Remote Electronics Unit

April 1989

Transmitter Instruction Manual

Micro Motion

FISHER-ROSEMOUNT Managing The Process Better

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MICRO MOTION

1 The Remote Electronics Unit

1.1 General Description

The Remote Electronics Unit (REU) is a mass flow transmitter. The REU, in conjunction with a Micro Motion Model D mass flow sensor, form a complete flowmeter. The REU can be located up to 500 feet (153 meters) from the flow sensor.

Factory calibration is directly traceable to the U.S. National Bureau of Standards, and because the meter measures mass flow directly, this calibration is unaffected by changing fluid properties.

The REU is field-ready and requires only simple adjustment to set the zero at the installation. Should the customer wish to change meter applications, the REU's printed circuit boards can be easily adjusted or replaced in the field.

1.2 Theory of Operation

Figure 1-1 shows the REU and identifies the circuit boards within it. Figure 1-2 shows the circuitry flow diagram from the sensor and through the REU. The REU is fuse-protected on the input voltage board against power surges from the 100, 115, or 220 VAC power supply and against shorts in the REU. The AC supply voltage is then routed through an encapsulated transformer which reduces it to approximately 25 VAC in preparation for conversion to DC voltages.

When the power supply is 12 to 30 VDC, the input voltage board converts the DC voltage to an AC voltage. This voltage is then routed through the transformer prior to conversion back to DC voltages. Fuses are provided on both the DC and AC portions of the circuit board.

On the drive board, the 25 VAC from the transformer is directed through a diode bridge, rectified, and regulated to ±15 VDC. On the signal board, precision voltage regulators provide the +10 VDC and -10 VDC used as reference voltages.

The safety board provides a safety barrier between the REU and the sensor. The intrinsically safe board consists of a network of zener diodes and resistors which limit both the voltage and current of the signals. This eliminates the need for external barriers when wiring into "non-safe" areas.

The drive and signal boards detect the signal from the left position detector to regulate the drive amplifier. This controls the amplitude at which the sensor tubes vibrate. The output is connected to the drive coil in the sensor. A positive feedback loop is converted back to a force via the drive coil to reinforce the sensor tubes' natural frequency of vibration.

Incoming flow signals from the left and right position detectors are generated by the motion of the sensor tubes. The signal board determines the angle of twist by time integrating the two position detector signals to produce the flow signal. It does this by comparing the left signal to a -VDC reference and the right signal to a +VDC reference. The action of the multiplexer/demultiplexer determines the time integration of the two signals. The phasing is determined by the left position detector. The resultant flow signal is sampled, filtered, and amplified before being routed to the drive board.

Figure 1-3 is a wave diagram depicting signal processing as performed by the logic circuitry under flow and no flow conditions. The sensor tube is visualized from the end viewpoint as right and left legs of fluid flow (incoming and outgoing). The magnetic position detectors produce the rectangular frequency waves used for measurement. The right and left sensor signals are altered electronically (as represented by broad R and narrow L waves) to avoid signal overlap.

Thus, when the sensor tube passes the midpoint during the upstroke, the right sensor signal is always detected before the left. Conversely, when the tube passes the midpoint during the downstroke, the left signal is always detected before the right. Again, this is due to the electronic alteration of the signals because the sensor tube leg containing outgoing fluid always crosses the midpoint first during both the up and downstrokes (as in Figure 1-4b).

The difference wave D signals the differences between the times at which the right and left sensor-tube legs pass the midpoint during the up versus the downstrokes. These pulse differences are sent to the linear integrator and integrated negatively for the upstroke pair and positively for the downstroke pair. When there is no flow through the sensor tube, the difference (wave D) pulse widths are equal in both directions. However, when fluid flows through the sensor tube there is a counterclockwise twist on the upstroke and a clockwise twist on the downstroke. This causes the two sensor-tube legs to cross the midpoint closer together in time during the upstroke and further apart during the downstroke (relative to "zero flow" conditions) so the difference pulse widths (wave D) are no longer equal.

Since the integrated slopes are both equal and constant, normal, forward flow-conditions result in a net positive integrator output which is sent to a sample-and-hold circuit. The integrator output is sampled just before the reference level is reset and is in the hold mode for the rest of the cycle. This signal is linearly proportional to the time difference and thus, to the mass flow rate.

When the flow direction is reversed, the forces and direction of twist are reversed and the integrator output is negative rather than positive. The mass flowmeter can therefore measure reverse direction flow as easily as forward flow.

The flow rate signal is routed to a voltage-to-frequency converter on the drive board. The drive board uses the signal from the temperature sensor to control the scaling of this conversion. It compensates for the temperature effects on the sensor tubes' modulus of rigidity (shear modulus). The flow direction determines the polarity of the flow signal. The zero indicator light receives a direct pulse output from the drive board. At "zero flow", the light responds directly to the primary zero adjustment.

The flow direction signal and the compensated flow-rate signal are sent to the isolation board. The isolation board contains two optical couplers which receive the flow rate and direction signals. The couplers reproduce the two pulse inputs as corresponding pulse outputs for further processing. The couplers effectively isolate the output signals from the rest of the REU electronics and sensor. This prevents current flow from the safe area into the hazardous area. The "breakdown" voltage rating is 1300 volts. Additionally, each coupler is protected from reverse surges by a zener diode and a fuse.

The output to the frequency and/or analog output boards is a scaled 0-10,000 Hz signal proportional to mass flow rate. The frequency board scales the output signal to interface with external equipment. The analog board converts the frequency signal to an analog signal prior to sending it to external equipment.

Once the logic circuitry processes the signal, a 0-10,000 Hz pulse output is sent to the frequency and/or analog output boards. The frequency board scales the pulse signal for digital rate display, control, and totalizing. The analog board converts the pulse signal to an analog voltage or current signal.

Schematic drawings for the various circuit boards are shown in Appendix III.

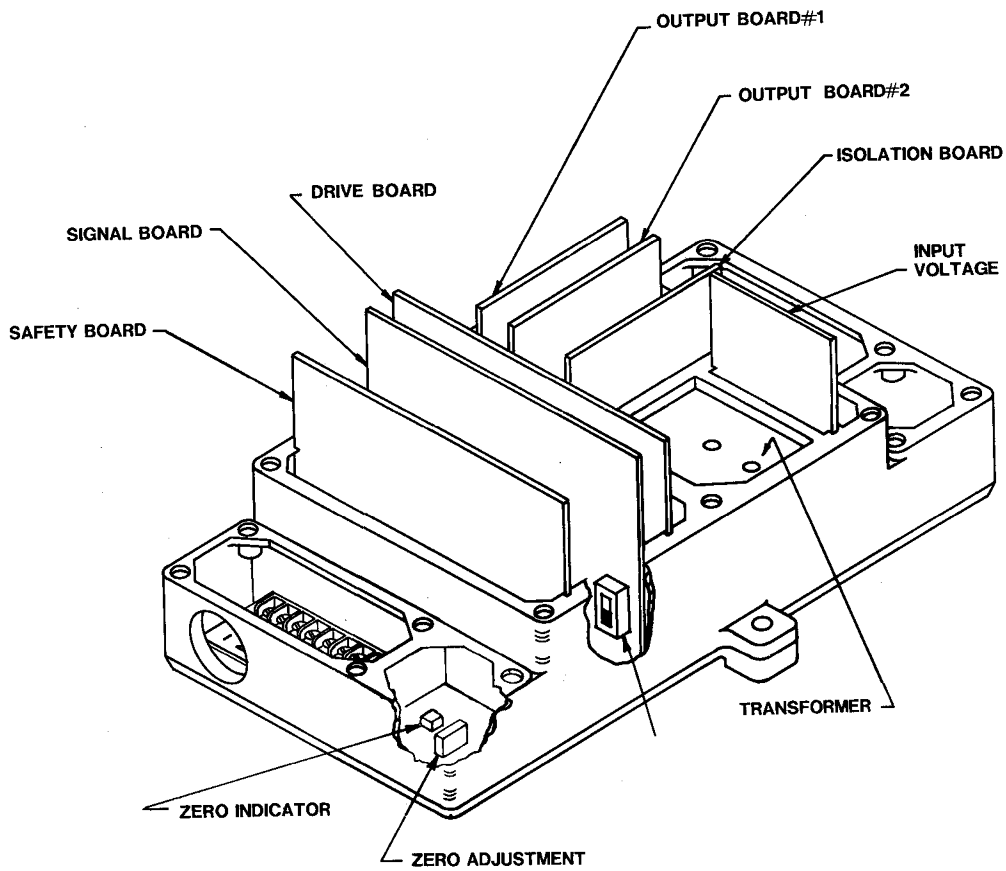
Table 1-1
REU Specifications

Accuracy	±0.2% of rate ± zero stability* (in conjunction with sensor)
Operating temperature	-40° to 130°F (-40° to 55°C)
Hazardous area classification	
UL & CSA listed	Class I, Division 2**
BVS listed	[EEx ib] IIB**
Output signals	
Analog	0-20 or 4-20 mA, 500 ohm max. load 0-5 or 1-5 VDC, 100k ohm min. input or optional; 0-50 or 10-50 mA, 250 ohm max. load 0-10, or 2-10 VDC, 100k ohm min. input
Frequency	Signal: 15-volt square wave, max. output adjustable from 1.5 to 10,000 Hz for scaling engineering units. Solid-state switch: 30 VDC rating, 1 amp sinking capability. Optional; fully-isolated output, solid-state relay, 250 Hz maximum, 250-volt rating at 150 mA.
Response time	Adjustable from 0.1 to 1.1 seconds Optional; adjustable from 5 to 6 seconds
Power	100, 115, or 220 VAC ±10%, 48 to 62 Hz or 12-30 VDC; 8 watts nominal.
Enclosure	Polyetherimide structural foam (Ultem™, product of General Electric Co.)
Weight	4.5 lb (2 kg)

* Zero set at process temperature ±20°F (±11°C).

** With approved sensor.

Figure 1-1
Remote Electronics Unit (REU) Compartments



(ZERO INDICATOR AND ADJUSTMENT ARE RECESSED)

Figure 1-2
Electronic Circuitry
Flow Diagram

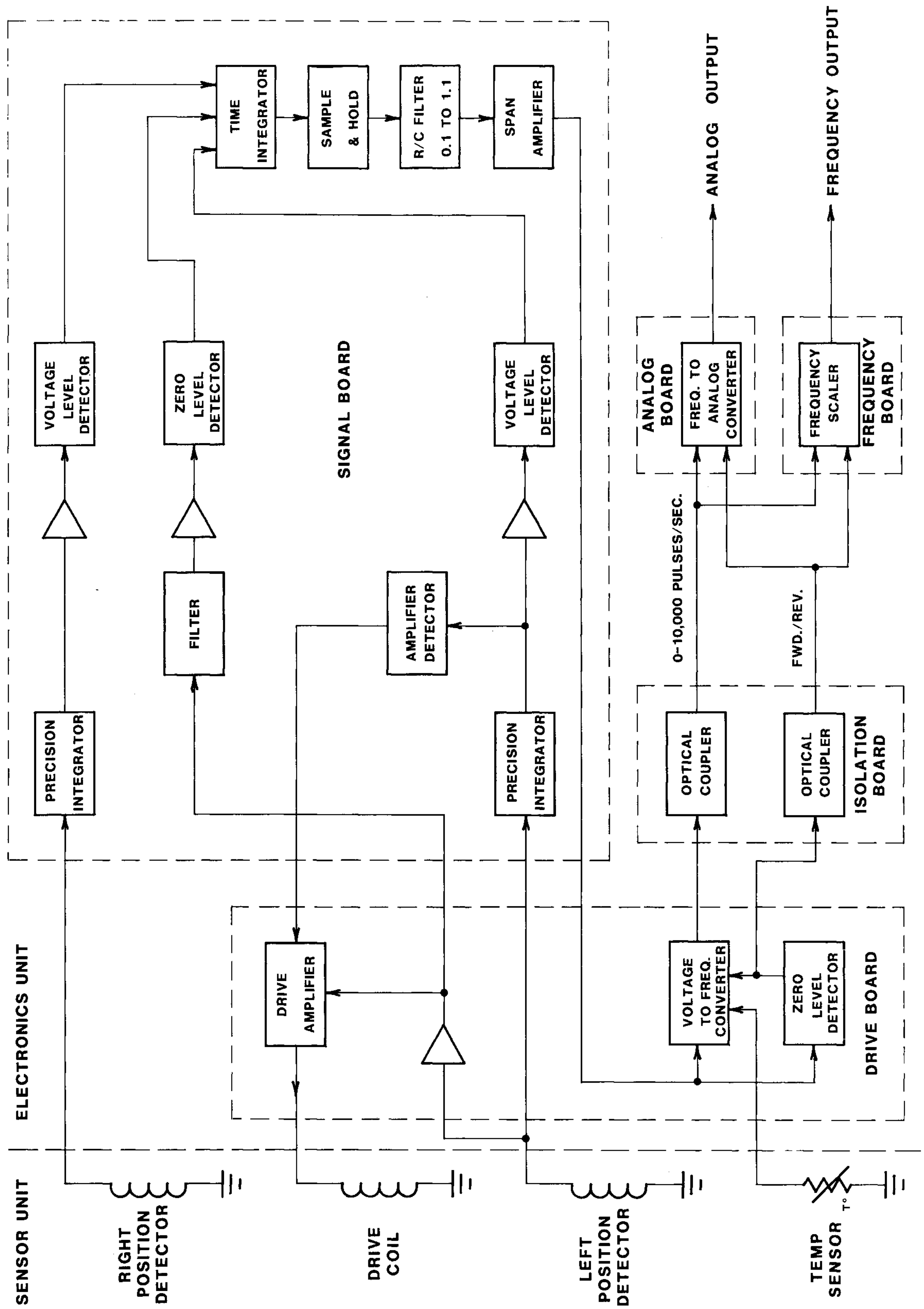
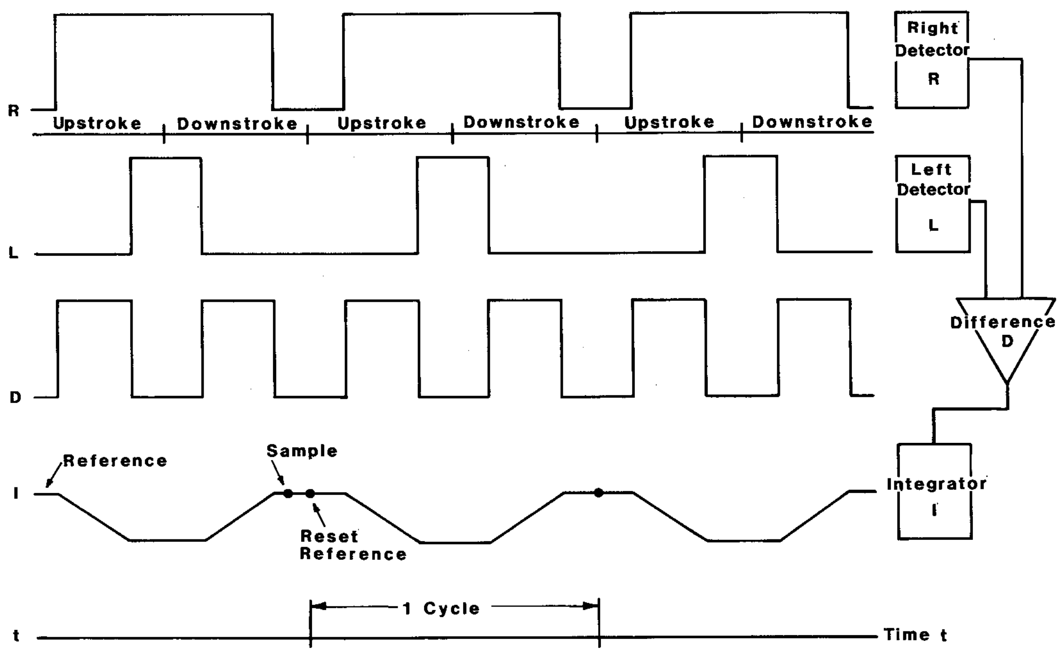


Figure 1-3
Wave Drawing Depicting Signal Processing



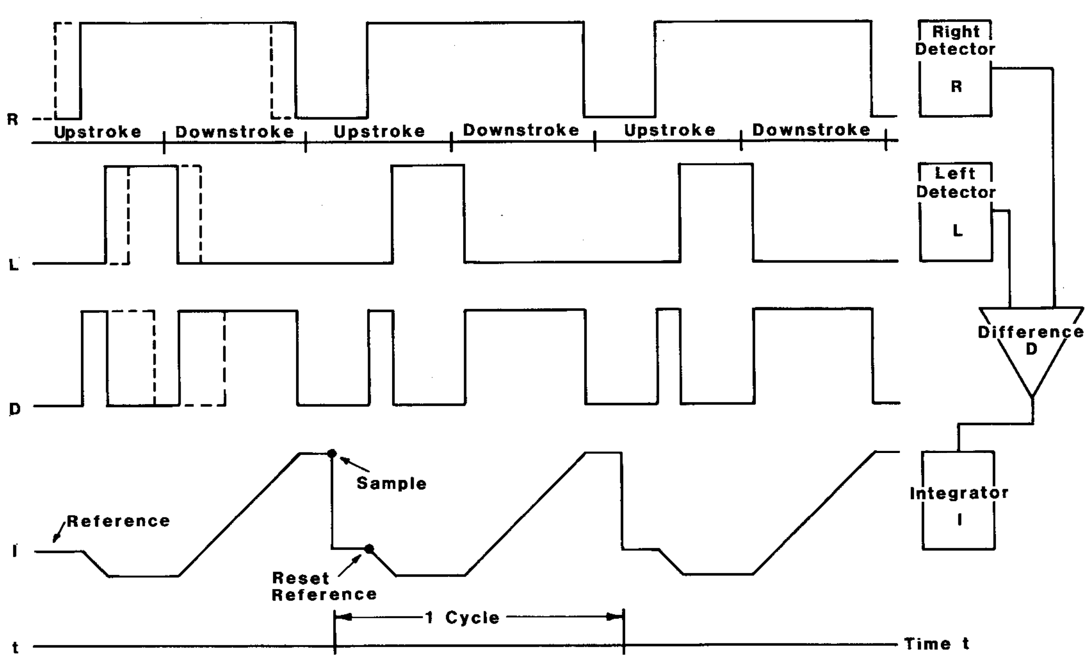


Figure 1-4a
End View of Sensor Tube
Showing Fluid Forces

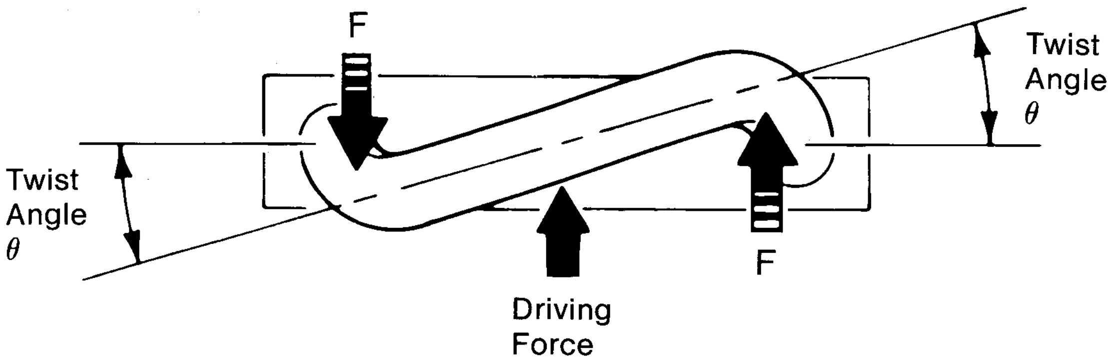
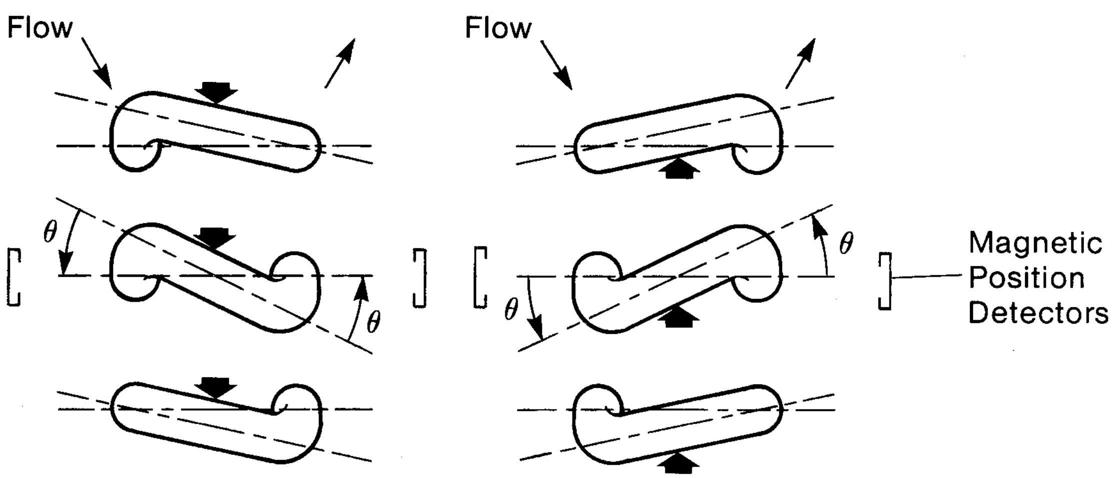


Figure 1-4b
Complete Cycle of Sensor Tube
Measurement of Twist Angle



2 Installation and Electrical Connections

2.1 General

For information regarding installation of the flow sensor, please refer to the Model D6 and D12, Model D25 - D300, or Model D600 Installation Planning Guides. These installation guides are included with the sensor when shipped from the factory.

The transmitter should be placed in an easily accessible place in a Division 2 hazardous area or safe area. The maximum ambient temperature should not exceed 130°F (55°C) for the transmitter.

Use separate conduits or cable trays for power and signal wiring. Cable tray installation requires Micro Motion-supplied Teflon® wiring or equivalent cable-tray compatible wiring.

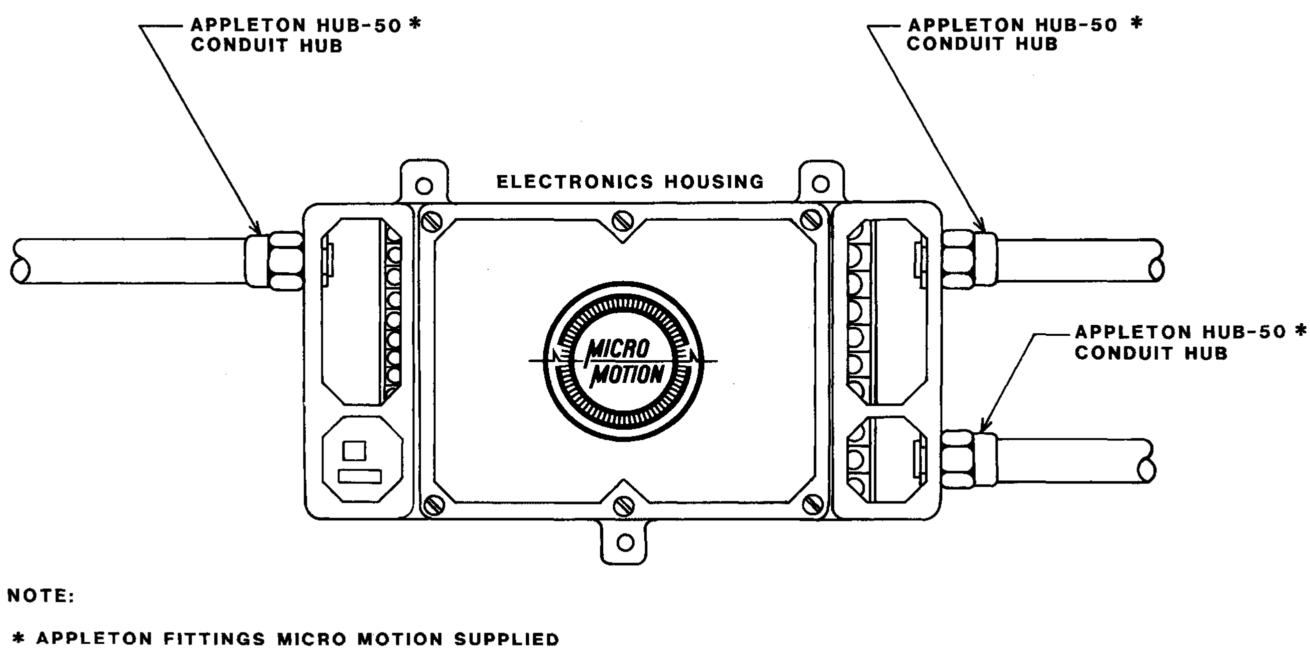
Wiring connections for the REU are located on both sides of the unit. Remove the terminal covers to expose the connections.

Appropriate ½-inch Appleton conduit-connectors are provided to seal the REU conduit knockout-openings against moisture, dust, etc. Conduit connectors, seals, and drip legs should be installed in all conduit to prevent internal conduit liquids from accumulating in the wiring termination area. Figure 2-1 shows the proper installation of connectors.

CAUTION: These Micro Motion supplied connectors must be used; use of other fittings may damage the REU housing.

CAUTION: Install to meet local code requirements.

Figure 2-1
REU Conduit Connections



Note: If cable is used alone, the cable material and the cable grip must be compatible with the application environment. Also, a drip loop and weather-tight connectors are recommended to prevent moisture from leaking into the electronics. If the application environment is highly corrosive, the cable grip or conduit and conduit connections must be corrosion resistant.

Wiring connections to the D25 through D300 meters are made at the manifold spacer. Loosen the slotted-head screws on the sensor wiring-compartment cover to gain access to the sensor wires.

Wiring connections to the D6 and D12 are made at a terminal strip within a signal wiring-termination compartment attached to the sensor.

