172	2	--	--	10.1/F	11.6/F
1/4	2.4	.10	7	7	7	4	4	4	92	64.9	8320G174	2	8320G200	3	17.1/F	11.6/F
1/4	3.2	.21	3	3	3	2	2	2	92	64.9	8320G176	2	8320G201	3	17.1/F	11.6/F
1/4	4.4	.30	1	1	1	1	1	1	92	64.9	8320G178	2	--	--	10.1/F	11.6/F
NORMALLY CLOSED (Closed when de-energized)																
1/8	1.2	.05	14	14	14	14	14	14	81	48.4	8320G132	1	8320G142	1	6.1/F	10.6/F
1/8	1.6	.08	10	9	9	9	9	9	81	48.4	8320G13	1	8320G45	1	6.1/F	10.6/F
1/8	2.4	.10	7	7	7	7	7	7	81	48.4	8320G15	1	8320G47	1	6.1/F	10.6/F
1/8	3.2	.18	3	3	3	3	3	3	81	48.4	8320G17	1	8320G49	1	6.1/F	10.6/F
1/4	1.6	.08	14	16	16	11	11	11	92	64.9	8320G182	2	--	--	17.1/F	11.6/F
1/4	2.4	.10	10	10	10	8	8	8	92	64.9	8320G184	2	8320G202	3	10.1/F	11.6/F
1/4	3.2	.21	6	6	6	4	4	4	92	64.9	8320G186	2	8320G203	3	10.1/F	11.6/F
1/4	4.4	.30	3	3	3	2	2	2	92	64.9	8320G188	2	--	--	10.1/F	11.6/F
NORMALLY OPEN (Open when de-energized)																
1/8	1.2	.05	14	14	14	14	14	14	81	48	8320G136	1	8320G146	1	6.1/F	10.6/F
1/8	1.6	.08	10	9	9	9	9	9	81	48	8320G27	1	8320G51	1	6.1/F	10.6/F
1/8	2.4	.01	7	7	7	7	7	7	81	48	8320G29	1	8320G53	1	6.1/F	10.6/F
1/8	3.2	.18	3	3	3	3	3	3	81	48	8320G31	1	8320G55	1	6.1/F	10.6/F
1/4	1.6	.08	17	17	17	11	11	11	92	65	8320G192	2	--	--	17.1/F	11.6/F
1/4	2.4	.10	10	10	10	7	7	7	92	65	8320G194	2	8320G204	3	10.1./F	11.6/F
1/4	3.2	.21	5	5	5	4	4	4	92	65	8320G196	2	8320G205	3	10.1/F	11.6/F
1/4	4.4	.30	3	3	3	2	2	2	92	65	8320G198	2	--	--	10.1/F	11.6/F

Notes: ① Supplied with cast UR disc.
② On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts; the watt rating for the 9.1/F solenoid is 11.1 watts.

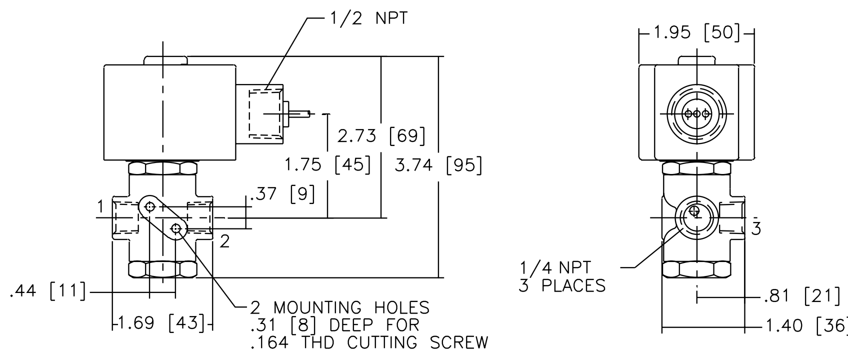
ASCO®

Dimensions: inches (mm)

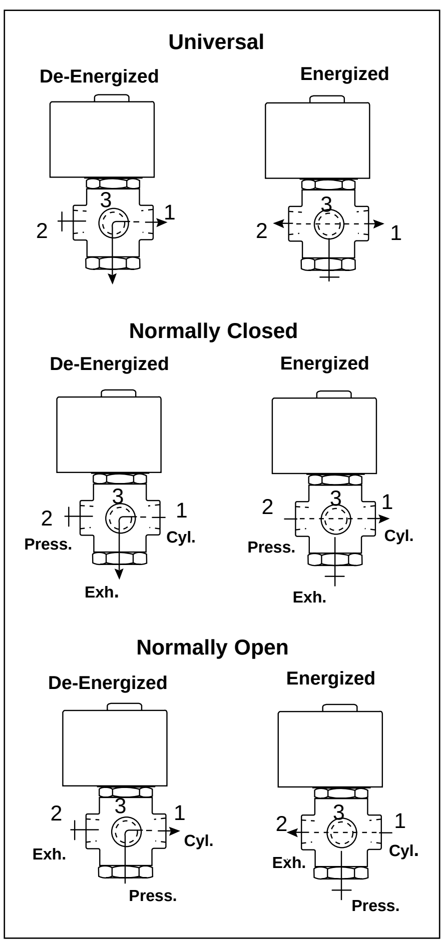
Constr. Ref. 1



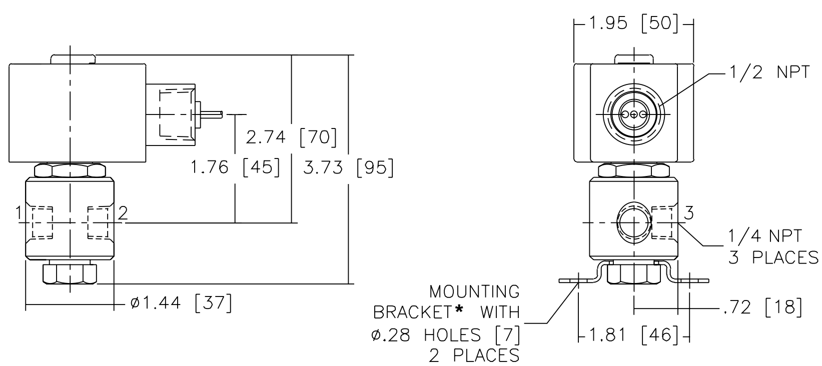
Constr. Ref. 2



FLOW DIAGRAMS



Constr. Ref. 3



* MOUNTING BRACKET IS STANDARD ON THIS CONSTRUCTION

NOTE:
Bulletin 8320 is for General Purpose Solenoid Enclosure

For Explosion Proof Solenoid Enclosure -
See Form No. V5380

Installation & Maintenance Instructions

GENERAL PURPOSE AND EXPLOSIONPROOF SOLENOIDS

SERIES 8003

Form No.V5380R9

IMPORTANT: See separate valve installation and maintenance instructions for information on: Operation, Positioning, Mounting, Cleaning, Preventive Maintenance, Causes of Improper Operation, Disassembly, and Reassembly of basic valve.

DESCRIPTION

Catalog numbers 80031 and 80032 solenoids have a Type 1, General Purpose Solenoid Enclosure. Catalog numbers EF80031, EF80032, 80033, and 80034 solenoids have an explosionproof solenoid enclosure designed to meet Enclosure Type 3–Raintight, Type 7 (C & D) ExplosionproofClass I, Division 1, Groups C & D and Type 9 (E, F, & G) – Dust Ignitionproof Class II, Division 1, Groups E, F, & G, and have a temperature range code of TC3. Series 8003 solenoids (when installed as a solenoid and not as part of an ASCO valve), are supplied with a core which has a 0.250–28 UNF–2B tapped hole with 0.38 or 0.63 minimum full thread.

OPERATION

When the solenoid is energized, the core is drawn into the solenoid base sub–assembly.

IMPORTANT: When the solenoid is de–energized, the initial return force for the core, whether developed by spring, pressure, or weight must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 1 lb. 5 oz. and 5 oz. for DC construction.

INSTALLATION

Check nameplate for correct catalog no., voltage, frequency, wattage, and service.

Enclosure Types 3, 4, 7, and 9

⚠ CAUTION: To prevent fire or explosion, do not install solenoid enclosure where ignition temperature of hazardous atmosphere is less than 160° C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180°C. See nameplate for service. Open circuit before disassembling. Reassemble before operating.

When used in –40°C Ambient Temperature Applications

⚠ WARNING: To prevent fire or explosion, use only conduit runs ½″ in size with a sealing fitting connected within 5 feet of the solenoid enclosure.

IMPORTANT: To protect a solenoid operator or valve, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601 and 8602 for strainers.

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub–assembly area.

Wiring

Wiring must comply with local codes and the National Electrical Code. The general purpose solenoid housing has a 7/8″ diameter hole to accommodate 1/2″ conduit. To facilitate wiring, the general purpose solenoid enclosure may be rotated 360° by removing the retaining cap or clip.

⚠ CAUTION: When metal retaining clip disengages, it will spring upward.

Rotate solenoid enclosure to desired position. Then replace retaining cap or clip before operating. On some solenoids, a grounding wire which is green or green with yellow stripes is provided. Use rigid metallic conduit to ground all enclosures not provided with a green grounding wire. For the explosionproof solenoid enclosure, electrical fittings must be approved for use in hazardous locations. The explosionproof solenoid enclosure has a 1/2″ conduit connection and may be rotated 360° to facilitate wiring.

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, from accidental disengagement of solenoid from valve body, hold housing securely by wrenching flats while removing or replacing housing cover.

To rotate enclosure, loosen housing cover using a 1″ socket wrench. Two wrenching flats are provided on the housing to hold it securely in place while the cover is being loosened or tightened. Rotate housing to desired position and replace cover before operating. Torque housing cover to 135 ± 15 in–lbs [15,3 ± 1,7 Nm].

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid including the core and solenoid base sub–assembly, not just the coil. Consult ASCO.

Solenoid Enclosure Assembly

Catalog 80031 and 80032 solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid enclosure.

Catalog EF80031, EF80032, 80033, and 80034 solenoids may be assembled as a complete unit. Tightening is accomplished by means of two milled slots (wrenching flats) above the threaded area of the solenoid base sub–assembly. Use special ASCO wrench supplied (order No. K168146–1). An alternate type wrench adapter is also available which tightens the assembly by means of four (4) pin holes in the solenoid base sub–assembly. If this alternate wrench is used the solenoid must be completely disassembled, see *Coil Replacement* section.

Solenoid Temperature

Standard solenoids are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched by hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize solenoid operator or valve, and vent fluid to a safe area before servicing.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise, or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- While in service, the solenoid operator or valve should be operated at least once a month to ensure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* indicates loss of power supply. Check for loose or blown fuses, open–circuited or grounded coil, broken lead wires or splice connections.
- **Burned–Out Coil:** Check for open–circuited coil. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate and as marked on the coil.
- **Low Voltage:** Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.

Coil Replacement

Solenoid Catalog Numbers 80031 and 80032

General Purpose Enclosure (Refer to Figure 1 below)

1. Disconnect coil lead wires and grounding wire if present.
2. Remove retaining cap or clip, nameplate (if present), and housing or housing with nameplate (alternate construction).

⚠ **CAUTION: When metal retaining clip disengages, it will spring upward.**

3. Slip spring washer, insulating washer, and coil off the solenoid base sub–assembly. Insulating washers are omitted when a molded coil is used.
4. Coil is now accessible for replacement
5. Torque housing cover to 135 ± 15 in–lbs [15,3 ± 1,7 Nm].

Catalog Numbers EF80031, EF80032, 80033 and 80034 Explosionproof Solenoid Enclosure

NOTE: This solenoid has two constructions, refer to Figure 2 on page 3 for the first construction and Figure 3 on page 4 for the alternate construction.

1. Disconnect coil lead wires and grounding wire if present.

⚠ **WARNING: To prevent the possibility of death, serious injury or property damage from accidental disengagement of solenoid from valve body, hold housing securely by wrenching flats while removing or replacing housing cover.**

2. Unscrew housing cover using 1″ socket wrench. Two wrenching flats are provided to hold the housing securely in place while the cover is being removed or replaced.
3. Remove take–up spring, flux washer, insulating washer, coil and insulating washer. For the alternate construction, slide retaining cup sideways to disengage it from the top of the solenoid base sub–assembly. Then remove yoke, spring washer, insulating washer, coil and insulating washer. Insulating washers are omitted when a molded coil is used.
4. Reassemble solenoid according to exploded view. Before reassembly, refer to NOTE following for cleaning and greasing requirements.
5. Torque housing cover to 135 ± 15 in–lbs [15,3 ± 1,7 Nm].

⚠ **CAUTION: Solenoid must be fully reassembled because the housing and internal parts complete the magnetic circuit. Be sure to replace an insulating washer at each end of non–molded coil.**

NOTE: Solenoid Catalog Nos. EF80031, EF80032, 80033, and 80034, —Installation and maintenance of explosionproof equipment requires more than ordinary care to ensure safe performance. All finished surfaces of the solenoid are constructed to provide flame–proof seal. Be sure that the surfaces are wiped clean before reassembling. Grease the explosionproof solenoid enclosure with DOW CORNING® 111 Compound lubricant or an equivalent high–grade silicone grease. Grease all joints thoroughly including the underside of the solenoid base sub–assembly flange and internal threads of the housing cover.

Part Name	Torque Value in Inch–Pounds	Torque Value in Newton–Meters
Solenoid Base Sub–Assembly	175 ± 25	19,8 ± 2,8

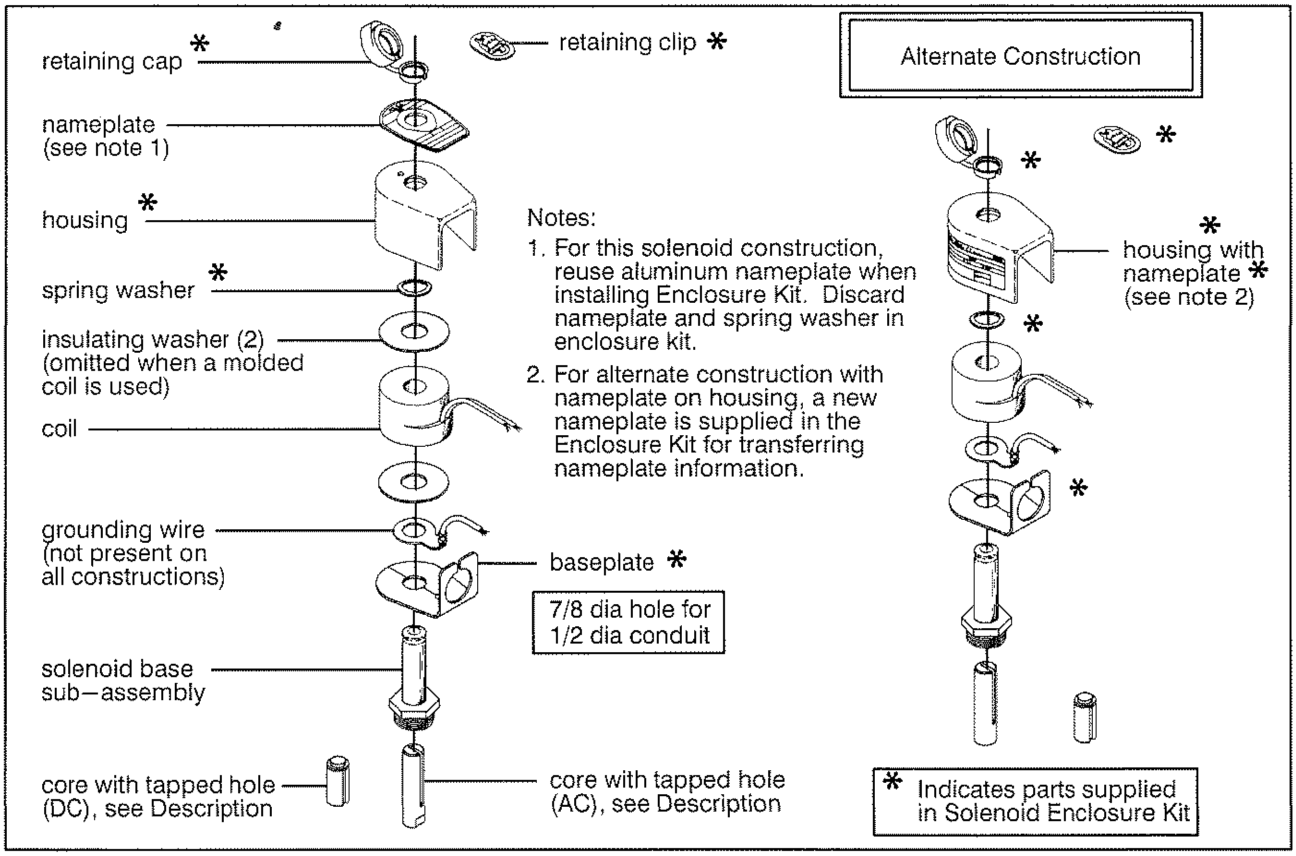


Figure 1, Catalog Nos. 80031 and 80032 General Purpose Solenoid Enclosure.

Torque Chart

Part Name	Torque Value in Inch–Pounds	Torque Value in Newton–Meters
Solenoid Base Sub–Assembly	175 ± 25	19,8 ± 2,8
Housing Cover	135 ± 15	15,3 ± 1,7

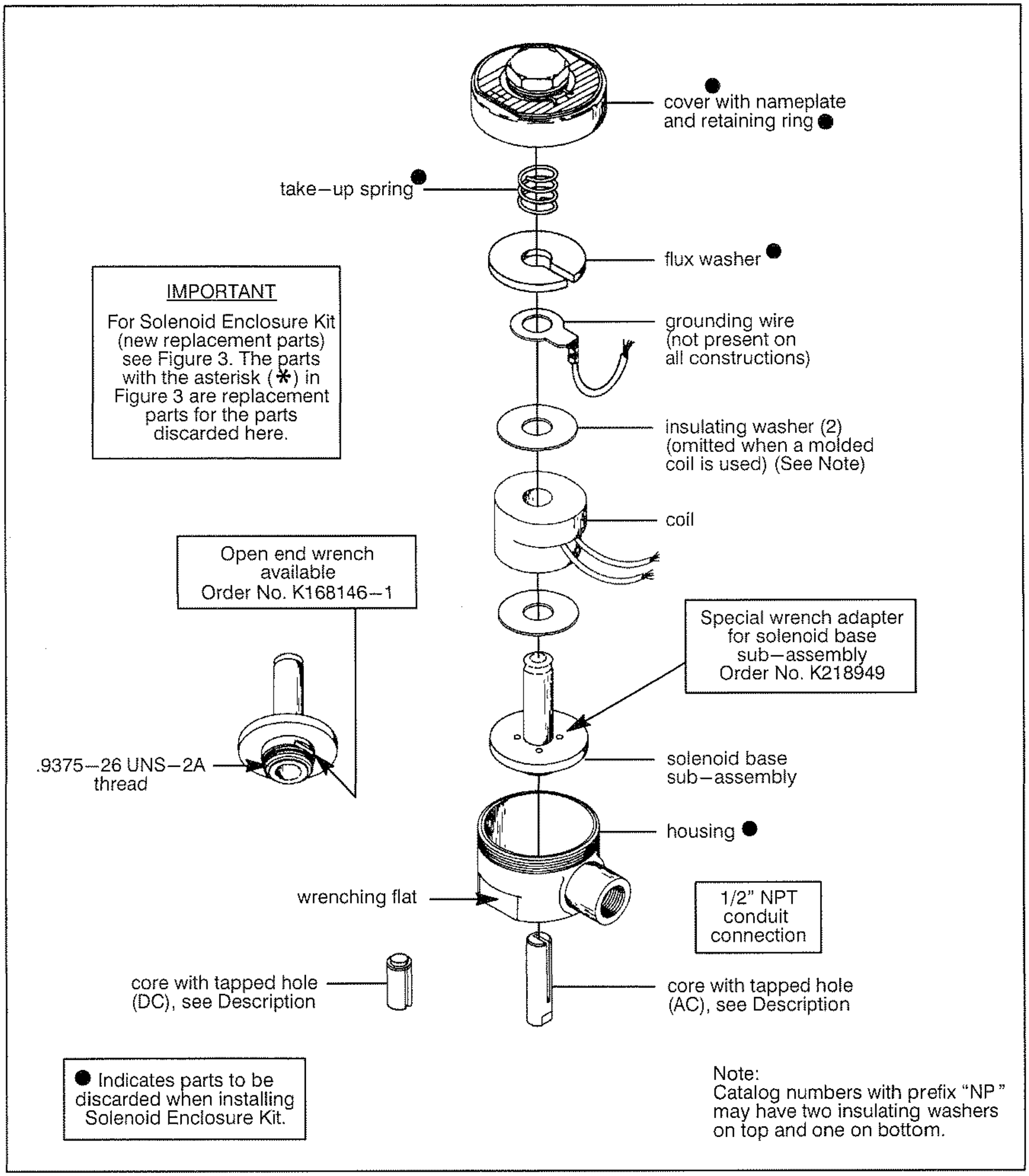


Figure 2. Catalog Nos. EF80031, EF80032 80033 and 80034 Explosionproof Solenoid Enclosure.

Torque Chart

Part Name	Torque Value in Inch–Pounds	Torque Value in Newton–Meters
Solenoid Base Sub–Assembly	175 ± 25	19,8 ± 2,8
Housing Cover	135 ± 15	15,3 ± 1,7

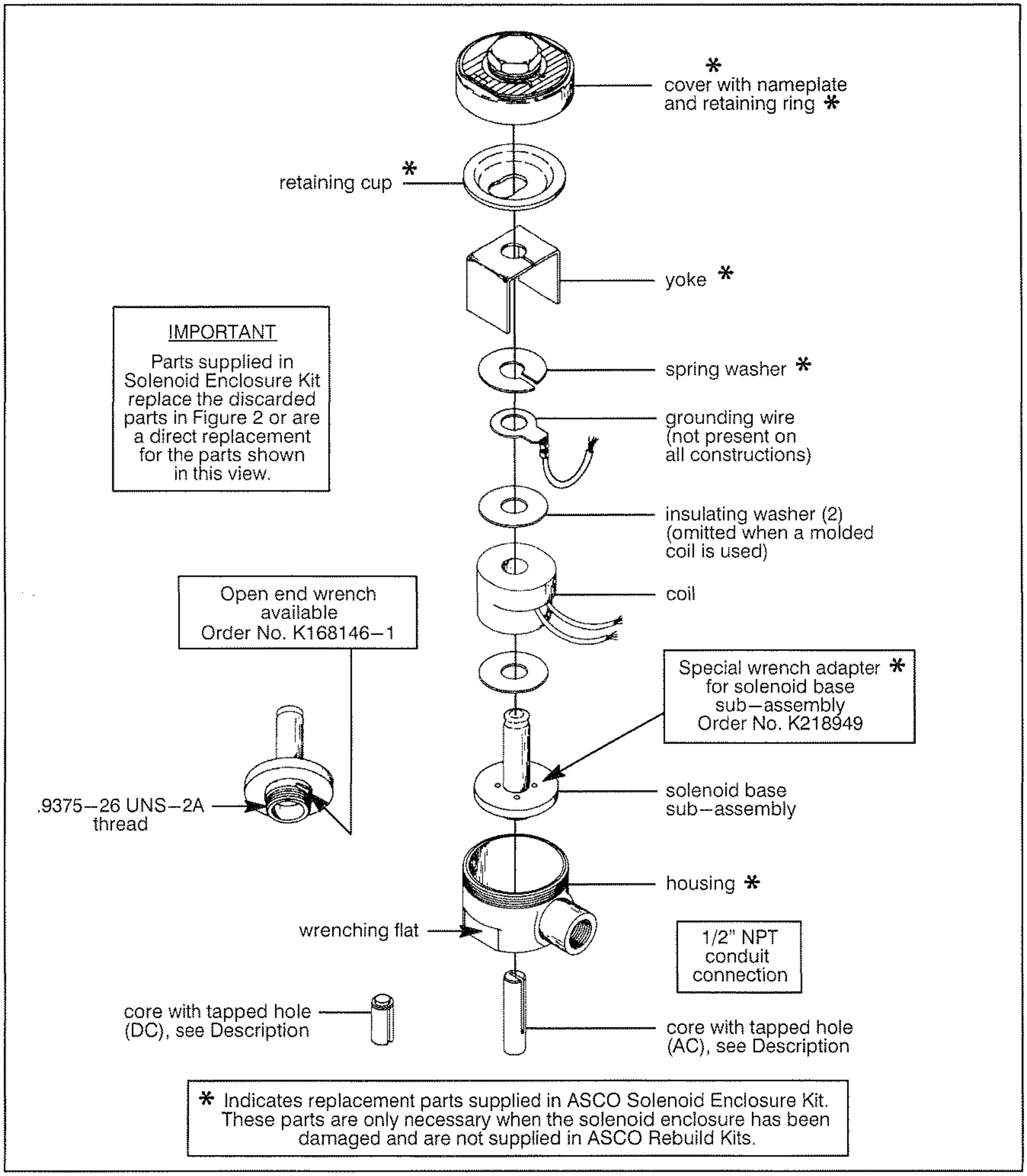


Figure 3. Catalog Nos. EF80031, EF80032, 80033 and 80034 Alternate Construction Explosionproof Solenoid Enclosure.

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VS 1

MURPHY
VS2-EX

VIBRATION SWITCH EXP

ANGI PART NUMBER 480-04347

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VS-7037N
Revised 04-05
Section 20
(00-02-0185)

Shock/Vibration Control Switches Installation Instructions

Models: VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94

MURPHY

Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit, and make sure installation conforms with NEC and local codes.

GENERAL INFORMATION

WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✔ **Disconnect all electrical power to the machine.**
- ✔ **Make sure the machine cannot operate during installation.**
- ✔ **Follow all safety warnings of the machine manufacturer.**
- ✔ **Read and follow all installation instructions.**

LISTED*

Model VS2EX

Description

The Murphy shock and vibration switches are available in a variety of models for applications on machinery or equipment where excessive vibration or shock can damage the equipment or otherwise poses a threat to safe operation. A set of contacts is held in a latched position through a mechanical latch and magnet mechanism. As the level of vibration or shock increases an inertia mass exerts force against the latch arm and forces it away from the magnetic latch causing the latch arm to operate the contacts. Sensitivity is obtained by adjusting the amount of the air gap between the magnet and the latch arm plate.

Applications include all types of rotating or reciprocating machinery such as cooling fans, engines, pumps, compressors, pump jacks, etc.

Models

VS2: Base mount; non hazardous locations.

VS2C: C-clamp mount; non hazardous locations.

VS2EX: Explosion-proof; Class I, Div. 1, Groups C and D.

VS2EXR: Explosion-proof with remote reset.

VS2EXRB: Explosion-proof; Class I, Div. 1, Group B; with remote reset.

VS94: Base mount; non hazardous locations, NEMA 4X/IP66.

Remote Reset Feature (VS2EXR, VS2EXRB and VS94 only)

Includes built-in electric solenoid which allows reset of tripped unit from a remote location. Standard on VS2EXR and VS2EXRB. Optional on VS94 (options listed below).

