USB Programmable, DIN Rail Mount Thin Transmitter

Model TT239-0600
Isolated 2-Wire Transmitter, Frequency/PWM/Pulse Input 4-20mA Output

USER'S MANUAL

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IMPORTANT SAFETY CONSIDERATIONS
It is very important for the user to consider the possible adverse effects of power, wiring, component, sensor, or software failures in designing any type of control or monitoring system. This is especially important where economic property loss or human life is involved. It is important that the user employ satisfactory overall system design. It is agreed between the Buyer and Acromag, that this is the Buyer's responsibility.

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GETTING STARTED

DESCRIPTION

The TT239 is an ANSI/ISA Type 2 transmitter designed to interface with frequency-time domain sensors and transducers, measure the input signal frequency or duty cycle, and modulate a 4-20mA current signal to drive a two-wire current loop. The transmitter will condition periodic or pulse waveform signals, and provide an isolated process current output. Configuration is performed using software and a USB connection to Windows-based PC's (Windows XP and later versions only).

Key Features

- **Fully configurable using Windows software via USB.**
- **Thin 12.5mm wide enclosure for high-density DIN-rail mounting.**
- **Wideband frequency inputs from 0.01Hz to 100KHz.**
- **Rapid response time and high accuracy.**
- **Measures Frequency and PWM/Duty Cycle.**
- **Adjustable output update time, cutoff frequency, debounce, and sample averaging.**
- **Accepts input voltage amplitudes up to ±170VDC (120VAC).**
- **Interfaces with both zero-crossing and non-zero crossing signals.**
- **Software configurable pull-up and pull-down resistors.**
- **+4VDC/+3VDC input pull-up for interfacing with sensors and transducers.**
- **Input and output circuits are fully isolated from each other.**
- **Convenient two-wire loop power with non-polarized output connections.**
- **Normal or reverse acting output.**
- **Namur compliant loop current.**
- **Wide-range DC power input from 12–32VDC.**
- **Wide ambient temperature operation from –40°C to 80°C.**
- **Very low Output Ambient Temperature Drift better than ±20ppm/°C.**
- **Thoroughly tested and hardened for harsh environments.**
- **CE Approved (Pending).**
- **UL/cUL Class1, Division 2 Approved (Pending).**

Application

The TT239 transmitter is designed for high-density mounting on 35mm T-type DIN rails. Modules may be mounted side-by-side on 0.5 inch (12.5mm) centers.

This model accepts frequency or pulse inputs and isolates the input signal allowing it to mate with grounded or non-grounded sensors.

The output signal is transmitted via a two-wire, 4–20mA current loop. The two-wire current signal can be transmitted over long distances with high noise immunity. Its inherent live-zero 4mA offset current offers built-in output fault detection, should an output wire break. Extra connection screws at the output allow it to be optionally wired for a "sourced" 4–20mA output configuration (see Option Output Wiring).

Mechanical Dimensions

Modules may be mounted to 35mm "T" type DIN rail (35mm, type EN50022), and side-by-side on 12.5mm (0.5-inch) centers.

CAUTION:

IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.

99.0
(3.90)

12.5
(0.50)

114.5
(4.51)
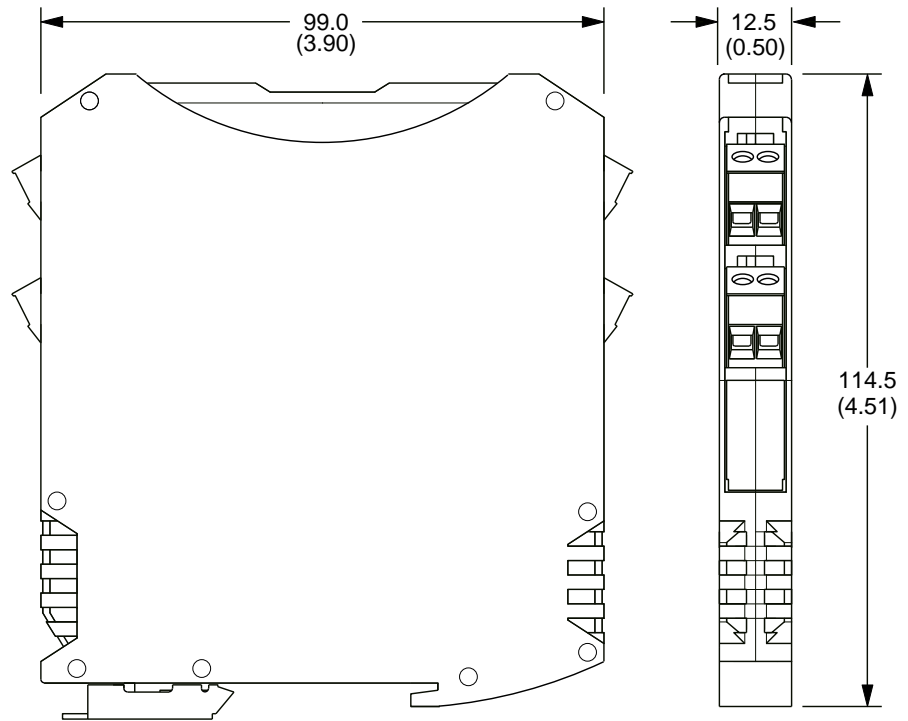
DIMENSIONS ARE IN MILLIMETERS (INCHES)

DIN Rail Mounting & Removal

Refer to the following figure for mounting and removing a module from the DIN rail.
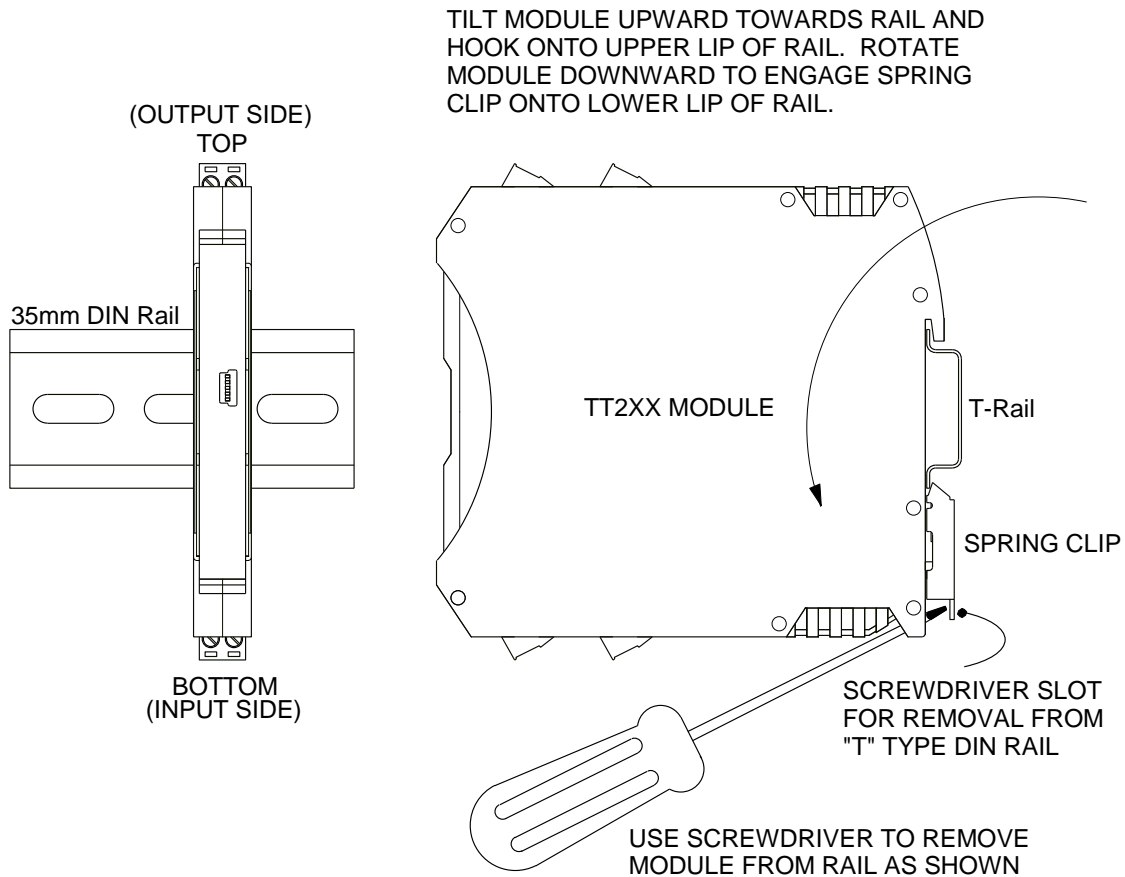
Mounting
A spring loaded DIN clip is located on the input side bottom. The rounded edge of the output side bottom allows the module to tilt upward so that it may be lifted from the rail when prying the spring clip back with a screwdriver. To attach a module to T-type DIN rail, angle the top of the module towards the rail and place the top groove of the module over the upper lip of the DIN rail. Firmly push the module downward towards the rail until it snaps into place.

Removal
To remove a module from the DIN rail, first separate the input terminal blocks from the bottom side of the module to create a clearance to the DIN mounting area. A screwdriver can be used to pry the pluggable terminals out of their sockets. While holding the module in place from above, insert a screwdriver into the lower path of the bottom of the module to the DIN rail clip and use it as a lever to force the DIN rail spring clip down while pulling the bottom of the module outward until it disengages from the rail. Tilt the module upward to lift it from the rail.

TT2XX MODULE DIN RAIL MOUNTING AND REMOVAL

TILT MODULE UPWARD TOWARDS RAIL AND
HOOK ONTO UPPER LIP OF RAIL. ROTATE
MODULE DOWNWARD TO ENGAGE SPRING
CLIP ONTO LOWER LIP OF RAIL.

(OUTPUT SIDE)
TOP

35mm DIN Rail

TT2XX MODULE

T-Rail

SPRING CLIP

BOTTOM
(INPUT SIDE)

SCREWDRIVER SLOT
FOR REMOVAL FROM
"T" TYPE DIN RAIL

USE SCREWDRIVER TO REMOVE
MODULE FROM RAIL AS SHOWN

ELECTRICAL CONNECTIONS

Wire terminals can accommodate 12–26 AWG solid or stranded wire. Input wiring may be shielded or unshielded type. Ideally, output wires should be twisted pair. Terminals are pluggable and can be removed from their sockets by prying outward from the top with a flat-head screwdriver blade.

Strip back wire insulation 0.25-inch on each lead and insert the wire ends into the cage clamp connector of the terminal block. Use a screwdriver to tighten the screw by turning it in a clockwise direction to secure the wire (0.5-0.6Nm torque). Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. As a rule, output wires are normally separated from input wiring for safety, as well as for low noise pickup.
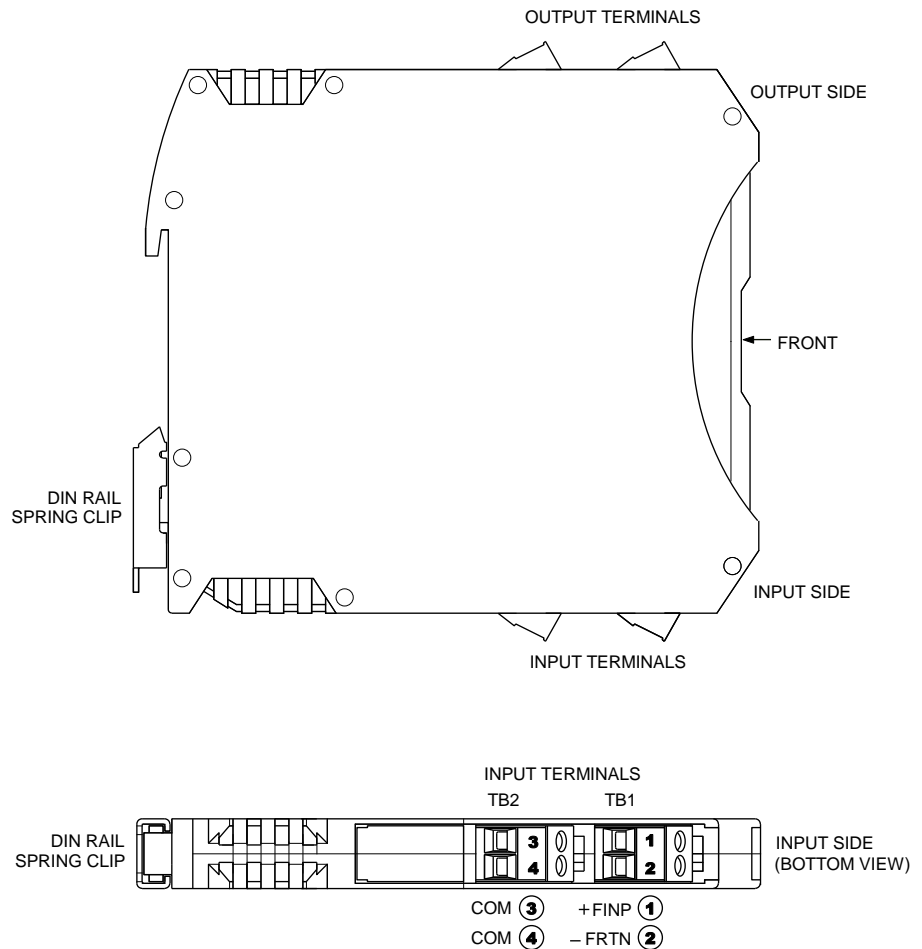
Sensor Input Connections

NOTE:

Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. As a rule, output wires are normally separated from input wiring and from power wiring for safety, as well as for low noise pickup.