For applications in which cable temperatures are above 150°F (65°C) or below 32°F (0°C), the light blue, Teflon-jacketed cable should be used. For applications in which temperatures stay between 32° to 150°F (0° to 65°C), the medium blue, PVC-jacketed cable can be used. The standard cable supplied is 10 feet (3 meters) long. Up to 500 feet (150 meters) of cable can be used between the transmitter and sensor. Cable lengths between 10 and 500 feet are available from the factory.

Note: Operation of the meter may be detrimentally affected if cable other than Micro Motion color-coded cable is used.

WARNING: To maintain intrinsic safety and performance, only low-power signal cables can be routed through the conduit alongside the sensor wiring.

2.2 Installing the REU

When mounting the REU, Micro Motion recommends following the practices described below.

1. The REU covers **must** be secured to achieve a complete seal against moisture on its surface. The tightening specification for the cover screws is 7 inch-pounds of torque. Tighten all screws uniformly.

2. Mount the REU in an area which protects it from ambient temperatures below -40° or above 130°F (below -40° or above 55°C).

3. Conduit should be installed with seals and drip legs to prevent liquid accumulation in the wiring termination areas.

4. Conduit knockouts should be sealed to maintain weather-tightness of the REU. Use a conduit size which allows a complete seal with the REU conduit knockout-openings. Mount the REU with the lid up and to a horizontal plane to avoid accumulation of moisture at conduit connections and lid seals.

5. Accessibility is important when mounting the REU. Be sure to mount the unit so that it is accessible for servicing such as for zero adjustment, board changes, and potentiometer checks.

2.3 Power Connections

DANGER: POWER MUST BE OFF WHEN MAKING WIRING CONNECTIONS.

The factory installs the input voltage board requested for the customer's application. This allows the meter to accept one of the following input voltages: 100, 115, 220 VAC, or 12-30 VDC. The input voltage board can be changed in the field to accommodate different supply voltages. Simply replace the input voltage board with the desired input-voltage board (see Section 3.6, Circuit Board and Fuse Replacement).

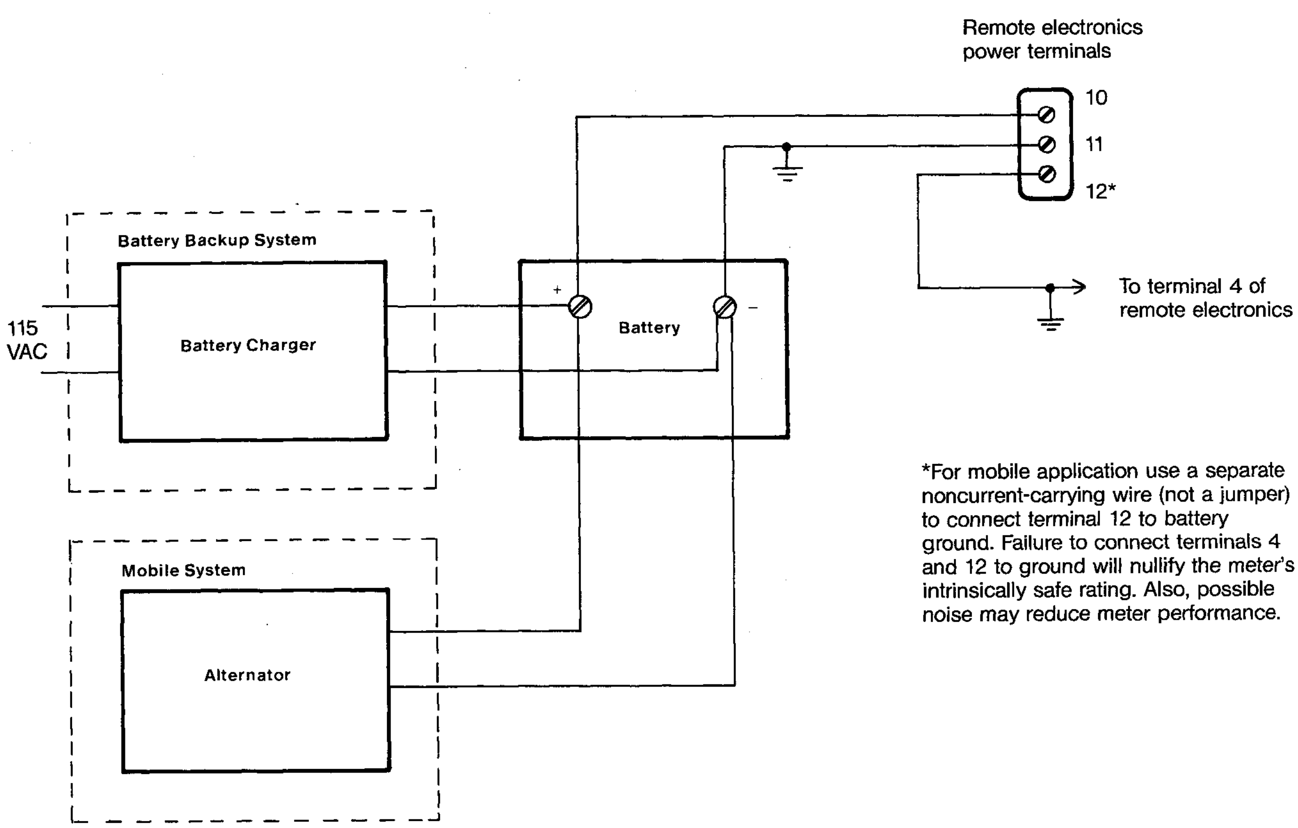
CAUTION: Power supply voltage must agree with the voltage stated on the input voltage board.

Input power connections are made on terminals 10 and 11 of the REU. When the meter is used with a DC power supply (see Figure 2-2), terminal 10 is positive and terminal 11 is negative. Terminal 12 is earth ground in all cases and must be connected.

CAUTION: Failure to connect terminals 4 and 12 to ground will nullify the meter's intrinsically safe rating.

CAUTION: Replace and tighten all REU covers before applying power and operating the meter.

Figure 2-2
Installation Drawing;
DC-Powered Meter Wiring



*For mobile application use a separate noncurrent-carrying wire (not a jumper) to connect terminal 12 to battery ground. Failure to connect terminals 4 and 12 to ground will nullify the meter's intrinsically safe rating. Also, possible noise may reduce meter performance.

Note: The mass flowmeter electronics unit must be equipped with a 12-30 VDC input voltage board.

2.4 Signal Wiring; Sensor to the REU

Signal connections are made via the interconnect cable between the sensor and terminals 1-9 of the REU. Only low-power signal cables can be routed through conduit alongside the sensor wiring if intrinsic safety requirements must be maintained.

2.4.1 Cable Connections

At least one end of the cable must be prepared in the field. Micro Motion, Inc. supplies the necessary butt-splices, spade-lugs, shrink-tubing, solder-sleeve connection wire and instructions with each meter. Individual wires are color-coded for easy identification. Refer to Figures 2-3 through 2-8 for wiring instructions.

If the interconnect cable exceeds 10 feet (3 meters) and a junction box is used, Figure 2-4 also shows how to connect the signal wiring from the sensor and the REU to the junction box.

Butt-splices are attached to the wires inside the manifold spacer. Route this end of the cable through the conduit opening. Then, insert the prepared wire ends into the butt-splices, being sure to match wire color to wire color. Crimp the interconnect cable to the butt-splice using a standard crimping tool.

Wires must be paired exactly as described below. If the cable is not supplied by Micro Motion, Inc., make certain each pair is individually shielded and that 20 gauge or larger diameter wire is used. All ground shields must be connected to the yellow wire at the sensor manifold and to terminal 6 at the REU. Be sure that the bare shields are insulated against potential shorting, such as to the meter case.

Note: Micro Motion, Inc. does not recommend cable lengths over 500 feet for interconnection between the REU and sensor.

- Wires connected to REU terminals 1 (brown) and 2 (red) must be paired together.
- Wires connected to REU terminals 3 (orange) and 7 (purple) must be paired together.
- Wires connected to REU terminals 5 (green) and 6 (blue) must be paired together.

CAUTION: Use of cable other than that supplied by Micro Motion, Inc. may be detrimental to meter performance.

2.4.2 Sensor Conduit Connections

The conduit fitting in the D25 through D300 sensor units is a ½-inch NPT female-size bushing. Connect a ½-inch NPT male cable-grip or flexible conduit to it. The cable grip must be compatible with the application environment. For example, if the meter is operating at 392°F (200°C), the conduit and conduit connectors, or cable grip must be capable of withstanding 392°F (200°C). Or, if the environment is corrosive, the conduit and conduit connectors, or cable grip must be corrosion-resistant. Conduit connectors and seals are recommended to prevent moisture from accumulating in wiring termination areas.

Flexible conduit can be UL-approved. Explosion-proof conduit is not required for intrinsic safety on meters up to and including the D300. The connection must, however, be sealed.

Figure 2-3
D6 - D300 Wiring

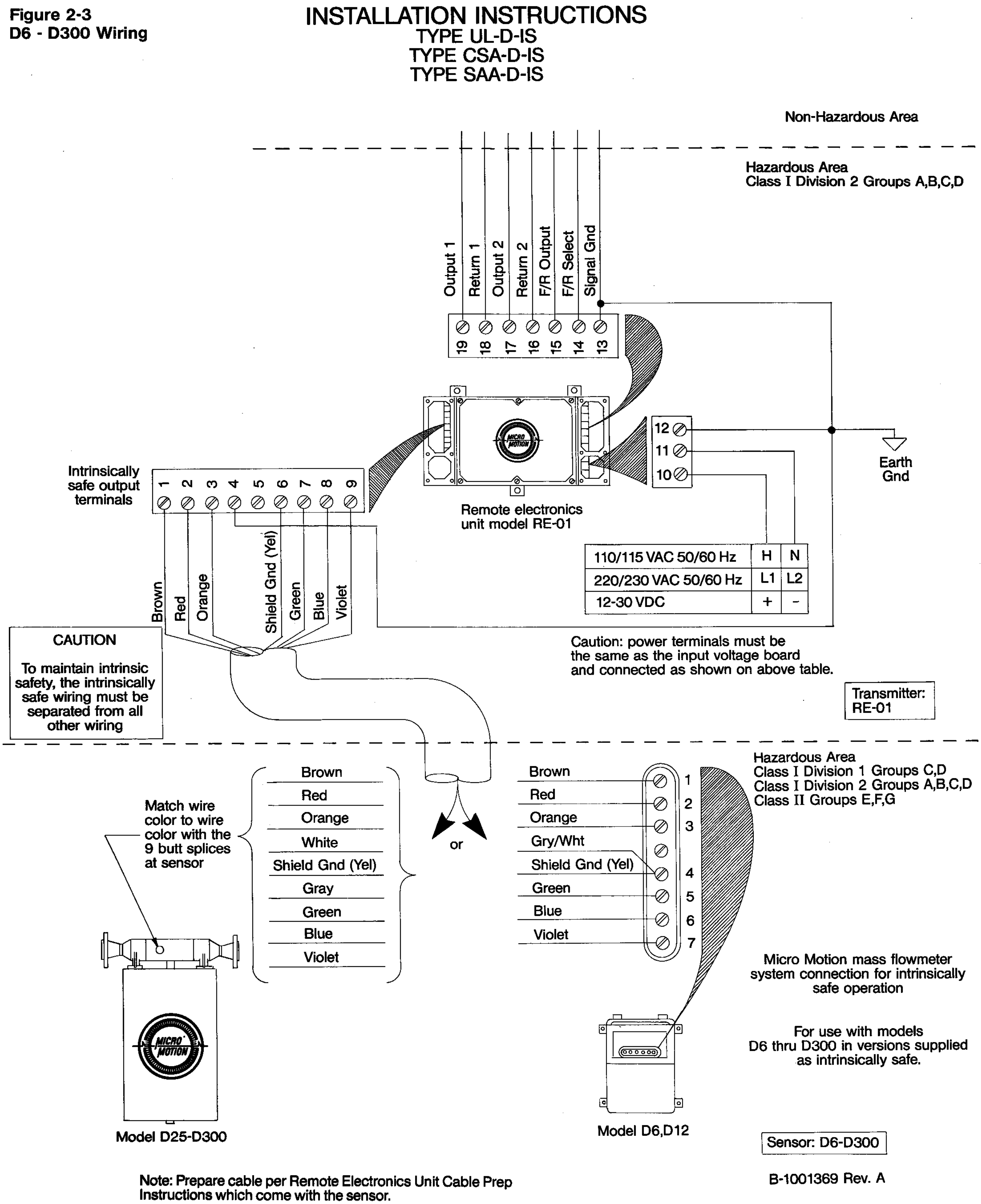
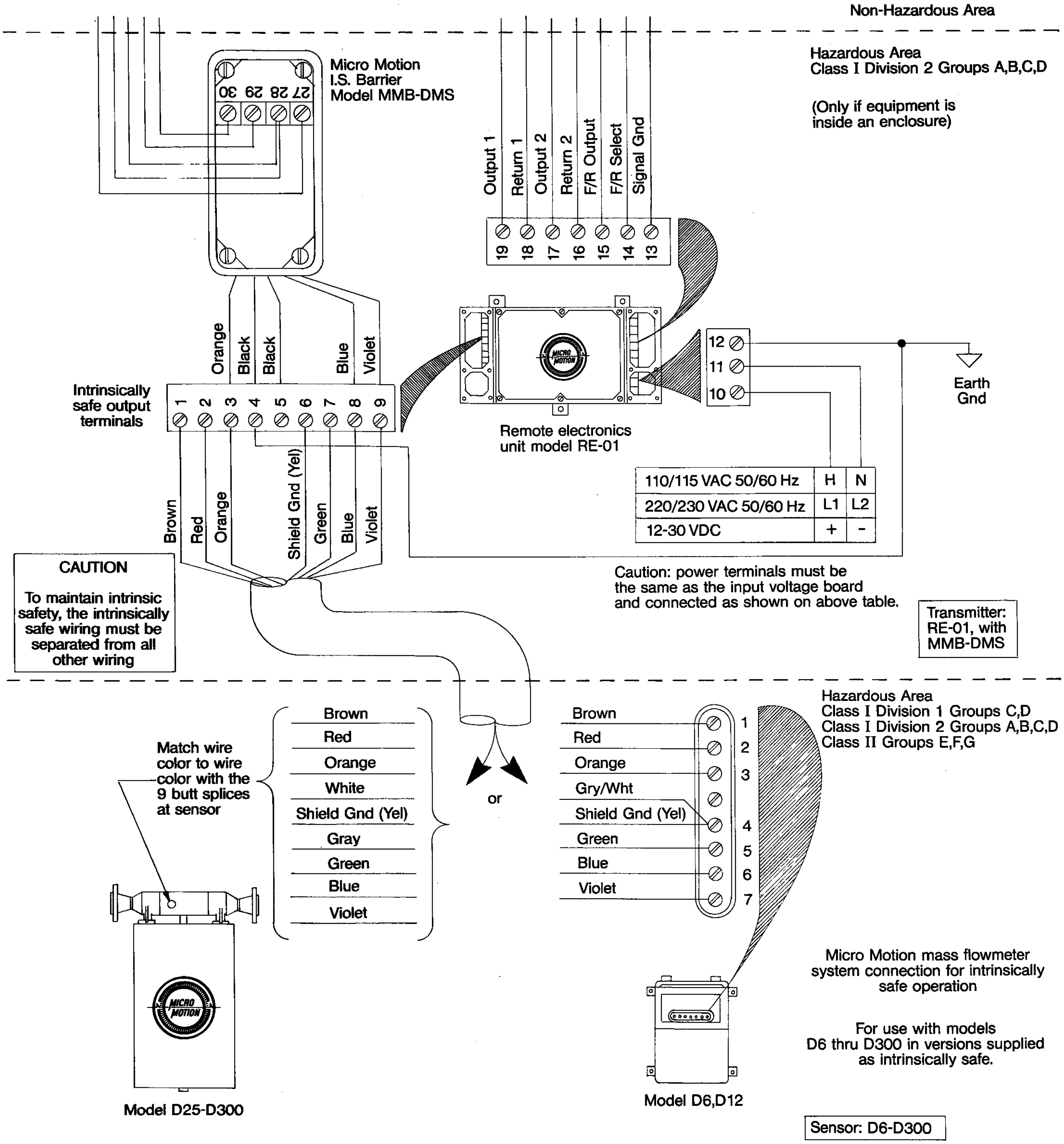


Figure 2-4
D6 - D300 Wiring
with DMS Barrier

INSTALLATION INSTRUCTIONS
TYPE UL-D-IS

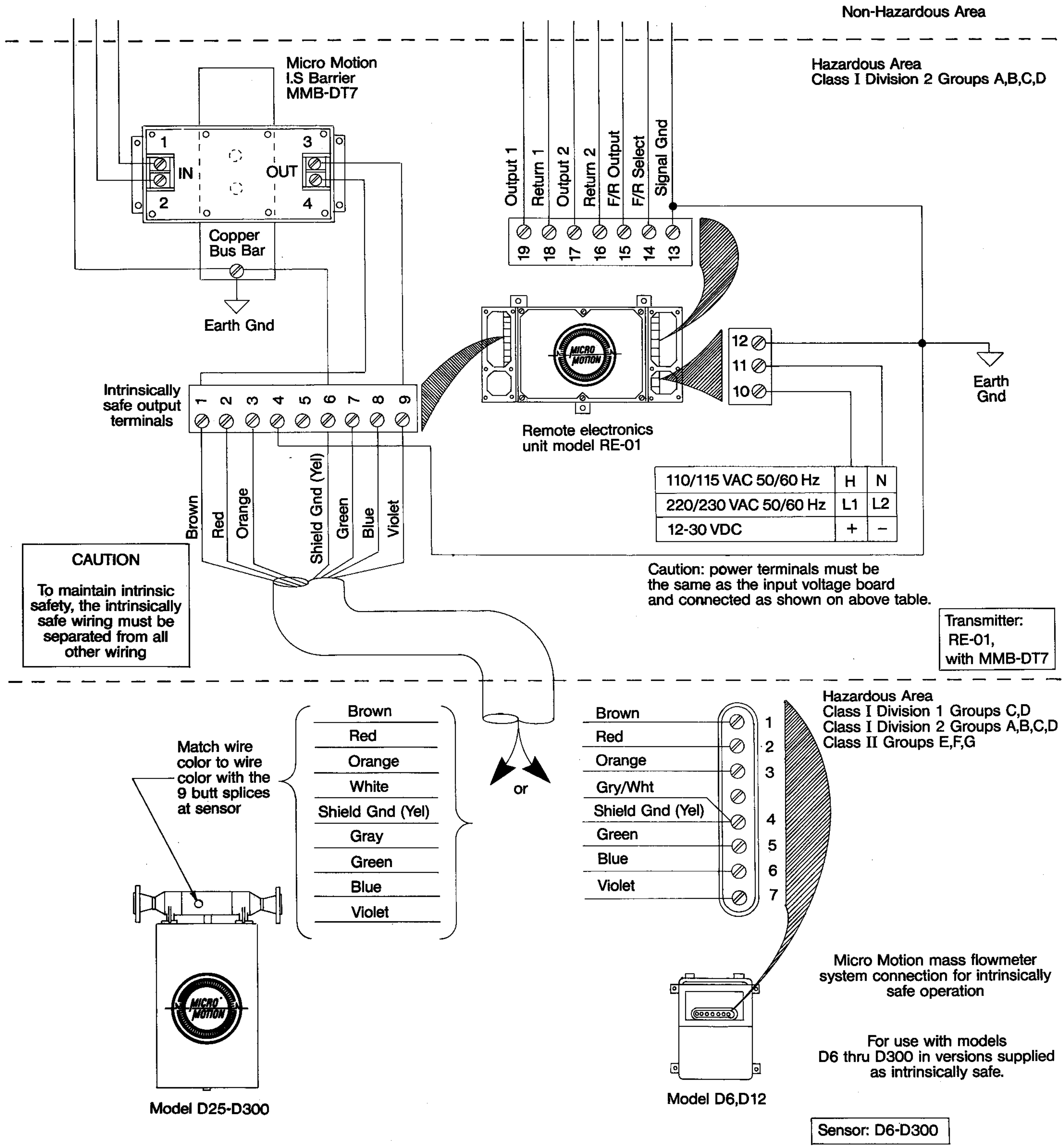


Note: Prepare cable per Remote Electronics Unit Cable Prep Instructions which come with the sensor.

B-1001373 Rev. A

Figure 2-5
D6 - D300 Wiring with DT7 Barrier

INSTALLATION INSTRUCTIONS
TYPE UL-D-IS
TYPE CSA-D-IS
TYPE SAA-D-IS



Note: Prepare cable per Remote Electronics Unit Cable Prep Instructions which come with the sensor.

B-1001371 Rev. A

Figure 2-6
D600 Wiring

Installation Instructions
Type UL-D-IS

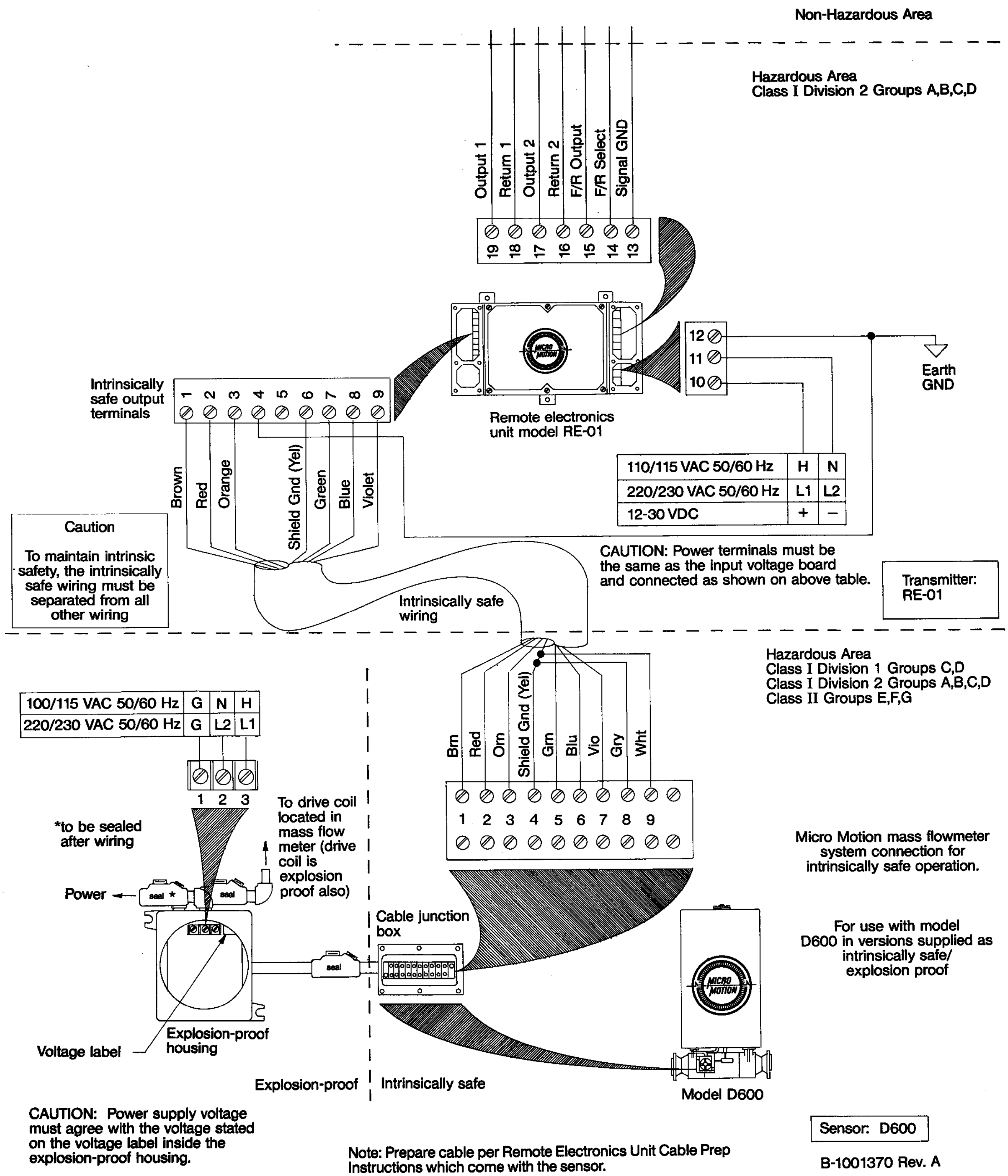
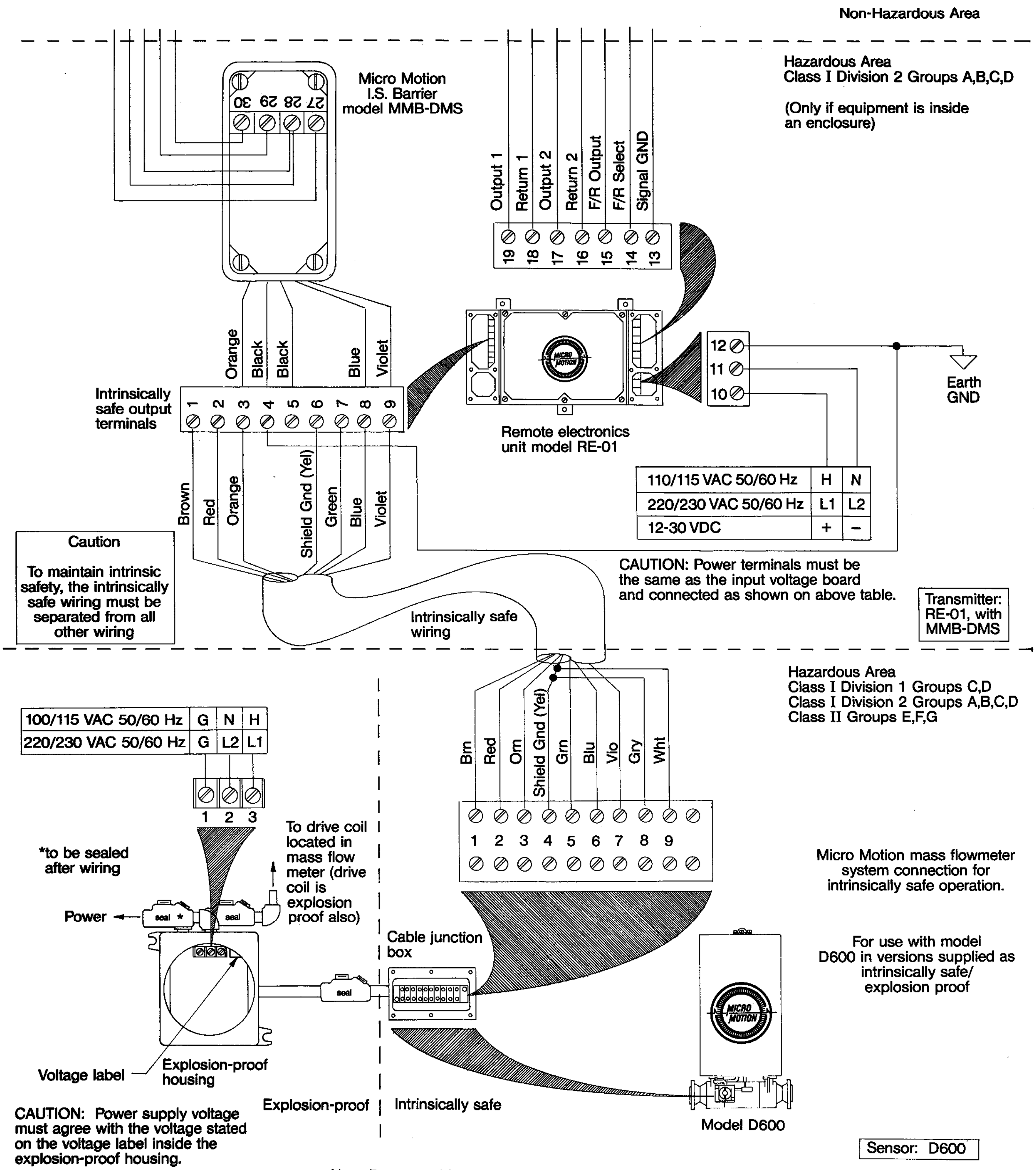


