FML250-IS

Intrinsically Safe Flow Monitor for LIQUID Applications

User Manual

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Notice

Proprietary Notice

The information contained in this publication is derived in part from proprietary data and trade secrets. This information has been prepared for the expressed purpose of assisting operating and maintenance personnel in the efficient use of the instrument described herein. Publication of this information does not convey any rights to use or reproduce it or to use for any purpose other than in connection with the installation, operation, and maintenance of the equipment described herein.

Technical Improvements

Turbines Incorporated may modify the technical data herein without notice.

1 SAFETY INSTRUCTIONS

The following instructions must be observed.

- Every effort has been made to design and manufacture this instrument to be safe for its intended use. A hazardous situation may occur if this instrument is not used for its intended purpose or is used incorrectly. Please note operating instructions provided in this manual.
- The instrument must be installed, operated, and maintained by personnel who have been properly trained. Personnel must read and understand this manual prior to installation and/or operation of the instrument.
- The manufacturer assumes no liability for damage caused by incorrect use of the instrument or for modifications or changes made to the instrument.
- The safety of any system incorporating the equipment is the responsibility of the assembler of the system.
- Apart from the batteries, there are no other user serviceable parts.

Les instructions suivantes doivent être respectées.

- Tous les efforts ont été faits pour concevoir et fabriquer cet instrument est sans danger pour son utilisation prévue. Une situation dangereuse peut se produire si cet instrument n'est pas utilisé conformément à sa destination ou est mal utilisé. S'il vous plaît respecter les instructions fournies dans ce manuel.
- L'appareil doit être installé, utilisé et entretenu par du personnel ayant reçu une formation adéquate. Le personnel doit lire et comprendre ce manuel avant l'installation et / ou le fonctionnement de l'instrument.
- Le fabricant décline toute responsabilité pour les dommages causés par une utilisation incorrecte de l'instrument ou de modifications ou de changements apportés à l'instrument.
- La sécurité de tout système intégrant l'équipement est de la responsabilité de l'assembleur du système.
- Outre les piles, il n'y a pas d'autres pièces réparables par l'utilisateur.

Table of Contents

2 DESCRIPTION

The FML250-IS Flow Monitor is a microcontroller based flow rate indicator and totalizer designed for Liquid Applications. Inputs include pulse and square wave flow meter inputs. Computations include calculation of liquid flow in several engineering units including mass. An internal 40 point linearizer allows linearization of typically non-linear liquid flow meters and extends the range of repeatable points outside the normal linear range. Outputs include an LCD display, open collector type pulse output and 4-20mA current loop.

2.1 Features

- Intrinsically Safe for Hazardous Locations
- 2-40 Point Linearizer
- Battery Powered Operation
- Pulse Input Supports Sine and Square Type Flow Meters
- All Features/Configuration Settings are Field Programmable
- Two Lines of Independent Display Capable of Displaying any of Several Calculated Values
- Front Panel Keypad for Display, Reset, and Factor Maintain Enclosure Integrity
- Built-in Test System for Diagnostics, Pulse Output, and 4-20mA Output Testing
- Comprehensive Warning and Error Reporting System
- Non-resettable “Grand” Totalizer
- Opto-isolated Pulse Output
- Pulse output includes overflow carry for avoiding counting errors due to missing pulses in the case of pulse output system overload
- Auto-ranging Rate Display
- Selectable Power Modes for Customized Battery Life and Display Refresh

2.2 IS Certification Standards

The following standards were used for FML250-IS certification:

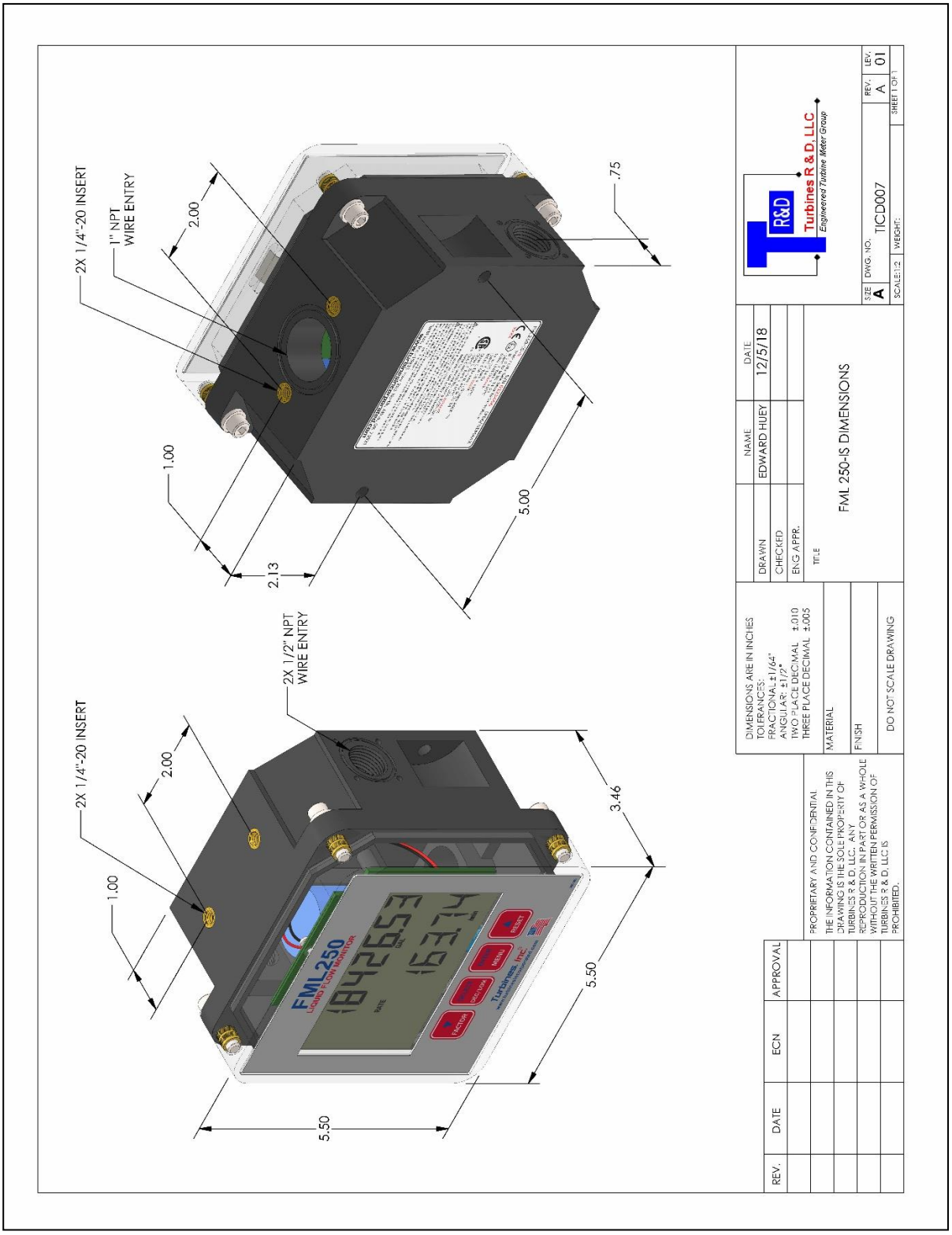
- UL 60079-0:2013
- UL 60079-11:2013
- CAN/CSA-C22.2 No. 60079-0:15
- CAN/CSA-C22.2 No. 60079-11:16
- EN 60079-0:2012
- EN 60079-11:2012
- IEC 60079-0:2011
- IEC 60079-11:2011

2.3 Technical Specifications

- **Display**
  - *Upper*
    - 8 digit 0.75” (19.05mm) high characters
    - Display item push button scrollable
    - Decimal locations: 0.0000001 to x1000
  - *Lower*
    - 6 digit 0.75” (19.05mm) high characters
    - Display item time stepped
    - Decimal locations: 0.00001 to x1000
  - Refresh rate: continuous, 1/16s, 1/8s, 1/4s, 1/2s, 1s, & 2s
  - Warnings for: Maintenance due, Flow rate, dead battery, running on battery
- **Power:**
  - *Internal by a 3.6V Lithium battery:*
    - Rated voltage: 3.6V
    - Nominal capacity: 17 Ah
    - Size: D cell battery standard
    - Provides backup power when 4-20mA loop powered
  - *External through 4-20mA Loop:*
    - Range: 9 to 28 VDC
    - Max Current: 25mA
    - Reverse polarity protected
- **K-Factor range**
  - Pulses per Gallon: 0.0000001 to 99,999,999
- **Signal Input (flow)**
  - Frequency: 1Hz-6kHz
  - Impedance: 10k ohms
  - Sensitivity(Sine): 10mVpp-28V pp
  - Sensitivity(Square): 3.3-28V (50% duty cycle)
- **Engineering Unit Conversions**
  - Pre-programmed units: GAL, CF, LIT, M3, BBL, LB, KG, SCF/GAL, MSCF/GAL, SM3/GAL, & MSM3/GAL*
  - Separate UOM for Total and Rate available
  - Custom units available based on GAL */GAL Gas equivalent for cryogenic liquids
- **Compensation**
  - Linearizer table 2 to 40 points
  - Temperature, pressure compensation (based on user defined conditions)
- **Time Base**
  - Rates can be displayed per second, minute, hour, day, and custom (based on seconds)
- **Outputs**
  - *Factored Pulse (50mA, 28VDC max)*
    - Opto-isolated open collector output
    - Output pulse: Frequency or fixed pulse width: 2, 5, 10, 50, 100, 250, 500, & custom ms
    - Pulse Output Divider: 0.01(x100), 0.1(x10), 1, 10, 100, 1000, & custom
  - *Factored Rate (4-20mA)*
    - Scalable low and high programmable
- **Error**
  - Display: ±0.01% reading (rate) or ± 1 count (total)
  - Digital output: ±1 pulse
  - Analog output: ±0.3% reading (rate)
- **Compliance**
  - CSA/US:
    - Class I, Division 1, Groups ABCD, T4
    - Class I, Zone 0, AEx ia [ia] IIC T4 Ga
    - Ex ia [ia] IIC T4 Ga
  - Pollution Degree: 2
  - Overvoltage Category: I
  - Altitude: 2000 m max
  - Ingress Protection: IP66, NEMA 4X
- **Environmental**
  - Operating: -30 to 60°C (-22 to 140°F)
  - Storage: -40 to 85°C (-40 to 185°F)
- **Enclosure**
  - Glass filled polycarbonate
  - Weight: 2 lbs.
  - *Mounting options:*
    - Turbine (1” NPT)
    - Wall
- **Other features**
  - EEPROM parameter storage
  - All parameters are field programmable via front panel push buttons for fast menu navigation and parameter entry
  - Secondary storage location for parameters and linearizer table

3 ENCLOSURE SPECIFICATIONS

3.1 Dimensional



3.2 Torque Specifications

In order to maintain enclosure ratings the following torque specs must be followed:

Item	Torque
lid screws (4)	14 in-lbs
1/2” NPT fittings	Finger tight + 3 turns
1” NPT fitting	Finger tight + 2.5 turns

4 MAINTENANCE AND SERVICE

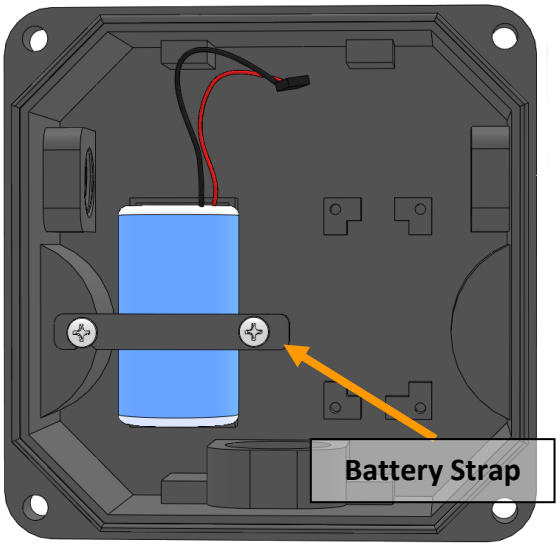
The only user serviceable part of the FML250-IS aside from the TB1 and TB2 connectors is the battery. The FML250-IS requires no routine maintenance aside from checking the low battery indicator on the LCD. When indicating a low battery, follow the instruction in the ***Battery Installation*** section below. When opening the cover to service the battery, avoid straining or pulling internal signal or power wires.

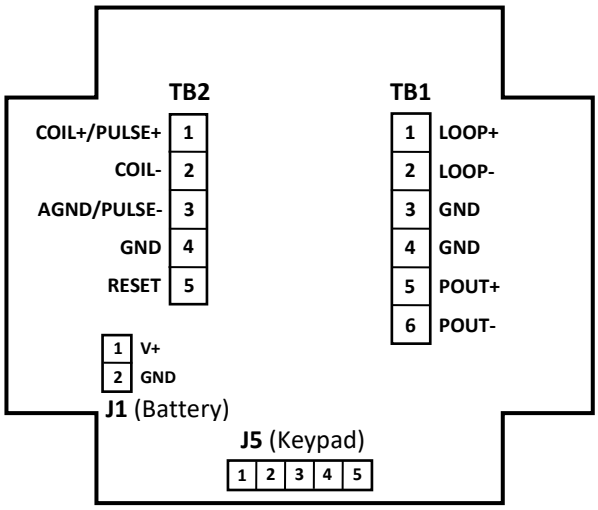
WARNING! Do not replace battery when an explosive environment is present.

WARNING! This equipment includes some external non-metallic parts, including the outer protective cover. The user shall ensure that the equipment is not installed in a location where it may be subjected to external conditions (such as high-pressure steam) which might cause a build-up of electrostatic charges on non-conducting surfaces. Additionally, cleaning of the equipment should be done only with a damp cloth.

4.1 Battery Installation

The FML250-IS comes standard with a 3.6 Volt Primary Lithium cell. This battery acts as the primary power for the unit unless loop power is connected, when it then serves as a battery backup for loop power loss. When the LCD indicates the battery needs to be replaced, follow these steps to ensure no information is lost during the replacement (see drawings below):





FML250-IS Main Board

1. Press the Menu button – This will save important run data
2. Remove the clear cover by removing the four cap bolts securing the cover
3. Disconnect the battery cable from J1 by depressing the locking mechanism integrated into the cable connector
4. Loosen the battery strap (#1 Philips head cap screw at the slotted end of the battery strap)
5. Swing the battery strap away from the battery and remove the old battery
6. Install a new battery in the battery cradle
7. Reconnect the battery connector to J1 ensuring the locking mechanism is facing to the left
8. Reassemble the unit in the reverse order, the unit is now ready for use

Lithium Battery Pack (TI P/N: 901577):
Life: approx. 5 years (power mode 3 at 500Hz continuous use)
Connector: 2-pin (Positive Pin 1, Negative Pin 2)
Voltage: 2.9 to 3.7VDC
Compliance: UL Listed

WARNING! Do not replace battery when an explosive environment is present. Replace only with a certified Turbines Incorporated P/N 901577 Lithium battery pack.

5 USER EXTERNAL CONNECTIONS

All of the FML250-IS connections are made through two removable connectors. To access the connectors, remove the FML250 cover and observe connectors (TB1 and TB2) on the back of the main circuit board.

