USB Programmable, DIN Form B Connection Head Transmitter

Model ST131-0600 & ST131-0610 Two-Wire Transmitter, RTD Input

USER'S MANUAL

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Symbols on equipment:

⚠

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

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For additional information, please visit our web site at www.acromag.com and download our whitepaper 8500-904, Introduction to Two-Wire Transmitters.

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.

GETTING STARTED

TECHNICAL REFERENCE

DESCRIPTION

The ST131-06x0 is an ANSI/ISA Type II transmitter designed to interface with a Platinum RTD (Resistance Temperature Detector) sensor, or resistance input, and modulate a 4-20mA current signal for a two-wire current loop. This unit is setup and calibrated using configuration software and a USB connection to Windows-based PC's (Windows XP and later versions only). The unit provides RTD sensor excitation, linearization, lead-wire compensation, and lead break or sensor burnout detection. It also offers an adjustable input and output range with adjustable alarm levels.

Key Features

- **Fully analog signal path (input signal is not digitized).**
- **Converts sensor signal with a single differential measurement.**
- **Digitally setup and calibrated w/ Windows software via USB.**
- **Pt RTD or Linear Resistance input support.**
- **Supports Degrees Celsius or Fahrenheit Temperature Units.**
- **Adjustable input range up to 850°C (1562°F) or 900Ω.**
- **Adjustable input excitation, linearization, and output range.**
- **Connects to two, three, or four wire sensors.**
- **Lead-wire compensation (3-wire).**
- **Up or down-scale lead-break/burnout detection.**
- **Adjustable output error/alarm levels outside of operating range.**
- **Non-polarized two-wire current output.**
- **Convenient two-wire loop power.**
- **Provides a linearized or non-linearized output response.**
- **Adjustable under-range and over-range levels. Namur compliant.**
- **High measurement accuracy and linearity.**
- **Wide ambient temperature operation.**
- **Hardened for Harsh Environments.**
- **Designed for DIN Form B sensor head mounting.**
- **Optional DIN Rail Adapter for T-type & G-type rail.**
- **CE Approved.**
- **Model ST131-0610 is UL Listed (USA & Canada) suitable for use in Class I, Division 2, Groups A, B, C, D Hazardous Locations, or Nonhazardous Locations only.**
- **Model ST131-0610 is ATEX Certified for Explosive Atmospheres.**
  Ex II 3 G Ex nA IIC T4 Gc -40ºC ≤ Ta ≤ +80ºC
  DEMKO 13 ATEX 1113348X

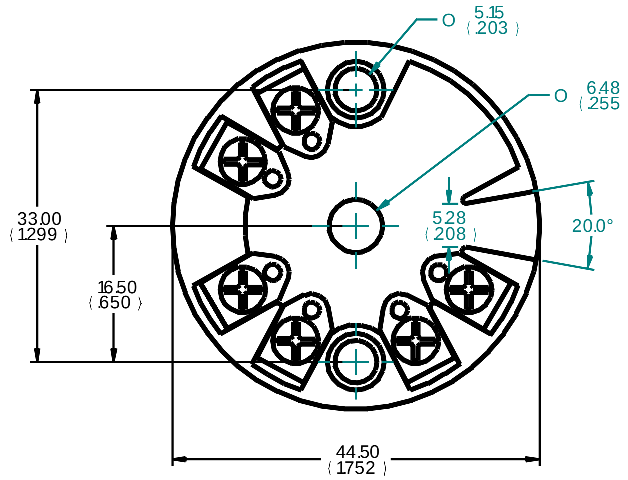
Application

This transmitter is designed for mounting in DIN Form B connection/sensor heads commonly used in thermowell applications for sensing temperature or for use in an enclosure with suitable strength and rigidity. Optionally, a DIN-rail adapter may be purchased for mounting the unit to T-type, or G-type DIN rail. The transmitter must be installed in an ATEX Certified enclosure with a minimum ingress protection rating of at least IP54. Enclosure must have a door or cover accessible only by the use of a tool (See page 33 for details).

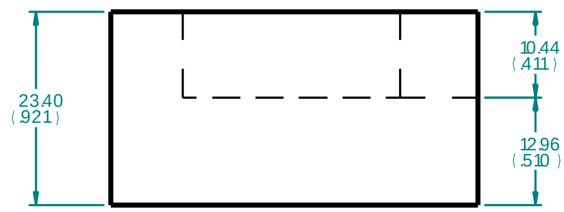
Its non-isolated input is intended to mate with non-grounded, 100Ω, Pt RTD temperature probes common to these thermowell applications. It provides an output current linearized to the RTD sensor temperature. Optionally, it can support simple resistance input and drive an output current linear to the sensor resistance.

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. Sensor lead-break detection and the inherent live-zero output offset offers convenient I/O fault detection, should an I/O wire break.

Mechanical Dimensions



Connection Head Mounting



DIN Rail Mounting

35mm T-Type DIN Rail

Dimensions in millimeters (inches)

G-Type DIN Rail

Note that this transmitter conforms to the mechanical limits set forth in the German standard DIN 43 729, for the Form B head style, and can be easily mounted in DIN Form B connection and thermowell protection heads, similar to the figure at upper left.

The M4 mounting screws and relief springs used to attach the transmitter to the connection head are ordered separately via Acromag Mounting Kit ST130-MTG (see Accessories section).

The unit may be optionally mounted to 35mm T-type or G-type DIN rail using the optional DIN mounting kit ST130-DIN as shown at left (see Accessories section).

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.

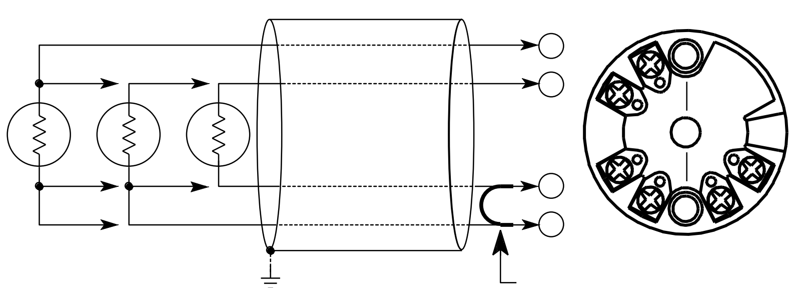
ELECTRICAL CONNECTIONS

Wire terminals can accommodate 14-28 AWG (2.08-0.081mm^2) solid or stranded wire. Input wiring may be shielded or unshielded twisted type. Ideally, output wires should be twisted pair. Strip back wire insulation 3/8-inch on each lead and wrap the bare wire in a clockwise direction around the terminal screw and below the SEMS washer. Tighten the screw to secure the wire at a torque rating range of 0.226 to 0.282 N-m. Terminals include wire loops for test clip attachment, or for redundant soldered wire connection required for heavy shock and vibration applications. Since common mode voltages can exist on signal wiring, adequate wire insulation should be used, and proper wiring practices followed. Output wires are normally separated from input wiring for safety, as well as for low noise pickup. Cables and/or conductors in conduit must have a minimum temperature rating of 110°C.

Sensor Input Connections

Sensor wires are passed up through the center of the transmitter and wire directly to transmitter input terminals 1, 2, 3, and 4, as shown in the connection drawings below. Observe proper polarity when making input connections.