-R15: Remote reset for 115 VAC
-R24: Remote reset for 24 VDC

Time Delay Option (VS94 only)

Overrides trip operation on start-up. For VS94 series models, the delay time is field-adjustable from 5 seconds up to 6-1/2 minutes with a 20-turn potentiometer (15 seconds per turn approximately). Options listed below:

-T15: Time delay for 115 VAC
-T24: Time delay for 24 VDC

Space Heater Options (VS94 only)

This optional space heater board prevents moisture from condensing inside the VS94 Series case. Options listed below:

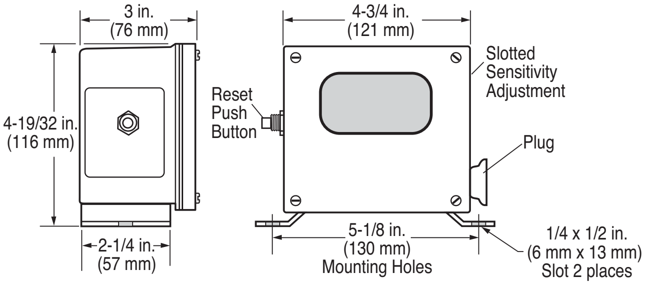
-H15: Space heater for 115 VAC
-H24: Space heater for 24 VDC

Warranty

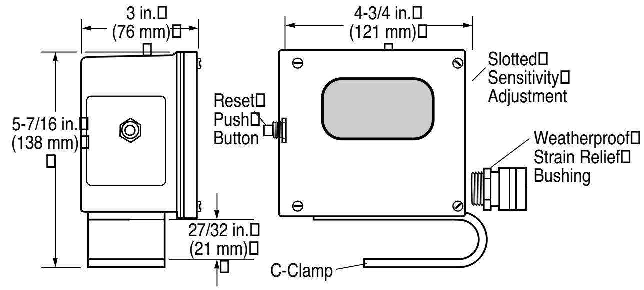
A limited warranty on materials and workmanship is given with this FW Murphy product. A copy of the warranty may be viewed or printed by going to www.fwmurphy.com/support/warranty.htm

DIMENSIONS

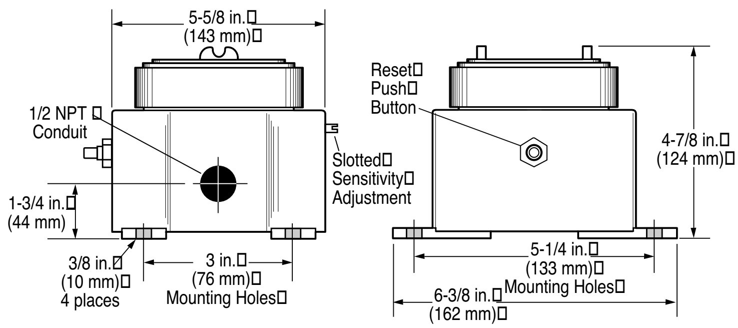
VS2



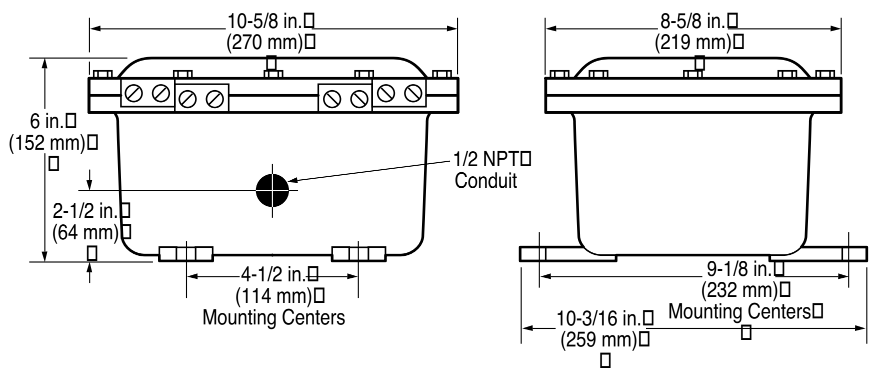
VS2C



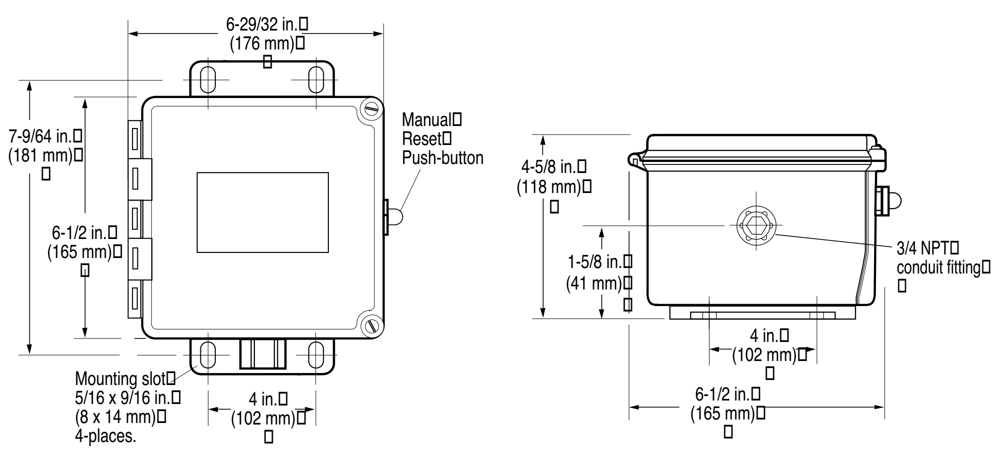
VS2EX and VS2EXR



VS2EXRB



VS94



SPECIFICATIONS

VS2 and VS2C

- **Case:** Weatherproof (equal to NEMA 3R) suitable for non-hazardous areas.
  VS2: *Base mount*
  VS2C: *C-clamp mount. Includes 45 feet (13.7 meters), 2-conductor 16 AWG, 30 strands/0.25 mm strand dia. (1.5 mm²) cable, and five cable hold down clamps.*
- **Contacts:** SPDT double make leaf contacts, 5A @ 480 VAC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

VS2EX

- **Case:** Explosion-proof and weatherproof aluminum alloy housing; meets NEMA 7/IP50 specifications; Class I, Division 1, Groups C & D; UL and CSA listed*
  VS2EX: *base mount*.
- **Snap-switches:** 2-SPDT snap-switches; 5A @ 480 VAC;* 2A resistive, 1A inductive, up to 30 VDC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Normal Operating Temperature:** -40 to 140°F (-40 to 60°C).

VS2EXR

- **Case:** Same as VS2EX.
- **Snap-switch:** 1-SPDT snap-switch and reset coil; 5A @ 480 VAC;* 2A resistive, 1A inductive, up to 30 VDC.
- **Remote Reset (optional):**

Option	*Operating Current*
-R15:	*350 mA @ 115 VAC*
-R24:	*350 mA @ 24 VDC*

- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Normal Operating Temperature:** -40 to 140°F (-40 to 60°C).

VS2EXRB

- **Case:** Explosion-proof aluminum alloy housing; rated Class I, Division 1, Group B hazardous areas.
- **Snap-switch:** 1-SPDT snap-switch with reset coil (option available for additional SPDT switch); 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.
- **Remote Reset:**

Option	*Operating Current*
-R15:	*350 mA @ 115 VAC*
-R24:	*350 mA @ 24 VDC*

- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

VS94

- **Case:** Polyester fiberglass reinforced; NEMA type 4 and 4X; IP66; CSA types 4 and 12.
- **Conduit Fitting:** 3/4 NPT conduit fitting connection.
- **Normal Operating Ambient Temperature:** 0 to 140°F (-18 to 60°C).
- **Snap-switches:** 2-SPDT snap acting switches; 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Heater (optional):**

Option	*Operating Current*
H15	*.023 A @ 115 VAC*
H24	*.12 A @ 24 VDC*

- **Remote Reset (optional):**

Option	*Operating Current*
R15	*.17 A @ 115 VAC*
R24	*.36 A @ 24 VDC*

- **Time Delay (optional):**

Option	*Operating Current*	*Standby Current*
T15	*.360 A @ 115 VAC*	*.01 A @ 115 VAC*
T24	*1.15 A @ 24 VDC*	*.01 A @ 24 VDC*

- **Time Delay/Remote Reset:** Adjustable 20-turn potentiometer from 5 seconds to 6-1/2 minutes (15 seconds per turn approximately).

*CSA and UL listed with 480 VAC rating.

INSTALLATION

WARNING: STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.

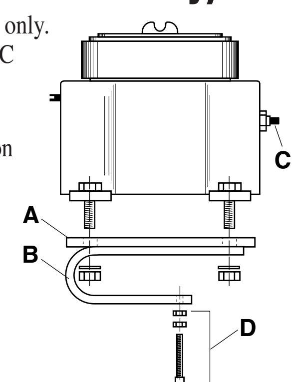
The VS2 and VS94 series shock switches are sensitive to shock and vibration in all three planes of motion - up/down, front/back and side/side. Front/back is the most sensitive (The reset pushbutton is located on the "front" of the unit). For maximum sensitivity mount the unit so that the front faces into the direction of rotation of the machine. (See Dimensions on page 2 for sensitivity adjustment location).

The VS2 and VS94 Series must be firmly attached/mounted to the machine so that all mounting surfaces are in rigid contact with the mounting surface of the machine. For best results, mount the instrument in-line with the direction of rotating shafts and/or near bearings. In other words, the reset push button should be mounted pointing into the direction of shaft rotation (see page 5). It may be necessary to provide a mounting plate or bracket to attach the VS2 and VS94 Series to the machine. The mounting bracket should be thick enough to prevent induced acceleration/vibration upon the VS2 or VS94 Series. Typically 1/2 in. (13mm) thick plate is sufficient. See illustrations on page 5 for typical mounting locations.

CAUTION: A dust boot is provided on the reset pushbutton for all series to prevent moisture or dust intrusion. The sensitivity adjustment for model VS2EX is not sealed; therefore, mounting orientation should be on a horizontal plane or with the sensitivity adjustment pointing down. Sensitivity adjustment for model VS2 is covered by a plug. The plug must be in place and tight to prevent moisture or dust intrusion.

C-Clamp Installation (VS2C model only)

A C-Clamp is supplied with the VS2C model only. The C-Clamp is shipped installed on the VS2C but must be installed on the VS2EX and VS2EXR switches.



1. The C-Clamp **(B)** will already be installed on a 1/4 in. (6 mm) thick steel mounting plate **(A)**. Bolt the VS2 switch to the mounting plate as illustrated — with four 5/16 in. bolts, nuts, and washers.
2. The mounting location should provide convenient access to the TATTLETALE® push button **(C)**.
3. The hardened set screw and nuts **(D)** are used to tighten the switch to an I-Beam or cross member such as a Sampson post of an oilwell pumpjack.

Continued on next page.

All Models

WARNING: STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.

1. Firmly secure the unit to the equipment using the base foot mount or C-Clamp if applicable. See ***C-Clamp Installation*** page 3.

For oilwell pumpjacks attach the VS2 and VS94 Series to the Sampson post or walking beam. See ***Typical Mounting Locations*** page 5.

2. Make the necessary electrical connections to the vibration switch. See ***Internal Switches,*** page 6 for electrical terminal locations and page 7 for typical wiring diagrams. **DO NOT EXCEED VOLTAGE OR CURRENT RATINGS OF THE CONTACTS.** Follow appropriate electrical codes/methods when making electrical connections. Be sure that the run of electrical cable is secured to the machine and is well insulated from electrical shorting. Use of conduit is recommended.

NOTE: If the electrical cable crosses a pivot point such as at the pivot of the walking beam, be sure to allow enough slack in the cable so that no stress is placed on the cable when the beam moves.

If conduit is not used for the entire length of wiring, conduit should be used from the electrical supply box to a height above ground level that prevents damage to the exposed cable from the elements, rodents, etc. or as otherwise required by applicable electrical codes. If conduit is not attached directly to the VS2 and VS94 Series switch, use a strain relief bushing and a weatherproof cap on the exposed end of the conduit. A “drip loop” should be provided in the cable to prevent moisture from draining down the cable into the conduit should the weathercap fail.

Sensitivity Adjustment

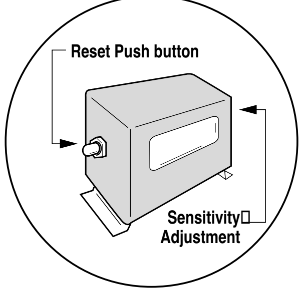
WARNING: REMOVE ALL POWER BEFORE OPENING THE ENCLOSURE. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON PERFORM ADJUSTMENTS, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES. DO NOT ADJUST SENSITIVITY WHILE THE MACHINE IS RUNNING. STAND CLEAR OF THE MACHINE AT ALL TIMES WHEN IT IS OPERATING.

All models of the VS2 and VS94 Series cover a wide range of sensitivity. Each model is adjusted to the specific piece of machinery on which it is installed. After the switch has been installed in a satisfactory location (see page 5) the sensitivity adjustment will be increased or decreased so that the switch does not trip during start-up or under normal operating conditions. This is typically done as follows:

1. REPLACE ALL COVERS, LIDS, AND ELECTRICAL ENCLOSURES.

2. Press the reset push button to engage the magnetic latch. To be sure the magnetic latch has engaged, observe latch through the window on the VS2 and VS2C (see DETAIL “A”). On the VS2EX, VS94 series the reset button will remain depressed meaning the magnetic latch has engaged.

DETAIL “A”



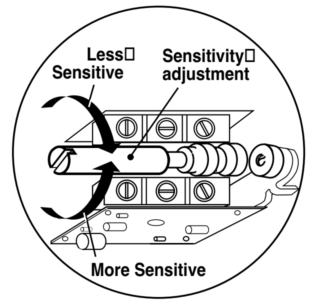
3. Start the machine.

4. If the instrument trips on start-up, allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise, (adjustment for VS94 and VS2EXRB models is located within the box, see DETAIL “B”).

WARNING: MAKE THE AREA NON-HAZARDOUS BEFORE OPENING THE EXPLOSION-PROOF (-EX) ENCLOSURES.

Depress the reset button and restart the machine. Repeat this process until the unit does not trip on start-up.

DETAIL “B”



5. If the instrument does NOT trip on start-up, stop the machine. Turn the sensitivity adjustment 1/4 turn counter-clockwise. Repeat the start-up/stop process until the instrument trips on start-up. Turn the sensitivity adjustment 1/4 turn clockwise (less sensitive). Restart the machine to verify that the instrument will not trip on start-up.

6. Verify that the unit will trip when abnormal shock/vibration exists.

VS94 Time Delay Adjustment

1. Apply power to the time delay circuit. (see page 7 for time delay circuit). The time delay function will be initiated.

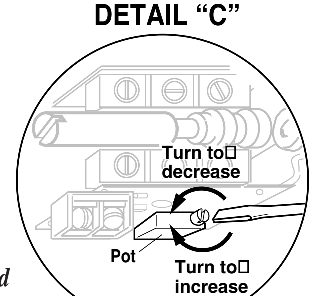
2. Time the length of the delay with a watch. Let time delay expire. After it expires, the override circuit will de-energize the solenoid, allowing the latch arm to trip. A clicking noise is heard.

WARNING: REMOVE ALL POWER BEFORE OPENING ACCESS DOOR. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON ADJUST THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES.

3. TURN THE POWER <u>OFF</u> TO RESET THE TIME DELAY CIRCUIT.

NOTE: Allow 30 seconds bleed-time between turning the power “OFF” and “ON.”

DETAIL “C”



4. Locate the time adjustment pot (DETAIL “C”). The time is factory-set at the lowest setting (5 seconds approximately). To increase time, rotate the 20-turn pot clockwise as needed (15 seconds per turn approximately).

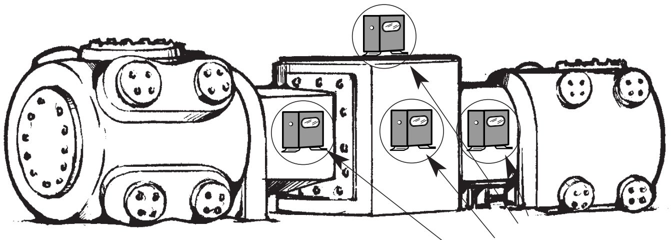
5. Repeat the above steps as necessary to obtain desired time delay.

NOTE: An external time delay can be used with the remote reset feature of the VS2EXR series to provide a remote reset and override of the trip operation on start-up. Time delay must automatically disconnect after equipment start-up.

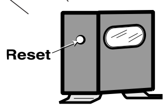
TYPICAL MOUNTING LOCATIONS

NOTE: These are typical mounting locations for best operation. Other mountings are possible. See *Installation* section on page 3.

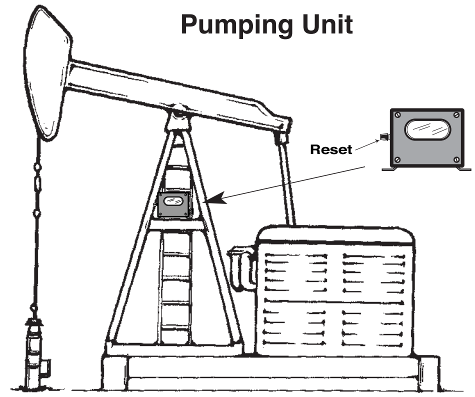
2-Throw Balance-Opposed Compressor



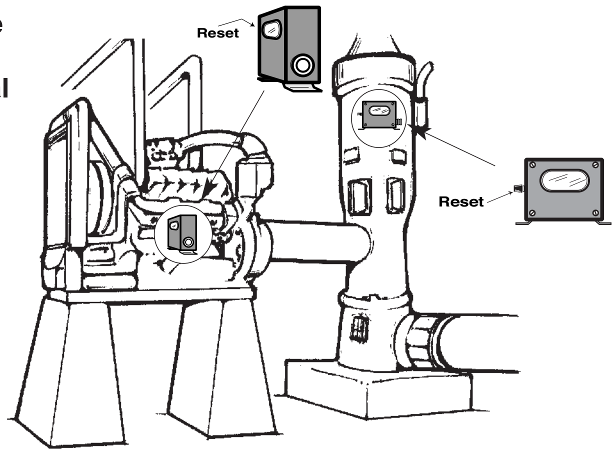
NOTE: If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.



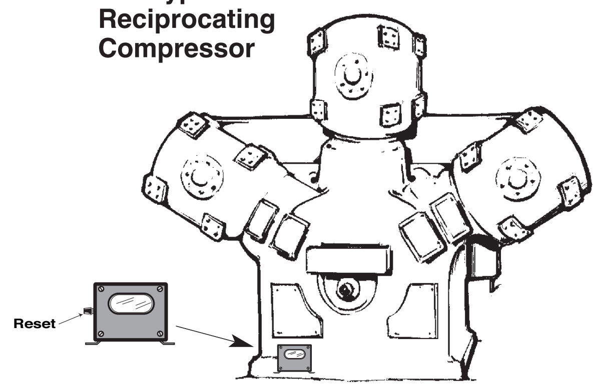
Pumping Unit



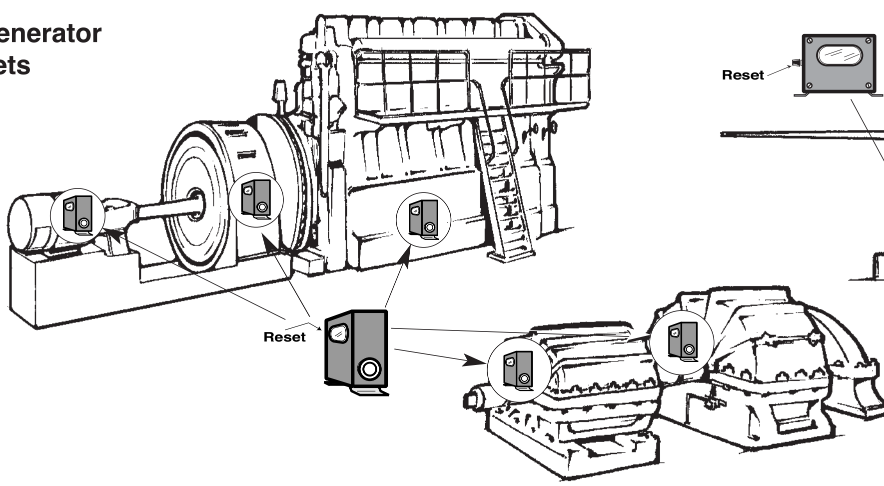
Engine and Vertical Shaft Pump



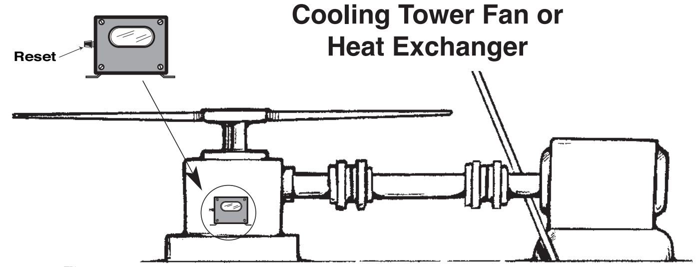
"Y" Type Reciprocating Compressor



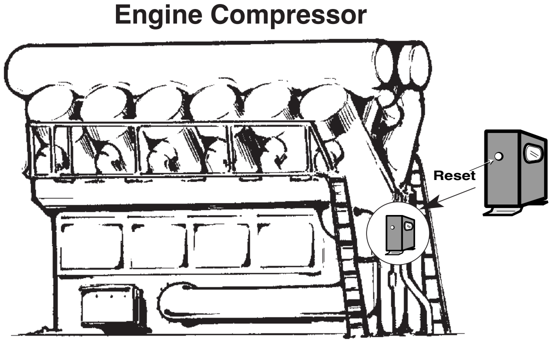
Generator Sets



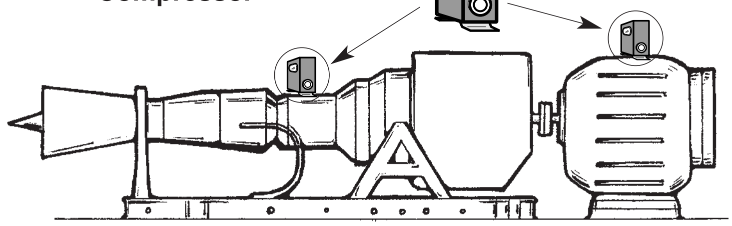
Cooling Tower Fan or Heat Exchanger



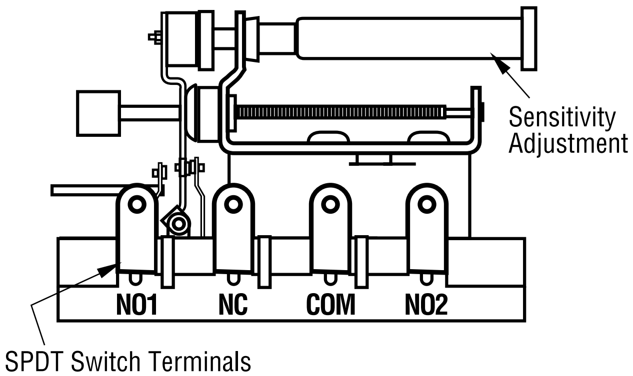
Engine Compressor



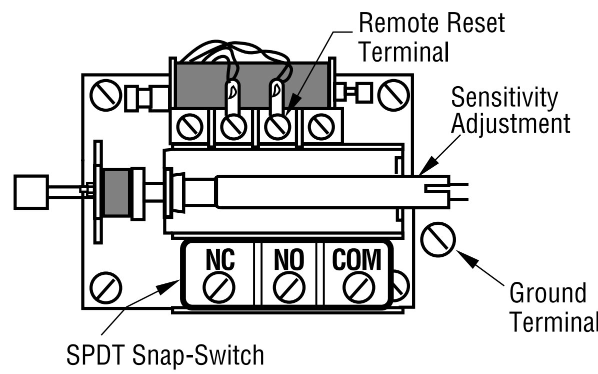
Turbine Centrifugal Compressor



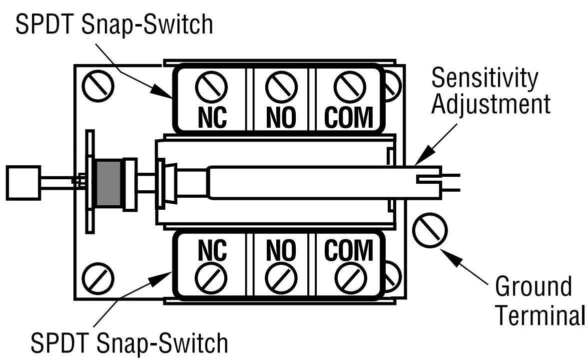
VS2 and VS2C



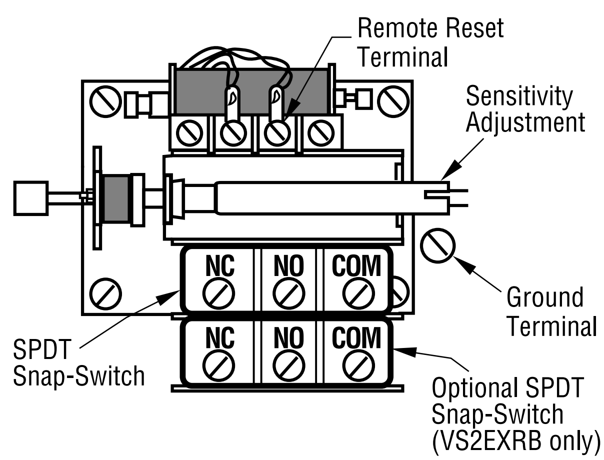
VS2EXR



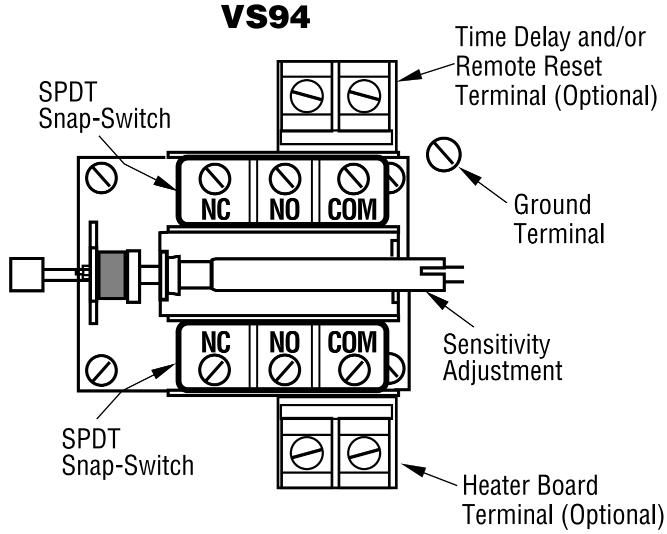
VS2EX



VS2EXB and VS2EXRB



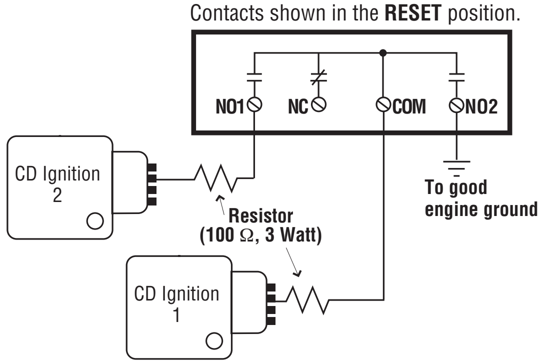
VS94



WARNING: REMOVE POWER BEFORE OPENING THE UNIT (ACCESS DOOR). STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING OPERATION. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON INSTALL AND WIRE THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND APPLICABLE CODES.

