Acromag®
THE LEADER IN INDUSTRIAL I/O

USB Programmable, DIN Rail Mount
Thin Transmitter

Model TT333-0700
4-Wire Transmitter, Thermocouple & mV Input
Universal Current & Voltage Output

USER'S MANUAL

ACROMAG INCORPORATED   **Tel: (248) 295-0880**
30765 South Wixom Road   **Fax: (248) 624-9234**
Wixom, MI 48393-2417 U.S.A.   **email: sales@acromag.com**

Table of Contents

All trademarks are the property of their respective owners.

IMPORTANT SAFETY CONSIDERATIONS
You must consider the possible negative effects of power, wiring, component, sensor, or software failure in the design of any type of control or monitoring system. This is very important where property loss or human life is involved. It is important that you perform satisfactory overall system design and it is agreed between you and Acromag, that this is your responsibility.

The information of this manual may change without notice. Acromag makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Further, Acromag assumes no responsibility for any errors that may appear in this manual and makes no commitment to update, or keep current, the information contained in this manual. No part of this manual may be copied or reproduced in any form without the prior written consent of Acromag, Inc.

GETTING STARTED

DESCRIPTION

Symbols on equipment:

⚠

Means "Refer to User's Manual (this manual) for additional information".

The TT333-0700 is an ANSI/ISA Type IV transmitter designed to interface with a thermocouple sensor (Type J, K, T, R. S, B, E, N), or millivoltage (±100mV) input source, isolate the input signal, and modulate a DC current or DC voltage signal at its output. This unit is configured and calibrated using configuration software and a USB connection to a Windows-based PC (Windows XP and later versions only). The unit provides an adjustable input range, a selectable output range, degrees °F or °C selection, T/C linearization, input isolation, break detection, variable input filter, and cold-junction compensation.

Key Features

- **Digitally configured and calibrated w/ Windows software via USB.**
- **Thin 17.5mm wide enclosure for high-density DIN-rail mounting.**
- **High measurement accuracy and linearity with 16-bit conversion.**
- **Adjustable input range and selectable output ranges.**
- **T/C Type J, K, T, R, S, B, E, N, or ±100mV input support.**
- **T/C inputs are linearized with respect to temperature.**
- **T/C inputs include accurate Cold Junction Compensation.**
- **Supports both Celsius and Fahrenheit temperature units.**
- **Universal Output for ±10V, ±5V, 0-10V, 0-5V, ±20mA, 0-20mA, and 4-20mA.**
- **Output drives DC current or DC voltage without rewiring.**
- **Normal or Reverse Acting output.**
- **Variable 4-level Digital Input Filter Adjustment.**
- **Up-scale or down-scale lead-break/burnout detection.**
- **Wide-range DC power input from 12-32V.**
- **Bussed Power and/or Redundant Power Ready.**
- **Wide ambient temperature operation.**
- **Thoroughly Tested and Hardened For Harsh Environments.**
- **CE Approved.**
- **FCC Conformity Class B.**
- **UL/cUL Class 1, Division 2 Approved.**
- **Model TT333-0700 is ATEX/IECEx Certified for Explosive Atmospheres.**

  〈Ex〉 **II 3 G Ex ec IIC T4 Gc -40°C ≤ Ta ≤ +80°C**

  DEMKO 15 ATEX 1561X   IECEx UL 18.0091X

Application

For additional information on these devices and related topics, please visit our web site at www.acromag.com.

This transmitter is designed for high-density mounting on T-type DIN rails. Units may be mounted side-by-side on 0.7 inch centers. It supports 12-32V DC power via terminals on the unit and can optionally be powered via a DIN-rail bus connector.

This model isolates the DC voltage signal produced by the thermocouple and can mate with grounded or non-grounded thermocouples. It provides an output current or voltage signal linearized to the T/C sensor temperature. Optionally, it supports a ±100mV input range and will drive an output current or voltage linear to the sensor millivoltage. The universal output signal is isolated from the input and power and will drive current or voltage signals for the ranges ±24mA, 0-20mA, 4-20mA, ±5V, ±10V, 0-10V, and 0-5V. The output of this transmitter is very unique in

that it can drive either current or voltage under digital control using the same two output terminals (only the load resistance must be adjusted). Sensor lead-break detection offers convenient I/O fault detection should an input wire break.

Mechanical Dimensions

Units may be mounted to 35mm "T" type DIN rail (35mm, type EN50022), and side-by-side on 0.7-inch centers.

WARNING: 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.
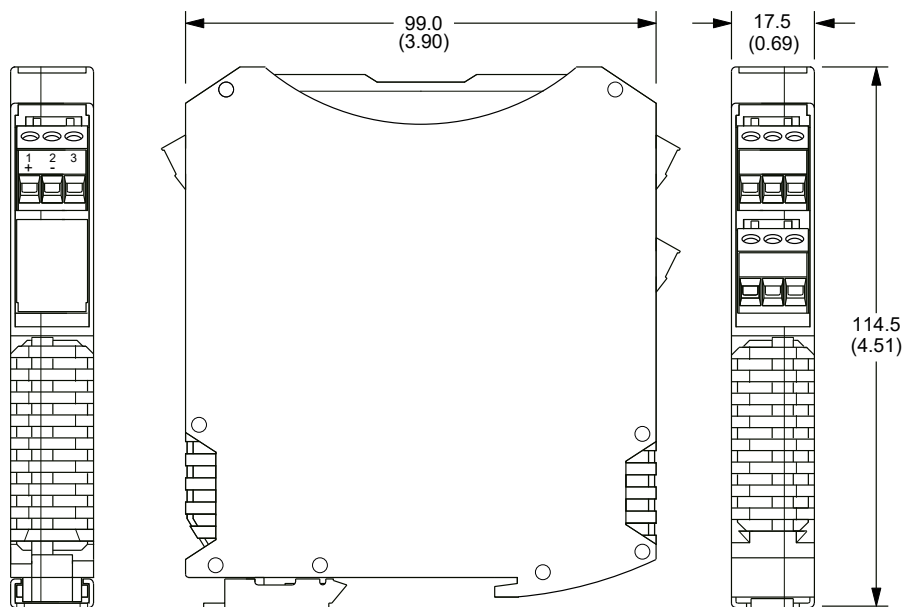
DIMENSIONS ARE IN MILLIMETERS (INCHES)

DIN Rail Mounting & Removal

Refer to the following figure for attaching and removing a unit from the DIN rail. A spring loaded DIN clip is located on the input side bottom. The opposite rounded edge at the bottom of the output side allows you to tilt the unit upward to lift it from the rail while prying the spring clip back with a screwdriver. To attach the module to T-type DIN rail, angle the top of the unit towards the rail and place the top groove of the module over the upper lip of the DIN rail. Firmly push the unit downward towards the rail until it snaps into place. To remove it 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. You can use a screwdriver to pry the pluggable terminals out of their sockets. Next, 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. Then simply lift it from the rail.

TT3XX 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

TT300
Series

35mm DIN Rail

USB

TT3XX 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
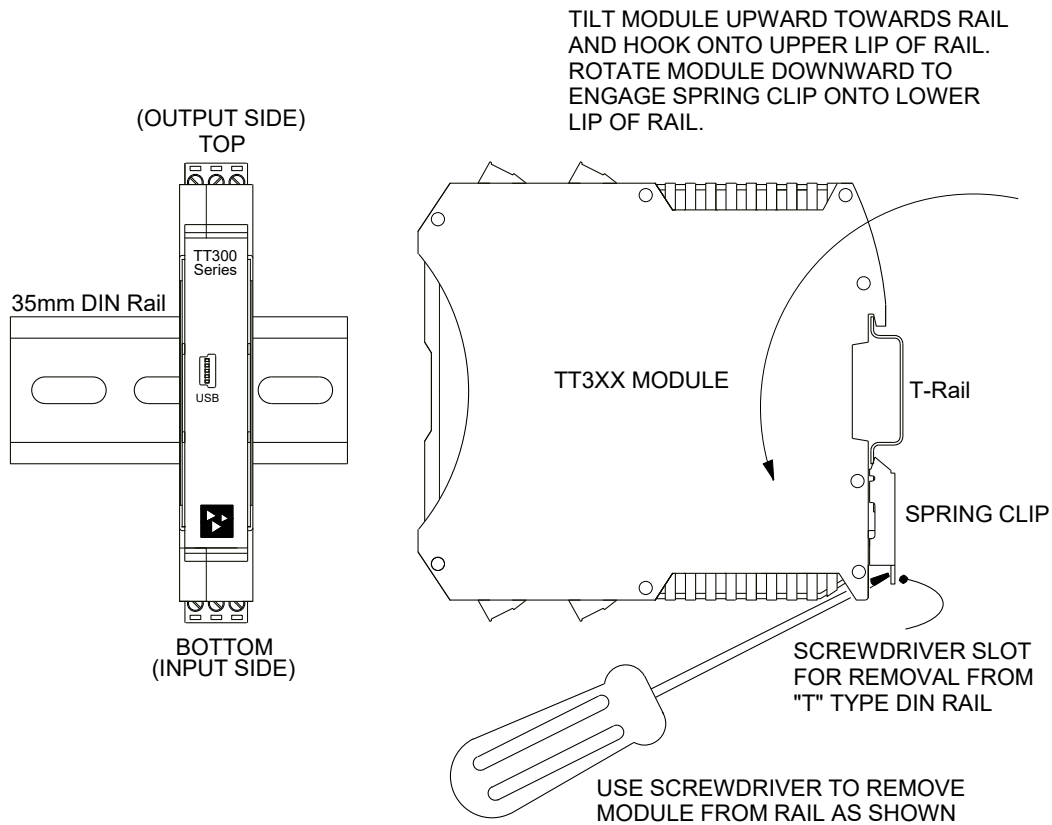
ELECTRICAL CONNECTIONS

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.
WARNING – EXPLOSION HAZARD – Substitution of any components may impair suitability for Class I, Division 2.
WARNING – EXPLOSION HAZARD – The area must be known to be non-hazardous before servicing/replacing the unit and before installing.

Wire terminals can accommodate 14–26 AWG (2.08–0.13mm^2) solid or stranded wire with a minimum temperature rating of 85°C. Input wiring may be shielded or unshielded type. Ideally, output wires should be twisted pair, or shielded 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

Sensor wires are wired directly to transmitter input terminals at the bottom of the module (the spring-loaded DIN clip side), as shown in the connection drawing below. Observe proper polarity when making input connections.

- **The Transmitter Input signal is isolated from the output and power**.
- **T/C inputs use input terminals "+" and "-" at Terminal Block TB1.** The positive input is on the left and labeled "+", and the negative input is to its right. Observe proper polarity. See connection figure below.

MODEL TT333-0700 INPUT SENSOR WIRING

THERMOCOUPLE
TYPE J, K, T, E, R, S, B, OR N
OR MILLIVOLT

SHIELDED CABLE

BOTTOM VIEW
(INPUT SIDE)

TB1

INPUT TERMINALS

INPUT +/-

SHIELD

OPTIONAL SHIELD GROUND
(SEE NOTE 2)

OPTIONAL
EARTH
GROUND
(SEE NOTE 1)

NO CONNECTION

NC

NOTE 1: DO NOT GROUND THE INPUT SENSOR IF UNIT IS CONNECTED TO A GROUNDED PC WITHOUT USING A USB ISOLATOR.

NOTE 2: SHIELDED CABLE IS RECOMMENDED. FOR BEST RESULTS, GROUND THE CABLE SHIELD AT THE END OF THE CABLE CLOSEST TO THE GREATEST POTENTIAL SOURCE OF DISTURBANCE, USUALLY THE SENSOR END.

DIN RAIL SPRING CLIP

INPUT SIDE   OUTPUT/POWER SIDE

OUTPUT TERMINALS

POWER TERMINALS

MODEL TT333-0700

BUS CONNECTOR
(OPTIONAL POWER)

DIN RAIL SPRING CLIP

Output Connections
(DC Current or Voltage)

This transmitter is an ANSI/ISA Type 4 in which the unit's power is separate from the input and output circuits.

- Output connections are polarized. Current is output from Output+ and is returned to Output-. Voltage output is positive at Output+.
- Variations in load resistance have negligible effect on output accuracy, as long as the load limits are respected with respect to output type.