- **Use Insulated or Non-Grounded Sensors Only** - Input is non-isolated. Do not ground any input leads.
- **Two-Wire Input Sensors Require Jumper -** For a 2-wire sensor, you must connect a short copper jumper wire between input terminals 3 and 4 at the transmitter. Alternately, if you want to compensate for sensor lead wire resistance, do not include this jumper but add a third copper lead from the sensor to terminal 4, as shown in the 3-wire connection figure.
- **Four-Wire Input Sensors Use 3-Wire Lead Compensation**.

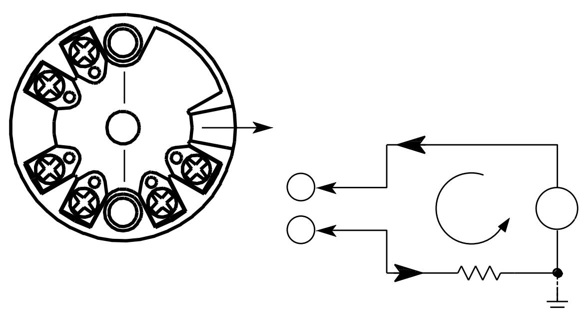


ELECTRICAL CONNECTIONS

Output/Power Connections

This transmitter has an ANSI/ISA Type 2 output in which the power and output signal share the same two leads, and the transmitter has a floating connection with respect to earth ground. In these applications, output wires normally pass through the output channel on top of the transmitter and are drawn through the egress path of the connection head. Connect a DC power supply and load in series in the two-wire loop as shown in the drawing below.

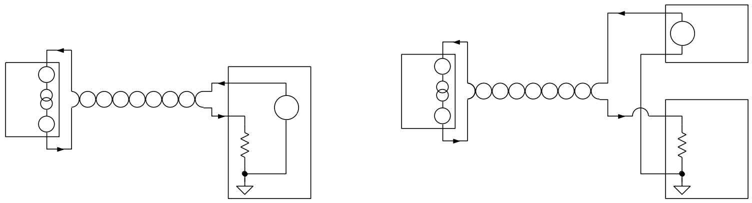
- Output connections are not polarized. The + and – designations are for reference only with current normally input to Output+ and returned via Output-.
- Loop supply voltage should be from 9-32V DC with the minimum voltage level set to supply over-range current to the load, plus 9V across the transmitter, plus any transmission line drop.
- Variations in power supply voltage between the minimum required and 32V maximum, has negligible effect on transmitter accuracy.
- Variations in load resistance has negligible effect on output accuracy as long as the loop supply voltage is set accordingly.
- Note the placement of earth ground in the current loop. This is very important when making connection to USB and will drive the need for USB isolation (see below).
- Always connect the output/power wires and apply loop power before connecting the unit to USB.



The output of this transmitter has a floating connection relative to ground which makes it flexible in the way it connects to various “Receiver” devices. In most installations, the loop power supply will be local to either the transmitter, or local to the remote receiver. Shielded twisted pair wiring is often used to connect the longest distance between the field transmitter and remote receiver. The receiver device is commonly the input channel of a Programmable Logic Controller (PLC), a Digital Control System (DCS), or a panel meter. Some receivers already provide excitation for the transmitter and these are referred to as “sourcing” inputs. Other receivers that do not provide excitation are referred to as “sinking” inputs, and these will require that a separate power supply connect within the loop. Here are example transmitter connection diagrams for “sourcing” and “sinking” receiver types:

ELECTRICAL CONNECTIONS

Output/Power Connections



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.

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 the 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 by placing a 0.1uF capacitor directly across the load.

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.

Earth Ground Connections

The unit housing is plastic and does not require an earth ground connection. If the transmitter is mounted in a metal housing, a ground wire connection is typically required, and you should connect the metal enclosure's ground terminal (green screw) to earth ground using suitable wire per applicable codes. See the Electrical Connections Drawing for Output/Power and note the traditional position of earth ground for the two-wire output current loop. The Type II transmitter output terminals have a floating connection relative to earth ground. Earth ground is normally applied at the output loop power minus terminal and in common with the loop load or loop receiver minus.

- Do not earth ground any input lead and use only insulated/non-grounded RTD sensors. This transmitter does not isolate its input signal.
- Respect the traditional position of earth ground in a two-wire current loop and avoid inadvertent connections to earth ground at other points, which would drive ground loops and negatively affect operation. This includes a USB connection to the transmitter, which should be made via a USB isolator, as most Personal Computers earth ground their USB ports, and this makes contact with both the signal and shield grounds.