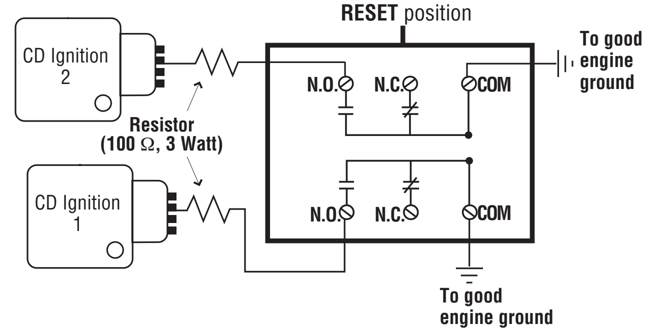
VS2 and VS2C
Typical Wiring Diagram for Single or Dual CD Ignition

SPDT Switch
Contacts shown in the **RESET** position.



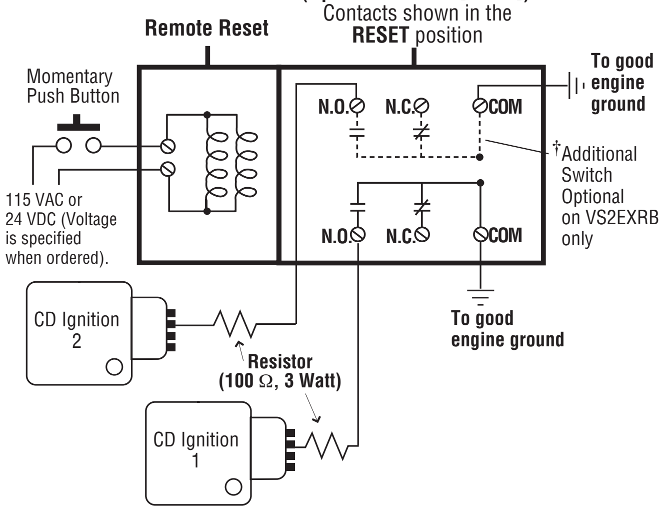
VS2EX
Typical Wiring Diagram for Single or Dual CD Ignitions

SPDT Switch
(Optional 2-SPDT [DPDT])†
Contacts shown in the **RESET** position

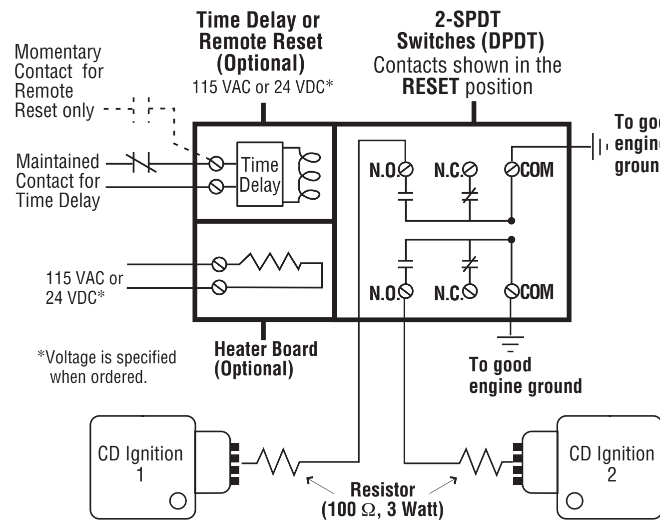


VS2EXR and VS2EXRB
Typical Wiring Diagram for Single or Dual CD Ignitions

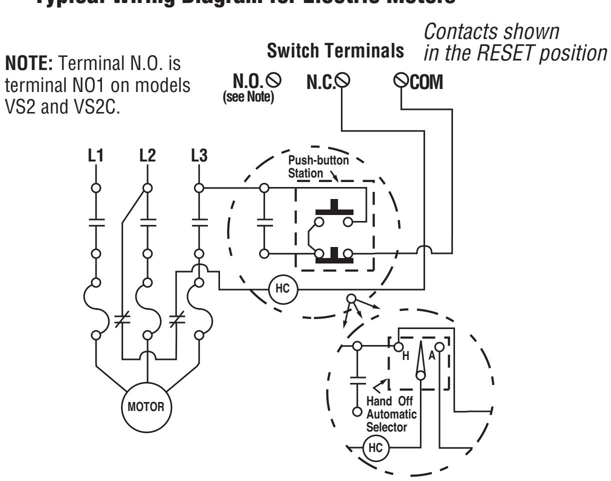
SPDT Switch
(Optional 2-SPDT [DPDT])†
Contacts shown in the **RESET** position



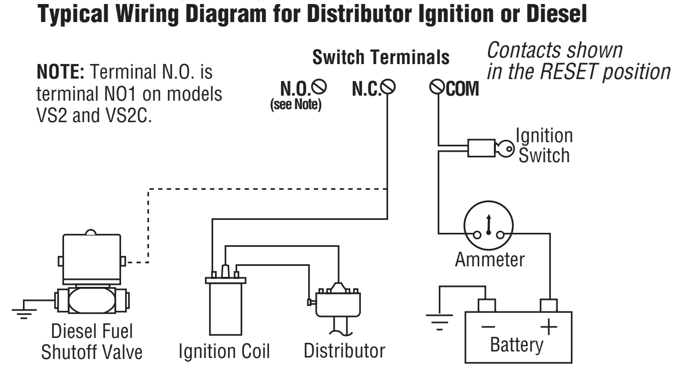
VS94
Typical Wiring Diagram for Single or Dual CD Ignitions



VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94
Typical Wiring Diagram for Electric Motors



VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94
Typical Wiring Diagram for Distributor Ignition or Diesel



PART NO.	DESCRIPTION
VS2	
20000030	Movement assembly
20000031	Glass and gasket assembly
20000032	Reset push button assembly
VS2C	
20000030	Movement assembly
20000031	Glass and gasket assembly
20000032	Reset push button assembly
20050021	Mounting clamp
20000185	VS2C 5-clamp hardware package assembly.
20050465	2-Conductor electrical cable, 45 feet (13.7 meters)
VS2EX	
20010091	Movement assembly
20050087	Cover
00000309	Cover gasket
20010090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20000288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20000289	C-clamp conversion mounting kit
VS2EXR	
20000262	Movement assembly
20050087	Cover
00000309	Cover gasket
20010090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20000288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20000049	Reset solenoid assembly (115 VAC)
20000234	Reset solenoid assembly (24 VDC)
20000289	C-clamp conversion mounting kit

PART NO.	DESCRIPTION
VS2EXRB	
20010090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20000288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20000057	*Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
20000058	*Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
20000287	***Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.***
20000290	***Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.***
20050077	Adjustment shaft
20000262	Movement assembly
20000049	Reset solenoid assembly (115 VAC)
20000234	Reset solenoid assembly (24 VDC)
VS94 Series	
25050506	Dust boot
00000232	Conduit fitting
20010090	Snap-switch and insulator kit (1 switch per assembly) **prior to September 1, 1995.****
20000288	**Snap-switch and insulator kit (1 switch per assembly) for models manufactured on September 1, 1995 or later.*****

* If no date code is found, refer to the old switch. Models with date 0895 and before use old switch. Dated 0995 after, use straight snap-switch arm, no rollers.
** Models dated Q1 thru Q8 (formed snap-switch arm and rollers).
***Models date coded Q9 thru Q12 and R1 thru R12 (straight snap-switch arm, no rollers).

MURPHY

USA–ISO 9001:2000 FM 28221
UK–ISO 9001:2000 FM 29422
ISO 9001 REGISTERED

HOSE

PARKER

Part # 5CNG-6

3/8 PARKER 5000# RED 5CNG SERIES

ANGI PART NUMBER 137-07238

Parflex CNG Hose

Electrically Conductive Compressed Natural Gas Hose

Parflex CNG Hose is specially developed for the conveyance of compressed natural gas. It is constructed of an electrically conductive nylon core designed to dissipate static build up and a fiber reinforcement for maximum pressure and flexibility. In addition, the polyurethane jacket provides abrasion resistance and protection from outdoor elements including ultraviolet light.

Typical applications for CNG Hose include:

- CNG Dispenser/Refueling
- Fleet Transit/On-Vehicle
- CNG Fuel Transfer
- At-Home CNG Refueling

Contact Information:

Parker Hannifin Corporation
Parflex Division
1300 North Freedom St.
Ravenna, OH 44266
phone 330 296 2871
fax 330 286 8433
www.parker.com/parflex

Product Features:

- Electrically conductive core tube
- Perforated polyurethane cover
- Sizes up to 1"
- Twin-line assemblies available to reduce installation time, eliminate tangling and reduce part number complexity

Specifications:

- Conforms to:
- NFPA 52
- ANSI/IAS NGV 4.2-1999
- ECE R110 - Sizes -3 and -8 only for assemblies purchased through Parker Polyflex (Europe)
- CSA12.52-M99

Parker

ENGINEERING YOUR SUCCESS.

CNG – Electrically Conductive Compressed Natural Gas Hose

Features

- Twin-line constructions available

Certifications

Conforms to:

- NFPA 52
- ANSI/IAS NGV 4.2
- ECE R110 - Sizes -3 and -8 only for assemblies purchased through Parker Polyflex (Europe)
- CSA12.52

C US

Applications/Markets

- CNG Dispenser/Refueling
- Fleet Transit/On-Vehicle
- CNG Fuel Transfer
- At-Home CNG Refueling

Part Number	Nominal I.D.		Maximum O.D.		Maximum Working Pressure		Minimum Bend Radius		Weight		Permanent Fitting Series
#	inch	mm	inch	mm	psi	MPa	inch	mm	lbs./ft.	kg./mtr.	
5CNG-3	3/16	5	.43	11	5,000	34.5	1.50	38	.05	.07	55
5CNG-4	1/4	6	.55	14	5,000	34.5	2.00	51	.08	.11	55
5CNG-6	3/8	10	.65	16	5,000	34.5	3.00	76	.09	.13	55
5CNG-8	1/2	13	.90	23	5,000	34.5	4.00	102	.21	.31	58
5CNG-12	3/4	19	1.15	29	5,000	34.5	7.50	191	.24	.36	58H
5CNG-16	1	25	1.59	40	5,000	34.5	10.00	254	.36	.53	58H

Construction

Tube: Electrically conductive nylon
Reinforcement: Fiber
Cover: Polyurethane

Operating Parameters

Temperature Range:
-40°F to +180°F (-40°C to +82°C)
Min. Burst Pressure is 4x Max. Working Pressure @ 73°F

Notes

Perforated cover
CNG Hose must be assembled at the factory or by a Parflex approved facility
Wire spring guards must be used on ANSI/CSA design certified CNG dispenser hose assembly sizes -3 through -8: single and twin-line bonded assemblies

Fittings

55 Series
58 Series
58H Series
Consult Parflex Division for approved fitting configurations

Accessories

PSG - Wire spring guard
CNGG - Vinyl hose guard
Consult Parflex CAT. 4660 for CNG guard selection

Colors

Red

Parker

HOSE

PARKER

Part # 5CNG-12

3/4 PARKER 5000# RED 5CNG SERIES

ANGI PART NUMBER 137-07241

Parflex CNG Hose

Electrically Conductive Compressed Natural Gas Hose

Parflex CNG Hose is specially developed for the conveyance of compressed natural gas. It is constructed of an electrically conductive nylon core designed to dissipate static build up and a fiber reinforcement for maximum pressure and flexibility. In addition, the polyurethane jacket provides abrasion resistance and protection from outdoor elements including ultraviolet light.

Typical applications for CNG Hose include:

- CNG Dispenser/Refueling
- Fleet Transit/On-Vehicle
- CNG Fuel Transfer
- At-Home CNG Refueling

Contact Information:

Parker Hannifin Corporation
Parflex Division
1300 North Freedom St.
Ravenna, OH 44266
phone 330 296 2871
fax 330 286 8433
www.parker.com/parflex

Product Features:

- Electrically conductive core tube
- Perforated polyurethane cover
- Sizes up to 1"
- Twin-line assemblies available to reduce installation time, eliminate tangling and reduce part number complexity

Specifications:

- Conforms to:
- NFPA 52
- ANSI/IAS NGV 4.2-1999
- ECE R110 - Sizes -3 and -8 only for assemblies purchased through Parker Polyflex (Europe)
- CSA12.52-M99

CNG – Electrically Conductive Compressed Natural Gas Hose

Features
- Twin-line constructions available

Certifications
Conforms to:
- NFPA 52
- ANSI/IAS NGV 4.2
- ECE R110 - Sizes -3 and -8 only for assemblies purchased through Parker Polyflex (Europe)
- CSA12.52

C US

Applications/Markets
- CNG Dispenser/Refueling
- Fleet Transit/On-Vehicle
- CNG Fuel Transfer
- At-Home CNG Refueling

Part Number	Nominal I.D.		Maximum O.D.		Maximum Working Pressure		Minimum Bend Radius		Weight		Permanent Fitting Series
#									lb	kg	
	inch	mm	inch	mm	psi	MPa	inch	mm	lbs./ft.	kg./mtr.	
5CNG-3	3/16	5	.43	11	5,000	34.5	1.50	38	.05	.07	55
5CNG-4	1/4	6	.55	14	5,000	34.5	2.00	51	.08	.11	55
5CNG-6	3/8	10	.65	16	5,000	34.5	3.00	76	.09	.13	55
5CNG-8	1/2	13	.90	23	5,000	34.5	4.00	102	.21	.31	58
5CNG-12	3/4	19	1.15	29	5,000	34.5	7.50	191	.24	.36	58H
5CNG-16	1	25	1.59	40	5,000	34.5	10.00	254	.36	.53	58H

Construction
Tube: Electrically conductive nylon
Reinforcement: Fiber
Cover: Polyurethane

Operating Parameters
Temperature Range:
-40°F to +180°F (-40°C to +82°C)
Min. Burst Pressure is 4x Max. Working Pressure @ 73°F

Notes
Perforated cover
CNG Hose must be assembled at the factory or by a Parflex approved facility
Wire spring guards must be used on ANSI/CSA design certified CNG dispenser hose assembly sizes -3 through -8: single and twin-line bonded assemblies

Fittings
55 Series
58 Series
58H Series
Consult Parflex Division for approved fitting configurations

Accessories
PSG - Wire spring guard
CNGG - Vinyl hose guard
Consult Parflex CAT. 4660 for CNG guard selection

Colors
- Red

HOSE

PARKER

Part # 5CNG-12-5CNG-6

3/4x3/8 PARKER 5000# RED/RED 5CNG SERIES

ANGI PART NUMBER 137-07245

Parflex CNG Hose

Electrically Conductive Compressed Natural Gas Hose

Parflex CNG Hose is specially developed for the conveyance of compressed natural gas. It is constructed of an electrically conductive nylon core designed to dissipate static build up and a fiber reinforcement for maximum pressure and flexibility. In addition, the polyurethane jacket provides abrasion resistance and protection from outdoor elements including ultraviolet light.

Typical applications for CNG Hose include:

- CNG Dispenser/Refueling
- Fleet Transit/On-Vehicle
- CNG Fuel Transfer
- At-Home CNG Refueling

Contact Information:

Parker Hannifin Corporation
Parflex Division
1300 North Freedom St.
Ravenna, OH 44266
phone 330 296 2871
fax 330 286 8433
www.parker.com/parflex

Product Features:

- Electrically conductive core tube
- Perforated polyurethane cover
- Sizes up to 1"
- Twin-line assemblies available to reduce installation time, eliminate tangling and reduce part number complexity

Specifications:

- Conforms to:
- NFPA 52
- ANSI/IAS NGV 4.2-1999
- ECE R110 - Sizes -3 and -8 only for assemblies purchased through Parker Polyflex (Europe)
- CSA12.52-M99

ENGINEERING YOUR SUCCESS.

CNG – Electrically Conductive Compressed Natural Gas Hose

Features

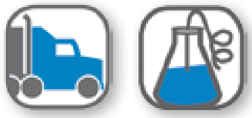
- Twin-line constructions available

Certifications

Conforms to:

- NFPA 52
- ANSI/IAS NGV 4.2
- ECE R110 - Sizes -3 and -8 only for assemblies purchased through Parker Polyflex (Europe)
- CSA12.52

Applications/Markets



- CNG Dispenser/Refueling
- Fleet Transit/On-Vehicle
- CNG Fuel Transfer
- At-Home CNG Refueling

Part Number	Nominal I.D.		Maximum O.D.		Maximum Working Pressure		Minimum Bend Radius		Weight		Permanent Fitting Series
#	inch	mm	inch	mm	psi	MPa	inch	mm	lbs./ft.	kg./mtr.	
5CNG-3	3/16	5	.43	11	5,000	34.5	1.50	38	.05	.07	55
5CNG-4	1/4	6	.55	14	5,000	34.5	2.00	51	.08	.11	55
5CNG-6	3/8	10	.65	16	5,000	34.5	3.00	76	.09	.13	55
5CNG-8	1/2	13	.90	23	5,000	34.5	4.00	102	.21	.31	58
5CNG-12	3/4	19	1.15	29	5,000	34.5	7.50	191	.24	.36	58H
5CNG-16	1	25	1.59	40	5,000	34.5	10.00	254	.36	.53	58H

Construction

Tube: Electrically conductive nylon
Reinforcement: Fiber
Cover: Polyurethane

Operating Parameters

Temperature Range:
-40°F to +180°F (-40°C to +82°C)
Min. Burst Pressure is 4x Max. Working Pressure @ 73°F

Notes

Perforated cover
CNG Hose must be assembled at the factory or by a Parflex approved facility
Wire spring guards must be used on ANSI/CSA design certified CNG dispenser hose assembly sizes -3 through -8: single and twin-line bonded assemblies

Fittings

55 Series
58 Series
58H Series
Consult Parflex Division for approved fitting configurations

Accessories

PSG - Wire spring guard
CNGG - Vinyl hose guard
Consult Parflex CAT. 4660 for CNG guard selection

Colors

Red

NOZZLE

SHEREX / OPW
CT5000S
NOZZLE – CT5000 4000PSI CAPTIVE VENT HEAVY DUTY

ANGI PART NUMBER 700-03945

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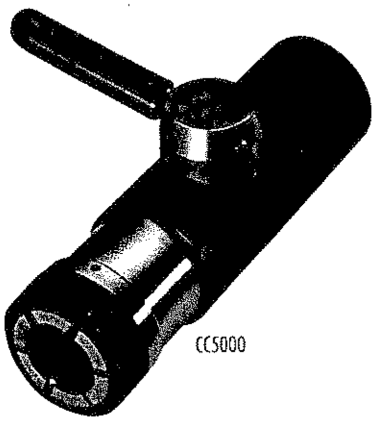
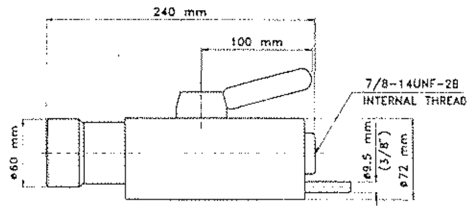
SHEREX/OPW 5000 SERIES BUS/HEAVY-DUTY TRUCK NOZZLES

Bus/Heavy-Duty Truck Nozzles

Sherex/OPW 5000 Series nozzles are designed for extremely high flow public and private CNG fueling systems. Applications include quick-fill, self-service fueling of transit buses and large trucks. All Sherex/OPW NGV fueling nozzles are designed and built to exacting engineering specifications for fueling safety and efficiency.



CC5000



CT5000

Key Features Include:

- **User-Friendly Single-Action Operation**- Entire fueling operation is initiated by simply engaging nozzle and receptacle with a single 180 degree rotation of the handle. This automatically secures the nozzle jaws onto the receptacle and activates a system of three internal valves that regulate fueling. The nozzle will not dispense gas until securely engaged onto an appropriate receptacle. When fueling is completed, rotation of the handle to the disconnect position automatically stops the flow of gas into the nozzle, vents the trapped gas, and releases the nozzle from the receptacle. The 5000 Series nozzles connect directly to the hose, eliminating the need for a three-way valve. They are designed for public or private self-service applications, eliminating the need for a trained attendant.
- **High Flow/Fast-Fill Capability**- To provide quick fueling of large storage vehicles. Internal seals are specially designed to meet the demands of fast-fill NGV fueling.
- **Directed Vent (CT5000)** - Directs the gas vented at disconnect and directs it out of the nozzle via a 3/8" stainless-steel tubing connection which can be piped to a remote venting location or back to the upstream side of the compressor. Directing the vent gas is environmentally desirable and will provide an added measure of safety by minimizing the amount of gas present at the filling site. It also reduces vent noise and escaped gas smell.
- **Jaw-Lock Technology**- Designed specifically for the frequent coupling and uncoupling of the high pressure gas connections of NGV fueling. Forces at the contact point are distributed over the entire surface area of the receptacle, virtually eliminating receptacle "grooving" and significantly reducing nozzle wear.
- **Ergonomic Design**- One simple and convenient motion ensures connection and dispensing by all users. Insulated jacket provides thermal protection for operator's hand.
- **Durable Construction**- Heavy-duty brass and stainless-steel construction provides excellent corrosion resistance in the harsh automotive environment. Hardened brass body is non-sparking for added safety.
- **Tamper Resistant**- Specially designed cam system actuates the front and rear valve module. Any tampering with the valve will result in an immediate shut-off of the dispensing process.
- **Individually Leak Tested and Inspected with Traceable Serial Number.**
- **Agency Listings**- ASME Pressure Vessel Registered, Railroad Commission of Texas, Special Application of German Pressure Vessel available.

Materials:

Body: Brass
Internal Components: Stainless Steel
Seals: Kel-F/Low Temperature Elastomer/Blended PTFE

Specifications:

Flow Rate: 141 Nm^3/min. Connected (5000 SCFM)
Temperature Range: -40° to 85° C (-40° to 185°F)

Ordering Information

Product Number	Inlet Thread Size	Design Pressure bar	Design Pressure psig
CC5000 *(non-directed vent)*	SAE 7/8"-14	282	4000
CT5000 *(directed vent)*	SAE 7/8"-14	282	4000

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS

H13741M
OCTOBER 1997

for Self Service Fueling Nozzles

TABLE OF CONTENTS

FOR USE WITH TYPE 1— CC1000, CT1000, CT1000S, CT1000L, CT1000 P36, CC5000, CT5000 NOZZLES

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Routine Maintenance 7

After One Year of Service 7

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SHEREX/OPW

SECTION A: INTRODUCTION

USE THIS MANUAL

manual has been prepared as a step by step installation guide for the following SHEREX/OPW Self-Service series of fueling ›zzles:

CT1000 P-36 CT1000 CT1000S CT1000L CC1000 CC5000 CT5000

This information is intended as general installation procedures and to familiarize the installer/end user with the techniques and procedures used.

ENERAL

The Self-Service series of natural gas fueling nozzles are designed to be used with the following receptacles for filling with compressed natural gas for vehicles (CNGV):

NGV1	CT1000 P36 nozzle CT1000 nozzle CT1000S nozzle CT1000L nozzle CC1000 nozzle	Any NGV1 P36 receptacle Any NGV1, P30, P36 or SR1 receptacle Any NGV1, P30, P36 or SR1 receptacle Any NGV1, P30, P36 or SR1 receptacle Any NGV1, P30, P36 or SR1 receptacle
Bus/Truck	CC5000 nozzle CT5000 nozzle	SR5, CR5, CL5, and CM5 series receptacles SR5, CR5, CL5, and CM5 series receptacles

The captive vent feature of the Self-Service series nozzles is designed to capture the small amount of high pressure gas that is contained between the nozzle inlet valve and the nozzle outlet valve prior to disconnecting.These nozzles are only intended for use as a Type 1 Class A fast fill unit, operating at the following service pressures:

		Maximum Service Pressure	NGV1 Rating
NGV1	CT1000 P36 nozzle CT1000 nozzle CT1000S nozzle CT1000L nozzle CC1000 nozzle	310 bar (4500 psi) 310 bar (4500 psi) 310 bar (4500 psi) 310 bar (4500 psi) 310 bar (4500 psi)	240 bar (3600 psi) 200 bar (3000 psi) 200 bar (3000 psi) 200 bar (3000 psi) 200 bar (3000 psi)
Bus/Truck	CC5000 nozzle CT5000 nozzle	310 bar (4500 psi) 310 bar (4500 psi)	N/A N/A

The Self-Service series nozzles have an operating temperature range of -40 C to 85 C (-40 F to 185 F).
NOTE: THE CT1000 P36 NOZZLE CANNOT FILL A P30 RECEPTACLE.

All SHEREX/OPW series nozzles require special installation precautions to ensure safe and reliable operation. The installation shall conform with the requirements of the Authorities having jurisdiction or, in the absence of requirements, with the Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems, NFPA 52 or the Natural Gas for Vehicles Installation Code, CAN/CGA B149.4, as applicable.

SECTION B: INSTALLATION

The inlet and seal for these Self-Service nozzles are as follows:

	Nozzle	Inlet	Seal
NGV1	CT1000 P36 nozzle CT1000 nozzle CT1000L nozzle CT1000S nozzle CC1000 nozzle	SAE J1926 - SAE 6 O-ring boss port with UNF 9⁄16" - 18 threads	Size #906 O-ring
Bus/Truck	CC5000 nozzle CT5000 nozzle	SAE J1926 - SAE 10 O-ring boss port with UNF 7⁄8" - 14 threads	Size #910 O-ring

All O-rings are manufactured of a compound that is suitable for use in compressed natural gas environments at the noted service temperatures (Figure 1).

IMPORTANT: THE VENT TUBE AND CHAMBER MUST NOT BE CONNECTED TO HIGH PRESSURE. A CHECK VALVE SHOULD BE INSTALLED IN THE VENT RECOVERY SYSTEM TO PROTECT THE VENT TUBE AND NOZZLE FROM HIGH PRESSURE INPUT OR BUILD UP. MAXIMUM VENT TUBE PRESSURE MUST BE KEPT BELOW 3.5 BAR (50 PSI) TO ALLOW EASY NOZZLE OPERATION.

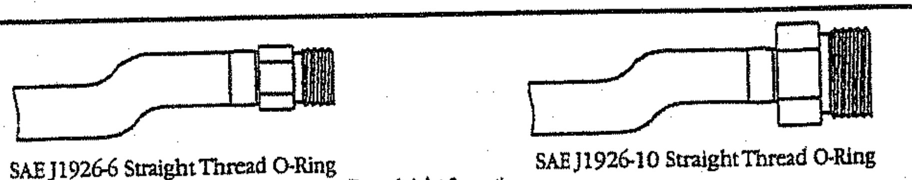

Figure 1: Inlet Connections

T1000, CT1000S, CT1000L, CT1000P36

A ¼" tube is used to vent the gas. A double ferrule compression fitting should be used to connect to a ¼" hose. The hose must be suitable for compressed natural gas with maximum service pressures up to 310 bar (4500 psi). It is of the utmost importance that there be no obstructions downstream of the vent line.