Figure 2-7
D600 Wiring
with DMS Barrier

Installation Instructions
Type UL-D-IS



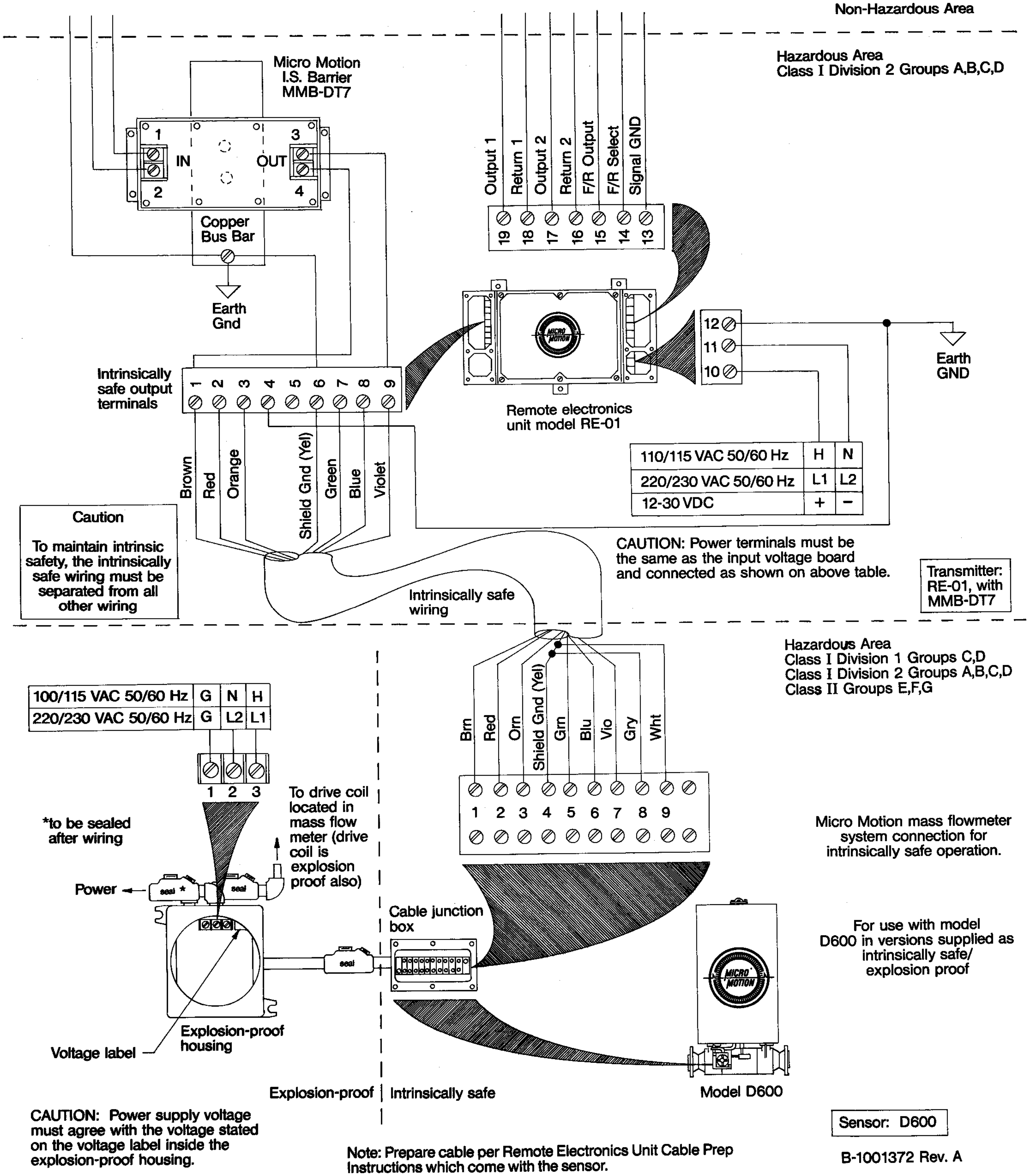
Note: Prepare cable per Remote Electronics Unit Cable Prep Instructions which come with the sensor.

B-1001374 Rev. A

Installation Instructions

Type UL-D-IS

Figure 2-8
D600 Wiring
with DT7 Barrier



2.4.3 Intrinsically-Safe Wiring Requirements

To maintain agency approval, intrinsically safe meters must be installed in accordance with Figures 2-3 through 2-8.

Note: Only CSA installation requires connecting the signal ground and terminal 13 to earth ground. This will reference output and signal ground to earth ground.

2.5 REU Output Wiring

Wiring to output devices should be separated from input power wiring to avoid possible electrical interference. Therefore, a separate wire entrance is provided for output devices.

CAUTION: Shields for the output signals should be connected only at the REU end.

2.5.1 Analog Output Wiring

When connecting a receiver to the REU milliamp output-circuit, terminals 16 and 17 of the REU are used. Terminal 17 is the signal line (+) and terminal 16 is the return (-). The negative signal (terminal 16) may be grounded or left ungrounded since it is galvanically isolated up to 1300 VDC. Twisted pair, shielded cable should be used for long runs.

The 4-20 mA signal output can power loop-powered process indicators, such as the Micro Motion Model PI 4-20 Process Indicator. Shields for the output signals should be connected to ground only at the transmitter end (terminal 16). The maximum allowable load is 500 ohms.

2.5.2 Flow Direction Wiring

The mass flowmeter is preset to measure forward flow. Terminals 13, 14, and 15 furnish the connections for flow direction display and selection. When the meter is installed for forward flow and no external flow-direction display is desired, no connections to terminals 13, 14, and 15 are required.

To set up the REU for reverse flow, a jumper must be installed between terminals 13 and 14.

For bidirectional flow, install a jumper between terminals 14 and 15.

For an external flow-direction indication, a signal is available from terminals 13 (signal ground) and 15 (forward/reverse output) of the REU. In this case, a high, open-collector output indicates forward flow direction and a low (about 0 VDC) output indicates reverse flow. This output will "sink" up to 0.1 amps.

2.5.3 Frequency Output Wiring

The output circuit is rated to 30 VDC, 1 ampere sinking capability. The output from the frequency board is a nominal, 15-volt, logic level square-wave, unloaded. The output impedance is 2.2k ohms at the 15-volt logic level. It can interface with TTL, DTL, CMOS, and most computer signals. Refer to the appropriate Micro Motion product instruction manual for additional frequency-output wiring information. If products other than Micro Motion products are used, please refer to their instruction or operating manuals for output wiring information.

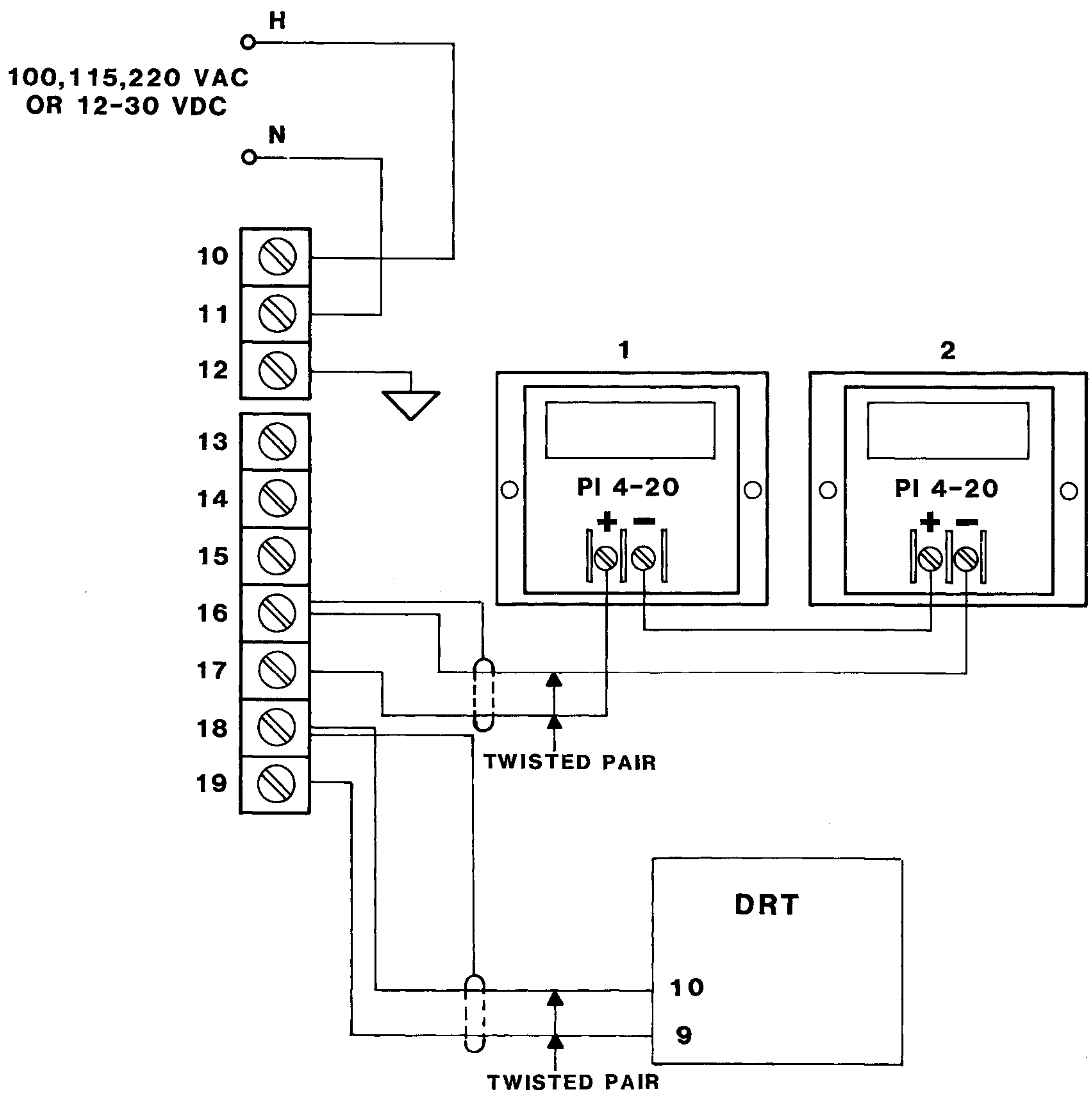
To connect a frequency output device to a standard mass flowmeter, use terminal 19 as the signal line and terminal 18 as the return. The frequency output wiring should be twisted pair and no less than 22-gauge shielded cable. Shields should be connected to ground at the transmitter end (terminal 13) only.

2.5.4 Fully Isolated Outputs

This option uses an optical coupler on the frequency output. This isolates the analog output from the frequency output. In standard meters, both outputs are referenced to the same floating signal-ground. On CSA installations, signal ground must be connected to earth ground.

For applications requiring fully isolated outputs, the frequency boards may be equipped with an optional modification. With this option, the circuit contains a solid-state relay rated to 250 volts at 150 mA. No pull-up resistor is provided; only a contact closure. The frequency is limited to 250 Hz maximum.

Figure 2-9
Typical Output Wiring;
PI 4-20 and DRT Installation



3 Operation and Maintenance

3.1 Power

After the meter has been correctly connected, power can be applied. To achieve specified accuracy, the Remote Electronics Unit (REU) should warm up for 30 minutes. If there is flow, the zero LED will light continuously or flash red or green. Let the fluid which is to be measured run through the sensor for about 15 minutes at a sufficient flow rate to completely purge the piping. Close the shut-off valve downstream of the sensor. The sensor should be *completely* filled with the fluid.

Note: Fluid flow to the sensor must be *completely* stopped or the zero flow setting will be incorrect. Problems setting zero flow occasionally occur because of leakage through valves.

3.2 Meter Primary Zero

Turn the "zero adjust" potentiometer with the "tweaker" (trim pot screwdriver) until the LED does not light, or flashes red or green no more than 1 to 2 times a second. After this procedure, the meter is ready for use.

3.2.1 Primary Zero Adjustment

The primary zero adjustment (PZA) establishes the zero flow signal. The potentiometer and a zero indicator light (a red/green LED) are used to adjust the primary zero. See Figure 1-1. An absolute zero setting totally extinguishes the zero indicator light at zero flow. As the setting deviates either high or low from actual zero, the indicator light blinks red or green, depending on the offset direction. The further the adjustment deviates, the more rapidly the indicator light blinks. One blink-per-second represents a zero error of approximately 0.03% of the calibrated, maximum full-scale flow rate; well within acceptable tolerances for most applications. A steady red or green light with no flow indicates a large deviation from actual zero and requires adjustment of the PZA.

Note: During normal forward flow, the LED will be a steady green. During reverse flow, the LED will be a steady red.

After installation, follow these steps to set the primary zero:

1. Apply power and run fluid through the sensor for about 15 minutes to reach normal operating conditions (i.e., at a sufficient flow rate to completely purge the piping).

2. Shut off fluid flow at a downstream valve, making sure the sensor tubes remain full of fluid and contain no trapped air or gases. A partially-filled sensor tube can result in an inaccurate zero setting and, consequently, an inaccurate output signal.

3. Observe the zero indicator. If the light is out or blinking (red or green) less than five times-per-second, the PZA is within an acceptable range. If the indicator is red, turn the potentiometer clockwise; if green, turn counterclockwise. In either case, adjust until the zero indicator blinks a maximum of five times-per-second. Run flow and repeat Steps 2 and 3.

Note: This adjustment is independent of flow direction.

Once the flowmeter has been properly mounted and the primary zero adjusted, the meter is ready for operation. If desired, conduct a flow test to verify factory calibration. Section 3.4 outlines this easy performance check.

After setting the primary zero, do not readjust it between batches. A blinking LED indicates an adequate zero setting. When the flow is shut off for several hours, the zero indicator may display a steady green or steady red light. This is because entrained gases may come out of the process solution within the sensor tubes. This is not a reason for concern, unless the gas in the tubes causes erratic performance. Resumption of flow should remove the gas pockets.

3.3 Factory Preset Adjustments

All items except the primary zero adjustment are factory preset. This section provides a brief description of the adjustable items. Also, it refers to other sections of the manual which contain additional information on their use. Appendix III provides assembly drawings and schematics. The adjustable items are clearly identified on the assembly drawings.

The time constant and frequency cutoff potentiometers are preset to factory standards. At installation, these may be reset, although normally they require no readjustment. Procedures for these adjustments are discussed in Sections 4.3.2.1 and 4.3.2.2.

3.3.1 Span Select Switches

This series of switches, located on the signal board, set the span of the meter. The sensitivity of the individual meter is determined. Then, the switch is set for the amount of amplification necessary to achieve approximately 10,000 Hz at the desired maximum full-scale flow-rate. This information is used by the output board for scaling or conversions, as applicable. Readjustment procedures are discussed in Section 4.4.1

3.3.2 Time Constant Potentiometer

Located on the signal board, this adjusts the meter response time from 0.1 to 1.1 seconds. It can be increased from the factory setting of 0.3 seconds to filter out low-level noise or decreased to improve response time. Readjustment procedures are discussed in Section 4.3.2.1.

3.3.3 Frequency Range Switches

These switches scale the internal flow-rate signal to the desired frequency output scaling. The proper percentage of the 0-10,000 Hz signal is then sent from the frequency board to the output device. Readjustment procedures are discussed in Section 4.4.2.

3.3.4 Frequency Cutoff Potentiometer

This disables frequency output below a predetermined value to limit low-level noise. This value can be adjusted to be 0.1% to 1.0% of the meter's calibrated, maximum full-scale flow rate. The factory presets this to approximately 0.3%. Readjustment procedures are discussed in Section 4.3.2.2.

3.3.5 Zero Adjust Potentiometer

The zero adjust potentiometer is located on the analog board. (Note: This is not the primary zero potentiometer.) It adjusts the low end of the analog output (e.g. 0 mA, 4 mA, 0 VDC). Readjustment procedures are discussed in Section 4.3.1.2.

3.3.6 Range Adjust Potentiometer

This analog board potentiometer sets the high end of the analog output (e.g. 20 mA, 5 VDC) at the maximum calibrated full-scale flow-rate (±5% adjustment). Readjustment procedures are discussed in Section 4.3.1.2.

3.3.7 Output Select Switch

This allows the meter to be reset for different analog-output interfaces. Readjustment procedures are discussed in Section 4.3.1.1.

3.4 Performance Check

Run a performance check only after changing calibration switch settings, or if the meter is suspect. Follow these steps:

1. Check the primary zero setting at normal operating temperature and under zero flow conditions (see Section 3.2).

2. If the meter is connected to a flow totalizer:

a. Run an amount of fluid into a container at a flow rate close to the calibrated maximum rate; constant flow rate is not necessary. The best results will be obtained if the test duration is at least 1 minute.

b. Weigh the mass and compare the weighed mass with the totalized mass.

If the meter is not equipped with a flow totalizer:

a. Perform the flow test at a constant rate and for a known duration of time to predict the total fluid mass delivered.

b. Weigh the fluid and compare weighed mass with predicted mass. If the metered or predicted mass and weighed mass agree within acceptable tolerances, the test is complete. If test results are not satisfactory, refer to Section 4 for a discussion of meter recalibration.

Note: Weighing apparatus, stop watch, meter mounting, zero offset, and control valve all contribute to system uncertainties. Make sure the test setup and procedure minimize, or account for, these variables.

The percent deviation between metered mass and weighed mass is numerically equal to the percent error at the average flow rate. Verify repeatability by re-running the test under the same conditions.

3.5 Preventive Maintenance

Maintenance requirements are minimal since the meter contains no seals, bearings, or moving parts. Protect the REU and sensor terminals from direct and repeated high-pressure washdowns, corrosive elements, or climatic extremes. Your factory representative can advise protective measures to shield the meter from potentially harmful environments.

The sensor is designed for clean-in-place or steam-in-place operations. Material buildup inside the sensor tube can be flushed away or ultrasonically cleaned as easily as other piping fixtures. Take care not to damage the sensor tube itself.

3.5.1 Cleaning Precautions

To avoid damaging the sensor during steam cleaning, do not allow temperatures to exceed the sensor's upper temperature rating. Do not insert cleaning implements into the sensor tube since the sensor assembly may be damaged.

3.6 Circuit Board and Fuse Replacement

Circuit boards and fuses are easily replaced in the field. To order parts, refer to Appendix IV.

3.6.1 Circuit Board Replacement

Follow these steps to replace a circuit board:

1. Shut off power to the meter.

2. Remove the REU electronics-compartment cover.

3. Using Figure 1-1, locate and remove the old board.

4. Using the old board or calibration data label (under compartment cover lid, see Figure 3-1), duplicate the setting of any adjustable items. Also, refer to Section 4.2 for additional information. Adjustable items are clearly shown on the assembly drawings in Appendix III.

5. Carefully insert the new board.

6. Replace the cover.

CAUTION: When replacing boards, be sure to use the correct replacement. Be especially careful with REU safety and drive boards. They should have yellow tags identifying them as REU components.

3.6.2 Fuse Replacement

Follow these steps to replace a fuse:

1. Shut off power to meter.

2. Remove the electronics compartment cover.

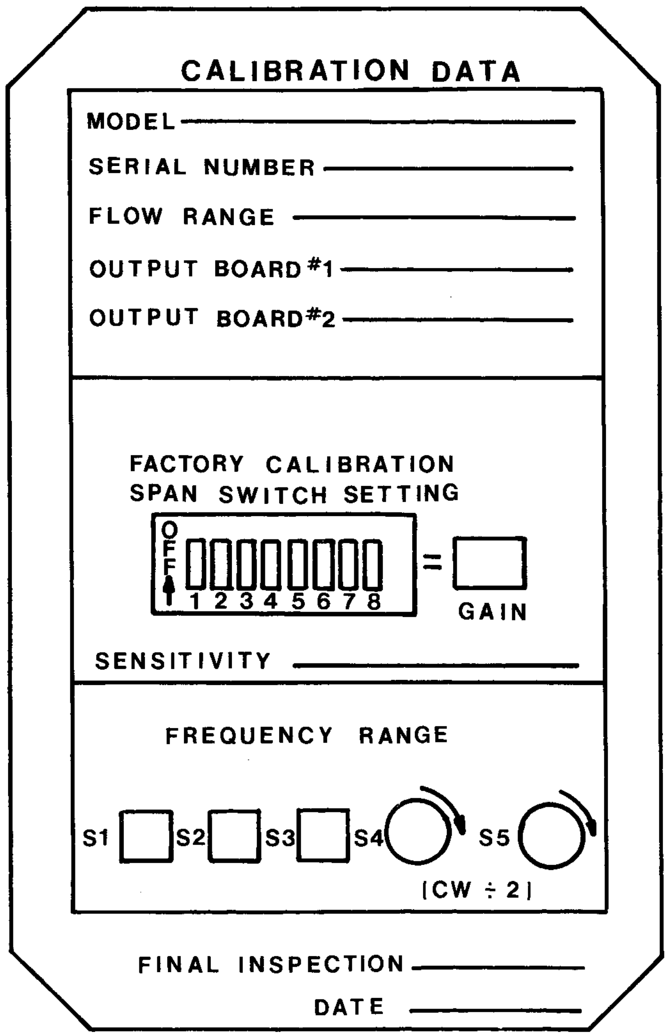
3. Remove the board on which the fuse is located.

4. Replace the fuse.

5. Reinsert the board.

6. Replace the cover.

Figure 3-1
Calibration Data Label



4 Recalibration

4.1 General

Initially, the mass flowmeter is factory calibrated to customer specifications. Recalibration may later be necessary to accommodate different flow ranges or applications. Recalibration is a simple procedure since the meter output is linear without compensation.

DANGER: MOST CALIBRATION ADJUSTMENTS REQUIRE AN OPERATING FLOWMETER. USE EXTREME CARE TO AVOID CONTACT WITH LIVE ELECTRICAL PARTS - PERSONAL INJURY OR DAMAGE TO METER COMPONENTS MAY RESULT.

CAUTION: Meter adjustments should be made by qualified personnel only.

4.2 Calibration Data Label

Figure 3-1 shows the calibration data label. It is located inside the large cover on the REU and provides useful information for recalibrating the meter.

The model number provides information about the meter size and electronics. The serial number is important when contacting the company for trouble-shooting assistance or when ordering replacement parts.

The flow range indicates the factory-calibrated, full-scale flow range.

In a dual output analog-frequency meter, the output boards will be set up as follows:

Output board #1 will normally be the frequency board. The label will show the calibrated frequency in hertz.

Output board #2 will normally be the analog board. The label will show the volt/milliamp selection.

In the case of a dual analog or dual frequency meter, the label shows the factory calibration of each board. Figure 1-1 shows the location of the output boards.

The calibration label shows the setting of the span select switch on the signal board. The switch position next to the numbers on the span select switch will always be the ON position. The label shows the factory setting of these switches with dashes on the switch diagram. **Gain** is the multiplier factor that results from these switch settings. **Sensitivity** is the minimum span that this sensor can achieve expressed in pounds-per-minute, except the Model D6, which is rated in pounds-per-hour.

The frequency range portion of the label shows the setting of the frequency range adjustment on the frequency board. If the meter is a dual frequency meter, the label will show two switch diagrams. The upper diagram will be for output board #1 and the lower diagram will be for output board #2.

4.3 Minor Adjustments

CAUTION: Retain a record of the original factory-calibration settings as indicated on the REU Calibration Data Label.