ELECTRICAL CONNECTIONS

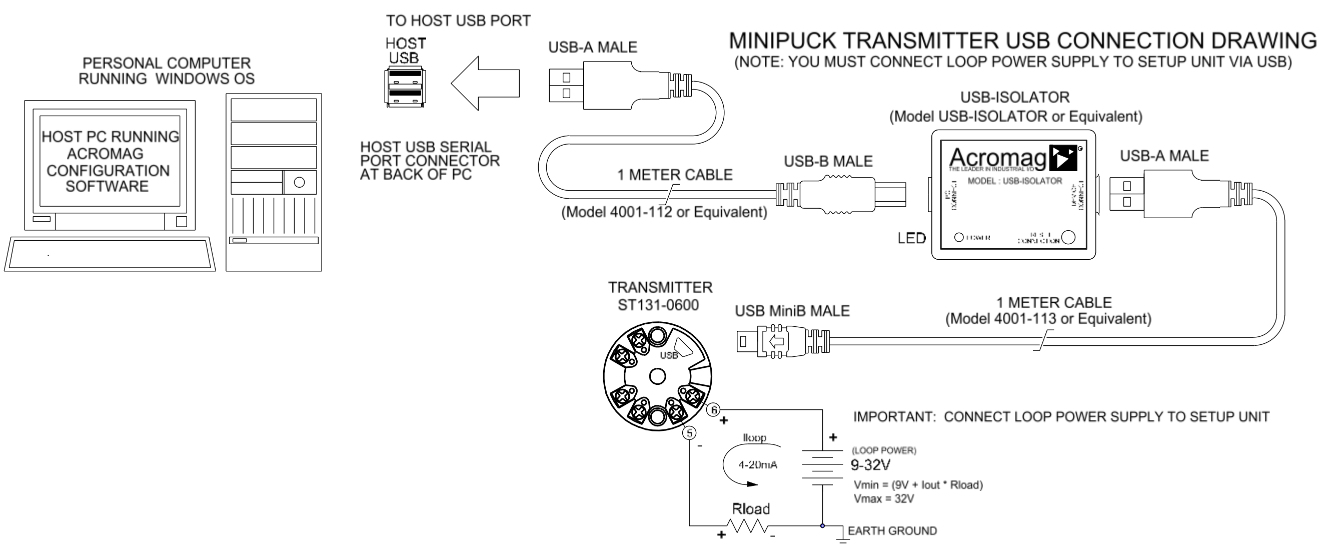
USB Connections

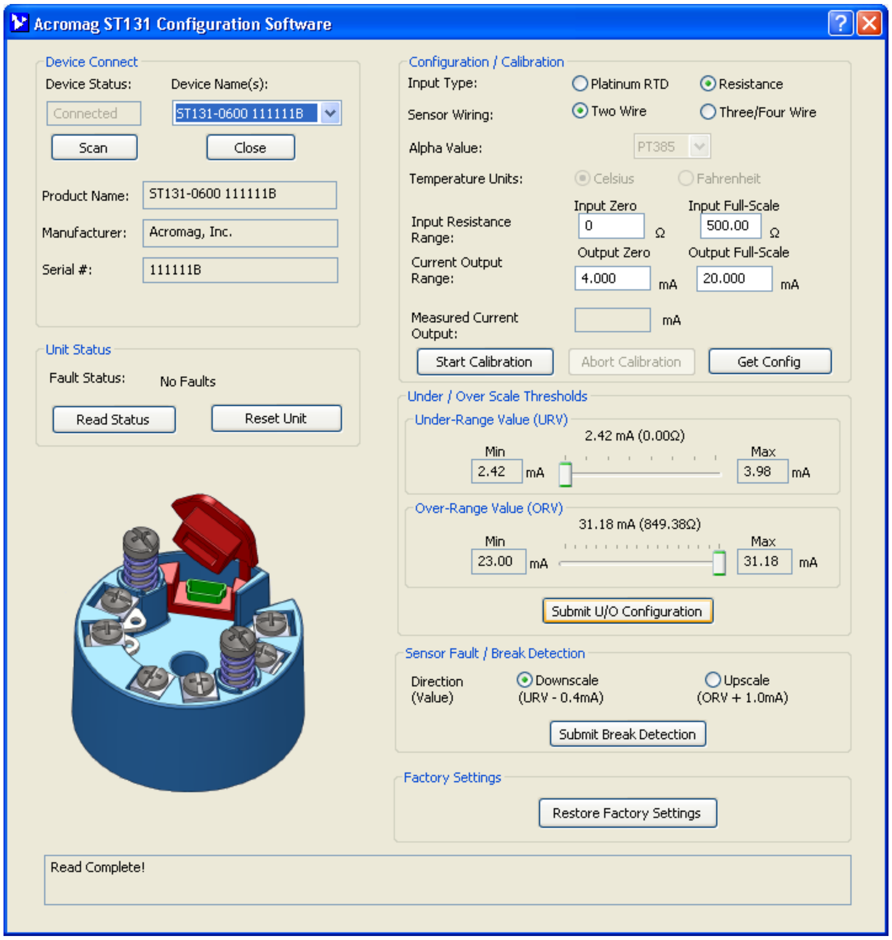
This transmitter is setup, configured, and calibrated via configuration software that runs on a Windows-based PC that is connected to the unit via USB (Windows XP or later version required). Refer to the drawing below to connect your PC or laptop to the transmitter for the purpose of reconfiguration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

WARNING – USB Connector is not for operational or maintenance use in hazardous locations. 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 its connection head, which may be in a hazardous area. Do not attempt to connect a PC or laptop to this unit while installed in a hazardous environment, as USB energy levels could ignite explosive gases or particles in the air.

- **USB Signal Isolation Required (See Below) -** 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).
- **Configuration Requires USB and Loop Power** - This transmitter draws power from both the current loop, and from USB during setup.
- **Connect Loop Power Before USB** - Always connect the transmitter to its loop power supply before connecting USB, or erratic operation may result.

IMPORTANT: All USB logic signals to the transmitter are referenced to the potential of its internal signal ground. This internal ground is held in common with the USB ground and 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 voltage 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. You could alternately avoid the use of an isolator if a battery powered laptop was used to connect to the transmitter, and the laptop has no other earth ground connection.





CONFIGURATION SOFTWARE

Introduction

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 at www.acromag.com. This software is also included on a CDROM bundled with the Configuration Kit ST13C-SIP (see Accessories section). For this model, look for program ST131Config.exe. The software is compatible with XP or later versions of the Windows operating system.

The configuration software screen for this model is shown at left. The configuration screen is divided into six sections as follows: Device Connect, Configuration & Calibration, Under/Over Scale Thresholds, Sensor Fault/Break Detection, Factory Settings, Unit Status, and the System Message Bar at the bottom of the screen. A short description of each of these groups follows. For a detailed explanation, see Configuration Step-by-Step in the Technical Reference section 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 screen and then click to point to a field or control to get a Help message pertaining to the item you pointed to.

Device Connect

- Scan for connected transmitters and open communications with them.
- Display the model number (Product Name), Manufacturer, and Serial Number of the connected transmitter.

This section is used to scan for connected transmitters, select a connected transmitter, open communications with it, and close connections with it. Device connection Status is also indicated here, along with the connected transmitter's ID info (Product Name/serial, Manufacturer, & Serial Number).

Configuration / Calibration

- Set the Input Type, Platinum RTD or Resistance.
- Set the input wiring to Two-wire or Three/Four-wire sensor connections.
- Set the alpha coefficient of your particular RTD curve.
- Set the RTD Temperature Units.
- Define your input temperature range or resistance range.
- Define your output current range.
- Read a unit's current configuration.
- Calibrate your transmitter zero, gain, excitation, and linearization.

Use the controls of this section to select an input type, specify the input wiring, specify the RTD "alpha" coefficient, specify input range zero & full-scale, and specify output zero & full-scale. **You must calibrate any changes you make in this section by clicking Start Calibration**.

CONFIGURATION SOFTWARE

Introduction

You can refer to the Technical Reference section of this manual for a more detailed description of every control described here.

The Configuration/Calibration section includes a type field where you are prompted to enter measured current values for zero and full-scale after starting calibration. You can also read the current transmitter configuration with “Get Config”, or “Abort” calibration if necessary.

Under/Over Scale Thresholds

- Select the output under-scale and over-scale thresholds to define your linear output operating range.
- Indirectly sets the upscale and downscale fault limits outside of your linear operating range to 1mA above over-scale, and 0.4mA below the under-scale threshold settings.

You can use the controls of this section to specify the under-scale and over-scale threshold levels of the output, and the corresponding upscale & downscale alarm limits. Once you have made your selections, you can click the “Submit U/O Configuration” button to engage your settings.

Break Detection

- Select output Downscale or Upscale lead-break or sensor fault detection.

Use these controls to select Upscale or Downscale lead break detection, then click the “Submit Break Detection” button to write your selection to transmitter memory. Note that a lead break or sensor burnout fault will send the output to the upper or lower alarm level, as directed by this setting. The alarm levels are outside the output operating range and are 1mA above the over-scale threshold, or 0.4mA below the under-scale threshold.

Factory Settings

- Restore a transmitter to its original factory calibration.
- Restore a transmitter to its initial factory configuration.

You can click the “Restore Factory Settings” button if you ever mis calibrate a transmitter in such a way that its operation appears erratic.

Unit Status

- Test the integrity of your USB connection to the transmitter.
- Read the Fault Status of your input signals with respect to the input amplifier.
- Reset the transmitter (sets the transmitter to its power-up configuration).

Use the “Read Status” control to test communication with the unit and to obtain diagnostic information relative to the input. Input Fault Status will be returned on the “Fault Status:” line, and in the system message bar at the bottom of the screen. Use the “Reset Unit” control to revert to the power-up or stored configuration, or to clear a checksum error. Refer to Read Status of the Configuration Step-by-Step section for more information.

Message Bar

- Displays the Fault Status of your transmitter input signal.
- Displays prompt instructions during calibration.

The system message bar at the bottom of the screen will display & repeat prompt instructions as you step through calibration. It also displays diagnostic messages after clicking “Read Status”.