TIP:

Input and output terminal blocks are a plug-in type and can be easily removed to facilitate module removal or replacement without removing individual wires.

Sensor wires are connected directly to the module input terminals at the bottom of the module (the spring-loaded DIN clip side). Transmitter input signals are isolated from output and power. Observe proper polarity when making input connections. **Refer to the example input connections on the following page.**

- **Transmitter input signal is isolated from output.**
- **Inputs are polarized. Observe proper polarity.**

ENABLE INPUT MODE*
UNIPOLAR ☑
BIPOLAR ☑
ENABLE LOGIC LEVEL*
PULL-UP ☑
PULL-DWN ☑
EITHER MODE MAY BE SELECTED

SINUSOIDAL/SQUARE/PULSE
TB1
+ FINP
− FRTN
① ②
SHIELDED CABLE
+ Waveform
− Generator
OPTIONAL SHIELD GROUND
SEE NOTE

ENABLE INPUT MODE
UNIPOLAR ☑
BIPOLAR ☐
ENABLE LOGIC LEVEL
PULL-UP ☑
PULL-DWN ☐

TTL
TB1
+ FINP
− FRTN
① ②
SHIELDED CABLE
+V
OPTIONAL SHIELD GROUND
SEE NOTE

ENABLE INPUT MODE
UNIPOLAR ☐
BIPOLAR ☑
ENABLE LOGIC LEVEL
PULL-UP ☐
PULL-DWN ☐

MAGNETIC PICKUP
TB1
+ FINP
− FRTN
① ②
SHIELDED CABLE
+ Magnetic
− Pickup
OPTIONAL SHIELD GROUND
SEE NOTE

ENABLE INPUT MODE
UNIPOLAR ☑
BIPOLAR ☐
ENABLE LOGIC LEVEL
PULL-UP ☐
PULL-DWN ☑

SOURCING PROXIMITY SENSOR (2-Wire)
TB1
+ FINP
− FRTN
① ②
SHIELDED CABLE
OPTIONAL SHIELD GROUND
SEE NOTE

ENABLE INPUT MODE
UNIPOLAR ☑
BIPOLAR ☐
ENABLE LOGIC LEVEL
PULL-UP ☐
PULL-DWN ☑

HIGH-SIDE SWITCH (Open Collector/Drain)
TB1
+ FINP
− FRTN
① ②
SHIELDED CABLE
V+   V+
OR
OPTIONAL SHIELD GROUND
SEE NOTE

ENABLE INPUT MODE
UNIPOLAR ☑
BIPOLAR ☐
ENABLE LOGIC LEVEL
PULL-UP ☑
PULL-DWN ☐

LOW-SIDE SWITCH (Open Collector/Drain)
TB1
+ FINP
− FRTN
① ②
SHIELDED CABLE
OR
OPTIONAL SHIELD GROUND
SEE NOTE

ENABLE INPUT MODE
UNIPOLAR ☑
BIPOLAR ☐
ENABLE LOGIC LEVEL
PULL-UP ☑
PULL-DWN ☐

DRY CONTACT
TB1
+ FINP
− FRTN
① ②
SHIELDED CABLE
OPTIONAL SHIELD GROUND
SEE NOTE

NOTE:

This ground connection is recommended for best results. If sensors are inherently connected to ground, use caution and avoid making additional ground connections which could generate ground loops and measurement error.

REFERENCE:

- Bipolar mode for zero-crossing signals
- Unipolar mode for non-zero crossing signals
- Internal 12.4KΩ pull-up resistor to +4VDC with ±28mV hysteresis or +3VDC with ±84mV hysteresis
- Internal 1KΩ pull-down resistor to −FRTN
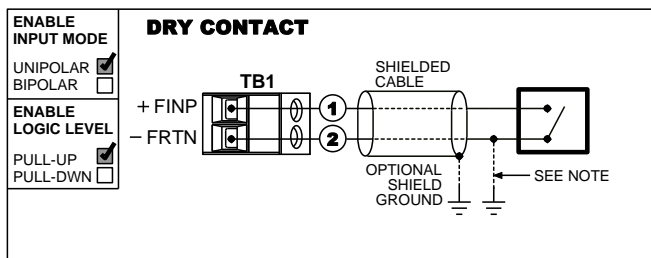
Output/Power Connections

Connect a DC power supply and load in series in the two-wire loop as shown in the drawing below. This transmitter has an ANSI/ISA Type II output in which the transmitter's power and output signal share the same two leads, and the transmitter output has a "floating" connection with respect to earth ground applied at the loop supply minus terminal.

- Output connections are not polarized. The output + and – designation are for reference only with current normally input to Output+ and returned via Output– (current-sinking).

- Loop supply voltage should be form 12–32VDC with the minimum voltage level adjusted to supply over-range current to the load, plus 12V MIN across the transmitter, plus any transmission line drop.

- Variations in power supply voltage between the minimum required and a maximum of 32VDC across transmitter, has negligible effect on transmitter accuracy.

- Variation in load resistance has negligible effect on output accuracy, as long as the loop supply voltage is set accordingly.

- Note the traditional placement of earth ground in the current loop. The transmitter output minus varies off this ground by the voltage drop in the load resistance and lead-wire.

MODEL TT2XX-0600 OUTPUT/POWER WIRING
TRADITIONAL LOOP-POWERED "SINKING OUTPUT" CONNECTIONS
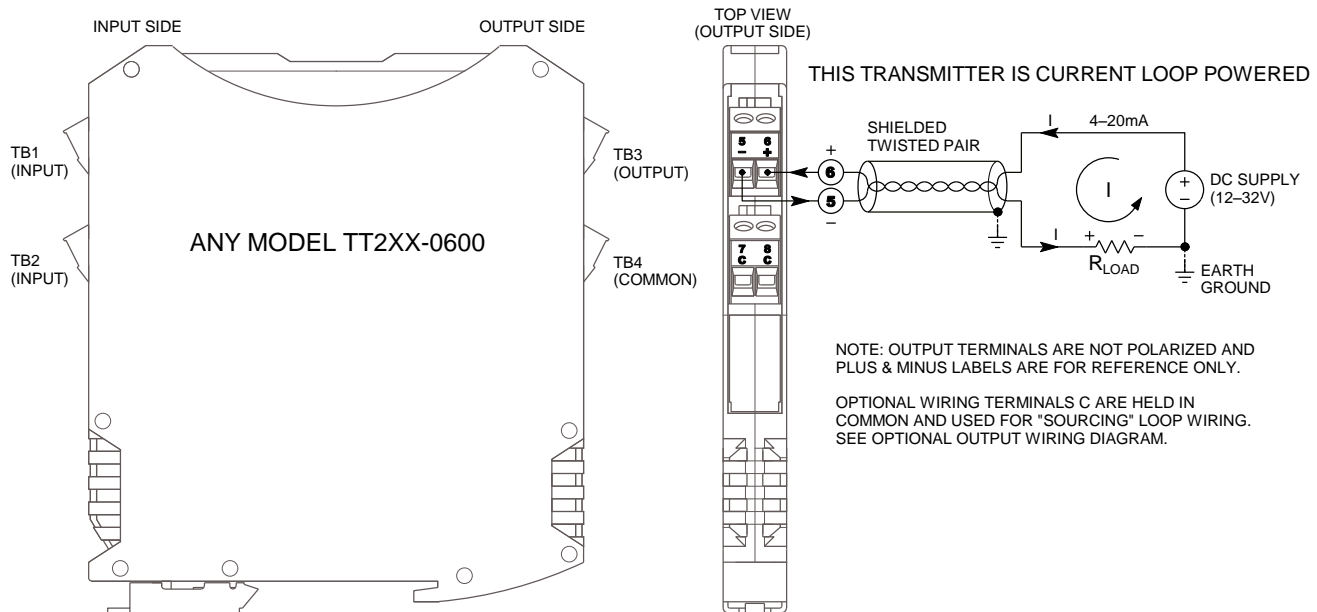
The traditional loop-powered "sinking" output connections are shown above. Shielded twisted-pair wiring is often used at the output to connect the longest distance between the field transmitter and the remote receiver as shown. The output of this transmitter fluctuates relative to earth ground by the voltage drop in the load and connection wire. This makes it flexible in the way it connects to various "Receiver" devices.
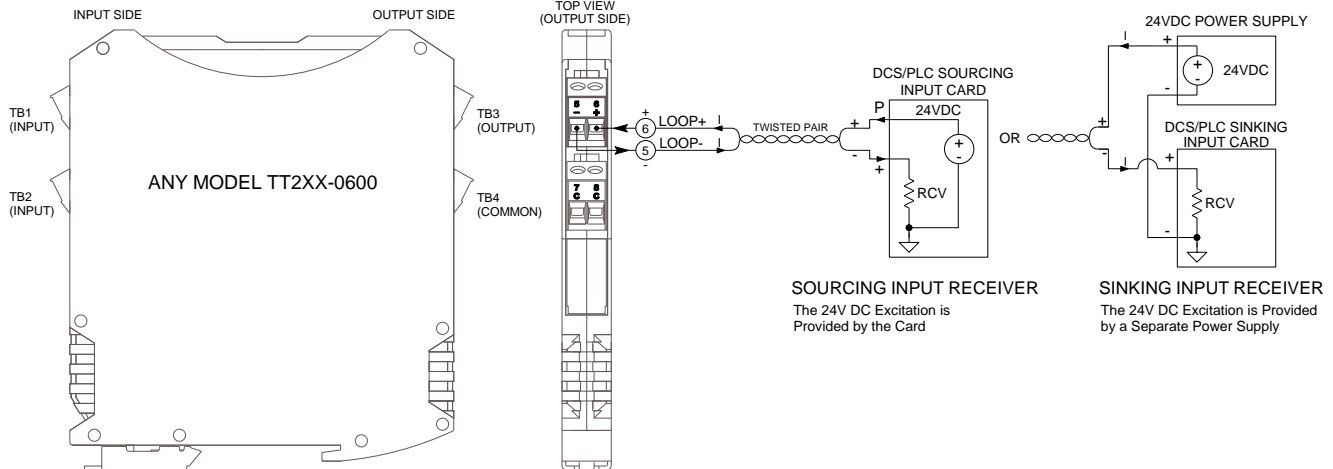
Output/Power Connections...