5.1 Wiring Guidelines

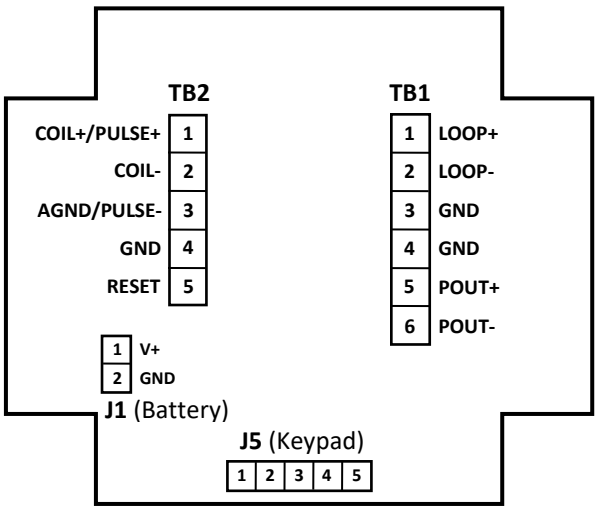
- All wires connected to the unit should be shielded.
- To help avoid ground loops and unexpected behavior, it is recommended that the cable shield be terminated only in the non-hazardous area. The shield end in the hazardous area should be left unconnected.
- Care should be taken to ensure that any exposed conductor is fully inserted into a connector to avoid shorting other circuitry on the mounting board.
- Shields should not cover more than one set of signal wires at a time.
- Supply wires should be 28-16 AWG.
- For intrinsically safe applications, total cable jacket thickness must be greater than 0.5mm and the distance from the branching point of the conductors to the terminal block shall not exceed 2cm.

5.2 User Terminal Connections

The FML250-IS terminal connectors and their descriptions are found on the rear of the FML250-IS main board (see drawings below). The connections are:

TB1 (Output signals)	
1	LOOP+ (Loop DC Positive)
2	LOOP- (Loop DC Negative)
3	GND
4	GND
5	POUT+ (Pulse Output Positive)
6	POUT- (Pulse Output Negative)

TB2 (Input signals)	
1	COIL+/PULSE+ (Sine/square signal positive)
2	COIL- (Sine signal negative)
3	AGND/Pulse- (Square signal negative)
4	GND (Reset DC negative)
5	RESET (Reset DC positive)

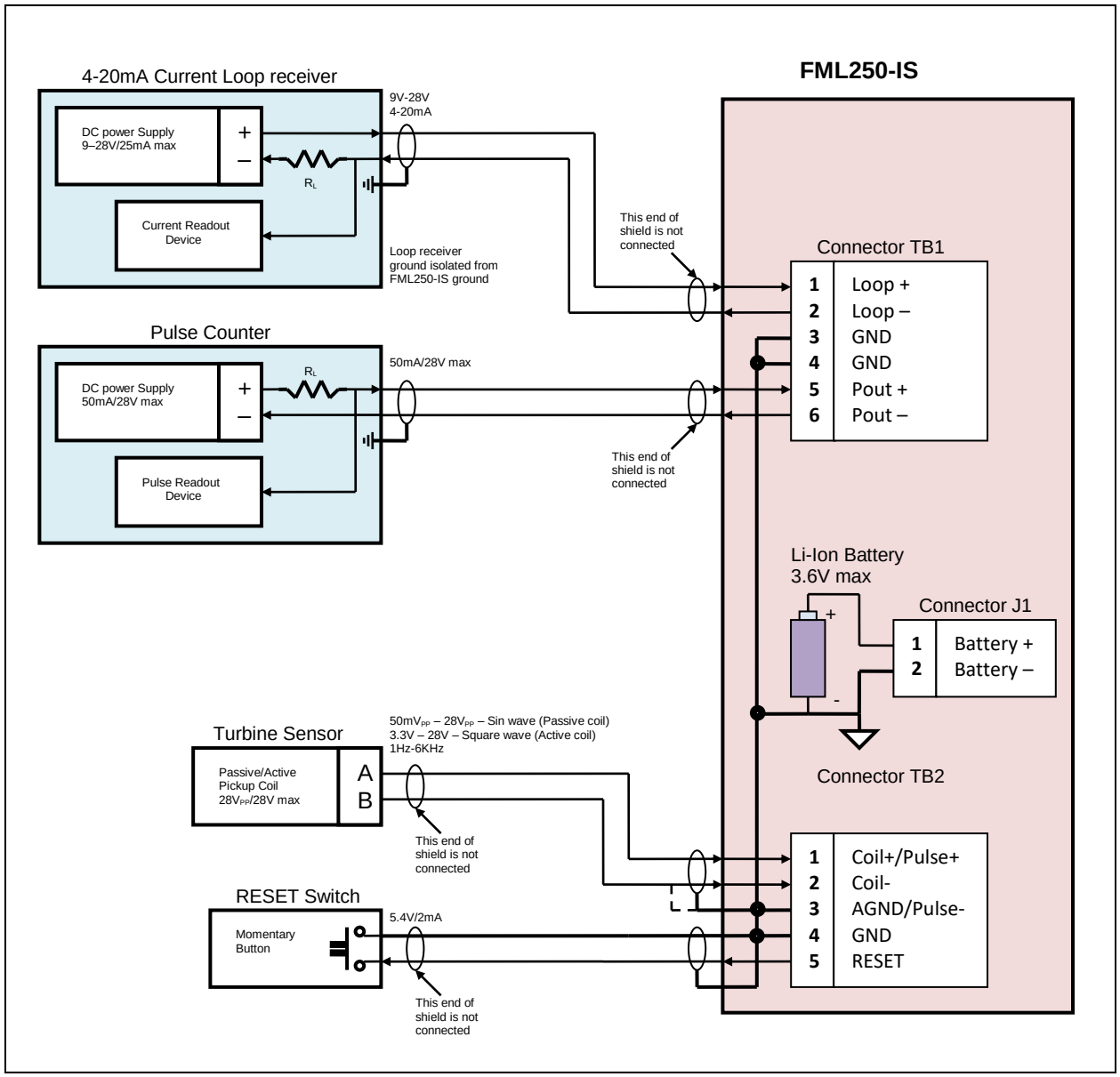


FML250-IS Main Board

WARNING! External power to be provided only by a 4-20mA Loop source whose ground is galvanically isolated from that of the FML250-IS.

5.3 Wiring Block Diagram

The FML250-IS supports connections with a variety of external devices: Turbine sensor, RESET Switch, 4-20mA Current Loop receiver and Pulse Counter. A block diagram illustrating the FML250-IS typical connection to the external devices is presented below.



FML250-IS wiring block diagram.

5.4 Wiring Examples

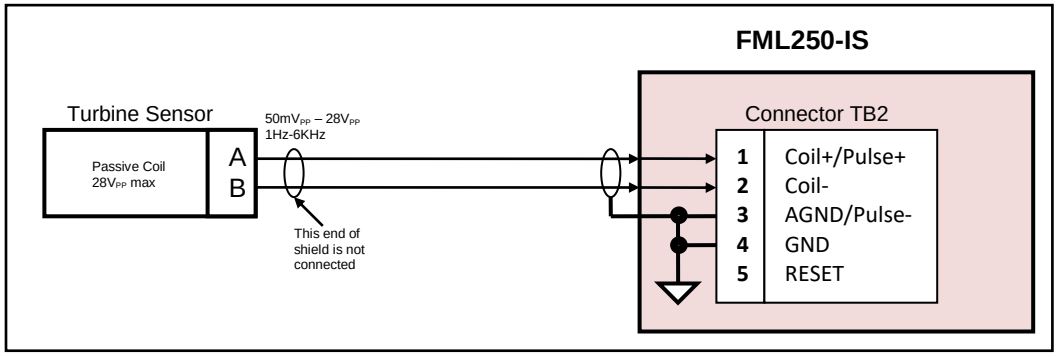
Wiring examples showing the specific connection between FML250-IS and each of the external devices that can be attached to it are presented below.

5.4.1 Connecting to a Turbine Sensor

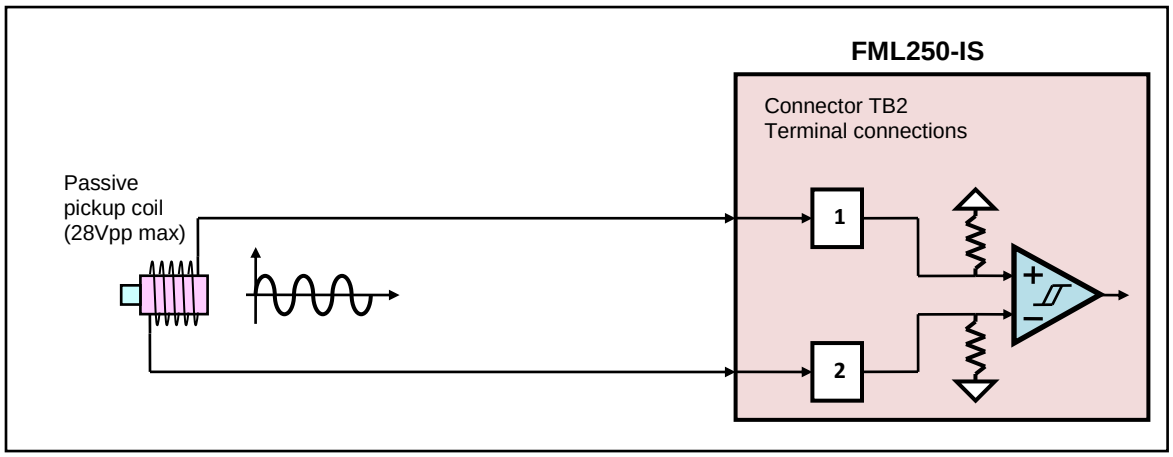
The turbine sensor provides the FML250-IS with a signal generated by a passive or active magnetic pickup coil. A passive magnetic pickup coil generates signals, which are approximately sinusoidal in shape, while the active magnetic pickup coil generates square wave signals having roughly 50% duty cycle. The FML250-IS accepts at its input and is able to process passive coil signals with amplitude in the range of 50mVPP to 28Vpp and, respectively, active coil signals with amplitude from 3.3V up to 28V, both in the frequency range of 1Hz and 6 KHz.
Examples of passive and active pickup coils wiring and their specific terminal connections are illustrated below.

Notes: An IS certified pickup coil is recommended to be used in conjunction with FML250-IS.
To reduce the influence of the external noise sources on the signal received from pickup coil, especially when low-level signals and long distances are involved, a shielded cable is recommended for connecting the pickup coil to FML250-IS.

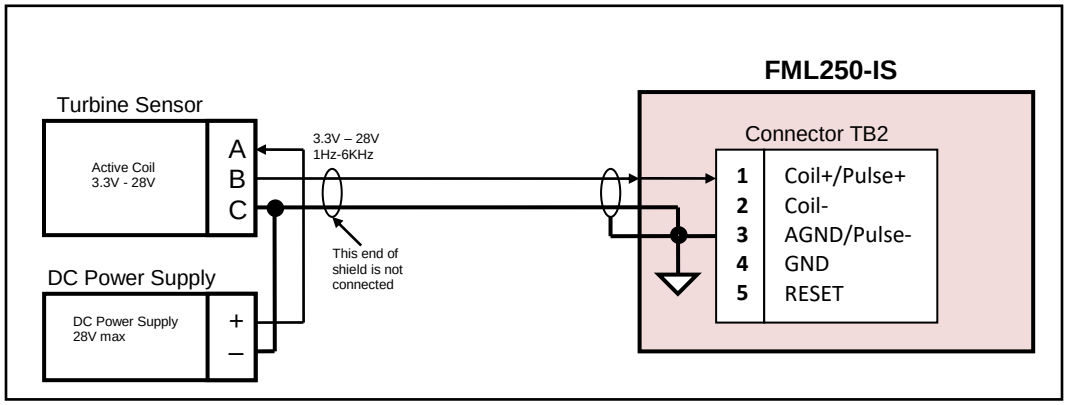
Active magnetic pickup coil power has to be supplied by a Class 2 or Limited Energy Source in accordance with CSA 61010-1-12



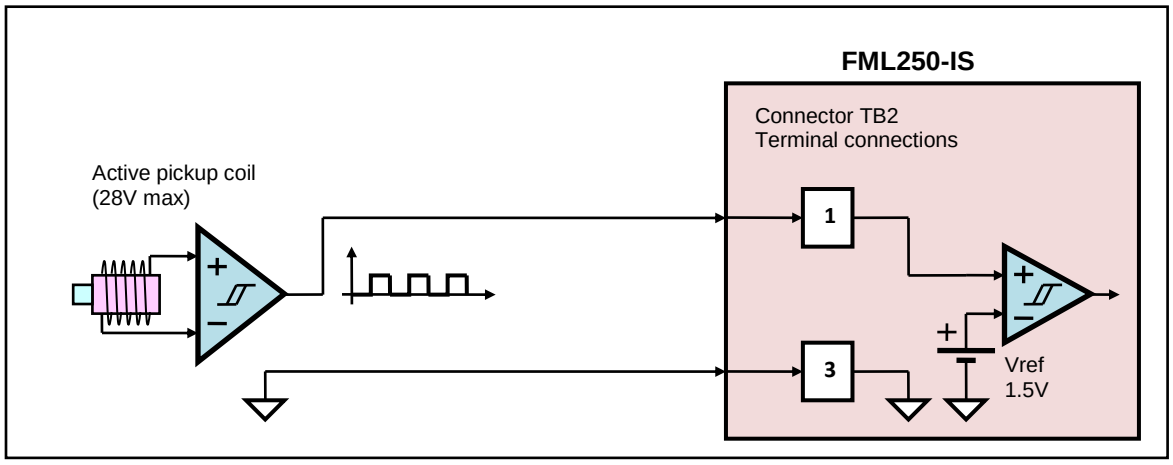
Passive pickup coil wiring



Passive pickup coil – terminal connections



Active pickup coil wiring, including the external DC power source.



Active pickup coil – terminal connections.

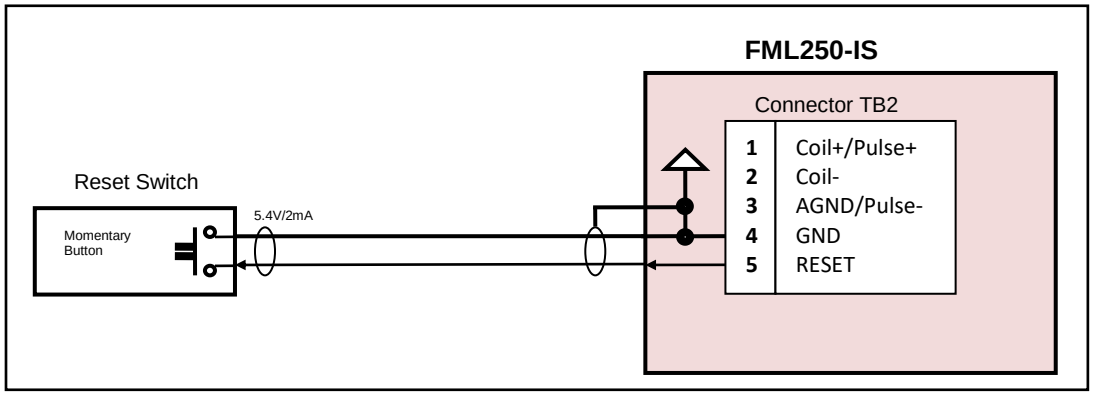
5.4.2 Connecting to a RESET Switch

The reset switch role is to reset the FML250-IS total volume to zero without requiring access to the interior of its enclosure. The reset function is accomplished by briefly short circuiting the reset input to ground.