TROUBLE-SHOOTING

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 loop and that your loop power supply voltage is sufficient to supply over-scale current into the load (MIN 0.020*Rload), plus 9V at the unit terminals, plus any line drop.*

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

POSSIBLE CAUSE	POSSIBLE FIX
Software Fails to Scan Transmitter…	
Bad USB Connection	Recheck USB Cable Connection
Loop power was enabled after connecting to USB.	You must enable the loop power supply before connecting to USB. With loop power present, disconnect then reconnect the USB cable to the transmitter.
USB has not enumerated the device.	Use the reset button on the Acromag USB isolator to trigger renumeration of the transmitter, or simply unplug/replug the USB cable to the transmitter.
Communication or power was interrupted while USB was connected and the configuration software was running.	Close the current connection with the software, re-scan the transmitter, select and re-open the transmitter for communication (or simply exit the Configuration software and reboot it).
Output Erratic, Not operational, or at Wrong Value…	
Missing USB isolation	If your two-wire output current loop is grounded, then connecting USB to the transmitter will drive a ground loop between your current loop and earth ground at the PC. Always use USB signal isolation, or alternatively, you can connect directly to a battery-powered laptop, which does not earth ground its USB connection.
Otherwise…	Verify loop power and voltage level. Try Closing the connection and re-opening it.
Output goes to Over-Range Value (ORV) or Under-Range Value (URV)…	
This indicates that the input signal is out of range. If the level is 1mA above the ORV or 0.4mA below URV, then this would indicate a sensor fault or lead break.	Check your input signal with respect to your calibrated range and reduce or increase it as required to drive your output current within its linear operating range. Also check the wiring of your input sensor.
Output goes 1mA above the selected Over-Range Value (ORV)…	
This is the Upscale alarm level and indicates the input signal exceeds the common mode range of the input. This can also occur if the third sensor wire is missing (3/4-wire RTD), a lead has broken, the sensor has burned out or open, or the jumper between terminals 3 & 4 of the transmitter is not installed (2-wire RTD).	An Upscale alarm is normally driven by a sensor fault, such as an open sensor or broken sensor lead with the transmitter lead break detection set to upscale. It can also be triggered by a very high sensor resistance that looks like an open sensor to the transmitter. Check your sensor resistance, sensor connections, and your connection to input terminal 4 to restore input operation. You can also check your sensor connections by measuring a voltage drop across your input resistance approximately equal to ~0.5mA* Sensor_Ohms? If connections are OK and you measure a voltage drop across the sensor, than your sensor value is likely out of range, or the unit has been mis calibrated.

TROUBLE-SHOOTING

Diagnostics Table

POSSIBLE CAUSE	POSSIBLE FIX
Output goes ~0.4mA below selected Under-Range Value (URV)…	
This is the Down-scale alarm level and indicates the input signal exceeds the common mode range of the input. This can also occur if the third sensor wire is missing (3/4-wire RTD), a lead has broken, the sensor has burned out or open, or the jumper between terminals 3 & 4 of the transmitter is not installed (2-wire RTD).	A Downscale alarm level is normally driven by a sensor fault, such as an open sensor or broken sensor lead with the transmitter lead break detection set to down-scale. It can also be triggered by a very high sensor resistance that looks like an open sensor to the transmitter. Check your sensor resistance, sensor connections, and your connection to input terminal 4 to restore input operation. You can also check your sensor connections by measuring a voltage drop across your input resistance approximately equal to ~0.5mA* Sensor_Ohms? If connections are OK and you measure a voltage drop across the sensor, than your sensor value is likely out of range, or the unit has been mis calibrated.
Output goes 0.4mA below the lowest possible Under-Range Value…	
An output level 0.4mA below the lowest URV setting can be indicative of a checksum error encountered in a data exchange with the internal EEPROM memory. This assumes that you have not configured an Under-Range Value to its lowest setting.	This is a rare error that is not likely to occur. If it is persistent, it may indicate a unit defect. You can reset the transmitter to clear this error, or simply cycle power to the transmitter. If it continues to occur, then you should try restoring factory calibration. If the error still occurs, you should consult with the factory and arrange for the unit to be returned for repair or replacement.
Cannot Communicate with Transmitter via USB…	
Loop power ON to the unit?	Unit requires a loop power connection, even when connected to USB. The loop power supply should also be present before connecting to USB.
A missing USB Isolator could cause a ground loop when connecting to USB from a Personal Computer.	A ground loop is created between a normally grounded two-wire current loop and earth ground of the PC USB port. Only connect to USB via a USB isolator, like the Acromag USB-ISOLATOR. Otherwise, use a battery powered laptop to configure the transmitter.
Unit fails to operate or has an erratic output signal…	
Is input grounded?	This non-isolated model is intended for use with ungrounded RTD probes and a grounded probe could inadvertently short the input bias voltage causing erroneous operation, in particular if the output loop is already grounded.

POSSIBLE CAUSE	POSSIBLE FIX
Unit drives a low current, but fails to drive current at/near/above 20mA…	
Loop supply voltage is too low to support full-scale or over-range current into the loop load.	Check power supply voltage level. Make sure it is at least 9V plus 0.020*Rload. If transmission distance is long, than it must have additional voltage to support the IR drop in the wire. Ideally, the voltage should have ample overhead to drive the load at the maximum output current, which is ~1mA above the Over-Range Value that you set.
Cannot Calibrate Input Channel…	
Is input wired properly?	Check input wires at terminals 2, 3, & 4.
Missing third input terminal connection.	You must include a wire to terminal 4 of the transmitter, either from the sensor itself (3-wire sensor connection), or a small jumper wire between terminals 3 & 4 at the transmitter (2-wire connection).
Cannot Calibrate Input Channel…	
You may have damaged the input PGA via a ground loop, or incorrect wiring.	If you cannot get the output signal to vary for a continuously variable input signal, your input signal is within range, and you have properly wired the input including connections to input terminal 4, then your input amplifier may have been damaged and the unit will need to be replaced.
Does not Operate or calibrate properly with a 2-wire input connection…	
Are you missing the jumper required between input terminals 3 and 4?	Check input wiring and make sure that terminals 3 & 4 are jumpered together for 2-wire connections. Note that the third-lead from the sensor, or the jumper between input terminals 3 & 4 forms the return path of the sensor excitation current and must be present to operate the unit.
Output shifts momentarily while using Read Status or Get Config…	
Reading/Writing the EEPROM memory momentarily consumes more current and this is evident by a momentary glitch in output current during reconfiguration.	Memory is powered by the loop supply. This is normal during reconfiguration via USB using the Configuration software and reflects the increased current draw during memory access. Note that the contents of memory is uploaded at power-up and repeated access of memory is not required during normal operation, except for reconfiguration.