MODEL TT33X-0700 OUTPUT WIRING
OUTPUT WIRED FOR DC CURRENT OR VOLTAGE
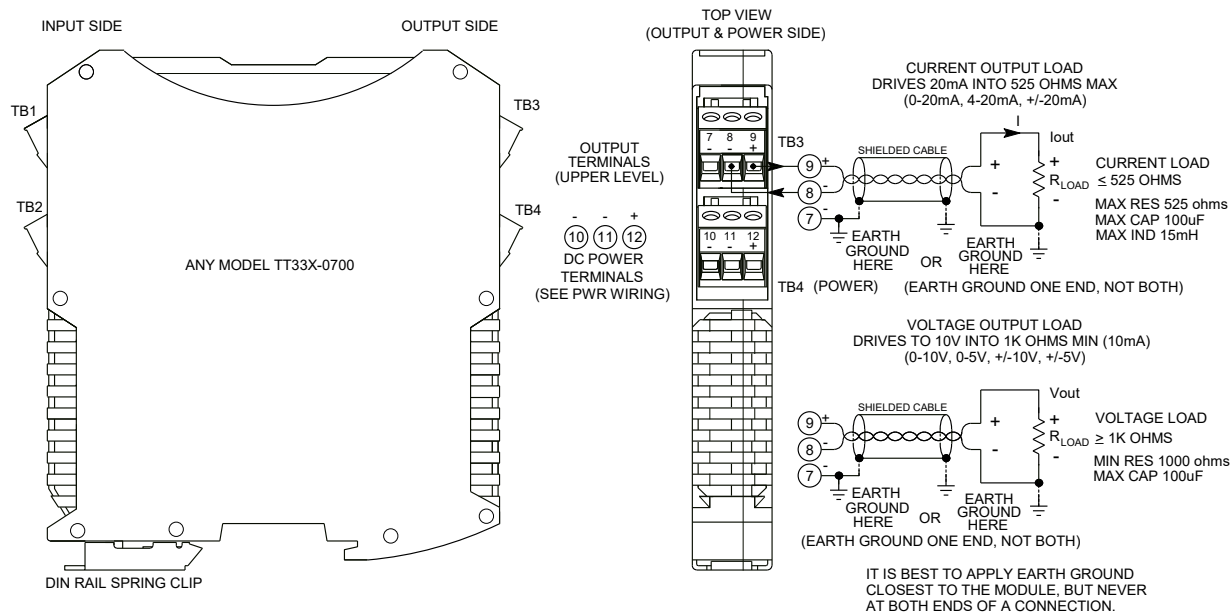
Observe proper polarity. Note that twisted-pair wiring is often used to connect the longest distance between the field transmitter output and the remote load as shown above. Shielded twisted pair wiring is recommended for best results. An output connection to earth ground will help protect the circuit from damage in noisy environments.

> **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 unit.

Output Connections…
(DC Current or Voltage)

TIP - Ripple & Noise: Additional filtering placed at the load can help reduce 60Hz/120Hz ripple often present in industrial environments. 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.

Power Connections

The unit is powered from 12-32V DC (36V DC peak) by connecting power as shown below. This transmitter can be optionally powered (or redundantly powered) via the DIN rail bus when coupled to the DIN rail bus connector (Acromag Model 1005-063) and a bus terminal block (Acromag 1005-220 or 1005-221). This optional method can also allow several modules to share a single power supply without wiring to each individually.

- Power connections are isolated from the input and output. The supply voltage should be from 12-32V DC. This voltage must never exceed 36V DC peak, or damage to the unit may result.
- Variations in power supply voltage between the minimum required and 32V maximum, has negligible effect on transmitter accuracy.
- Note the placement of earth ground at power. If the power supply minus lead is not already earth grounded, then the power cable minus (DC-) and the cable shield should be earth grounded closest to the module. The input and output circuit commons of this module are capacitively coupled to DC- through high-voltage isolation capacitors (for shunting transient energy to earth ground at DC-), offering some transient protection even if their respective circuit commons happen to float (not recommended).

MODEL TT333-0700 POWER WIRING
UNIT IS DC-POWERED ONLY AT 12 TO 32VDC.
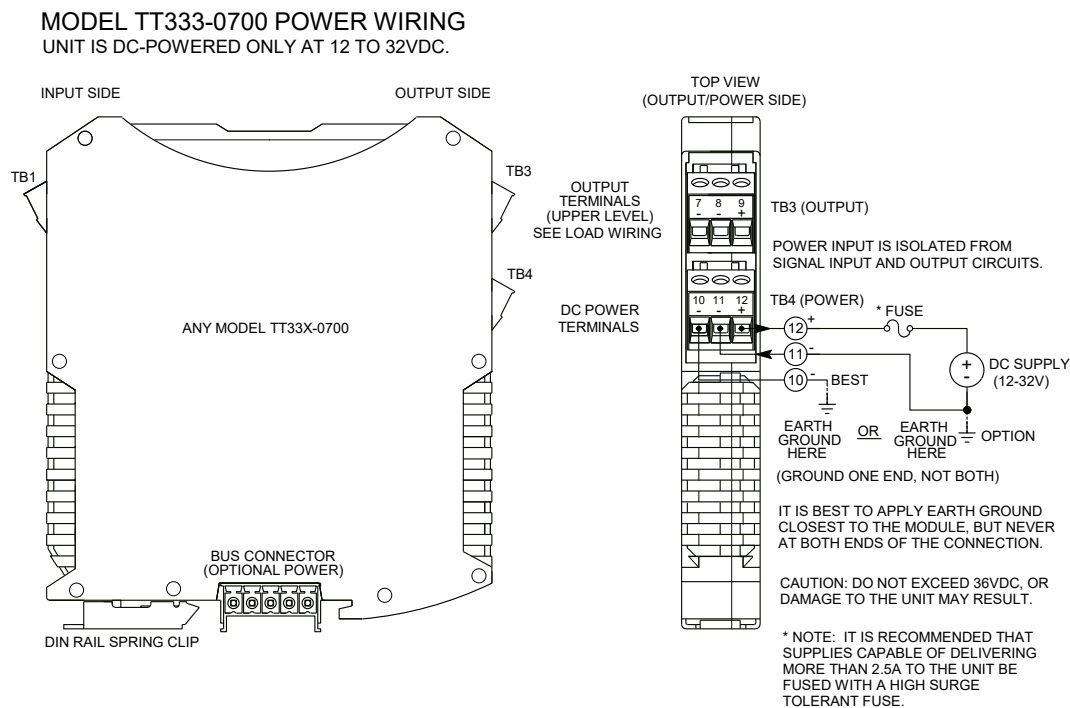
Power Connections…

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize this equipment before servicing.

IMPORTANT – External Fuse: If unit is powered from a supply capable of delivering more than 2.5A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 2.5A or less (for example, see Bel Fuse MJS or RJS fuse types).
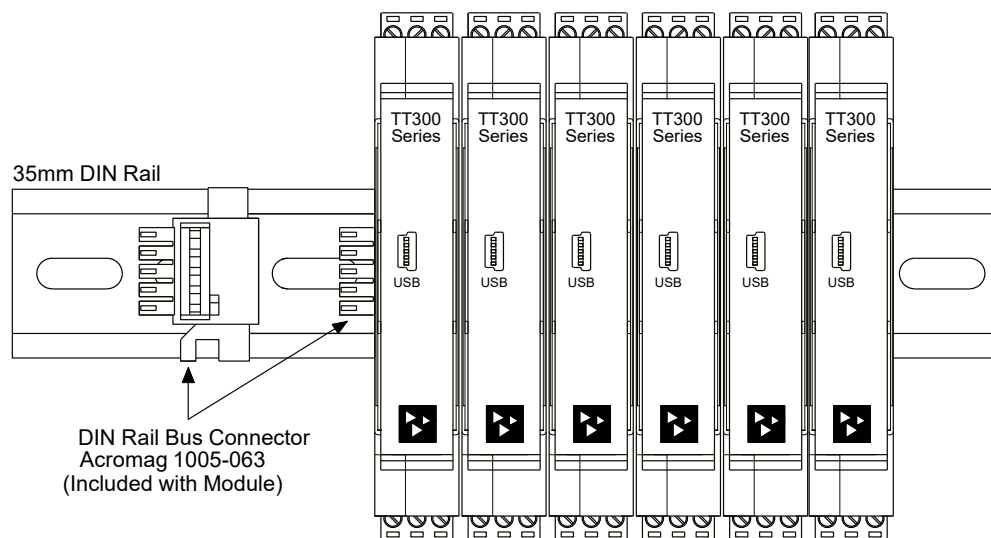
Optional Bus or Redundant Power Connection

Power is normally connected to the TB4 power terminals of the unit as shown on the previous page. However, this transmitter is equipped to be optionally or redundantly powered via its DIN rail bus connector provided (Acromag 1005-063), when mated to an optional plug-in terminal block (Acromag 1005-220 or 1005-221, depending on side of entry). Power input via the bus connector terminal is diode-coupled to the same point in the circuit as unit power connected at power terminal TB4. You can elect to power multiple units by snapping them together along the DIN rail bus, then using a mating terminal block (select a Left or Right side connector, see figure of next page). While the intent of the bus power connector is to allow several units to conveniently share a single supply, you may also use the bus power connector to redundantly power units (with local power also applied at TB4), allowing a backup supply to maintain power to the unit(s) should the main supply at TB4 fail

Your unit comes equipped with the bus connector 1005-063 shown below. This connector allows units to snap together, side-by-side, along the DIN rail and share these connections. But to complete connection to power, you will additionally need an optional plug-in bus terminal block (Acromag 1005-220 for left-side, or 1005-221 for right-side connections). Refer to the figure of the following page which shows how to wire power to the optional bus connector using these connectors.

⚠

Important – End Stops: If this module uses the optionally powered (or redundantly powered) via the DIN rail bus for hazardous location installations (Class I, Division 2 or ATEX/IECEx Zone 2) it must use two end stops (Acromag 1027-222) to secure the terminal block and module (not shown).

35mm DIN Rail

DIN Rail Bus Connector
Acromag 1005-063
(Included with Module)

TT300
Series

TT300
Series

TT300
Series

TT300
Series

TT300
Series

TT300
Series

USB   USB   USB   USB   USB   USB

Optional Bus Power Connections…

The figure below shows how to wire power to the optional bus terminal block when mated to the bus connector included with the unit. Note that power is wired to the rightmost bus terminals on the right, or the left-most terminals on the left. Observe proper polarity.

YOU CAN OPTIONALLY CONNECT POWER TO THE DIN RAIL BUS CONNECTOR ALONG THE DIN RAIL USING THE OPTIONAL TERMINALS AS SHOWN.

TT300 Series

35mm DIN RAIL   LEFT   RIGHT

DIN RAIL BUS POWER

DC-
DC+

DC-
DC+

USB

FUSE

DC SUPPLY
(12-32V)

EARTH
GROUND

FEMALE TERMINAL BLOCK
ACROMAG 1005-220
(LEFT-SIDE CONNECTION)

MALE TERMINAL BLOCK
ACROMAG 1005-221
(RIGHT-SIDE CONNECTION)

CAUTION: DO NOT EXCEED 36VDC, OR DAMAGE TO THE UNIT MAY RESULT.

NOTE: IT IS RECOMMENDED THAT SUPPLIES CAPABLE OF DELIVERING MORE THAN 2.5A TO THE BUS BE FUSED WITH A HIGH SURGE TOLERANT FUSE.

FOR REDUNDANT POWER, CONNECT POWER TO BUS AS SHOWN AND WIRE POWER TO POWER TERMINAL OF MODULE AT TB4.