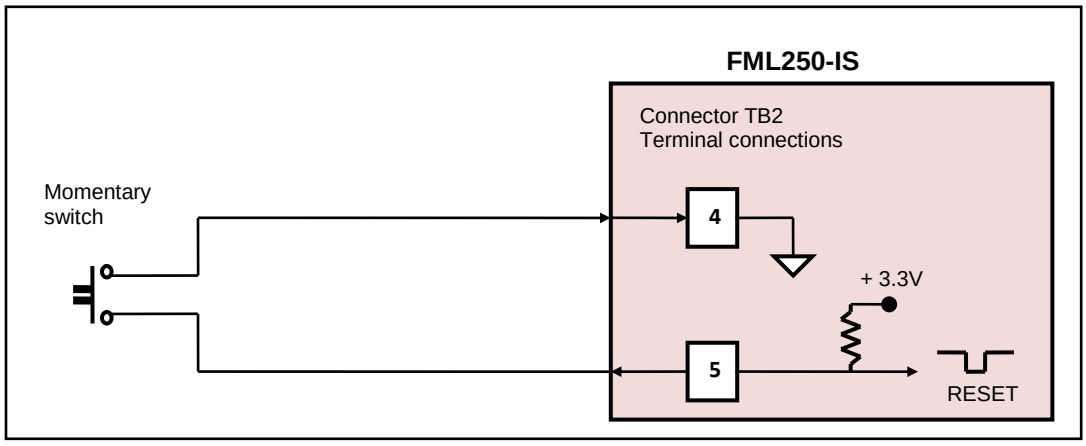
Examples of RESET wiring and its specific terminal connections are illustrated below.

Note: For avoiding fault resets produced by external sources of noise, especially for applications where long distances are considered, a shielded cable is recommended for connecting the reset switch to FML250-IS.

The reset switch is considered a simple apparatus as defined in the IEC 60079-11 standard.



RESET switch wiring.



RESET switch – terminal connections.

5.4.3 Connecting to a 4-20mA Current Loop

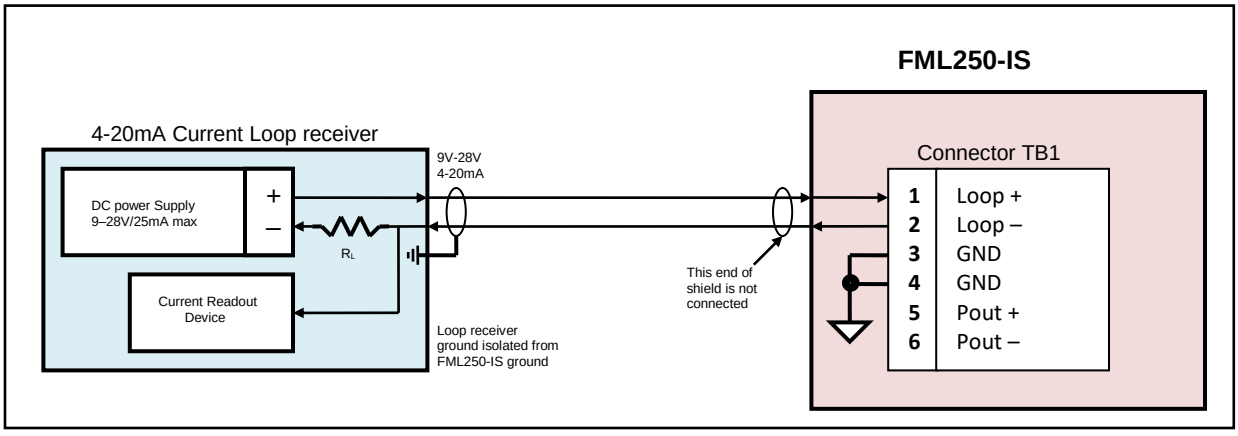
The 4-20mA current loop provides an output current proportional with the measured flow rate in the range of 4mA to 20mA. The two main components of the Current Loop receiver illustrated below are a DC power supply and a current readout device. These two components of the Current Loop receiver, although shown together, can also be implemented as two separate units. The RL resistor also may be included or not in the Current Readout device and it can be placed on the negative (loop return current) side of the loop dc supply source, as it is shown in the below figure, or on its positive side. A pair of twisted conductors is commonly used to connect the 4-20mA Current Loop receiver to FML250-IS. When FML250-IS is supplied from a loop DC source its internal Li-Ion battery functions as a supply backup for assuring an uninterrupted operation in the eventuality that the loop DC source fails.

Examples of 4-20mA Current loop receiver wiring and its specific terminal connections are illustrated below.

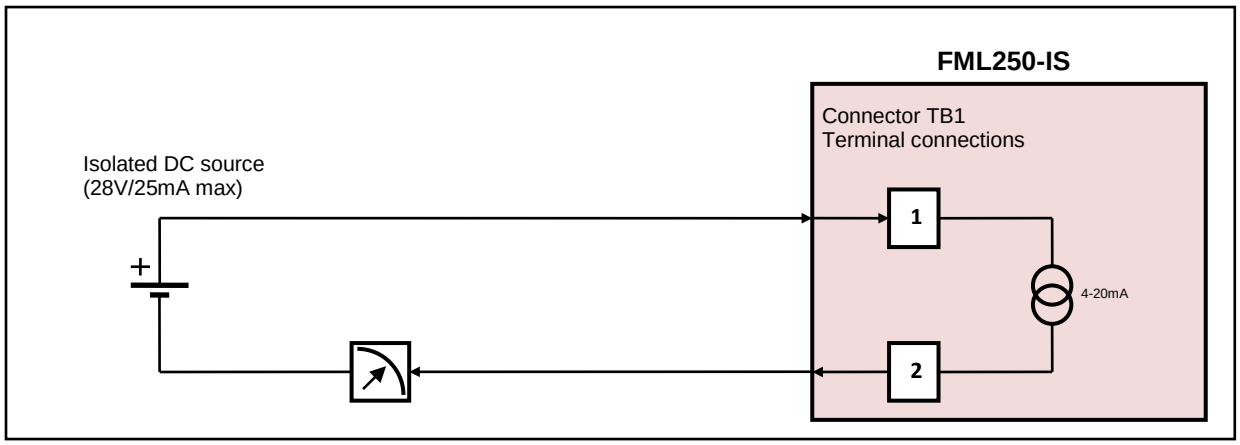
Notes: In order to assure the Current Loop proper operation The Current Loop receiver ground has to be insulated/floating with regards to the FML250-IS ground.

To reduce the influence of the external noise sources on the current loop accuracy a shielded cable is recommended for connecting the FML250-IS and the loop receiver.

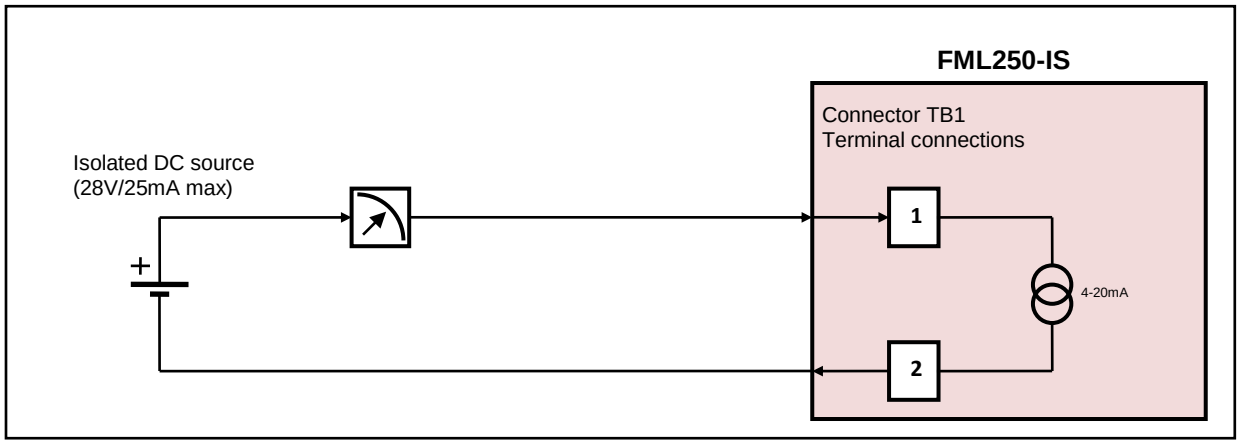
Current Loop power to be supplied by a Class 2 or Limited Energy Source in accordance with CSA 61010-1-12



4-20mA Current loop wiring.



4-20mA Current loop – terminal connections. The current measuring instrument placed on the negative side of the 4-20 mA Loop.



4-20mA Current loop – terminal connections. The current measuring instrument placed on the positive side of the 4-20 mA Loop.

5.4.4 Connecting to a Pulse Counter

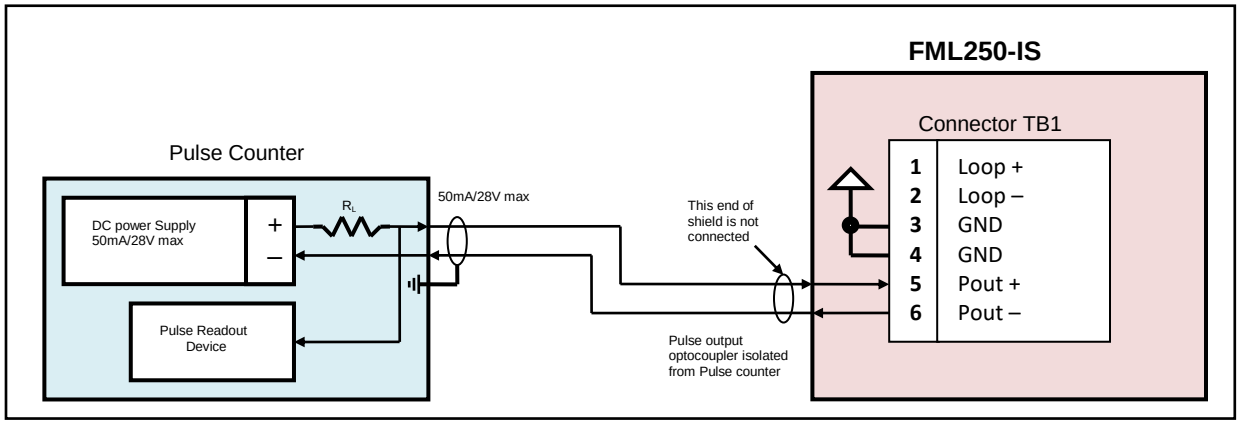
The pulse counter, formed by a DC power supply and a pulse readout device, detects and accumulates the factored pulses received from the FML250-IS pulse output. The rate of factored pulses created by FML250-IS is based on the flow rate information received from the turbine sensor and a user-defined volume per pulse ratio. The pulses produced by FML250-IS internal circuitry are sent to pins 5 and 6 of TB1 connector through an optocoupler which assures 5KVrms ground isolation between the FML250-IS ground and the ground of the external pulse counter. Pins 5 and 6 of TB1 connector acts as an open collector with a maximum rating of 28V and 50mA and they can be configured with the load RL as a pull up or pull down resistor, as it is illustrated in the below wiring diagrams.

Although the DC power supply and pulse readout device are shown as part of the pulse counter, they also can also be implemented as two separate units with the resistor RL included or not in the pulse readout device.

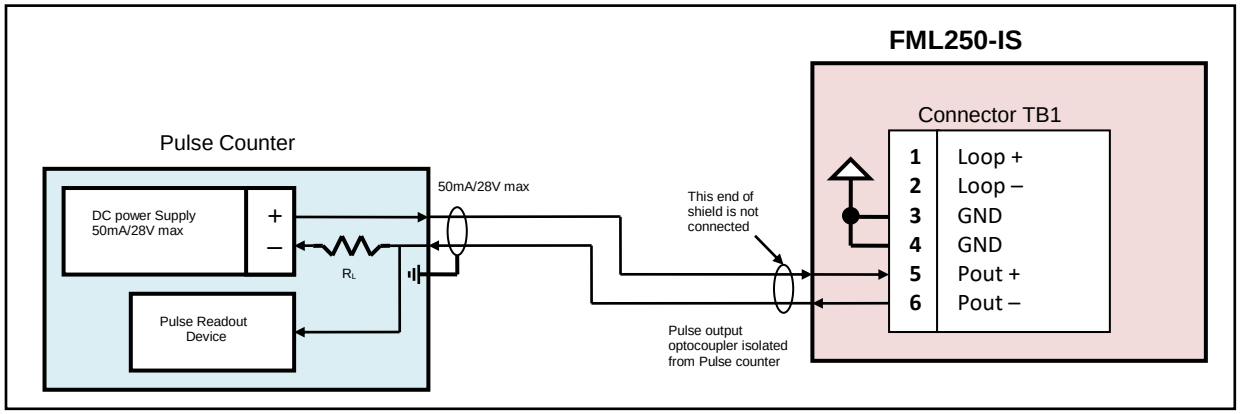
Examples of PULSE COUNTER wiring and its specific terminal connections are illustrated below.

Note: To reduce the influence that the square wave signals generated by FML250-IS might have on the low level signals possibly passing nearby, a shielded cable is recommended for connecting the pulse counter to FML250-IS.

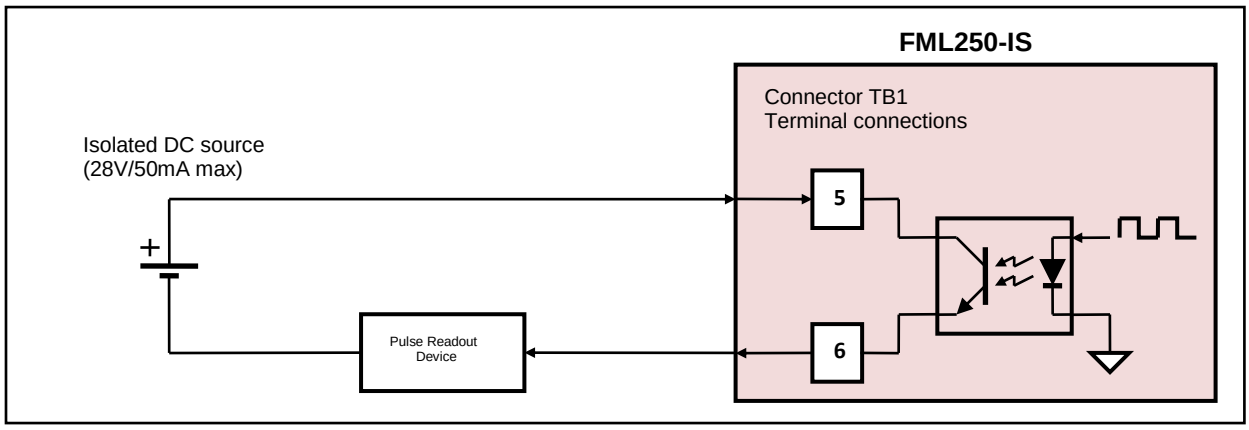
Pulse counter DC power to be supplied by a Class 2 or Limited Energy Source in accordance with CSA 61010-1-12



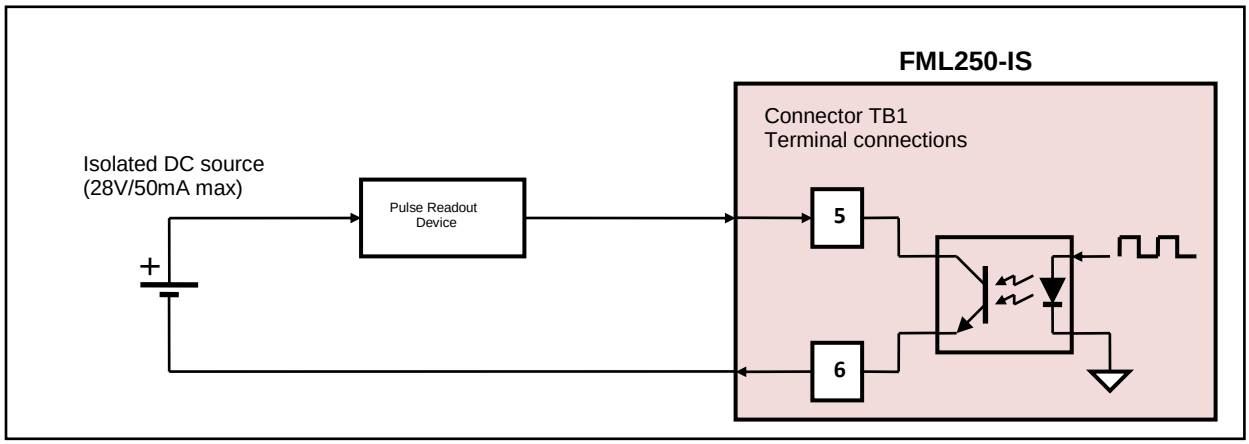
Pulse counter wiring with RL connected in pull down configuration.