:T5000

A ⅜" tube is used to vent the gas. A double ferrule compression fitting should be used to connect to a ⅜"(minimum) flex hose. The hose must be suitable for compressed natural gas with maximum service pressures up to 310 bar (4500 psi). It is of the utmost importance that there be no obstructions downstream of the vent line.

> **WARNING:** UNDER NO CIRCUMSTANCES CAN NPT FITTINGS BE USED ON THESE NOZZLES! DO NOT USE THREAD SEALING TAPES OR COMPOUNDS.

nsure that the correct size SAE sealing o-ring (#906 or #910) is installed on the male UNF fitting (9⁄16"-18 or 7⁄18"-14) ccording to the fitting and O-ring manufacturer's instructions. We recommend using a Buna-N rubber compound specified for use with compressed natural gas and all compressor oils, including synthetic oils. An O-ring with durometer 90 is preferred and the MIL-P-25732 specification compounds perform very well under these conditions. SHEREX/OPW provides the proper O-ring with all new nozzles.

2. Be sure all sealing surfaces are clean, smooth and free of any oil, grease or other contaminants.

3. The nozzle should be tightened onto the fitting to a minimum torque of the following:

	Nozzle	Type of Wrench	Tighten To:
NGV1	CT1000 P36 nozzle CT1000 nozzle CT1000S nozzle CT1000L nozzle CC1000 nozzle	27 mm (1 1/16") wrench	Minimum 20 N.m, Maximum 33 N.m (15-24 ft-lbs) (Figure 2)
Bus/Truck	CC5000 nozzle CT5000 nozzle	36 mm wrench	Minimum 24 N.m, Maximum 41 N.m (18-30 ft-lbs) (Figure 2)

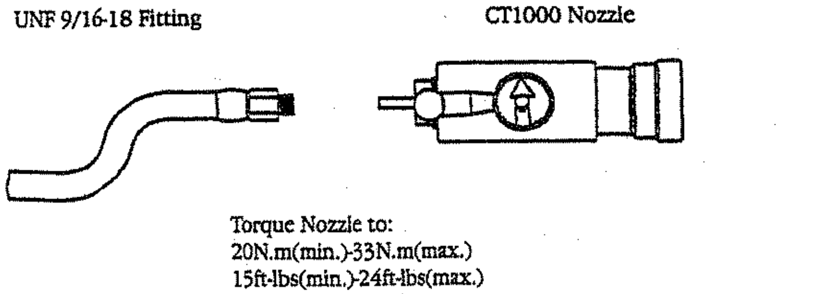

Figure 2: Required Installation Torque

4. After installation, test the unit for leaks.The handle should be cycled a few times (see warning attached to nozzle). Pressurize and test the connection using a suitable leak detector (e.g., SNOOP®).Test pressures should include low pressures (under 7 bar /100 psi) and up to the following maximum service pressure of 310 bar (4500 psi).

WARNING: ENSURE THAT THE HOSE AND NOZZLE ARE DEPRESSURIZED BEFORE REMOVING NOZZLE OR DOING ANY MAINTENANCE.

SECTION C: OPERATION

Connecting to a receptacle is easily accomplished by following these procedures.

1. Ensure the nozzle is intended to connect to the receptacle in accordance with the following table:

Nozzle	NGV1	Sherex Description
CC1000 CT1000 CT1000S CT1000L	P30 or P36 P30 or P36 P30 or P36 P30 or P36	NGVI-P30, SR1 type receptacles
CT1000 P36	P36	NGVI-P36
CC5000 CT5000	— —	SR50XX, CR50XX

2. Remove the nozzle from the rest position and verify the indicating arrows are opposing (OFF position) with the handle in the 3 o'clock position (Figure 3). This opens the jaws.

WARNING: DO NOT APPLY EXTREME FORCE TO THE NOZZLE HANDLE. INTERNAL COMPONENTS MAY BE DAMAGED BY HIGH TORQUE ON THE OPERATING HANDLE.

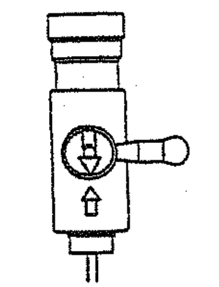

Figure 3 - Off Position

3. Connect by pushing the nozzle forward onto the receptacle first and rotating the handle clockwise until the indicating arrows are in line (ON position) with the handle in the 9 o'clock position. The "pushing on" is important and prevents handle from damage.

IMPORTANT: DO NOT ATTEMPT TO COUPLE THE NOZZLE AND RECEPTACLE WHEN THE RESPECTIVE AXIS OF THE NOZZLE AND RECEPTACLE ARE OFFSET OR AT AN ANGLE. (FIGURE 4 & 5)

If the nozzle will not connect to the receptacle, ensure that the nozzle is fully vented and in the "OFF" or "NO FLOW" position.

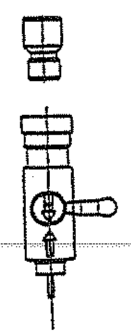

Figure 4: Proper Coupling Alignment

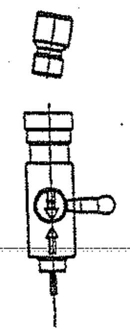

Figure 5: Improper Coupling Alignment

SECTION C: OPERATION

REMOVAL IS EASILY ACCOMPLISHED:

5. When fueling is complete, turn the station dispenser OFF.

6. Turn the nozzle handle counter clockwise to the 6 o'clock position so that the arrows are perpendicular. This stops the flow of gas. Turn the handle through the vent position (about 5 o'clock) to relieve the internal pressure of the nozzle (Figure 6). The vented gas is from the nozzle. The hose remains pressurized.

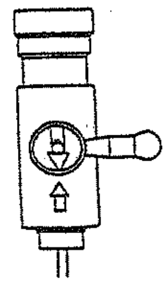

Figure 6 - Nozzle Flow Stopped

WARNING:	**DO NOT APPLY EXTREME FORCE TO THE NOZZLE HANDLE. INTERNAL COMPONENTS MAY BE DAMAGED BY HIGH TORQUE ON THE OPERATING HANDLE.**

NOTE:	**THERE IS A BRIEF SOUND OF GAS VENTING WHEN GOING THROUGH THE DISCONNECT MOTION. THIS IS NORMAL VENTING OF THE CAVITY IN THE NOZZLE.**

In the event that a popping sound is heard during venting, this is an indication that there is an obstruction in the vent. If the nozzle is difficult to disconnect from the receptacle or venting does not stop after a few seconds, return the nozzle handle to the fill position, close the vehicle manual shut-off valve on the vehicle and repeat from Step D:2, above. If problems persist, the entire supply to the nozzle and vent lines must be depressurized and thoroughly inspected. If station inspection reveals nothing, return the nozzle to SHEREX/OPW immediately with a full description of the problem.

7. Further rotate the nozzle handle counter-clockwise to the 3 o'clock position so that the arrows are lined up. This opens the jaws and releases the receptacle.

8. Place the nozzle in a **CLEAN, PROTECTED AREA.**

SECTION D: SERVICE

These Self Serve nozzles must be stored in a clean protected area. The nozzle must not be exposed to debris, dirt, water or chemicals. Service life is dependent on handling and care of the nozzle. Contamination increases the potential for nozzle malfunction. Unusual operation must be reported to the service representative immediately! These captured vent nozzles (CT1000, CT1000S, CT1000L, CT1000-P36, CT5000) have an internal filter to prevent damage caused from gas-borne debris. A SHEREX/OPW in line filter is recommended at the inlet of non-protected nozzles, for maximum protection of your investment.

ROUTINE MAINTENANCE

1. Inspect the jaws and clean any dirt, grease, or oil from the stainless steel exhaust valve with a clean, lint free cloth. Do not use any solvents as this may result in seal degradation and create the likelihood of personal injury with subsequent use.

2. The entire nozzle should be cleaned periodically by wiping with a cloth or rag. This should occur on average twice per month, more frequently if the nozzle is constantly in use or is used under extremely dirty conditions.

3. Repeatedly depress the exhaust valve to ensure smooth operation. In the event that the valve remains depressed, do not attempt to dislodge it. Call the local service representative immediately!

4. Every four months, the inside diameter at the front opening of the CT1000-P36 nozzle (Figure 7) should be measured. If the inside diameter is greater than 24.7mm, then the nozzle should be returned to SHEREX/OPW for repair.

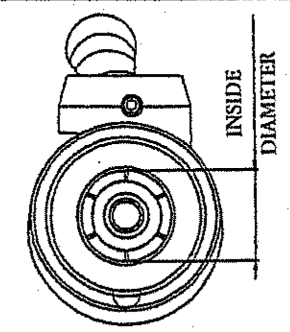

Figure 7: Front Opening

NOTE: A GO/NO GO GAUGE FOR THE JAWS CAN BE PURCHASED FROM SHEREX/OPW.

AFTER ONE YEAR OF SERVICE

The unit should be routinely checked for leaks while under service pressure. This should be carried out by the local service representative.

A R FOUR YEARS OF SERVICE

The unit should be returned to SHEREX/OPW for replacement of all seals. This period should be reduced to twenty-four (24) months if the potential exists for misuse, abuse, or the nozzle is used in extreme environmental surroundings.

Special tools and care are required to clean and remove the filter element from the filtered nozzles. In the interests of safety and performance, only specially trained and qualified technicians can remove and service the filter.

BREAKAWAY - INLINE

SHEREX / OPW
ILB-5
BREAKAWAY – INLINE ILB5 HEAVY DUTY

ANGI PART NUMBER 700-07289

REBUILD KIT – ILB5 BREAKAWAY – 761-07345

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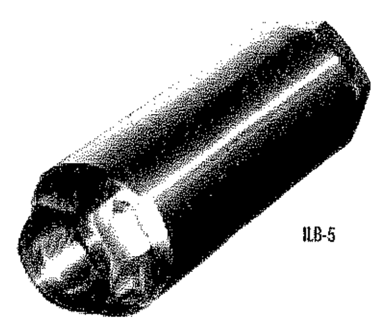
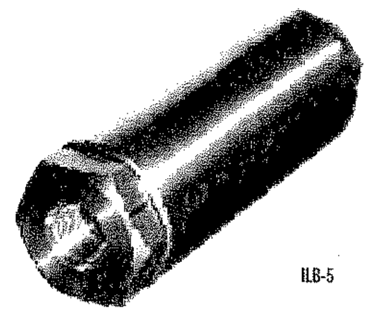
CNG/OPW IN-LINE BREAKAWAY

In-Line Breakaway (ILB-5) - Heavy-Duty Truck/Bus

CNG/OPW has developed an in-line breakaway that can be used in heavy-duty truck and bus NGV refueling applications. This unit will function consistently, independent of the inlet pressure. Depending on your needs and budget constraints, the CNG/OPW offers breakaway products that fit your application.



ILB-5



ILB-5

Key Features Include:

- **Durable, Corrosion-Resistant Construction** - Stainless steel and specially plated steel construction provide improved durability and corrosion resistance in harsh environments.
- **Reconnectable Design** - Allows the component to be reused, reducing maintenance costs.
- **Innovative Valve System** - The sealing system in this breakaway minimizes the amount of vent gas during a drive-away incident.
- **High Flow/Super Fast Fill Capacity** - This is CNG/OPW's fastest flowing breakaway. This breakaway will provide quick fueling of large storage vehicles. Internal seals are specifically designed to meet the demands of fast-fill NGV fueling.
- **Easy Installation** - The in-line breakaway has SAE - 10 O-ring fittings for easy installation in line between the dispenser and nozzle.
- **Individually Inspected, Leak and Breakaway Tested, with Traceable Serial Numbers.**
- **Disconnection Force** - 150–200 lbs. (668–890 N).

Materials:

Body: Stainless Steel

Internal Components: Stainless Steel

Seal: Specially formulated polymers and elastomers specific to high pressure NGV applications.

Specifications:

Min. Flow Rate: 5000 SCFM @ 3000 psid

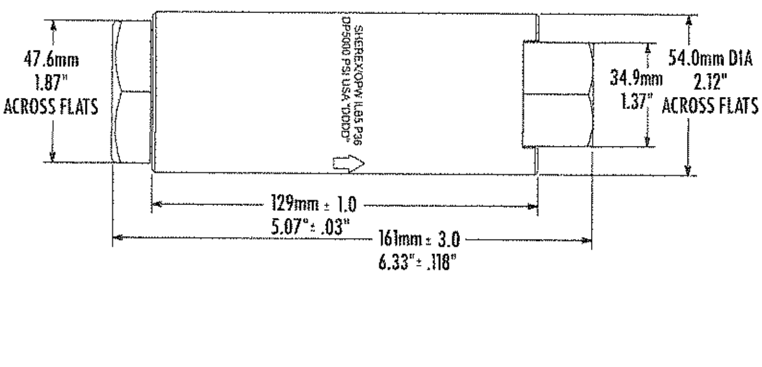
Temperature Range: -40° to 85° C (-40° to 185° F)

Weight: 5 lbs.

Cv: 3.6

Design Pressure: 5000 psig (345 Bar)

Agency Listings Pending



Ordering Information

Product Number	Inlet Thread Size	Outlet Thread Size	Max. Allowable Service Pressure
ILB-5	SAE - 10 7/8 - 14 UNF (female)	SAE - 10 7/8 - 14 UNF (female)	4500psig (310 Bar)

OPW
CNG/ALTERNATIVE FUELING PRODUCTS

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS FOR INLINE BREAKAWAY DEVICES (ILB)

FOR USE WITH ANY CERTIFIED ELECTRICALLY CONDUCTIVE HOSE INTENDED FOR FILLING COMPRESSED NATURAL GAS OR COMPRESSED HYDROGEN VEHICLES UP TO SERVICE PRESSURES OF 5000 PSI.

SECTION A: INTRODUCTION

How to use this Manual

This manual has been prepared as a step by step users guide for the Sherex/OPW ILB series of Inline Safety Breakaway Valves.

This information is intended as a general outline to familiarize the installer/end user with the techniques and procedures used to install, reconnect and maintain the Breakaway Device.

General

The Inline Breakaway (ILB) series of valves are intended to protect the dispenser, vehicle and fueling nozzle from damage if a vehicle moves away from the refueling point while still coupled to the fuel line.

The ILB is designed to be used with any approved hose intended for filling compressed natural gas vehicles (CNGV) or Compressed Hydrogen Vehicles (CH2). The ILB operates at service pressures up to 5000 psi and has an operating temperature range of –40 C to 85 C (-40 F to 185 F). These units are designed to separate within range of 150 +/- 30 lbs (670 +/- 134 N) as specified by the ANSI NGV4.4 Breakaway Device Safety Standard.

SECTION B: INSTALLATION

The inlet and seal for these Inline Breakaways are as follows:

Breakaway	Inlet/Outlet	Seal
ILB-1 Or **ILB-H**	SAE J1926 – 6 o-ring Boss port with 9/16-18 UNF threads	Size #906 (P/N 1146) 70 durometer NBR Nitrile
ILB-2	¼ NPT Port	N/A
ILB-5	SAE J1926 – 10 o-ring Boss port with 7/8-14 UNF threads	Size #910 (P/N1127) 70 durometer NBR Nitrile
ILB-6	½ NPT Port	N/A

Please note: The NPT Port ILB breakaway valves (ILB-2 and ILB-6) are not intended for use in North American applications and do not carry approvals or certifications.

CAUTION: THE ILB MUST BE CONNECTED BETWEEN THE DISPENSER AND THE NOZZLE SO IT IS FREE TO ALIGN ITSELF IN A STRAIGHT MANNER BETWEEN ITS TWO HOSES. (FIGURE 1)

Installation Procedure

Step 1. Inspect the unit and ensure that both halves are fully connected. If you can easily pull the two halves apart then please refer to Section D: Re-assembly before continuing with the installation.

Step 2. Ensure that the threads on both the hose fitting as well as the inlet and outlet ports are clean and free of any debris, oil, grease or teflon tape.

Step 3A. For ILB-1, ILB-H and ILB-5 Breakaways, ensure that the proper sealing o-rings are installed on the male hose fittings according to the fitting and o-ring manufacturer's instructions. These o-rings must be 70 Durometer Nitrile (NBR). Two of these o-rings are included with each assembly instruction sheet and must be installed. For additional o-rings contact Sherex/OPW customer service; order part number 1146 for the ILB-1 and ILB-H and part number 1127 for the ILB-5.

OPW

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS FOR INLINE BREAKAWAY DEVICES (ILB)

Step 3B. For the ILB-2 and ILB-6 Breakaways, apply an appropriate amount of pipe sealant to the male fittings. **DO NOT USE TEFLON TAPE.**

Step 4. Only use the wrench flats when tightening the hose to the ILB breakaways - do not grasp the housing.

Step 5. Ensure that the flow direction arrow is pointing in the direction of gas flow. (the arrow points to nozzle)(FIGURE 2)

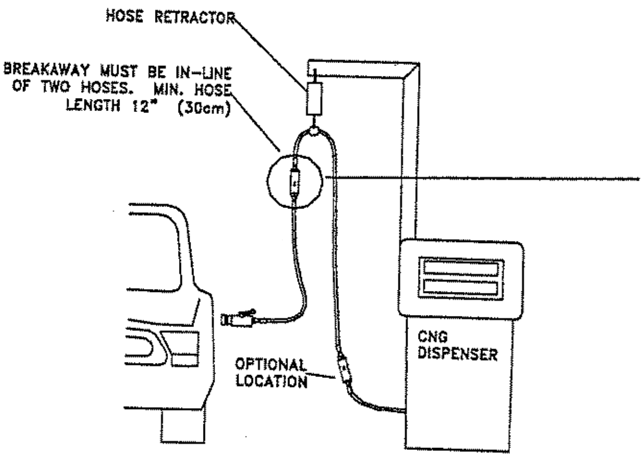


FIGURE 1. INSTALLATION DETAILS

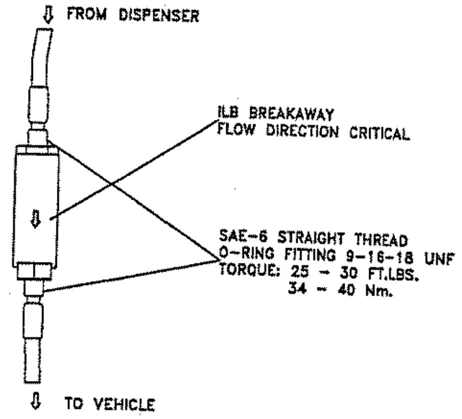


FIGURE 2. FLOW DIRECTION

Step 6. Using a properly sized wrench, tighten the fitting to a torque of 25 ft.lbs. (34Nm) to 30 ft.lbs. (40 Nm). Warning: Excessive over tightening will gall the threads and weaken the connection. **Do not wrench across coupling.**

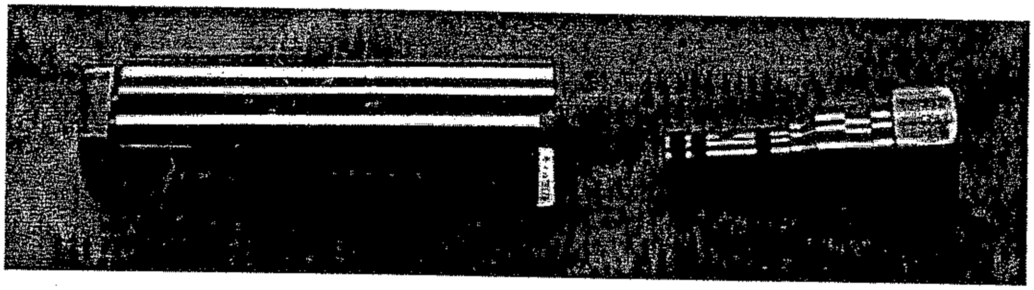
Step 7. After installation, test the unit for leaks. Pressurize and test the connection using a suitable leak detector (e.g. Snoop®). The test pressures should include both low (100 psi / 0.86 MPa) and high (3600 – 5000 psi / 25-35 MPa). For safety reasons, always pressurize at the low pressure first.

OPW

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS FOR INLINE BREAKAWAY DEVICES (ILB)

SECTION C: SEPARATION OF ILB

The ILB will spit into two parts upon disconnection when a force within the range of 150 +/- 30 lbs (670 +/- 134 N) is applied axially to the breakaway coupling. (FIGURE 3.)



Stationary Module **Breakaway Module**

FIG 3. Breakaway Modules

The Stationary Module is the portion the remains permanently attached to the hose on the dispenser. It shuts off the gas supply from the upstream dispenser, storage tanks and compressor. The Breakaway Module (vehicle side) will detach and slowly vent off the gas stored in the hose and nozzle that remain coupled to the vehicle. This is to ensure that the driver is not carrying a pressurized hose away from the station, eliminating a dangerous situation.

NOTE: UPON SEPARATION, A VERY LOUD NOISE SHOULD BE EXPECTED.

CAUTION: A HOSE BREAKAWAY EVENT IS INTENDED TO PROTECT THE FUELING DEVICE, DISPENSER, AND VEHICLE. HOSE STRETCH WILL CAUSE A WHIPPING ACTION FOR THE BREAKAWAY MODULE. AS A RESULT, PERSONAL INJURY MAY OCCUR IF SOMEONE IS IN THE WAY OF THE HOSE DURING A BREAKAWAY EPISODE.

SECTION D: RE-ASSEMBLY AFTER BREAKAWAY

Reconnection Procedure

Step 1. Depressurize the dispenser system and hose before attempting re-connection.

Step 2. Clean dirt or debris from both halves of the Breakaway unit before re-assembly is attempted.

Step 3. Inspect both parts of the Breakaway. Make sure that the o-ring seals have not been damaged (Slits or rough spots) (Figure 4). If so, please contact Sherex/OPW customer service for replacement o-rings. For the ILB-1, ILB-H and ILB-2 order o-ring P/N 42020. For the ILB-5 and ILB-6 order o-ring P/N 42007. If the Breakaway Module is damaged or missing, a replacement kit is available as well. If the o-rings are dry lubricate them with light grease (e.g. Parker O-Lube ®) or mild soap before re-assembly.

FIG 4. Breakaway Module O-Rings

Step 4. Inspect the Stationary Module and ensure that the inner garter spring is present and properly situated in the groove (Figure 5). A replacement garter spring is available from Sherex/OPW customer Service. For the ILB-1, ILB-H and ILB-2 order spring P/N 42024. For the ILB-5 and ILB-6 order spring P/N 42007.

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS FOR INLINE BREAKAWAY DEVICES (ILB)

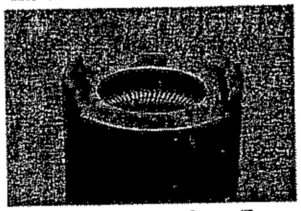


FIG 5. Garter Spring Location

Step 5. Hold the Breakaway module so that the wrench flats will fit into the slot on the Stationary Module. (Figure 6)

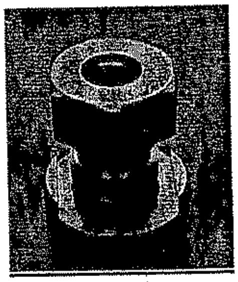


FIG 6. Reconnection Alignment

Step 6. Push the Breakaway Module into the Stationary Module until a definite click is felt and the wrench flats are in the groove on the Stationary Housing (Figure 7).

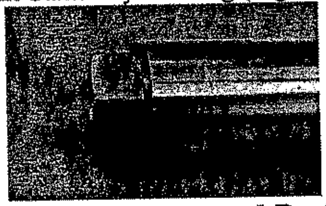


FIG 7. Fully Connected Position

Step 7. After re-assembly, test the unit for leaks. Pressurize and test the connection using a suitable leak detector (e.g. Snoop®). The test pressures should include both low (100 psi / 0.86 MPa) first and high (3600 psi / 25 MPa). Always pressurize at the low pressure first to ensure that the reconnection has been made correctly.

CAUTION: DO NOT ATTEMPT ANY REPAIR IF LEAKAGE PERSISTS. DOING SO WILL VOID ALL WARRANTIES.

SECTION E: ROUTINE CHECKS

After One Year of Service:

- The unit should be routinely checked for leaks while under service pressure.
- This should be carried out by the local service representative.

After Four Years of Service:

- The unit should be returned to Sherex/OPW for rebuilding and replacement of all seals.
- This period should be reduced to twenty-four (24) months if the potential exists for misuse, abuse, if the ILB is used in extreme environmental surroundings, or if more than 20 breakaways have occurred on the unit.

PLEASE CONTACT Sherex/OPW Inc. FOR TRAINING, TOOLS AND REPLACEMENT PARTS.

OPW

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OPW SHEREX
ILB-1

BREAKAWAY-INLINE OPW ILB-1
SAE-6 (9/16 - 18 UNF)

ANGI PART NUMBER 700-07488

REBUILD KIT - 761-07317

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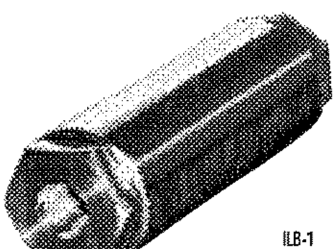
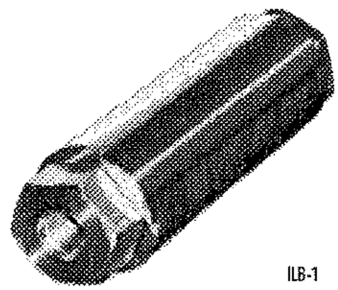
CNG/OPW IN-LINE BREAKAWAY

In-Line Breakaway (ILB-1)

CNG/OPW has developed an in-line breakaway that can be used in automotive NGV refueling applications. This unit will function consistently, independent of the inlet pressure. Depending on your needs and budget constraints, the CNG/OPW offers breakaway products that fit your application.



ILB-1



ILB-1

Key Features Include:

- **Durable, Corrosion-Resistant Construction** - Stainless steel and specially plated steel construction provide improved durability and corrosion resistance in harsh environments.
- **Reconnectable Design** - Allows the component to be reused, reducing maintenance costs.
- **Innovative Valve System** - The sealing system in this breakaway minimizes the amount of vent gas during a drive-away incident.
- **High Flow** - The flow path has been matched to provide ample flow for all NGV-1 Type 1 and Type 2 nozzles.
- **Reduced Size and Weight** - To allow for more applications where size may be a concern.
- **Easy Installation** - The in-line breakaway has SAE - 6 O-ring fittings for easy installation in line between the dispenser and nozzle.
- **Individually Inspected, Leak and Breakaway Tested, with Traceable Serial Numbers.**
- **Disconnection Force** - 150–200 lbs. (668–890 N).