Earth Ground Connections

The unit housing is plastic and does not require an earth ground connection. If the module is mounted in a metal housing, an earth ground wire connection to the metal housing's ground terminal (green screw) is usually required using suitable wire per applicable codes. Circuits wired to input, output, and power should be earth grounded as reflected in the connection diagrams. The ground connections noted are recommended for best results and help protect the unit by giving it a low impedance path to ground for shunting destructive transient energy. See the Electrical Connections Drawings for Input, Output, and Power, and note the position of earth ground. Earth ground should be applied at the input power minus terminal (DC-). The input and output circuit returns are additionally shunted to earth ground applied at power minus via internal isolation capacitors.
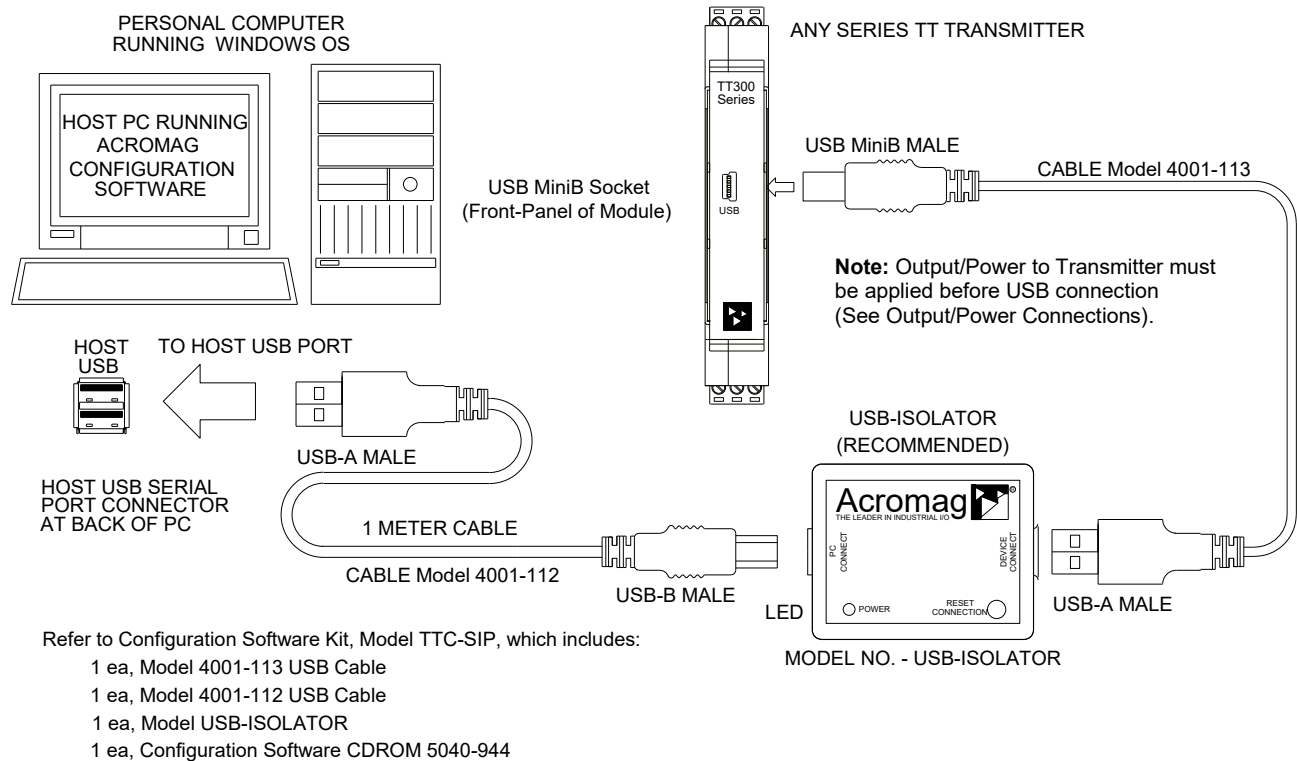.

- Avoid inadvertent connections to earth ground at other points than those indicated, as this could drive ground loops and negatively affect operation.
- A USB isolator is recommended when configuring or calibrating a unit to avoid the ground loop that occurs if your input is also earth grounded (A PC commonly earth grounds its USB port and this makes contact with both the USB signal and shield ground which is held in common to the input circuit ground of this transmitter).

USB Connections

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

TT SERIES USB TRANSMITTER CONNECTIONS
USED FOR CONFIGURATION AND CALIBRATION OF THE TRANSMITTER IN A SAFE OR ORDINARY LOCATION

PERSONAL COMPUTER
RUNNING WINDOWS OS

HOST PC RUNNING ACROMAG CONFIGURATION SOFTWARE

ANY SERIES TT TRANSMITTER

TT300 Series

USB MiniB MALE

USB MiniB Socket
(Front-Panel of Module)

USB

CABLE Model 4001-113

Note: Output/Power to Transmitter must be applied before USB connection (See Output/Power Connections).

HOST USB

TO HOST USB PORT

HOST USB SERIAL PORT CONNECTOR AT BACK OF PC

USB-A MALE

1 METER CABLE

CABLE Model 4001-112

USB-B MALE

USB-ISOLATOR
(RECOMMENDED)

Acromag
THE LEADER IN INDUSTRIAL I/O

PC CONNECT   DEVICE CONNECT

POWER   RESET CONNECTION

LED

USB-A MALE

MODEL NO. - USB-ISOLATOR

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 setup 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 unit while installed in a hazardous area, as USB energy levels could ignite explosive gases or particles in the air.

- USB Signal Isolation is recommended and required when connected to a grounded input – Input and USB connections are isolated from the output and power of this model. USB Isolation is recommended for safety and noise suppression, but required when the input signal happens to be grounded (i.e. when non-insulated or grounded sensors are used). You may use Acromag model USB-ISOLATOR to isolate your USB port, or you can optionally use another USB signal isolator that supports USB Full Speed operation (12Mbps).

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. Thus, an isolator is required when the input signal is grounded and the unit is connected to the USB port of an earth-grounded PC. You could avoid the use of an isolator if a battery powered laptop was instead used to connect to the transmitter, and the laptop had no other earth ground connection, either directly or indirectly via a connected peripheral.

CONFIGURATION SOFTWARE

Quick Overview – Android

This transmitter can be configured and calibrated via the Acromag Agility™ Config Tool App. This software can be downloaded free of charge from the Google Play store at play.google.com. To connect to this transmitter, a USB OTG (On-The-Go) cable (Acromag 5028-565) and USB A to Mini-B cable (Acromag 4001-113) are required. This app is compatible with Android devices using Ice Cream Sandwich (4.0) or later.
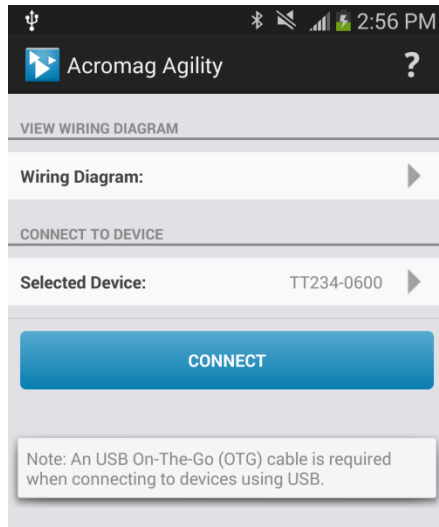
The initial connection screen of the app is shown at left. Once a device is connected, the main portion of the app will launch. The screen is divided into three tabs for this model. A short description of each tab follows.

Connection Screen Setup – DEVICE SELECT (First Connect to Unit Here)
- Select from connected transmitters by tapping the [Select Device] button. This will bring up a list of attached devices. Select the desired device and tap the Connect button to open the device.
- To view wiring diagrams of a particular transmitter, tap the [Wiring Diagram] button and select the desired model. Swipe left or right to view more diagrams. No connection is required to view the diagrams.
- Android requires user permission to access external hardware. If the Device List displays "No Device Permission", select this device and when prompted to give permission to access the USB device, tap [OK].

Configuration Tab – CONFIGURE I/O
- Once connected, the app will automatically read your transmitter and display its current configuration.
- Changing any option on this page will send the changes to the transmitter instantly. The device status at the bottom of the page will report if the changes were sent successfully.
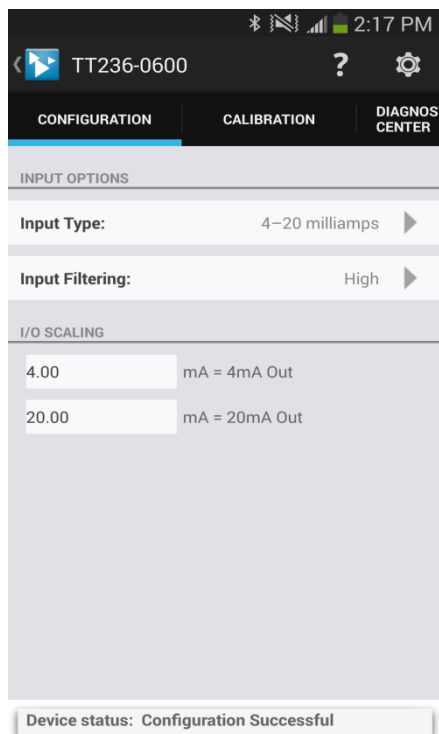
Calibration Tab – (Calibrate the Input and/or Output if Needed)
- On screen instruction will guide the setup to properly calibrate the transmitter. After completing instructions, tap the [Calibrate] button.
- The device status at the bottom of the page will report if the calibration was sent successfully.

Diagnostic Center Tab – (Verify Input operation)
- Select the polling indicator by tapping the [Indicator] button.
- Start polling by tapping the [Start Polling] button.

Utility Page – (Reboot or Restore Settings)
- Tap the [Gear] in the Action bar to access the Utility Page.
- You can tap the [Restore/Reset Factory] utility buttons to get out of trouble if you ever misconfigure or miscalibrate a transmitter.

Quick Overview – Windows

*Click **"Open"** to connect to the TT333-0700 and your screen will look similar to the following:*
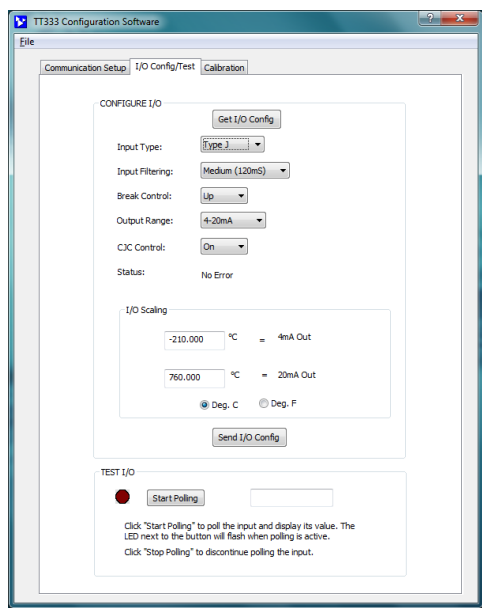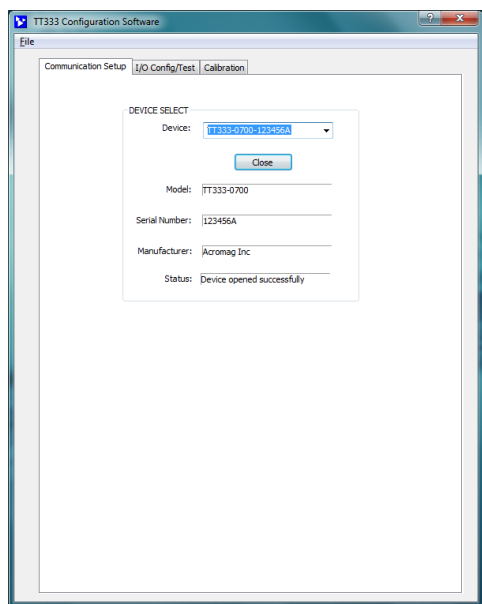
This transmitter can only be configured and calibrated via its Configuration Software and a USB connection to your PC or laptop. The configuration software can be downloaded free of charge from our web site www.acromag.com. This software is also included on a CDROM bundled with the Configuration Kit TTC-SIP (see Accessories section). For this model, look for the program TT333Config.exe. This software is compatible with XP or later versions of the Windows operating system.

The initial configuration software screen for this model is shown at left. Configuration information is divided across three pages (tabs) as follows: Communication Setup, I/O Config/Test, and Calibration. A short description of each of these configuration pages follows.

Communication Setup (First Connect to Unit Here)
- Select from connected transmitters and Open/Close communication with them.
- Display the Model, Serial Number, and Manufacturer of the connected transmitter and report the status of communication with it.