Pulse counter wiring with RL connected in pull up configuration.



Pulse output – terminal connections. The pulse readout device placed on the negative side of the DC source.



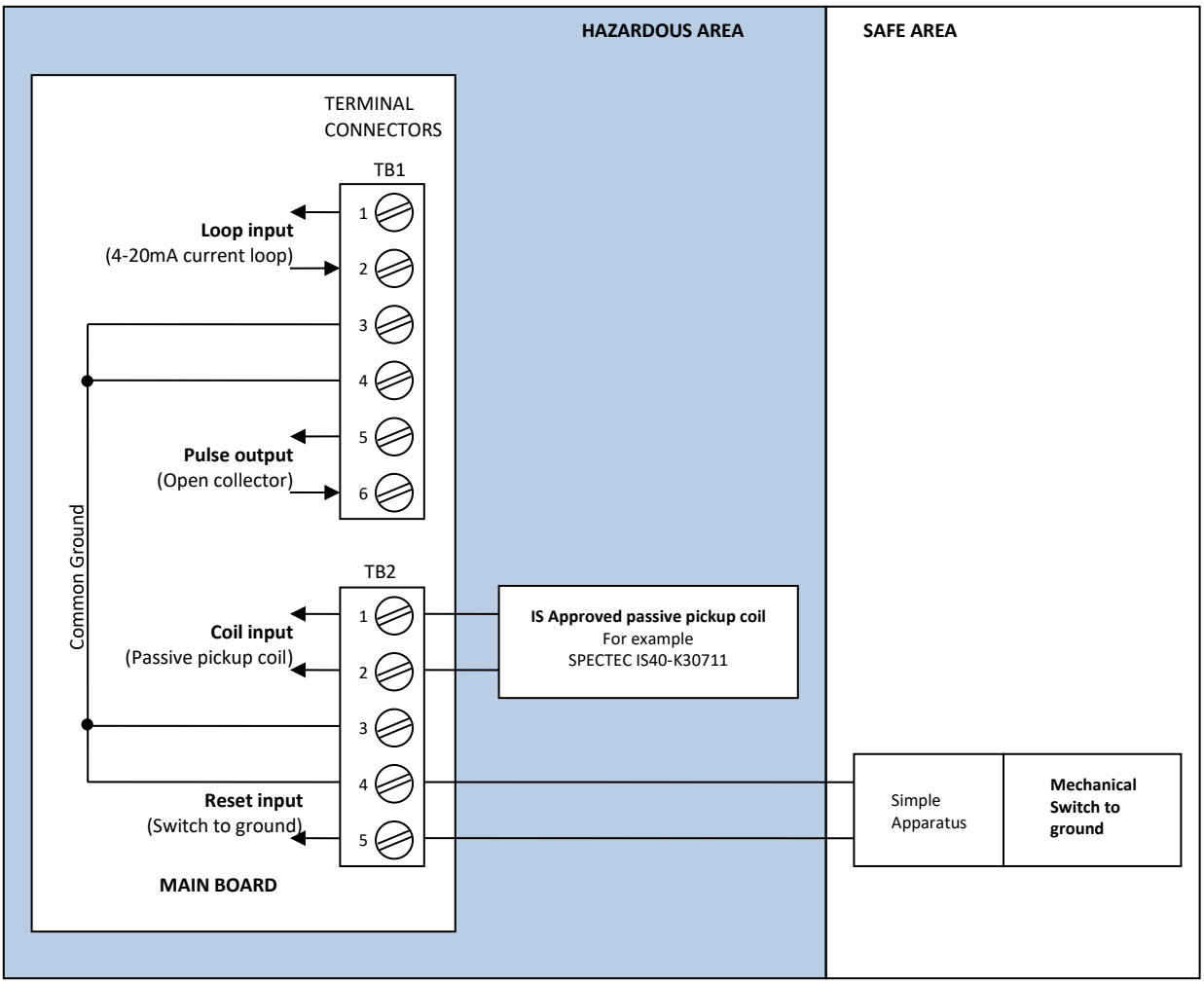
Pulse output – terminal connections. The pulse readout device placed on the positive side of the DC source.

WARNING! For an FML250-IS installed in a hazardous location, all field wiring must conform to wiring methods for intrinsically safe installations as defined by the National Electric Code in United States or by the Canadian Electric Code in Canada. Other International, State and local wiring codes may also apply

6 CONFIGURATION EXAMPLES FOR INTRINSICALLY SAFE INSTALLATIONS

6.1 Example 1

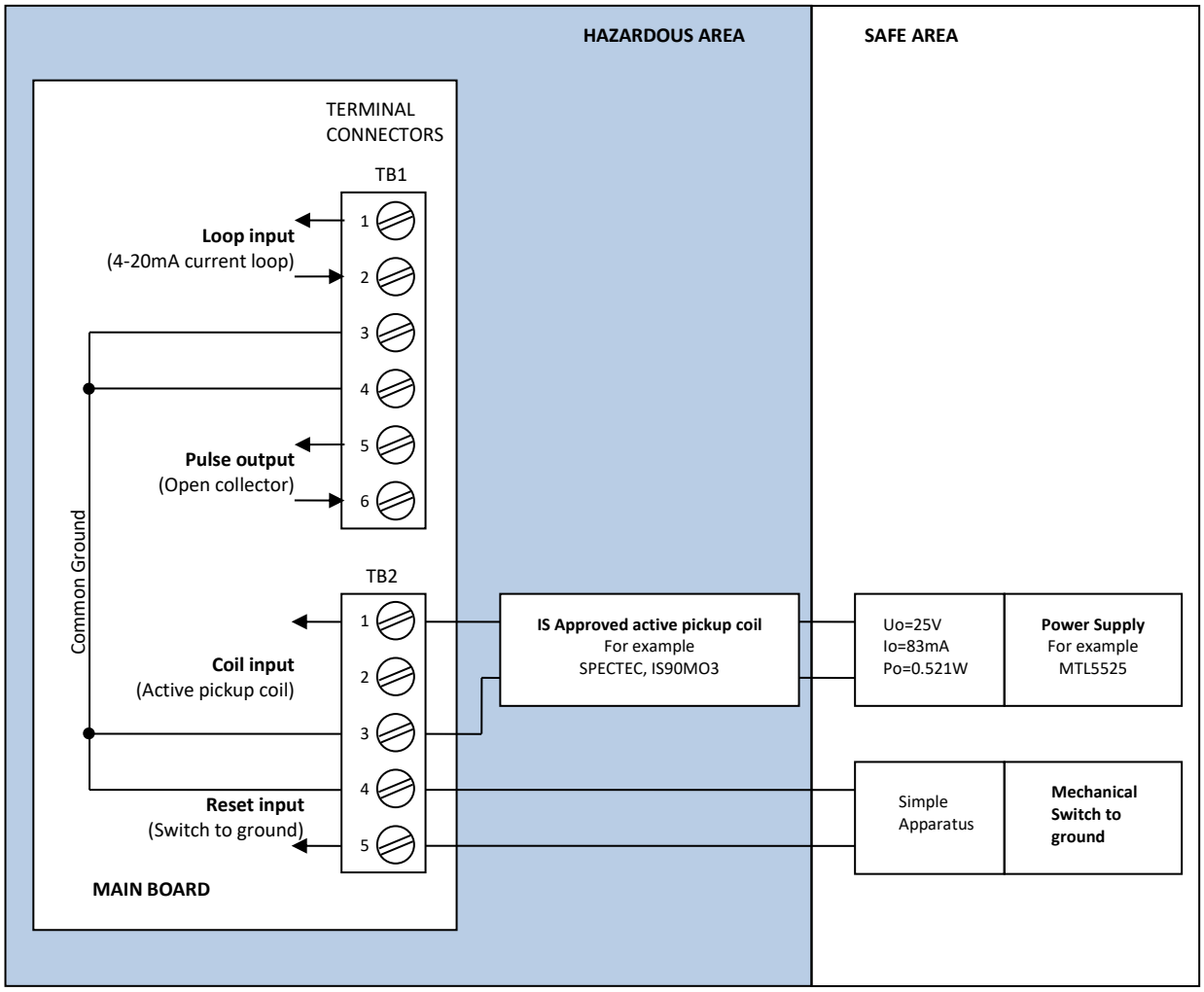
The following example illustrates a FML-IS supplied from an internal 3.6V battery and receiving at pins 1 and 2 of TB2 connector a signal from an IS approved passive pickup coil placed in the hazardous area, close to FML250-IS.
Also, to allow the remote reset of FML250-IS, a mechanical switch is included in the diagram. It is attached to pins 4 and 5 of TB2 connector and it initiates a FML250-IS reset by providing a short circuit to ground when activated. Although in the diagram the mechanical switch is placed in the safe area, being considered a Simple Apparatus, it also can be safely placed in the hazardous area, near FML250-IS.



FML250-IS, battery supplied and receiving signal from an IS approved passive pickup coil; FML250-IS remote reset assured by a mechanical switch placed in safe area.

6.2 Example 2

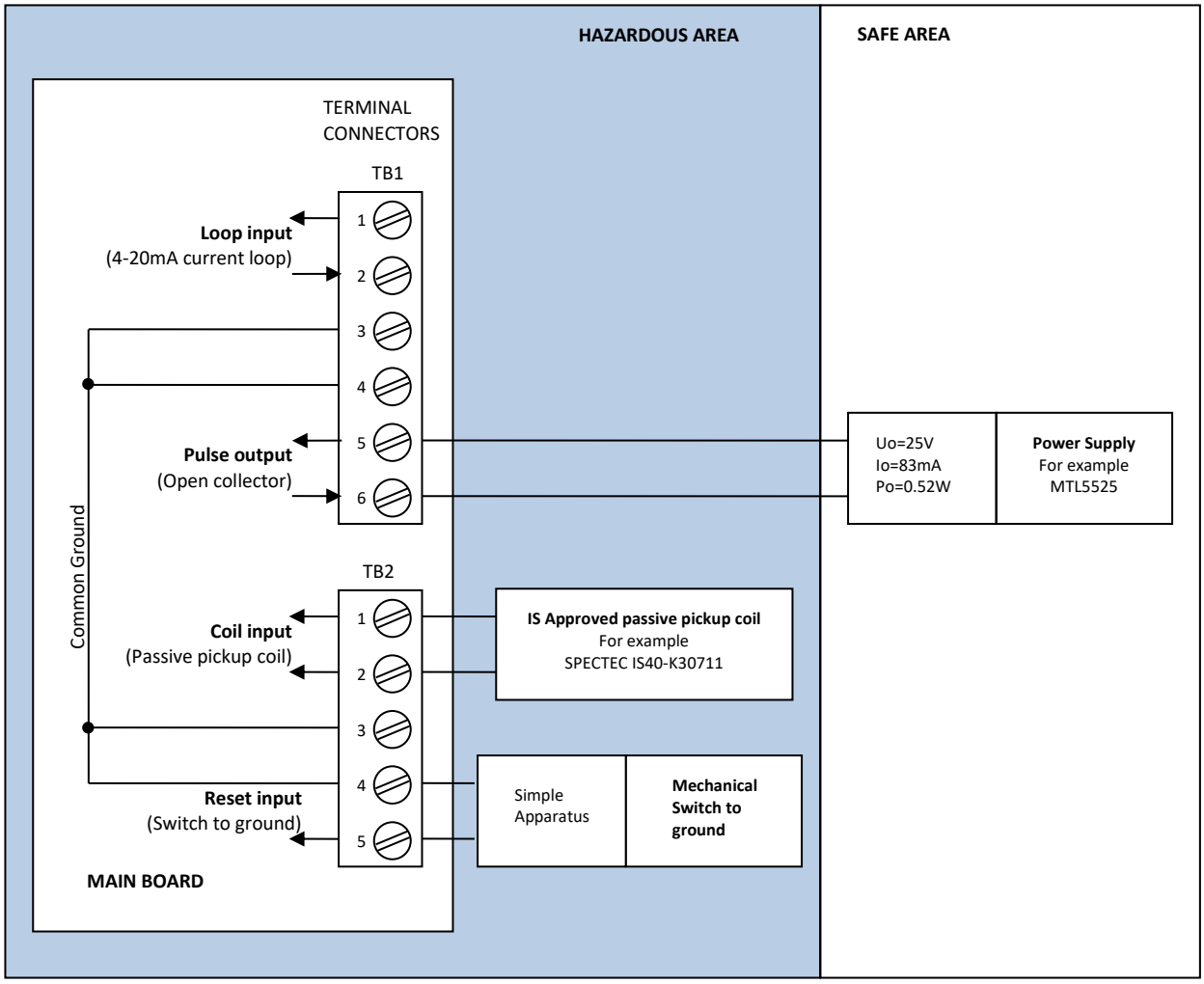
The following example illustrates a FML250-IS supplied from an internal 3.6V battery and receiving at pins 1 and 3 of TB2 connector square wave signals from an IS approved active pickup coil placed in the hazardous area, close to FML250-IS.
Also, to allow the remote reset of FML250-IS, a mechanical switch is included in the diagram. It is attached to pins 4 and 5 of TB2 connector and it initiates a FML250-IS reset by providing a short circuit to ground when activated. Although in the diagram the mechanical switch is placed in the safe area, due to being considered a Simple Apparatus, it also can be safely placed in the hazardous area.



FML250-IS, battery supplied and receiving signal from an IS approved active pickup coil; FML250-IS remote reset assured by a mechanical switch placed in safe area.

6.3 Example 3

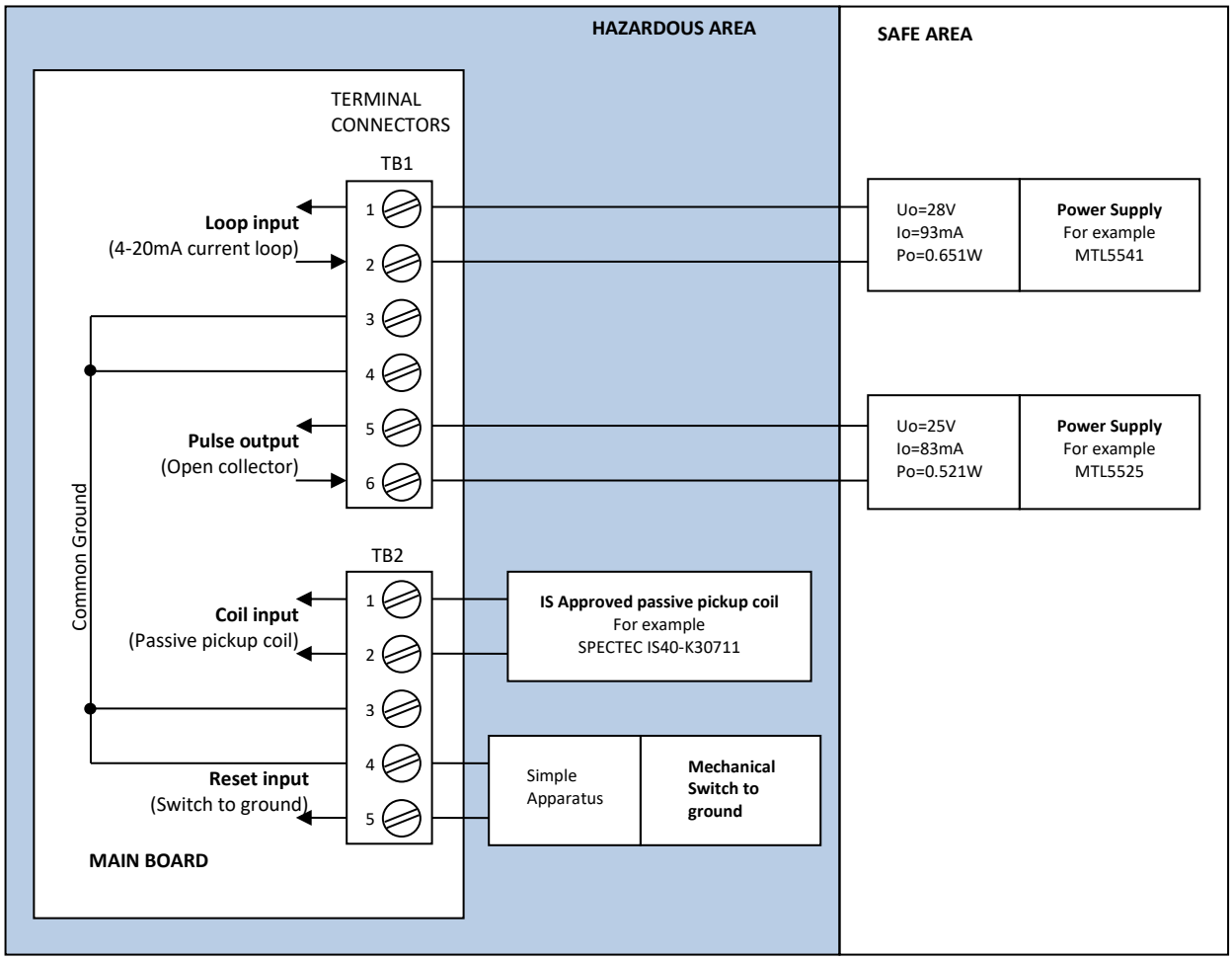
The following example illustrates an FML250-IS internally supplied from a 3.6V battery and receiving at pins 1 and 2 of TB2 connector signals from an IS approved passive pickup coil placed in the hazardous area, close to FML250-IS. Based on the pickup coil signals the FML250-IS delivers factored pulses to an external pulse counter through the open collector type output provided at pins 5 and 6 of TB1 connector.
Also, to allow the reset of FML250-IS, a mechanical switch is connected to pins 5 and 6 of TB2 connector. The mechanical switch, being considered a Simple Apparatus, can be placed in the hazardous area near the FML250-IS, as it is shown in the below diagram.