In most installations, the loop power supply will be local to either the transmitter, or local to the remote receiver. Common receiver devices include the input channel of a Programmable Logic Controller (PLC), a Distributed Control System (DCS), or a panel meter. Some receivers already provide excitation for the transmitter loop and these are referred to as "sourcing" inputs. Other receivers that do not provide the excitation are referred to as "sinking" inputs, and these will require that a separate power supply connect within the loop. These types of receivers are depicted below.
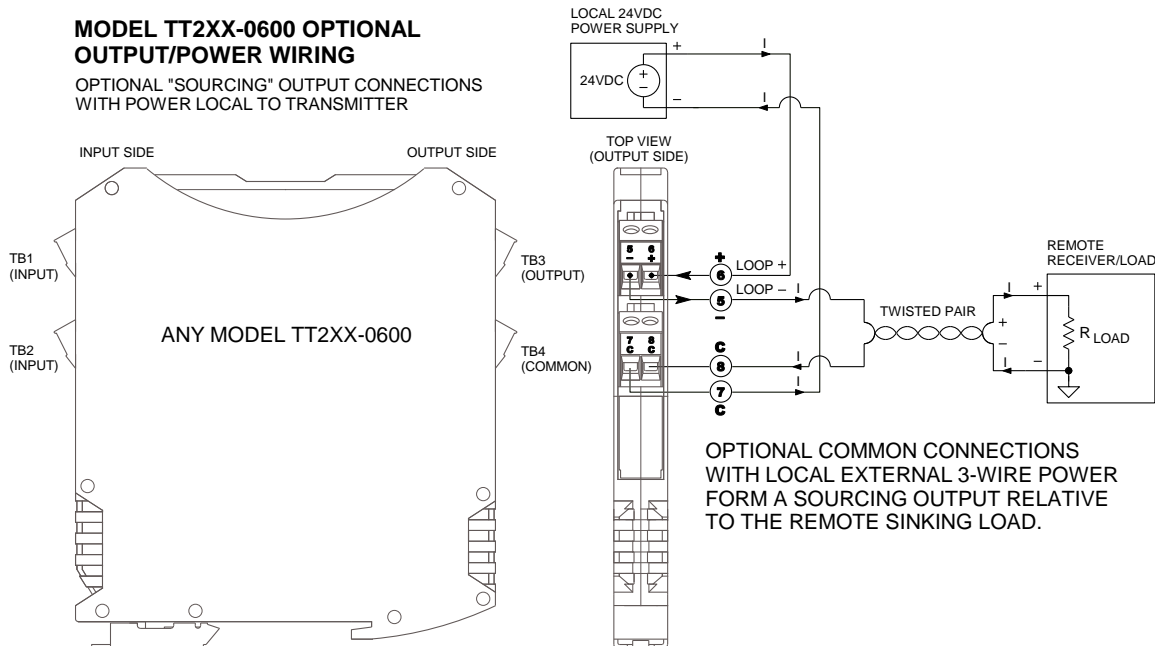
MODEL TT2XX-0600 OUTPUT/POWER WIRING

WARNING: For compliance to applicable safety and performance standards, the use of twisted pair output wiring is recommended. Failure to adhere to sound wiring and grounding practices as instructed may compromise safety, performance, and possibly damage the transmitter.

TIP – Ripple & Noise: Power supply ripple at 60Hz/120Hz is normally reduced at the load by the transmitter, but additional filtering at the load can reduce this ripple further. For large 60Hz supply ripple, connect an external 1uF or larger capacitor directly across the load to reduce excessive ripple. For sensitive applications with high-speed acquisition at the load, high frequency noise may be reduced significantly by placing a 0.1uF capacitor directly across the load, as close to the load as possible.

TIP – Inductive Loads: If the two-wire current loop includes a highly inductive load (such as an I/P current-to-pressure transducer), this may reduce output stability. In this case, place a 0.1uF capacitor directly across the inductive load and this will typically cure the problem.

Output/Power Connections...

This model includes two extra terminal connections at TB4 marked "C", which provide a convenient wiring point for a "sourcing" wiring variation as shown below. Internally, these two terminals are connected in common with each other and do not connect to the internal circuit. Use of these terminals in the wiring scheme allows external power to be connected local to the transmitter and form a "sourcing" output entity from this "sinking" output as shown.

MODEL TT2XX-0600 OPTIONAL OUTPUT/POWER WIRING
OPTIONAL "SOURCING" OUTPUT CONNECTIONS WITH POWER LOCAL TO TRANSMITTER

INPUT SIDE   OUTPUT SIDE

TB1 (INPUT)
TB2 (INPUT)
ANY MODEL TT2XX-0600
TB3 (OUTPUT)
TB4 (COMMON)

LOCAL 24VDC POWER SUPPLY
24VDC

TOP VIEW (OUTPUT SIDE)

LOOP +
LOOP −
C
C

REMOTE RECEIVER/LOAD
TWISTED PAIR
R LOAD

OPTIONAL COMMON CONNECTIONS WITH LOCAL EXTERNAL 3-WIRE POWER FORM A SOURCING OUTPUT RELATIVE TO THE REMOTE SINKING LOAD.

Earth Ground Connections

The transmitter housing is plastic and does not require an earth ground connection, except where the optional input cable shield is terminated on the transmitter. If the transmitter is mounted in a metal enclosure, an earth ground wire connection to the metal enclosure's ground terminal (green screw) is usually required using suitable wire per applicable codes. See the Output/Power Wiring Drawing for Output/Power connections and note the traditional position of earth ground for the two-wire output current loop. Earth ground is normally applied at the output loop power minus terminal and in common with the loop load or loop receiver minus. The Type II transmitter output terminals have a floating connection relative to earth ground and their potential varies with the voltage drop in the load and connection wire.
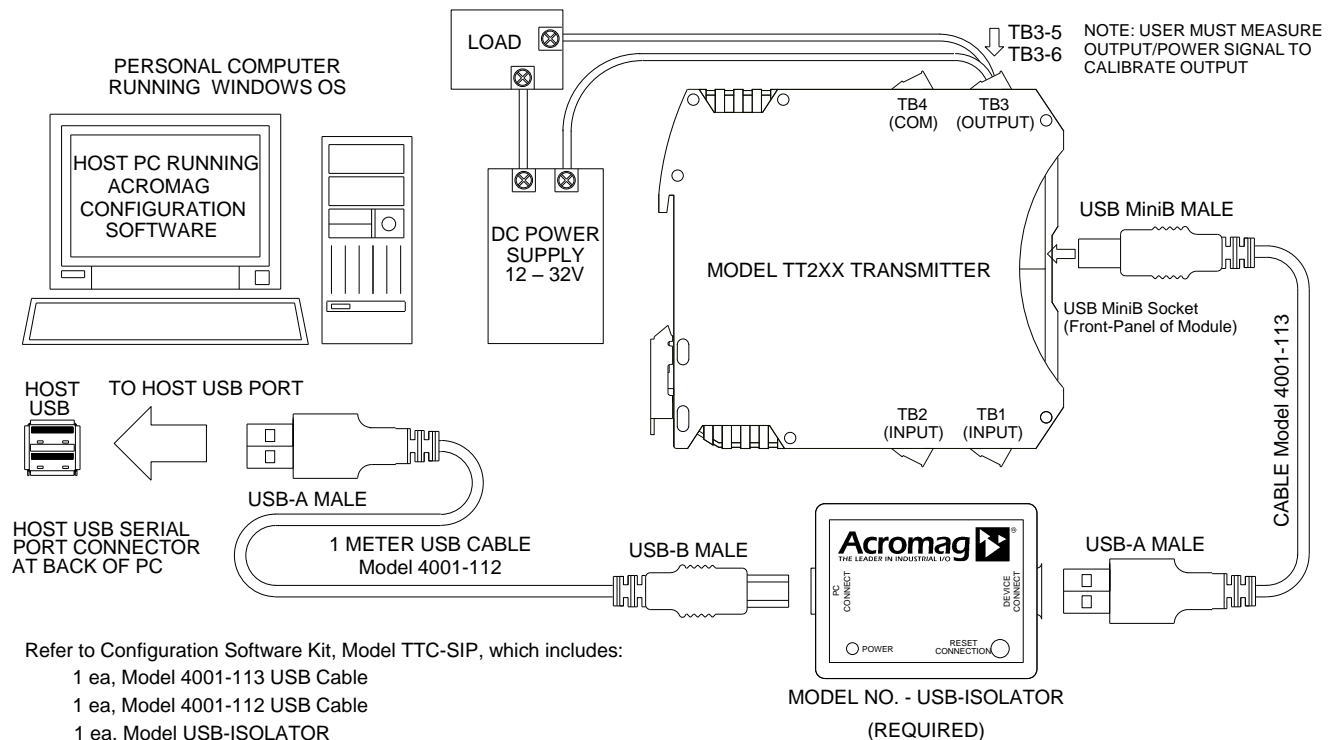
- Respect the traditional position of earth ground in a two-wire current loop and avoid inadvertent connections to earth ground at other points in the output circuit, which would drive ground loops and negatively affect operation. The input circuit is isolated and may additionally be earth grounded.

- A USB isolator is recommended when configuring or calibrating a transmitter to avoid the ground loop that occurs if the input sensor is also earth grounded (PC USB ports are commonly earth grounded and make contact with both the USB signal and shield ground which is held in common to the input circuit ground of the transmitter).

USB Connections

This transmitter is configured and calibrated via configuration software that runs on Windows-based PCs connected to the transmitter via USB (Windows XP or later version required). Refer to the following drawing to connect a PC to the transmitter for the purpose of configuration and calibration using this software.

TT SERIES USB TRANSMITTER CONNECTIONS

USED FOR CONFIGURATION AND CALIBRATION OF THE TRANSMITTER IN A SAFE OR ORDINARY LOCATION

Refer to Configuration Software Kit, Model TTC-SIP, which includes:

    1 ea, Model 4001-113 USB Cable
    1 ea, Model 4001-112 USB Cable
    1 ea, Model USB-ISOLATOR
    1 ea, Configuration Software CDROM 5040-944

WARNING:

The intent of mating USB with this transmitter is so that it can be conveniently configured and calibrated in a safe area, then installed in the field which may be in a hazardous area. Do not attempt to connect a PC or laptop to this transmitter while installed in a hazardous area, as USB energy levels could ignite explosive gases or particles in the air.

- **USB Signal Isolation is Required (See Below) –** Acromag model USB-ISOLATOR may be used to isolate the USB port, or optionally, another USB signal isolator that supports USB Full Speed operation (12Mbps).
- **Configuration Requires USB <u>and</u> Loop Power –** This transmitter draws power from both the current loop and from USB during setup.

IMPORTANT: USB logic signals to the transmitter are referenced to the potential of the transmitter's input ground. This ground is held in common with USB ground and USB cable shield ground. The potential of the transmitter's current output pin (output minus) relative to earth ground will vary according to the load current and load resistance (net IR drop). Without isolation, this IR drop would drive a potential difference between the normally grounded current loop and the grounded USB connection at the PC, causing a ground loop that would inhibit setup and calibration, and may even damage the transmitter. This is why an isolated USB connection is recommended. The use of an isolator can be avoided if a battery powered laptop PC is used to connect to the transmitter, and the laptop has no other earth ground connection, either directly or via a connected peripheral.

CONFIGURATION SOFTWARE

Quick Overview

*Click **"Open"** to connect to the TT239-0600 and the software will look similar to the following:*
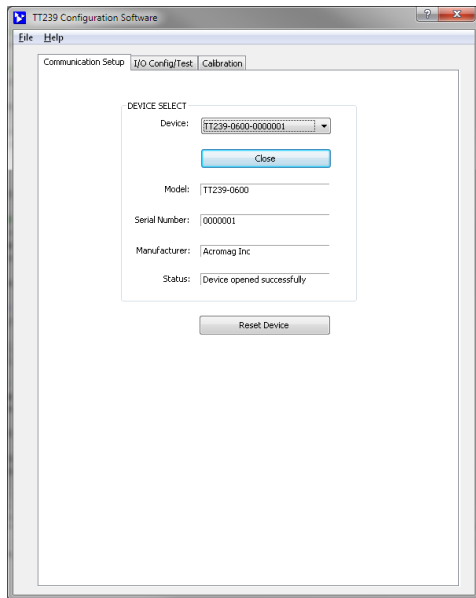
This transmitter can only be configured and calibrated via its configuration software and a USB connection to a PC or laptop. The configuration software is contained in a zip file that can be downloaded free of charge from our web site at www.acromag.com. For this transmitter, download the file named "**9500459.zip**". If you do not yet have a user account, you will need to create one before the download becomes accessible. The zip file will extract to an executable file which installs software to the "/Program Files/Acromag" directory on your computer. Note: You need administrator privileges on the PC you wish to install this software. Once installed, navigate to the "/Program Files/Acromag" directory and open the correct software for your particular model. This software is also included on a CDROM bundled with the Configuration Kit TTC-SIP (see Accessories). For this transmitter, use the software named "**TT239 Config.exe**".

