Electronic Water Level Gauge

Installation, Operation And Maintenance of

Aquarian 3000M 4-20 mA Module with RS-485 Serial Output

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Aquarian 3000M 4-20 mA Module with RS-485 Serial Output

Instruction Manual

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About this Manual

This instruction manual describes the architecture and operation of the Aquarian 3000 Mini 4-20 mA Module as supplied by ***Fossil Power Systems Inc.***

Although care was exercised to make this Manual specific and complete, it is not intended that it and its accompanying equipment manuals should provide for all potential operating and maintenance conditions. It must be recognized that no amount of written instruction can replace intelligent thinking and reasoning on the part of qualified personnel. It is the responsibility of these personnel to become completely familiar with the mechanical, electrical and control systems involved, including their characteristics and performance under various operating conditions.

This knowledge can be obtained through the basic information provided in this manual, supplemented by advice and recommendations from this Company's field agents and by actual experience.

Operation, maintenance and performance of any equipment not furnished by this Company are the sole responsibility of others.

The nature of the electronics, the harsh operation environment and the potential hazards associated with live steam require that only qualified personnel install and maintain the equipment.

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1 INTRODUCTION

The AQUARIAN 3000 Mini Analog 4-20 mA Interface Module is an intelligent I/O card designed to provide an isolated 4-20 mA analog signal. The output is an analog representation of the height of water in the column. The water height is determined by the existing logic in the Aquarian 3000 Mini system.

Integrity is assured with watchdog logic that is independent of processor operation and through periodic checks performed by the processor on its own support logic.

IMPORTANT: This 4-20 mA output is a stepped signal and is not intended for level control. It should only be used for remote indication or level recording.

Features include:

- An isolated two-wire 4-20 mA industry standard current loop interface.
- Module fault alarm contact output.
- Analog Module powered from 3000M electronics (default) or from external power source (optional).
- Current loop powered from the 4-20 Module (default) or from an external power supply (optional).
- Serial link to Remote Display.

The Analog 4-20 mA Interface Module will be referred to as the Analog Module in this manual.

2 PACKAGING

If not factory installed, the Analog Module will be shipped in one box weighing 1 Kg (2.2 lb.). Prior to installing this equipment, clean all packing material from around the unit and inspect for any damage that may have occurred during shipment.

The purchaser must file any claims for loss or damage with the carrier. The manufacturer, on request, will furnish a copy of the bill of lading and freight bill if occasion to file a claim arises.

3 INSTALLATION

Reference:

- Figure 2 - Cabinet Mounting
- Figure 4 - Ribbon Cable Connections

The Analog Module is installed on the side of the enclosure as shown in Figure 2. Each Analog Module is shipped with four sets of mounting screws and flat nuts.

Connect the analog module to the Aquarian 3000 Mini board with the ribbon cable supplied. Insert one end of the cable into Header H1 on the analog board and the other end to the connector on the Mini just under the metal plate. The orientation of the connector is very important. Refer to Figure 4 for proper connection.

Analog Modules that are factory installed and shipped with the AQ3000M electronics are pre-wired with ribbon cable.

4 START-UP AND OPERATION

Reference:

- Figure 3 - Jumper Settings
- Figure 5 - Current Loop Power Supply Connections

4.1 Analog Output

The primary function of the Analog Module is to provide an analog signal in the range of 4-20 mA on a two-wire process control current loop. This signal is completely isolated from the Aquarian 3000 Mini power supplies and is directly proportional to the water level, as determined by the existing Aquarian 3000 Mini logic.

The standard default factory settings are:

- 4-20 mA Output
- Analog Module powered by 3000M Electronics through ribbon cable
- Current loop powered by Analog Module internal 24VDC power supply

The analog signal is brought out on terminals 4 and 5, labeled *ANALOG (+)* and *ANALOG (-)*. No other terminals on the Analog Module are used.

Current Loop External Power Supply Option

Current loop connections to the Analog Module are shown in Figure 5 for the cases of internal and external power supplies. The power supply for the current loop is determined by the setting of jumper J3. The

Analog Module generates an internal 24VDC, which is normally used as the loop supply. This is represented in Figure 5(a). The maximum loop resistance for this setting is approximately 1000 ohms.

If the power source is already in the loop or for larger loop resistances, the circuit in Figure 5(b) must be used.