I/O Configure (Configure the Unit Here)
- You can click the **[Get I/O Config]** button to retrieve the I/O configuration of the currently connected transmitter.
- Select the **Input Type** (thermocouple type or select ±100mV).
- Set the digital **Input Filtering** level to High, Medium, Low, or None (No digital filtering). The corresponding I/O response time varies with the filter setting and is indicated in parenthesis next to your selection.
- Set the **Break Control** to Upscale or Downscale TC Break detection.
- Select **Output Range** (±10V, ±5V, 0-10V, 0-5V, ±20mA, 0-20mA, 4-20mA).
- Use **CJC Control** to set Cold Junction Compensation On or Off.
- View the unit's configuration status in the **Status** field after sending.
- Use the **I/O Scaling** fields to specify the specific input range endpoints that are to correspond to the output range endpoints.
- Set the input temperature units to Degrees Celsius or Fahrenheit.
- After making all I/O configuration and scaling changes, send your settings to the unit by clicking the **[Send I/O Config]** button and then follow the on-screen prompts.

I/O Test (Optional, Verify Unit Operation Here)
- Click the **[Start Polling]** button to periodically read your input channel and validate its operation. Click **[Stop Polling]** to stop polling the input channel. Note the simulated red lamp to the left of the button flashes slowly when the software is polling the input channel. Stop polling before sending a configuration or selecting another page.

For a detailed configuration and calibration procedure, see the Operation Step-By-Step section of the Technical Reference on page 16.

Quick Overview - Windows..

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 screen and then click to point to a field or control to get a Help message pertaining to the item you pointed to.
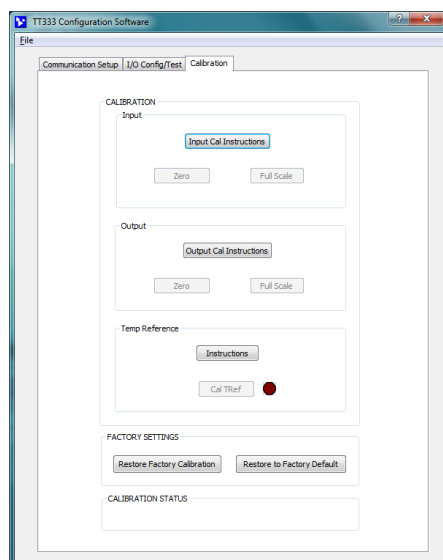
CALIBRATION (Calibrate the Input, Output, or CJC Reference if Needed)

The unit has already been factory calibrated. If you encounter excess error, you can click the Calibration tab to display the Calibration page shown at left.

This section is used to separately calibrate the input, output, and/or CJC Temperature Reference sensor of the unit, as needed. You simply click the respective [Instructions] button and follow the on screen prompts. Detailed instructions on how to calibrate the unit is found in the Operation Step-By-Step section of the Technical Reference portion of this manual.

To calibrate the Input or Output stage of this model, simply click the respective "Cal Instructions" button and follow the on-screen prompts.

Input…
Before attempting calibration, first set the Input Range to calibrate from the I/O Config/Test page and be sure to click the **[Send I/O Config]** button. On the Calibration page, click the **[Input Cal Instructions]** button to begin input calibration and follow the on-screen prompts.

When you click the **[Zero]** or **[Full Scale]** buttons of the Input Calibration section, you will be prompted to apply a specific voltage level at TB1, according to your selected range. Once you have applied this signal to the input terminals, click the **[OK]** button of the prompt and follow the on-screen instructions to complete input calibration.

Output…
Click the **[Output Cal Instructions]** button to begin output calibration. You will be prompted to adjust the input signal as required to drive the output to its precise output range zero or full-scale level. Then once the output is set to zero or full-scale, you simply click the corresponding **[Zero]** or **[Full-Scale]** button of the CALIBRATION - Output section to set the output range zero or full-scale endpoint.

Temp Reference…
This section calibrates the cold-junction temperature reference used for cold junction compensation of T/C input types. Click the **[Instructions]** button to begin reference calibration. You will be prompted to connect a TC Type J ice point reference to the input. You must already have the Type J TC range calibrated to accomplish CJC calibration.

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, or for sanitation purposes when decommissioning a module.

Calibration Status (Bottom of Screen)
•   Displays communication status messages for the calibration process.

The CALIBRATION STATUS message bar at the bottom of the screen will display status messages relative to calibration.

TECHNICAL REFERENCE

OPERATION STEP-BY-STEP

Connections

This section will walk you through the Connection-Configuration-Calibration process step-by-step. But before you attempt to reconfigure or recalibrate this transmitter, please make the following electrical connections.

Connect Input
Connect Output
Connect Power
Connect PC/USB
Configure I/O
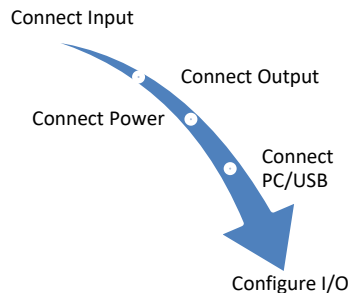
Note: Your input source, output meter, and load resistor (current output) must be accurate beyond the unit specifications, or better than ±0.1%. A good rule of thumb is that your equipment accuracy should be four times better than the rated accuracy you are trying to achieve with this transmitter.

Calibration Connections:

1. **Connect Input:** Connect a precision voltage source or thermocouple calibrator to the input as required, and observe proper polarity.

    In the absence of a thermocouple calibrator, a convenient method of configuring the TC input would be to use a precision mV source with this module's CJC set to OFF. This method allows the mV source to be wired directly to the input terminals using copper wires. The module's cold junction compensation is turned off and the mV values applied to the input are the equivalent thermoelectric voltages that correspond to the minimum and maximum temperatures of your desired T/C input range, specific to each T/C type. Refer to the table on the next page for a list of supported thermocouple voltages at specific temperatures. After setting the range zero and full-scale in this manner, CJC should be returned back to ON to enable cold junction compensation when the input is wired using thermocouple wires.

2. **Connect Output:** Wire an output load to the unit 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 unit. 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 to accurately read output current as a function of the IR voltage drop produced in the load resistor (recommended for current outputs).

3. **Connect Power:** Wire 12-32VDC power to the unit at TB4 as shown in the Electrical Connections section. Optionally, you may wire power to the bus terminal as shown in the optional power connections drawing. But in either case, never exceed 36VDC peak, or damage to the unit may result.

    Apply power to the transmitter before connecting to USB. You will not be able to configure or calibrate the unit without power also applied, as this device does not use USB power.

4. **Connect to PC via USB:** Connect the transmitter to the PC using the USB isolator and cables provided in Configuration Kit TTC-SIP (refer to Electrical Connections section). You may omit the isolator if you are using a battery powered laptop to connect to the unit, or if your input source is not grounded.

    Now that you have made your connections and applied power, you can execute the TT333Config.exe software to begin configuration of your unit (software is compatible with XP or later versions of the Windows OS).

Thermocouple milliVoltage Versus Temperature
(Per National Institute of Standards and Technology (NIST/ITS-90) Thermocouple Tables)

TEMP	Thermoelectric Voltage In milliVolts (With Reference Junction at 0°C)							
°C	J	K	T	E	R	S	B	N
- 260		---	**-6.232**	---	---		---	---
- 250	---	---	-6.180	---	---	---	---	---
- 230	---	---	-6.007	---	---	---	---	**-4.226**
- 210	**-8.095**	---	-5.753	---	---	---	---	-4.083
- 200	-7.890	**-5.891**	-5.603	**-8.825**	---	---	---	-3.990
- 150	-6.500	-4.913	-4.648	-7.279	---	---	---	-3.336
- 100	-4.633	-3.554	-3.379	-5.237	---	---	---	-2.407
- 50	-2.431	-1.889	-1.819	-2.787	**-0.226**	**-0.236**	---	-1.269
0	0.000	0.000	0.000	0.000	0.000	0.000	---	0.000
+ 50	2.585	2.023	2.036	3.048	0.296	0.299	---	1.340
+ 100	5.269	4.096	4.279	6.319	0.647	0.646	---	2.774
+ 150	8.010	6.138	6.704	9.789	1.041	1.029	---	4.302
+ 200	10.779	8.138	9.288	13.421	1.469	1.441	---	5.913
+ 250	13.555	10.153	12.013	17.181	1.923	1.874	---	7.597
+ 260	14.110	10.561	12.574	17.945	2.017	1.962	**0.317**	7.941
+ 300	16.327	12.209	14.862	21.036	2.401	2.323	0.431	9.341
+ 350	19.090	14.293	17.819	24.964	2.896	2.786	0.596	11.136
+ 390	21.297	15.975	20.255	28.146	3.304	3.164	0.746	12.603
+ 400	21.848	16.397	**20.872**	28.946	3.408	3.259	0.787	12.974
+ 450	24.610	18.516	---	32.965	3.933	3.742	1.002	14.848
+ 500	27.393	20.644	---	37.005	4.471	4.233	1.242	16.748
+ 550	30.216	22.776	---	41.053	5.021	4.732	1.505	18.672
+ 600	33.102	24.905	---	45.093	5.583	5.239	1.792	20.613
+ 650	36.071	27.025	---	49.116	6.157	5.753	2.101	22.556
+ 700	39.132	29.129	---	53.112	6.743	6.275	2.431	24.527
+ 760	**42.919**	31.628	---	57.870	7.461	6.913	2.854	26.883
+ 800	---	33.275	---	61.017	7.950	7.345	3.154	28.455
+ 900	---	37.326	---	68.787	9.205	8.449	3.957	32.371
+ 950	---	39.314	---	72.603	9.850	9.014	4.387	34.319
+1000	---	41.276	---	**76.373**	10.506	9.587	4.834	36.256
+1200	---	48.828	---	---	13.228	11.951	6.786	43.846
+1300	---	52.410	---	---	14.629	13.159	7.848	**47.513**
+1372	---	**54.886**	---	---	15.645	14.033	8.642	---
+1400	---	---	---	---	16.040	14.373	8.956	---
+1600	---	---	---	---	18.849	16.777	11.263	---
+1700	---	---	---	---	20.222	17.947	12.433	---
+1750	---	---	---	---	20.877	18.503	13.014	---
+1768	---	---	---	---	**21.101**	**18.693**	13.223	---
+1800	---	---	---	---	---	---	13.591	---
+1820	---	---	---	---	---	---	**13.820**	---

Note (Table): Shaded cells refer to the calibration range end points used to calibrate the full range of the T/C type for this model. Bold column entries refer to the nominal T/C input range end points of this model.

Configuration
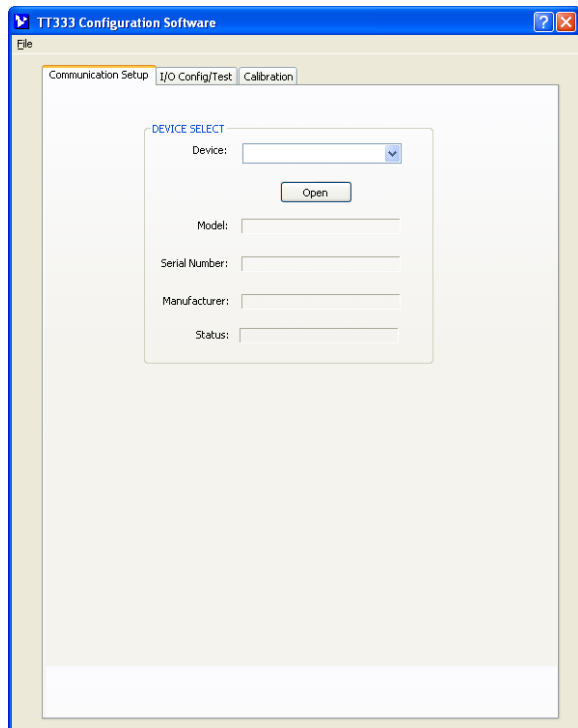
Note that you should already have power connected to the transmitter at this point. This model does not utilize USB power and you will not be able to configure, calibrate, or test the unit without power applied.

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

Connect your PC to the unit via USB, and the unit's model-serial information will appear in the Device field as shown in the second screen at the bottom left.