TROUBLE-SHOOTING

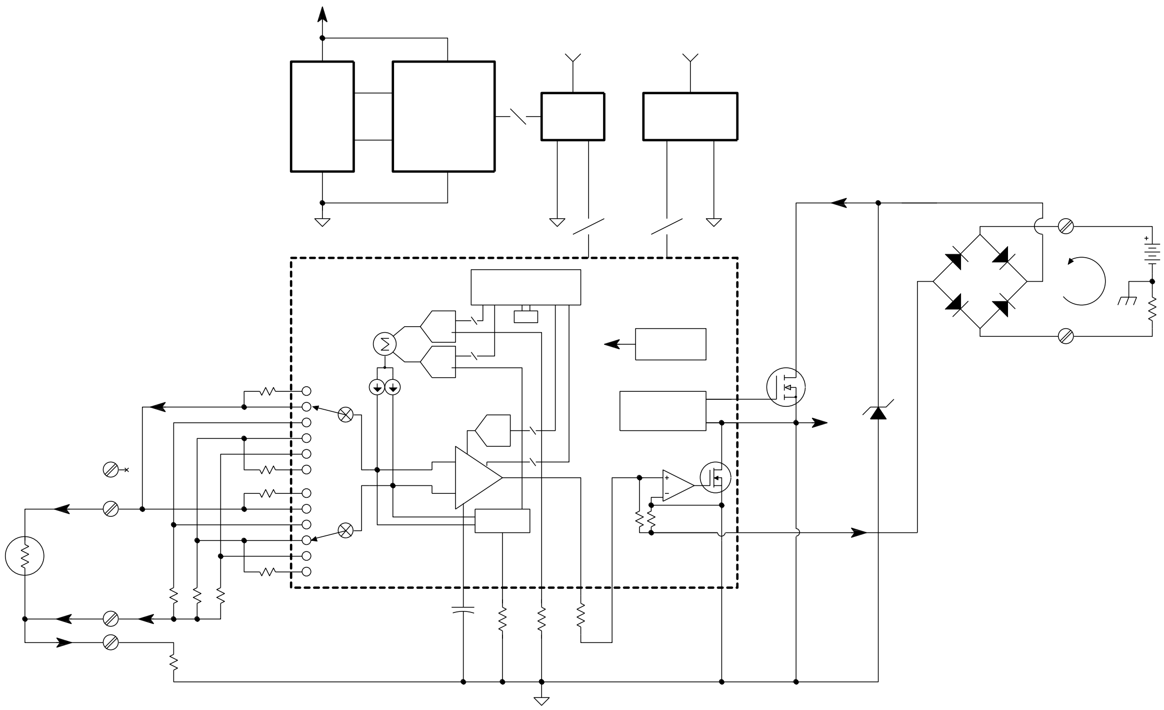
Diagnostics Table

Service & Repair Assistance

This unit contains solid-state components and requires no maintenance, except for periodic cleaning and transmitter configuration parameter (zero and full-scale) verification. The potted Surface Mounted Technology (SMT) board contained within this enclosure is impossible to repair, except for firmware. 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 restores firmware. Please refer to Acromag's Service Policy and Warranty Bulletins or contact Acromag for complete details on how to obtain repair or replacement.

TECHNICAL REFERENCE

Block Diagram



Key Points of Operation

- Signal Path is Analog
- Unit is Loop Powered
- Input is Non-Isolated
- Conversion is Differential
- Configuration is Digital
- Calibration is Digital
- Converts RTD with a Single Differential Measurement
- Output/Power Terminals are Not Polarized
- Only ± Leads must be balanced for lead compensation.

This digitally calibrated analog transmitter uses a unique, low noise, voltage to current conversion scheme that delivers 12-bit equivalent performance but does not actually digitize the input signal. Instead it uses integrated Digital-to-Analog Converters (DAC) to adjust the zero offset, control the excitation currents, and drive linearization correction to the input. These DAC's work together to achieve nearly 12-bits of adjustment resolution, but do not operate directly on the analog input signal itself. Likewise, there are no microcontrollers in the I/O signal path of this design, and no embedded firmware relative to processing the signal. Transmitter functionality is actually hard-wired (integrated) into an application specific component IC. The only microcontroller in this design is used to convert the external USB signals to an internal SPI bus signal during reconfiguration. Windows configuration software is used to write configuration parameters into non-volatile EEPROM memory at setup. These stored parameters are auto-downloaded into the transmitter ASIC at power-up and will define its normal operation. Setup involves selecting the input type (Pt RTD or Resistance), input wiring (2-wire or 3/4-wire), the Pt RTD alpha coefficient, the input range zero (-50°C, 0°C, or 0°F), the input range full-scale (up to 850°C or 900Ω), the output range zero, the output range full-scale, specifying the output over and under-scale thresholds and alarm detents, and setting upscale or down-scale lead break or sensor fault detection.

Block Diagram

This transmitter uses a unique signal processing method that reduces error by converting the 3 or 4-wire sensor with a single differential measurement, including the lead-wire compensation. During operation, a small excitation current is passed through the positive lead of the RTD element. A matching excitation current is passed through a zero-pedestal resistor Rz and into the minus lead of the sensor element. These currents combine and return to the unit via a third lead that is terminated with a common-mode resistance in the unit (3-wire connection). The voltage drop, produced in the series-connected zero resistor of the minus lead, has the effect of driving the differential input voltage across the bulb and in parallel with the input amplifier near 0V, for bulb temperatures near the minimum temperature for the RTD range (-50°C, 0°C, or 0°F). The return current sinking through the common-mode resistance drives a positive-biased, differential voltage signal proportional to the RTD element resistance. The differential voltage measured by the transmitter is corrected slightly to make it linear with temperature by modulating the sensor excitation current with a value determined during calibration, then converted to a proportional process current at its output. Because the currents in each lead match, and if both the positive and negative leads to the RTD are of the same length, type, and diameter, then the IR drop in these lines will create small common-mode voltages that are effectively rejected by the differential instrumentation amplifier measurement. In this way, the measured signal is compensated for the additional resistance of the ±lead wires without making a separate measurement. Refer to the block diagram above to gain a better understanding of how this transmitter works.

Note that a third sensor wire is used to compensate the sensor for the resistance of the lead wires, which can affect the accuracy of the RTD bulb given its low initial resistance (100 ohms at 0°C typical), and its small change in resistance per degree of temperature change. In this design, the third lead wire is used as the return path for both the positive and negative sensor lead currents. Then as long as both the positive and negative leads wires to the bulb are of the same type and length, their individual contributions to the differential signal cancel out (as equal IR drops in each lead), and the precise voltage across the RTD element is measured directly proportional to its sensed temperature. Without this third lead, the sensor excitation current returns via the minus lead and combines with the minus lead current in the small jumper placed between terminals 3 & 4 of the transmitter for a 2-wire sensor connection. This unbalances the sensor measurement preventing lead-wire compensation. The current returned via the third sensor lead is shunted through a common-mode resistor, effectively biasing the input signal above 0V and into the common mode input range of the amplifier. The small resistance of this line adds a small common-mode voltage that increases the bias and is essentially rejected by the amplifier. Note that if the sensor is connected via two-wires, the lead-wire resistance is not compensated for. For two-wire sensors, you additionally have to include a small jump-wire between leads 3 & 4 which allows the combined excitation currents to reach the common-mode shunt resistor and properly bias the sensor. Note that any 2-wire sensor can be made to compensate for its lead-wire resistance by simply adding a third lead to the sensor (in place of the jumper), and for this unit, that third lead can be a different size and type of material than the ±input leads to the sensor.

Block Diagram

The zero point of the calibrated range is set via zero resistor Rz that is connected in series in the minus input lead. From the factory, three resistance values are installed in three separate minus lead paths, and are at ohm values just below that of a 100Ω Pt RTD corresponding to temperatures -50°C, 0°C, and 0°F. Note that for two-wire sensor connections, only a 0°C input range zero may be selected. The voltage drop produced in Rz drives the differential voltage measured across the sensor to be near zero at Tmin of the RTD range, as the excitation current in each lead is matched. The combined excitation current of each lead is then shunted into a 475Ω common mode resistor Rcm, producing a positive bias for the input sensor within the input common mode range of the differential amplifier, as it ensures that the lowest common mode input voltage is greater than the minimum range limit of the amplifier.