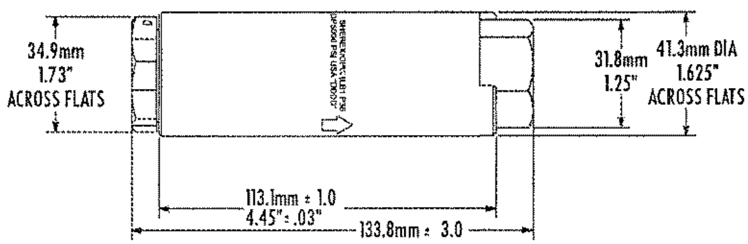
Materials:

Body: Stainless Steel
Internal Components: Stainless Steel
Seal: Specially formulated polymers and elastomers specific to high pressure NGV applications.

Specifications:

Min. Flow Rate: 2000 SCFM @ 3000 psid
Temperature Range: -40° to 85° C (-40° to 185° F)
Weight: 2.3 lbs.
Cv: 1.17
Design Pressure: 5000 psig (345 Bar)

Agency Listings Pending



Ordering Information

Product Number	Inlet Thread Size	Outlet Thread Size	Max. Allowable Service Pressure
ILB-1	SAE - 6 9/16 - 18 UNF (female)	SAE - 6 9/16 - 18 UNF (female)	3600psig (P36) (248 Bar)

OPW
CNG/ALTERNATIVE FUELING PRODUCTS

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS FOR INLINE BREAKAWAY DEVICES (ILB)

FOR USE WITH ANY CERTIFIED ELECTRICALLY CONDUCTIVE HOSE INTENDED FOR FILLING COMPRESSED NATURAL GAS OR COMPRESSED HYDROGEN VEHICLES UP TO SERVICE PRESSURES OF 5000 PSI.

SECTION A: INTRODUCTION

How to use this Manual

This manual has been prepared as a step by step users guide for the Sherex/OPW ILB series of Inline Safety Breakaway Valves.

This information is intended as a general outline to familiarize the installer/end user with the techniques and procedures used to install, reconnect and maintain the Breakaway Device.

General

The Inline Breakaway (ILB) series of valves are intended to protect the dispenser, vehicle and fueling nozzle from damage if a vehicle moves away from the refueling point while still coupled to the fuel line.

The ILB is designed to be used with any approved hose intended for filling compressed natural gas vehicles (CNGV) or Compressed Hydrogen Vehicles (CH2). The ILB operates at service pressures up to 5000 psi and has an operating temperature range of -40 C to 85 C (-40 F to 185 F). These units are designed to separate within range of 150 +/- 30 lbs (670 +/- 134 N) as specified by the ANSI NGV4.4 Breakaway Device Safety Standard.

SECTION B: INSTALLATION

The inlet and seal for these Inline Breakaways are as follows:

Breakaway	Inlet/Outlet	Seal
ILB-1 Or **ILB-H**	SAE J1926 – 6 o-ring Boss port with 9/16-18 UNF threads	Size #906 (P/N 1146) 70 durometer NBR Nitrile
ILB-2	¼ NPT Port	N/A
ILB-5	SAE J1926 – 10 o-ring Boss port with 7/8-14 UNF threads	Size #910 (P/N1127) 70 durometer NBR Nitrile
ILB-6	½ NPT Port	N/A

Please note: The NPT Port ILB breakaway valves (ILB-2 and ILB-6) are not intended for use in North American applications and do not carry approvals or certifications.

CAUTION: THE ILB MUST BE CONNECTED BETWEEN THE DISPENSER AND THE NOZZLE SO IT IS FREE TO ALIGN ITSELF IN A STRAIGHT MANNER BETWEEN ITS TWO HOSES. (FIGURE 1)

Installation Procedure

Step 1. Inspect the unit and ensure that both halves are fully connected. If you can easily pull the two halves apart then please refer to Section D: Re-assembly before continuing with the installation.

Step 2. Ensure that the threads on both the hose fitting as well as the inlet and outlet ports are clean and free of any debris, oil, grease or teflon tape.

Step 3A. For ILB-1, ILB-H and ILB-5 Breakaways, ensure that the proper sealing o-rings are installed on the male hose fittings according to the fitting and o-ring manufacturer's instructions. These o-rings must be 70 Durometer Nitrile (NBR). Two of these o-rings are included with each assembly instruction sheet and must be installed. For additional o-rings contact Sherex/OPW customer service; order part number 1146 for the ILB-1 and ILB-H and part number 1127 for the ILB-5.

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS FOR INLINE BREAKAWAY DEVICES (ILB)

Step 3B. For the ILB-2 and ILB-6 Breakaways, apply an appropriate amount of pipe sealant to the male fittings. **DO NOT USE TEFLON TAPE.**

Step 4. Only use the wrench flats when tightening the hose to the ILB breakaways - do not grasp the housing.

Step 5. Ensure that the flow direction arrow is pointing in the direction of gas flow. (the arrow points to nozzle)(FIGURE 2)

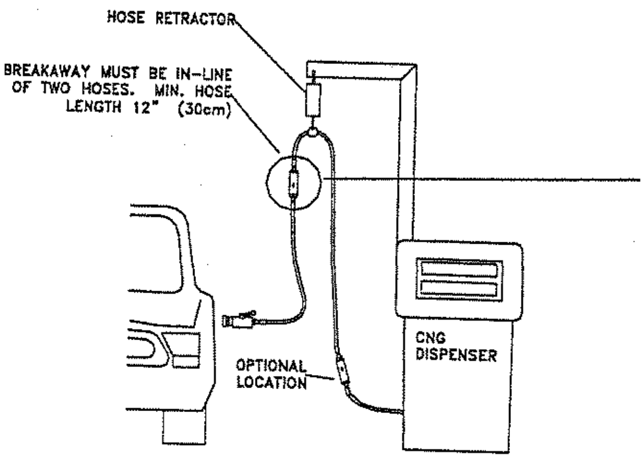


FIGURE 1. INSTALLATION DETAILS

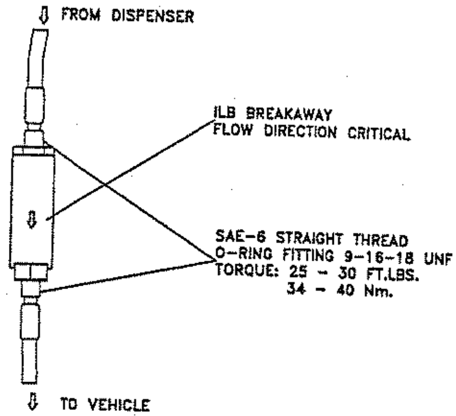


FIGURE 2. FLOW DIRECTION

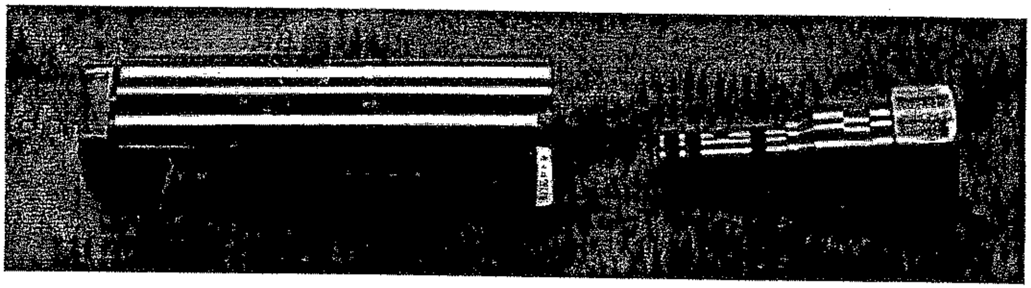
Step 6. Using a properly sized wrench, tighten the fitting to a torque of 25 ft.lbs. (34Nm) to 30 ft.lbs. (40 Nm). Warning: Excessive over tightening will gall the threads and weaken the connection. **Do not wrench across coupling.**

Step 7. After installation, test the unit for leaks. Pressurize and test the connection using a suitable leak detector (e.g. Snoop®). The test pressures should include both low (100 psi / 0.86 MPa) and high (3600 – 5000 psi / 25-35 MPa). For safety reasons, always pressurize at the low pressure first.

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS FOR INLINE BREAKAWAY DEVICES (ILB)

SECTION C: SEPARATION OF ILB

The ILB will spit into two parts upon disconnection when a force within the range of 150 +/- 30 lbs (670 +/- 134 N) is applied axially to the breakaway coupling. (FIGURE 3.)



Stationary Module **Breakaway Module**

FIG 3. Breakaway Modules

The Stationary Module is the portion the remains permanently attached to the hose on the dispenser. It shuts off the gas supply from the upstream dispenser, storage tanks and compressor. The Breakaway Module (vehicle side) will detach and slowly vent off the gas stored in the hose and nozzle that remain coupled to the vehicle. This is to ensure that the driver is not carrying a pressurized hose away from the station, eliminating a dangerous situation.

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SECTION D: RE-ASSEMBLY AFTER BREAKAWAY

Reconnection Procedure

Step 1. Depressurize the dispenser system and hose before attempting re-connection.

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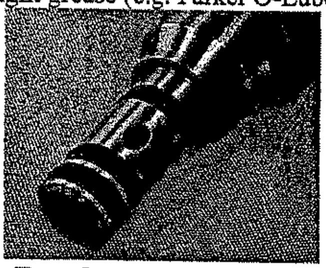

FIG 4. Breakaway Module O-Rings

Step 4. Inspect the Stationary Module and ensure that the inner garter spring is present and properly situated in the groove (Figure 5). A replacement garter spring is available from Sherex/OPW customer Service. For the ILB-1, ILB-H and ILB-2 order spring P/N 42024. For the ILB-5 and ILB-6 order spring P/N 42007.

INSTALLATION INSTRUCTIONS TO QUALIFIED TECHNICIANS FOR INLINE BREAKAWAY DEVICES (ILB)

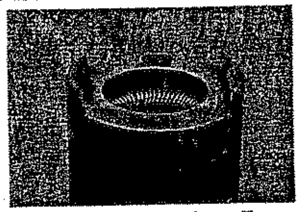

FIG 5. Garter Spring Location

Step 5. Hold the Breakaway module so that the wrench flats will fit into the slot on the Stationary Module. (Figure 6)

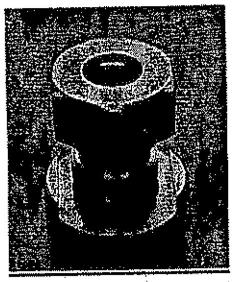

FIG 6. Reconnection Alignment

Step 6. Push the Breakaway Module into the Stationary Module until a definite click is felt and the wrench flats are in the groove on the Stationary Housing (Figure 7).

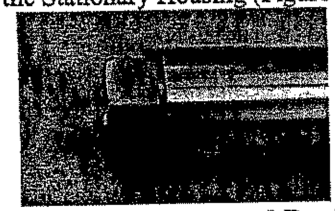

FIG 7. Fully Connected Position

Step 7. After re-assembly, test the unit for leaks. Pressurize and test the connection using a suitable leak detector (e.g. Snoop®). The test pressures should include both low (100 psi / 0.86 MPa) first and high (3600 psi / 25 MPa). Always pressurize at the low pressure first to ensure that the reconnection has been made correctly.

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SECTION E: ROUTINE CHECKS

After One Year of Service:

- The unit should be routinely checked for leaks while under service pressure.
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After Four Years of Service:

- The unit should be returned to Sherex/OPW for rebuilding and replacement of all seals.
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HOSE RETRACTOR

RED JACKET
884-034-5
RETRACTOR – SINGLE HOSE METAL REEL

ANGI PART NUMBER 702-07231

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RED JACKET®

VAPOR RECOVERY OVERHEAD RETRACTOR INSTALLATION INSTRUCTIONS

MODEL NO. 884-019-5 (Box Only) Coaxial Hose
MODEL NO. 884-034-5 (Box Only) without Hose Clamp STD

The Red Jacket Overhead Retractor is certified for use in Stage II vapor recovery installations under Executive Order G-70-15-D of the California Air Resources Board.

BOX INSTALLATION

The Red Jacket Overhead Retractors listed above are intended to be mounted onto a crossbar. On small spans, 2" x 2" 1/8" steel tubing, properly supported, has been successfully used.

IT IS THE RESPONSIBILITY OF THE INDIVIDUAL PERFORMING THE INSTALLATION TO COMPLY WITH ALL LOCAL CODES AND SAFETY REGULATIONS REGARDING GASOLINE AND VAPORS.

1. Install crossbar at desired height, usually 5-7 Ft. above the island.
2. Drill 3/8" mounting holes in the crossbar at the selected location.
3. Mount the Red Jacket Retractor Box using the (2) 3/8" - 16 x 3 1/2" hex bolts, (2) flat washers and (2) nuts as shown in Figure 1.

HOSE INSTALLATION

Fluid Hose — 5/8 inch inside diameter, U.L. listed for gasoline. 12 foot length.*
Vapor Hose — 5/8 inch inside diameter, U.L. listed for gasoline. Length as needed to permit natural drainage when hanging, but sufficient to avoid strain on the hose at the dispenser swivel when full extended.*

*Hose length referenced is based on standard softwall hose. Mounting configuration, hose type and climate may affect flexibility of hose. (Retractors for use with 5/8" or 3/4" I.D. Hose are available with either standard or heavy-duty reels.)

Swivels — 360° in line, .495 inches minimum inside diameter, one on each end of both hoses.
Hose Ties — Minimum of five (5), Panduit DHC 1.12 x 1.75, or equivelent.

1. Slip the hose into the clamp provided and adjust to comply with the 10" max. loop at the nozzle See Figure 2 below. Tighten securely.
2. Pull the hose to its full length. It should extend easily and then retract completely.
3. If adjustment is required in spring tension, remove the (4) screws from the cover, extend cable approximately 18", wind or unwind one turn at a time and repeat step 2.

FIGURE 1

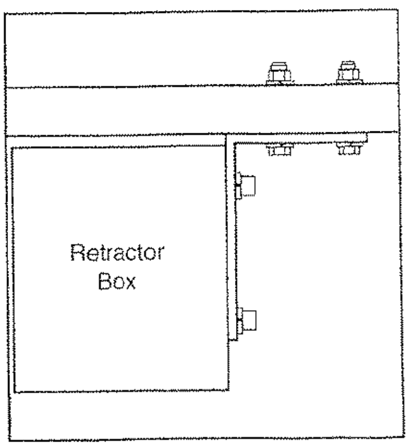
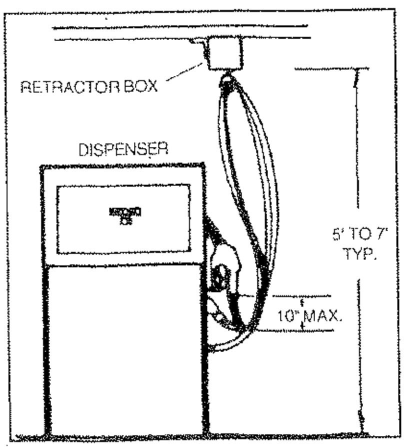


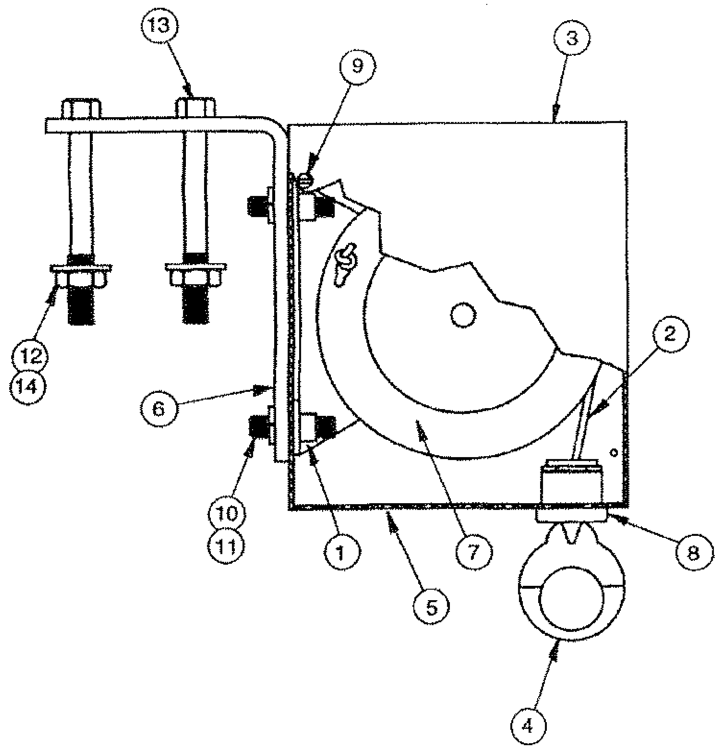
FIGURE 2



051-144 Rev. F

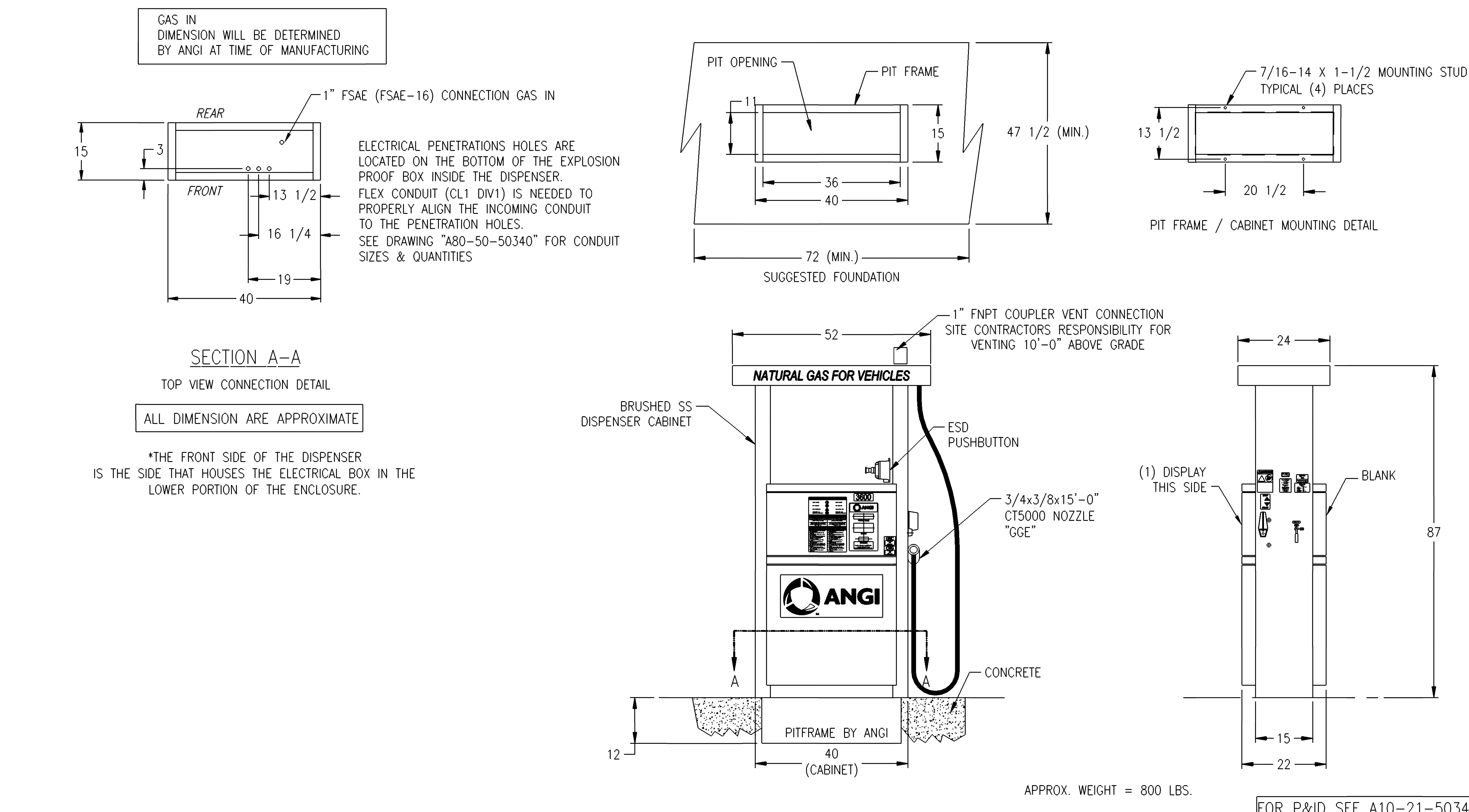
Hose Retractor Parts List

(Bracket Mount)



Item	Part Number	Qty.	Description
1	009-217-1	1	Bracket
2	780-905-1	10'	Cable, 5/32" nylon braided
3	014-408-1	1	Cover
4	014-407-1	1	Clamp, VR co-ax hose
5	029-020-1	1	Frame
6	009-222-1	1	Bracket, angle
7	071-124-1	1	Reel, heavy duty
7	071-130-1	1	Reel, standard duty
8	125-002-5	1	Eye, cable assembly
9	026-618-1	4	Screw, #6 x 3/8" pan head
10	026-574-1	2	Screw, 3/8" - 16 x 1" socket head
11	026-480-1	2	Lockwasher, 3/8"
12	026-577-1	2	Washer, 3/8"
13	076-330-1	2	Hex Bolt, 3/8" - 16 x 3 12"
1 4	026-307-1	2	Nut, 3/8" - 16 zinc plated

REDJACKET®



FOR P&ID SEE A10-21-50340

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

ANGI

ANGI ENERGY SYSTEMS
305 W DELAVAN DR
JANESVILLE, WI 53546
PH: 608-563-2800
www.angienergy.com

UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES .005-.015
ALL DIMENSIONS IN INCHES

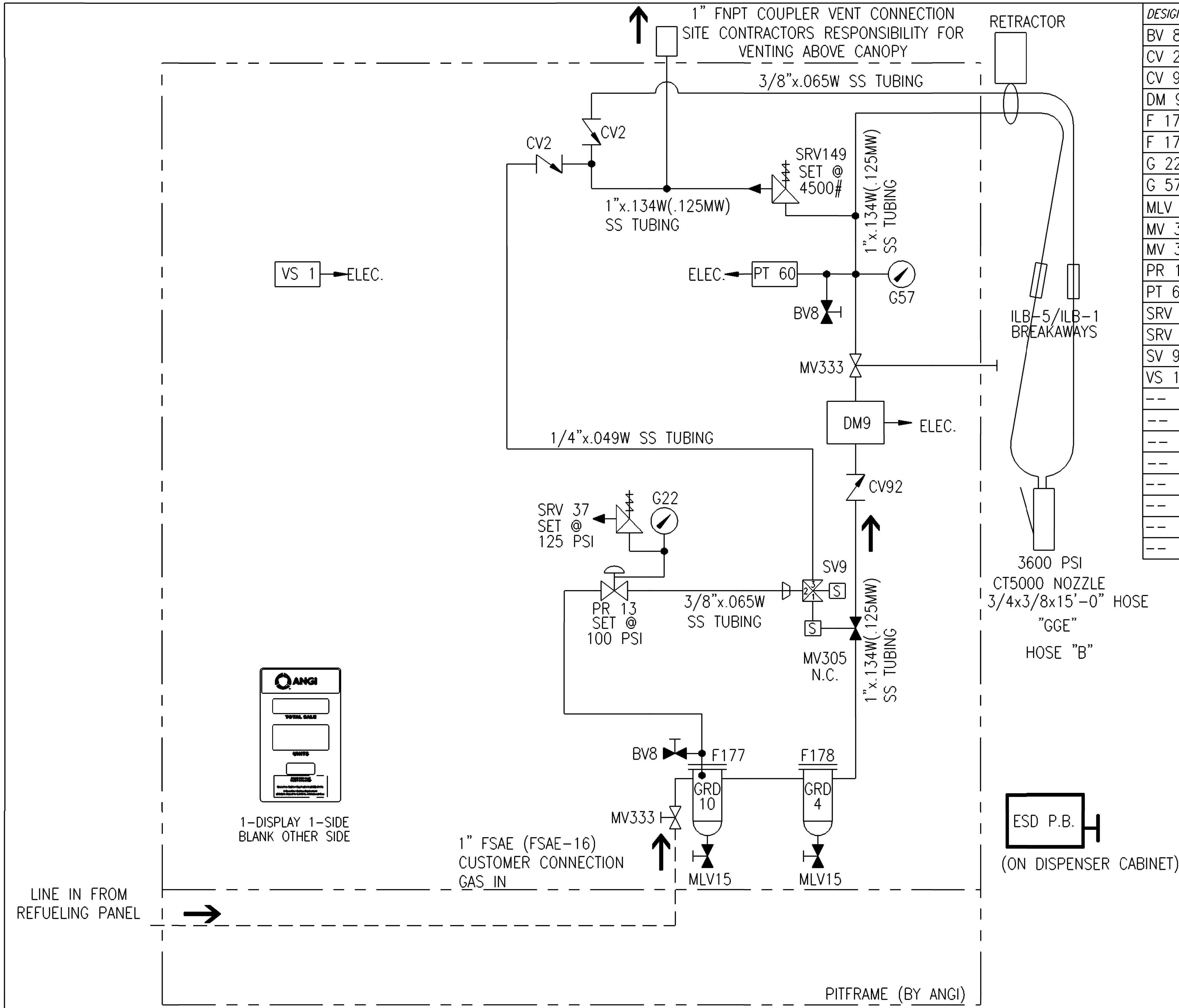
FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE: DISPENSER – 1-HOSE, 1-METER, 1" S-II W/NO SEQUENCING GAD –

CUSTOMER: CLEAN ENERGY – ARLINGTON TRANSIT
PROJECT NO. 50340

DRN	DATE	SCALE	DRAWING NO.	REV.
HMR	2/29/16	NTS	A10-22-50340	–
CHK –	DATE –	SHT 1 / TOT 1		

AUTOCAD WINDCHILL



DESIGNATOR	PART NUMBER	DESCRIPTION
BV 8	330-07312	VALVE-PURGE 7/16-20MSAE 6000# SS
CV 2	336-02419	VALVE-CHECK HOKE 1/4 ML 6000# KEL-F SS 2# CRACKING SPRG
CV 92	336-07321	VALVE-CHECK HOKE 1 FSAE 6000# SS 20# CRACKING SPRING
DM 9	902-07240	METER-CNG50 W/10' 4WIRE CABLE W/NO RFT, NO DISPLAY
F 177	772-07307	FILTER-ANGI JS6D SAE-24 GRD10 ELEMENT 5500#
F 178	772-07308	FILTER-ANGI JS6D SAE-24 GRD4 ELEMENT 5500#
G 22	741-07240	GAUGE-PRES 200#/B BM PM GF WIKA
G 57	741-07289	GAUGE-PRES 10,000#/B BM PM GF WIKA
MLV 15	330-07385	VALVE-NEEDLE 1/4 FNPT 6000#
MV 305	334-07515	VALVE/ACT-ASSY SVF H7 SAE-16 6000# N.C. W/A2S-110-11-V
MV 333	334-07544	VALVE-BALL SVF H7 SAE-16 6000#
PR 13	500-01674	REGULATOR-MECO 150#
PT 60	410-07298	TRANSDUCER-PRESSURE AST 0-6000# IS/UL CL1 DIV1&2
SRV 37	331-04522	VALVE-RELIEF CIRCLE SEAL 125# 1/4
SRV 149	331-08049	VALVE-RELIEF 4500# MERCER C-ORF 3/4MNPT INx1FNPT 4600SCFM
SV 9	330-07243	VALVE-SOL 3WY 1/4 150# 120V NC BRS UL
VS 1	480-04377	SWITCH-VIBRATION EXPRF
--	700-03945	NOZZLE-3600# OPW/SHEREX CT5000
--	700-07288	BREAKAWAY-INLINE OPW/SHEREX ILB-1
--	700-07289	BREAKAWAY-INLINE OPW/SHEREX ILB-5
--	702-07231	RETRACTOR
--	N50-28-001-005	HOSE ASSY-3/4x3/8x15' PARKER JIC 37 DEG ILB-5/ILB-1
--	820-07400-005	HOSE ASSY-3/4x3/8x11'-6" PARKER JIC 37-DEGREE (137-07245)
--	820-07500-003	HOSE WHIP SUPPLY ASSY-3/4x30" PARKER JIC 37-DEG (137-07241)
--	820-07600-002	HOSE WHIP VENT ASSY-3/8x34" PARKER JIC 37-DEG (137-07238)

LEGEND

BV	=BLEED (PURGE) VALVE	PR	=PRESSURE REGULATOR
CV	=CHECK VALVE	PT	=PRESSURE TRANSDUCER
DM	=MASS FLOW METER	SRV	=SAFETY RELIEF VALVE
F	=FILTER	SV	=SOLENOID VALVE
G	=PRESSURE GAUGE	VS	=VIBRATION SWITCH
MLV	=MANUAL LINE (NEEDLE) VALVE	VTA	=VENT TO ATMOSPHERE
MV	=MANUAL BALL VALVE		

FOR GAD SEE A10-22-50340

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION
A	3/8/16 HMR	MOVED INLET BV & MECO FEED TO FILTER PORT			

ANGI

ANGI ENERGY SYSTEMS
305 W DELAVAN DR
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PH: 608-563-2800
www.angienergy.com

UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES .005-.015
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE: DISPENSER – 1-HOSE, 1-METER, 1" S-II W/NO SEQUENCING PID –

CUSTOMER: CLEAN ENERGY – ARLINGTON TRANSIT

PROJECT NO. 50340

DRN HMR | DATE 2/29/16 | SCALE NTS | DRAWING NO. A10-21-50340 | REV. A

CHK – | DATE – | SHT 1 | TOT 1

AUTOCAD WINDCHILL

SINGLE LANE REF. SCHEMATIC E45-00-107

VALVE TYPE	ITEM	PART NO.	ELECTRIC FITTING	QTY.
SOLENOID	43	(FC)391-00304	BUSHING-ELEC 3/4x1/2	1
	44	(FC)384-01422	NIPPLE-ELEC 1/2xCL	2
	81	(FC)384-03157	NIPPLE-ELEC 1/2x21/2	0

VALVE TYPE	ITEM	PART NO.	ELECTRIC FITTING	QTY.
ACTUATED	43	(FC)391-00304	BUSHING-ELEC 3/4x1/2	2
	44	(FC)384-01422	NIPPLE-ELEC 1/2xCL	2
	81	(FC)384-03157	NIPPLE-ELEC 1/2x21/2	1

NOTE: 1 OF EACH ITEM#19-22 AND ITEM#42, FUSES ARE TO BE SHIPPED WITH CONTROL PANEL AS SPARES.