FML250-IS, battery supplied and receiving signal from an IS approved passive pickup coil; Square pulses provided to an external load through an open collector type pulse output; FML250-IS reset assured by a mechanical switch placed in hazardous area.

6.4 Example 4

The following example illustrates an FML250-IS externally supplied with a voltage in the range of 9 to 28V from a 4-20mA current loop power supply and receiving at pins 1 and 2 of TB2 connector signals from an IS approved passive pickup coil placed in the hazardous area, close to FML250-IS. Besides sending flowrate information through the 4-20mA loop, FML250-IS also delivers factored pulses to an external pulse counter through the open collector type output provided at pins 5 and 6 of TB1 connector.
Also, to allow the remote reset of FML250-IS, a mechanical switch is attached to pins 5 and 6 of TB2 connector. The mechanical switch, being considered a Simple Apparatus, can be placed in the hazardous area near the FML250-IS, as it is shown in the below diagram.



FML250-IS, loop supplied and receiving signal from an IS approved passive pickup coil; Square pulses provided to an external load through an open collector type pulse output; FML250-IS remote reset assured by a mechanical switch placed in hazardous area.

7 OPERATION OVERVIEW

Details of the operation of the FML250-IS can be found in this section.

7.1 Flow Calculations

Calculation of uncompensated flow rate:

$$FlowRate = \frac{Fin}{KFactor}$$

Calculation of uncompensated flow total:

$$FlowTotal = \frac{PulseInSum}{KFactor}$$

Grand total is calculated independently from total.

7.2 Linearization

Linearization, as it pertains to the FML250-IS, is the selection and interpolation of a K-Factor from a table of calibrated values based on frequency. Whenever a new frequency is detected, the unit will look up adjacent frequency values in the linearizer table and calculate a K-Factor (using linear interpolation). If the frequency value is below the lowest frequency in the table, then the linearizer uses the lowest point in the table. If the frequency value is above the highest point in the table, then the linearizer continues to use the K-Factor from the highest point in the table.

7.3 Units of Measure

All unit of measure calculations are based on the conversion of the desired unit of measure to the system units of measure (Gallons or Liters). Special units of measure are available for weight equivalent units such as pounds and kilograms. These conversions are straight conversion from gallons (or l) to weight based on the weight of one gallon (or l) as entered in the menu for that UOM.

7.4 Pulse Output

The pulse output of the FML250-IS consists of an optically isolated open collector pulse output, a pulse width, and a pulse divider. To calculate the pulse output, the unit takes the net grand totalizer value for the last update time and divides it by the pulse output divider (in the setup menu). Because the divider is allowed to be smaller than 1, the pulse divider can be made to be a multiplier. Pulse output calculation uses the following formula:

$$OutputPulses = \frac{LastUpdateTotalizerPulses}{PulseOutDivider}$$

The pulse width is the number of milliseconds the pulse is active. This will need to be small enough that all of the pulses that need to be outputted have time to complete, but large enough that the receiving equipment can still detect them. To calculate the maximum pulse width:

$$PW\ max = \frac{PulseOutDivider}{2 * (TotalOutputPulses/Second)}$$

Note: Pulse Width is ½ of Pulse Period.

Example: If the totalizer is observed to be increasing by 300 every second and the Pulse Output Divider is set to 10, then the maximum allowed pulse width is:

$$PWmax = \frac{10}{300 * 2} = 0.0166s = 16ms$$

Notes: The output pulse is indicating that one (totalizer U/M) / (Pulse Output divider) has flowed through the meter.

If the display shows "E" on the top left digit, then the pulse output system is being overloaded and output pulses are being lost. This is due to the above calculation being exceeded (the pulse width is too wide for the number of pulses being asked to be outputted per second). This can be solved in several ways: Reduce the Pulse Width, Reduce the number of decimal places in the Totalizer, or increase the Pulse Divider.

7.5 Warnings

The FML250-IS has an extensive warning system that serves more than to alert the user to operation outside a set of parameters. As can be seen in the menu system section of the manual, there are several parameters within the system that are continuously monitored. Most of these warnings do not affect the operation of the unit. For example, if the rate is out of range, the total and grand total calculations are still performed as they are described above. In these cases, the only indication of a warning is the warning icon (see the Front Panel Display section) and if the warning value is displayed (such as rate), then instead of the actual number, the display will indicate the warning. The warning will show as "--OL--" (over limit), "--UL--" (under limit), etc.

7.6 Alarms

When action is needed when a warning is active, the FML250-IS has an alarm system. This alarm system takes the warning system and puts it into action. As can be seen in the Alarm menu item, any given warning can be made to activate the alarm system. The alarm system is only active during the actual time that the selected warning is also active. It can be noted that the alarm values for a given alarm are identical to the corresponding warning value. One can think of the alarm system to be the logical AND of the warnings and the selected Alarms. Because of this, only the desired warnings will trigger the Alarm system.

The only alarm system action is the “No Total” which is used to stop the totalizers from counting. For instance, if the Low Rate warning value is set to 5 (U/M is always the same as the displayed U/M), the Low Rate Alarm is set, the No Total Alarm is set, and the flow input calculated value is below 5, then the totalizer will not accumulate even if there are pulses coming in on the flow input. In this way, any enabled Alarm that has a corresponding active warning will cause the totalizer to stop.
There are a few warnings that cannot be made to trigger the Alarm system. These can be noted in the Warnings section of the Test menu.

7.7 Display

The display consists of two numeric blocks: the Upper value and the Lower value. Both of these blocks display a value from a list of available values set in the menu system. The Upper value is sequenced by swiping pressing the **SELECT** button. The Lower value is sequenced automatically using a timer. The value of the timer is set in the Display menu. Each display can be made to display only one value by setting all of the other slots to “Skip”. Any display slot may be set to Skip.

7.8 Reset

The FML250-IS has two totalizers. The total that is indicated with **TOTAL** is resettable. The total that is indicated with **GRAND** is not resettable. There are three means by which the resettable totalizer can be reset:

- The **RESET** button on the front panel can be pressed while in run mode. The lower display indicates “-RESET-”.
- The reset input pins (TB1-7 and TB1-8) can be shorted for a brief time. The pulse must be at least 50ms. The lower display indicates “-RESET-”
- The reset menu item can be activated.

7.9 Power

The FML250-IS can receive power from two sources:

- An internal Lithium battery pack
- External 4-20 mA loop source

When the unit is powered from an external 4-20mA loop source, the battery will act as a backup supply of power if/when the external power is lost. This switch over is instantaneous and automatic. No user intervention is needed. The unit will only use the battery if the voltage of the external 4-20mA loop source is below the input voltage specification.
When running on battery, power can be conserved by adjusting the refresh rate of the unit by changing the power mode. When observing the power mode menu item, the number of times the unit will refresh is shown on the right. By causing the unit to refresh less often, less power is

used to recalculate and display any updated values. This can also be used to "slow down" or filter the display to make it less jumpy. Values will effectively be averaged over the time between refreshes.

Power Mode	Refresh Rate (#/s)
0	0.5 (one update every two seconds)
1	1
2	2
3	4
4	8
5	16
6	Continuous*

* In continuous mode, the refresh rate is not tied to any timer and will occur as fast as the internal calculations will allow.

7.10 Auto-Calibration

The FML250-IS has an Auto-Calibration feature that allows the user to easily adjust the K-factor based on a known delivery of liquid. The feature takes a displayed value of product that is observed on the FML250-IS display and automatically calculates an adjusted K-factor based on the actual value of that delivery.

Additionally, a prove is available for performing the displayed delivery portion of the Auto-Calibration mode on the fly. Delivery total will be displayed during the prove run. Any total added during the prove run will be added to the main totalizer as well as the grand totalizer.

Given:

T(disp) – *Total Displayed in configured units of measure (Entered by the user or automatically calculated by current K and received pulses from the turbine during prove mode)**
T(act) – *Actual Total Delivered in configured units of measure entered by user*
K(cur) – *Current K-factor (in PPG or PPL)*

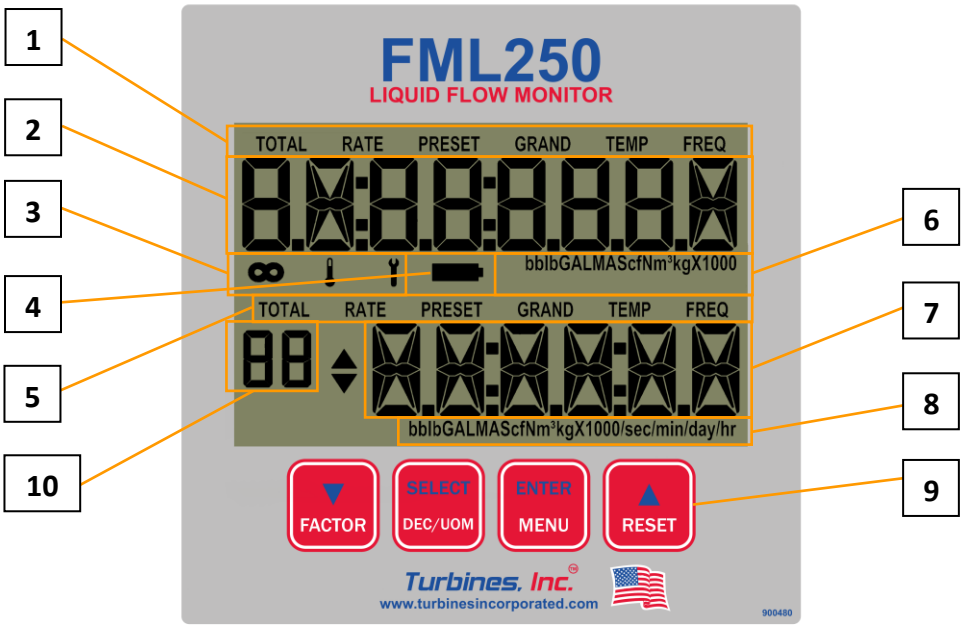
Percent error:

$$\boldsymbol{Error}(\%) = \left(\frac{\boldsymbol{T(disp)} - \boldsymbol{T(act)}}{\boldsymbol{T(act)}}\right) * \mathbf{100}$$

Calculated (new) K-factor:

$$\boldsymbol{K(calc)} = \left(\frac{\boldsymbol{Error}(\%)}{\mathbf{100}} * \boldsymbol{K(cur)}\right) + \boldsymbol{K(cur)}$$

8 FRONT PANEL DISPLAY AND CONTROLS



1. **Upper display type indicator** – This portion of the display indicates what value is being displayed in the upper display value.
2. **Upper display value** – This is the upper display value. This is one of the items in the upper display list and is selected with item #1 above.
3. **Warnings/errors indicator** – These icons indicate one or more of the following items are outside the warning limits:
    a. **Infinity** – Flow Rate
    b. **Wrench** – Maintenance timer has expired. In addition, there are several other fault and warning conditions that may cause this icon to illuminate. See the Warnings section in the Operation Overview below.
4. **Battery** – The battery icon indicates the battery is below normal operating voltage and must be changed.
5. **Lower display type indicator** – This portion of the display indicates what value is being displayed in the lower display value.
6. **Upper display units of measure** – These will show the units of measure for the upper display (usually Total/Grand Total). On some units, these icons show the combined units of measure for the unit (The lower display UOM icons are not present). **Note:** this is only used for flow values.
7. **Lower display value** – This is the lower display value. This is one of the items in the lower display list and is sequenced via the lower display timer.
8. **Lower display units of measure** – These will show the units of measure for the lower display (usually Rate). Some units only show the time base for the lower display.
9. **Front panel buttons** – These buttons are used together to manipulate all of the items, values, and selections in the menu system.

a. ▼/**FACTOR**:
   i. **Run:**
      1. **Holding** – Holding the factor button down at any time in run mode will change the upper display to the current K-factor the unit is using for calculations (in pulses/Gallon or pulses/Liter). A linearized value is indicated by the presence of an '' after the number. In this case, the number listed is the numerically linearized factor calculated from the linearizer table.
      2. **Quickly Pressing** – Quickly pressing the factor button will cause the menu to be entered and quickly jumped to the factor editing menu (or meter size if easy menu is selected prior).
   ii. **Menu** – Sequences through menu items or selections (in reverse).

b. **SELECT/DEC/UOM**:
   i. **Run**– Sequences the upper display through its display list. If a value is in error, then holding the button will display the default value (that is, the value being used for calculation purposes).
   ii. **Menu** – Is used to select menus for entering or editing.

c. **ENTER/MENU**: Enters the menu system, accepts changes, and exits menu items within the menu system.

d. ▲/**RESET**:
   i. **Run** – Causes the resettable totalizer to become zero.
   ii. **Menu** – Sequences through menu items or selections.

10. **Menu/Submenu item number** – Shows the Menu or Submenu number that is currently being viewed or edited. This will correspond to the number listed in the Menu System and the Main Menu Flowchart sections of this manual.

9 MENU SYSTEM

The Menu system consists of several items that allow the user to manipulate aspects of the FML250-IS operation. The menu can be entered two ways:

1. Pressing the **MENU** button – When entering the menu using the **MENU** button, the user is presented with the option of three menu types:
    a. **EASY** (EASY) – This menu only asks for the following items:
        i Meter Size – This is the size of the meter and will automatically use the standard factor for Turbines Incorporated standard TM Series flow meters.
        ii Unit of measure
        iii Time Unit of measure
    b. **FACTOR** (FACTOR) – This sequences through all of the menu items below except for the Linearizer section.
    c. **LINEAR** (LINEAR) – This sequences through all of the menu items below except for the Factor section.
2. Pressing (momentarily) the **FACTOR** button
    a. This enters the menu system starting with the following based on previous selection:
        i **EASY**: Meter Size
        ii **FACTOR**: K-Factor
        iii **LINEAR**: Linearizer

9.1 User Interface

All values and selections within the menu system are manipulated through the use of the front panel buttons. These four buttons have overloaded functions that allow a simple yet effective means of entering data. To enter the menu system, press the **ENTER/MENU** button.