4.3.1 Adjusting for Different Analog Output Interfaces

4.3.1.1 Output Select Switch. The analog output select-switch determines whether the flow signal output will be in milliamps or volts, as well as specifying the range. This dual switch, labeled Output Select, is located on the analog board (Figures A-4 and A-5, Appendix III) and allows two select combinations. Switch 2 (the milliamp/voltage select switch) establishes milliamps output in the OFF position or volts output in the ON position. Switch 1 establishes the analog output range. The OFF position selects a range of 0-20 mA or 0-5 VDC. The ON position selects 4-20 mA or 1-5 VDC. These switches can easily be reset to accommodate different output interfaces. An analog output board with ranges of 0-50 or 10-50 mA, or 0-10 or 2-10 VDC is a standard option.

Note: When changing meter output interfaces, reset the select switches to the desired output and range. Also check the primary zero and analog zero and range adjustments.

4.3.1.2 Analog Zero/Range Adjust Potentiometers. The analog output board generates an analog output signal proportional to the mass flow rate. The analog zero adjustment sets the low end of the analog output. The range adjustment sets the high end of the analog output. The potentiometers, located side-by-side on the analog output board (Figures A-4 and A-5, Appendix III), allow fine tuning of their respective adjustments within ±5% of the calibrated settings.

Follow these steps to recalibrate the analog zero and range adjustments:

1. Check both output select-switch settings (Section 4.3.1.1).

2. Check the primary zero adjustment (Section 3.2.1).

3. Disconnect wires to the analog output device. Connect a milliammeter or voltmeter to the analog output terminals.

4. With the sensor tubes full of fluid, no flow, and the PZA adjusted, set the zero adjust to show the appropriate (0 mA, 4 mA, 0 VDC, or 1 VDC) no-flow value. Turning the potentiometer clockwise increases the setting, while turning it counterclockwise decreases the setting.

5. At maximum calibrated flow, set the analog range adjust to show the appropriate (20 mA or 5 VDC) full-scale flow value. Turning the potentiometer clockwise increases the setting, while turning it counterclockwise decreases the setting. A full turn will alter the meter output range by approximately 1%.

Note: If a range error still exists when the adjustment has reached the end of its effect, the span select switch will have to be rescaled (see Section 4.4.1).

6. Recheck the setting of both the zero adjust and range adjust potentiometers. A performance check (see Section 3.4) is also recommended to verify the accuracy of the new settings.

4.3.2 Filtering Low Level Noise

4.3.2.1 Time Constant Potentiometer. The time constant adjusts the response time of the meter output. It is used to filter undesirable output caused by fluctuations in flow rate. The time constant potentiometer (TC filter), located on the signal board (Figures A-14 and A-15, Appendix III), is an analog filter adjustable between 0.1 and 1.1 seconds (5-6 seconds optional). The TC filter is preset at the factory to approximately 0.3 seconds. To slow the response time, turn the TC filter clockwise; for a quicker response, turn the TC filter counterclockwise.

4.3.2.2 Frequency Cutoff Potentiometer. This 1% adjustment (10% is optional) disables frequency output below a predetermined value. It limits low level noise, which may be interpreted as flow by a digital totalizer when flow is at or near zero. The frequency cutoff on the frequency board (Figures A-6 and A-7, Appendix III) is preset at the factory to about 0.3%. It is adjustable between 0.1% and 1.0% of the meter's calibrated full-scale flow-rate. Turning the frequency cutoff potentiometer clockwise increases the cutoff, while turning it counterclockwise decreases the cutoff percentage.

4.4 Recalibrating the Meter for Different Flow Ranges

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Note: The procedure for recalibrating the meter discussed below is different from recalibration procedures covered in Model D Flowmeter Instruction Manuals dated previous to June, 1985. Both recalibration procedures are valid and only pertain to the span select switch (SSS).

4.4.1 Span Select Switch

The span select switch (SSS) establishes the overall, calibrated full-scale flow-range of the meter. The factory presets the SSS for the amount of amplification necessary to achieve approximately 10,000 Hz output to the frequency board or maximum output on the analog board at the calibrated full-scale flow-rate. To alter the flow range calibration by more than ±5%, the SSS must be rescaled. Since the adjustment is coarse (about 1%), follow rescaling with a performance check (see Section 3.4). Also, readjust the analog and frequency ranges (see Sections 4.3.1.2 and 4.4.2.1 respectively).

The SSS is an 8-position bit switch located on the signal board (Figures A-14 and A-15, Appendix III). The switches on the SSS carry the values noted in Table 4-1 when they are in the OFF position.

Table 4-1
Span Select Switch Values

Switch Number	1	2	3	4	5	6	7	8
Value	0.1	0.2	0.4	0.8	1.6	3.2	6.4	12.8

For example, suppose switches 3, 7, and 8 are OFF. Their values are 0.4, 6.4, and 12.8, respectively. Therefore, the meter span is 19.6, since:

$$0.4 + 6.4 + 12.8 = 19.6$$

Note: The switch position next to the numbers on the span select switch is always the ON position. The calibration data label (see Figure 3-1) shows the factory setting of these switches with dashes on the switch diagram.

Follow these steps to rescale the meter range, determine the new span, and reset the SSS:

1. Calculate the new SSS setting using the formulas below:

$$N_2 = [(F_1/F_2)(N_1 + 1)] - 1$$

where
N_2 = New SSS setting
N_1 = Initial SSS setting
F_1 = Initial, calibrated, maximum flow-rate
F_2 = Desired maximum flow-rate

Note: If N_2 is greater than 25.5 or is a negative number, the desired flow rate is outside the range possible for the sensor size.

2. Turn all switches, to the ON position. Then, refer to Table 4-1 to determine which switches must be turned off. The correct combination of switches is obtained by starting with the highest switch value less than or equal to the new span value (N_2). Turn this switch off and subtract its value from the new span. Repeat this procedure with each successive, highest-remaining switch value, but subtract from the preceding difference, rather than from the span. Continue until the final difference is zero or insignificant to the lowest switch value.

3. Run a performance check (see Section 3.4) and recalibrate the analog and frequency ranges (see Sections 4.3.1.2 and 4.4.2.1 respectively).

For example, suppose the initial SSS setting (N_1) is 19.6 (switches 3, 7, 8 are OFF), the initial, calibrated maximum flow-rate (F_1) is 15 lb/min, and the desired maximum flow-rate (F_2) is 20 lb/min.

Use the formula in Step 1 to determine the new SSS setting:

$$N_2 = (15/20)(19.6 + 1) - 1$$
$$N_2 = 14.45 = 14.5$$

Refer to Step 2 to determine the correct combination of switches for the new span-select switch value (N_2) of 14.5. Turn off the span select switches and subtract the highest successive switch-values until the final difference is zero:

Switch 8 is OFF since 14.5 - 12.8 = 1.7
Switch 5 is OFF since 1.7 - 1.6 = 0.1
Switch 1 is OFF since 0.1 - 0.1 = 0

4.4.2 Frequency Range Switches

The frequency range switches (frequency board, Figures A-6 and A-7, Appendix III) scale the flow rate signal to the proper output percentage. For example, if a customer requests 1700-Hz output at calibrated full-scale flow, the signal from the drive board (approximately 10,000 Hz) must be scaled to 17% before it is sent to the output device. The frequency range consists of five switches which perform the scaling operation. The five switches operate in the following manner:

S701, S702, and S703 are 10-position rotary switches which together form a fine adjustment multiplier. They allow a percentage of the primary flow signal to pass on to binary divider-switches S704 and S705.

Switches S704 and S705 act as a single rotary switch which divides the flow signal input by $2^{(N-1)}$. N is the position number (1-13) of the switch.

Note: As the setting of switches S704 and S705 increases, the frequency output decreases.

When switch 4 is at position 1, the maximum output frequency is approximately 10,000 hertz. At position 2, the maximum output frequency is approximately 5,000 hertz. The output frequency is halved successively until the final switch setting of 13. At position 13, the maximum output frequency is 2.5 hertz. Table 4-2 shows the setting of switches S704 and S705 for different frequency-output ranges.

Note: If S704 is set between 1 and 8, the setting on S705 does not matter. However, if a setting between 9 and 13 on S705 is desired, line up the arrow in the center of S704 with the arrow on the board. This engages S705.

Table 4-2
Frequency Output with Switch Position and Minimum On/Off Times

Frequency Output (Hz)	Switch S704/S705 Position	Min. On/Off Time (msec)
5,000 to 10,000	1	0.05
2,500 to 5,000	2	0.1
1,250 to 2,500	3	0.2
625 to 1,250	4	0.4
312 to 625	5	0.8
156 to 312	6	1.6
78 to 156	7	3.2
40 to 78	8	6.4
20 to 40	9	13
10 to 20	10	26
5 to 10	11	52
2.5 to 5	12	100
1.3 to 2.5	13	200

For example, the five switches may be set as follows for a frequency output of 1,700 hertz at the calibrated full-scale flow-rate:

S701 = 6
S702 = 8
S703 = 3
S704 = 3
S705 is not engaged

Switches S701 - S703 are a percentage multiplier (S701 = 6, S702 =8, and S703 = 3). In this case, they allow 68.3% of the flow signal to pass on to divider switches (S704 and S705). Switches S704 and S705 are set at 3 and thus, divide the flow signal input by $2^{(3-1)}$. The electronics perform the percentage multiplication first. However, it is easier to understand the scaling process by calculating the binary division first.

For this example, assume the actual frequency output at the calibrated full-scale flow-rate is 9,956 hertz. Perform the binary division:

$$9956 / 2^{(3-1)} = 2489$$

Then, calculate the percentage multiplication:

$$2489 \times 0.683 = 1700$$

The frequency range switches can be recalibrated for a different range or adjusted to correct a calibration error. The recalibration and adjustment procedures vary slightly and are outlined in Sections 4.4.2.1 and 4.4.2.2.

4.4.2.1 Frequency Range Recalibration

Follow these steps to recalibrate the frequency switches for a different range:

1. Record the values of switches S701-S703 as a three-digit percentage value.

2. Record the initial maximum output in hertz. If the meter still has the factory preset calibration, this can be found on the calibration data label (see Figure 3-1).

3. Determine the new setting of frequency range switches S701-S703 using the following formula:

where $N_2 = N_1 (F_2/F_1)$
N_2 = New switch setting (S701-S703)
N_1 = Initial switch setting (S701-S703)
F_2 = Desired maximum output in hertz
F_1 = Initial maximum output in hertz

4. N_2, the new switch setting of S701-S703, is the new percentage multiplier. The percentage multiplier has a maximum setting of 999 (99.9%). Use the largest percentage possible (over 50.0%) of the frequency output signal. Therefore, N_2 must fall between 500 and 999. If the new switch setting is not between 500 and 999, it must be changed. This is done to allow the S703 switch finer resolution per incremental change.

To change N_2:

a. If N_2 is less than 500, multiply the value of N_2 by 2. This multiplies the frequency output percentage by 2.

b. If N_2 is greater than 999, divide the value of N_2 by 2. This divides the frequency output percentage by 2.

Note: Follow this step and Step 5 carefully. Whenever N_2 changes according to this step, the setting of switches S704 and S705 will change according to Step 5.

5. According to Step 3, the new setting of N_2 produces the desired frequency output. Therefore, if the value of N_2 is changed according to Step 4, the frequency output is no longer correct. Switches S704 and S705 compensate for the change.

When the change in the value of N_2 multiplies the frequency output by 2 (Step 4a), switches S704 and S705 are incremented to divide the frequency output by 2.

When the change in the value of N_2 divides the frequency output by 2 (Step 4b), switches S704 and S705 are decremented to multiply the frequency output by 2.

Thus, the final frequency output is correct. Table 4-2 shows the setting of switches S704 and S705 for different frequency-output ranges.

To change switches S704 and S705:

5a. If the value of N_2 was doubled according to Step 4a, turn S704 (or S705) one position clockwise. This divides the frequency output by 2.

5b. If the value of N_2 was halved according to Step 4b, turn S704 (or S705) one position counterclockwise. This multiplies the frequency output by 2. The second note in Section 4.4.2 describes the method for engaging S705.

6. Repeat Steps 4 and 5 until N_2 falls between 500 and 999.

7. Reset switches S701-S703 to the new setting (the final N_2 value between 500 and 999).

8. Ordinarily, the recalibration of the frequency range switches will be well within the accuracy specification, so no further steps are necessary. However, if the frequency recalibration was preceded by recalibration of the span select switch, perform Steps 1-5 of Section 4.4.2.2 to verify the new setting. If a minor calibration error exists, also perform Steps 6-11 of Section 4.4.2.2.

For example, starting with Step 1 above, suppose S701 = 6, S702 = 8, and S703 = 3. Then, the switches have an initial three-digit percentage multiplier value of 683 (68.3%). Assume the initial maximum output is 1,700 Hz. The example in Section 4.4.2 explains how the initial setting of the switches corresponds to the frequency output at calibrated full-scale flow. The desired frequency output for this example is 3,000 Hz.

Use the formula in Step 3 to determine the new frequency-range switch setting:

N_2 = 683 (3000/1700) = 1205

Following Step 4, N_2 = 1205, or 120.5%. For the initial calibration, 68.3% of the 2,489 hertz was required to output 1,700 hertz (see Section 4.4.2 for an example). To output 3,000 hertz would require 120.5% of the 2,489 hertz, which is not possible with a three-digit multiplier. Therefore, according to Step 4b, divide the value of N_2 by 2.

1205 / 2 = 603

Because of the above step, the percentage multiplier is now set to multiply the 2,489 hertz by 60.3%.

2489 X 0.603 = 1500.8

This is slightly more than half of the desired frequency output. Therefore, according to Step 5b, turn switch S704 (set at 3) one position counterclockwise (to a setting of 2). This multiplies the flow signal (2,489 hertz) by 2.

2489 X 2 = 4978

Consequently, the percentage multiplier is now set to multiply 4978 hertz by 60.3%.

4978 X 0.603 = 3001.7

For Step 7, reset N_2 to the three-digit percentage value of 60.3% (603): S701 = 6, S702 = 0, and S703 = 3. The frequency output at calibrated full-scale flow is now 3,001.7 hertz. Exactly 3,000 hertz cannot be obtained with this procedure because the percentage multiplication must be rounded to three positions. Even so, the recalibration error is less than 0.1%, within the accuracy specification of 0.2%. If you wish to verify the calibration, proceed with Step 8.

Follow these steps, if the previous switch setting is unknown:

1. Locate the frequency range in Table 4-2 which includes the desired frequency output. Reset switches S704 and S705 to the position indicated.

2. Calculate the setting of switches S701-S703 according to the following formula:

$$N_2 = F_2/F_1$$

where N_2 = New switch setting (S701-S703)
F_1 = Highest frequency within selected range
F_2 = Desired frequency output

The new N_2 is expressed as a three-digit percentage.

3. Reset switches S701-S703 to the new value.

4. At this point, a minor calibration error will exist because the signal from the drive board at calibrated full-scale flow is not exactly 10,000 Hz. Perform Steps 1-11 of Section 4.4.2.2, Frequency Range Adjustment, to adjust for this meter factor.

For example, if the desired frequency is 3,000 Hz, then according to Step 1 above, switches S704 and S705 should be set to position 2 (frequency output between 2,500 and 5,000 hertz).

Use the formula in Step 2 to calculate the new setting of switches S701-S703 (N_2):

$$N_2 = 3000/5000 = 0.600$$

The new N_2 value expressed as a three-digit percentage is 600. Reset switches S701-S703 (S701 = 6, S702 = 0, and S703 = 0).

Adjust the new calibration according to Section 4.4.2.2.

4.4.2.2 Frequency Range Adjustment

Follow these steps to adjust the frequency range after recalibration or when a calibration error exists:

1. Check the primary zero setting at normal operating temperature with no flow.

2. Run fluid into a container at a flow rate close to the maximum.

3. Weigh the fluid and compare the weighed (reference) mass to the metered mass.

4. Record both mass quantities.

5. If the above procedure indicates a calibration error, perform Steps 6-11 below. Otherwise, no adjustment is necessary.

6. Use the formula below to determine the new setting of frequency range switches S701-S703.

where $N_2 = N_1 (M_s/M_f)$
N_2 = New switch setting (S701-S703)
N_1 = Initial switch setting (S701-S703)
M_s = Scale mass (weighed)
M_f = Flowmeter mass (metered)

7. N_2 must fall between 500 and 999.

To obtain a setting between 500 and 999:

7a. If N_2 is less than 500, multiply the value of N_2 by 2. This multiplies the frequency output percentage by 2.

7b. If N_2 is greater than 999, divide the value of N_2 by 2. This divides the frequency output percentage by 2.

8. Any change in the value of N_2 according to Step 7 requires adjustment of switches S704 and S705.

To adjust switches S704 and S705:

8a. If the value of N_2 was doubled according to Step 7a, turn S704 (or S705) one position clockwise. This divides the frequency output by 2.

8b. If the value of N_2 was halved according to Step 7b, turn S705 (or S705) one position counterclockwise. This multiplies the frequency output by 2.

9. Repeat Steps 7 and 9 until N_2 falls between 500 and 999.

10. Reset switches S701-S703 to the new setting (the N_2 value between 500 and 999).

11. Repeat Steps 1-5 in this section to verify the new setting.

For example, assume Steps 2 through 5 produce the following data:

The fluid mass weighs 100.0 pounds, the meter indicates 101.3 pounds, and the switches are set at 603 (S701 = 6, S702 = 0, and S703 = 3). Since the difference between the weighed mass and the metered mass exceeds the expected accuracy (± 0.2%), a calibration error exists. Steps 6-11 must be performed.

Use the formula in Step 6 to determine the new setting of switches S701-S703:

$$N_2 = 603\ (100.0/101.3) = 595$$

If in following Steps 7, 8, and 9, the new setting (595) falls between 500 and 999, then no adjustment of S704 or S705 is necessary. Simply reset switches S701-S703 to the new value. Thus, S701 = 5, S702 = 9, and S703 = 5.

Finally, verify this new setting according the Steps 1-5 above.

Customer Service: For recalibration assistance, the Micro Motion Customer Service Department can be reached at 1-800-522-MASS/6277 (in Alaska or Colorado, call 303-530-8400). This "800" phone number can be used for 24-hour emergency assistance, except in Alaska or Colorado.

5 Trouble-Shooting

5.1 General Guidelines

There are a number of general guidelines that should be followed when trouble-shooting a Micro Motion flowmeter. First, before beginning the diagnostic process, ensure that the flowmeter has been installed consistent with the Micro Motion Installation Planning Guide for the flowmeter model being used. This instruction manual provides important, detailed information and drawings pertaining to proper installation of the flowmeter.

Second, verify that there are no problems with the reference that indicates the meter is in error or malfunctioning.

Third, if possible, leave the meter in place when trying to trouble-shoot a problem. Problems are often a result of the specific environment in which the meter operates.

Fourth, check all signals under both flow and no-flow conditions. The procedures described below should be used. Also, Table 5-2 shows the resistance values for the drive, left, and right position-detector (pick-off) coils. This procedure guarantees that no causes or symptoms will be overlooked.

5.2 Symptom Definitions

In order to effectively trouble-shoot a malfunctioning flowmeter, the symptoms of failure must be accurately identified. Once this is accomplished, their causes can be eliminated. As previously stated, the problem should be specified in as much detail as possible. Following are the four main symptoms found in the field and their definitions.

No Output: A no output condition exists when there is flow through the meter and no output is registered.

Unresponsive Output: The output remains constant even though the actual flow rate changes.

Erratic Output: The output changes randomly, i.e., it is unrelated to changes in actual flow rate, it is erratic.

Intermittent Output: Intermittent output starts and stops randomly. While present, the output accurately reflects the flow rate.

5.3 Corrective Maintenance; Trouble-Shooting

On new installations, most malfunctions result from mounting, piping, or wiring problems. Check these items before attempting service on the meter. Also, the calibration setting should agree with the calibration data label. Use Figure 1-1 to locate the various REU circuit boards.

Trouble-shooting procedures for different meter problems are given in Sections 5.3.1 through 5.3.10. Table 5-1 outlines which procedures should be followed to correct the most common problems. Follow the procedures in the order given to expedite problem correction.

DANGER: SOME TROUBLE-SHOOTING PROCEDURES REQUIRE AN OPERATING FLOWMETER. EXERCISE EXTREME CARE TO AVOID CONTACT WITH LIVE ELECTRICAL PARTS, OTHERWISE, PERSONAL INJURY OR DAMAGE TO METER COMPONENTS COULD RESULT.

5.3.1 Input Power Wiring

Incorrect wiring, power supply problems, or blown fuses may cause no output or erratic output. Follow these steps to isolate problems of this type:

1. Make sure the meter is ON and fluid is flowing; the zero indicator light should be lit. If the zero indicator light is lit, the problem is not the input power; proceed to the next section suggested in Table 5-1. If the zero indicator does not light, continue with Steps 2 through 6.

Table 5-1
Trouble-shooting

Problem	Trouble-Shooting Steps to Follow
No Output	5.3.1, 5.3.2, 5.3.3, 5.3.4
Erratic Output	5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.6, 5.3.7, 5.3.8, 5.3.9
Zero Instability	5.3.5, 5.3.6, 5.3.7, 5.3.8, 5.3.9,
Calibration Error	5.3.10, 5.3.5, 5.3.6, 5.3.7, 5.3.8, 5.3.9

2. Remove the terminal covers and the electronics compartment cover.

3. Check both the incoming power connections (Section 2.3) and the signal-wiring cable connection (Section 2.4) to be sure the meter is receiving power. Make any necessary corrections and observe the output.

Note: If a DC power supply is being used, check the power source. The meter requires 1 amp minimum for start-up.

4. Shut off flow and power to the meter.

5. Remove the input voltage board and check the fuses. Replace any blown fuses according to Section 3.6.2. Part numbers for replacement fuses are given in Appendix IV.

Note: The supply voltage must agree with the voltage stated on the input voltage board.

6. Check for signal continuity (Section 5.3.4).

5.3.2 Flow Direction Wiring

Check the flow-direction wiring connections to terminals 13, 14 and 15 according to Section 2.5.2. If the wiring does not correspond to the flow direction, the analog output will decrease with increasing flow and the frequency output will not register. For units which can display bidirectional flow, such as the Micro Motion DRT, the unit will display only forward flow, unless a jumper is installed between REU terminals 14 and 15.

5.3.3 Output Devices

If the meter is sending an accurate signal to the output displays, but the displays do not register, the problem is in the receiving device. The meter must be ON and have fluid flowing to check the output signal to the receiving devices.

Follow these steps **to check the analog output:**

1. Temporarily remove the analog board.

2. Check the accuracy of the output select-switch setting (see Section 3.3.7). If it is incorrect, change the setting, reinsert the board, and observe the output.

3. Disconnect the output wires.

4. If the output select switch is correctly set, but set for milliamps, remove the analog board and temporarily flip the select switch to deliver a voltage output.

5. Reinsert the analog board.

6. Connect a voltmeter to the analog output and return terminals (normally 17 and 16, respectively).

7. If the voltmeter registers an output voltage corresponding to flow rate, disconnect and check the receiving device.

8. If the analog output decreases with increasing flow, check the flow direction wiring (Sections 2.5.2 and 5.3.2). If there is no apparent output, check the signal continuity (Section 5.3.4).

→ **Note:** If the meter output is in milliamps, be sure to reset the select switch before reattaching the output device.

Follow these steps **to check the frequency output:**

1. Connect a frequency counter, such as a Micro Motion DRT, to the output and return terminals of the flowmeter frequency output (normally 19 and 18, respectively).

2. If the frequency counter registers an output corresponding to flow rate, disconnect and check the receiving device.

3. If there is no apparent pulse output, first check the flow direction wiring, (Sections 2.5.2 and 5.3.2) and then check the signal continuity (Section 5.3.4).

5.3.4 Signal Continuity

The preceding steps help isolate signal problems at the input and outputs. This section provides steps for following the signal through the meter, from the sensor to the isolation board within the REU.

Follow these steps **to check the position detectors and drive coil** within the sensor:

1. Turn OFF power to the meter. If the installation makes this too difficult, remove the input voltage board, being very careful not to touch any live connections or fuses.

2. Remove the safety board.

3. Check the resistance of the position detectors and drive coil with an ohmmeter. The leads of the ohmmeter should be connected to the following terminals:

To check:	**Use:**
Right position detector	terminals 6 and 8
Left position detector	terminals 6 and 7
Drive coil	terminals 1 and 2
Lead-length compensator	terminals 3 and 6

4. Compare actual resistance values to the nominal values in Table 5-2. Values should be close to those indicated if the process is near room temperature. To calculate resistances at other temperatures, refer to the Note at the bottom of Table 5-2. More importantly, the two position detectors should have resistance values within 10% of each other. If not, the problem is within the sensor.

Note: There are no user serviceable parts in the sensor. Contact the factory.

Follow these steps **to check the resistance temperature device (RTD):**

5. Check the RTD by connecting the leads of an ohmmeter to terminals 6 and 9. The value should range between 95 and 112 ohms at room temperature. Refer to the Table 5-2 Note to calculate resistance values for other temperatures.

Note: If the RTD is open, the meter will indicate 30-50% lower than true flow rate. The RTD is within the sensor; consult the factory for service.

Follow these steps **to check the signal board:**

6. Using a voltmeter, check for ±10 V and ±15 V on the test points (see Table A-2 and Figure A-15 in Appendix III). If the +15 or -15 V is missing, replace the drive board. If the +10 or -10 V is missing, replace the signal board. Refer to Appendix IV, Replacement Parts List, and Section 3.6, Circuit Board and Fuse Replacement.

Follow these steps **to check the drive board:**

7. With the meter ON and process fluid flowing, use a frequency counter to check the pulse output. The pulse test point should indicate 0 pulses at no flow, approximately equal to 10,000 Hz at calibrated full-scale flow. With a voltmeter, check for +1.5 to +9 VDC on the drive-gain test point (see Table A-1 and Figure A-12 in Appendix III). Replace the drive board if there is no signal. A high voltage may indicate that the sensor tube assembly is not vibrating. The problem may be system-related. Contact the factory. Refer to Appendix IV, Replacement Parts List, and Section 3.6.