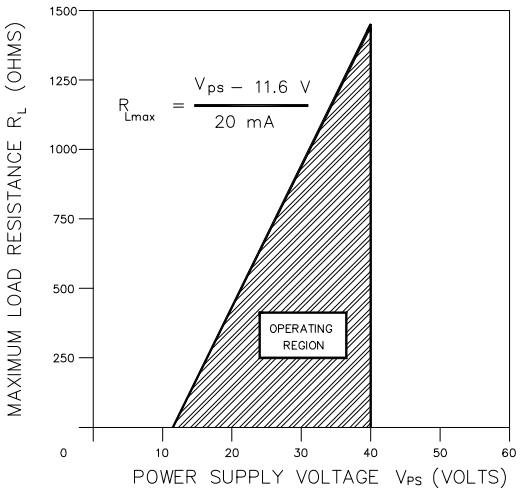

Figure 1 - Loop Resistance

The figure above shows the load diagram for various external power supplies. It gives the maximum load, RL that can be driven to a full 20 mA for any given power supply, Vps. For the system to work properly, the power supply must be matched to the load.

For example, a 28 VDC power supply in the current loop will allow a maximum load of 820 ohms.

4-20 mA Output Signal vs. Water Level

The current output at each probe level will be different for each column configuration. The output signal at each probe water level is proportional to the water level in the column. Refer to documents provided with the system for analog signal assignments.

The "no water" and first probe conditions have been assigned an arbitrary current of 4.3 mA and 5 mA, respectively. All other current values have been chosen so that they are directly proportional to the probe heights.

4.2 Contact Output

A single normally-closed alarm contact allows the status of the module to be monitored externally. This relay will de-energize on any one of the following conditions:

1. Processor failure - independent watchdog logic constantly monitors the processor and will trip if it fails. As long as the indicator is on, the processor is functioning properly.
2. Processor support failure - the processor continuously checks its support logic (RAM, EPROM, etc.) and will alarm if any of these fail. The indicator will come on in this case, but the processor will still attempt to function.

The Fault relay is a normally-closed contact which is output on terminals 9 and 10.

4.3 Optional Transformer Setup, External Power Source

If the transformer option has been purchased, a three position terminal block, transformer and a bridge rectifier will be added to the Analog Module PC Board. Set the jumper J1 to "EXT" side, if not already done, and connect a power source to the terminal blocks 1 through 3 labeled "L" (LINE), "N" (NEUTRAL) and "G"(GROUND).

5 DETECTION THEORY

The primary function of the Analog Module is to provide a discrete analog output for each probe position of the Aquarian 3000 Mini. Each probe location has a corresponding fixed analog value in the range of 4-20 mA.

This signal is not simply a series of discrete analog values at each probe location, but a continuous signal moving at a fixed time constant. This time constant is given in seconds/inch (or seconds/cm) and determines the overall rate or speed of the analog signal as it moves from level to level. The normal rate is 5 seconds/inch (2 seconds/cm). A different time constant can be requested at the time of purchase.

5.1 Analog Signal

For single level changes, the movement of the analog signal is a simple linear application of the time constant. For example, consider the level change from probe 6 to probe 7 which are 3 inches apart. The time constant is 5 seconds/inch. The analog signal will increment linearly requiring 15 seconds to reach the value representing probe 7.

For level changes greater than one probe distance, the signal will travel in an "exponential" fashion. The current will change quickly at first and then slow down as it comes closer to the actual water level.

Consider the case where the level has quickly changed from level 4 to level 7 and the probe heights are as follows:

Probe 4 +1 inch
Probe 5 +2 inches
Probe 6 +4 inches
Probe 7 +5.5 inches

The time constant is again 5 seconds/inch. The probe distance is initially 3 levels. The time constant is initially divided by 3 and will be 1.7 seconds/inch. The analog signal will travel linearly from level 4 to level 5 at this accelerated rate.

Once the signal reaches level 5, the probe difference is 2, so the time constant is now 2.5 seconds/inch (5/2). The signal will then take 5 seconds to travel from level 5 to level 6 (2 inches difference).

Once the signal reaches level 6 it will continue at 5 seconds/inch until it reaches level 7.

The table below summarizes the current signal travel for the above situation.

Level Change	4 to 5	5 to 6	6 to 7
Time Constant (sec/inch)	5/3 = 1.7	5/2 = 2.5	5/1 = 5
Distance (inches)	1	2	1.5
Traveling Time (sec)	1.7	5.0	7.5

The above examples are for increasing water levels. For decreasing water levels, the same philosophy applies.