9.1.1 Navigating the menu

- **▲/RESET**
    - Step forward through the various menu, submenu items, and selections
- **ENTER/MENU**
    - Initially used to enter the menu system
    - Once a value has been changed, this button is used to accept the new value/selection. If a new value/selection is presented and this is not pressed, then the changed value will be ignored
    - If a value has not been changed, this is used to exit the menu or drop out of a submenu
- **SELECT/DEC/UOM**
    - Used to allow a new selection of the displayed menu item to be made using the arrow buttons (▲/▼) (the wrench icon will flash when the arrows are active)
    - Used to enter a submenu (such as the Test submenu).
    - When the battery icon is displayed for a custom/editable value, holding this will allow editing of the custom value.

- ▼/**FACTOR**
  - Step backward through the various menu, submenu items, and selections

9.1.2 Editing a number

Some numbers in the menu can be edited. This is denoted by the existence of the batt icon on the display. When this is present, the **SELECT** button can be held to gain access to edit the number.

- ▲/**RESET**
  - Used to step forward through the current item selections
  - Used to increment the value of the selected digit or the decimal point (when flashing)
- **ENTER/MENU**
  - Used to accept the currently displayed portion of the value and move on to the next portion of the edit (up to three portions: sign, significand, and decimal)
- **SELECT/DEC/UOM**
  - Any time the batt icon appears in the menu, this button can be used to begin the editing steps (hold to edit)
  - Once editing has started, this button toggles the sign (if available) and steps through the digits to be changed
- ▼/**FACTOR**
  - Used to step backward through the current item selections
  - Used to decrement the value of the selected digit or the decimal point (when flashing)

9.2 Menu System Items

To enter the menu system, press the **ENTER/MENU** button from run mode. A Lockout code may be required. If so, enter the lockout code by using the encoders as described above (Editing a number).

Note: The K-factor may be easily directly accessed by pressing the **FACTOR** button from run mode based on previous selection:

- **EASY**: Jump to the Meter Model Number section below (#4)
- **FACTOR**: Jump to the K-Factor section below (#2)
- **LINEAR**: Jump to the Linearizer section below (#3)

1. Menu Selection

Selects between the Easy Setup, single K-Factor, and Linearizer operation

1.1 Easy Setup (EASY)

This selection will allow a very quick and easy subset of the parameters needed to setup the FML250-IS for use with a standard Turbines Incorporated flow meter. If this item is selected, only the following will be available in the menu:
Meter Size (#4): This is the Turbines Incorporated meter part number

- Totalizer U/M (#5)
- Rate U/M (#7)
- Time U/M (#9)

Other menu item assumptions are (made when the meter size is selected)

- Totalizer Decimal: 0.1
- Rate Decimal: Auto-range
- 4-20mA: Low and high values are set to the range of the flow meter selected
- Warning (Flow): Low and high values are set to the range of the meter selected
- Pulse Output is disabled
- All other settings are left unchanged

2. K-factor (FACTOR)

When K-Factor selection is made, this item allows the editing of the K-Factor. The unit of measure is fixed to the UOM System selected in the Service menu.

3. Linearizer (LINEAR)

When Linearizer selection is made, this item shows the number of valid linearizer points that are currently entered. Pressing the **SELECT** button will allow the linearizer table to be edited. Once pressed, the linearizer table can be stepped through using the ▲▼ buttons. To edit a number, press the **SELECT** button again. A frequency value of zero will indicate no more points are to be entered. To save the linearizer table, after editing any number, press the **MENU** button. If the table is acceptable, it will be saved.

Note: The points must be entered in ascending frequency order and contain at least two points.

4. Meter Model Number (METER)

When the Easy menu is selected, the K-factor is selected by selecting the meter size. This configuration is meant to be used with Turbines Incorporated standard meters which part numbers start with “TM”.

5. Totalizer Units of Measure (T UNIT)

Selects which unit of measure is desired for the totalizer in the FML250-IS. Items that show the batt icon are user editable conversions. To edit, hold **SELECT**. Once done editing, be sure to press **MENU** to accept the custom selection as the active conversion. The custom unit (the one

that has no unit icon) is based on Gallons. This conversion is the number of units per Gallon that are desired. The following units of measure SCF/GAL, MSCF/GAL, SM3/GAL, & MSM3/GAL are editable and are meant to be used for gas equivalent conversions usually in cryogenic liquid measurements. A table of common gas equivalents can be found in the appendix.

6. Totalizer Decimal place (t dEC)

The fixed decimal location to be used for the totalizer and the grand totalizer functions.

7. Ratemeter Units of Measure (r UNIt)

Selects which unit of measure is desired for the ratemeter of the FML250-IS. Items that show the batt icon are user editable conversions. To edit, hold **SELECT**. Once done editing, be sure to press **MENU** to accept the custom selection as the active conversion. The custom unit (the one that has no unit icon) is based on Gallons. This conversion is the number of units per Gallon that are desired. The following units of measure SCF/GAL, MSCF/GAL, SM3/GAL, & MSM3/GAL are editable and are meant to be used for gas equivalent conversions usually in cryogenic liquid measurements. A table of common gas equivalents can be found in the appendix.

8. Decimal place (r dEC)

The fixed decimal location to be used for the ratemeter functions. The auto-range option "-AUtO-" causes the ratemeter decimal place to change automatically.

9. Time Units of Measure (tI ME)

Selects the time base for the Ratemeter function. The custom unit (the one that has no unit icon and shows the batt) is based on seconds. So, this conversion is the number of seconds per unit that are desired. To edit, hold **SELECT**. Once done editing, be sure to press **MENU** to accept the custom selection as the active conversion.

12. Pulse Input (PUL I N)

The pulse in menu allows modification of values that are used by the pulse input module. Press **SELECT** to enter the pulse input submenu.

12.1 Pulse input type (tYPE)

- Magnetic (MAGNEt): This is the standard input type for the unpowered pickup coil on most Turbines Inc. flow meters. This input reacts to the sensitivity setting.
- Square (SQUArE): This input type is for sourced (powered) pulse inputs. These are typically seen in standard powered pickup coils.

13. Pulse Out (PULOUt)

The pulse out menu allows modification of values that are used in the pulse output module. The pulse output is calculated based on the value of the grand totalizer over time. As the grand totalizer increases, these pulses are used to determine the output pulses sent to the pulse output. Press **SELECT** to enter the pulse out submenu.

13.1 Pulse Out Enable (OUtPUt)

It enables or disables the pulse output module. When disabled, there is an increase in battery life.

Note: If the display shows "E" on the top left digit in run mode, then the pulse output system is being overloaded and output pulses are being lost (pulse width is too wide for the number of output pulses per refresh interval). This can be solved by: reducing the Pulse Width, Totalizer decimals, increasing the Pulse Divider or by using the Overflow carry option (section 13.4)

13.2 Pulse width (Wi dtH)

It selects the width of the output pulse in milliseconds. The custom width (the one that shows the batt) is based on milliseconds. To edit, hold **SELECT**. Once done editing, be sure to press **MENU** to accept the custom selection as the active pulse width.

13.3 Pulse Divide (di Vi dE)

It selects the pulse divider. To determine the number of output pulses, the calculated number of pulses will be divided by this number. Example: The grand totalizer increased by 50 between the last update and the current update. If the pulse divide is 10, then there will be 5 output pulses and If the divider is 0.1, then 500 pulses will be outputted. There is a custom divider (the one that shows the batt). To edit, hold **SELECT**. Once done editing, be sure to press **MENU** to accept the custom selection as the active divider.

13.4 Overflow carry (CArrY)

It enables or disables the Overflow carry option.
When this option is enabled, PT420 stores the overflow pulses and adds them later, in the periods of reduced flowrate. This option is recommended for avoiding missing pulses in situations when pulse output system is overloaded.

14. 4-20mA Output (4-20mA)

14.1 4-20mA Output Enable (OUtPUt)

Enables or disables the 4-20mA output. When disabled, there is a small increase in battery life.

14.2 Low (4mA) Output Set Point (LOW)

It selects the rate value to represent 4 mA output current. The UOM is the same as is set for the Ratemeter.

14.3 High (20mA) Output Set Point (HIGH)

It selects the rate value to represent 20 mA output current. The UOM is the same as is set for the Ratemeter.

15. Warnings (WARNIN)

The warnings menu allows modification of values that are used to determine the activation of a warning. Warning limits do not affect operation except for display purposes. To cause a warning to affect operation (totalizer inhibit), set the values in this menu and then activate them in the Alarms menu. Press **SELECT** to enter the warnings submenu.

15.1 Rate Low (RATE LOW)

This sets the low Ratemeter warning value. U/M is selected when selecting Rate U/M above.

15.2 Rate High (RATE HIGH)

This sets the high Ratemeter warning value. U/M is selected when selecting Rate U/M above.

16. Alarms (ALARM)

The alarms menu allows each warning in the unit to trigger cause the totalizer to be stopped (inhibited). The alarm is a “follow” function meaning it is only active as long as there is an active corresponding warning. Press **SELECT** to enter the Alarms submenu. There are several system warnings that can be made to trigger the system alarm:

16.1 No total (0x00001) (NO tOt) dc/dc low power

When this is enabled, the totalizer will be inhibited when any selected alarm and corresponding warning is active. This is useful for preventing the totalizer count when some conditions are unfavorable for accurate flow. For instance, if the flow meter becomes non-linear below a certain flow rate, then this can be enabled and the low flow alarm enabled with the value of the minimum linear flow programmed in the low flow warning.

16.5 Maintenance expired (0x00010) (MAINt)

Active when the maintenance timer expires.

16.6 Battery operation (0x00020) (ONBATT)

Active when the unit is running on battery.

16.7 Low battery (0x00040) (dEAd b)

Active when the internal battery is low

16.9 Pulse Output Overload (0x00100) (PLS OL)

Active when the last attempt to output pulses resulted in an overload. The pulse output system is being overloaded and output pulses are being lost. This is due to the pulse output calculation being exceeded (the pulse width is too wide for the number of pulses being asked to be outputted per second).

16.11 Low Flow (0x00400) (LO FL)

Active when the ratemeter value is below the low flow warning value.

16.12 High Flow (0x00800) (HI FL)

Active when the ratemeter value is above the high flow warning value.

17. Display (dISPLY)

The display menu allows modification of values that are used to determine the values displayed when the unit is operating normally. Press **SELECT** to enter the display submenu.

17.1 Display Upper (UPPER)

The display upper menu is used to select the values to be displayed in the upper portion of the display. The value shown is a list of the currently selected display items. For example, if the number 000002 1 is displayed, this means the upper display will sequence through the two values: Total and Grand Total. The sequence is controlled one at a time via **SELECT**. To edit, press **SELECT**. The menu will allow stepping through the eight possible display slots (via the ▲▼ buttons) and give the option to select several display values (via **SELECT**) for each slot. To skip a slot, select skip. Any combination of values and skips are available.
The available display values are:

1. Skip
2. Total
3. Grand Total
4. Rate
7. Frequency
8. Battery voltage.

17.2 Display lower (LOWER)

The display lower menu is used to select the values to be displayed in the lower portion of the display. The value shown is a list of the currently selected display items. For example, if the number 0000053 is displayed, this means the lower display will sequence through the two values: Rate and Battery voltage. The sequence is controlled one at a time via an internal timer. To edit, press **SELECT**. The menu will allow stepping through the eight possible display slots and give the option to select several display values for each slot. To skip a slot, select skip. Any combination of values and skips are available. The available display values are listed in the Display upper menu item above.

17.3 Display lower time (LO dLY)

This sets the lower display sequence time. The custom time (the one that shows the batt) is based on seconds. To edit, hold **SELECT**. Once done editing, be sure to press **MENU** to accept the custom selection as the active.

18. Power mode (POWER)

This sets the power mode or operating refresh time. The number displayed on the left is the current power mode. When changing, the new selection is in the bottom left and the number on the right is the number of refreshes per second. No custom value is allowed here.

19. Maintenance (MAI NE)

The maintenance menu allows modification of values that are used to determine operation of the maintenance timer. The maintenance timer is only active when the ratemeter indicates a value above zero. The number displayed at this menu item is the current amount of time that has elapsed on the maintenance timer. When the maintenance timer exceeds the maintenance time value (19.1 below), the maintenance warning is triggered. Press **SELECT** to enter the maintenance submenu.

19.1 Maintenance time (MAI NE)

This sets the value of the maintenance timeout. When the internal maintenance timer exceeds this value, the maintenance timer warning will be triggered (and alarm if enabled). To edit, hold **SELECT**.

19.2 Restart the maintenance timer (RESARE)

This will restart the maintenance timer to zero.

20. Reset totalizer (RESET)

This will reset the resettable totalizer to zero.

21. Test (-TEST-)

The test menu allows observation and testing of the units various inputs and outputs at the basic non-calculated level. Items in this menu are not subject to the calculations present in the normal operation mode thereby ensuring the unit is operating and connected properly to external equipment. Press **SELECT** to enter the maintenance submenu.

21.1 Warnings {active} (WARNI N)

The warnings test submenu is used to determine what warnings are currently active in the unit. The value displayed is a hexadecimal representation of all warnings together. To view each warning individually, pressing **SELECT** will allow the ▲▼ buttons to step through all of the warnings. Refer to the Alarms menu item above for a description (and item number) of each warning. There are three additional warnings (that cannot be selected as alarms). They are:

21.1.2 Process defaults (0x00002)

Active when the unit process values were not successfully restored from EEPROM. This usually indicates something has gone wrong with the internal EEPROM storage. These include the totalizer, grand totalizer, maintenance timer, and internal timers/counters. This warning will be cleared when the process values are successfully saved to EEPROM (this occurs every time the menu is entered).

21.1.3 Setup defaults (0x00004)

Active when unit is using the menu system or linearizer table defaults. This usually indicates something has gone wrong with the internal EEPROM storage. When this is active, the menu system should be checked for valid entries. This warning will be cleared when the menu system parameters are successfully saved to EEPROM.

21.1.4 Calibration defaults (0x00009)

Active when unit is using internal calibration defaults. This usually indicates something has gone wrong with the internal EEPROM storage. When this is active, the internal sensor calibration values have been lost. This will cause the sensor readings (temperature and pressure) to be inaccurate and cause calculation errors. This warning cannot be cleared by the user and the unit must be returned to the factory for service.

Note: The number following the items listed above (and those listed in the Alarms menu) can be logically OR'd together to show the number listed in the outer Alarm or Warning menu.

21.2 Serial Number (SERI AL)

This is the unit Serial number.

21.3 Total edit (tOt Ed)

This allows the totalizer to be edited in the case of an accidental totalizer reset operation. The U/M is set using the totalizer U/M menu setting above. When the totalizer is edited, the internal partial pulse totalizer is reset. To edit, press **SELECT**.

21.4 Auto-Calibration (CALI brAt AUtO)

This sub-menu allows automatic calculation of a corrected K-factor based on information from an external calibration run such as from a calibrated vessel to provide automatic K-factor adjustment. UOM for the displayed and actual values are not important as long as they are the same.

21.4.1 Current K (CURR K)

This shows the current K-factor that was entered in 1.2 above. This is form information purposes only. If the Linearizer is enabled, then this will show -LI NEAR- instead.

21.4.2 Displayed Value (dI SPLd)

This is the value that was observed on the FML250-IS.

21.4.3 Accumulating Prove Mode (PROVE)

Prove mode is used to deliver a known volume of liquid on the fly. Once a known amount of liquid has passed through the flow meter, press **ENTER** to copy this value into the Displayed value. Pressing the **SELECT** button will reset the total. The delivery will use the current K-factor or linearizer as configured in the menu. Prove mode will only show if the displayed value is zero. This menu will affect the running total and grand total values of the unit.