The initial configuration software window for this model is shown at left. Configuration information is divided across three pages as follows: Communication Setup, I/O Config/Test, and Calibration.

**Communication Setup (First Connect to Module Here)**
- Scan for connected transmitters and Open/Close communications with them.
- Display the Model, Serial Number, and Manufacturer of the connected transmitter and report the status of communication.
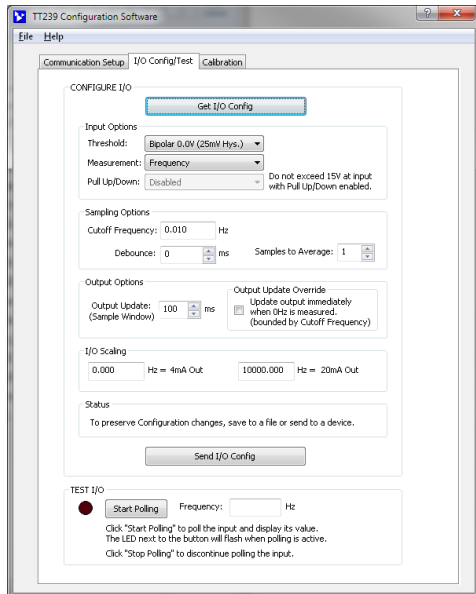
I/O Config/Test (Configure and/or Test the Module Here)
- Select the *Threshold*. Select Bipolar for zero crossing signals or Unipolar for non-zero crossing signals.
- Select the *Measurement*. Options are Frequency or Duty Cycle.
- Select the *Pull Up/Down* depending on the input sensor type.
- Enter the *Cutoff Frequency*. Inputs below the Cutoff Frequency are measured as 0Hz.
- Enter the *Debounce* time. The input must be steady for this length of time before the transmitter will conduct a measurement.
- Enter the number of *Samples to Average*. This controls the number of samples included in the FIFO queue (first-in, first-out).
- Enter the *Output Update*. This controls the rate at which the output is updated (sample window).
- Enter the *I/O Scaling*. Specify the input frequencies to correspond to Zero-Scale and Full-Scale.
- Submit the configuration settings to the transmitter by clicking the **[Send I/O Config]** button to write the settings to the non-volatile EEPROM memory.
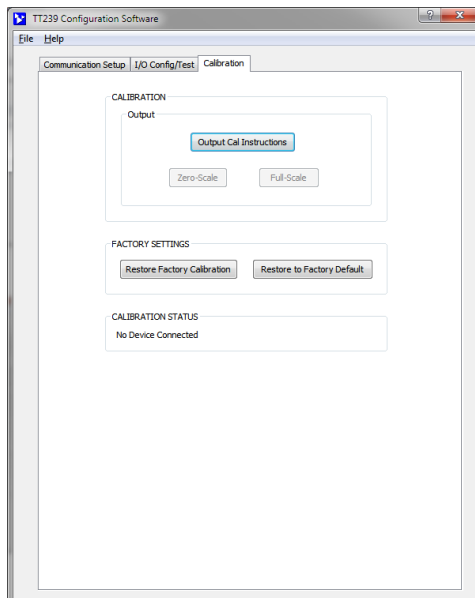
Quick Overview...
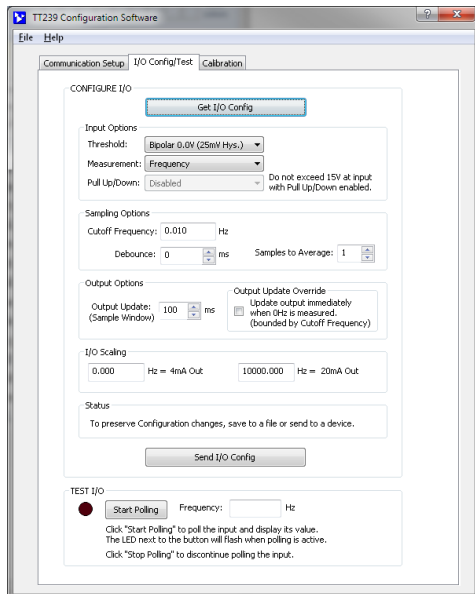
I/O Test (Optional, Verify Transmitter Operation Here)
After making I/O configuration changes, use the I/O Test controls to verify the transmitter's operation. Click "Start Polling" to periodically read the input channel and validate its operation. Click "Stop Polling" to stop polling the input channel.

For detailed configuration and calibration procedures, see the Operation Step-By-Step section of the Technical Reference of this manual.

HELP:

You can press **[F1]** for Help on a selected or highlighted field or control. You can also click the **[?]** button in the upper-right hand corner of the window and click to point to a field or control to get a Help message pertaining to the item you pointed to.

Calibration (Calibrate the Output if Needed)
This transmitter has already been factory calibrated. If you encounter excessive error, you can click the Calibration tab to display the Calibration control page as shown at left.

For output zero-scale endpoint adjustment, click the **[Zero-Scale]** button to open the zero-scale configuration popup. Use a current meter or digital volt meter to accurately measure the transmitter output signal and enter the measurement in the input field provided. Click the **[Submit Measurement]** button to send the calibration to the transmitter.

For output full-scale endpoint adjustment, click the **[Full-Scale]** button to open the full-scale configuration popup. Use a current meter or digital volt meter to accurately measure the transmitter output current and enter the measurement in the input field provided. Click the **[Submit Measurement]** button to send the calibration to the transmitter.

Factory Settings (Use only in case of trouble or for sanitation purposes)
- Restore a transmitter to its original factory calibration
- Restore a transmitter to its initial factory configuration

You can click the **[Restore Factory]** buttons if you ever misconfigure or miscalibrate a transmitter in such a way that its operation appears erratic.

Calibration Status (Bottom of Window)
The Calibration Status bar at the bottom of the window will display status messages relative to calibration over USB.
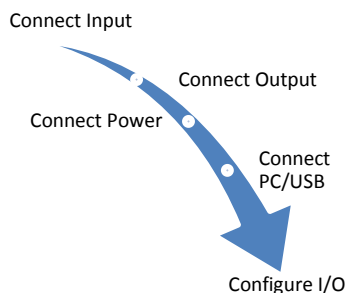
TECHNICAL REFERENCE

OPERATION STEP-BY-STEP

Connections

This section will walk you through the Connection–Configuration–Calibration process step-by-step. Before attempting to reconfigure or recalibrate this transmitter, verify the following electrical connections:

Connect Input

Connect Output

Connect Power

Connect PC/USB

Configure I/O

Calibration Connections:

NOTE: When calibrating, the output meter and load resistor (for current output) must be accurate beyond the transmitter specifications, or better than ±0.1%. As a general rule, calibration equipment accuracy should be four times better than the rated accuracy you are trying to achieve with this transmitter.

Connect Output: Connect an output load to the transmitter appropriate for either current or voltage, as required by your application. You will need to measure the output current or voltage accurately in order to calibrate the output of the transmitter. You could connect a current meter in series with the load to read the output current directly, or a digital volt meter in parallel with the load to measure output voltage. Alternatively, you could simply connect a voltmeter across a precision load resistor, and then accurately read the output current as a function of the IR voltage drop produced in the resistor (recommended for current outputs).

#### Calibration & Configuration Connections:

Connect Output/Power: Refer to Output/Power Connection section and wire an output current loop to the transmitter as illustrated. You will need to measure the output current accurately in order to calibrate the transmitter. You can connect a current meter in series in this loop to read the loop current directly (not recommended). Alternatively, you could simply connect a voltmeter across a series connected precision load resistor in the loop, and accurately read the output current as a function of the IR voltage drop produced in this resistor (recommended). In any case, be sure to power the loop with a voltage that is minimally greater than the 12V required by the transmitter, plus the IR drop of the wiring and terminals, plus the IR drop in the load. To computer the IR drop, be sure to use a current level that considers the over-scale current (up to 24mA).

Loop Power Supply Voltage: Make sure your voltage level is at least 12V plus 0.020*load_resistance. Ideally, it should be great enough to drive the 24mA over-range current into your load (i.e. up to 12V+ 0.024*Rload, assuming line drop is negligible and the maximum possible over-range is considered). Always apply power to the transmitter output loop even when connected to USB.

Connect to PC via USB: Refer to USB Connections section and connect the transmitter to the PC using the USB isolator and cables provided in the Configuration Kit TT-SIP.

Now that you have made your connections and applied power to your loop, you can execute the "TT239 Config.exe" software to begin configuration of the transmitter (software is compatible with XP or later versions of the Windows operating system).
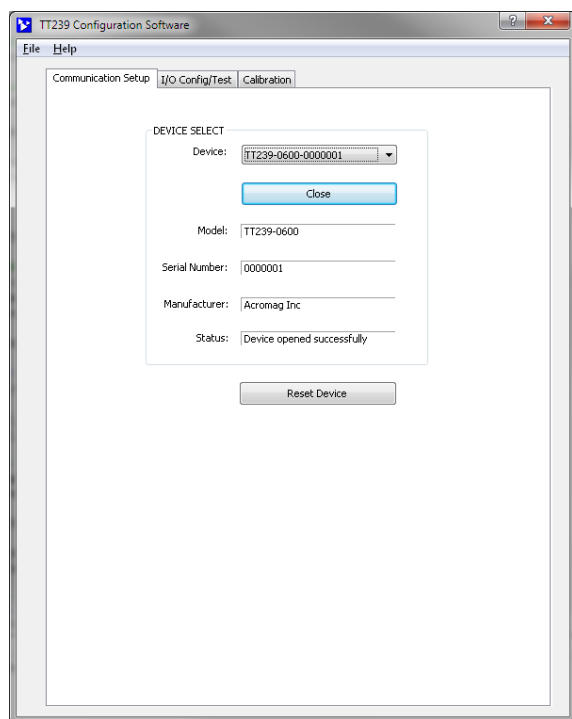
Connections...
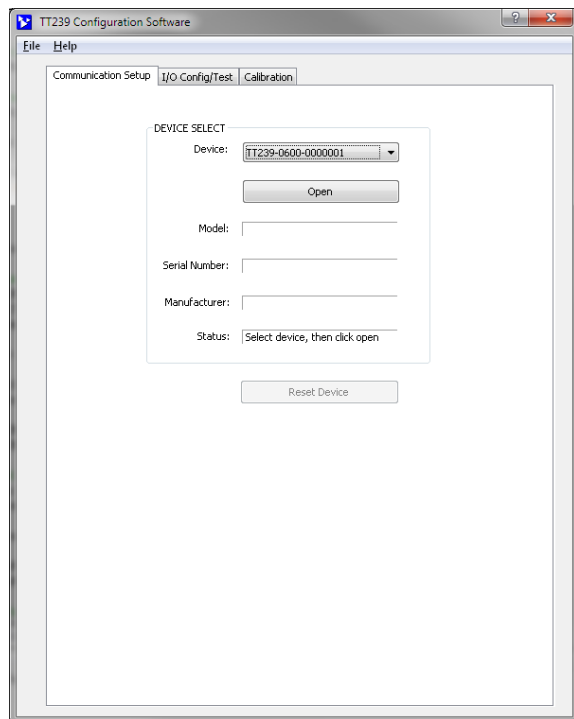
NOTE: You should already have power connected to the transmitter.

After executing the Acromag Configuration software for this transmitter, the window shown at left will appear, if you have not already connected to the transmitter via USB (note fields are blank under these conditions).

Connect your PC to the transmitter via USB, and the transmitter's model-serial information will appear in the device field as shown in the second window at left.

If you happen to be connected to more than one transmitter via a USB hub, you can use the device scroll field to select another transmitter, using the serial information suffix of the model number to discern one transmitter from another.