If you happen to be connected to more than one unit via a USB hub, you can use the Device scroll field to select another unit, using the serial information suffix of the Device Model number to discern one unit from another.
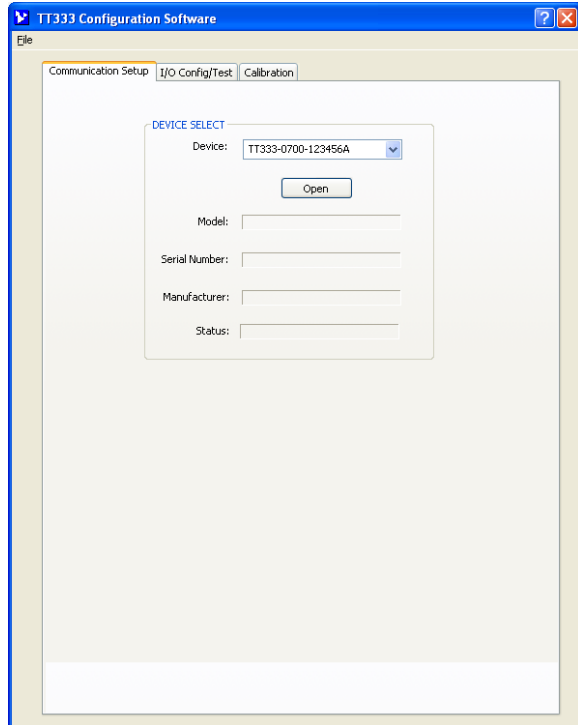
Once you have selected a device, click the **[Open]** button to open communication with the unit.

After connecting USB and clicking [Open], the selected unit's Model, Serial Number, Manufacturer, and connection status message will be displayed as shown in the first screen on the next page. Note the Status field indicates "Device opened successfully" as shown.

TIP: Always Close a connection with one device before selecting another device.

If you have trouble or need help with this software…

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 screen and click to point to a field or control to get a Help message pertaining to the item you pointed to.

Configuration…
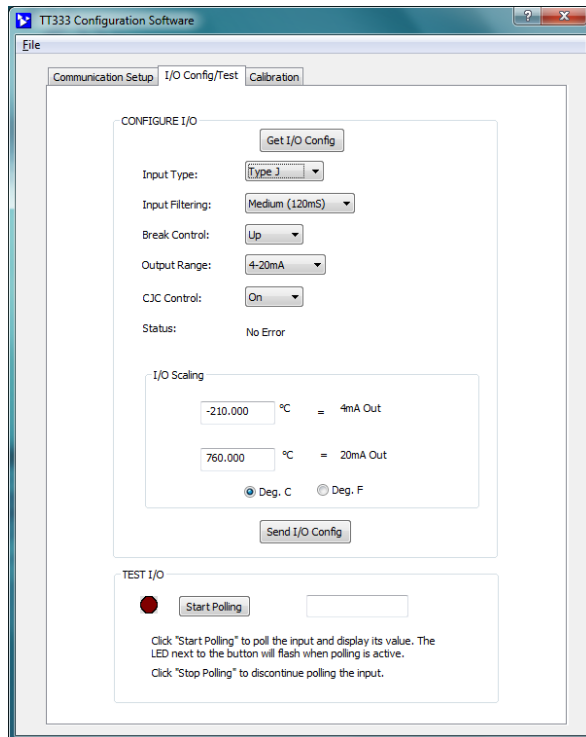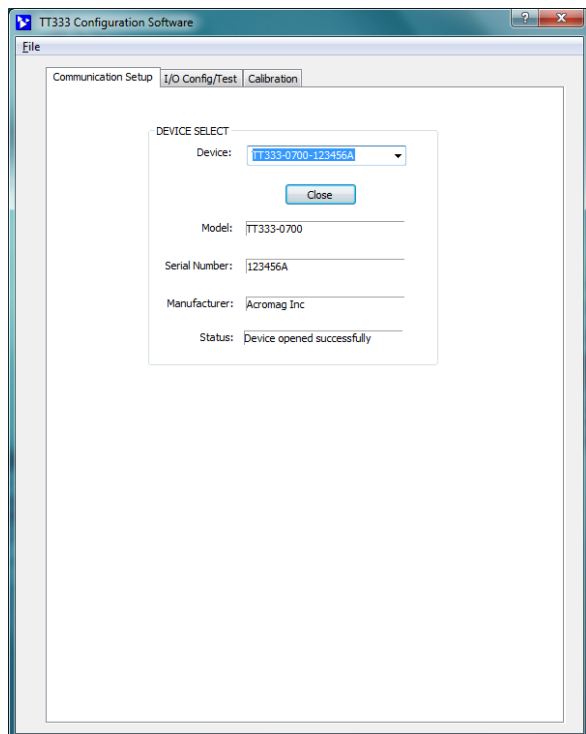
At this point, you can click the **"I/O Config/Test"** tab to begin configuring the unit, or to optionally test its operation. When you click this tab, the software retrieves the unit's current configuration and displays it similar to the second screen at left.

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

Select the Input Type (J, K, T, R, S, E, B, N, or ±100mVDC)…

- If you select any T/C type, your output will be linear with respect to sensor temperature, not sensor millivolts.
- If you select "100mV", the output current will be linear with respect to input voltage, not temperature, and no special TC linearization will be performed. Note that "100mV" represents ±100mV range capability.

Input Type refers to the **Thermocouple Type** or the ±100mV input range (the range limits for your chosen T/C type will be indicated in the I/O scaling section).

Note that any input range you pick can be rescaled to the output, allowing you to use only a portion of a selected input range to drive a current or voltage output, as desired. You can even scale the input in reverse for a reverse acting output. However, resolution will decrease proportionally as you rescale the input signal smaller than the nominal range. Each halving of the nominal range will reduce resolution by 1 bit. Rated performance assumes a 10mV minimum input span. Setting spans smaller than this can magnify error, especially for very small input ranges, which essentially degrade the signal-to-noise ratio of the input and diminish its resolution.

Note that if you make any changes to the I/O Config/Test screen, which initially represents the current configuration of the connected module, the only way to preserve your preferences is to write them to the device by clicking the **[Send I/O Config]** button after completing your changes, or you can optionally save them to a file by clicking **"File"** in the upper left-hand corner of the screen.

Select the Input Filtering (None, Low, Medium, or High)…

You may select an additional level of digital filtering to apply to the input channel as Low, Medium, High, or None (No digital filtering). The respective I/O response times are indicated in parenthesis next to your filter selection. Note that higher filter levels result in lower average noise, but with slower I/O response times.

Configuration…
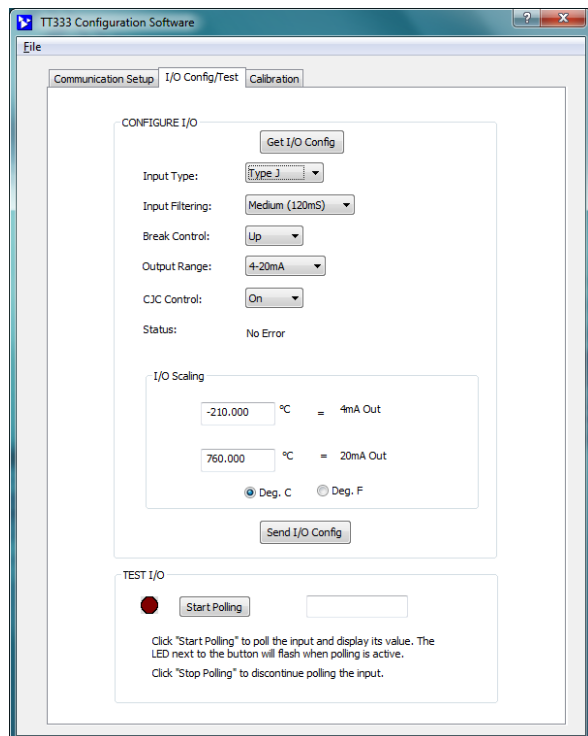
Note: *CJC temperature values are resolved to 0.05°C using the internal lookup tables for the T/C type. As such, units configured for small input spans may appear less accurate with CJC ON, as ±0.05°C becomes a greater percentage of a smaller span. Keep this in mind when resolving measurements with short spans and high gains.*

Set the <u>Break Control</u>…

You can select an **Up**scale or **Down**scale break detection level to send the output to if a TC input wire happens to break open. TC wires are generally very small in diameter and prone to breakage. Set this level carefully to make your process failsafe when breakage occurs.

Set the <u>Output Range</u>…

This unit has a universal voltage and current output circuit that allows you to select output ranges of ±20mA, 0-20mA, 4-20mA, ±10V, ±5V, 0-10V, or 0-5V. Voltage outputs may drive 1KΩ or higher loads, while current outputs may drive 525Ω or less. Note the ±20mA output drives current to the load in both directions--it always sources current to the load and does not sink current.

Set the CJC Control (Thermocouple Inputs)…

This model embeds a very accurate temperature sensor near the input + and – terminals in order to Cold-Junction Compensate the thermocouple signal wires. To explain, the voltage measured from a TC reflects the difference in temperature between each end. Thus, in order to discern the actual temperature being sensed, it is necessary to know the temperature at the other end (this is usually referred to as the Cold Junction). We use a cold junction temperature sensor to sense the temperature of the thermocouple junction at the terminal blocks of the unit.

The connection between the thermocouple and the copper terminals of the cold junction does introduce additional thermocouples into the circuit. However, because these errant thermocouples that occur at the junctions of the ± terminals are close together and at identical temperatures, their effect on the principal measurement cancels out of the derivation. Thus, to keep error to a minimum, you should avoid any environmental or installation effects that could drive a difference in temperature between the ± input terminals. For example, touching one terminal and not the other, wiring different wire gages on each terminal, etc.

You normally turn CJC On via this control for making T/C measurements, but you can elect to turn it off temporarily, if you wish to calibrate the T/C input using a voltage source that connects to the module via copper wires (as opposed to the specific wire materials of various thermocouple types). In this instance, your voltage source would then be set to the thermoelectric voltage of the specific thermocouple at the temperature point you are trying to reproduce.

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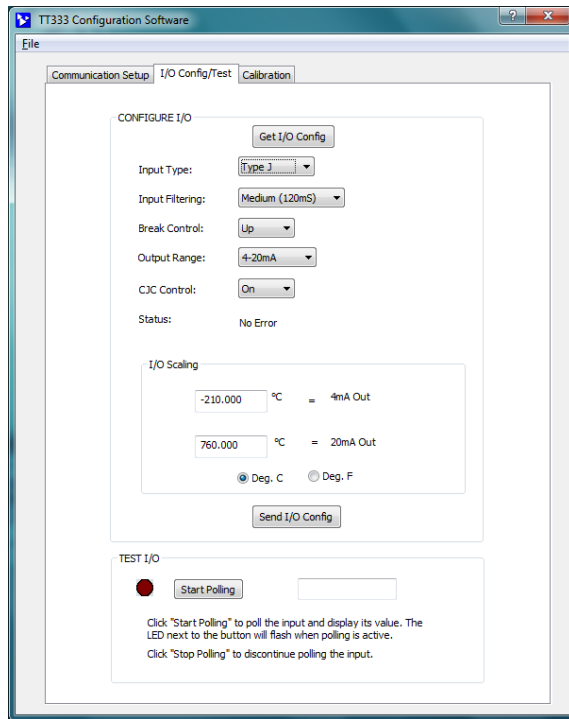
HELP – You can press **[F1]** for Help on a selected or highlighted field or control. You can also click the **[?]** button in the upper-right hand corner of the screen and click to point to a field or control to get a Help message pertaining to the item you pointed to.

TIP: Note that if CJC is ON, and your input signal is at 0°C (0.000mV), the temperature value displayed will be equivalent to the ambient temperature at the input terminals (i.e. your cold junction temperature). You can get a feel for how stable your CJC temperature is by observing this value while shorting the input.

Select the Input/Output Scaling…

You may rescale selected input types to use only a portion of the respective input range to drive the universal output if desired. Be careful not to reduce the input range too much, as resolution is proportionally diminished and noise/error is magnified.

In the I/O Scaling fields, set the input signal minimum/zero value to correspond to the output zero value (i.e. -20mA, 0mA, 4mA, -5V, -10V, or 0V, depending on the output range selected). Also set the input signal maximum/full-scale value to correspond to the output full-scale (i.e. 20mA, 10V, or 5V, depending on output range selected). You can optionally swap scaling levels to configure a reverse acting output response. Approximately 5% of over/under range is built into each output range. You must use valid range endpoints in the same units as selected.