Follow these steps **to check the isolation board:**

8. Check the fuses. Replace according to Section 3.6.2, if necessary. Order replacement fuses according to Appendix IV.

CAUTION: The isolation board fuses are 1/32 amp. Use a low milliamp ohmmeter when checking fuses to avoid blowing them.

9. Check for +15 V on the isolation-board test point. Use the negative side of component C400 (see Figure A-10) as the reference ground. If no voltage is present, replace the isolation board. Refer to Appendix IV, Replacement Parts List, and Section 3.6.1, Circuit Board Replacement.

5.3.5 Primary Zero Adjustment

Check to be sure no air or gas bubbles have accumulated in the sensor tube during the adjustment process. See the Installation Planning Guide for your size sensor for recommended sensor orientation. Also, the process fluid must not be flashing or boiling inside the sensor tubes. If these possibilities have been eliminated, adjust the primary zero according to Section 3.2.1.

5.3.6 Shutoff Valves

Check all in-line shutoff valves for leaks. Leakage could result in actual flow through the meter. A downstream shutoff valve is recommended to ensure actual zero flow when setting the primary zero adjustment.

5.3.7 Pipe Supports

Process piping can occasionally resonate at the same frequency as the sensor tube assembly. Additional pipe supports prevent this problem. Refer to the Installation Planning Guide for the sensor being used.

5.3.8 Low Level Noise

To filter out undesirable low-level noise such as extraneous vibration, refer to Sections 3.3.2 and 3.3.4 for time constant and frequency-cutoff potentiometer adjustments.

5.3.9 Calibration Settings

Compare the switch settings on the signal and frequency boards (refer to Figures A-15 and A-6, respectively) to the calibration data label (see Figure 3-1). These should match unless the application requirements have changed. If the application has changed, the switch settings should comply with the new requirements. If not, follow the recalibration procedures described in Section 4. If the calibration settings are correct, but the measurement does not appear accurate, run a performance check (see Section 3.4).

CAUTION: Retain a record of the original factory calibration settings as indicated on REU Calibration Data Label.

5.3.10 Recalibration

Section 3.3 describes the adjustable items on the meter. Any recalibration procedure (see Section 4) should be followed by a performance check (see Section 3.4).

5.4 Customer Service

The Micro Motion Customer Service Department can be reached at 1-800-522-MASS (in Alaska or Colorado, call 303-530-8400). This "800" phone number can be used for 24-hour emergency assistance, except in Alaska or Colorado.

Table 5-2 Coil Resistances (in ohms)

Sensor Model #	Drive Coil	Position Detector Coils (left and right)
DS006S	2900 ± 200	315 ± 30
DH006S	2900 ± 200	315 ± 30
DS006H	515 ± 50	315 ± 30
DS012S	1290 ± 120	290 ± 30
DH012S	1290 ± 120	290 ± 30
DS012H	295 ± 30	290 ± 30
DS012T	1290 ± 120	290 ± 30
DS025S*	2570 ± 200	195 ± 20
DH025S*	2570 ± 200	195 ± 20
DS025H	2570 ± 200	195 ± 20
DS040S	380 ± 40	290 ± 30
DH040S	380 ± 40	290 ± 30
DS040H	380 ± 40	290 ± 30
DS100S	105 ± 10	290 ± 30
DH100S	105 ± 10	290 ± 30
DS100H	105 ± 10	290 ± 30
DL100	105 ± 10	290 ± 30
DS150S	105 ± 10	290 ± 30
DH150S	105 ± 10	290 ± 30
DS150H	105 ± 10	290 ± 30
DS150R	105 ± 10	290 ± 30
DL200	45 ± 4	290 ± 30
DS300S	60 ± 6	290 ± 30
DH300S	60 ± 6	290 ± 30
DS300H	60 ± 6	290 ± 30
DS300R	60 ± 6	290 ± 30
DS600S	8 ± 1	290 ± 30

*Balanced meter

→ **Notes:** 1. Resistance readings are with dry/empty sensor tubes. These are nominal values at room temperature. Temperature alters resistance by 40% per 100°C. The actual resistance values will be higher or lower than the values shown, as temperature increases or decreases respectively.

2. The resistance of the left and right position-detector coils should be within 10% of each other.

3. The resistance values shown may not apply to older sensors.

Appendix I Remote Zero Option

1.0 Description

The Remote Zero Option is used to zero a Remote Electronics Unit (REU) when the unit is mounted in an explosion-proof enclosure or in an installation where occasional re-zeroing is impossible or difficult. An explosion-proof switch mounted externally activates the remote zero circuit on the signal board and allows the REU to zero itself. Other switching arrangements are possible for activating the remote zero circuit.

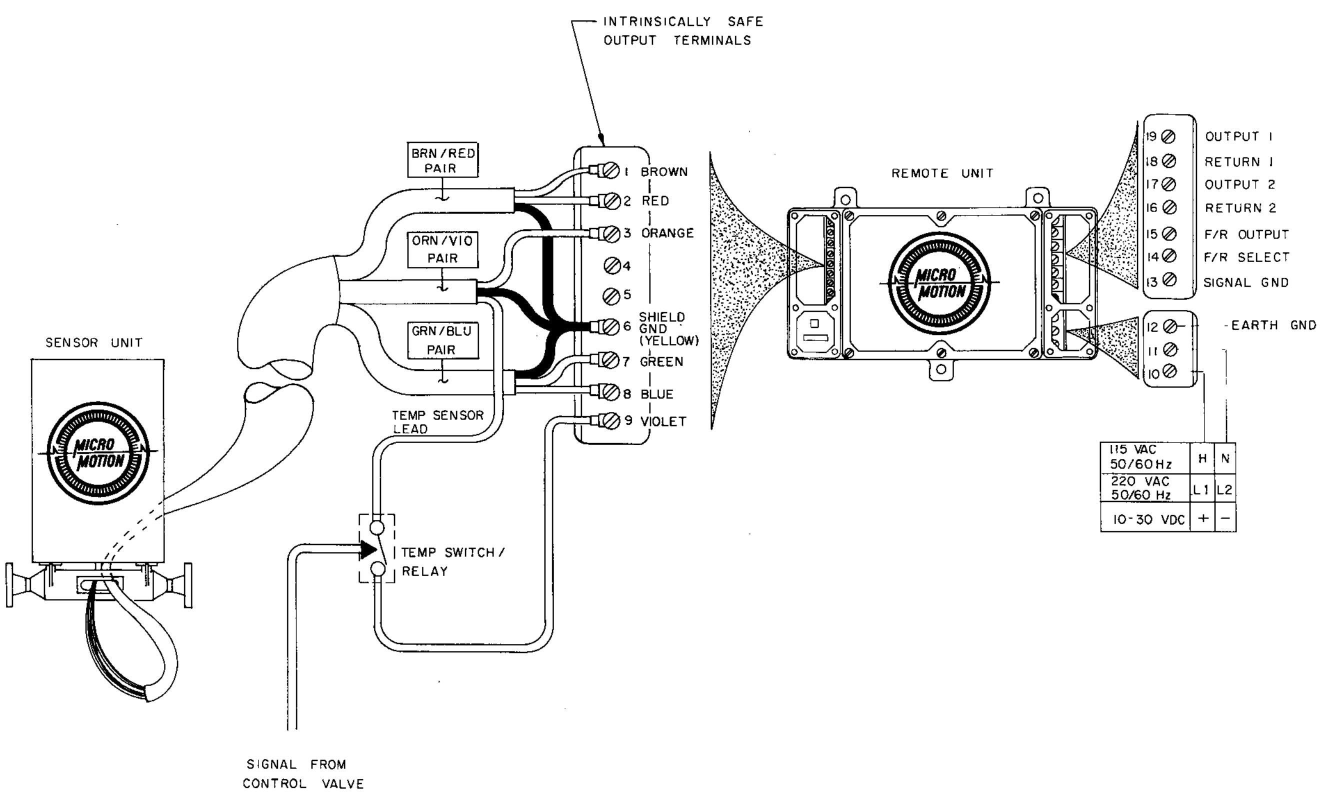
2.0 Installation

Installation of a mass flowmeter with the Remote Zero Option is the same as for any other Micro Motion meter with one exception. A switch must be placed in the temperature sensor wire between the sensor unit and terminal #9 of the REU (see Figure A-1).

2.1 Wiring

The switch should be wired to be closed under normal operating conditions (i.e., contacts N.C.). When zeroing is required, the switch should be in the open position for approximately 10 seconds. When the REU is mounted in a Micro Motion supplied explosion-proof enclosure, an externally mounted explosion-proof switch is provided for this purpose.

Figure A-1
Temperature Switch Wiring

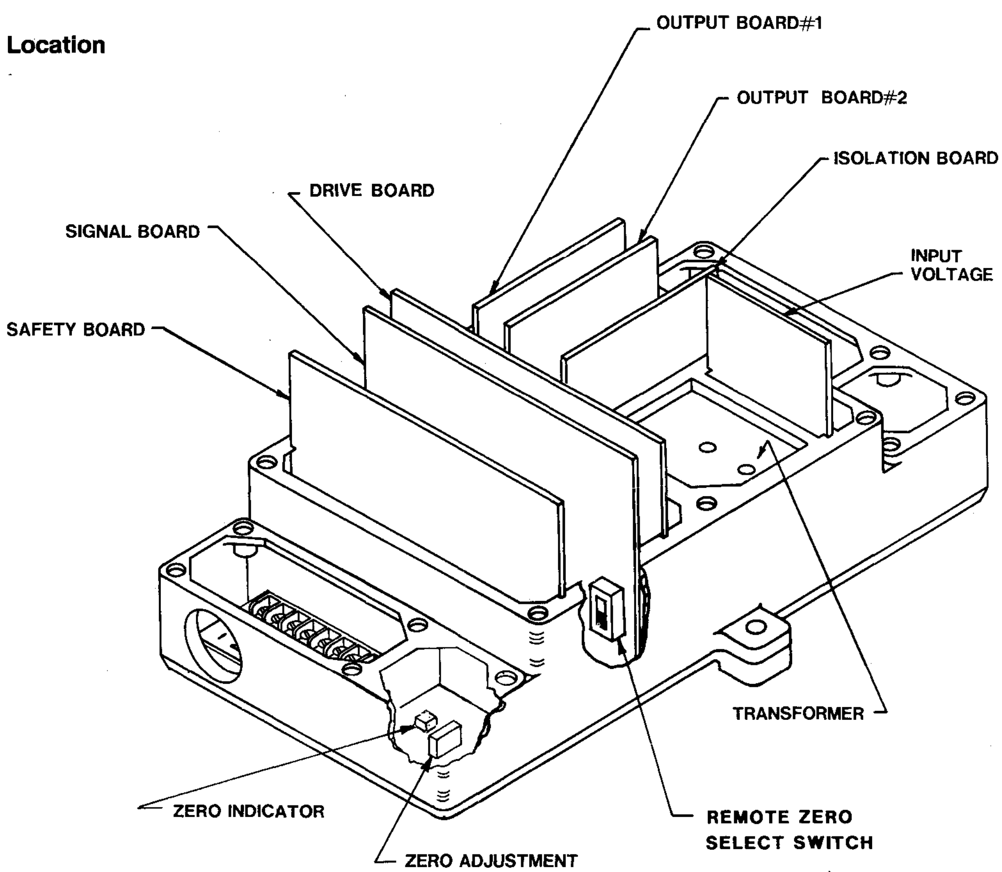


3.0 Set-Up

The remote zero selector switch is located on the back of the signal board within the REU compartment (see Figure A-2). When the switch is in the up position (see Figure A-3), the meter is in the manual zero mode. When the switch is in the down position, the meter is in the remote zero mode.

Initially, the remote zero select-switch should be placed in the up (manual) position and the temperature sensor switch should be closed. Follow the primary zero adjustment procedure as described in Section 3.2.1 of this manual. After properly zeroing the REU, place the remote zero select-switch in the down (remote) position. The flowmeter will now be in the remote zero mode.

Figure A-2
Remote Zero Switch Location



(ZERO INDICATOR AND ADJUSTMENT ARE RECESSED)

3.1 System Considerations

1. Leaky valves and improper mounting of the meter will cause a false zero reading, resulting in non-linear and erroneous output.

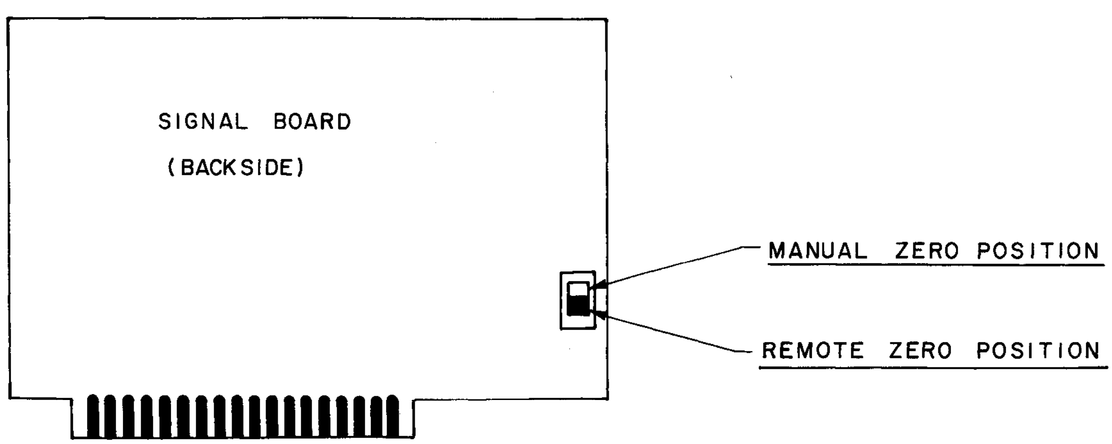
2. A non-calibrated condition will occur if there is flow through the meter while the temperature sensor switch is open. The remote zero circuit will interpret the flow signal as a zero offset and try to adjust it accordingly.

Note: If power to the meter is lost, the auto-zero must be reset.

4.0 Operation

Interrupting the signal from the temperature sensor activates the remote zero circuit. This circuit compares the primary flow signal (sig out) to ground. At zero flow, the voltage should be zero (ground). The Remote Zero Option electronically adjusts any discrepancy. It extinguishes the red or green light just as manual adjustment of the primary zero does. To remotely zero an offset of 20 mV takes approximately 10 seconds. Flow should not be resumed until the light is extinguished.

Figure A-3
Remote Zero Switch Positions



Appendix II Slug Flow Board Option

1.0 Introduction

Systems where the mass flowmeter is normally full, but occasionally acquires gas vapors in the piping in the form of slugs, may require special monitoring. Also, during the loading or unloading of fluids from such places as tanker transports, batching tanks, or holding tanks, special monitoring may be desirable. The Slug Flow Inhibit Board is intended for use in systems susceptible to slug flow, and on loading/unloading applications. This board has been designed to replace the Remote Electronics Unit signal board.

2.0 Principle of Operation

The Slug Flow Inhibit Board monitors the density of the fluid in the sensor tubes. If the fluid density falls out of the normal operating range, the board inhibits the output of flow pulses. Typically, fluid densities will range between 0.5 specific gravity (SG) and 3.0 SG, however, gas densities are much less than 0.5 (based upon water as the reference). Therefore, the board is normally set-up to inhibit the output of flow pulses when the fluid density is less than 0.5 SG.

In some instances, when the sensor is filled with fluid from an initially empty state, the vibrating U-tubes may become unbalanced, causing the flow rate indication to jump excessively high. To minimize errors associated with this occurrence, the board also monitors the signal-out voltage. If the signal-out voltage exceeds 3.5 V, the board will inhibit the output of flow pulses. Since the full scale calibration of the meter corresponds to a voltage of 3.1 V, the meter should not be operated at flow rates greater than the calibrated maximum full-scale flow-rate. This circuit was designed for positive voltages, therefore, it will not function properly if the meter is mounted in the reverse flow orientation.

3.0 System Set-Up

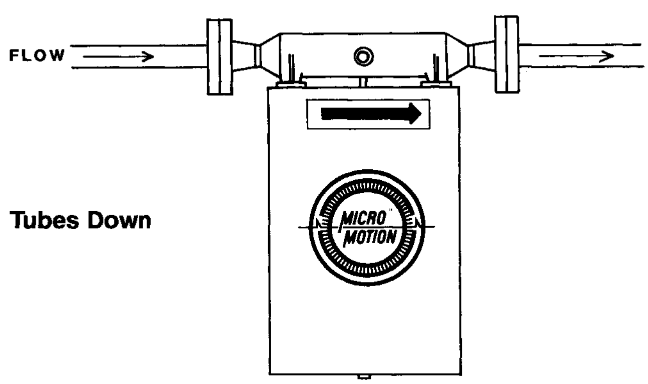
The system set-up depends upon whether the application is for loading and unloading or for a slug flow problem.

3.1 Slug Flow

If the Slug Flow Inhibit Board is going to be used for an application with a slug flow problem, the sensor should be mounted with the tubes down (see Figure 1). This should prevent slugs of air from being trapped in the sensor tubes.

Typically, when a slug of gas moves through a pipe, a quantity of liquid accompanies the slug. When the Slug Flow Inhibit Board detects the presence of the gas slug in the sensor tube, it will inhibit the output of flow pulses. Therefore, any liquid accompanying the gas slug will not be measured by the flowmeter. The flow total registered during slug flow will be somewhat less than the actual total. The amount of flow not counted by the flowmeter will depend upon the duration and number of gas slugs.

Figure 1
Recommended Mounting Orientation: Slug Flow



3.2 Loading/Unloading

If the board is going to be used in a loading/unloading application, the sensor should be mounted either in the flag position or with the tubes up (see Figures 2a and 2b). For the D300 meter, the flag mount position is preferred. A check valve located downstream of the flow sensor is recommended to prevent fluid from draining back into the sensor and being measured twice during unloading. The check valve should be mounted as close to the sensor as possible.

In loading/unloading applications, the sensor is typically empty on start-up, a batch is run, and the sensor is purged of liquid at the end of the run. In some instances the piping will not be completely purged of fluid. A flag mount or mounting with the tubes up prevents any liquid left in the pipe from draining into the flow sensor. This type of mount will insure the sensor is empty after the pipeline is purged. If fluid is allowed to drain back into the sensor, the effective specific gravity of the liquid and air in the tubes could fall into the normal operating range. This could result in the flowmeter exhibiting erroneous flow counts.

The performance of the flowmeter is very dependent upon the installation. Each application will require good engineering judgment in order to perform well. A start-up technique that has worked well for loading and unloading applications is described below:

1. Mount shut-off valves upstream and downstream of the flowmeter.

2. Close the upstream valve.

3. Open the downstream valve to allow one-quarter or less of the normal fluid flow. This will minimize the amount of fluid missed on start-up.

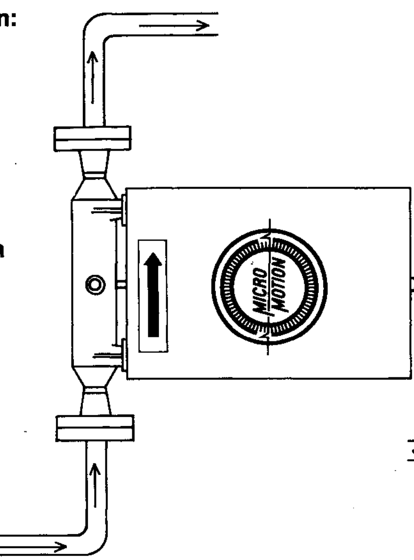
4. Slowly open the upstream valve to force the air out, and slowly fill the flowmeter. This slow opening minimizes the shock to the sensor and reduces the recovery time.

5. Once the flowmeter begins counting in a normal manner, slowly open the downstream valve until it is fully open. The amount of time required before the downstream valve can be fully opened is typically less than 2 minutes, however, the timing will depend upon the particular application.

Just as with slug flow, the Slug Flow Inhibit Board will prevent a portion of the fluid flow from being counted during loading/unloading. The amount of fluid not counted will depend upon the piping arrangement, the meter location, the fluid properties, the flow rate, and the purging method. However, if the start-up and purge operation are always performed in the same manner, the amount of fluid not measured by the flowmeter can be characterized.

Figure 2
Recommended Mounting Orientation: Loading/Unloading

Figure 2a
Flag Position



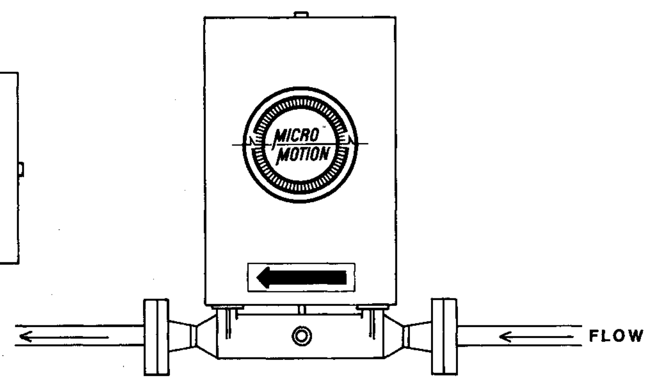


Figure 2b
Tubes Up

3.2.1 Calculating the Loading/Unloading Correction Factor

1. Place a container at the end of the pipe run.

2. Run three to five test batches representative of a normal run. Start with the sensor empty and purge the sensor at the end of each run. The batch size is unimportant as long as the pipeline is completely filled before purging.

3. Weigh the fluid.

4. Subtract the total measured by the flowmeter from the actual fluid weight. If the loading/unloading procedure is consistent, the difference calculated from the test runs should also be fairly consistent.

5. Average the results from the test runs. This is the correction factor.

When the batches are completed, the correction factor should be added to the flowmeter total to give the corrected total.

4.0 Board Set-Up

There are several techniques available for setting up the Slug Flow Inhibit Board. These techniques are discussed below. Drawings of the board are presented in Figure 3. These drawings should be referred to when performing board set-up. The Slug Flow Inhibit Board replaces the Remote Electronics Unit signal board. Be certain to set the span select switch and time constant potentiometer on the Slug Flow Inhibit Board to the same settings used on the signal board. Next, rezero the meter upon initial operation.

Note: It is recommended that the flowmeter calibration be checked when changing boards for a retrofit application.

Figure 3
Slug Flow Inhibit
Board Switch Locations

Figure 3a

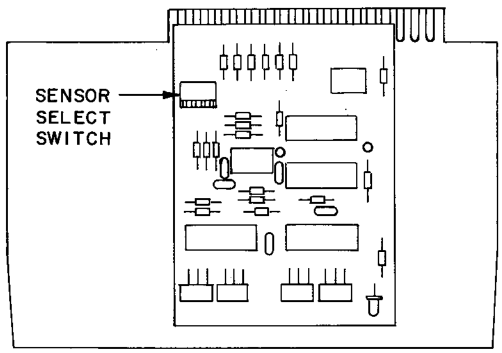


Figure 3b

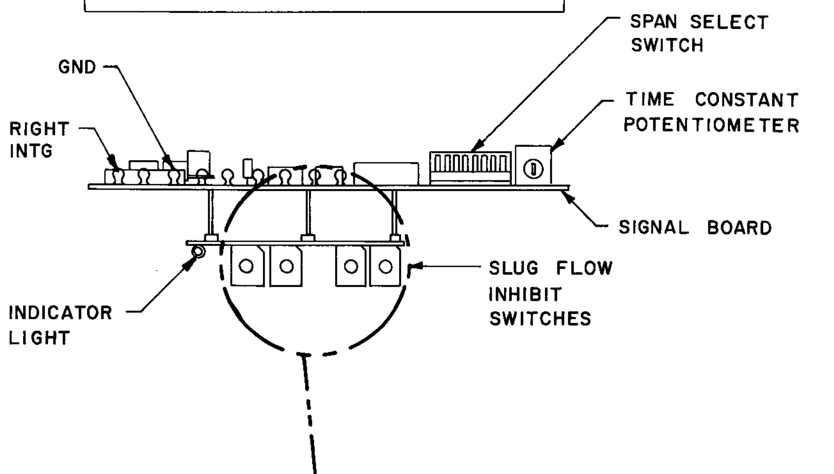
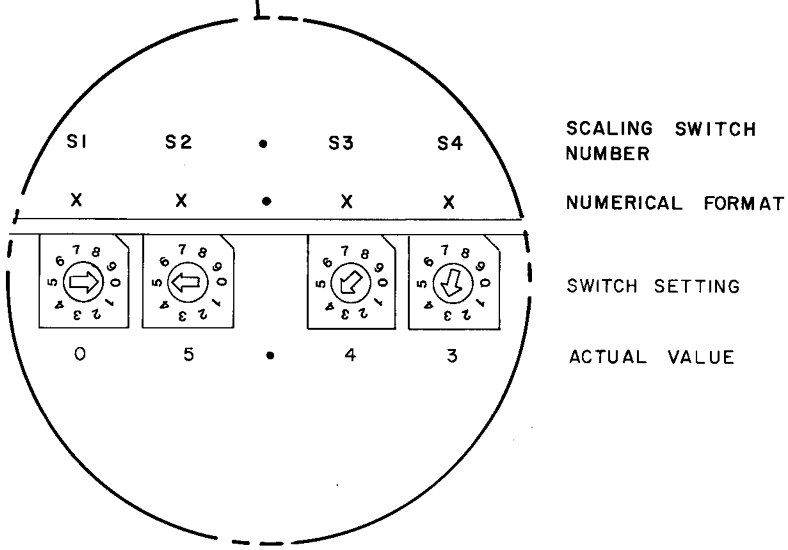


Figure 3c



Different size sensors have different natural frequencies of vibration. Therefore, a four-position dip switch (the sensor select switch) has been provided to allow the signal board to be set-up for any size sensor (see Figure 3a). Refer to Table 1 for the proper sensor select-switch settings.