Select a transmitter from the drop down menu. When you click on a transmitter name from the drop down menu, the software will automatically attempt to open a connection with the selected transmitter. If the software does not have an open connection with the transmitter, click the **[Open]** button to open a connection with the transmitter.

After opening a connection to a transmitter, the transmitter's Model, Serial Number, Manufacturer, and connection status will be displayed as shown in the image on the left. In addition, the Status field will indicate "Device opened successfully" as shown in the image at left.

Configuration
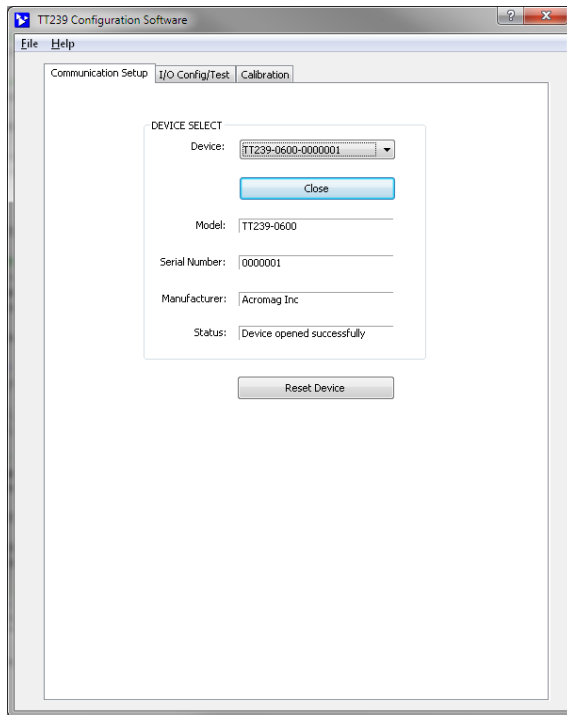
At this point, you can click the **"I/O Config/Test"** tab to begin configuring the transmitter, or to optionally test its operation. The I/O Config/Test window is the image shown at left.

When you click the **"I/O Config/Test"** tab, the software retrieves the transmitter's current configuration and displays it similar to the image shown at left.

If you are connected to a transmitter, the initial I/O Config page represents the current configuration of the connected transmitter before making changes. Otherwise, if you have loaded the configuration from a saved a file, or if you have made changes to any fields, you can click the **[Get I/O Config]** button to retrieve the transmitter's current configuration.

NOTE: If you make any changes to the selections indicated, the only way to preserve your changes is to write them to the transmitter by clicking the **[Send I/O Config]** button after completing your selections, or save them to a file by opening the **"File"** menu in the upper left-hand corner of the window and selecting **"Save As…"**.

Select the Threshold…
The *Threshold* should be selected based on the type of input signal the transmitter is measuring. Select Bipolar when the input signal is zero crossing. Select Unipolar when the input signal is non-zero crossing. There are two levels of hysteresis available for both Bipolar and Unipolar options. The hysteresis is listed in parenthesis.

Select the Measurement…
Select Frequency to measure the frequency of the input signal. Select Duty Cycle to measure the duty cycle of the input signal.

NOTE: The maximum input frequency when *Measurement* is set to Duty Cycle is 3KHz.

Select the Pull Up/Down…
Select Pull-Up to pull the +FINP terminal to +3VDC through 12.4KΩ. Select Pull-Down to pull the +FINP terminal to the –FRTN terminal through 1KΩ. Select Disabled to disconnect the internal resistors. Refer to the example input connections in the Sensor Input Connections section for common sensor configurations.

WARNING: Do not exceed 15VDC with the internal pull-up or pull-down resistors enabled, or damage to the circuit will result. Limit internal pull-up/pull-down resistor power to less than 0.25W. **Disable the Pull-up/Pull-down if the input to the transmitter is AC mains voltage (120V$_{RMS}$).**
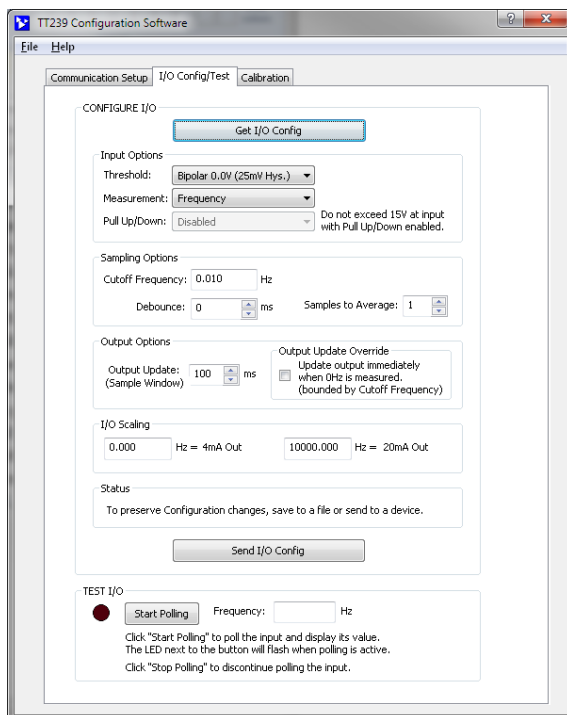
Configuration...
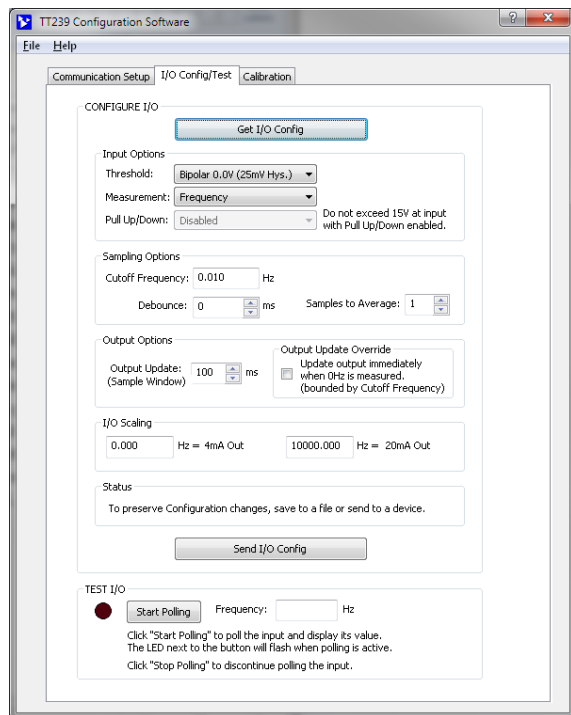
HELP:

Press **[F1]** for Help on a selected or highlighted field or control. Alternatively, click the **[?]** button in the upper-right hand corner of the window and click a field or control to receive a Help message pertaining to the item pointed to.

Enter the Cutoff Frequency...
The *Cutoff Frequency* controls the minimum frequency the transmitter will measure. When the frequency of the input signal falls below the *Cutoff Frequency*, the transmitter will measure 0Hz.

NOTE: Once the *Cutoff Frequency* is reached, the transmitter will retain the last measurement and will wait a specified duration before measuring 0Hz. This duration is equal to the period of the *Cutoff Frequency*. If no input is captured within this duration, the transmitter will measure 0Hz. For example, a 0.25Hz *Cutoff Frequency* would configure the transmitter to wait 4 seconds before measuring 0Hz.

Enter the number of Samples to Average...
This transmitter captures and saves samples in a FIFO (first-in, first-out) queue. The number of samples in this queue is equal to the number of *Samples to Average*. The FIFO queue is used to calculate a running average. Samples are added to the FIFO queue at the Output Update rate.

NOTE: It is often useful when measuring a gear using a magnetic pickup to set the number of *Samples to Average* equal to the number of teeth on the gear. Using this technique, variations in gear teeth spacing will be averaged over one revolution, yielding a constant frequency measurement.

Enter the Debounce...
The *Debounce* time controls the length of time the transmitter will wait until the input signal is steady (not crossing threshold) before measuring the input signal.

NOTE: *Debounce* is useful for filtering out temporary signal glitches such as those generated by contact relays. For best results, set the *Debounce* to twice the expected duration of contact bounce.

Enter the Output Update...
The *Output Update* sets the rate at which the output will be updated with the scaled input measurement. The transmitter will always update the output at this rate unless the *Output Update Override* is selected when the input falls below the *Cutoff Frequency*.

NOTE: The *Output Update* determines the time available for the transmitter to capture the input signal. Therefore, the accuracy of the calculated measurement will decrease as the *Output Update* becomes faster. Using a slower *Output Update* allows the transmitter to capture more of the input signal and calculate a more accurate measurement.

Configuration...
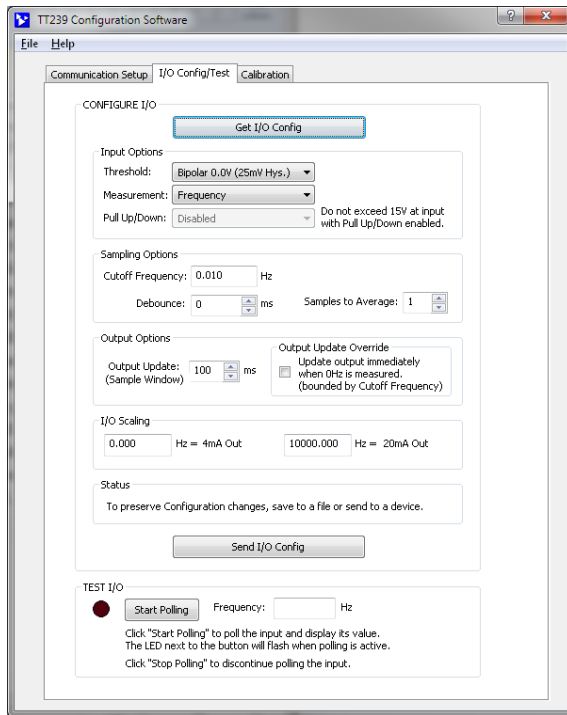
HELP:

Press **[F1]** for Help on a selected or highlighted field or control. Alternatively, click the **[?]** button in the upper-right hand corner of the window and click a field or control to receive a Help message pertaining to the item pointed to.

NOTE:

Under-range (3.6mA) and over-range (24mA) capability is built into the output range by design. See Output Specifications for more detail.

Other Configuration Controls

Select the Output Update Override (Optional)...
Select the *Output Update Override* checkbox if the desired behavior upon reaching the *Cutoff Frequency* is to update the output immediately to 0Hz. Left unchecked, the time before the output signal reaches 0Hz will be a function of the number of *Samples to Average* and the *Output Update* rate.

Enter the I/O Scaling values...
You may rescale the input range to use only a portion of the input range to drive the output if desired. Be careful not to reduce the input range too much, as resolution will be proportionally diminished and noise/error magnified.

In the corresponding *I/O Scaling* field, enter the input signal minimum/zero value to correspond to the output range Zero-Scale value (4mA). Also set the input range Full-Scale (20mA). You can optionally swap *I/O Scaling* values to configure a reverse acting output response if desired. Note: Under-range (3.6mA) and over-range (24mA) is built into the output range by design.

If the I/O Scaling Zero-Scale and Full-Scale points are chosen too close together, performance will be degraded.

Submit I/O Configurations
Once you have made your configuration selections, click the **[Send I/O Config]** button to write them to the transmitter. You can read the status of your sent message in the Status field. Alternately, you could select **"Save As..."** from the upper left-hand **"File"** menu to save the configuration settings to a file on your PC for later reference.

At this point, you can verify the transmitter's operation by clicking on the **[Start Polling]** button of the TEST I/O Section of the page to trigger the software to periodically read the transmitter's input measurement and display its value in the field to the right of the polling toggle button. Note the simulated LED next to the button flashes each time the input is sampled. Click **[Stop Polling]** to stop polling the input.

The **[Restore Factory Calibration]** button resets transmitter and causes it to revert to its factory calibration without effecting user configuration. Useful if there was an error during recalibration that degraded performance or the I/O channel appears erratic.

The **[Restore Factory Default]** button restores a transmitter to its original factory state (See Specifications Reference Test Conditions). This includes calibration and configuration. This control can be used as a sanitation tool to restore the transmitter to its initial configuration.