If the input zero and full-scale points are too close together (span is too small), resolution is diminished and performance will be degraded. A minimum effective span of 10mV is recommended to achieve rated performance. Pick your range values carefully, as you will have to precisely drive the range zero and full-scale levels to calibrate your input range later (if needed).

You can also select degrees Celsius or Fahrenheit units of the scaling controls (thermocouple Input types only).

Once you have made your configuration selections, click the **[Send I/O Config]** button to write them to the module.   The status of this transaction will be displayed in the **Status** field. You should get "No Error" after writing your configuration to the unit if successful. Otherwise, your reconfiguration may not be complete. Alternately, you could click **"File"** in the upper left hand corner to save the configuration settings to a file on your PC, for later recall.

Test I/O to check Your Input & Validate Your Configuration…

The Test I/O area of your screen is useful to view your continuously variable input measurement in the field adjacent to the Start/Stop Polling button. Simply click the **[Start Polling]** toggle button, and the input will be repeatedly polled and displayed in the adjacent field. Click **[Stop Polling]** to turn polling off before moving onto the next page.

You should turn polling off while trying to calibrate the unit, or changing its configuration.

Once you've configured your unit, you could choose to calibrate your input and/or output channel if you encounter excessive measurement error, or to satisfy company maintenance requirements. Click the "Calibration" tab to access the calibration controls for calibration of input range, output range, or the cold junction compensation sensor, as shown on the next page.

Calibration (Optional)
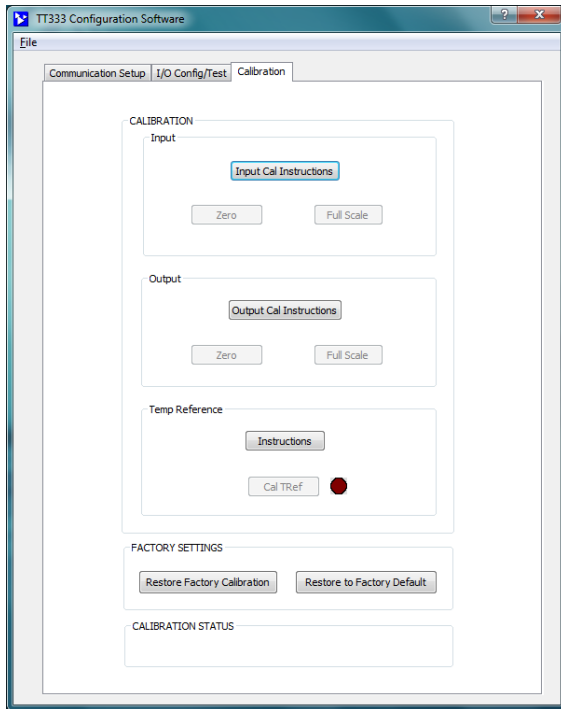
CAUTION-Input Calibration: Driving input levels outside of the nominal input range of the unit will not be acceptable for calibration of zero or full-scale. Since input levels cannot be validated during field calibration, incorrect signal levels will produce an undesired output response.

<u>Optional Calibration of Input, Output, and Tref…</u>

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

This section is used to optionally calibrate the input, output, and/or cold junction temperature reference of the unit. Your unit has already been factory calibrated and you should only attempt to recalibrate a unit if needed, and only if you have very accurate equipment to accomplish calibration. You can begin calibration of any of these three stages by clicking the corresponding "Instructions" button and following the on-screen prompts. Note that the button text will change according to the step.

Each calibration is a separate interactive process in which the software prompts you to apply input signals and measure corresponding output signals. For example, it will first prompt you to apply the zero input signal, then measure and record the corresponding zero output signal. Second, it does the same for the full-scale input signal and the corresponding full-scale output signal. Note that as input span is reduced, resolution also diminishes. The Configuration Software will usually let you know when you need to adjust your desired range limits as you enter them.

CAUTION: Input signal levels outside of the nominal input range of the unit will not be accepted for configuration of zero or full-scale. Since not all input levels can be validated during field programming, connecting or entering incorrect signals will produce an undesired output response.

Input Calibration
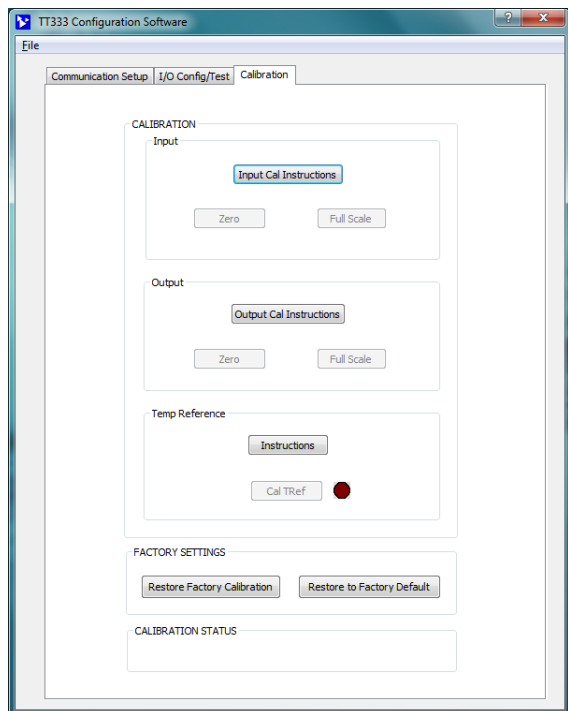
Click the **[Input Cal Instructions]** button to begin input calibration and enable the input [Zero] and [Full-Scale] buttons.
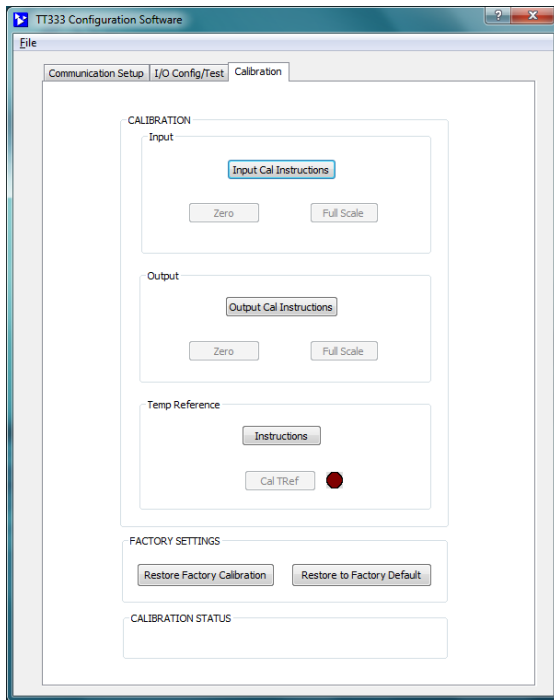
Use this procedure to calibrate the selected input type.

1. First select your Input Type and **Turn off CJC**. Click the "Send Config" button of the I/O Config/Test page. After setting your input, click on the Calibration tab to access the calibration controls.
2. Click on the **[Input Cal Instructions]** button.
3. Click on the Input **[Zero]** button and you will be prompted to input the minimum value of your selected input type at the input channel. The software does not use your scaled zero, but the zero of the nominal range type.
4. Once you have input the zero signal precisely, click the **[OK]** button of the prompt to calibrate zero and follow the on-screen prompt.
5. Click on the **[Full Scale]** button and you will be prompted to input the maximum value of your selected input range at the input channel. It does not use your scaled full-scale, but the full-scale of the nominal range type.
6. Once you input full-scale precisely, click the **[OK]** button of the prompt to calibrate full-scale and follow the on-screen prompt**.**
7. For input calibration of all ranges, you would repeat steps 1-6 for each input type indicated in bold below (note that some ranges are calibrated coincidentally). For example, Type K and Type N are calibrated by calibrating Type J. Type R and Type S are calibrated by calibrating by calibrating Type T. Of course, coincident ranges may still be individually calibrated if desired for increased precision.

Input Calibration Values For Supported Input Ranges

| Available Input Ranges	INPUT CALIBRATION POINTS	
	LOW CALIBRATION POINT (Cal Lo)	HIGH CALIBRATION POINT (Cal Hi)
Type J TC	0.0°C (0.000mV)	700.0°C (39.130mV)
Type K TC	0.0°C (0.000mV)	1300.0°C (52.410mV)
Type N TC	0.0°C (0.000mV)	1200.0°C (43.846mV)
Type T TC	0.0°C (0.000mV)	390.0°C (20.255mV)
Type R TC	0.0°C (0.000mV)	1700.0°C (20.222mV)
Type S TC	0.0°C (0.000mV)	1700.0°C (17.947mV)
Type E TC	0.0°C (0.000mV)	950.0°C (72.603mV)
Type B TC	260°C (0.317mV)	1700°C (12.433mV)
±100 mVDC	-100.000 mVDC	100.000 mVDC

Output Calibration

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

This model has a universal output with seven selectable ranges: ±20mA, 0-20mA, 4-20mA, ±10V, ±5V, 0-10V, and 0-5V. Output ranges are calibrated separately, one at a time. The ±5V range is a sub-range of the ±10V range. Use this procedure to calibrate the selected output range endpoints:

1. Select your Input Type, Output Range, and Turn off CJC. Click the **[Send Config]** button of the I/O Config/Test page. Click on the Calibration tab of this page to access the calibration controls.
2. Click on the CALIBRATION-Output **[Output Cal Instructions]** button.
3. Click on the Output **[Zero]** button.
4. Input the required signal displayed in the pop-up box and adjust it as necessary to drive the output range to its precise output zero level and click **[OK].** Be sure to measure this level accurately, or performance will be degraded. After driving the output to its range zero, click the Output **[Zero]** button of the Calibration Output section to calibrate the output zero level for the output range.
5. Click on the Output **[Full Scale]** button.
6. Input the required voltage as displayed in the pop-up box and adjust it as necessary to drive the output precisely to its output range full-scale and click **[OK].** Be sure to measure this level accurately, or performance will be degraded. After driving the output to the range full-scale level, click the Output **[Full-Scale]** button of the Calibration Output section to calibrate the output full-scale level for the output range.

If your output acts erratic or appears imprecise, you may need to repeat output calibration, being very careful to set the output precisely and take accurate output measurements. If you are measuring a voltage across the output load resistance, make sure that you use the exact load resistance when calculating the current being measured. Also when rescaling your input, make sure that you still have adequate input span, as too-tight input spans have diminished resolution and will magnify error.

Temp Reference Calibration
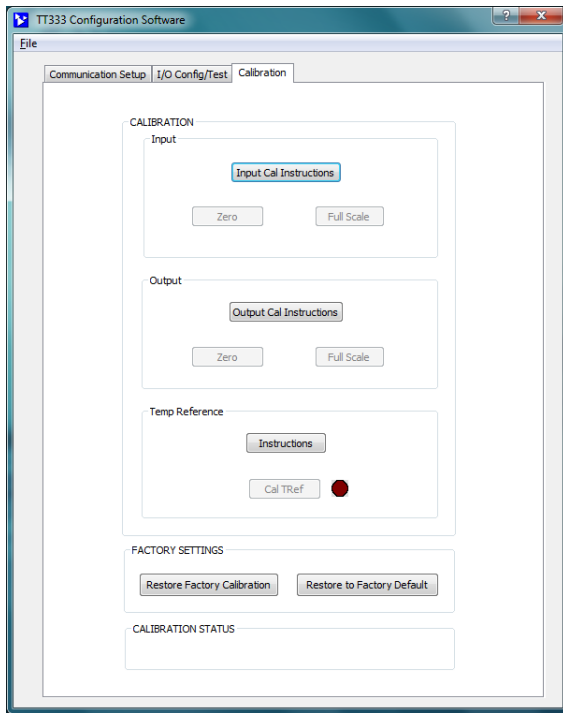
The voltage measured from a T/C reflects the difference in temperature between each end of the T/C. In order to discern the actual temperature being sensed, it is necessary to know the temperature at the other end, usually referred to as the Cold Junction. This model embeds a very accurate temperature sensor near the input + and – terminals in order to cold-junction compensate the thermocouple signal in this manner.

Use this procedure to calibrate the Temp Reference of the Cold Junction Compensation circuit.