Note that the excitation currents are digitally adjustable via the Iref DAC. From the factory, this current is set to a nominal value of 493uA via the 12.1K Rset resistor (480uA to 510uA range). It can be digitally adjusted to other levels during calibration. The excitation current values are also influenced by the linearity DAC. All RTD's have a nonlinear response over temperature that is approximated by a quadratic equation. The linearity DAC uses positive feedback from the input signal to produce a system response that is also nearly quadratic, but curving in the opposite direction, producing a net response that is very linear. This DAC allows the nonlinearity error to be calibrated out by modulating the excitation current with the input signal of the RTD during calibration and will produce a nearly 40:1 improvement in linearity. The adjustment range of this linearity correction is set via the 15.8K Rlin resistor, which has been optimized for increased accuracy for the most common spans that occur between -50°C and +500°C.

The PGA includes a zero DAC that allows the magnitude of the zero-output current to be precisely adjusted near 4mA. The output voltage of the PGA voltage amplifier is converted to current through a 6.34K Rvi resistor at its output, just prior to the current amplifier that drives the output loop. The current gain of this output current amplifier is 50x. Note that the output loop is bridge-coupled to the transmitter, making the transmitter output polarity insensitive.

The USB port ground is common to the circuit ground. The USB port ground of most PC's is common to the USB cable shield and earth ground. The output current loop is typically earth grounded at the loop supply minus connection. 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 the traditional current loop earth ground.

CONFIGURATION STEP-BY-STEP

This section of the manual will walk you through the reconfiguration process step-by-step. But before you attempt to reconfigure or recalibrate this transmitter, please make the following electrical connections:

Calibration Connections

Calibration Connections:

1. Connect a precision resistance decade box or RTD calibrator to the input, as required (refer to Electrical Connections section). Your resistance source must be adjustable over the range desired for zero and full-scale. A 3-wire or 4-wire sensor connection is recommended, as this will compensate for sensor lead resistance (this unit will use 3-wire lead compensation for 4-wire sensors). Be sure to either wire a third lead to the remote sensor or install a short copper jump-wire between input terminals 3 & 4 of the transmitter, as this serves as the return path for the excitation current and must be present for operation. The input resistance source must be accurate beyond the unit specifications (better than ±0.1%). A good rule of thumb is that your source accuracy should be four times better than the rated accuracy you are trying to achieve with the transmitter.

2. Wire an output current loop to the transmitter as shown in the Electrical Connections section. You will need to measure the output current accurately in order to calibrate the unit. You could connect a current meter in series in this loop to read the loop current directly. Alternatively, you could simply connect a voltmeter across a series connected precision load resistor in the loop, then accurately read the output current as a function of the voltage IR drop produced in this resistor (recommended). In any case, be sure to power the loop with a voltage that minimally must be greater than the 9V required by the transmitter, plus the IR drop of the wiring and terminals, plus the IR drop in the load. To compute the IR drop, be sure to use a current level that considers the over-scale current and alarm limit by adding 1mA to the over-scale threshold that you select (this could be as high as 30mA depending on your selection of over-scale threshold).
   The output load resistance and meter must be accurate beyond the unit specifications (better than ±0.1%). A good rule of thumb is that your load and meter accuracy should be four times better than the rated accuracy you are trying to achieve with the transmitter.

   Loop Power Supply: Make sure that your power supply voltage level is at least 9V plus 0.020*load_resistance. Ideally, it should be great enough to drive the over-range alarm current into your load (i.e. greater than or equal to 9V+ 0.030*Rload, assuming the line drop is negligible, and the maximum possible over-range threshold is configured).

   The non-volatile memory of the transmitter receives its power from the loop supply, not USB. Therefore, apply power to the transmitter output loop and always power the loop <u>before</u> connecting to USB.

3. Connect the transmitter to the PC using the USB isolator and cables provided in Configuration Kit ST13C-SIP (refer to Electrical Connections section). You may omit the isolator if you are using a battery powered laptop to connect to the unit.

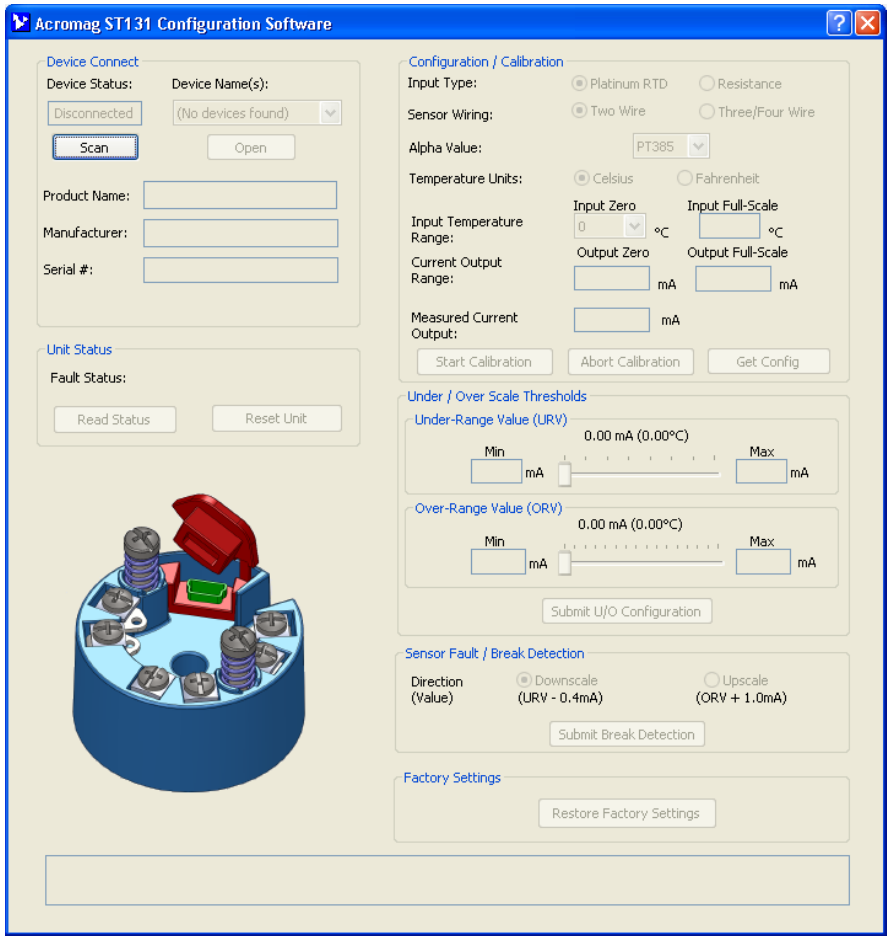
   Now that you have wired the unit, applied power, and connected the unit to USB, you can execute the Configuration Software program for your model (ST131Config.exe) to begin reconfiguration. This software is only compatible with XP or later versions of the Windows operating system.