Calibration (Optional)
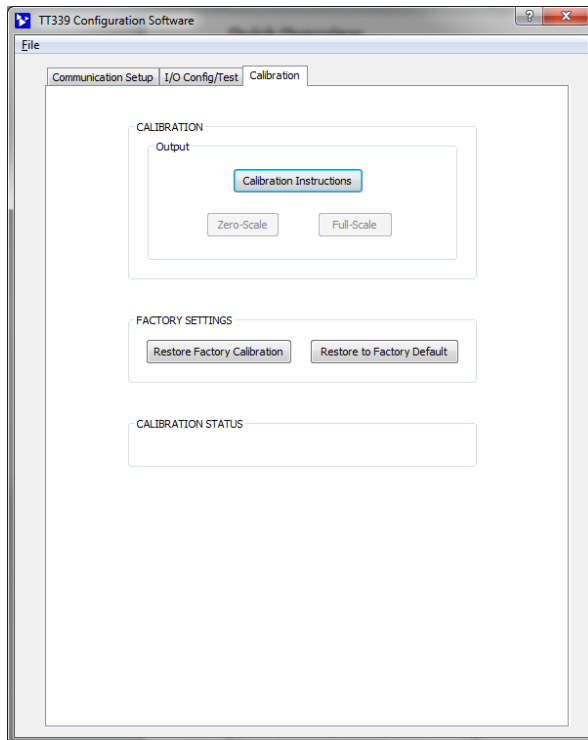
Once you've configured the transmitter, you are ready to install it in the field, as the transmitter has already been factory calibrated. If you later encounter error that is out of specification, you can click the **"Calibration"** tab to display the Calibration control page shown at left.

CALIBRATION – Output

IMPORTANT: This transmitter has already been factory calibrated with a high level of precision. If you attempt to recalibrate the output channel, you could degrade its performance if it is not done properly, or it is done using lower grade equipment. Consider your decision to recalibrate carefully.

Before attempting to recalibrate the output channel, make sure you write your selections to the transmitter by clicking the [Send I/O Config] button.

Click the **[Output Cal Instructions]** button to begin output calibration and enable the Output [Zero-Scale] and [Full-Scale] buttons.

For output zero-scale endpoint adjustment, click the **[Zero-Scale]** button to open the zero-scale configuration pop-up. Use a current meter or digital volt meter to accurately measure the transmitter output current and enter the measurement in the input field provided. Click the **[Submit Measurement]** button to send the calibration to the transmitter.

For output full-scale endpoint adjustment, click the **[Full-Scale]** button to open the full-scale configuration pop-up. Use a current meter or digital volt meter to accurately measure the transmitter output current and enter the measurement in the input field provided. Click the **[Submit Measurement]** button to send the calibration to the transmitter.

NOTE: To measure output current, you can alternatively connect a voltmeter across a precision load resistor, and then accurately read the output current as a function of the IR voltage drop produced in the resistor.

BLOCK DIAGRAM

TT239-0600 SIMPLIFIED SCHEMATIC
(FILTERING AND DETAIL OMITTED FOR CLARITY)
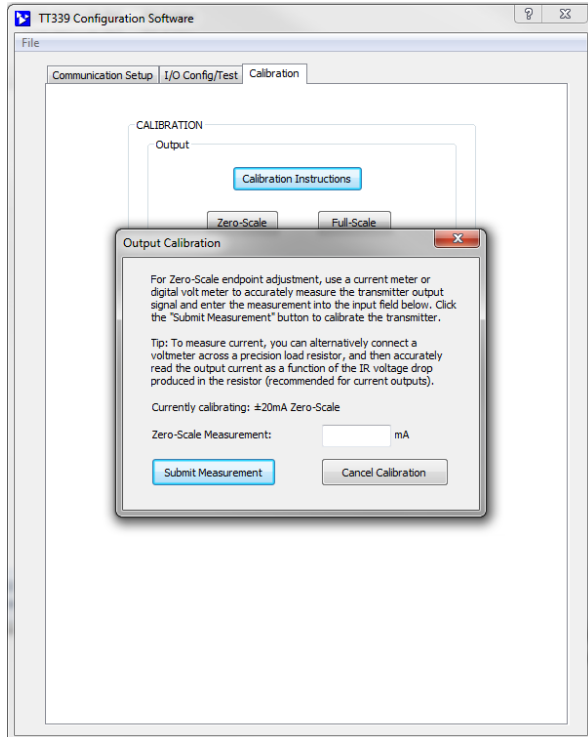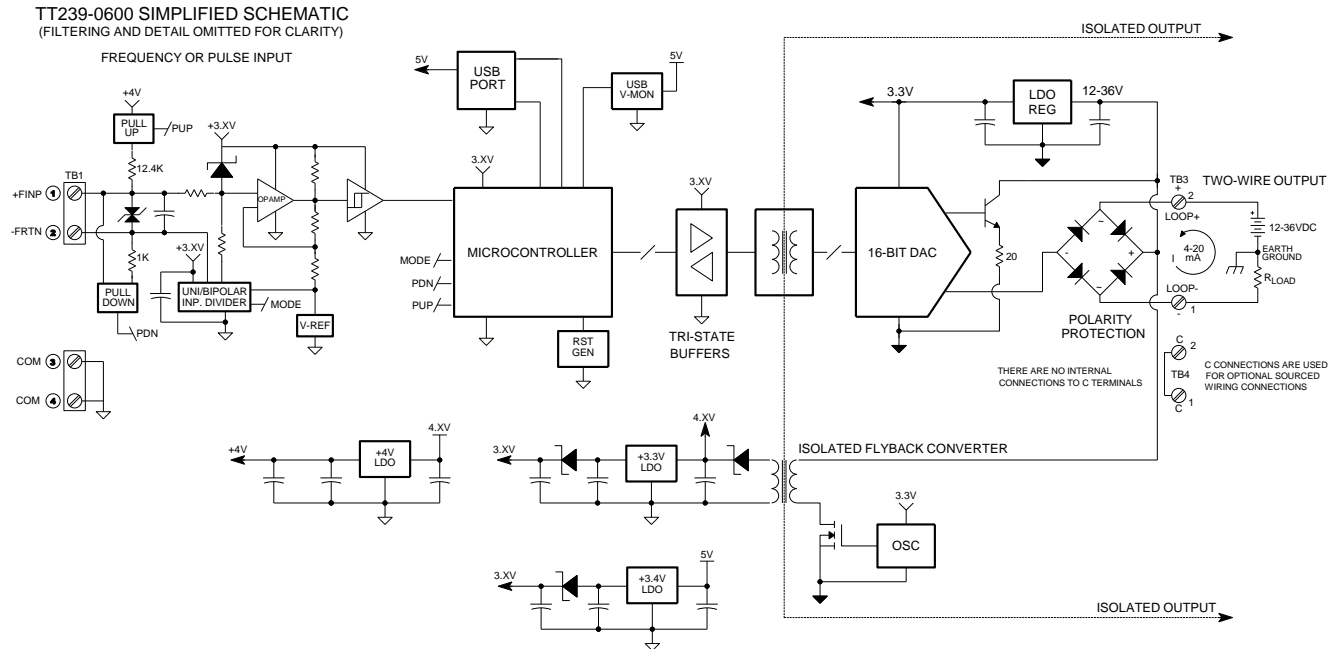

How It Works

Key Points of Operation

- Loop Powered

- Input is Isolated from Output

- Input circuit is common to USB ground

- USB powers a portion of the input circuit when connected, but not the output

The TT239 transmitter uses a 32-bit microcontroller to measure the input signal and communicate to the output DAC via a serial digital pulse stream. The digital communication stream is isolated via a pulse transformer and is received by the 16-bit output DAC which drives a 4–20mA process current. Power for the isolated input side of the circuit is provided via an isolated flyback converter that operates in parallel with the output loop. Setup involves setting the input threshold, measurement type, cutoff frequency, samples to average, debounce time, output update time, and scaling the input range endpoints to 4mA and 20mA at the output. Output scaling can also be done in reverse to produce a reverse acting output signal. The maximum over-range output signal is approximately 24mA, the under-range signal is 3.6mA. Refer to the block diagram above to gain a better understanding of how this transmitter works.

The input/USB, output/power circuits are isolated from each other. The USB port ground is common to the input circuit ground. The USB port ground of most PC's is also common to the USB cable shield and earth ground. Input sensors could be grounded or ungrounded. For this reason, it is recommended that USB signals be isolated when connected to a PC to prevent a ground loop from occurring between the PC earth ground and a grounded input sensor, which would have the negative effect of pulling the input bias supply to ground, clipping the negative portion of the bipolar input range.

Flow Chart
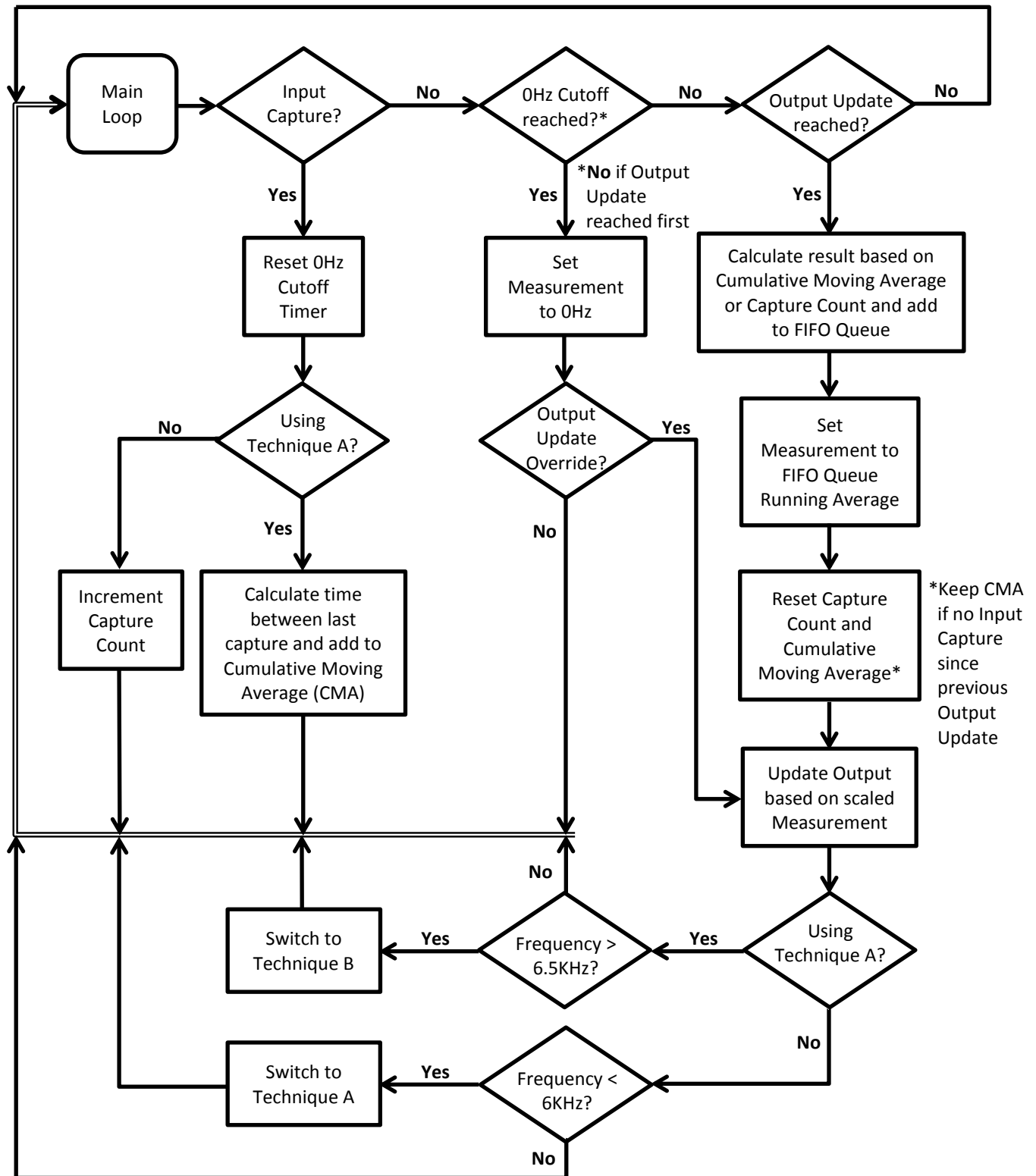
Measurement Techniques

This transmitter utilizes one of two measurement techniques at any given time to measure the input frequency and switches dynamically between the two measurement techniques as needed to maximize system performance. These two measurement techniques are referred to as Technique A and B as listed in the Flow Chart on the previous page.