The Analog Module attempts to follow the water level as closely as possible. If the signal is moving upward, and the level suddenly moves down, then the signal will immediately

reverse. It does not have to reach a discrete probe level before changing direction.

Consider the case where the water is fluctuating around a single probe. The level indicated is normally the level below this probe. As water splashes on the higher probe, the system momentarily indicates water at this higher level. The current will start to move toward the higher probe as water splashes on it. But when the water moves back, the current value immediately reverses direction, without having to first travel to the higher probe.

5.2 Valid Water Height

The search for water begins at the lowest probe with a valid water condition determined by the following criteria:

1. If a probe indicates water, but there is steam on both sides of it, then this water is assumed to be a fault. The water level will be set to the first probe position below the faulted probe that indicated water.
2. If a probe indicates steam, but there is water at the next two higher levels, then this steam is assumed to be a fault. The search will continue.
3. The water level is determined by the highest probe indicating a valid water condition.

6 Serial Output

The Module also has a 3-wire RS-485 Serial Output link to drive Aquarian 3000 Mini Remote Display indicators.

The standard remote display panel located in the control room requires two wires per probe plus power. For a 12 probe system this means running at least a 26 conductor cable between the AQ Mini cubicle and the remote display, which is usually several hundred feet. The serial interface on this Module uses only a 3 conductor cable to run to perform the same function. A serial interface is used to communicate to the display rather then a parallel link.

A two conductor cable with shield is required, and is connected to the RS485 terminals 6 (+), 7 (-) and 8 (SH). All terminals must have a connection at both ends, including the shield (SH). Refer to specifications section for recommended cable.

Multiple Remote Displays can be daisy chained together. The maximum distance from cubicle to furthest Display is 4000 feet.

The standard Remote Display does not have a serial interface; it must be requested at the time of purchase. It is not possible to have both parallel and serial interfaces on the same Display.

7 SPECIFICATIONS

Analog Interface	Isolated from Aquarian 3000 Mini power supplies. 4-20 mA current loop representative of the water level Current at probe locations accurate to within ±0.3mA of calculated For specific probe output values, refer to customer documents
Indications	Logic power (+5V) OK Mini voltage level (+12) OK Processor OK
Terminal Blocks	12-24 AWG
Fault Relay Contact Rating	8 Amp at 24 VDC (resistive) 10 Amp at 120 VAC (resistive) 1/3 hp at 120 VAC Output NC alarm contact
Serial Link	2 conductor 20 gauge plus shield
Recommended cable:	(P/N 6650-1900) Provo 5501, Belden 9463, or equivalent Twinax 78 ohm, PVC jacket blue 100% aluminum foil shield 57% braided tinned copper shield
Maximum distance:	4000 ft

Supply Voltage (Only when configured for optional External Power Source)

120 (105-125) VAC
240 (210-250) VAC

Supply Frequency (Only When configured for optional External Power Source)

50-60 Hz

Supply Current (Only When configured for optional External Power Source)

½ Amp @ 120VAC
¼ Amp @ 240VAC

External current loop supply (with optional power supply)