CONFIGURATION STEP-BY-STEP

Reconfiguration

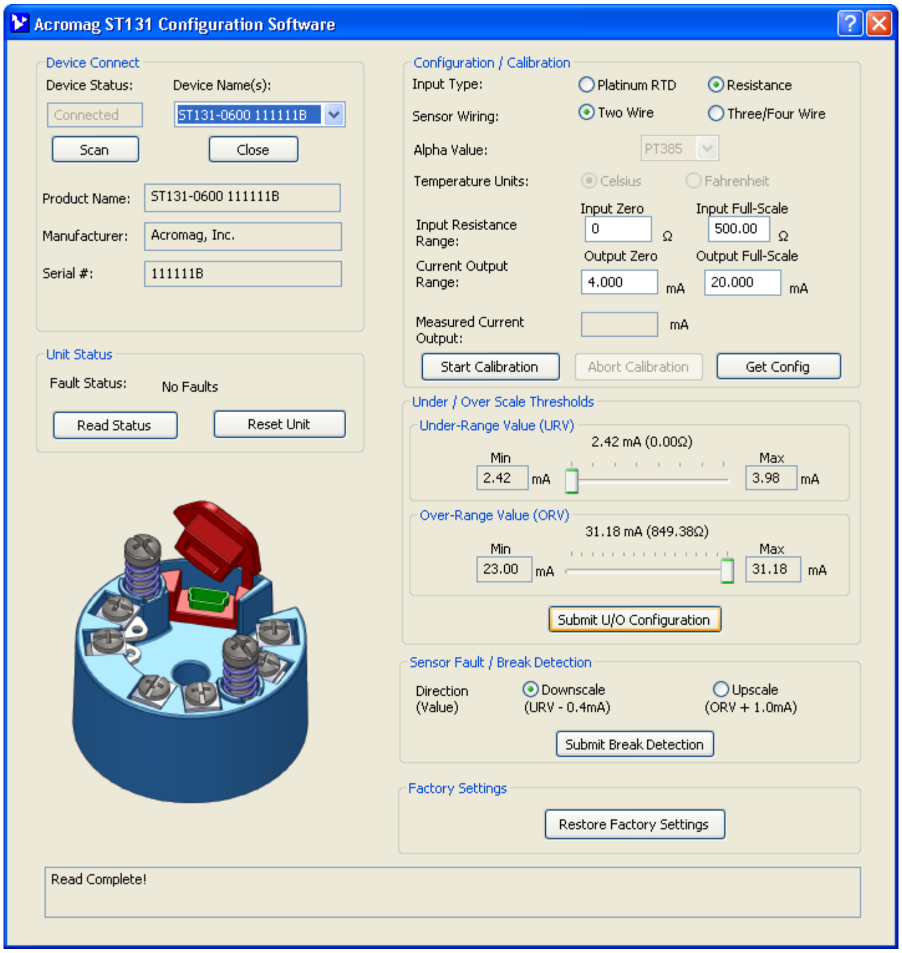
HELP – You can press F1 for Help on a selected or highlighted field or control. You can also click the [?] button in the upper-right hand corner of the screen and click to point to a field or control to get a Help message pertaining to the item you pointed to.

After executing the Acromag Configuration software for this model, a screen similar to the following will appear if you have not already connected to your transmitter via USB (note some fields are faded out under these conditions):



Note that without a device already connected via USB, the Device Status field indicates “Disconnected”. After you connect USB, the first step to begin reconfiguration is to select the device to connect to using the scroll window of the Device Name field. Use the scroll bar to click on and select a transmitter from this list in order to open it for reconfiguration (use the serial number to discern a particular transmitter). Then click the “Open” button to connect to the selected device.

If your transmitter was already connected via USB when you booted this software, your screen will look more like the one below, where the software has already initiated a connection to the transmitter for you (see Device Connect area and note that Device Status indicates “Connected”). Note that the software automatically opened the connection with the transmitter and “Read Complete” is indicated in the message bar at the bottom of the screen. Additionally, most fields and controls are not faded out and await your input.



CONFIGURATION & CALIBRATION

Reconfiguration

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.

If more than one transmitter is connected via USB through a USB hub, the software automatically opens a connection with one of the transmitters and "Read Complete" is indicated in the message bar at the bottom of the screen. You can discern which transmitter is open by referring to the product's unique serial number indicated next to the Product Name. If your intent was to open a different transmitter on the hub, then you will have to "Close" the current connection and use the Device Name scroll bar to select another transmitter (discern by serial number). Then click "Open" to open it for communication.

If you break the USB connection to a transmitter, the software will automatically close the connection for you. When you reconnect the USB cable, you will have to click "Open" to reopen communication with the transmitter. If you have more than one transmitter connected via a hub, then you will have to use the Device Name scroll bar to first select a transmitter (discern unit by serial number), and then click "Open" to open communication with it.

Note that you must already have loop power connected to the transmitter before you execute this software. If you do not, the software will prompt you to make this connection when you execute the software program. If you later interrupt loop power while already using the software and while connected to USB, you may have to re-open communication with the unit.

CONFIGURATION STEP-BY-STEP

Reconfiguration

Open the Transmitter for Communication….

Once you have opened a transmitter for communication, the device status will change from "Ready" to "Connected", and the transmitter ID information will be displayed in the Product Name, Manufacturer, and Serial Number fields. At this point, the connected transmitter is ready for reconfiguration and the appropriate configuration fields become active and await your input.

If you want to see how the connected unit is already configured before changing its configuration, click the "Get Config" button of the Configuration & Calibration controls to retrieve its current configuration information. Note the message bar at the bottom of the screen and it should display a message like "Read Complete! Normal Operation, inputs in range"

IMPORTANT: If you make <u>any</u> changes to the Configuration Parameters, you will have to recalibrate the unit via the "Start Calibration" button in order to actually write those changes to the transmitter.

Select the <u>Input Type</u>…

In the Calibration section of this screen, select an input type: Platinum RTD, or Resistance.

- If you select **"Platinum RTD",** your output will be linear with respect to sensor temperature, not resistance, and you will additionally have to use the "Alpha Value" scroll window to select your particular RTD curve type (alpha is only used by the software to recommend resistance values during calibration).
- If you select **"Resistance",** your output current will be linear with respect to sensor resistance, not temperature, and no special linearization will be performed.

Select the <u>Sensor Wiring</u>…

This selection tells the unit which inputs to connect to its internal PGA, and which inputs to connect its excitation sources to.

- If you select **"Two-Wire"**, your input measurement will not be compensated for the sensor lead resistance, and your input range zero will be fixed at 0°C (Pt RTD). *Note that in most thermowell applications, the sensor leads are less than 2 feet long, and will have negligible resistance, minimizing the importance of lead-wire compensation in these applications.*
- If you select **"Three-Wire"**, your input measurement will be compensated for its lead-wire resistance, as long as the ± input leads are of the same length, size, and type. Additionally, you will be able to select an input zero of -50°C, 0°C, or 0°F (input zero is a fixed selection of 3 different values, while the full-scale is programmable to any value in range). If you have a four-wire sensor, select "Three-Wire".

  A selection of "Two Wire" requires that you additionally wire input terminals 3 & 4 together with a short copper jumper wire. A selection of "Three Wire" requires that a third lead be wired to input terminal 4 and the other end of this lead connects to the minus terminal at the sensor. In both cases, this "third-wire" connection serves as the return path for the excitation current and it <u>must be present</u> in either form in order to make your measurement. If you have actually wired a four-wire sensor, it will use 3-wire lead compensation.

CONFIGURATION STEP-BY-STEP

Reconfiguration

Select the Alpha Value…
(Pt RTD Only, for internal use only)

For the Pt RTD Input Type, you should specify the **Alpha Value** of your particular RTD curve. The software only uses this information to compute the input resistances required to calibrate your selected input range for Platinum RTD Input Types, which it then returns in message prompts during the calibration process.

If you are calibrating to a particular curve not indicated, you may select this value arbitrarily and just substitute your own resistance values during calibration that will correspond to your particular curve at the temperatures noted.