21.4.4 Actual Value (ACtUAL)

This is the actual amount of liquid that was delivered corresponding to the displayed value above.

21.4.5 Error % (ERROR%)

This is the error percent calculated based on the displayed and actual values above.

21.4.6 New K (NEW K)

This is the new K-factor calculated based on the existing K-factor and the above error %. If the Linearizer is enabled, this will not show.

21.4.7 Apply New Value(s) (APPLY)

This is a final confirmation that the user wants the results of this auto-calibration procedure to be made permanent in the unit. If Yes is accepted, then the K-factor calculated above will be copied into the K-factor of the device. If the Linearizer is enabled, then the error percent will be applied to each point in the Linearizer table and then saved.

21.5 Frequency {Flow input} (FREQ)

This item shows the current frequency of the connected flow meter. Holding **SELECT** will show the maximum frequency the unit has ever seen ("M" will show up on the display). This value is not resettable.

21.7 Pulse output test (PLSOUT)

This allows the user to simulate a pulse output. Press **SELECT** to enter the Pulse Output test mode. Press the ▲▼ buttons to select the number of output pulses desired for the test. Press **ENTER** to begin the pulse output. The number of remaining pulses will be displayed until all pulses are completely outputted. The pulse width from the Pulse Width menu is used for the output pulses. The CONT selection will cause the pulse output simulator to send pulses until stopped. Press **ENTER** to interrupt the pulse output and select a different number of output pulses. Press **SELECT** to exit the Pulse Output test mode.

21.8 4-20 mA Simulator (SMULATE LOOP)

This allows the user to simulate the 4-20mA Loop Output. The following selections are available (Press **SELECT** to step through these):

- 4.0mA – The output is set to constant 4.0mA*
- 8.0mA – The output is set to constant 8.0mA*
- 12.0mA – The output is set to constant 12.0mA*
- 16.0mA – The output is set to constant 16.0mA*
- 20.0mA – The output is set to constant 20.0mA*
- UP – The output is increased from 4.0mA to 20.0mA in 0.1mA increments about 4 times a second
- UD – The output is increased from 4.0mA to 20.0mA and back down to 4.0mA repeatedly in 0.1mA increments (and decrements) about 4 times a second

* **Note:** At any time when the constant outputs are selected, the output can be increased or decreased by pressing the ▲▼ buttons.

* Press **ENTER** to exit the Loop Output test mode.

21.9 Battery voltage (bAtt V)

This is the current battery voltage in volts.

- L – Indicates the unit is running off of the Lithium battery input.
- E – Indicates the unit is running off of external Loop power. When E is present, the battery indicated above is being used as a backup power source and will become active automatically if the External power source is removed.

21.10 Test LCD (tStLCd)

When **SELECT** is pressed, every segment of the LCD will illuminate.

21.11 Device ID (dEV Id) (optional)

This is the device id used for serial communications.

21.12 Store parameters #2 (PAR2St)

This allows the menu parameters to be stored in a secondary location. The purpose of this is to save the menu parameters in a safe location to allow menu parameters to be modified without fear of losing the current settings. Use the Service menu to restore the menu parameters from this second location.

21.13 Store linearizer table #2 (LI N2St)

This allows the linearizer table to be stored in a secondary location. The purpose of this is to save the linearizer in a safe location to allow the linearizer table to be modified without fear of losing the current values. Use the Service menu to restore the linearizer table from this second location.

21.14 Code version (CodE)

This displays the current code version.

21.15 Reboot (REbOOt)

This allows the unit to be rebooted without removing the power. Rebooting is necessary to enter the Service menu. A warning menu of Lose Parameters (LOSE PAr-AM) will be displayed warning that all changed parameters within the menu system will be lost if the system is rebooted. To avoid losing anything changed, answer no and exit the menu. This will save the menu parameters. Then re-enter the menu and proceed directly to the test-reboot item. The system will reboot with no loss of menu parameters.

22. Lockout code (LOCOUT)

The lockout code displayed is the code that must be entered to enter the menu system or the Service menu. If the lockout code is all zeros, then the lockout system is disabled and the menu system may be entered without a lockout code. To change the lockout code, press **SELECT**.

10 SERVICE MENU

The service menu is used to manipulate a few global settings for the FML250-IS. To enter the service menu, perform a reboot (in the menu under test) or remove and reapply all power. While the unit is starting up, some of the segments on the display will rotate. During this animation, press and hold the **MENU** button. Once the menu is seen, release the **MENU** button. If there is a lockout code entered in the main menu, then it must be entered next. If the lockout code is unknown, the factory can be contacted for a code that will allow the first two items listed below.

The service menu consists of the following items:

1. **System Units of Measure (SYSTEM)**

This allows the System U/M to be either American or Metric. This setting affects the following menu items:

Value	American AMERICAN	Metric METRIC
K-Factor(s) (pulses per)	Gallons	Liters

When changing the System UOM, two more questions will be asked:

- **Load system (LOAd SYSUOM)**

This allows the System U/M to be applied to other user items in the menu. This affects the following menu items:

Value	American	Metric
Total & Rate	Gallons	Liters

- **Store configuration (StOr CONFIG)**

This allows the updated values in the previous load system U/M's to the active menu system. This is equivalent to the normal save upon exiting the menu system.

2. **Load safe (SAFE LOAd)**

This overwrites the entire menu system with factory defaults (also sets the lockout code to 000000).

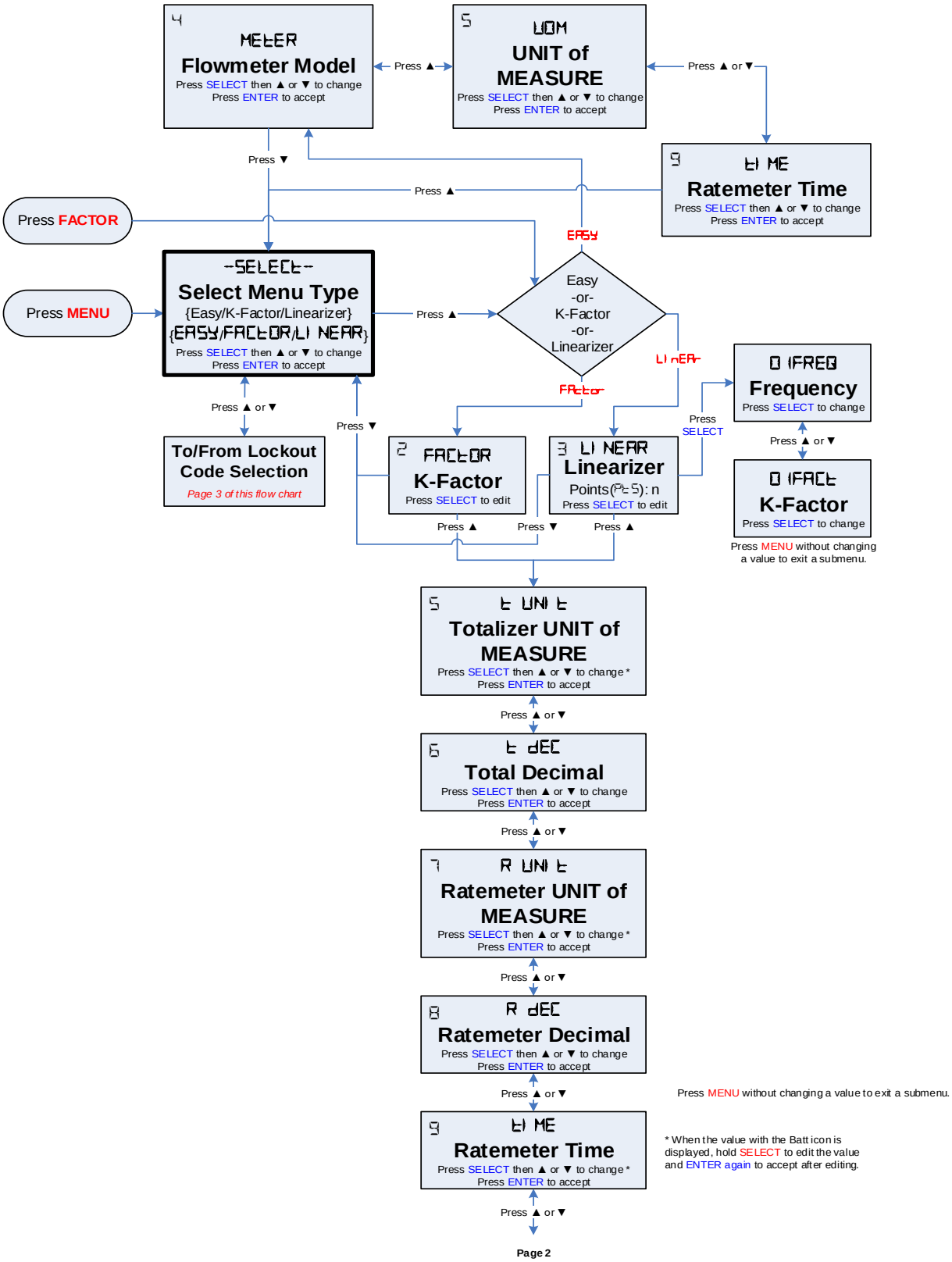
3. Load parameter #2 (LOAd PARAM2)

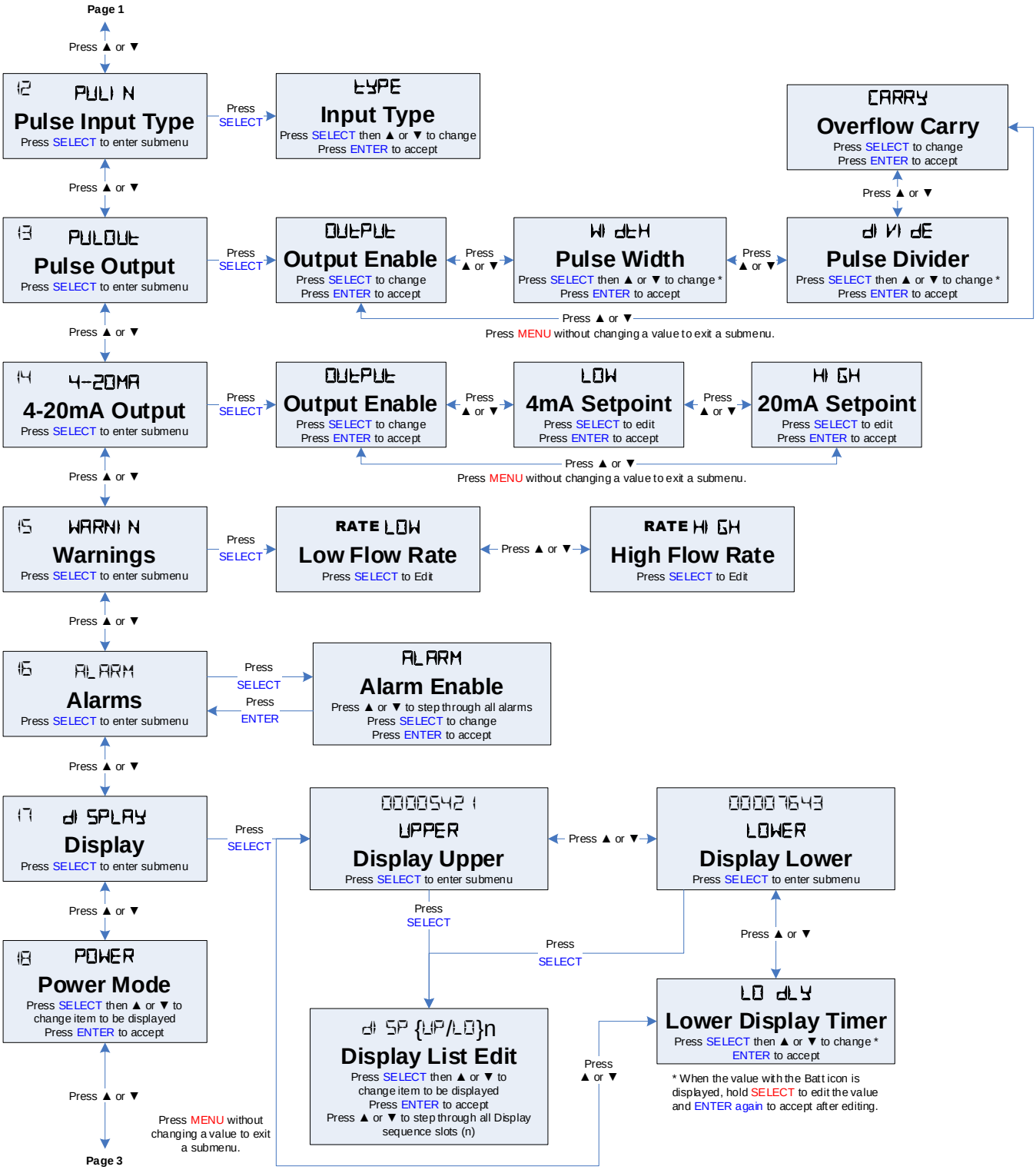
This allows the menu system values to be restored from the second parameter storage location thus making them active.

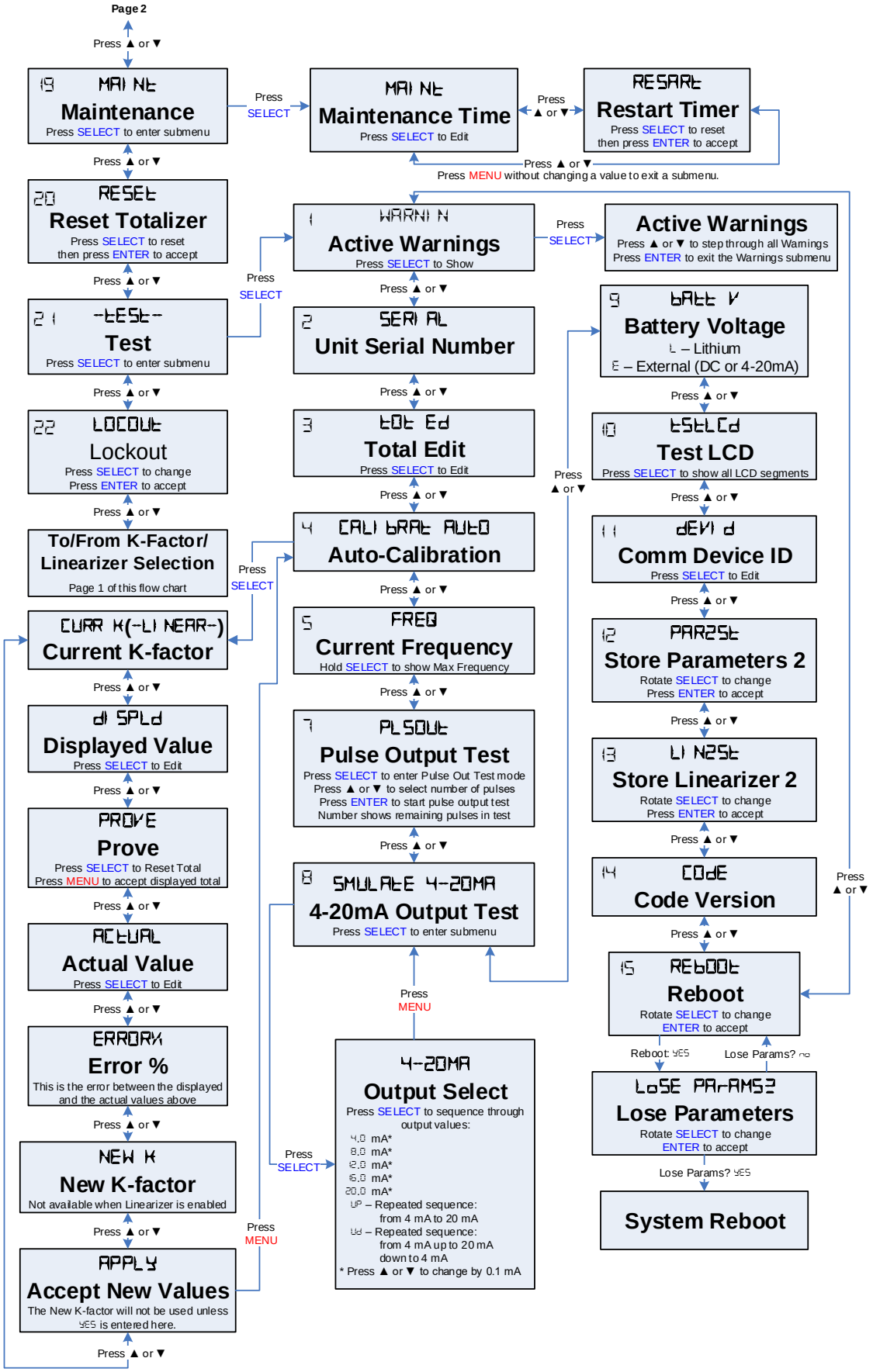
4. Load linear #2 (LOAd LI NER2)

This allows the linearizer table to be restored from the second storage location thus making it active.