NO.	QTY.	PART NUMBER	DESCRIPTION	LENGTH
1	1	403-07263	BOARD-S-2 MCDS INTERFACE PCB	
2	1	403-07261	BOARD-CPU COMPLETE S-2 DISPENS	
3	2	437-07229	TERMINAL-PLUG 2 PIN 5.08mm PIT	
4	3	437-07230	TERMINAL-PLUG 4 PIN 5.08mm PIT	
5	1	437-07231	TERMINAL-PLUG 5 PIN 5.08mm PI	
6	1	437-07232	TERMINAL-PLUG 6 PIN 5.08mm PIT	
7	1	437-07233	TERMINAL-PLUG 8 PIN 5.08mm PIT	
8	1	437-07234	TERMINAL-PLUG 10 PIN 5.08mm PI	
9	4	437-07235	TERMINAL-PLUG 12 PIN 5.08mm PI	
10	2	(FC)432-07257	RAIL-DIN 35MM TERMINAL	20.50"
11				
12	5	FC 432-07245	TERMINAL BLK-END CLAMP DIN	
13	1	400-07376	OUTLET-POWER AC SINGLE DIN RAI	
14	1	400-08151	BARRIER-ANALOG GALVANIC REPEATER	
15	1	400-07515	BARRIER-IS FOR CNG50 METER(902	
16	1	400-08150	BARRIER-DIGITAL, GALVANIC DUAL CHANNEL	
17	1	407-07242	POWER SUPPLY-24VDC 2A DIN RAIL	
18	8	441-07242	FUSE HOLDER-DIN RAIL 30A	
19	2	440-07249	FUSE-1/4 AMP 250V FAST ACTING	
20	4	440-07291	FUSE-.75 AMP 250V AGC FAST ACTI	
21	4	440-07268	FUSE-1.5 AMP 250V AGC FAST ACT	
22	4	440-07248	FUSE-1 AMP 250V FAST ACTING	
23	1	400-08297	RESISTOR-5K Ohm 25W WIRE WOUND	
24	1	FC 432-07321	TERMINAL-END COVER DUK 4/10	
25	3	FC 432-07319	TERMINAL BLK-UK5N 41AMP 800V	
26	1	490-07283	BREAKER-CIRCUIT 5A DIN CL498 1	
27	4	(FC)400-07253	STANDOFF-6-32x1/2 ML-FML HEX	
28	5	(FC)400-07387	STANDOFF-8-32x1 FML HEX	
29	1	920-07243	ENCL-12Hx18Wx6D MCDS&S-2 EXPF	*
30	2	(FC)432-07256	TERMINAL BLK-GROUND DIN RAIL	
31	1	(FC)705-07229	GROMMET-7/8IDx1 5/8ODx7/16 THK	
32	1	430-07238	TERMINAL-GROUND CONNECT	
33	4	(FC)	NUTS, #6-32 HEX	
34	4	(FC)	SCREWS, #6-32 3/8" ROUND HEAD SLOT	
35	16	(FC)	SCREWS, #8-32 3/8" ROUND HEAD ALLEN	
36	8	(FC)	WASHERS,#6 INTERNAL TEETH STAR LOCK	
37	16	(FC)	WASHERS,#8 INTERNAL TEETH STAR LOCK	
38	2	(FC)421-01140	BOX-OUTLET 3/4 C	
39	1	(FC)311-01620	PLUG-PIPE ELEC 3/4	
40	2	700-07647	HOLDER-BATTERY 9VOLT	
41	2	700-07646	BATTERY-9VOLT PANASONIC INDUST	
42	2	440-07276	FUSE-.13 AMP 250V FAST ACTING	
43			SEE CHART	
44			SEE CHART	
45				
46	1	(FC)374-00746	ELBOW-ELEC 1/2	
47	2	432-07395	TERMINAL BLOCK - PLUG 3 POS	

NO.	QTY.	PART NUMBER	DESCRIPTION	LENGTH
48	1	(FC)404-02167	SEAL OFF-1/2 MLxFML	
49	1	490-07241	RELAY W/BASE 120V 6A 35MM DIN	
50	1	400-07559	CAPACITOR-4700UF 25V	
51	1	400-07243	PROBE-TEMP 1/2 MNPT MCDS	
52	1	432-07355	TERMINAL BLK-32A 3POLE #12WIRE	
53	1	(FC)793-05055	TAG-TERMINAL TS1 1/2x1 BLK/WHT	
54	1	(FC)793-08011	TAG-WARNING/SUBSTITUTE.... MADE ON BRA	
55				
56	1	432-07357	TERMINAL BLK-32A 12POLE #12WIR	
57	1	(FC)793-05057	TAG-TERMINAL TS7 1/2x1 BLK/WHT	
58	1	400-07571	CABLE-SERIAL DISP CNTRL DB9 FM	
59	1	400-06131	HOOD-DBA FOR CTC COM CABLE (80	
60	1	400-07570	CONN-CRIMP MNPT DB9	
61	1	(FC)384-03262	NIPPLE-ELEC 3/4xCL	
62	2	490-07249	RELAY W/BASE 24V 6AMP PDT	
63	1	600-07566	PLATE-S-2 PHENOLIC BARRIER ISO	
64	1	FC 432-07360	TERMINAL BRIDGE-41AMP UK5N SCREW TYPE	
65				
66	4	(FC)400-07669	STANDOFF-1/4-20x3/4x3/8 MLxFML	
67	1	430-07251	TERMINAL-GROUND BAR ASSY 5CIRC	
68	1	600-07554	BRACKET-S-2 PHENOLIC BARRIER I	
69	2	(FC)791-07462	DECAL-GROUND SYMBOL 3/4DIA GRN	
70	2	(FC)432-07292	TERMINAL BLK-UKK5 2-TIER 32AMP	
71	1	(FC)432-07293	TERMINAL-END COVER UKK5 FOR 2-	
72	4	400-08174	BARRIER-1CH OUTPUT, GALVANIC PHOENIX	
73	1	FC 432-07375	TERMINAL MARKER-UC-TM 6 UNPRINTED 6.2	
74	1	600-07556	PLATE-BACK 18x12 S-II DISP EXP	
75	1	FC 400-07712	PLATE-ISOLATION TERMINAL STRIP	
76				
77	1	FC 793-08009	TAG-FUSE CHART	
78	1	403-07291	BOARD CIRCUIT S-II, COMM EXPANSION	
79	1	E45-10-024	CABLE POWER COMM EXPANSION BD	
80	1	***-*****	SEE P6/7 FOR BATT PLATE DRILL DETAILS	
81			SEE CHART	
82	1	FC 793-10001	TAG-TORQUE 5CIRCUIT GROUND BAR	
83	1	FC 793-10032	TAG-TORQUE PHOENIX BARRIER	
84	1	FC 793-10009	DECAL-PHOENIX UK5N TERMINAL TORQUE	
85	1	FC 793-08003	TAG-SERIAL P&ID	
86				
87	1	791-07506	DECAL-ELECTRICAL PANEL-WARNING-HAZARD	
88	1	FC 791-07508	DECAL-METLAB SERIALIZED 1x2-1/2 w/BLK TEXT	
89	1	FC 793-08024	DECAL-CLASSIFICATION FOR ELECTRICAL SHO	
90	1	FC 793-10036	TAG-TORQUE PHOENIX LED/SOLENOID DRIVER	
91	1	FC 793-10037	TAG-TORQUE PHOENIX ANALOG REPEATER	
92	1	FC 793-10003	TAG-TORQUE Phoenix UKK5	
93	2	FC 793-10008	TAG-DIN GROUND TORQUE BLK/WHT	

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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UNLESS OTHERWISE SPECIFIED

BREAK SHARP EDGES .005-.015

ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

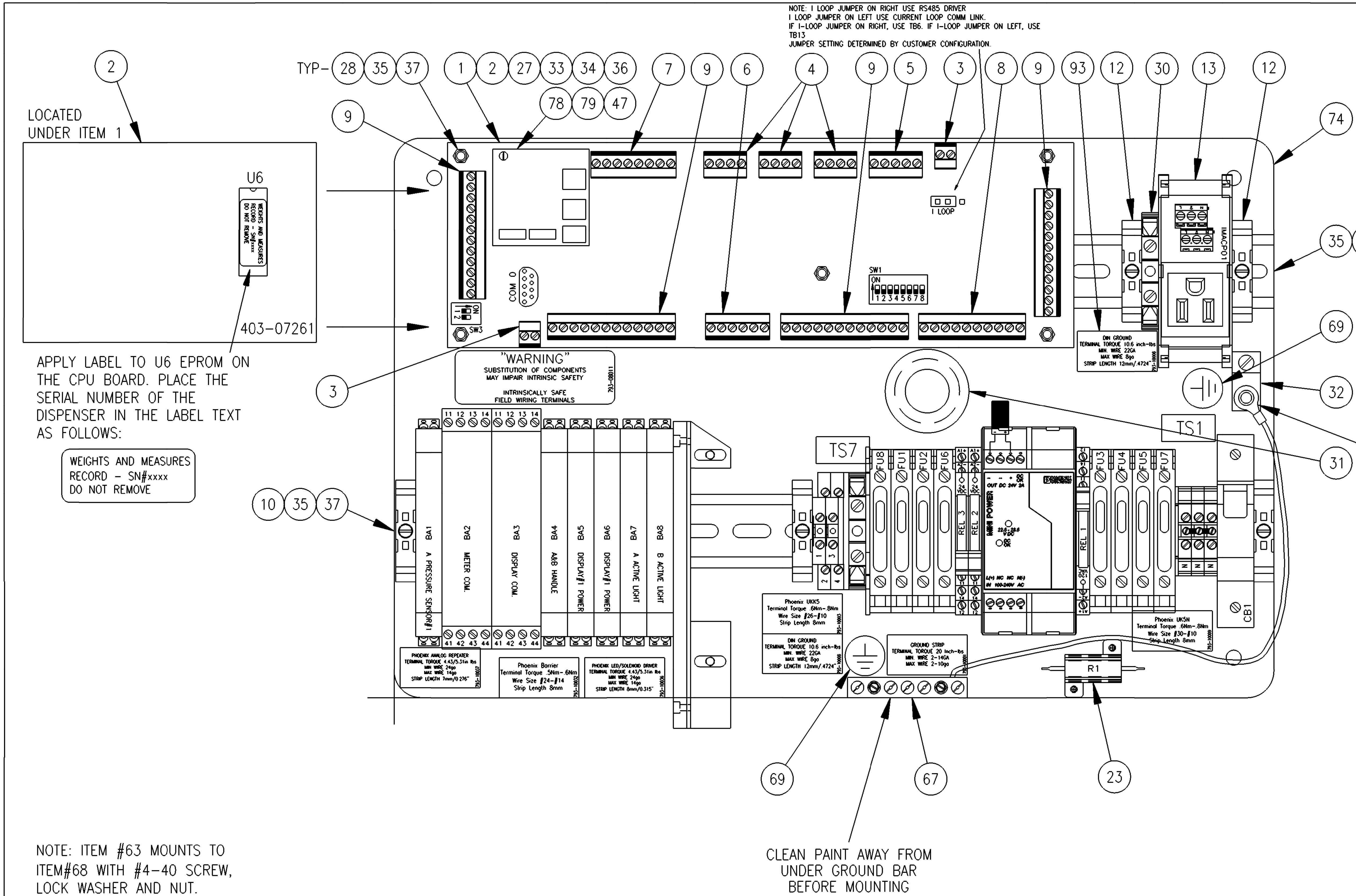
TITLE CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START/STOP PUSHBUTTONS/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

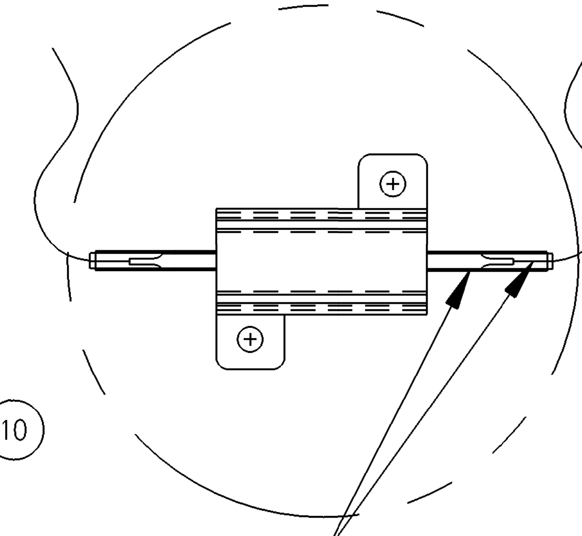
CUSTOMER | PROJECT NO.

DRN NDA | DATE 01/06/14 | SCALE 1:3 | DRAWING NO. N20-30-140 | REV. -

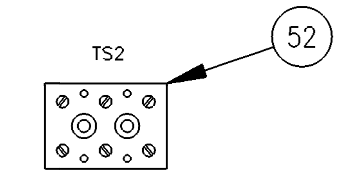
CHK | DATE | SHT 1 | TOT 7

AUTOCAD WINDCHILL

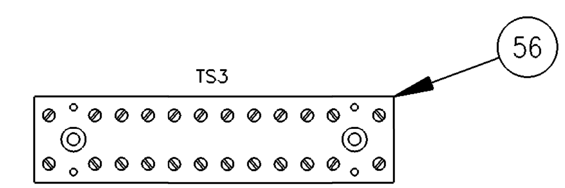




INSTALL #12 GREEN WIRE BETWEEN GROUND LUG AND EQUIPMENT GROUND TERMINAL STRIP USE UL APPROVED RING TERMINAL



MOUNTS HORIZONTALLY ON INSIDE RIGHT WALL OF ENCLOSURE



NOTE: ITEM #63 MOUNTS TO ITEM#68 WITH #4-40 SCREW, LOCK WASHER AND NUT. FASTEN ITEM#68 TO PANEL WITH #8-32 SCREWS

SINGLE LANE REF. SCHEMATIC E45-00-107

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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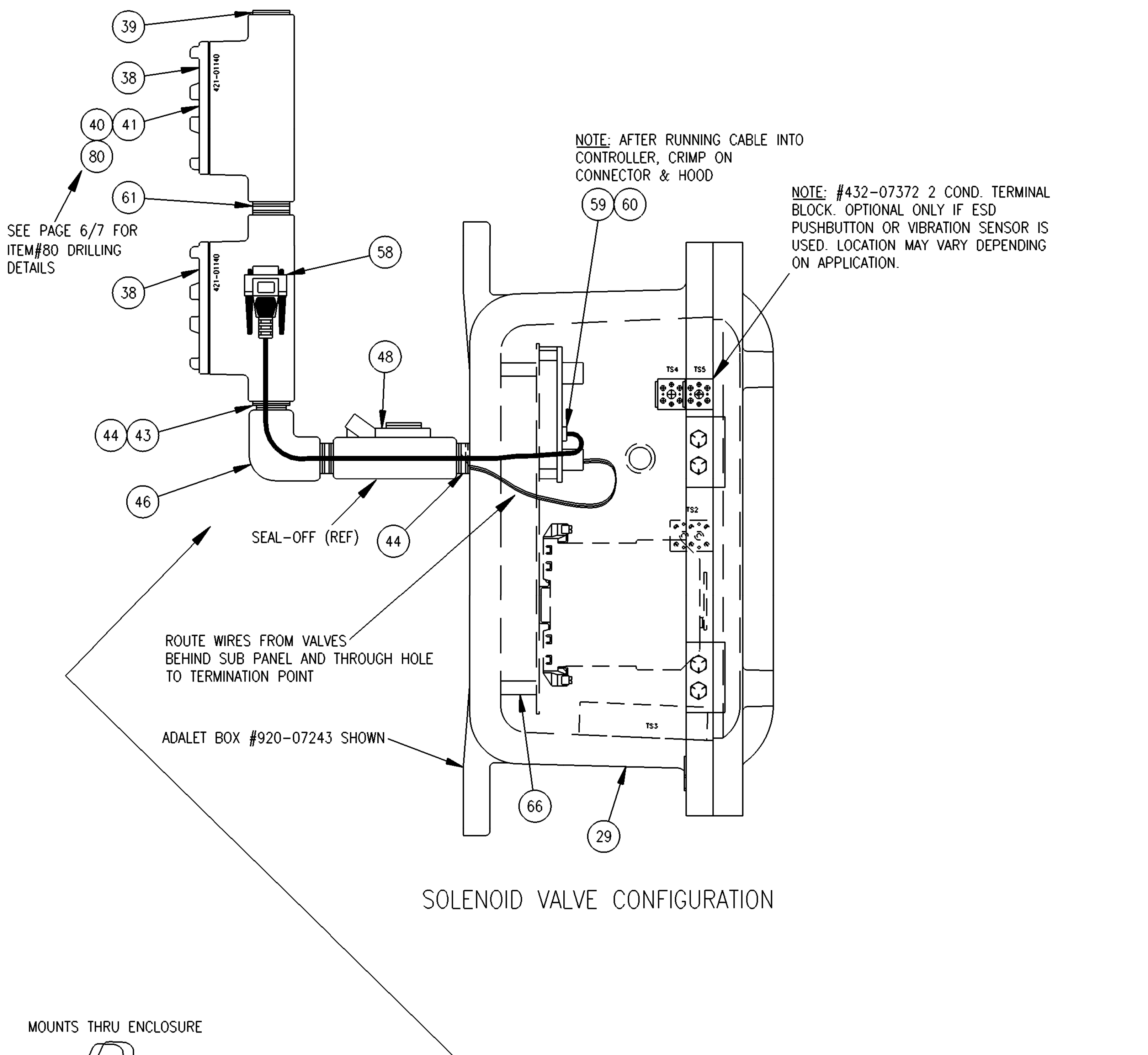
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

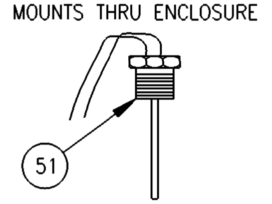
TITLE CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START/STOP PUSHBUTTONS/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER			PROJECT NO.	
DRN NDA	DATE 01/06/14	SCALE 1:2	DRAWING NO.	REV.
CHK	DATE	SHT 2 TOT 7	N20-30-140	-

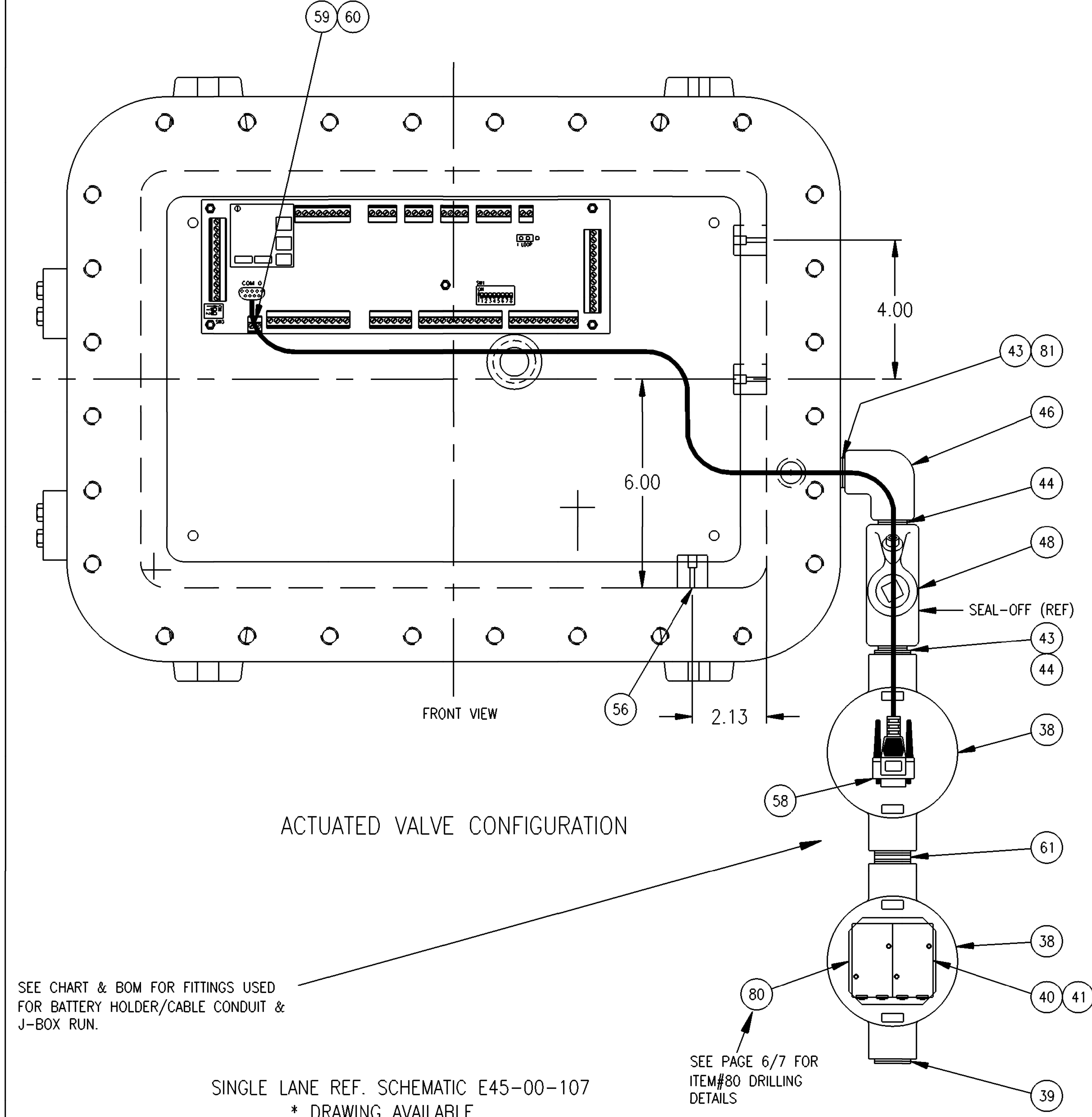
AUTOCAD WINDCHILL



SOLENOID VALVE CONFIGURATION



**NOTE: BATTERY HOLDER/CABLE CONDUIT & J-BOX RUN ARE SHOWN IN 2 CONFIGURATIONS. THERE MAY BE OTHER CONFIGURATIONS DEPENDING ON DISPENSER LAYOUT.



ACTUATED VALVE CONFIGURATION

SEE CHART & BOM FOR FITTINGS USED FOR BATTERY HOLDER/CABLE CONDUIT & J-BOX RUN.