Technique A: For measuring input frequencies less than 6500Hz. This measurement technique uses the input capture as a gate, and counts the number of system clock cycles (6MHz) between two input captures. The nature of this method results in reduced input resolution with increasing input frequency. Input resolution can be calculated as follows: 1 part in [6MHz / Input Frequency (Hertz)].

Note: When using Technique A, it is possible that the input signal period is greater than the Output Update rate. In the event that the Output Update is reached before a new input capture has occurred (since previous Output Update), the output of the transmitter will reflect the last input measurement (unchanged from previous Output Update). Conversely, multiple input captures can occur when the input signal period is less than the Output Update rate. Each new input capture contributes to the Cumulative Moving Average (CMA). The measurement calculated based on the CMA is added to the FIFO queue on every Output Update.

Technique B: For measuring input frequencies greater than 6000Hz. This measurement technique counts the number of input captures within a user-configured time span (Output Update). Due to this method's dependence on Output Update, the input resolution increases with increasing Output Update. Input resolution can be calculated as follows: 1 part in [6MHz * Output Update (milliseconds)].

Note: A 500Hz hysteresis is used when switching the measurement techniques. The measurement technique switch occurs at 6000Hz or 6500Hz depending on the measurement technique currently in use.

TROUBLESHOOTING

Diagnostics Table

POSSIBLE CAUSE	POSSIBLE FIX
Cannot Communicate with Transmitter via USB…	
Output shifts off-range when you connect USB…	
Output Erratic, Not operational, or at Wrong Value…	
Transmitter fails to operate or exhibits an output shift…	
A missing USB Isolator could cause a ground loop between a grounded input sensor and earth ground at the connected PC's USB port.	Without a USB isolator, a ground loop is possible between a grounded input signal source and earth ground of the PC USB port. It is best to connect to USB via a USB isolator for this reason, and for increased safety and noise immunity. Use an isolator like the Acromag USB-ISOLATOR. Otherwise, use a battery powered laptop to configure the transmitter which does not normally earth ground its USB port.

Diagnostics Table…

Before attempting repair or replacement, be sure that all installation and configuration procedures have been followed and that the transmitter is wired properly. Verify that power is applied to the transmitter and that your supply voltage is at least 12V.

If the problem still exists after checking your wiring and reviewing this information, or if other evidence points to another problem with the transmitter, an effective and convenient fault diagnosis method is to exchange the questionable transmitter with a known good transmitter.

Acromag's Application Engineers can provide further technical assistance if required. Repair services are also available from Acromag.

POSSIBLE CAUSE	POSSIBLE FIX
Software Fails to Detect Transmitter…	
Bad USB Connection	Recheck USB Cable Connection
USB has not enumerated the transmitter.	Use the reset button on the Acromag USB isolator to trigger re-enumeration of the transmitter, or simply unplug/re-plug the USB cable to the transmitter.
Communication or power was interrupted while USB was connected with the configuration software running.	Close the current connection with the software, select and re-open the transmitter for communication (or simply exit the configuration software and restart it).
Output goes to Over-Range (24mA) or Under-Range Limit (3.6mA)…	
This indicates that either the input signal is out of range, or a sensor lead has broken. It can also occur due to contention between earth ground at the PC USB port and the input sensor.	Check the input signal with respect to its range and reduce or increase it as required to drive the output within its linear operating range. A fully Over-Range or Under-Range signal can be driven by a sensor fault, such as an open or broken sensor lead. If USB is not isolated, check for a ground loop between a grounded sensor and earth ground of the PC USB port.
Cannot Measure Input Signal…	
Input may be wired incorrectly to the input terminals.	Input signal should be wired to TB1 at terminals 1 and 2. Observe proper polarity.
Input signal may not be crossing *Threshold.*	Check that the input signal crosses the selected *Threshold*.
Input signal may contain glitches that are triggering the Debounce.	Set Debounce to 0ms or make sure the duration of glitches on the input signal does not exceed the Debounce time.
Input frequency may be below the *Cutoff Frequency*.	Check that the frequency of the input signal is greater than the configured Cutoff Frequency.
Configuration Software reports Timeout Errors…	
USB connection between host PC and transmitter became unsynchronized.	Exit and restart the Configuration Software to allow the USB to re-enumerate the transmitter.

Service & Repair Assistance

This transmitter contains solid-state components and requires no maintenance, except for periodic cleaning and transmitter calibration and verification (zero and full-scale). Its enclosure is not meant to be opened for access and can be damaged easily if snapped apart. It is highly recommended that a non-functioning transmitter be returned to Acromag for repair or replacement. Acromag has automated test equipment that thoroughly checks and calibrates the performance of each transmitter, and can restore firmware. Please refer to Acromag's Service Policy and Warranty Bulletins, or contact Acromag for complete details on how to obtain repair or replacement.

ACCESSORIES

Software Interface Package

Software Interface Package/Configuration Kit – Order TTC-SIP

- USB Signal Isolator
- USB A-B Cable 4001-112
- USB A-mini B Cable 4001-113
- Configuration Software CDROM 5040-944

This kit contains all the essential elements for configuring TT230 & TT330 family Transmitters. Isolation is recommended for USB port connections to these transmitters and will block a potential ground loop between your PC and a grounded current loop. A software CDROM is included that contains the Windows software used to program the transmitter.

USB Isolator

USB Isolator – Order USB-ISOLATOR

- USB Signal Isolator
- USB A-B Cable 4001-112
- Instructions 8500-900

This kit contains a USB isolator and a 1 meter USB A-B cable for connection to a PC. This isolator and cable are also included in TTC-SIP (see above).

USB A-B Cable

USB A-B Cable – Order 4001-112

- USB A-B Cable 4001-112

This is a 1 meter, USB A-B replacement cable for connection between a PC and the USB isolator. It is normally included with the TTC-SIP Software Interface Package and also with the isolator model USB-ISOLATOR.

USB A-mini B Cable

USB A-mini B Cable – Order 4001-113

- USB A-mini B Cable 4001-113

This is a 1 meter, USB A-miniB replacement cable for connection between the USB isolator and the transmitter. It is normally included in the TTC-SIP.

Note that software for all TT Series models is available free of charge, online at www.acromag.com.
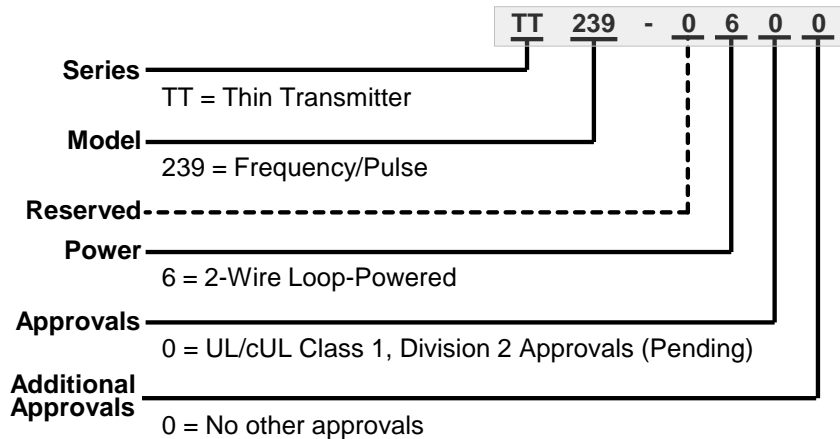
SPECIFICATIONS

Model Number

Model TT239-0600

- Signal Transmitter
- Isolated RTD Input
- Two-Wire Powered
- CE Approved (Pending)
- Includes UL/cUL Class 1, Division 2 approvals (Pending)

Custom calibration to customer specifications can be added as a separate item at time of purchase.

	TT	239	-	0	6	0	0

Series
TT = Thin Transmitter

Model
239 = Frequency/Pulse

Reserved

Power
6 = 2-Wire Loop-Powered

Approvals
0 = UL/cUL Class 1, Division 2 Approvals (Pending)

Additional Approvals
0 = No other approvals

Optional factory calibration to customer specifications is ordered as a separate line item at time of purchase, and on a per unit basis. Factory calibration will require the specification of input threshold, measurement type, pull-up/pull-down, cutoff frequency, debounce, samples to average, output update, and I/O scaling. Normal or reverse acting output and a filter level can also be specified. Use form 8500-858 for specifying this calibration from our web site at www.acromag.com.

The standard model without adding custom factory calibration is calibrated by default to reference test conditions. Recalibration of any transmitter will require use of a TTC-SIP configuration kit, ordered separately (see Accessories section). Modules can be mounted on standard 35mm "T" Type DIN rail.

Input

Input Reference Test Conditions: ±5.0V Square Wave; Input Threshold = Bipolar 0.0V; Hysteresis ±28mV; Measurement = Frequency; Pull Up/Down = Disabled; Cutoff Frequency = 0.5Hz; Samples to Average = 1; Debounce = 0ms; Output Range = 4-20mA (into 250Ω load); I/O Scaling = 0Hz to 10KHz, Normal Acting; Output Update = 100ms; Output Update Override = Disabled; Ambient Temperature = 25°C; Power Supply = 24VDC.

Input Frequency: Frequency Measurement – 0Hz to 100KHz.

Duty Cycle Measurement – 0Hz to 3KHz.

Input Acquisition Time: See Output Update.

Input Impedance: 35.5KΩ, typical.

Input Pull-up/Pull-down (Internal): Software selectable 12.4KΩ pull-up to +4V/+3V when input hysteresis configured as ±28mV/±84mV respectively, 1KΩ pull-down to –FRTN, or disabled to disconnect the internal resistors.

CAUTION! Do not exceed 15VDC at input terminal TB1 with the internal pull-up or pull-down resistors enabled, or damage to the circuit will occur.

Disable Pull-up/Pull-Down if transmitter input is AC mains voltage (120V$_{RMS}$).

Input…

Unipolar Signal Configuration:
    Input Amplitude: Recommend 3VDC minimum, ±170VDC (120V$_{RMS}$) maximum.
    Input Threshold: See table below.
    Input Hysteresis: Configurable for ±28mV, or ±84mV, typical.

Input Threshold for Unipolar Signal Configuration Per Input Range		
Input Range	**Input Threshold, Typical**	
	±28mV hysteresis	**±84mV hysteresis**
0Hz to 20KHz	1.6VDC	5.2VDC
20KHz to 100KHz	2.1VDC	5.5VDC

Bipolar (Zero-Crossing) Signal Configuration:
    Input Amplitude: See table below.
    Input Threshold: 0mV, typical.
    Input Hysteresis: Configurable for ±28mV, or ±84mV, typical.

Input Amplitude for Bipolar Signal Configuration Per Input Range		
Input Range	**Minimum Amplitude, Typical**		**Maximum Amplitude**
	±28mV hysteresis	**±84mV hysteresis**	
0Hz to 20KHz	±50mV	±125mV	±170VDC (120V$_{RMS}$)
20KHz to 100KHz	±150mV	±200mV	

Input Resolution and Accuracy: Frequency measurement utilizes one of two measurement techniques depending on the input frequency. The technique used for measuring 0Hz up to 6500Hz results in decreased internal resolution with increasing frequency. A 500Hz hysteresis from 6000Hz to 6500Hz is used when switching sampling algorithms. The technique used for measuring frequencies at or above 6000Hz has a constant internal resolution which is determined by the software configured Output Update time. Resolution for frequencies up to 6500Hz can be calculated as follows: 1 part in [6MHz / Input Frequency (Hertz)]. Resolution for frequencies at or above 6000Hz can be calculated as follows: 1 part in [6MHz * Output Update (milliseconds)].