Allowable range:	13 to 40 VDC
Maximum load	1400 ohm at 40 VDC

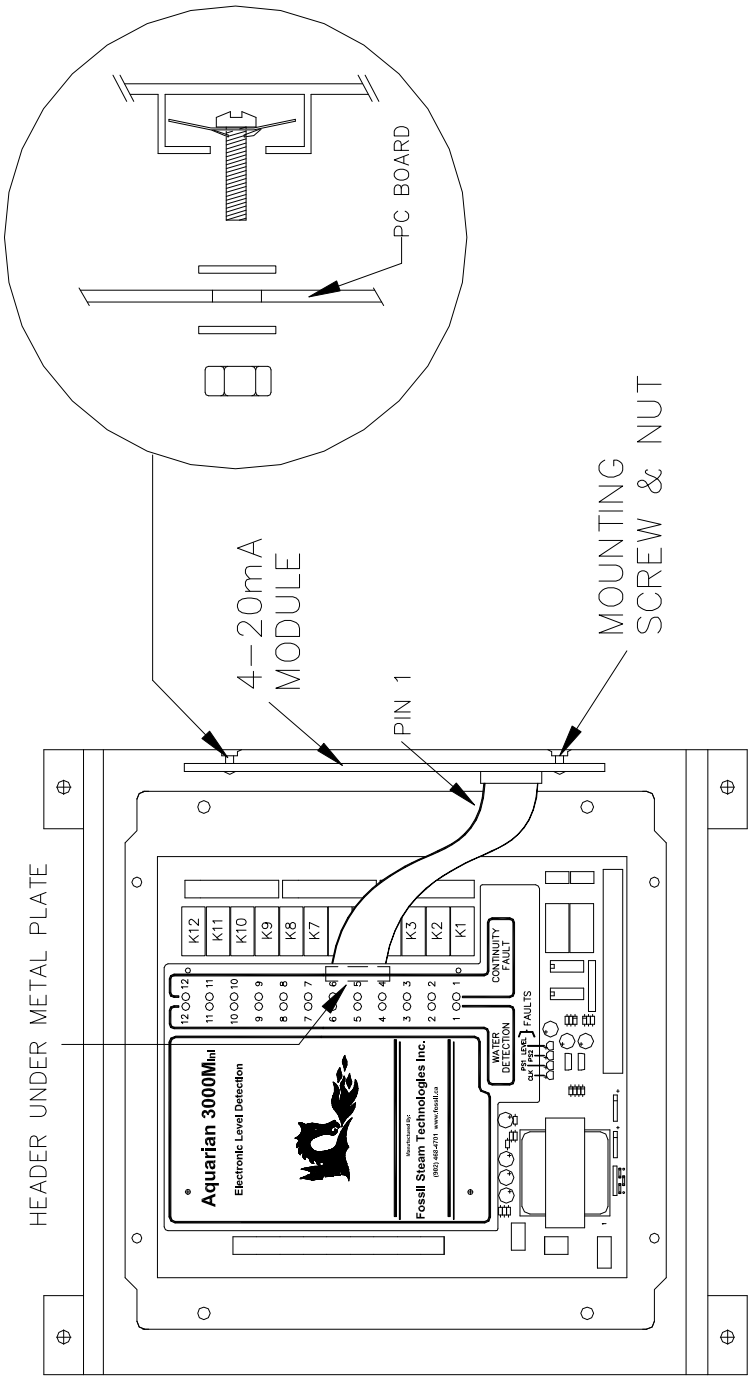

Figure 2 - Cabinet Mounting

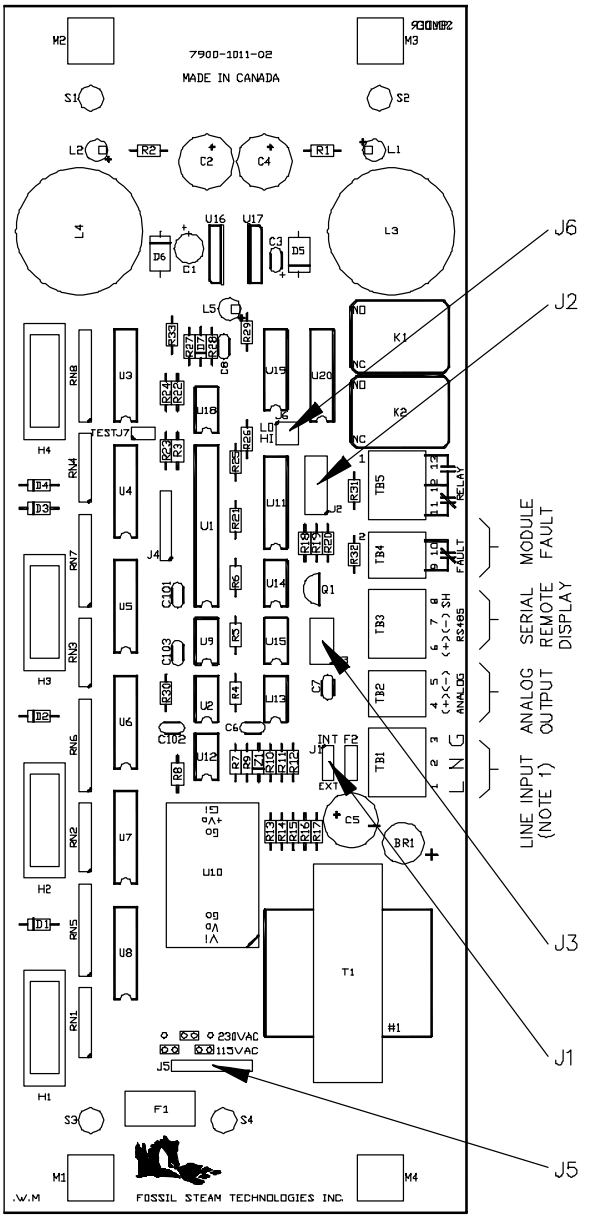

TABLE A

4–20 MA MODULE JUMPER SELECTIONS	
SUPPLY POWER SOURCE J1	☒ INTERNAL J1 INTERNAL ☐ EXTERNAL J1 EXTERNAL
LINE VOLTAGE J5	☒ 115 VAC ☐ 230 VAC HARDWIRED JUMPERS
PROBE CONFIGURATION J6 REFER ALSO TO TABLE C	☒ 12 PROBE LO HI ☐ 24 PROBE LO HI ☐ 48 PROBE LO HI

TABLE B

CURRENT LOOP

INTERNALLY POWERED LOOP
(700 OHM MAX RESISTANCE)

☒ J3
☒ J2 4–20mA ☐ J2 1–5VDC
☐ J2 0–20mA ☐ J2 0–5VDC ☐ J2 0–10VDC

EXTERNALLY POWERED LOOP

☐ J3
☐ J2 4–20mA ONLY 4–20mA OUTPUT AVAILABLE WITH EXTERNAL SUPPLY

LEGEND:

☒ DEFAULT SETTINGS
☐ AVAILABLE OPTION

Figure 3 - Jumper Settings

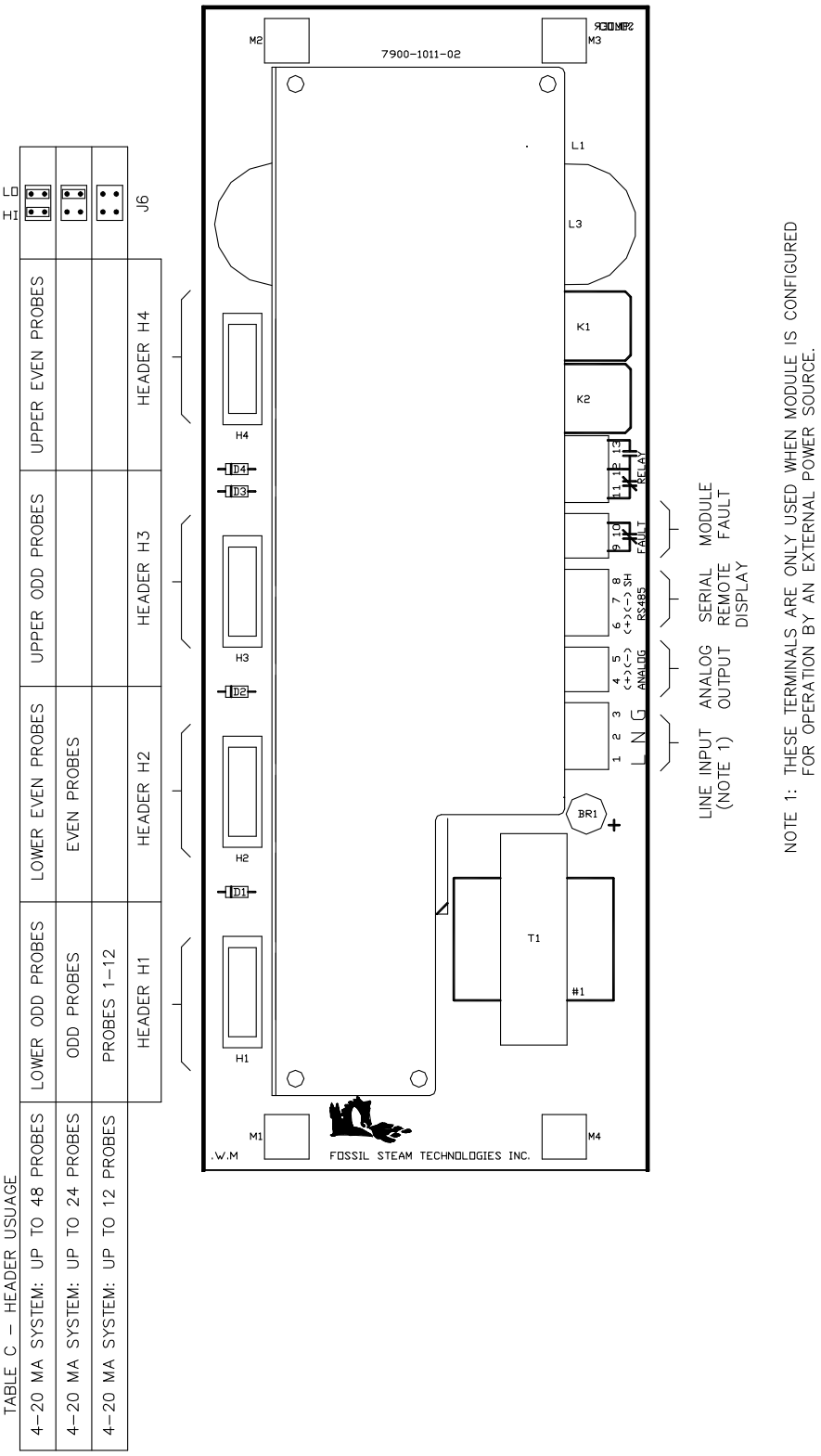

Figure 4 - Ribbon Cable Connections