SINGLE LANE REF. SCHEMATIC E45-00-107
* DRAWING AVAILABLE

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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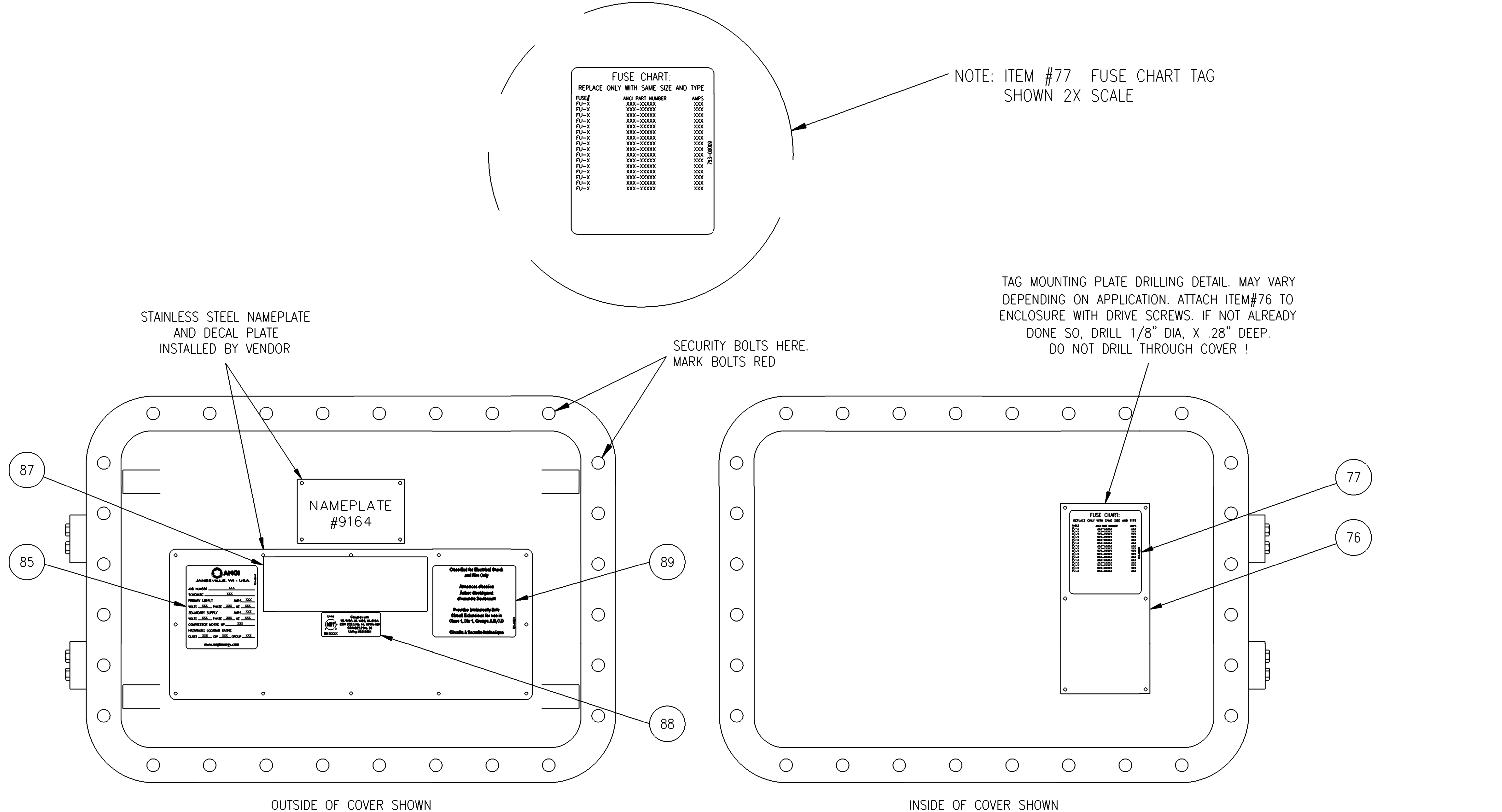
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START/STOP PUSHBUTTONS/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER			PROJECT NO.
DRN NDA	DATE 01/06/14	SCALE 1:4	DRAWING NO. N20-30-140
CHK	DATE	SHT 3 TOT 7	REV. -

AUTOCAD WINDCHILL



REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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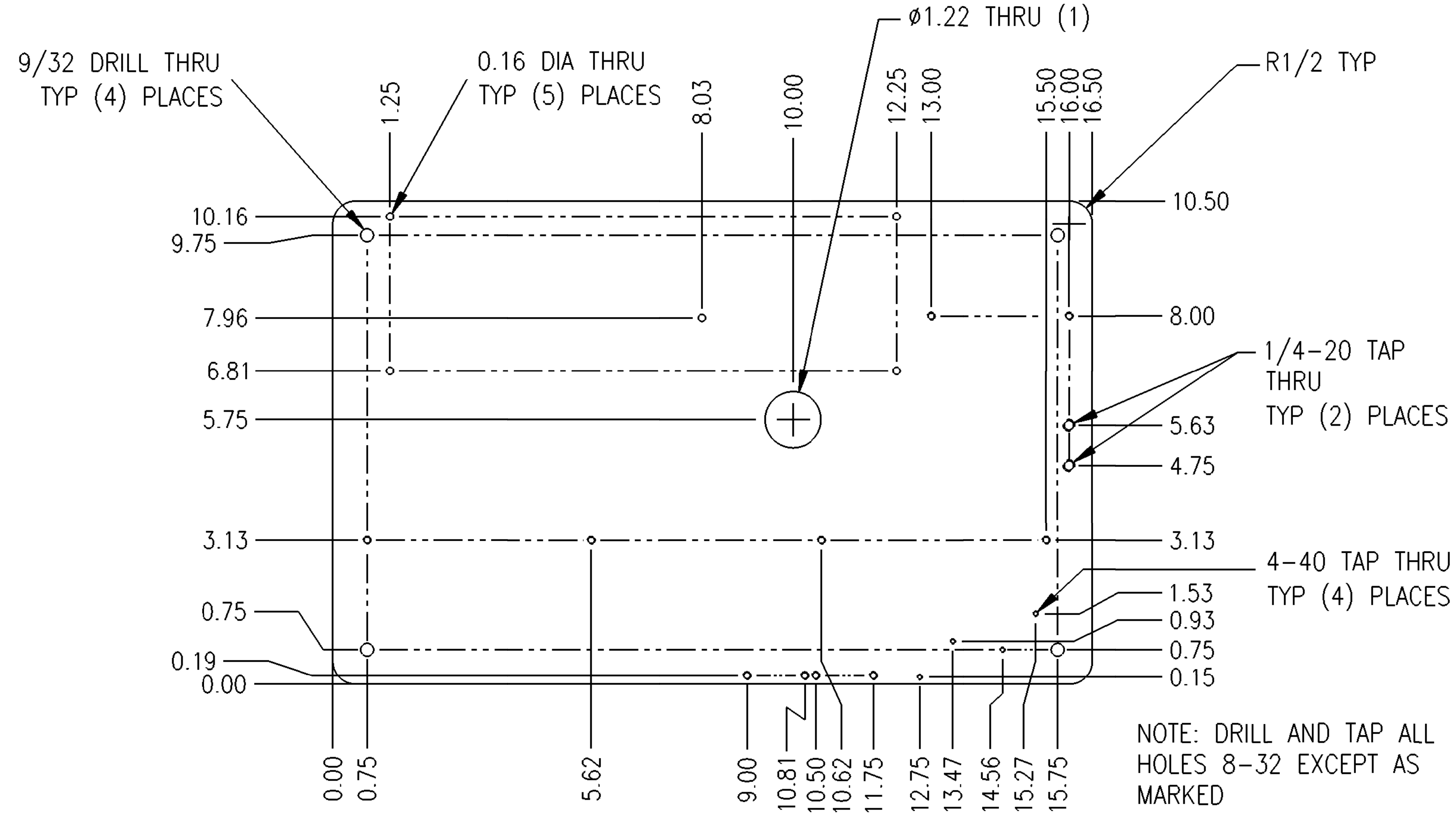
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

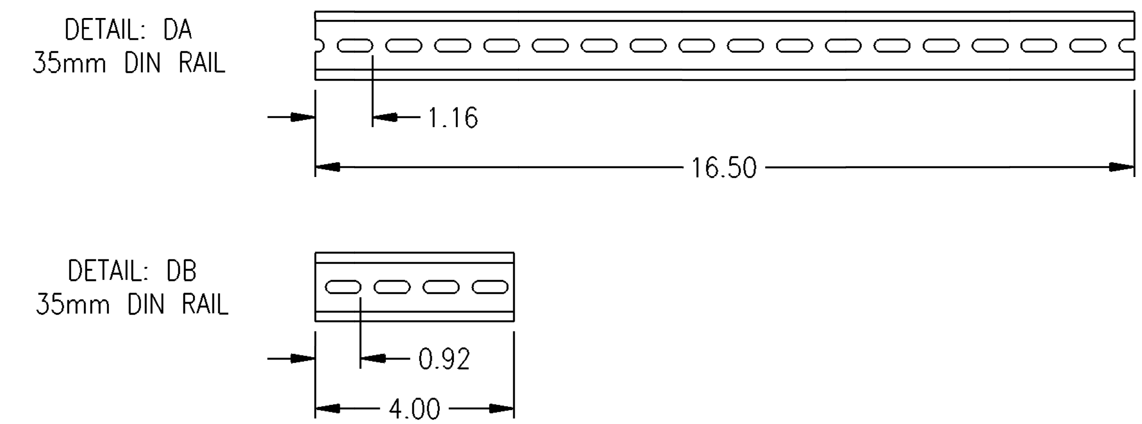
TITLE CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START/STOP PUSHBUTTONS/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

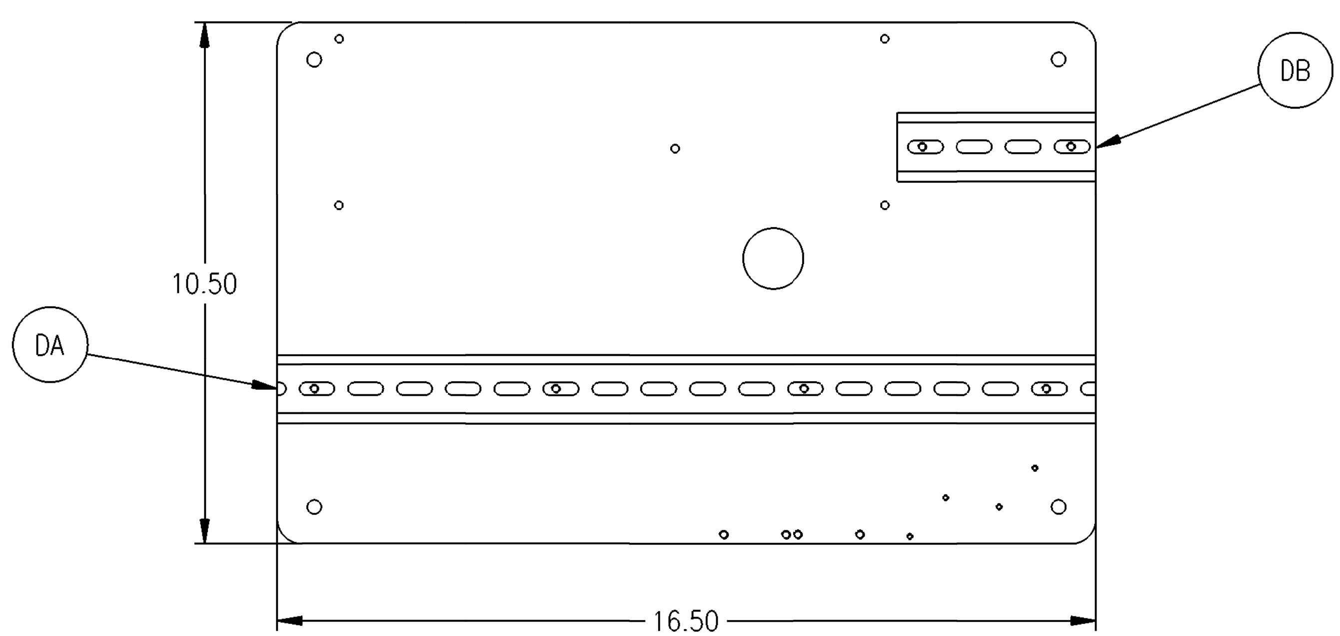
CUSTOMER			PROJECT NO.	
DRN NDA	DATE 01/06/14	SCALE 1:4	DRAWING NO. N20-30-140	REV. -
CHK	DATE	SHT 4 TOT 7		

AUTOCAD WINDCHILL



NOTE: DRILL AND TAP ALL HOLES 8-32 EXCEPT AS MARKED





REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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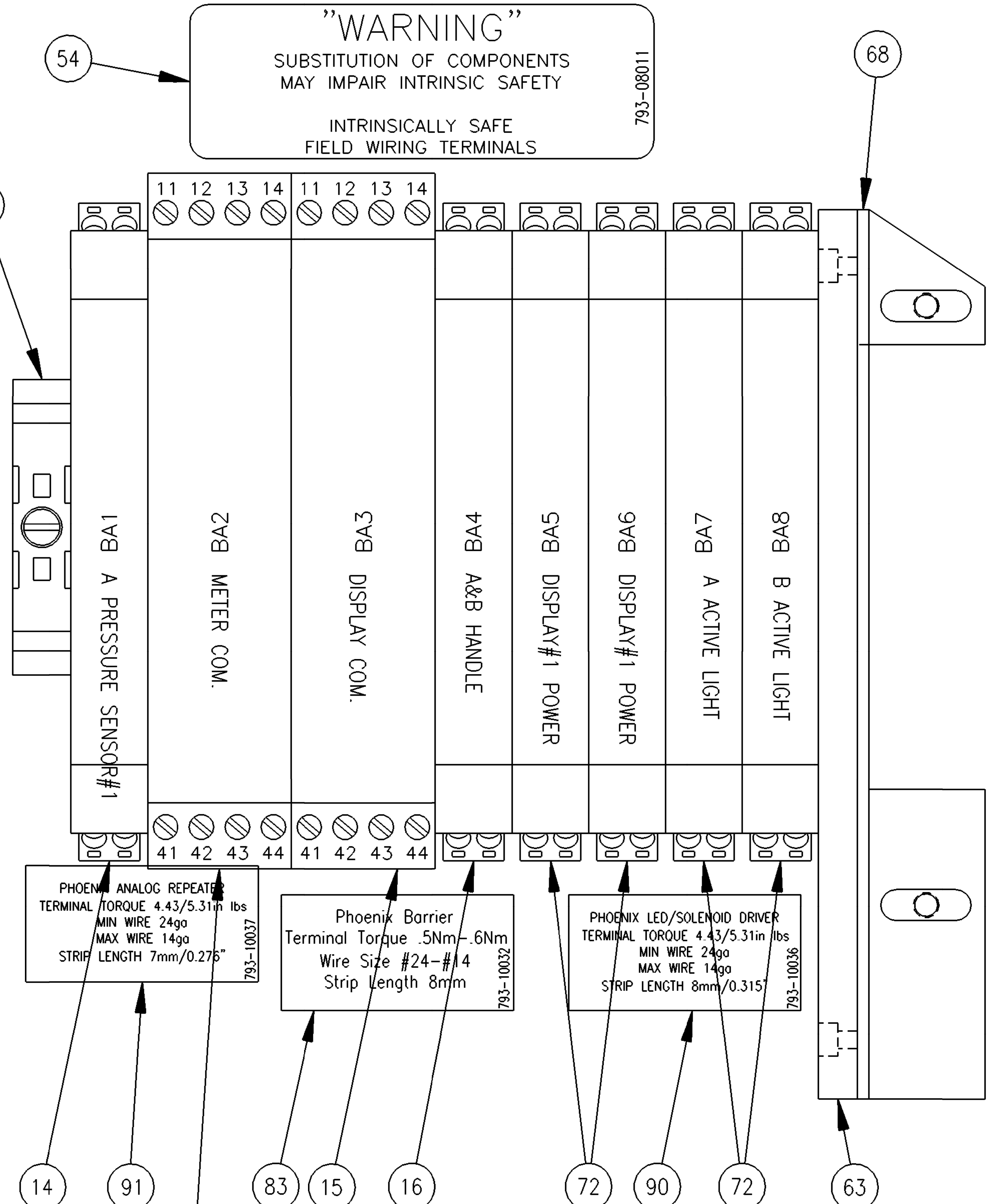
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

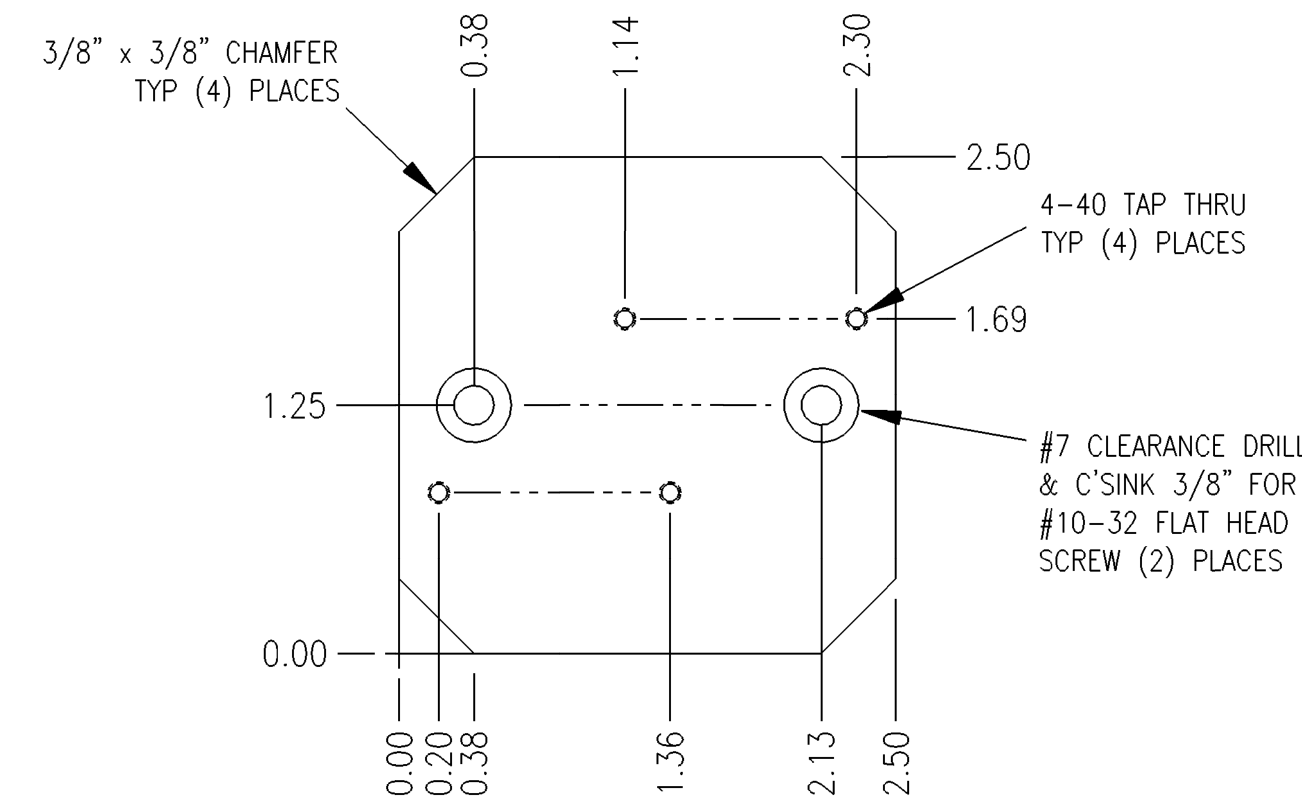
TITLE CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START/STOP PUSHBUTTONS/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER			PROJECT NO.
DRN NDA	DATE 01/06/14	SCALE 1:4	DRAWING NO. N20-30-140
CHK	DATE	SHT 5 TOT 7	REV. –

AUTOCAD WINDCHILL



BA2 IS INCLUDED WITH THE
FLOW METER (902-07240)



ITEM#80 DRILLING DETAILS

MATERIAL: 16 GAUGE
GALVANIZED STEEL

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

ANGI

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UNLESS OTHERWISE SPECIFIED

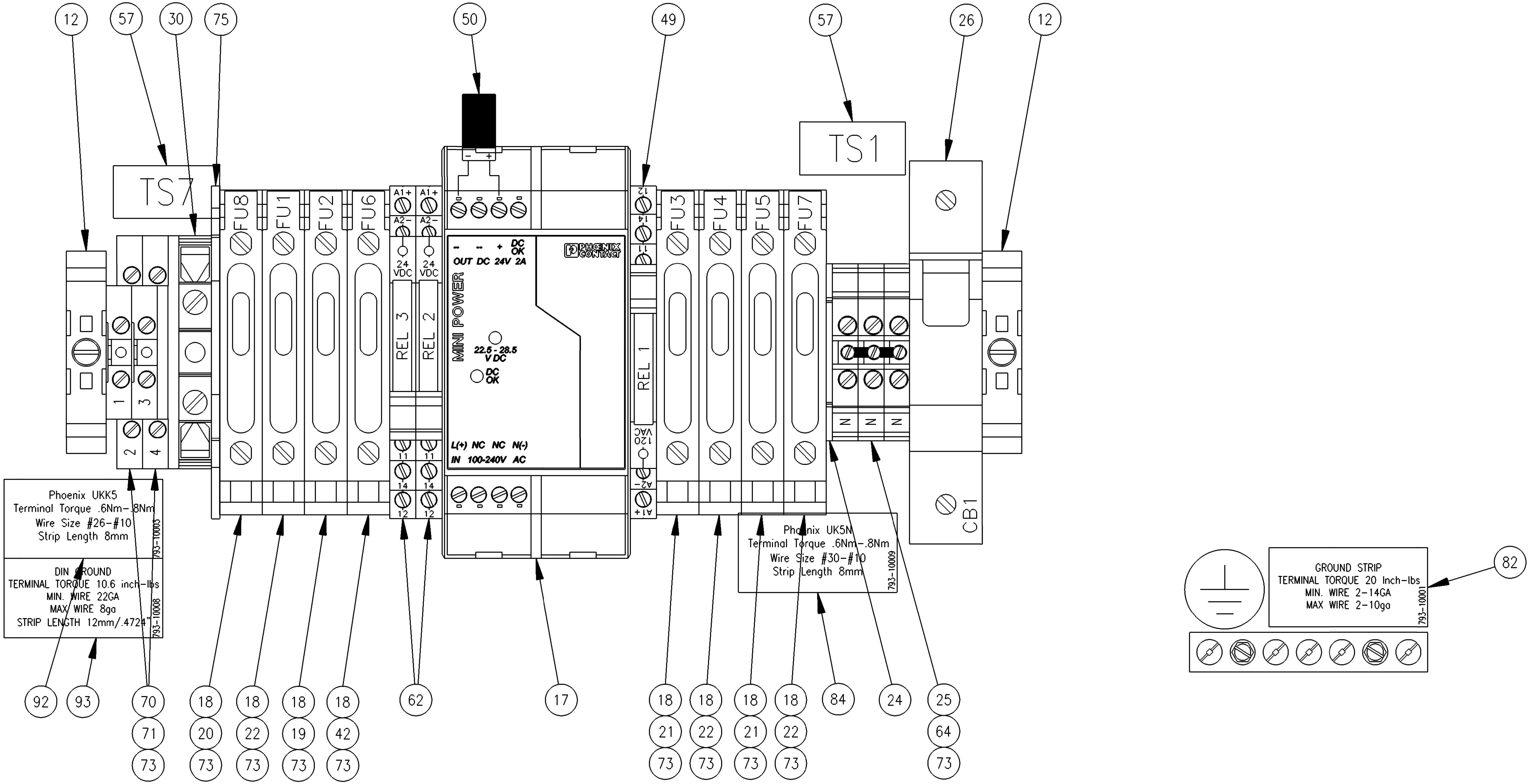
BREAK SHARP EDGES .005-.015
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START/STOP PUSHBUTTONS/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER			PROJECT NO.	
DRN NDA	DATE 01/06/14	SCALE 1:1	DRAWING NO. N20-30-140	REV. –
CHK	DATE	SHT 6 TOT 7		

AUTOCAD WINDCHILL



REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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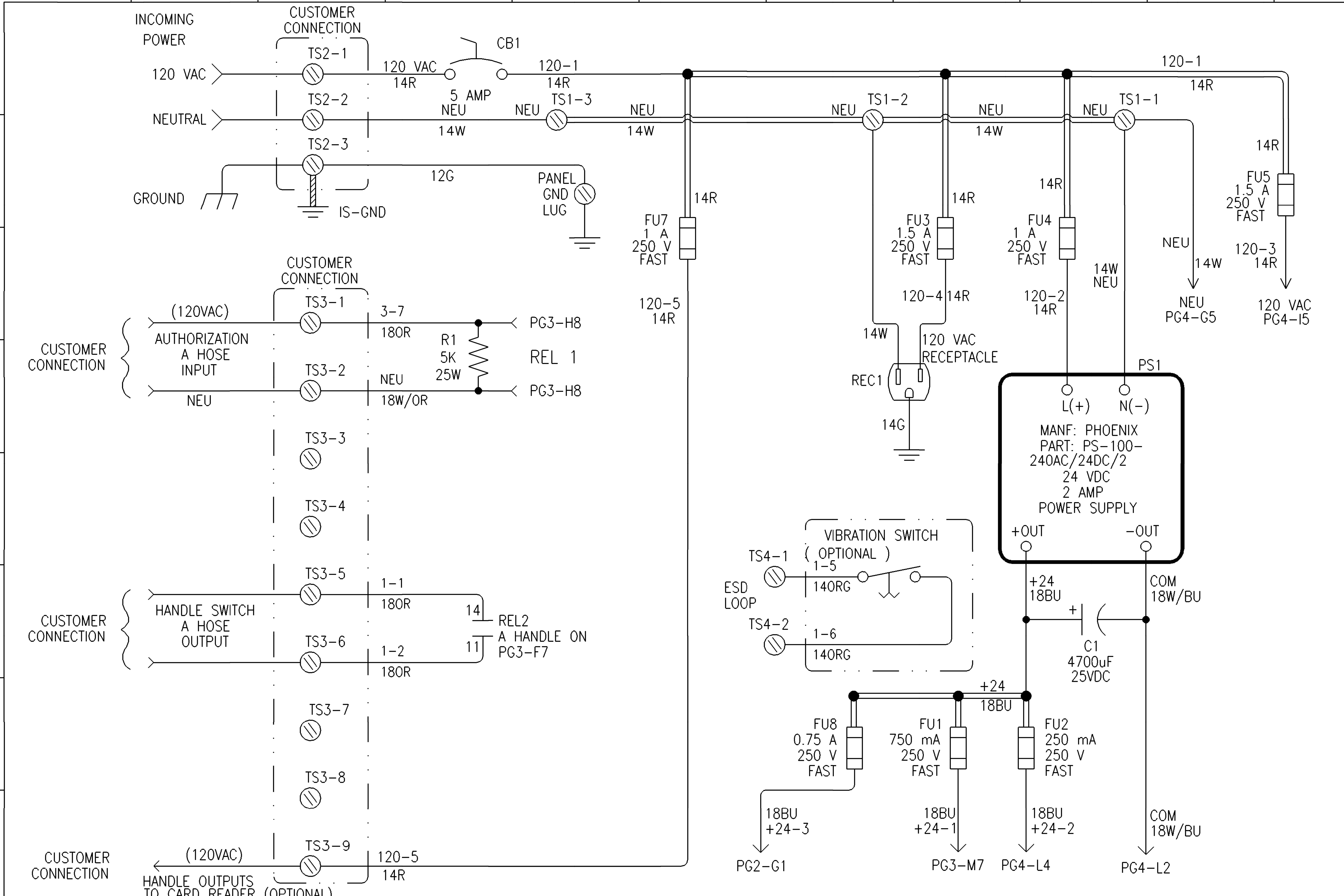
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START/STOP PUSHBUTTONS/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER			PROJECT NO.
DRN NDA	DATE 01/06/14	SCALE 1:1	DRAWING NO. N20-30-140
CHK	DATE	SHT 7 TOT 7	REV. –