Input Range Resolution and Measurement Accuracy Per Input Range				
	Input Range	**Output Update**	**Input Resolution**	**Typical Accuracy**
Frequency Measurement	0Hz to 100Hz	Any value	1 part in 60000	±0.05Hz
	0Hz to 1000Hz	Any value	1 part in 6000	±0.5Hz
	0Hz to 5000Hz	Any value	1 part in 1200	±1Hz
	0Hz to 10KHz	10ms	1 part in 60000	±200Hz
		100ms	1 part in 600000	±20Hz
		1000ms	1 part in 6000000	±2Hz
	0Hz to 100KHz	10ms	1 part in 60000	±400Hz
		100ms	1 part in 600000	±40Hz
		1000ms	1 part in 6000000	±4Hz

Input…

Input Range Resolution and Measurement Accuracy Per Input Range				
Duty Cycle Measurement	**Input Range**		**Input Resolution**	**Typical Accuracy**
	Input Carrier Frequency	**Input Duty Cycle**		
	0Hz to 100Hz	1% to 99%	1 part in 60000	±0.02%
	0Hz to 1000Hz	10% to 90%	1 part in 6000	±0.2%
	0Hz to 3000Hz	20% to 80%	1 part in 1200	±2.0%

Input Minimum Pulse Width:

Input Minimum Pulse Width Per Signal Configuration & Input Range				
Input Range	**Unipolar Configuration**		**Bipolar Configuration**	
	±28mV Hys.	**±84mV Hys.**	**±28mV Hys.**	**±84mV Hys.**
0Hz to 20KHz	10µs	6µs	5µs	4µs
20KHz to 100KHz	4µs	3µs	3µs	2µs

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), ±220V clamp level typical. Also includes differential input diode clamping, capacitive filtering, and series resistance.

Input Filter Bandwidth: -3dB at 35KHz, typical.

Noise Rejection (Common Mode): 92dB @ 60 Hz, typical with 100Ω input unbalance.

Noise Rejection (Normal Mode): Not Applicable.

Input Zero and Full-Scale Adjustment: Input range endpoints are selectable over the full input range (0Hz to 100KHz). Input Zero and Full-Scale selections will be mapped to the output zero (4mA/ 0%) and full-scale (20mA / 100%) endpoints. Configuration supports normal or reverse acting operation (i.e. Input 0Hz to 2000Hz or Input 2000Hz to 0Hz).

Zero-Scale Adjust: Adjustable over 0% to 90% of Full-Scale Input.

Full-Scale Adjust: Adjustable over 0.5Hz to 100KHz.

Span Adjust: Minimum recommended span 10% of full-scale.

Cutoff Frequency Adjust: Adjustable over 0.01Hz to 100KHz.

Debounce Adjust: Adjustable over 0ms to 1000ms in 1ms increments.

Output

Output Accuracy: Accuracy is better than ±0.05% of span, typical (±0.1% maximum), for nominal input spans. Relative accuracy varies with calibrated input and output span. Accuracy includes the combined effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.

Output DAC Resolution: Output DAC is 16-bit and its output current is approximated via the expression (programmed_count/65536)*24mA. The min loop current is ~3.6mA, typical, which is approximated via a DAC program count of 9830. Likewise, 4mA corresponds to a count value of ~10923, and 20mA to ~54613. Thus, for the 4-20mA output range, we have an output resolution of 54613-10923, or 1 part in 43690. The effective I/O resolution of this transmitter will be the lowest resolution of either the input, or the output.

Output Update: Adjustable from 10ms to 5000ms. Determines the rate at which the output signal is updated.

Output Settling Time: 1ms, 0% to 98% for a step-change in input, typical.

Output Range: 4 to 20mA DC nominal range, with under-range capability down to 3.6mA, and over-range capability up to 24mA. The output signal is linear with respect to the measured frequency or duty cycle.

Output Ripple/Noise: Less than ±0.1% of output span.

Note (High Speed Acquisition): Additional filtering at the load is recommended for sensitive applications with high-speed acquisition rates. High frequency noise is often reduced or eliminated by placing a 0.1uF capacitor directly across the load. For excessive 60Hz supply ripple with current output, a 1uF or larger bulk capacitor is recommended at the load.

Output Ambient Temperature Drift: Includes the combined effects of zero and span drift over temperature and is better than ±20ppm/°C (±0.0020%/°C) over the ambient temperature range for reference test conditions (see Input Specifications).

Output Power Supply: This device is output loop powered from 12–32VDC SELV (Safety Extra Low Voltage), 24mA maximum. The supply voltage across the transmitter must never exceed 36V, even with a shorted load. The supply voltage level must be chosen to provide a minimum of full-scale current to the load (0.020*R typical), plus 12V minimum to the transmitter terminals, plus any line drop. Ideally, the supply should be able to drive over-scale current levels up to 24mA into the load. Reverse polarity protection is inherent as output terminals are not polarized. The ± output polarity labels on the enclosure are for reference only.
CAUTION: Do not exceed 36VDC peak to avoid damage to the transmitter. Terminal voltage above 12V minimum must be maintained across the transmitter during operation.

Output Power Supply Effect: Less than ±0.001% of output span per volt DC of supply change.
Output Load Resistance Effect: Less than ±0.001% of output span for a ±100Ω change in load resistance.

Output…

Output Compliance and Load Resistance Equation: 12V minimum, transmitter. Transmitter will drive 12V typical to the load with a 24V loop supply and 20mA loop current (600Ω), assuming negligible line drop. Compute R_{load} (Max) = (V_{supply} − 12V)/0.020A for 20mA full-scale output current. Refer to the following table:

V_{supply} Volts	Max R_{load} w/20mA & No Line Drop
13V	50Ω
18V	300Ω
24V	600Ω
32V	1000Ω

Ideally, it should be possible to drive the over-scale current of 24mA to the load and this would yield a maximum load resistance of 500Ω for 24mA of loop current and a 24V loop supply.

USB Interface

IMPORTANT:

The input of this transmitter is isolated from its output and can be connected to grounded or un-grounded input sensors. However, the transmitter's input circuit ground is connected in common to the USB power/signal/shield ground. This will in-turn make a connection to earth ground at the PC when directly connected to the USB port of a PC without using an isolator. Failure to connect USB without isolation would connect the 1.25V input bias supply to input ground if the sensor is also earth grounded. This will interfere with operation and cause the output to shift. For this reason, USB isolation is strongly recommended when connecting to a PC. Otherwise, in the absence of USB isolation, and when connected to a grounded input sensor, a battery powered laptop could be used to connect to the transmitter, as the laptop does not normally connect to earth ground.

Transmitter includes a USB socket for temporary connection to a PC or laptop for the purpose of setup and reconfiguration. USB isolation is required when connected to a grounded input sensor (see "IMPORTANT" note on the left). During reconfiguration and calibration, the transmitter receives power from both the USB port and the output loop. Both power sources must be present to calibrate the transmitter.

CAUTION: Do not attempt to connect USB in a hazardous environment. Transmitter should be configured and calibrated in a safe environment only.

Data Rate: USB v1.1 full-speed only, at 12Mbps. Up to 32K commands per second. USB 2.0 compatible.

Transient Protection: Transient voltage suppression on USB power and data lines.

USB Connector: 5-pin, Mini USB B-type socket, Hirose Electric UX60-MB-5S8.

Pin	Definition
1	+5V Power (Transient protected, but not used by module)
2	Differential Data (+)
3	Differential Data (-)
4	NC – Not Connected
5[1]	Power Ground (Connects to Signal Ground via ferrite bead)
SHLD[1]	Signal Ground (Connects directly to Signal Ground)

[1]**Note:** Most Host Personal Computers (except battery powered laptops) will connect earth ground to the USB shield and signal ground.

Cable Length/Connection Distance: 5.0 meters maximum.

Driver: No special drivers required. Uses the built-in USB Human Interface Device (HID) drivers of the Windows Operating System (Windows XP or later versions only).

Enclosure & Physical

General purpose plastic enclosure for mounting on 35mm "T-type" DIN rail.

Dimensions: Width = 12.5mm (0.5 inches), Length = 114.5mm (4.51 inches), Depth = 99.0mm (3.90 inches). Refer to Mechanical Dimensions drawing.

I/O Connectors: Removable plug-in type terminal blocks rated for 12A/250V; AWG #26-12, stranded or solid copper wire.

Program Connector: USB Mini B-type, 5-pin. See USB Interface.

Case Material: Self-extinguishing polyamide, UL94 V-0 rated, color light gray. General purpose NEMA Type 1 enclosure.

Circuit Board: Military grade fire-retardant epoxy glass per IPC-4101/98.

DIN-Rail Mounting: Transmitter is normally mounted to 35x15mm, T-type DIN rails. Refer to the DIN Rail Mounting & Removal section for more details.

Shipping Weight: 0.5 pounds (0.22 Kg) packed.

Environmental

These limits represent the minimum requirements of the applicable standard, but this product has typically been tested to comply with higher standards in some cases.

Operating Temperature: -40°C to +80°C (-40°F to +176°F).

Storage Temperature: -40°C to +85°C (-40°F to +185°F).

Relative Humidity: 5 to 95%, non-condensing.

Isolation: Input/USB, output/power circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). Complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.

Installation Category: Suitable for installation in a Pollution Degree 2 environment with an Installation Category (Over-voltage Category) II rating per IEC 1010-1 (1990).

Shock & Vibration Immunity: Conforms to: IEC 60068-2-6: 10-500 Hz, 4G, 2 Hours/axis, for sinusoidal vibration; IEC 60068-2-64: 10-500 Hz, 4G-rms, 2 Hours/axis, for random vibration, and IEC 60068-2-27: 25G, 11ms half-sine, 18 shocks at 6 orientations, for mechanical shock.

Electromagnetic Compatibility (EMC)
Minimum Immunity per BS EN 61000-6-1
1. Electrostatic Discharge Immunity (ESD), per IEC 61000-4-2
2. Radiated Field Immunity (RFI), per IEC 61000-4-3
3. Electrical Fast Transient Immunity (EFT), per IEC 61000-4-4
4. Surge Immunity, per IEC 61000-4-5
5. Conducted RF Immunity (CRFI), per IEC 61000-4-6

Class B Product with Emissions per BS EN 61000-6-3
1. Enclosure Port, per CISPR 16
2. Low Voltage AC Mains Port, per CISPR 14, 16
3. DC Power Port, per CISPR 16
4. Telecom / Network Port, per CISPR 22

Agency Approvals

Safety Approvals (Pending): UL Listed (USA & Canada). Hazardous Locations – Class I, Division 2, Groups A, B, C, D. Consult Factory.
Electromagnetic Compatibility (EMC): CE marked, per EMC Directive 2004/108/EC. Consult factory.

Reliability Prediction

MTBF (Mean Time Between Failure): MTBF in hours using MIL-HDBK-217F, FN2. *Per MIL-HDBK-217, Ground Benign, Controlled, $G_B G_C$*

Temperature	MTBF (Hours)	MTBF (Years)	Failure Rate (FIT)
25°C	923,711	105.4	1,083
40°C	628,630	71.8	1,591

Configuration Controls

Software Configuration Only via USB
This transmitter drives an analog output current proportional to a frequency or duty cycle input measurement calculated by a microcontroller. No switches or potentiometers are used to make adjustments to this transmitter. Its behavior as an isolated signal amplifier/transducer is determined via programmed variables set using a temporary USB connection to a host computer or laptop running a Windows-compatible configuration software program specific to the transmitter model. This software provides the framework for digital control of all configuration and calibration parameters, and this information is stored in non-volatile memory.

Refer to Operation Step-By-Step in the Technical Reference section of this manual for detailed information on available software control of this model.

REVISION HISTORY

The following table details the revision history for this document:

Release Date	Version	EGR/DOC	Description of Revision
30-OCT-13	A	JMO/KLK	Initial Acromag release.
05-NOV-13	B	JMO/KLK	Re-characterized Input Minimum Pulse Width
12-NOV-13	C	JMO/KLK	Added MTBF Reliability Prediction