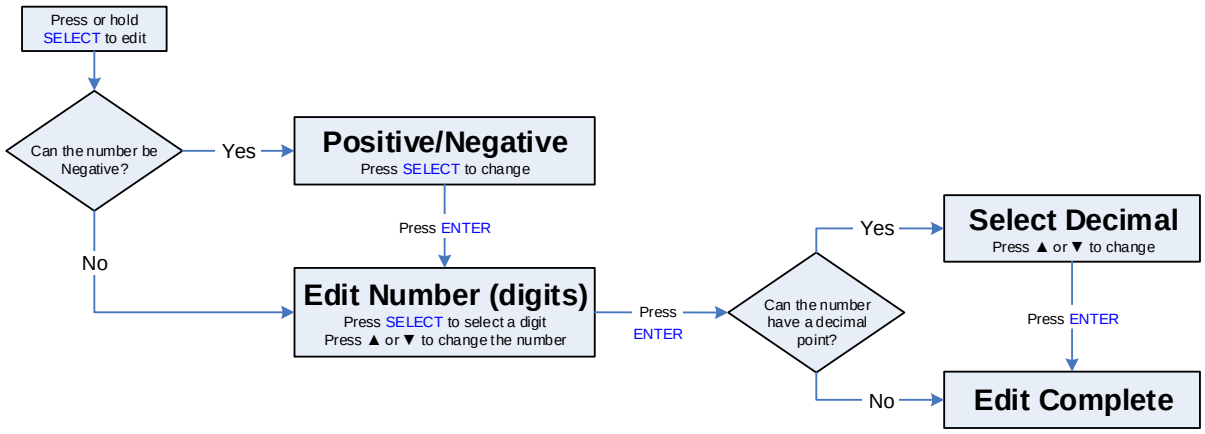
11 MAIN MENU FLOWCHART



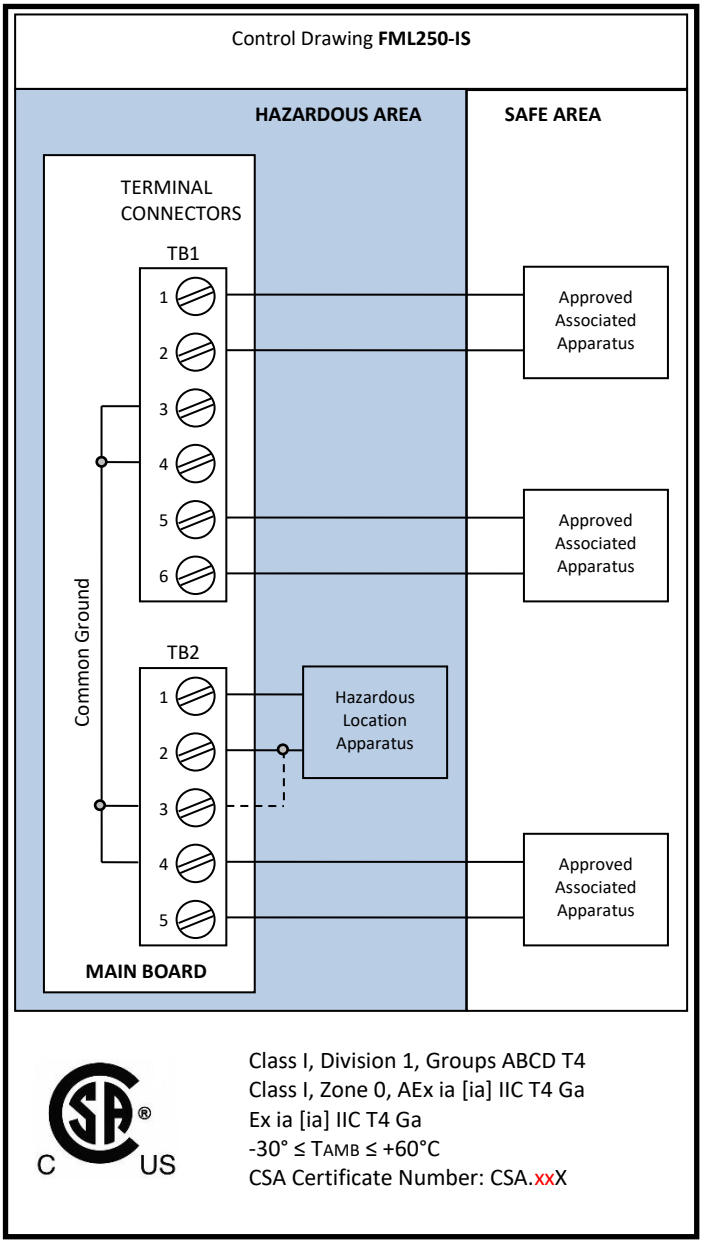

Page 1
Press ▲ or ▼
12 PULI N
Pulse Input Type
Press SELECT to enter submenu
Press SELECT
TYPE
Input Type
Press SELECT then ▲ or ▼ to change
Press ENTER to accept
CARRY
Overflow Carry
Press SELECT to change
Press ENTER to accept
Press ▲ or ▼
13 PULOUT
Pulse Output
Press SELECT to enter submenu
Press SELECT
OUTPUT
Output Enable
Press SELECT to change
Press ENTER to accept
Press ▲ or ▼
WI DTH
Pulse Width
Press SELECT then ▲ or ▼ to change *
Press ENTER to accept
Press ▲ or ▼
DI VI DE
Pulse Divider
Press SELECT then ▲ or ▼ to change *
Press ENTER to accept
Press ▲ or ▼
Press MENU without changing a value to exit a submenu.
14 4-20MA
4-20mA Output
Press SELECT to enter submenu
Press SELECT
OUTPUT
Output Enable
Press SELECT to change
Press ENTER to accept
Press ▲ or ▼
LOW
4mA Setpoint
Press SELECT to edit
Press ENTER to accept
Press ▲ or ▼
HI GH
20mA Setpoint
Press SELECT to edit
Press ENTER to accept
Press ▲ or ▼
Press MENU without changing a value to exit a submenu.
15 WARNI N
Warnings
Press SELECT to enter submenu
Press SELECT
RATE LOW
Low Flow Rate
Press SELECT to Edit
Press ▲ or ▼
RATE HI GH
High Flow Rate
Press SELECT to Edit
16 ALARM
Alarms
Press SELECT to enter submenu
Press SELECT
Press ENTER
ALARM
Alarm Enable
Press ▲ or ▼ to step through all alarms
Press SELECT to change
Press ENTER to accept
17 DI SPLAY
Display
Press SELECT to enter submenu
Press SELECT
00005421
UPPER
Display Upper
Press SELECT to enter submenu
Press ▲ or ▼
00007643
LOWER
Display Lower
Press SELECT to enter submenu
Press SELECT
Press SELECT
Press ▲ or ▼
LO DLY
Lower Display Timer
Press SELECT then ▲ or ▼ to change *
ENTER to accept
* When the value with the Batt icon is displayed, hold SELECT to edit the value and ENTER again to accept after editing.
Press ▲ or ▼
DI SP {UP/LO}n
Display List Edit
Press SELECT then ▲ or ▼ to change item to be displayed
Press ENTER to accept
Press ▲ or ▼ to step through all Display sequence slots (n)
18 POWER
Power Mode
Press SELECT then ▲ or ▼ to change item to be displayed
Press ENTER to accept
Press ▲ or ▼
Page 3
Press MENU without changing a value to exit a submenu.


Page 2
Press ▲ or ▼
19 MAINt
Maintenance
Press SELECT to enter submenu
Press SELECT
MAINt
Maintenance Time
Press SELECT to Edit
Press ▲ or ▼
RESARt
Restart Timer
Press SELECT to reset then press ENTER to accept
Press ▲ or ▼
Press MENU without changing a value to exit a submenu.
20 RESEt
Reset Totalizer
Press SELECT to reset then press ENTER to accept
21 -tESt-
Test
Press SELECT to enter submenu
22 LOCOUt
Lockout
Press SELECT to change
Press ENTER to accept
To/From K-Factor/ Linearizer Selection
Page 1 of this flow chart
CURR K(-LI NEAR-)
Current K-factor
dI SPLd
Displayed Value
Press SELECT to Edit
PROVE
Prove
Press SELECT to Reset Total
Press MENU to accept displayed total
ACtUAL
Actual Value
Press SELECT to Edit
ERROR%
Error %
This is the error between the displayed and the actual values above
NEW K
New K-factor
Not available when Linearizer is enabled
APPLY
Accept New Values
The New K-factor will not be used unless YES is entered here.
1 WARNI N
Active Warnings
Press SELECT to Show
Active Warnings
Press ▲ or ▼ to step through all Warnings
Press ENTER to exit the Warnings submenu
2 SERI AL
Unit Serial Number
3 tOt Ed
Total Edit
Press SELECT to Edit
4 CALI bRAt AUtO
Auto-Calibration
5 FREQ
Current Frequency
Hold SELECT to show Max Frequency
7 PLSOUt
Pulse Output Test
Press SELECT to enter Pulse Out Test mode
Press ▲ or ▼ to select number of pulses
Press ENTER to start pulse output test
Number shows remaining pulses in test
8 SMULAtE 4-20MA
4-20mA Output Test
Press SELECT to enter submenu
4-20MA
Output Select
Press SELECT to sequence through output values:
4.0 mA*
8.0 mA*
12.0 mA*
16.0 mA*
20.0 mA*
UP – Repeated sequence: from 4 mA to 20 mA
Ud – Repeated sequence: from 4 mA up to 20 mA down to 4 mA
* Press ▲ or ▼ to change by 0.1 mA
9 bAtt V
Battery Voltage
L – Lithium
E – External (DC or 4-20mA)
10 tStLCd
Test LCD
Press SELECT to show all LCD segments
11 dEVI d
Comm Device ID
Press SELECT to Edit
12 PAR2St
Store Parameters 2
Rotate SELECT to change
Press ENTER to accept
13 LI N2St
Store Linearizer 2
Rotate SELECT to change
Press ENTER to accept
14 CodE
Code Version
15 REbOOt
Reboot
Rotate SELECT to change
ENTER to accept
Reboot: YES
Lose Params? no
LoSE PArAMS?
Lose Parameters
Rotate SELECT to change
ENTER to accept
Lose Params? YES
System Reboot
Press ▲ or ▼
Press SELECT
Press MENU

Editing a Number



12 FML250-IS CONTROL DRAWING



Entity parameters for FML250-IS

Connector TB1 on the main board

Terminals 1 and 2, Input parameters:	Ui = 28V	Ci = 33nF
	Ii = 0.1A	Li = 0mH
	Pi = 0.7W	
Terminals 5 and 6, Input parameters:	Ui = 28V	Ci = 0nF
	Ii = 0.1A	Li = 0mH
	Pi = 0.7W	

Connector TB2 on the main board

Terminals 1 and 2, Output parameters:	Uo = 5.4V	Co = 64.9µF
	Io = 4mA	Lo = 1.9H
	Po = 6mW	
Terminals 1 and 3, Input parameters:	Ui = 28V	Ci = 1.8nF
	Ii = 0.1A	Li = 9.1µH
	Pi = 0.7W	
Terminals 1 and 3, Output parameters:	Uo = 5.4V	Co = 64.9uF
	Io = 2mA	Lo = 8.8H
	Po = 3mW	
Terminals 4 and 5, Output parameters:	Uo = 5.4V	Co = 65µF
	Io = 2mA	Lo = 10H
	Po = 3mW	

- Operational temperature: -30 to 60°C (-22 to 140°F)
- Warning: Substitution of components may impair suitability for intrinsic safety.
- The Associated Apparatus manufacturer's installation drawing must be followed when installing the equipment.
- The cable parameters are determined by the parameters of the installation in which the FML250-IS is connected.

- The following output parameters requirements must be met for all intrinsically safe barriers or hazardous location apparatus connected between terminals (1, 2) and (5, 6) of TB1 connector on the main board and (1, 3) of TB2 connector on the main board.

  Uo ≤ FML250-IS input parameter Ui
  Io ≤ FML250-IS input parameter Ii
  Po ≤ FML250-IS input parameter Pi
  Co ≥ Sum of the cable capacitance and FML250-IS input parameter Ci
  Lo ≥ Sum of the cable inductance and FML250-IS input parameter Li

- The following input parameters requirements must be met for all intrinsically safe barriers or hazardous location apparatus connected between terminals (1, 2), (1, 3) and (4, 5) of TB2 connector on the main board.

  Ui ≥ FML250-IS output parameter Uo
  Ii ≥ FML250-IS output parameter Io
  Pi ≥ FML250-IS output parameter Po
  Ci ≤ Difference between FML250-IS output parameter Co and the cable capacitance
  Li ≤ Difference between FML250-IS output parameter Lo and the cable inductance

- This product conforms to the dielectric withstand requirements of UL/CSAEN/IEC 60079-11, 6.3.13.
- Use only **Turbines Inc. P/N 901577** Intrinsically Safe battery in hazardous Locations.
- Installations in Canada should be in accordance with **Canadian Electrical Code, CSA 22.1, Part 1**. Installations in US should be in accordance with **ANSI/ISA RP12.06.01** "Installation of Intrinsically Safe Systems for Hazardous Locations" and the National Electrical Code (**ANSI/NFPA 70**)

13 FLUID PROPERTIES

Liquid	Reference Temp (°R)	Coefficient of Thermal Expansion (1/°F)	Density (LB/GAL)	SCF/GAL
AIR	141.87	0.00162620	7.293611	97.2920
AMMONIA	431.47	0.00057040	5.698802	-
ARGON	157.07	0.00148610	11.615503	112.4820
CO2	449.67	0.00126090	8.733752	74.0400
ETHYLENE	332.17	0.00068257	4.556502	-
FUELOIL2	519.67	0.00008850	7.884300	-
GASOLINE	519.67	0.00037030	6.256250	-
HELIUM	7.57	0.00011477	1.222050	102.1500
HYDROGEN	27.47	0.00072590	0.590700	113.5330
KEROSENE	519.67	0.00026810	6.923316	-
METHANE	200.97	0.00105230	3.539861	94.3770
NATL GAS	200.97	0.00105230	3.539861	-
NITROGEN	139.27	0.00149170	6.742847	93.1358
NX-19	200.97	0.00105230	3.539861	-
OXYGEN	162.27	0.00134580	9.519392	115.0220
PROPANE	519.67	0.00071780	4.233797	133.4050
WATER	519.67	0.00010150	8.337656	-

Document Revision History

Revision	Description	Date
A	Initial release	08/15/2019
B	Added paragraph 13.4 Overflow Carry in section 9.2 Menu System	11/05/2019