1. Click on the CALIBRATION-Temp Reference **[Instructions]** button.
2. First, calibrate the TC Type J input range as indicated in the Input Calibration procedure shown above.
3. Set the output to its zero level.
4. Connect a TC Type J, ice point reference to the device input terminals.
5. Click the **[Cal Tref]** button.
6. In the pop-up box, click **[OK].**

TIP: The connections between the thermocouple and the copper input terminals will introduce additional thermocouples into the circuit. Because these errant thermocouples which occur at the junctions of the ± terminals are close together and at identical temperatures, their effect on the principal measurement cancels out of the derivation. But to keep error to a minimum, you should avoid any environmental or installation effects that could drive a difference in temperature between the ± input terminals. For example, touching one terminal and not the other, wiring different wire gages on each terminal, mounting the unit in a fan's air stream, etc.

Factory Settings

You can use the **[Restore Factory Calibration]** button to restore the transmitter's original factory calibration if you think you made an error during recalibration, degraded its performance, or the I/O channel appears erratic.

You can use the **[Restore to Factory Default]** button to return the unit to its original factory configuration settings. This does not restore calibration, only configuration. This button can be used as a sanitation tool to restore the unit to its initial configuration when decommissioning a module.

Calibration Status

This field displays calibration status messages like "No Error", "Transfer Error", and "Timeout Error" during calibration. If you encounter a Transfer or Timeout Error, you may have to repeat the calibration process.

BLOCK DIAGRAM

TT333-0700 SIMPLIFIED SCHEMATIC
(FILTERING AND DETAIL OMITTED FOR CLARITY)

ISOLATED INPUT CIRCUIT

ISOLATED OUTPUT CIRCUIT

T/C or mV INPUT — TB1 — INPUT FILTER — INPUT BIAS — CJC TEMP SENSOR — 24b A/D CONV — MICROCONTROLLER — MOSI / CLK / OSEL / MISO — SPI — 16-BIT DAC — UNIVERSAL OUTPUT DRIVER — TB3 OUT+ — 2.5V REF — ERR / DSEL — RST GEN

USB PORT — USB V-MON — 5V — VX

ISOLATED POWER — ISOLATED FLYBACK CONVERTER — BUS CONN — BUS POWER 12-32V — TB4 — LOCAL POWER 12-32V — FLYBACK CONVERTER — OUTPUT POWER — INPUT POWER — +3.3V LDO

BUCK REG — +5V — BIPOLAR BOOST CONVERTER — -16V — +16V — ISOLATED OUTPUT

How It Works

Key Points of Operation

- Unit is DC Powered
- Power is Isolated
- Input is Isolated
- Input is Differential
- Input circuit ground is common to USB ground.
- Output is universal, current or voltage, on same terminals.

This transmitter uses a 32-bit microcontroller and a high-resolution A/D to convert the input signal to the serial digital SPI bus, isolated via digital isolators, and transmitted to an output DAC which drives a universal output driver for current or voltage. This particular output is very unique in that it may drive current or voltage to the load without having to change load connections. The output type and range are user-configured. Power for the isolated input and isolated output circuits is provided via an isolated flyback converter that operates on voltage wired to the power terminals at TB4, or the bus power terminals along the DIN rail. Setup involves selecting the input type (T/C or mV), upscale or downscale break detection, turning CJC on or off as desired, selecting a filter level, and scaling the input range endpoints to the output range endpoints. Current or voltage output ranges are selectable. A cold junction compensation temperature sensor is located near the input terminals. Output scaling can also be done in reverse to produce a reverse acting output signal. Refer to the block diagram above to gain a better understanding of how this transmitter works.

The input/USB, output, and 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 and truncating the negative portion of the range.

TROUBLESHOOTING

Diagnostics Table

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

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

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

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…	
Unit 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 Personal Computer's USB port.	Without USB isolation, a ground loop is possible between a grounded input signal and earth ground of the PC USB port. The input of this model is normally biased to 1.25V off input ground to process negative-going signals. A grounded signal source could inadvertently short this bias to earth ground and clip the negative input range with a non-isolated USB connection to a PC. For this reason and for increased safety and noise immunity, it is best to connect to USB via a USB isolator. 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.
Software Fails to Detect Transmitter…	
Bad USB Connection.	Recheck USB Cable Connection.
USB has not enumerated the device.	Use the reset button on the Acromag USB isolator to trigger renumeration of the transmitter, or simply unplug and replug the USB cable to the transmitter.
Communication or power was interrupted while USB was connected with configuration software running.	Close the current connection with the software, then select and re-open the transmitter for communication (or simply exit the Configuration software and reboot it).
For an input step, the output appears to make 2 steps to reach its final value…	
For a step change in the input, the A/D needs 2 input samples to charge to its final level.	When you step the input signal, it takes two samples for the A/D to charge up to its final output level, and this is evident when using a scope to examine the output transition in response to a step change at the input, which appears to make two steps in its transition to its final level.
Output Noise Seems Excessive…	
Scaled input range is too small.	Scaling the input to very small spans diminishes input resolution and signal to noise ratio, potentially magnifying error. Increase the input span.

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
Output goes right to Over-Range (~105%) or Under-Range Limit…	
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 upscale or down-scale signal can be driven by a sensor fault, such as an open or broken sensor lead. Also check the wiring of your input sensor. If you are not isolating USB, check for a ground loop between a grounded input and earth ground of the PC USB port.
Cannot Calibrate Input Channel…	
Is input wired properly?	Check that input is wired to ± input terminals using correct polarity.
Full-Scale Current Output Multiplied By Load Resistance is Less than Expected…	
Your load resistance (including the lead resistance) exceeds 525Ω.	Reduce the load resistance to a value ≤ 525Ω (be sure to account for lead resistance over long transmission distances).

Service & Repair Assistance

This unit contains solid-state components and requires no maintenance, except for periodic cleaning and transmitter calibration (zero and full-scale) verification. Its enclosure is not meant to be opened for access and can be damaged easily if snapped apart. Thus, 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 Series TT Transmitters. Isolation is recommended for USB port connections to these transmitters and will block a potential ground loop between your PC and a grounded input. A software CDROM is included that contains the Windows software used to program TT transmitters.

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 1M 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 your PC and the USB isolator. It is normally included with the TTC-SIP Software Interface Package and also with 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 any Series TT transmitter. It is normally included in TTC-SIP.

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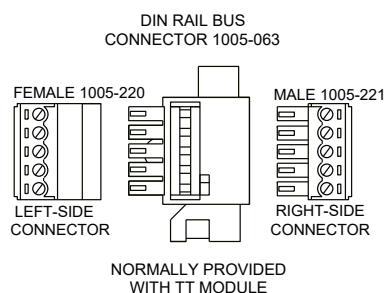
USB OTG Cable

USB OTG Cable – Order 5028-565

- USB OTG Cable 5028-565

This is a 6 inch, USB On-The-Go cable for connection between the USB A-mini B Cable and a mobile phone or tablet. It is required to use the Acromag Agility™ Config Tool App.

Note that the Acromag Agility ™ Config Tool is available free of charge, online at the Google Play store.

DIN Rail Bus Connector Kit

DIN RAIL BUS
CONNECTOR 1005-063

FEMALE 1005-220   MALE 1005-221

LEFT-SIDE
CONNECTOR   RIGHT-SIDE
CONNECTOR

NORMALLY PROVIDED
WITH TT MODULE

Bus Connector Kit for DIN Rail Bus Connection to Power Model TTBUS-KIT

This kit contains one each of the following terminals

- DIN Rail Bus Connector 1005-063 for 17.5mm TT Modules.

- Left Side terminal block, female connector 1005-220.

- Right Side terminal block, male connector 1005-221.

- Two End Stops for 35 mm DIN Rails 1027-222 (not shown).

This module was shipped with the first item included in this kit, DIN Rail Bus Connector 1005-063, and this kit offers a spare. Left and right side terminal blocks that mate directly to the bus connector are included in this kit. These terminals are used to optionally (or redundantly) drive power to Series TT modules via their DIN rail bus connector. This also allows modules to neatly and conveniently share connections to Power. Two end stops 1027-222, used to secure the terminal block and module for hazardous location installations.

End Stops

Two End Stops – Order 4001-252

- Two 1027-222 End Stops for 35 mm DIN Rail mounting

For hazardous location installations (Class I, Division 2 or ATEX/IECEx Zone 2), you can use two end stops (Acromag 1027-222) to help secure modules to 35mm DIN rail (not shown).

SPECIFICATIONS

Model Number

Model TT333-0700

*Signal Transmitter
Isolated DC I/V Input
Four-Wire Powered
CE Approved
Includes UL/cUL Class 1, Division 2 approvals*

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

The TT333 model prefix denotes a thermocouple and DC millivoltage input type of the DIN-Rail Mounted Series TT "Thin Transmitter" family. The trailing "-0700" model suffix denotes 4-wire power with CE and UL/cUL Class 1, Division 2 Approvals.

Optional factory calibration to your own 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 Type (J, K, T, R, S, E, B, N, or ±100mVDC), Input Filtering (Low, Medium, or High), Upscale or Downscale Break, Output Range (±20mA, 0-20mA, 4-20mA, ±10V, ±5V, 0-10V, or 0-5V), CJC On or OFF, scaled input range zero, scaled input range full-scale, and a normal or reverse acting output. You can obtain form 8500-858 for specifying this calibration info from our web site at www.acromag.com.

The standard model without adding custom factory calibration is calibrated by default to input TC Type J, medium filter, with full -210°C to +760°C input range scaled to a 4-20mA DC output, with medium filter selection, upscale break detection, and a normal-acting output.

Recalibration of any model will require use of a TTC-SIP configuration kit, ordered separately (see Accessories section).

Models can be mounted on standard 35mm "T" Type DIN rail.

Input

Reference Test Conditions: TC Type J with a 10mV minimum span (e.g. Type J with 200°C span), or ±100mV range with a 10mV minimum calibrated span; Output 4-20mA; Ambient = 25°C; Power Supply = 24VDC.
Input & Accuracy: Configurable for native input types/ranges shown in Table 1 below. Unit provides T/C linearization, T/C Cold-Junction Compensation (CJC), and lead break detection.

Table 1: Range/Accuracy		ISA/ANSI Color	°C Temp Range	Typical[1] Accuracy
T/C	T/C Material			
J	+Iron,-Constantan	White/Red	-210 to +760°C	±0.5°C
K	+Chromel,-Alumel	Yellow/Black	-200 to +1372°C	±0.5°C
T	+Copper, -Constantan	Blue/Red	-260 to +400°C	±0.5°C
R	+Pt/13%Rh, -Constantan	Black/Red	- 50 to +1768°C	±1.0°C
S	+Pt/10%Rh, -Constantan	Black/Red	- 50 to +1768°C	±1.0°C
E	+Chromel,-Constantan	Purple/Red	-200 to +1000°C	±0.5°C
B	+Pt/10%Rh, -Pt/6%Rh	Gray/Red	+260 to 1820°C	±1.0°C
N	+Nicrosil, -NISIL	Orange/Red	-230 to -170°C;	±1.0°C
			-170 to +1300°C	±0.5°C
mV	NA	NA	±100mV	±0.05% ±0.1% Max

Input...

[1]**Note (Table 1):** Accuracy is generally ±0.1% of the full-scale span, typical, or per the table 1 specification, whichever is greater.

[2]**Note (Table 1): Accuracy in Table 1 is given with CJC switched <u>off</u>.** CJC uncertainty should be combined with the uncertainty numbers of Table 1 to determine a potential overall inaccuracy. Relative inaccuracy with CJC enabled may increase by as much as $\pm0.5°C$ during the post power-on warm-up period, but will be $\pm0.2°C$ typical after nearing thermal equilibrium in about five minutes.

Break Detection: Can be set for Upscale or Downscale open sensor or lead break detection. Limits are output range dependent. Upscale output limit is approximately 21 mA or 10.5 V, or 5.25V. Downscale limit is approximately -21mA, or 0mA, or 3mA, or -10.5V.

IMPORTANT: Calibration should be done with break detection already set as required by the application, as changing it will affect calibration somewhat.

Input Linearization (T/C Inputs): Within $\pm0.25°C$ of the NIST tables.

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 5.6V clamp level typical. Also includes differential input diode clamping, capacitive filtering, and series resistance.

Analog to Digital Converter (A/D): Input utilizes a 24-bit, Σ-Δ A/D converter, with only the first 16-bits used. Its signal is then normalized to a bipolar range count of ±25000 to simplify I/O scaling (see Input Resolution below).