AUTOCAD WINDCHILL



PG3-H8 PAGE REFERENCE
- VERTICAL LOCATOR
- HORIZONTAL LOCATOR
- PAGE NUMBER
- PAGE ABBREVIATION

PAGE REFERENCES TRANSFER WIRE NUMBERS BETWEEN PAGES AND IDENTIFY THE LOCATION OF THE WIRE'S DESTINATION

C1-1-1 CABLE NUMBERING
- SEGMENT NUMBER (IF MORE THAN ONE)
- CABLE NUMBER
- PAGE OF ORIGIN
- CABLE INDICATION

FUSE CHART

FUSE #	ANGI PART NUMBER	AMPS
FU-1	440-07291	0.75
FU-2	440-07249	.25
FU-3	440-07268	1.5
FU-4	440-07248	1
FU-5	440-07268	1.5
FU-6	440-07276	.125
FU-7	440-07248	1
FU-8	440-07291	0.75

ASSEMBLY#N20-30-140

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES .005-.015
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

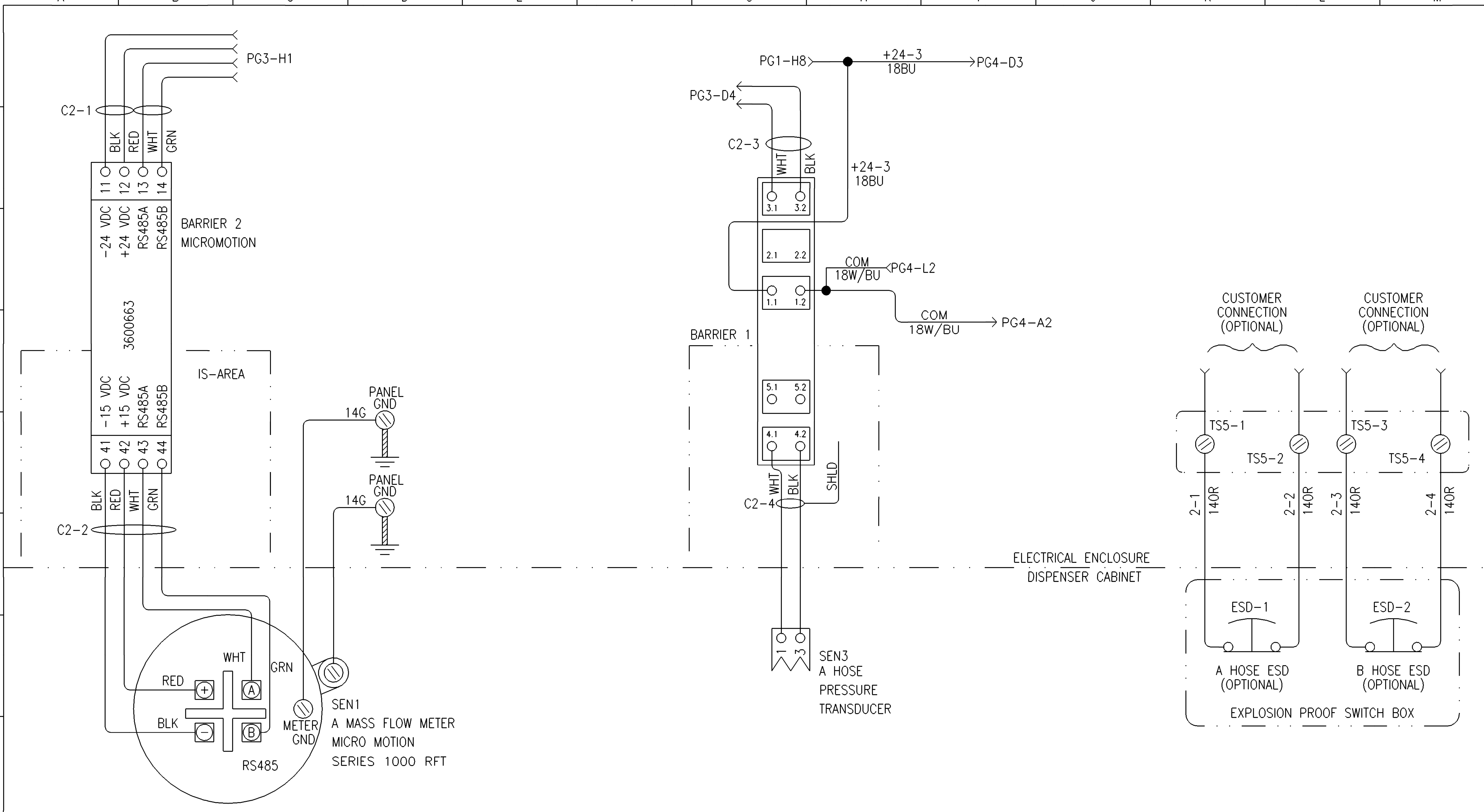
TITLE: CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START PUSHBUTTON/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER | PROJECT NO.

DRN NDA | DATE 03/14/16 | SCALE 1:1 | DRAWING NO. E45-00-107 | REV. -

CHK | DATE | SHT 1 | TOT 9

AUTOCAD WINDCHILL



REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

ANGI

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ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
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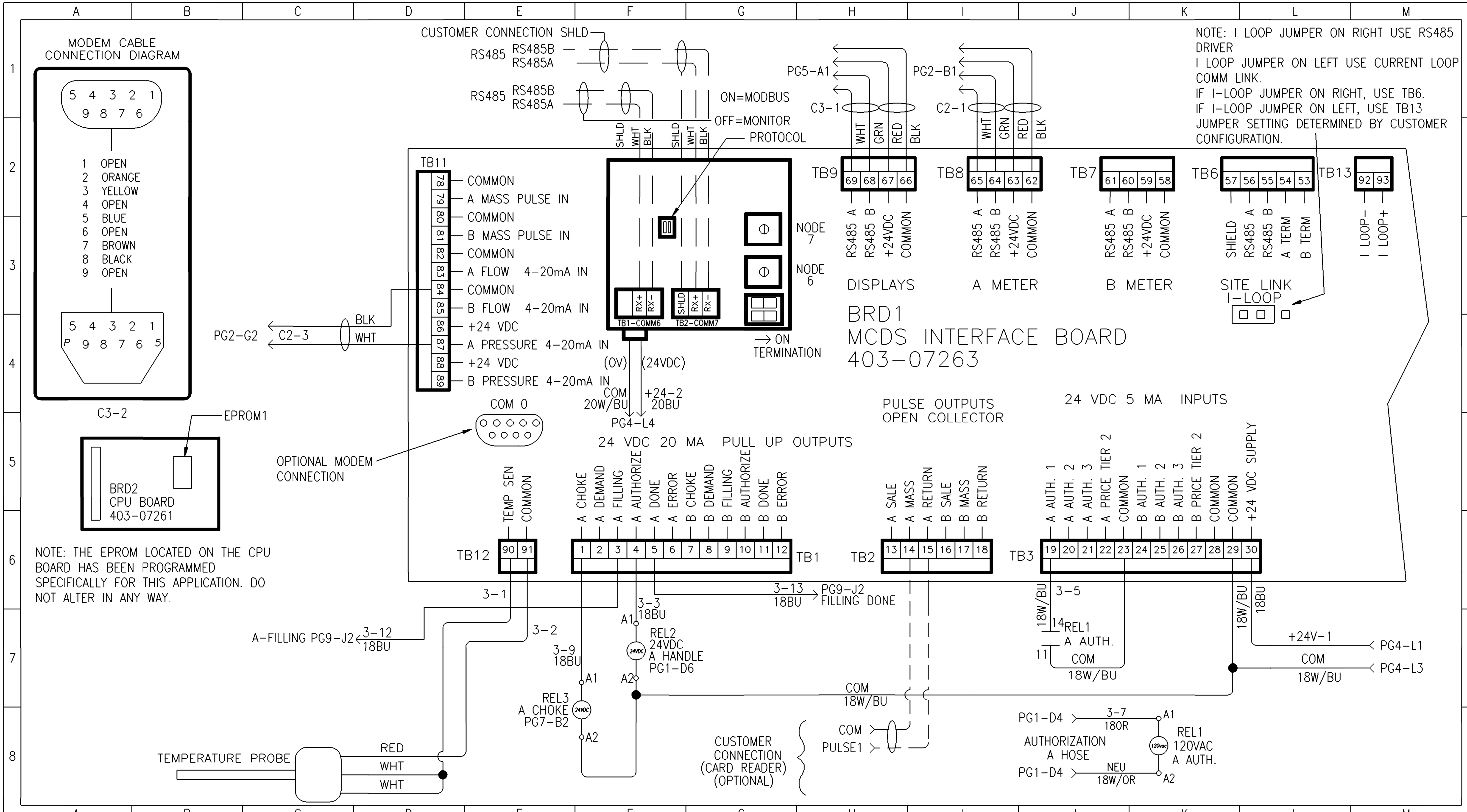
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE: CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START PUSHBUTTON/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER		PROJECT NO.	
DRN NDA	DATE 03/14/16	SCALE 1:1	DRAWING NO. E45-00-107
CHK	DATE	SHT 2 TOT 9	REV. -

AUTOCAD WINDCHILL



REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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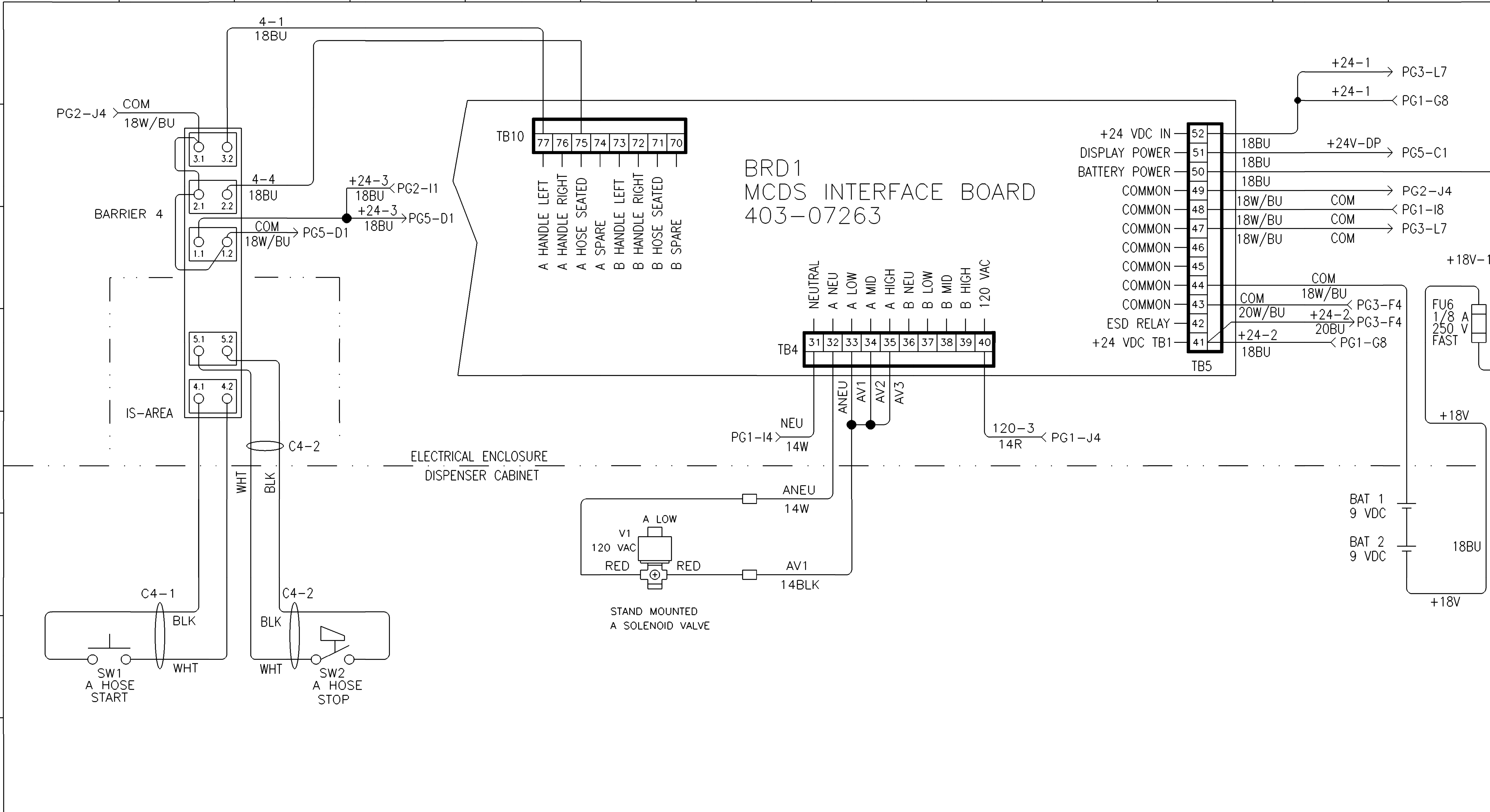
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE: CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START PUSHBUTTON/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER | PROJECT NO.

DRN	DATE	SCALE	DRAWING NO.	REV.
NDA	03/14/16	1:1	E45-00-107	-
CHK	DATE	SHT 3	TOT 9	

AUTOCAD WINDCHILL



REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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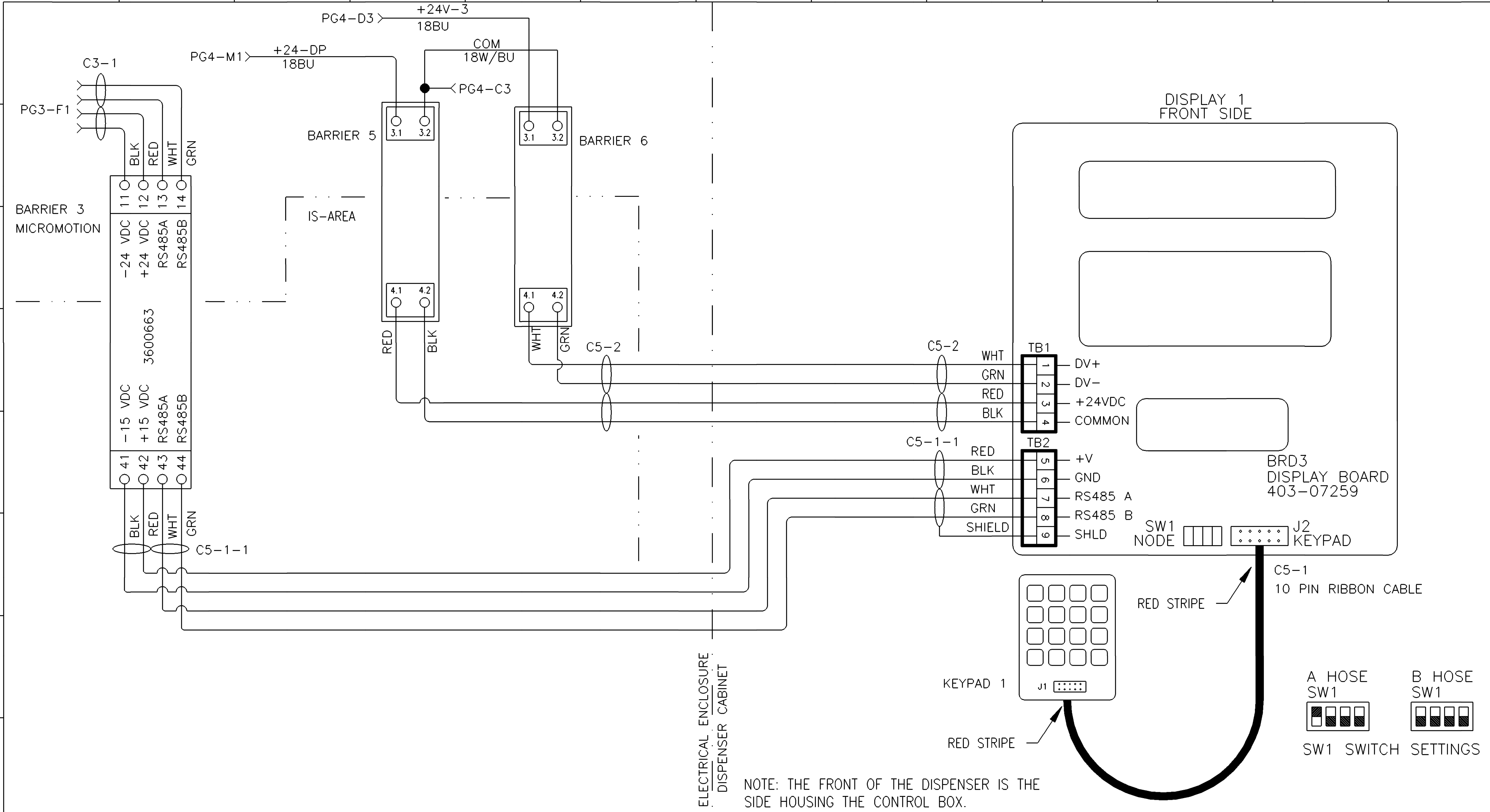
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE: CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START PUSHBUTTON/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER			PROJECT NO.	
DRN NDA	DATE 03/14/16	SCALE 1:1	DRAWING NO.	REV.
CHK	DATE	SHT 4 TOT 9	E45-00-107	–

AUTOCAD WINDCHILL



REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

ANGI

ANGI ENERGY SYSTEMS
305 W DELAVAN DR
JANESVILLE, WI 53546
PH: 608-563-2800
www.angienergy.com

UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES .005-.015
ALL DIMENSIONS IN INCHES

FRACTIONAL	± 1/8
TWO PLACE DECIMAL	±.010
THREE PLACE DECIMAL	±.005
ANGLES	±1°

TITLE: CNTRLR-DISP-S-2 ELEC. PANEL 1 HOSE, 1 METER, 1 DISP/START PUSHBUTTON/LIGHTS (CHOKE SIGNAL), SINGLE BANK, 120 VAC

CUSTOMER				PROJECT NO.	
DRN NDA	DATE 03/14/16	SCALE 1:1		DRAWING NO. E45-00-107	REV. -
CHK	DATE	SHT 5	TOT 9		

AUTOCAD WINDCHILL

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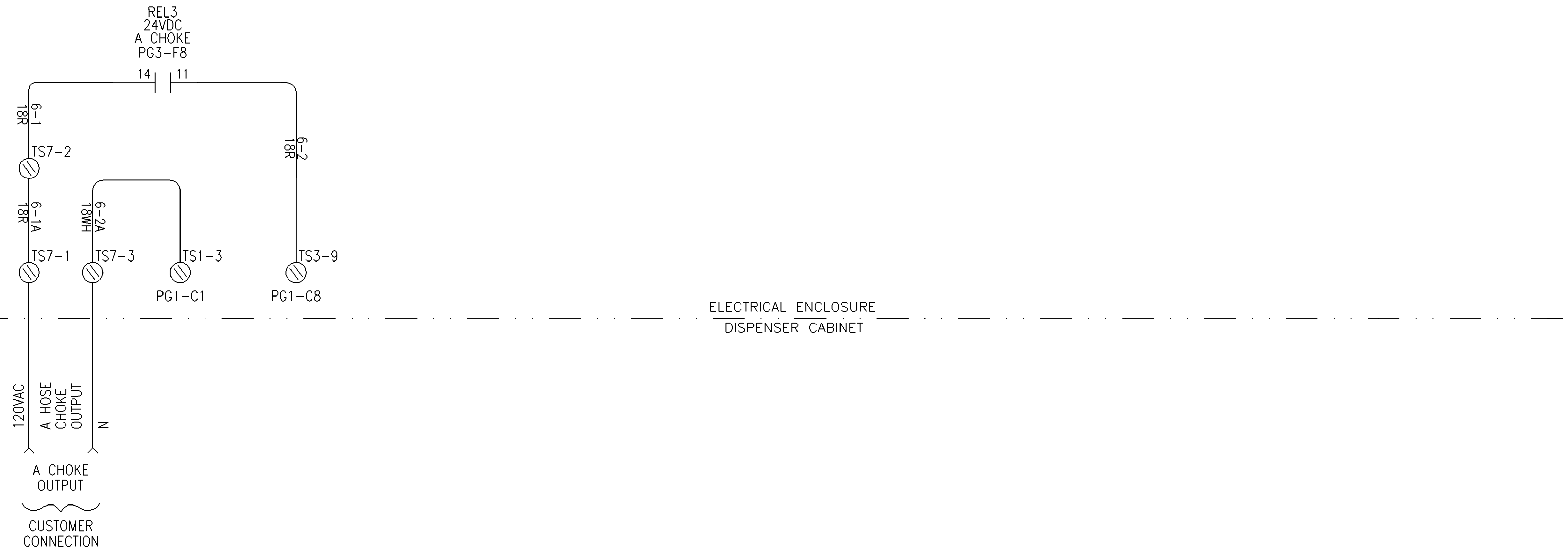
CUSTOMER			PROJECT NO.	
DRN NDA	DATE 03/14/16	SCALE 1:1	DRAWING NO. E45-00-107	REV. –
CHK	DATE	SHT 6 TOT 9		

AUTOCAD WINDCHILL



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CUSTOMER			PROJECT NO.	
DRN NDA	DATE 03/14/16	SCALE 1:1	DRAWING NO.	REV.
CHK	DATE	SHT 7 TOT 9	E45-00-107	-

AUTOCAD WINDCHILL

XXXXX/SER0XXXXX

JOB NUMBER

SERIAL NO.

ANGI
JANESVILLE, WI - USA
793-08003

JOB NUMBER	XXXXX/SER0XXXXX
SCHEMATIC	E45-00-107
PRIMARY SUPPLY	AMPS 5
VOLTS 120VAC	PHASE 1 HZ 60
SECONDARY SUPPLY	AMPS 2.0
VOLTS 24VDC	PHASE N/A HZ N/A
MOTOR HP N/A	FLA N/A
ENCL. TYPE	4
SHORT CIRCUIT CURRENT RATING	5KAIC
HAZARDOUS LOCATION RATING	
CLASS I DIV 1	GROUP B,C&D

www.angienergy.com

CABLE NO.	PART NO.	DESCRIPTION
C9-7	122-00357	ALPHA 2401C, 2 WIRE
C9-8	122-00357	ALPHA 2401C, 2 WIRE
C5-2	122-07231	BELDEN 8723, 4 WIRE
C5-1	120-07244	RIBBON CABLE, 10 WIRE
C5-1-1	122-07231	BELDEN 8723, 4 WIRE
C4-2	122-00357	ALPHA 2401C, 2 WIRE
C4-1	122-00357	ALPHA 2401C, 2 WIRE
C3-2	122-07231	BELDEN 8723, 4 WIRE
C3-1	122-07231	BELDEN 8723, 4 WIRE
C2-4	122-00357	ALPHA 2401C, 2 WIRE
C2-3	122-00357	ALPHA 2401C, 2 WIRE
C2-2	122-07231	BELDEN 8723, 4 WIRE
C2-1	122-07231	BELDEN 8723, 4 WIRE

REV	DATE/BY	DESCRIPTION	REV	DATE/BY	DESCRIPTION

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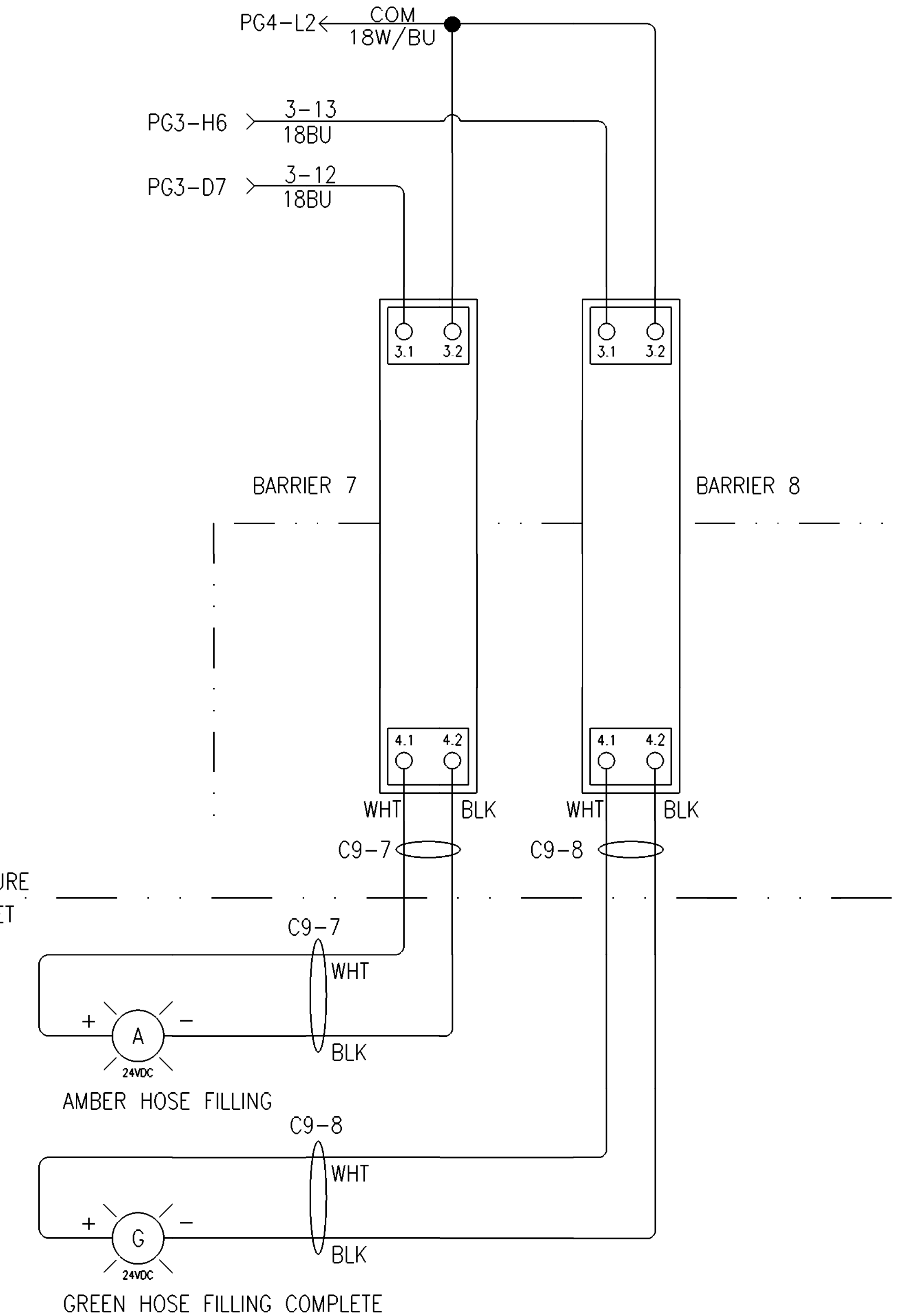
CUSTOMER | PROJECT NO.

DRN NDA | DATE 03/14/16 | SCALE 1:1 | DRAWING NO. E45-00-107 | REV. –
CHK | DATE | SHT 8 | TOT 9

AUTOCAD WINDCHILL



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CUSTOMER

PROJECT NO.

DRN	DATE	SCALE	DRAWING NO.	REV.
NDA	03/14/16	1:1	E45-00-107	-
CHK	DATE	SHT 9 TOT 9		

AUTOCAD WINDCHILL