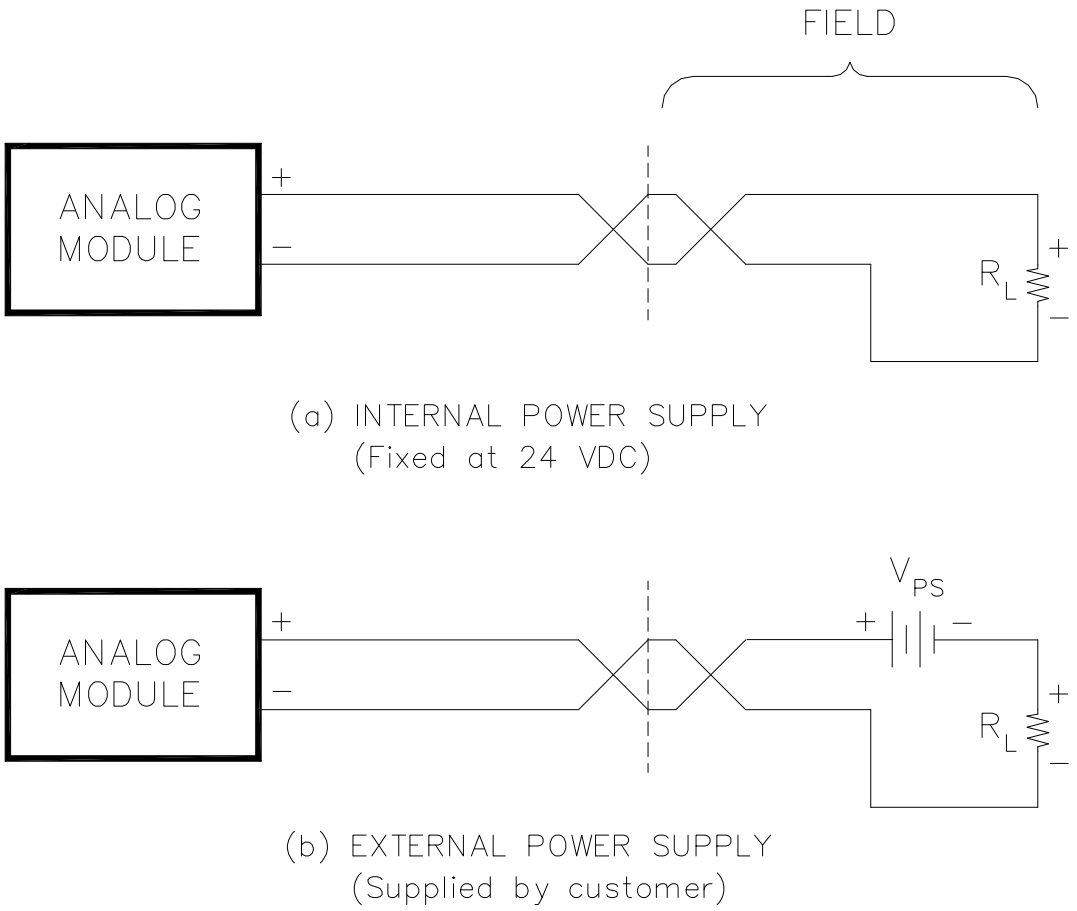

Figure 5 - Current Loop Power Supply Connections

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