Sampling Rate (A/D): Input is sampled at a variable rate according to the input filter selection as follows:

A/D SAMPLING RATE (SAMPLES/SECOND) PER INPUT FILTER			
NONE	LOW	MED	HIGH
214.65sps	53.6625sps	13.42sps	1.6775sps

Input Filter: Normal mode RC filtering, plus digital filtering, optimized and fixed per filter selection within the Σ-Δ ADC. See Normal Mode Noise Rejection and Output Response Time.

Input Zero and Full-Scale Adjustment: Input range endpoints are selectable over the full range indicated in Table 1 for each input type. Input Zero and Full-Scale selections must be within the nominal ranges indicated and will be mapped to the output zero and full-scale (100%) current or voltage endpoints, according to output range selected. Keep in mind that your input resolution is reduced as your scaled input range is reduced. Likewise, error in degrees is magnified as the input span is reduced. Rated performance is based on a 10mV minimum input span.

Input Bias Current: ±125nA typical (TC break current).

Noise Rejection (Common Mode): Varies with input filter selection between 102dB (no filter) and 138dB (high filter), typical, with 100Ω input unbalance.

Noise Rejection (Normal Mode): Varies with input filter selection. Table below indicates the typical rejection at 60Hz for each input filter selection. Note that at the medium and high input filter settings, the A/D converter adds 80dB minimum of rejection for frequencies between 49Hz and 61Hz.

	TYPICAL 60Hz REJECTION PER INPUT FILTER			
INPUT	NONE	LOW	MED	HIGH
TB1 TC/mV	0.5dB	20dB	> 80dB	> 80dB

Input…

Input Resolution: The A/D divides the input range into a number of parts that can be calculated by subtraction using the expression for A/D Counts = (Vin*Gain/1.25)*32768 + 32786, with Gain=8, 16, 32, or 64, depending on Input Type (see table). The resultant A/D count is then converted to TC temperature via a linearizer function for the TC type (the output is made linear with respect to TC temperature). The linearizer conversion to temperature only resolves to 0.05C, which does limit the input resolution, in particular for small spans. For example, an input span of 200°C would yield a linearizer resolution of 200/0.05=4000 parts. The temperature returned by the linearizer is then linearly interpolated to the output based on a straight line calculation that is formed by mapping the input range endpoints you specify to the output range endpoints of the output range you select. The effective I/O resolution for a given range will be the lowest resolution of the A/D, or its linearized value (using 0.05C intervals), as the D/A resolution is always greater. An indication of relative input resolution is expressed as the number of parts between the input range low and high endpoints, and this shown in the table below for the nominal range of each input type.

In Range	Gain	Full Range	A/D Input Resolution
±100mV DC	8	-100mV to +100mV	1 part in 41674
T/C Type J	16	-210 to +760°C (-8.095mV to 42.919mV)	1 part in 21397
T/C Type K	16	-200 to +1372°C (-5.891mV to 54.886mV)	1 part in 25492
T/C Type T	32	-260 to +400°C (-6.232mV to 20.872mV)	1 part in 22737
T/C Type R	32	-50°C to +1768°C (-0.226mV to 21.101mV)	1 part in 17891
T/C Type S	32	-50°C to +1768°C (-0.236mV to 18.693mV)	1 part in 15879
T/C Type E	8	-200 to +1000°C (-8.825mV to 76.373mV)	1 part in 17868
T/C Type B	64	+260 to 1820°C (0.317mV to 13.820mV)	1 part in 22654
T/C Type N	16	-230 to +1300°C (-4.226mV to 47.513mV)	1 part in 21701
CJC Sensor (Internal)	1	-50°C to 150°C (0V to 1V)	1 part in 58982

When scaling small input temperature spans to the output, your effective input resolution will be proportionally diminished below the nominal resolution indicated above. The actual effective I/O resolution of your transmitter will be the lowest resolution of either the input A/D, or the linearization conversion to temperature (resolves to 0.05°C, T/C inputs only). The output resolution is always greater and will never be the limiting factor. In most cases, your resolution will be dominated by the 0.05°C temperature resolution for the thermocouple linearizer, in particular for small input spans.

Input...

Thermocouple CJC Reference: Table 2 below shows the relative accuracy of the CJC sensor used in this circuit. CJC has been factory calibrated at 25°C to ±0.1°C. The accuracy of CJC over the full operating range will be about ±1.0°C.

Table 2: CJC[1] Sensor Accuracy

CJC Range	Typical	Maximum
25°C	±0.1°C	±0.3°C
10 to 80°C	±0.3°C	±0.6°C
-40 to 80°C	±0.5°C	±1.2°C

[1]Note: Cold Junction Compensation may be switched off to permit the direct connection of a mV source via copper wires to the input to simplify calibration. Otherwise a hand-held calibrator may be used. For best results, allow the module to reach thermal equilibrium and warm up for 5-10 minutes prior to calibrating CJC. Also, position the module as it will be in its application. Input is normally calibrated with CJC OFF, and CJC calibration is done separately.

Analog to Digital Converter (A/D): Input utilizes a 24-bit, Σ-Δ A/D converter, with only the first 16-bits used. Its signal is then normalized to a bipolar range count of ±25000 to simplify I/O scaling (see Output Resolution below).

Output

Output Range Selection: Unit can be configured for one of seven nominal output ranges below (all output ranges include approximately 5% of over-range capability).

OUTPUT RANGE	OUTPUT RANGE w/ OVER-RANGE
-10V to +10V	-10.5V to +10.5V
-5V to +5V	-5.25V to +5.25V
0-10V	-0.5527V to +10.5V
0-5V	-0.27634V to +5.25V
±20mA	-21mA to +21mA
0-20mA	-1.1054mA to +21mA
4-20mA	-1.1054mA to +21mA

Accuracy: Accuracy is generally better than ±0.05% of span, typical (±0.1% maximum), for nominal input ranges. This includes the effects of repeatability, terminal point conformity, and linearization, but does not include sensor error, nor CJC sensor error.

Note: Scaling smaller than nominal input ranges to the output can increase potential error as input resolution and the signal-to-noise ratio is diminished for very small input spans.

Output Load: Voltage output can drive loads down to 1KΩ minimum. Current output can drive 21mA DC into 0-525Ω.

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 Ripple: Less than ±0.1% of output span, typical.

Output...

Output Ambient Temperature Drift: Includes the combined effects of zero & span drift w/temperature and is typically better than ±80ppm/°C (±0.0080%/°C) over the ambient temperature range for reference test conditions (see Input Specifications).

Output Resolution: Output is driven by a 16-bit Voltage DAC (Maxim MAX5216GUA+) with a 2.5V reference, and driving a universal current/voltage output driver. The output resolution per selected output range is indicated below. The effective I/O resolution of the unit will be dominated by the input stage and its conversion to temperature (TC inputs), relative to the programmed I/O range (see Input Resolution).

OUTPUT RANGE	Output Resolution, 1 lsb, % of Span
-10V to +10V	1 part in 62415, 320.436uV, 0.001602%
-5V to +5V	1 part in 31208, 320.439uV, 0.003204%
0-10V	1 part in 59240, 168.805uV, 0.001688%
0-5V	1 part in 60262, 82.971uV, 0.001659%
±20mA	1 part in 62259, 0.642477uA, 0.001606%
0-20mA	1 part in 58596, 0.341320uA, 0.001707%
4-20mA	1 part in 46877, 0.341319uA, 0.002133%

Output Response Time: Varies with input filter level for a step change in the input signal as follows (can also vary with output type and load):

Input Filter	NONE	LOW	MED	HIGH
Response Time	14ms, typical	38ms, typ.	117ms, typ.	848ms, typ.

USB Interface

IMPORTANT – USB Isolation is recommended: 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 Personal Computer without using an isolator. Failure to connect USB without isolation would short the 1.25V input bias supply to input ground if the sensor is also earth grounded. This will interfere with operation, truncate the negative input range, and possibly cause the output to shift. USB isolation is strongly recommended when connecting to a PC.

Unit includes a USB socket for temporary connection to a PC or laptop for the purpose of configuration and calibration. USB isolation is required when also connected to a grounded input sensor (see "IMPORTANT" note below). During reconfiguration and calibration, the transmitter receives power from its power connection (via DIN rail bus or power terminal TB4), <u>not</u> USB. As such, you must separately connect power to the unit when you connect USB.

CAUTION: Do not attempt to connect USB in a hazardous environment. Transmitter should be setup and configured 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: Adds transient voltage protection on USB power & data lines.

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).

USB Connector: 5-pin, Mini USB B-type socket, Hirose 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.

Power

Power Supply (Connect at TB4 or via DIN Rail Bus Terminal): 12-32V DC SELV (Safety Extra Low Voltage), 1.3W maximum. Observe proper polarity. Reverse voltage protection is included. Current draw varies with power voltage as follows (currents indicated assume a current output driving 21mA into a load).

SUPPLY	TT333-0700 CURRENT
12V	85mA Typ / 94mA Max
15V	69mA Typ / 76mA Max
24V	44mA Typ / 48mA Max
32V	33mA Typ / 36mA Max

CAUTION: Do not exceed 36VDC peak to avoid damage to the unit. Terminal voltage at or above 12V minimum must be maintained across the unit during operation.
Power Supply Effect: Less than ±0.001% of output span effect per volt DC change.

Enclosure & Physical

General purpose plastic enclosure for mounting on 35mm "T-type" DIN rail.
Dimensions: Width = 17.5mm (0.69 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: 5-pin, Mini USB B-type socket, Hirose UX60-MB-5S8..
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 with humi-seal conformal coating.
DIN-Rail Mounting: Unit 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, and power circuits are all 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).

Environmental…

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.

This is a 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

Electromagnetic Compatibility (EMC): CE marked, per EMC Directive 2004/108/EC.

FCC Conformity: This device complies with Part 15, Class B of the FCC rules.

Safety Approvals: UL Listed (USA & Canada). Hazardous Locations – Class I, Division 2, Groups A, B, C, D Hazardous Location or Nonhazardous Locations only. These devices are open-type devices that are to be installed in an enclosure suitable for the environment.

ATEX/IECEx Certified: Model TT333-0700 is ATEX/IECEx Certified for Explosive Atmospheres per ATEX Directive 2014/34/EU which complies with standards EN IEC 60079-0:2018, EN IEC 60079-7:2015 +A1:2018, IEC 60079-0 Edition 7, and IEC 60079-7 Edition 5.1.

⟨Ex⟩ II 3 G Ex ec IIC T4 Gc -40ºC ≤ Ta ≤ +80ºC

DEMKO 15 ATEX 1561**X**   IECEx UL 18.0091**X**

X = Special Conditions

1) The equipment shall only be used in an area of not more than pollution degree 2, as defined in EN/IEC 60664-1.
2) The equipment shall be installed in an enclosure that provides a degree of protection not less than IP 54 and only accessible with the use of a tool in accordance with EN/IEC 60079-0.
3) Transient protection shall be provided that is set at a level not exceeding 140 % of the peak rated voltage value at the supply terminals to the equipment.

Reliability Prediction

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	1,164,398 hrs	132.9 years	859
40°C	756,418 hrs	86.3 years	1,322

Configuration Controls

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

Software Configuration Only via USB
This transmitter drives an analog output current or voltage proportional to a sensor input based on the differential voltage measurement across the thermocouple sensor. 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.

Revision History

The following table show the revision history for this document:

Release Date	Version	EGR/DOC	Description of Revision
29-MAR-13	A	BC/ARP	Initial Acromag release.
26-JULY-13	B	CAP/ARP	Added UL Mark to this model (removed pending), refer to ECN #13G017 for additional information. Added note to USB connections drawing, refer to ECN #13F005 for additional information.
16-DEC-13	C	JEB/ARP	Updated MTBF Numbers. Removed P.O. Box from address.
4-NOV-14	D	JEB/ARP	Added Acromag Agility™ Config Tool Quick Guide. Added USB OTG cable in Accessories Section.
15-OCT-2015	E	CAP	Added ATEX symbols / statements.
27-NOV-2018	F	CAP/ARP	Added IECEx / FCC statements.
18 NOV 2022	G	CAP/AMM	Update EN IEC Standards. Changed ATEX/IECEx protection method from "nA" to "ec".