Table 1
Sensor Select-Switch Settings

Sensor	Switch 1	Switch 2	Switch 3	Switch 4
D6	On	On	On	Unused
D12	On	On	On	Unused
D25	On	On	On	Unused
D25 (bal)	Off	On	On	Unused
D40	On	On	On	Unused
D100	Off	On	On	Unused
D150	Off	On	On	Unused
D300	Off	Off	On	Unused
D600	Off	Off	Off	Unused

Once the sensor model has been selected, the specific gravity inhibit-point must be determined. The simplest inhibit point set-up method is to use the factory-predetermined standard sensor settings. These standard settings inhibit the flow signal when the fluid specific gravity is less than approximately 0.5 SG. These board settings are presented in Table 2. There are several special sensor designs which will require the switch settings to be calculated. This includes any sensors which do not contain a model number listed in Table 2. Refer to Appendix B for the procedure for calculating the switch settings. If a new flow sensor and Remote Electronics Unit are purchased with the slug flow inhibit option, the board will be preset at the factory.

Table 2
Slug Flow Inhibit Standard Switch Settings

Sensor	Switch Settings
D6	05.54
D12	06.37
D25	06.27
D25 (bal)	05.84
D40	04.82
D100	06.10
D150	05.44
D300	06.00
D600	11.15

→ **Note:** Switch S1 is 1 for the D600 and 0 for all other sensors.

New switch settings can be calculated if a specific gravity inhibit-point other than 0.5 SG is desired. Refer to Section 5 of this Appendix for the procedure for calculating a new specific gravity inhibit-switch setting.

If the Slug Flow Inhibit Board is going to be retrofitted into an existing Remote Electronics Unit, the switch settings for a standard sensor may not be adequate. The Model D Mass Flowmeter design has been modified somewhat since its introduction. These modifications have changed the sensor natural frequency. Therefore, early Model D Meters will have slightly different slug flow inhibit-switch settings than those presented in Table 2.

If the standard switch settings are not adequate for a retrofit application, there are two methods available for determining the proper settings. New settings can be calculated as detailed in Section 6 of this Appendix, or the Slug Flow Inhibit Board indicator light can be used to approximate the settings fairly well. The indicator light should be on when the sensor is full of fluid. When the sensor is empty, or partially empty, flow pulses should be inhibited and the indicator light should be off. Under these conditions, the flowmeter will register flow when the light is on and will inhibit flow from being registered when the light is off. Details for using the indicator light to determine the switch settings are presented in Sections 7 and 8 of this Appendix.

Note: Due to tolerances in the various electronic components and differences in sensor natural frequencies, the calculated switch setting may not result in precise specific gravity cut-off points. The indicator light should always be used to insure that calculated switch settings are adequate. Fine-tuning during set-up may be required.

5.0 Calculating Switch Settings For Any Specific Gravity

$$SS = \frac{\sqrt{SG + A}}{B}$$

Where: SS is the value for the switch setting.
SG is the desired fluid specific-gravity inhibit-point.
A and B are calculation constants obtained from the table below.

Calculation Constants For Standard Sensors

Sensor	A	B
D6	7.65	0.516
D12	6.71	0.422
D25	8.33	0.474
D25 (bal)	3.56	0.345
D40	3.98	0.440
D100	4.10	0.351
D150	2.31	0.308
D300	1.07	0.209
D600	1.03	0.111

Example: D150 meter desired inhibit-point = 0.75 SG

$$SS = \frac{\sqrt{0.75 + 2.31}}{0.308} = 5.68$$

Switch Settings: S1=-0 S2=5 S3=6 S4=8

6.0 Procedure For Determining Calculation Constants

A frequency (or period) measuring device is required for determining the vibration period of the sensor tubes. A frequency counter, universal counter, or oscilloscope with high resolution can be used to measure the vibration period of the tubes. Tube period readings must be taken with the sensor tubes empty and then full of water.

1. Insert the Slug Flow Inhibit Board into the signal board plug-in slot. Make sure power is OFF during this operation. (See Figure 1-1 for the signal board location).

2. Connect the ground lead from the frequency measuring device to the board test point labeled GND.

3. Connect the other lead to the board test point labeled RIGHT INTG. The output will be a sine waveform.

4. Turn the power ON to the Remote Electronics Unit and the frequency measuring device.

5. Make sure the sensor tubes are empty. Record the tube period measured by the counter. (Period = 1/frequency).

6. Fill the sensor tubes with water. Record the tube period measured by the counter.

The period measured with the sensor tubes empty corresponds to a fluid specific gravity of 0. The period measured with the sensor tubes full of water corresponds to a fluid specific gravity of 1.0.

The calculation constants are determined for the sensor in the following manner:

Where $K = \dfrac{1.0}{T^2\ \text{Full} - T^2\ \text{Empty}}$

T^2 Full = Tube period for full sensor in milliseconds

T^2 Empty = Tube period for empty sensor in milliseconds

$A = K \times T^2$ Empty

$B = 2 \times \sqrt{K}$

A and B are the calculation constants

The calculation constants A and B are used to determine the switch settings. Refer to Section 5 of this Appendix for the method for calculating switch settings. Typically, the fluid specific gravity (SG) setting used is 0.5.

7.0 Using the Indicator Light for Determining Switch Settings (Sensor Cannot Be Emptied)

The following procedure describes the steps required for using the indicator light to set-up the Slug Flow Inhibit Board. This method can be used if the sensor cannot be emptied of process fluid.

1. Insert the Slug Flow Inhibit Board into the signal board plug-in slot. Make sure power is OFF during this operation. (See Figure 1-1 for the signal board location.)

2. Make sure the sensor tubes are full of process fluid. Turn the power ON to the Remote Electronics Unit.

3. Set switches S2, S3 and S4 to nines: 999. Switch S1 is zero for all sensors except the D600 where S1 is 1. The light should be off.

4. Start with switch S2 (see Figure 3c). Turn the switch counterclockwise (from 9 to 8 to 7 etc.) until the light comes on. Turn it back clockwise one notch so that the light goes out.

5. Repeat for switch S3. If the light doesn't come on, set switch S3 to 0 and go to step 6.

6. Turn switch S4 counterclockwise until the light comes on. Turn the switch back clockwise until the light just goes out.

7. Record the value of the switch settings.

The board will now be set to inhibit flow counts at the actual fluid specific-gravity. Now the switches must be set for the desired specific gravity inhibit-point.

8. Determine the desired specific gravity inhibit-point (0.5 SG is recommended).

9. Subtract the specific gravity inhibit-point from the actual fluid specific-gravity. This is the inhibit span.

Example:	Fluid specific gravity:	0.92 SG
	Inhibit specific gravity:	-0.50 SG
	Inhibit span:	0.42 SG

10. Multiply the calculated inhibit span by the appropriate scale factor presented in the table below.

Switch Setting Scale Factors

Sensor	Scale Factor
D6	0.34
D12	0.44
D25	0.31
D25 (bal)	0.72
D40	0.47
D100	0.67
D150	1.00
D300	1.90
D600	3.69

Example: D100 meter: 0.42 X 0.67 = 0.28

11. Subtract the value determined in Step 10 above from the switch setting recorded in Step 7.

Example:	Switch setting from Step 7:	5.21
	Value from Step 10:	-0.28
	Switch setting:	4.92

12. Set the switches to the value calculated in Step 11. The indicator light should be on.

13. If possible, empty the sensor of fluid to insure the indicator light goes out when the sensor is empty.

14. If ~~the~~ indicator light does not go on when the sensor is empty, the switch setting is too low. If this occurs, use the method described in Section 8 of this Appendix.

8.0 Using the Indicator Light for Determining Switch Settings (Sensor Can Be Emptied)

This method can be used if there is no available equipment for measuring the tube period or frequency.

1. Perform Steps 1 through 7 from the procedure described in Section 7 of this Appendix.

2. Empty the sensor tubes. Reset the switches S2, S3 and S4 to nines: 999. Repeat Steps 4 through 7 from the procedure described in Section 7 of this Appendix.

3. Take the average of the switch setting values for a full sensor and an empty sensor.

4. Set the switches to the average switch-setting value. This method will set the inhibit point at approximately one-half of the fluid specific gravity.

Example:	Switch setting from Step 1:	5.82
	Switch setting from Step 2:	4.82

Final Switch setting: $\frac{5.82 + 4.82}{2} = 5.32$

Appendix III Remote Electronics Unit Board Schematics

Appendix III contains schematic and assembly drawings of the printed circuit boards within the REU. A brief paragraph, which identifies the field-adjustable items and test points, accompanies each pair of drawings. The paragraph includes cross-references to the sections within this manual which cover the adjustments. Descriptions of these items are covered in Sections 3.3 through 3.3.7. The signal processing which occurs on each board is described in Section 1.2. Also, Figure 1-1 shows the location of each circuit board. The terminal points are shown on each schematic. The location of pin 1 of each terminal socket is shown on the interconnection-board assembly drawing.

Analog Board

The analog board (Figures A-4 and A-5) has three adjustable items. The analog output selection-switch (S800) is labeled Output Select on the board. The volt/milliamp choices it provides are also labeled. Reset it according to Section 4.3.1.1. The analog board also has two potentiometers, the zero adjust (P801) and the range adjust (P800) potentiometers. Sections 3.3.5 and 3.3.6 cover their use.

Figure A-4
Analog Board
Assembly Drawing

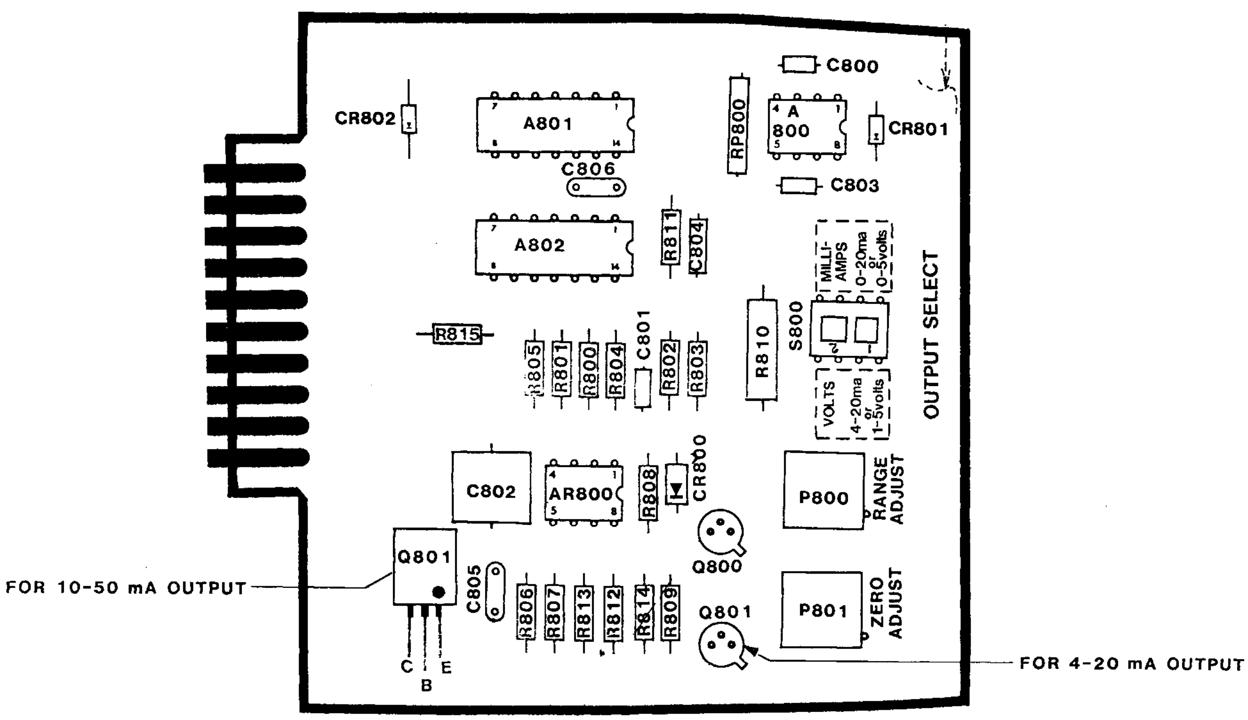
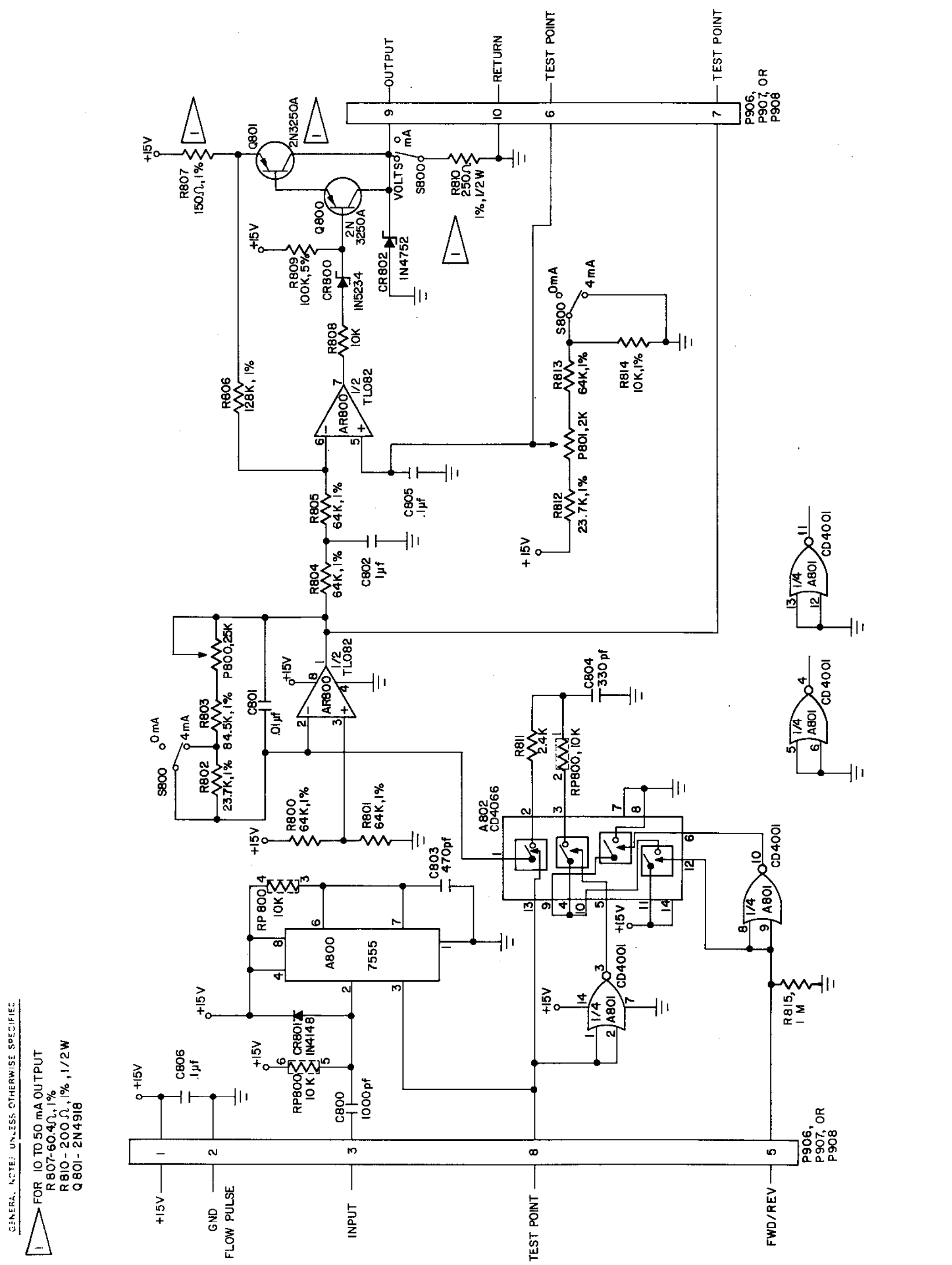


Figure A-5
Analog Board Schematic



Frequency Board

The five frequency switches (S701-S705) are located on the frequency board (Figures A-6 and A-7). Section 4.4.2 covers frequency range adjustment and recalibration of these switches. To identify the frequency range switches on the board:

S701 = S1
S702 = S2
S703 = S3
S704 = S4
S705 = S5

The calibration data label shows the factory setting of these switches.

Note: S4 and S5 together form a single rotary switch. If S4 is set between 1 and 8, the setting on S5 is not relevant. However, if the arrow in the center of S4 lines up with the arrow on the board, S5 is engaged. Then, the position of S5 between 9 and 13 determines the switch setting.

The frequency board also has a potentiometer (P700). This frequency cutoff potentiometer is labeled Zero Hole Adj.; Section 3.3.4 covers its use.

Figure A-6
Frequency Board
Assembly Drawing

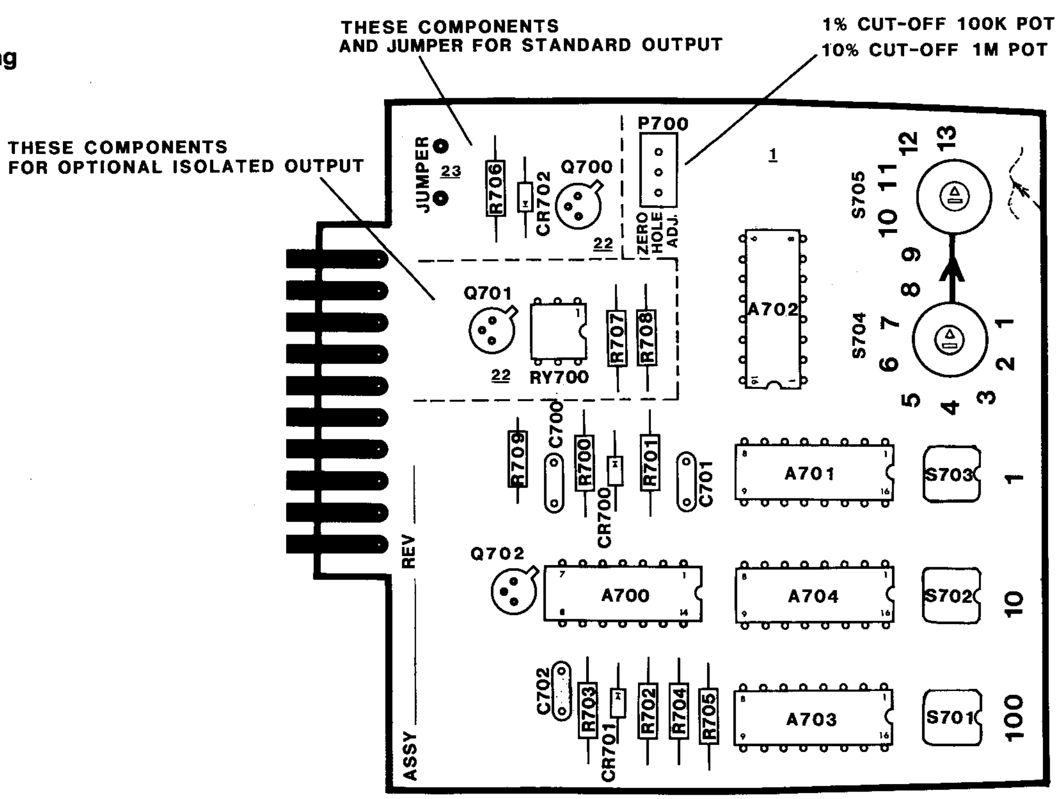
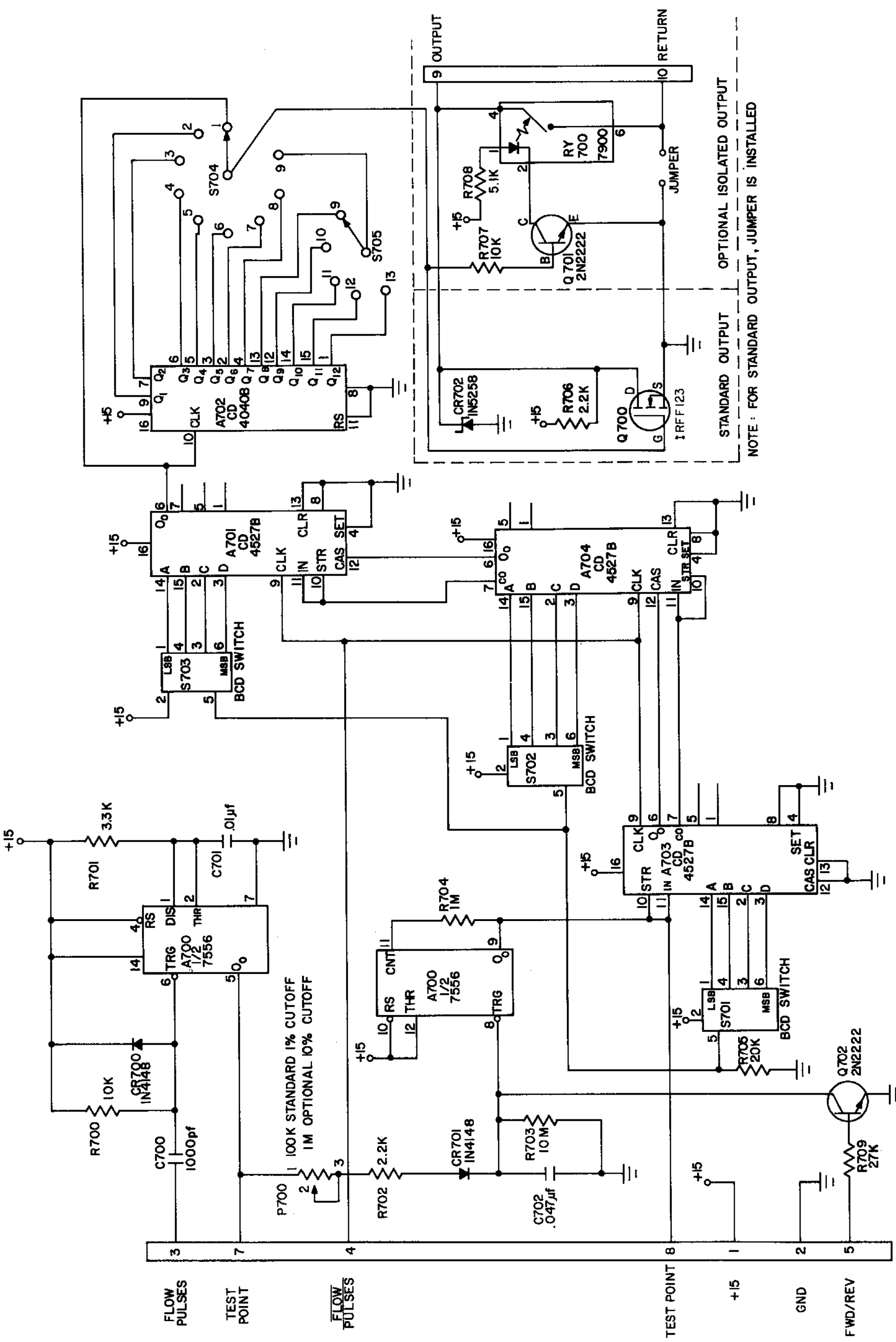


Figure A-7
Frequency Board Schematic



Safety Board

The safety board (Figures A-8 and A-9) provides a barrier between the sensor and the electronics. It has no adjustable components.

Figure A-8
Safety Board
Assembly Drawing

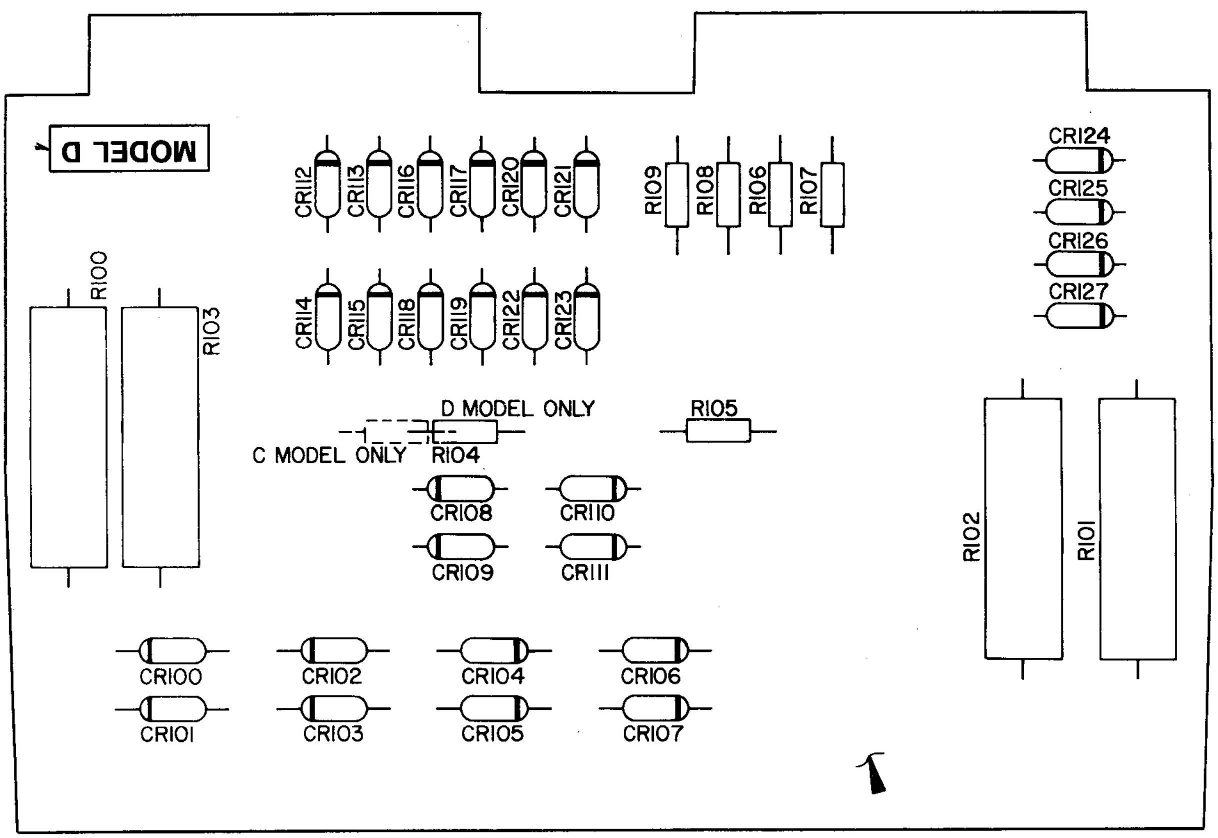
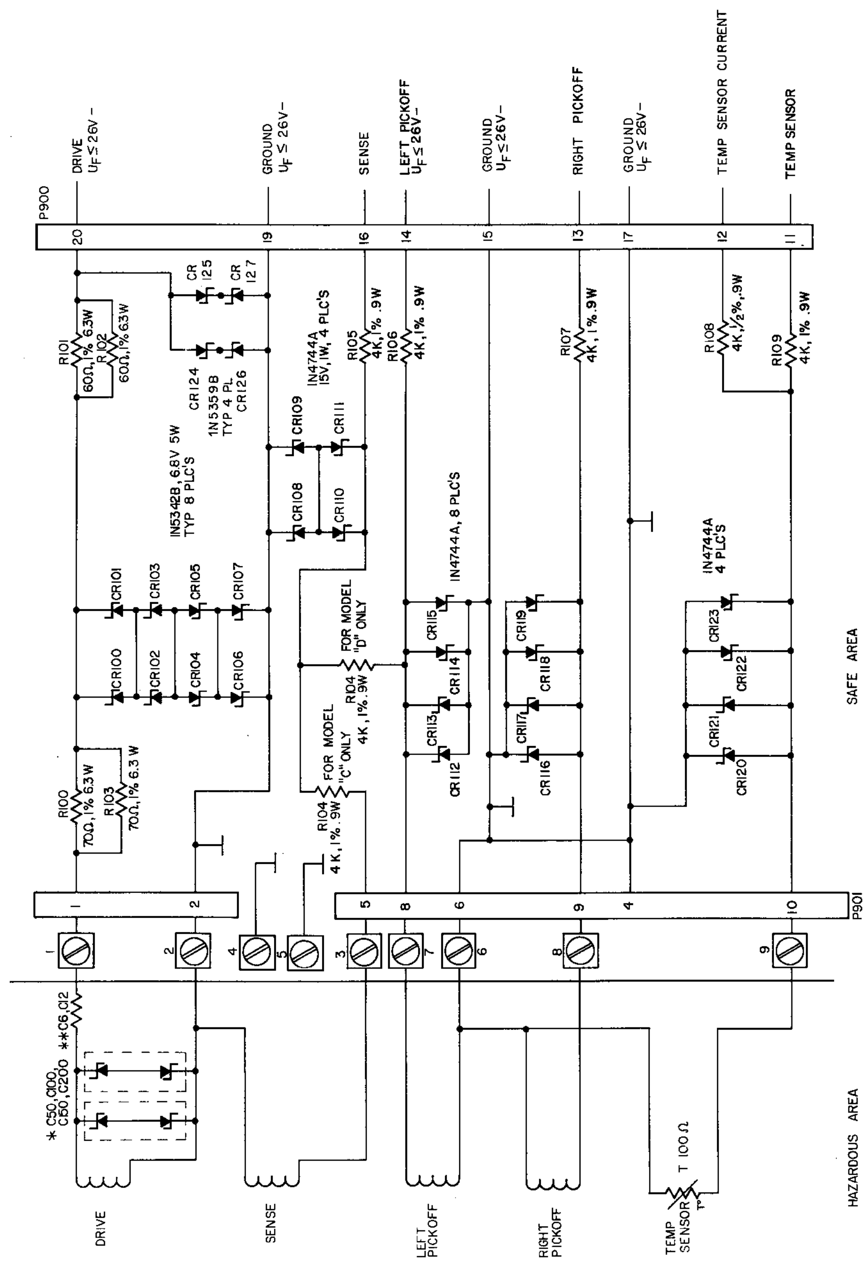


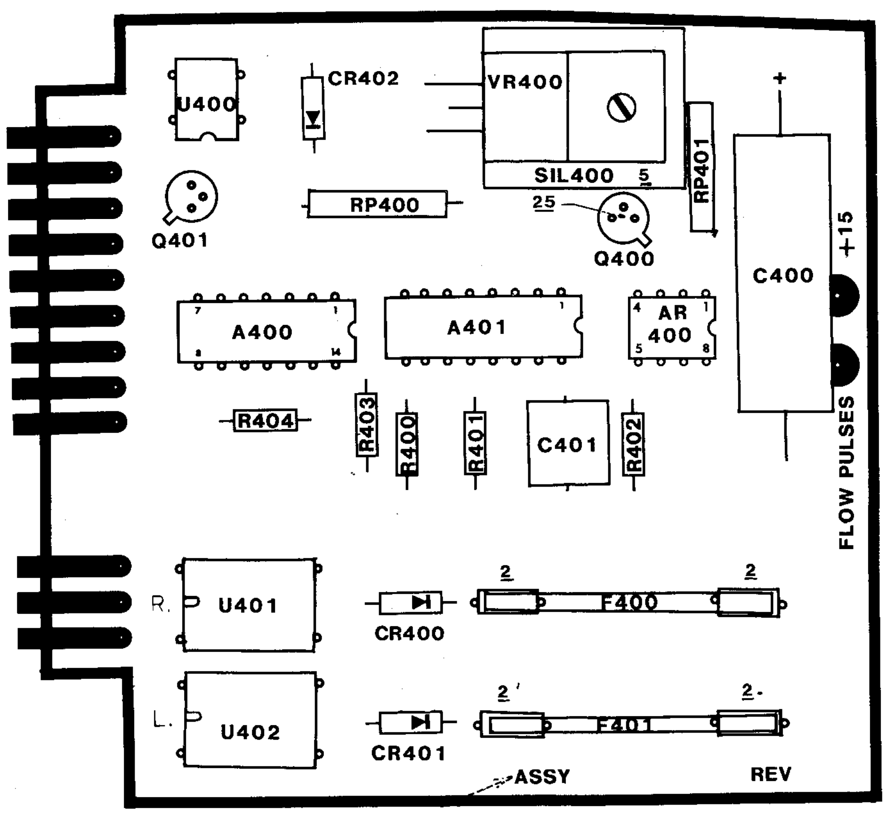
Figure A-9
Safety Board Schematic



Isolation Board

The isolation board (Figures A-10 and A-11) has two test points; one for checking flow pulses, the other for checking the voltage level. Section 5.4, Steps 8 and 9 cover troubleshooting procedures.

Figure A-10
Isolation Board
Assembly Drawing



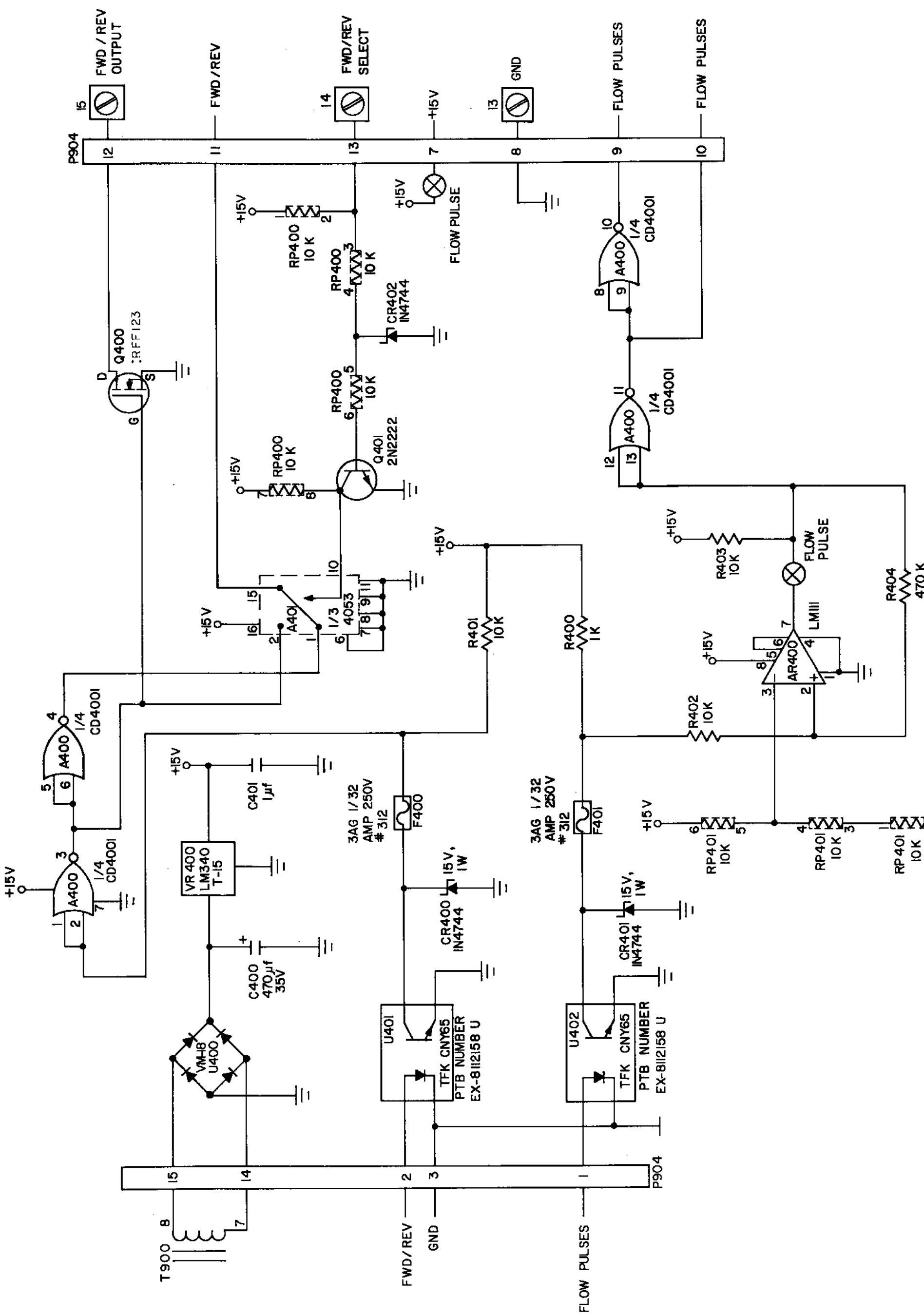
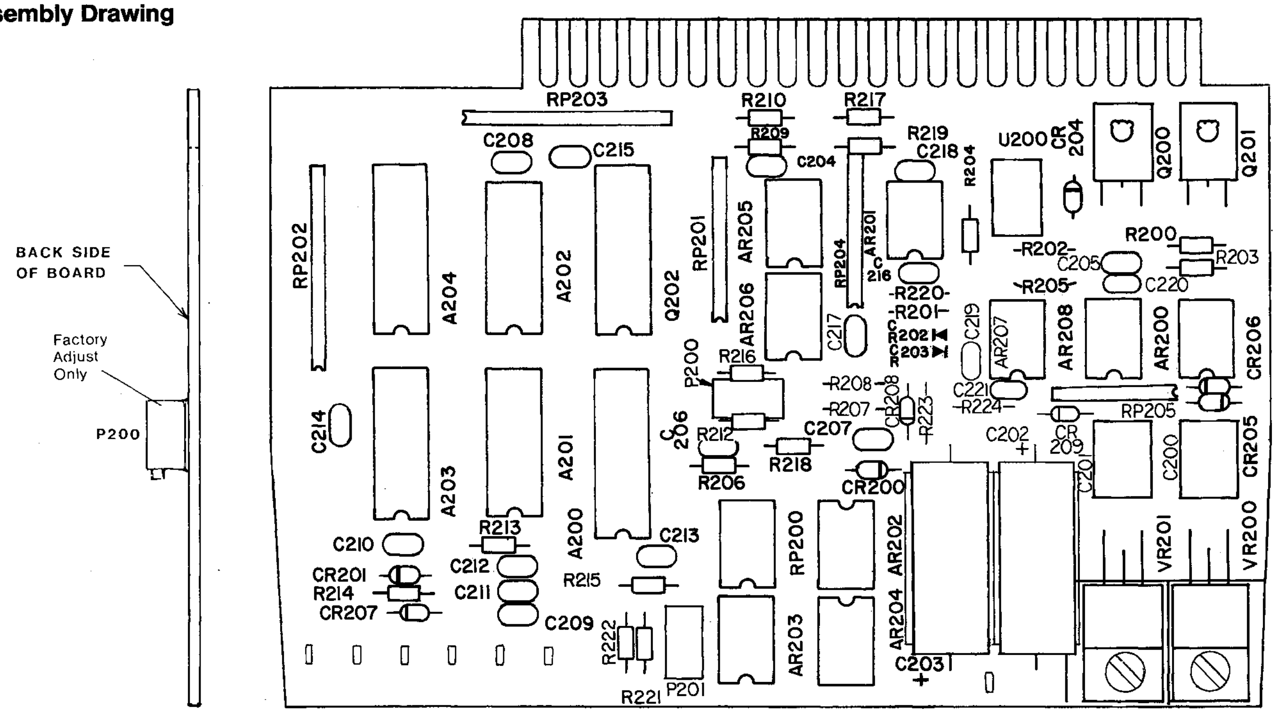


Figure A-11
Isolation Board
Schematic

Figure A-12
Drive Board
Assembly Drawing



Drive Board

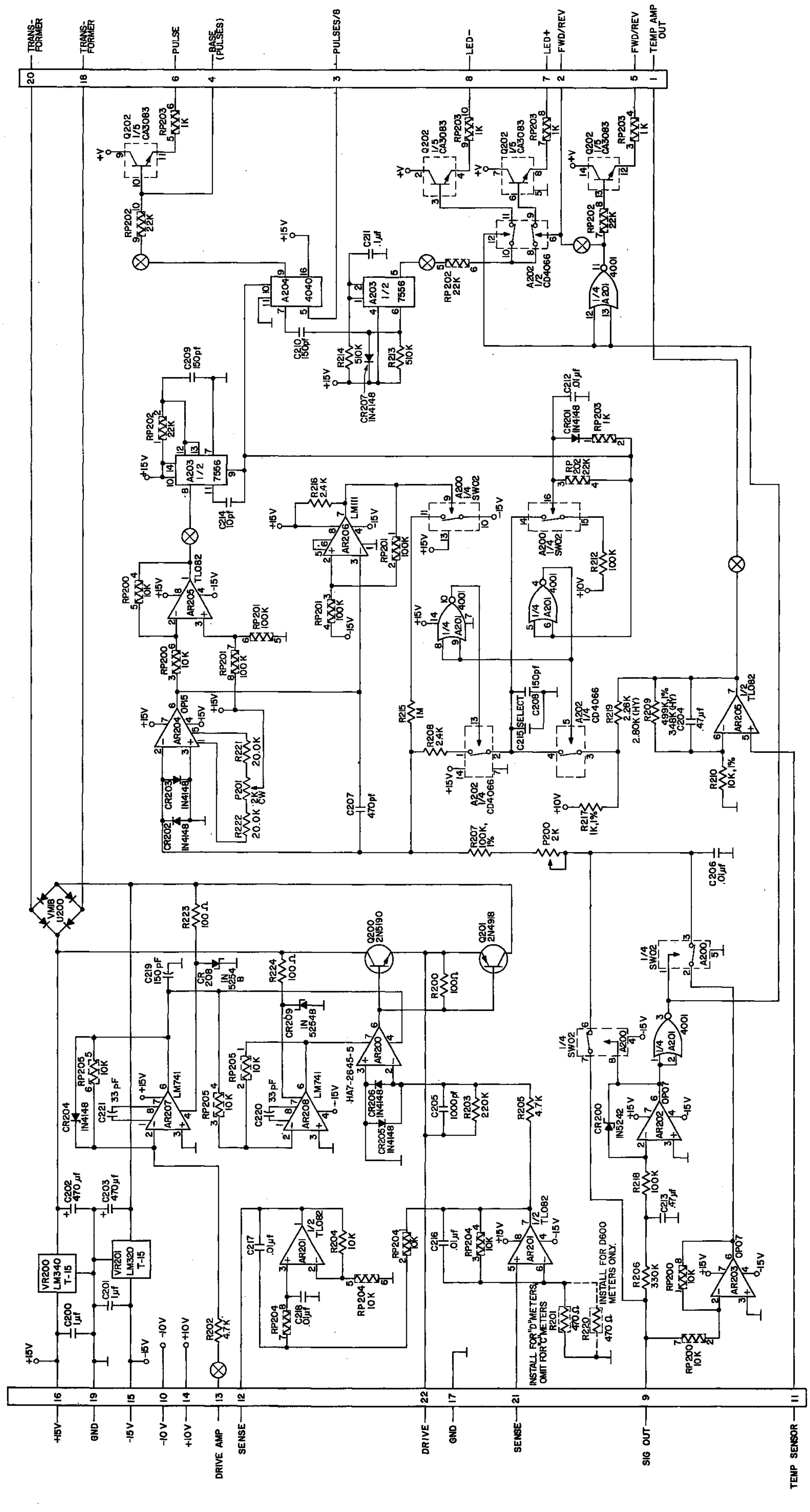
The drive board (Figures A-12 and A-13) has six test-point wires. Table A-1 describes them. Section 5.3.4, Step 7 explains the procedure for checking signal continuity on the drive board.

Note: The D600 drive board contains different components than the standard Model D drive board. It is labeled D600 and is not interchangeable with other Model D drive boards.

Table A-1
Drive Board Test Points

Test Point	Description
Pulses	A square wave; 0 VDC to +15 VDC. The frequency will vary according to flow rate. The frequency will be 0 with a no flow condition and = 10,000 Hz at maximum flow rate.
Fwd/Rev	Either 0 VDC and green zero-indicator light for forward flow or +15 VDC and a red zero-indicator light for reverse flow.
Zero Pulses	Internal use only.
Temp Amp Out	The Temp Amp Out reading increases as the temperature of the sensor. Approximately 3.6 VDC when the process fluid is near room tempterature. Increases to approximately 4.4 V at 125°F.
Pulses Intg Out	Internal use only.
Drive Gain	Range: +1.5 VDC to +9 VDC.

Figure A-13
Drive Board
Schematic



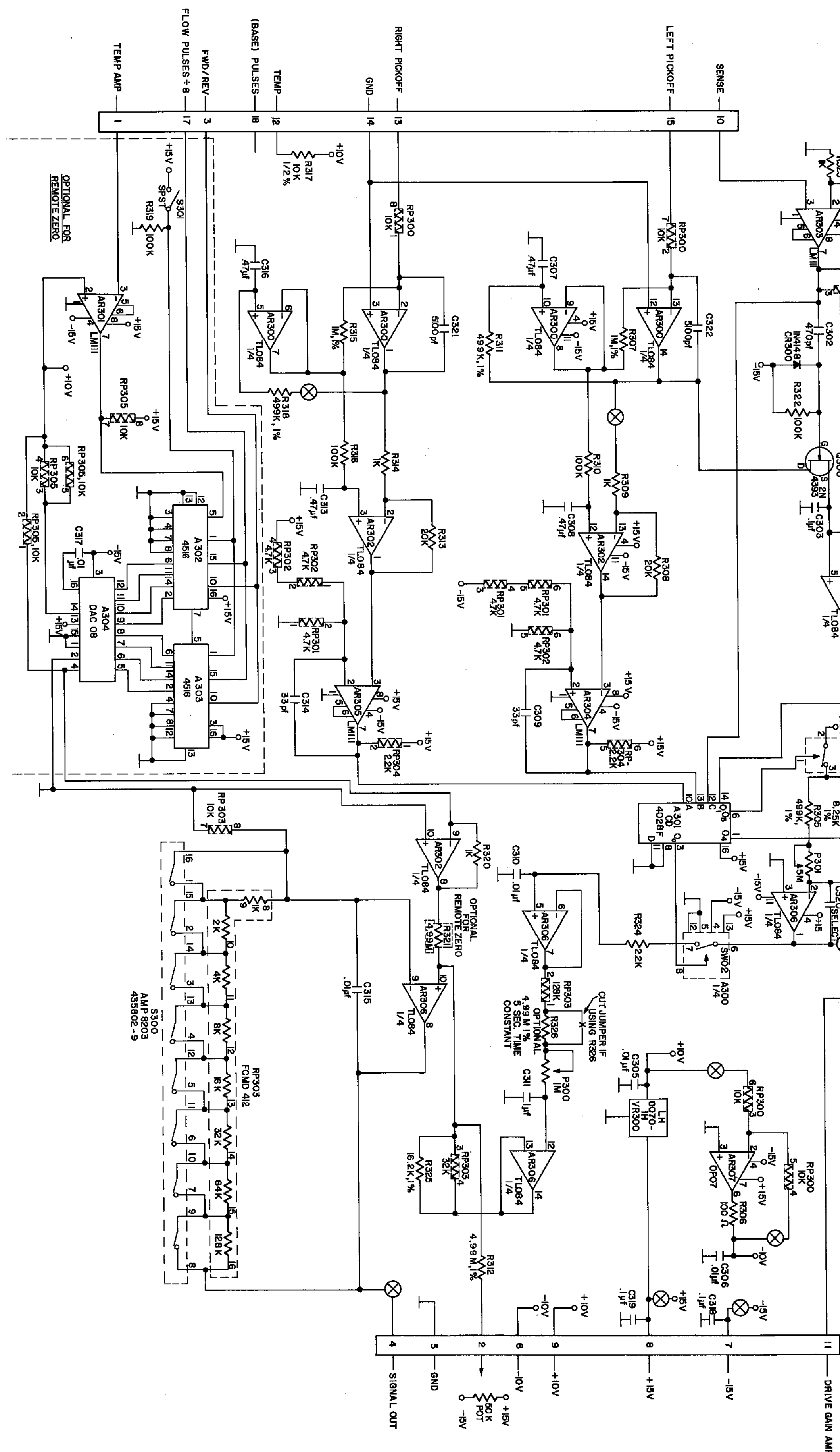
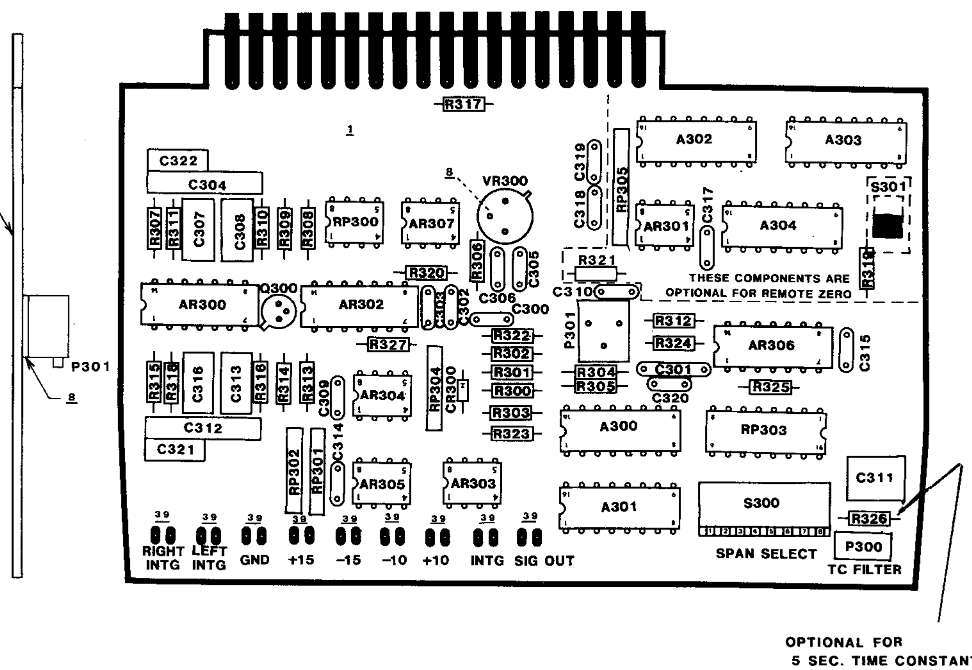


Figure A-14
Signal Board
Schematic

Figure A-15
Signal Board
Assembly Drawing



Signal Board

The user may adjust two factory-preset items on the signal board (Figures A-14 and A-15). They are the span select switch (S300) labeled Span Select on the board, and the time constant adjustment-potentiometer (P300) labeled TC Filter. Section 4.4.1 covers recalibration of the span select switch. Section 4.3.2.1 covers adjustment of the TC filter.

Table A-2 describes the signal board test-points. Section 5.3.4, Step 6 explains how to check for signal continuity on the signal board.

Table A-2
Signal Board Test Points

Test Point	Description
Left Intg	8 V p-p (2.8 RMS) and 40-150 Hz. The frequency depends upon the meter size and the process fluid.
Right Intg	Same as Left Intg, except 8 V p-p ±0.5 VDC
Gnd	Reference ground for the low voltage section of the remote electronics. Isolated from the output ground.
+15 V	+15 VDC ± 1V.
-15 V	-15 VDC ± 1V.
+10 V	+10 VDC ± 100 mV.
-10 V	-10 VDC ± 100 mV.
Intg	Square wave, base band 0 VDC at no flow, amplitude -1.5 to -4 VDC. With flow, there will be a step seen on the positive-going wave form.
Sig out	Range: approximately ±3 VDC. 0 VDC at no flow, +3 VDC at maximum forward flow, -3 VDC at maximum reverse flow.

Interconnection Board

The interconnection board schematic shows the connections from terminal points on each board to the other boards and the output terminals. The assembly drawing shows where pin 1 of each board is located when the board is in the socket.

Figure A-16
Interconnection Board Assembly Drawing

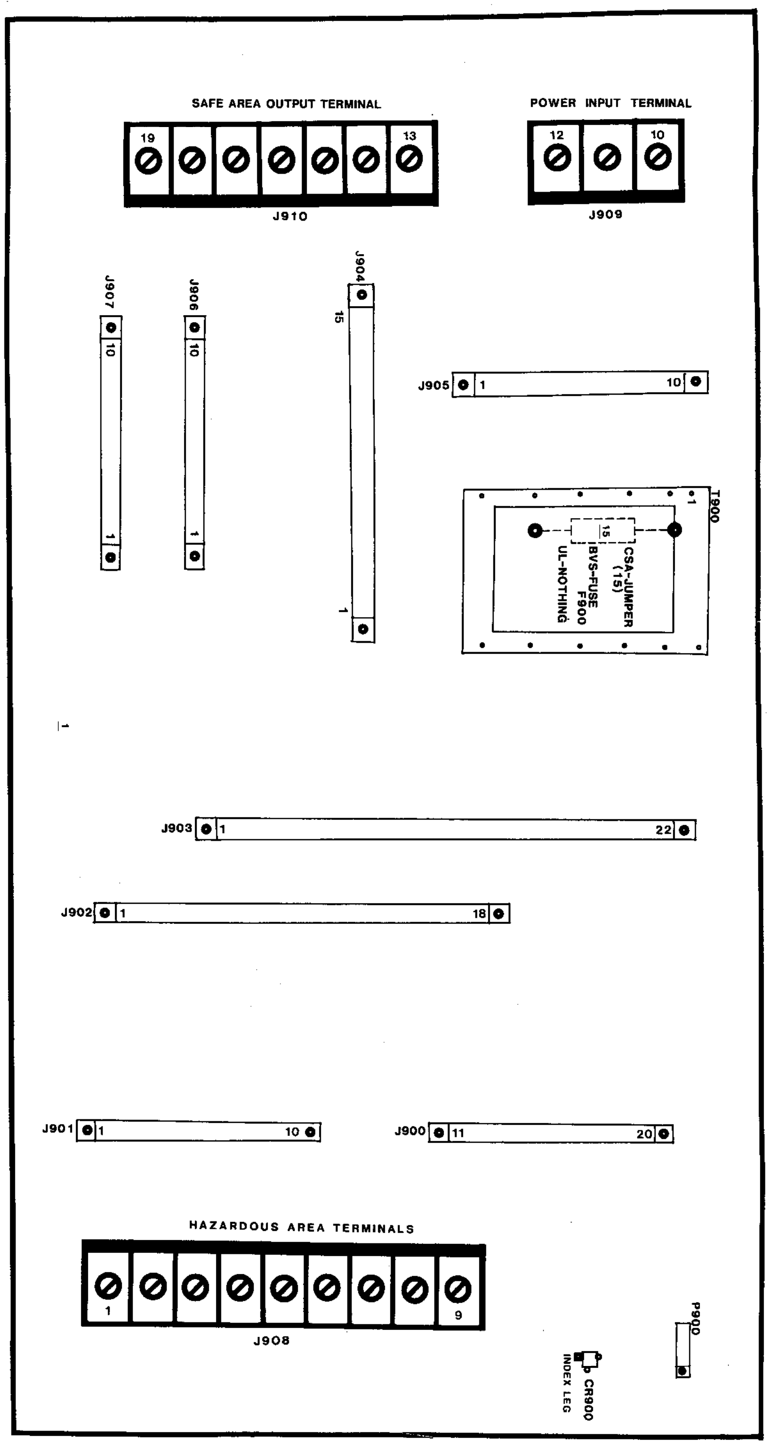
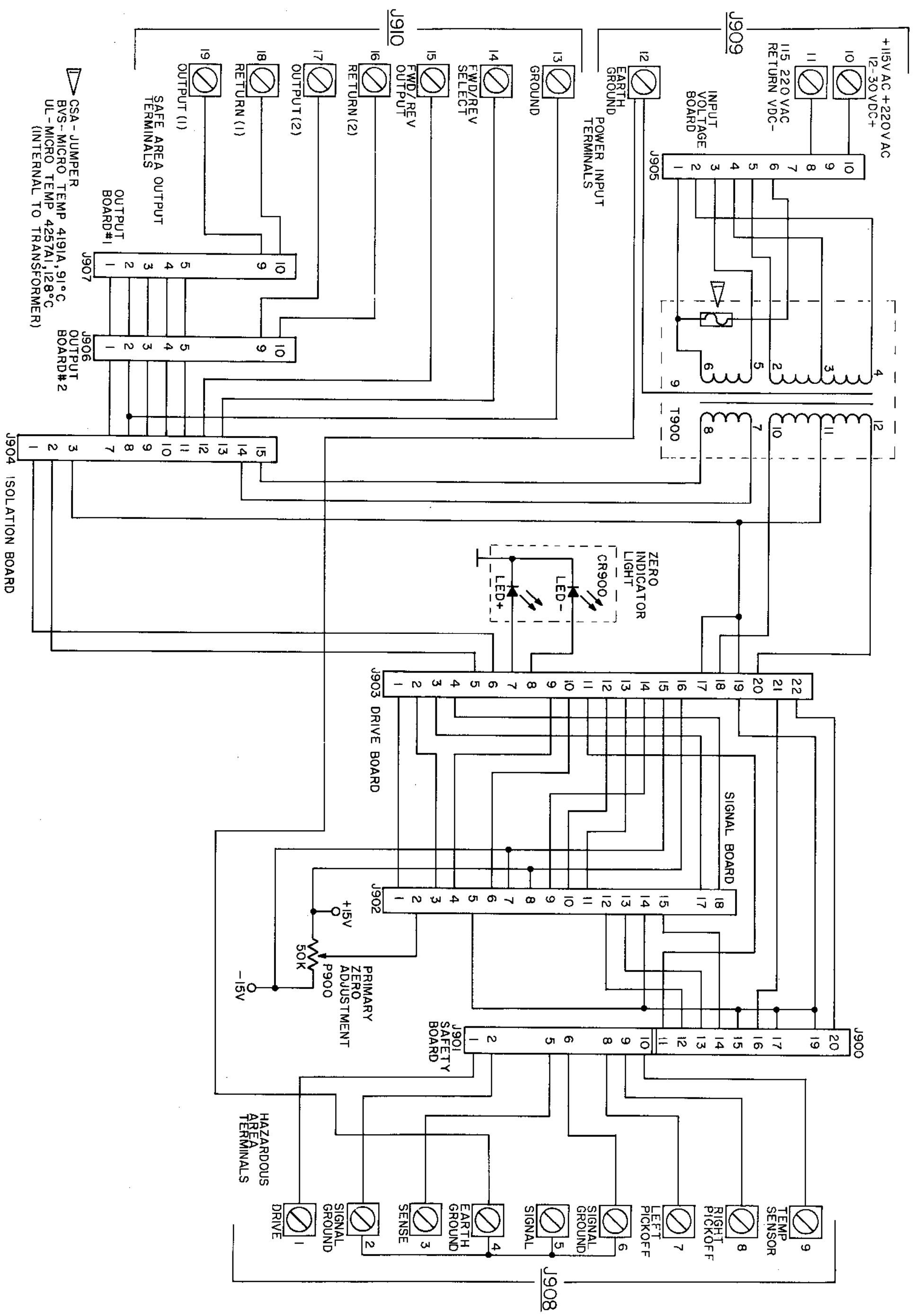


Figure A-17
Interconnection Board Schematic



Appendix IV Spare/Replacement Parts List

RE-01 Components	Product Part Number
Analog Output Board	
0/4-20 mA. 0/1-5 VDC	0203821
0/10-50 mA. 0/2-10 VDC	0203822
Frequency Output Board	
Regular	0203811
Isolated Output	0203813
10% Cutoff	0203812
Isolated Output; 10% Cutoff	0203814
Drive Board	0203832
Drive Board (D600)	0203833
Drive Board D Remote HY	0203834
Signal Board	
Regular	0203841
Remote Zero	0203842
5 Second Constant	0203843
5 Sec. Const./Remote Zero	0203844
Signal Board/Slug Flow Inhibit	
Regular	0221151
Remote Zero	0221152
5 Second Constant	0221153
5 Sec. Const./Remote Zero	0221154
Input Voltage Board	
115 VAC	0203851
115 VAC/CSA	0203852
220 VAC	0010113
100 VAC	0010119
12-30 VDC	0010559
Isolation Board	0070102
Safety Board	0203802
Remote Electronics Compartment w/covers	
UL	0231001
BVS	0231002
CSA	0231003
Remote Electronics Covers	
Main	0203867
Power/Output	0203869
I.S. Terminals, new/long style	0231007

Housing	0228701
Card Cage Assembly	1001713
Display Cover	1001712
Terminal Cover	1001711
Cable Assembly AC	1001504
Power Board 100 VAC	0224253
Power Board 115 VAC	0224251
Power Board 230 VAC	0224252
Terminal Board 100 VAC	0230803
Terminal Board 115 VAC	0230801
Terminal Board 230 VAC	0230802
I.S. PCA	1001180
Output Board (only one)	
Standard Output	0224601
Standard + V	0224602
Standard + mA	0224603
Standard + Freq.	0224604
Standard + Freq. + V	0224605
Standard + Freq. + mA	0224606
Fuses	
30mA 3AG Isolation Bd. (pair)	1000077
100mA 3AG Input Power Bd. 220 VAC (pair)	1000078
250mA 3AG Input Power Bd. 100 VAC (pair)	1000079
500mA Micro PS-12 (pair)	1000080
200mA 3AG Input Voltage FMS-3, DC Input Board (pair)	1000081
1 A 3AG DC Inverter Bd. (pair)	1000082
2A Micro Line Fuse C Model, Accessory (pair)	1000083
1.5A 3AG Fuse Board D600 Booster Amp. (pair)	1000343
750 mA 3AG Fuse Board D600 Booster Amp. (pair)	1000344
REU Cable Prep. Kit	1001708

Appendix V REU Cable Preparation Instructions

Important Note

Since December, 1987, cable that is shipped with standard sensors is already prepared at the factory as described below (9-wire feedthrough). However, since field preparation of cable may be required at some time, the following instructions have been provided.

Parts List

This cable preparation package contains the following:

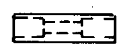
Two (2) pieces of 1-inch (25-mm) black shrink-tubing
One (1) piece of 3-inch (75-mm) yellow tubing
One (1) piece of 4-inch (100-mm) yellow tubing
One (1) butt-splice
Sixteen (16) pieces; spade-lugs
One (1) piece of gray, 4-inch (100-mm), 22 AWG wire
One (1) piece of white, 4-inch (100-mm), 22 AWG wire

Note: Some parts in this package may not be needed.

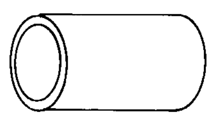
Parts

The parts described in these instructions are pictured below.

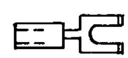
Note: For the D25 through D300, butt-splices are already attached to the sensor wires coming from inside the sensor manifold spacer.



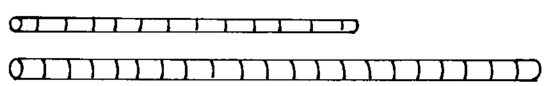
Butt-splice



Shrink-tubing



Spade-lug



Yellow tubing; 3-inch (75-mm) and 4-inch (100-mm)

General

Run the cable through conduit before preparing the cable ends. The factory normally prepares the cable end which connects to the sensor. Typically, the unprepared end of the cable is run through conduit from the sensor to the Remote Electronics Unit.

Note: Cable must be prepared carefully to avoid grounding the shields to the sensor case or to conduit.

Nine-Wire Cable Preparation; Remote Electronics Unit End

To prepare the cable end which connects to the Remote Electronics Unit, perform the following steps:

1. Remove a 4 inch (100 mm) length of sheathing from the cable. This includes removing the fibrous material between the wires, as well as the foil and cellophane joining the twisted pairs of wires.

CAUTION: Do not cut the individual wires or strip the insulation on them yet.

2. Twist the 3 bare shield-wires together.

3. Slip the 4-inch (100-mm) piece of yellow tubing over the shields. The yellow tubing should be pushed on as close to the cable sheathing as possible to reduce the amount of exposed wire.

4. Slip one piece of 1-inch (25-mm) shrink-tubing over the wires and cable sheathing. The shrink-tubing should cover any portions of the shield-wires which remain exposed next to the cable sheathing.

5. Heat the shrink-tubing to shrink it around the cable. A heat gun is preferred for this task.

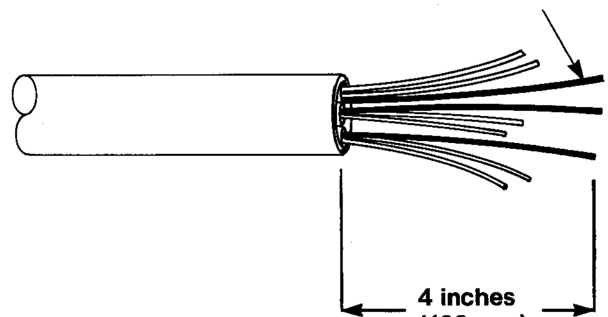
CAUTION: Do not burn the cable!

6. After the cable has cooled, strip 1/4 inch (6 mm) of insulation from the individual wires. If less than 1/4 inch (6 mm) of the shield-wires extend from the yellow tubing, trim the tubing.

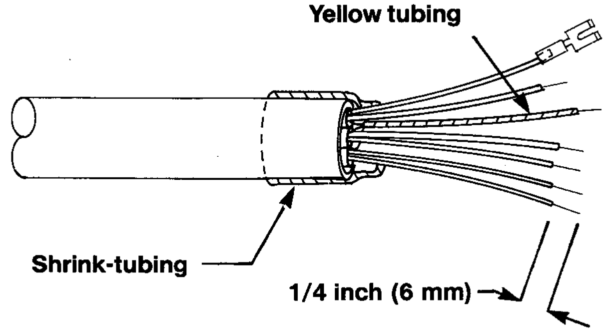
7. Slip the stripped wire ends of the individual wires into the spade-lugs. No bare wire should be exposed. Crimp the spade-lugs onto the wires. Connect the spade-lugs to the Remote Electronics Unit terminal strip in the following order:

Remote Electronics Unit Terminal	
	1....Brown wire
	2....Red wire
	3....Orange wire
	6....Yellow shield-wire (1 spade-lug)
	7....Green wire
	8....Blue wire
	9....Violet wire

Steps 1 and 2



Steps 3 through 7



Cable Preparation for D25 Through D600 Sensors; Sensor End (Normally already done at the factory)

To prepare the cable end which connects to the sensor, perform the following steps:

1. Remove a 3 inch (75 mm) length of sheathing from the cable. This includes removing the fibrous material between the wires, as well as the foil and cellophane joining the twisted pairs of wires.

CAUTION: Do not cut the individual wires or strip their insulation yet.

2. Locate the shield-wire for the **brown/red** twisted-pair and clip it off as close to the piece of 3-inch (75-mm) ble to reduce the amount of exposed wire.

3. Locate the shield-wire for the **violet/orange** twisted-pair and slip one piece of 3-inch (75-mm) yellow tubing on as close to the cable sheathing as possible to reduce the amount of exposed wire.

4. Locate the shield-wire for the **blue/green** twisted-pair and clip 2 1/2 inches (62 mm) off. Slip a butt-splice over the shield-wire as close to the cable sheathing as possible and crimp the end closest to the cable sheathing. Trim 1/4 inch (6 mm) of insulation from the 4-inch (100-mm) pieces of white and gray wires found in the cable preparation parts package. Slip the stripped end of the white and gray wires into the butt-splice and crimp them together.

5. Slip a piece of 1-inch (25-mm) shrink-tubing over all the wires and the cable sheathing. The shrink-tubing should cover any portion of the shield-wire which remains exposed next to the cable sheathing.

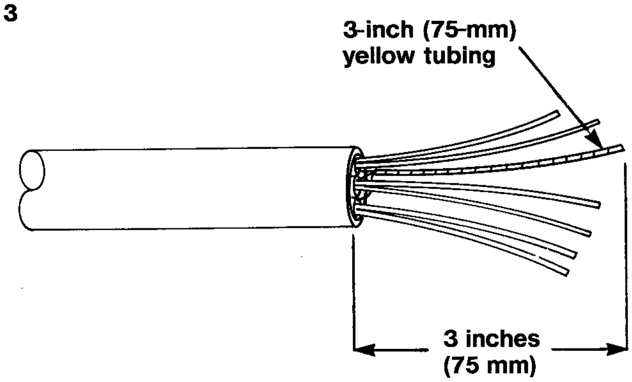
6. Heat the shrink-tubing to shrink it around the cable. A heat gun is preferred for this task.

CAUTION: Do not burn the cable!

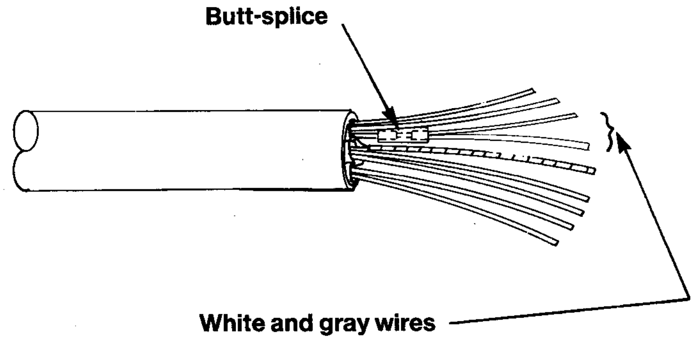
7. After the cable has cooled, cut the white and gray wires to the approximate length of the other wires.

8. Strip 1/4 inch (6 mm) of insulation from the individual wires. If less than 1/4 inch (6 mm) of wire extends from the yellow tubing, trim the tubing.

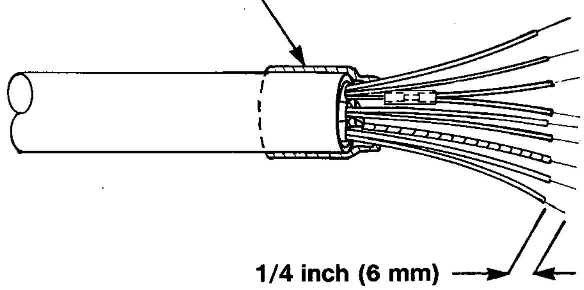
Steps 1 through 3



Step 4



Steps 5 through 8



Cable Connections; Sensor End

1. **Models D25 through D300**: While matching the wire colors, insert the stripped wire ends from the cable side into the butt-splices which come from the sensor manifold and crimp together. See Figure 1.

2. **Model D600:** Insert the stripped wire ends from the cable side into individual spade-lugs and crimp. Connect to the D600 terminal block as shown in Figure 1.

3. **Models D6 and D12, and all Model C meters with 7-wire feedthrough:** Insert the stripped wire ends of the white and gray wires into one (1) spade-lug and crimp. Insert all other wires into separate spade-lugs and crimp. Connect these spade-lugs to the sensor terminal block as shown in Figure 2.

Cable Preparation for All Other Sensors with 7-Wire Feedthrough; Sensor End

Perform the following steps:

1. Clip the white wire and tape the end so it can not short to anything.

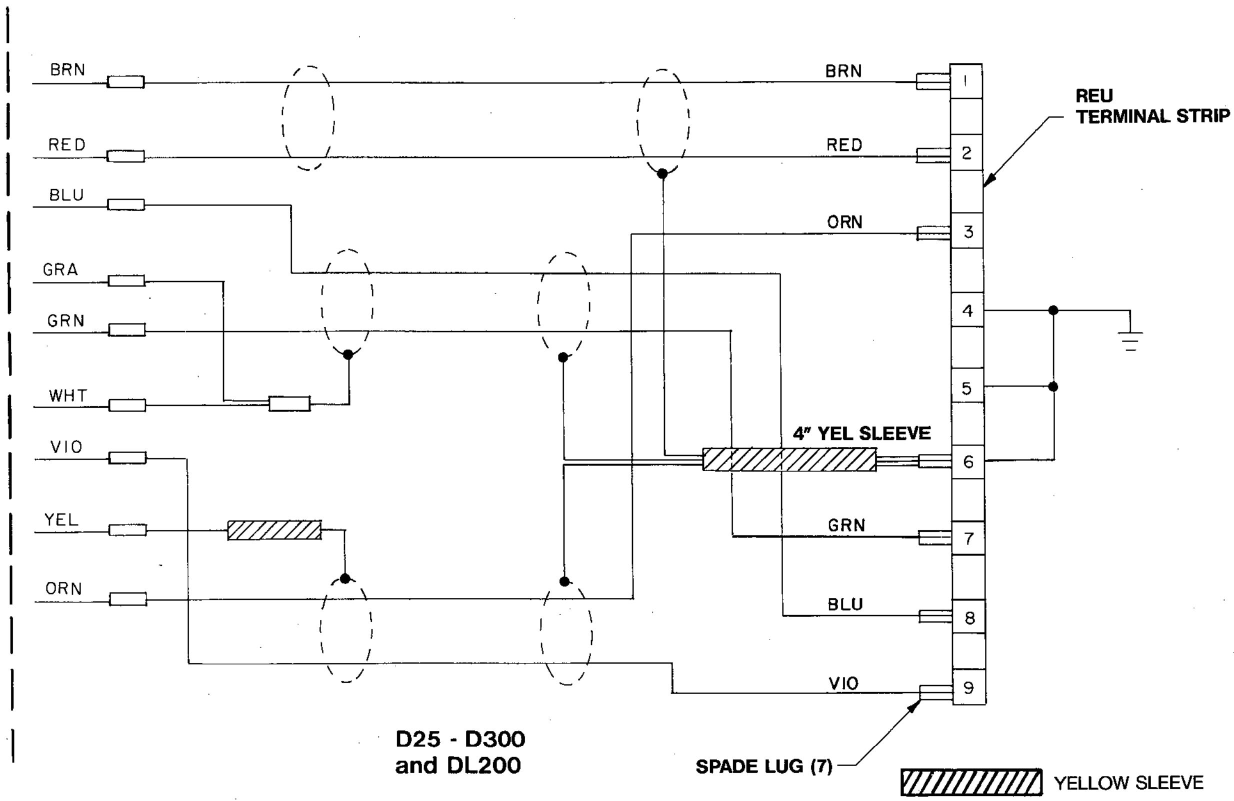
2. Connect the cable wires to the butt-splices from the sensor in the following order.

Sensor Wires	**Cable Wires**
Brown	Brown
Red	Red
Orange	Orange
Yellow	Gray and yellow shield-wire
Green	Green
Blue	Blue
Violet	Violet
	White (clipped and taped - see Step 1 above)

Figure 1
D25 - D600
and DL200

D600 Terminal
Block Wire Key

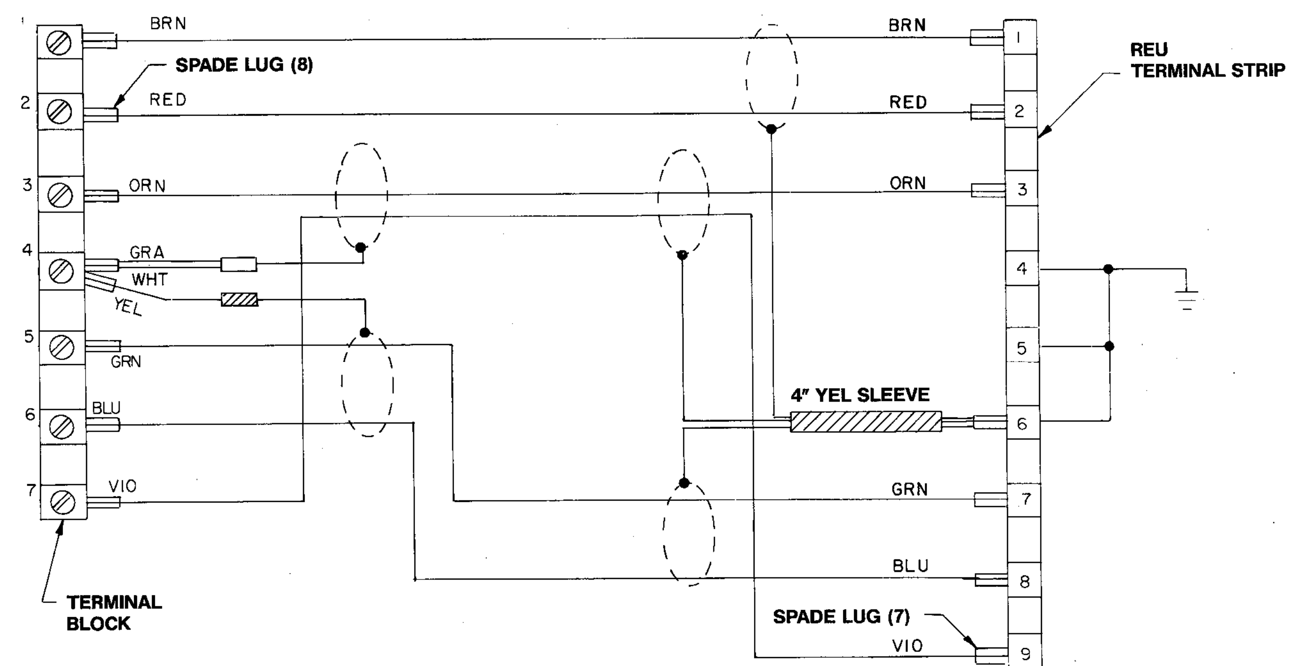
1 - Brown
2 - Red
3 - Orange
4 - Shield gnd (yellow)
5 - Green
6 - Blue
7 - Violet
8 - Gray
9 - White



YELLOW SLEEVE

BUTT SPLICE
(EXCEPT DL200)

Figure 2
D6, D12, and Model C meters



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