Note: [1]*Alpha (α) is used to identify the RTD curve and its value is derived by dividing the sensor resistance at 100°C (boiling point of water) minus the sensor resistance at 0ºC (freezing point of water), by the sensor resistance at 0°C, then by 100°C ($\alpha = [R_{100°C} - R_{0°C}] / R_{0°C} / 100°C$). For Pt 100Ω, this is 38.5Ω/100.0Ω/100°C, or 0.00385Ω/Ω/°C, and represents the average change in resistance per ºC.*

Select the Temperature Units…
(Pt RTD Only)

For your input range, select the temperature units in degrees Celsius or degrees Fahrenheit. Note that input ranges specified in degrees Fahrenheit will have a fixed input range zero of 0°F. Units in °C can chose an input range zero of -50°C or 0°C.

Select the Input Range Zero and Input Range Full-Scale…

Next you need to select the input temperature range for the Pt RTD Input Type, or your input resistance range for the Resistance Input Type.

For Platinum RTD types, use the scroll bar to select your **Input Zero** temperature: -50°C, 0°C, or 0°F (Zero is a fixed value for Pt RTD).

For Resistance Input Type, you instead enter an **Input Zero** value in ohms (0Ω typical, for a 0-500Ω range, or 100Ω typical for a 100-200Ω range). Note that some zero values will not be acceptable, and the software may prompt you to make adjustments. Note that if you choose 0Ω as your input zero, then your under-scale threshold selection below cannot be achieved, except for the purpose of setting the downscale alarm limit, which is ~0.4mA below your under-scale threshold setting.

Your selection of Input zero is the RTD temperature or input resistance that will correspond to 0% of output. Note that some under-range is built-in later via the Under-scale Threshold selection, which is set separately (see below).

Note that this selection indirectly determines the PGA minus lead connection from the input multiplexer. Different paths are chosen which have different pedestal resistors installed that happen to be set just below the corresponding resistance of the platinum input sensor at its zero temperature. An equivalent sensor input resistance actually drives the differential signal measurement to 0V. For example, the Resistance Input Type will use the 0°C pedestal resistor which is 98.8Ω.

CONFIGURATION STEP-BY-STEP

Reconfiguration

Next, enter your Input Full-Scale temperature (Pt RTD Input), or full-scale resistance (Resistance Input Type).

Your Input Full-Scale selection will correspond to 100% of output. For Pt RTD, you can enter any value up to 850°C. For the Resistance input type, you can enter any resistance value up to 900Ω. Note that the unit does convert under-range and over-range values outside of the 0% and 100% limits, and this is set by separately selecting the output Under/Over-scale Thresholds.

Not all combinations of Input Zero and Input Full-Scale will be possible. The software may prompt you to make another selection. Also, if the input zero and full-scale points are chosen too close together, performance will be degraded. A minimum span of 50°C is recommended. Note that you will have to be able to precisely drive the corresponding input range resistance values for zero and full-scale in order to calibrate your input range later.

Select the Output Range Zero and Output Range Full-Scale…

In the **Output Zero** and **Output Full-Scale** fields, enter the output currents that are to correspond to 0% and 100% of output respectively. This is typically 4mA and 20mA, respectively, but you could optionally specify an output zero from 3.5mA up to 6.0mA, or an output full-scale from 16mA up to 24mA. Note that the output range over-scale and under-scale thresholds are specified separately and will determine the linear operating range of the output including possible over/under-range outside of these approximate limits.

If the output zero and full-scale points are chosen too close together, performance will be degraded. Use input spans greater than 50°C.

The actual operating range limits of your input sensor will depend on the linear output operating range defined by the output under-scale and over-scale threshold limit settings (set separately below). Threshold limiting allows you to define an under-scale threshold, typically between 2.1mA and 3.6mA, and an over-scale threshold between 21mA and 30mA. This indirectly corresponds to a linear operating range outside of the input zero and full-scale limits. It also indirectly defines the fault current levels which will be ~0.4mA below the under-scale threshold for down-scale detection, and ~1.0mA above the over-scale threshold for upscale detection. The Min/Max range of adjustment has already been calibrated at the factory and the Min/Max values indicated will vary between units. Note that the range of adjustment for the threshold levels can vary as much as ±10% of span between units for the same "digital" setting.

Zero & Full-Scale Calibration

Calibrate your I/O Range Selection…

IMPORTANT: If you make any changes to the Configuration parameters, you must re-calibrate your input. Any changes to the Input Type, Sensor Wiring, Input Zero/Full-Scale, or Output Zero/Full-Scale, are not written to the transmitter until you complete the calibration sequence that is initiated by clicking the "Start Calibration" button.

You can use the **"Get Config"** Calibration control button to read the current configuration of the unit if you like, perhaps to determine the active configuration prior to recalibrating it.

CONFIGURATION STEP-BY-STEP

Zero & Full-Scale Calibration

Note that it will over-write the configuration parameter selections of this screen that you may have just changed. It a good idea to always check the current configuration selections to affirm your intentions before clicking "Start Calibration".

After making your input type and I/O range selections, you can click the **"Start Calibration"** button of the Calibration section to begin calibrating your selections. Calibration is a simple twostep process (Resistance Input), or three step process (Pt RTD Input), that adjusts the I/O range zero, the PGA gain and excitation, and linearization (Pt RTD only). If you make a mistake and need to repeat a step, just click "Abort Calibration" to restart from the beginning.

Calibration is an interactive process in which the software prompts you to apply input signals and then measure the corresponding output current. First, it will prompt you to apply the zero-input signal resistance, then measure and record the corresponding zero output signal current. Second, it does the same for the full-scale input resistance and the corresponding full-scale output current signal (it makes adjustments to gain at this stage, but with linearization turned off). Third for Pt RTD input types, it enables linearization and prompts you to apply the full-scale input resistance signal again and then measure and record the corresponding full-scale output current (it uses this second full-scale measurement to adjust the magnitude of its linearization correction for the sensor). There may still be combinations of zero and full-scale that you will not be able to adjust and calibrate the unit for. For example, this might occur for very tight input spans, or odd endpoints. The Configuration Software will usually let you know when you need to adjust your desired limits as you enter them.

CAUTION: RTD Input levels outside of the nominal input range of the unit (-50° to +850°C, or 0-900Ω) 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.

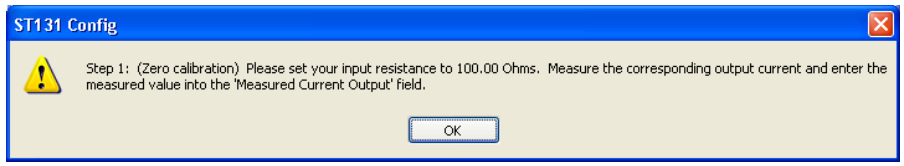
By default, the unit is factory calibrated to a 100Ω, Pt385 RTD type, using a 3-wire sensor connection, and a 0° to 200°C input span to drive a 4mA to 20mA output span. For our example below, we will instead use the 0 to 500°C portion of the Pt RTD type to drive a 4 to 20mA output range.

CONFIGURATION STEP-BY-STEP

Zero & Full-Scale Calibration

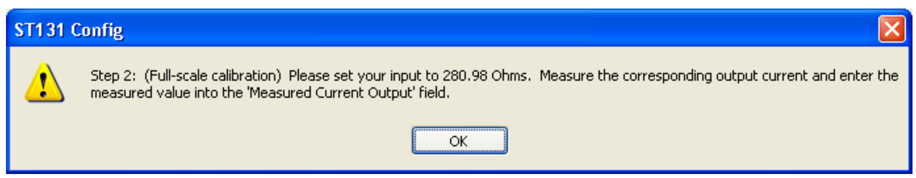
Transmitter Zero, Full-Scale, & Linearizer Calibration Procedure

1. After configuring your input type and I/O ranges, you can begin calibrating the transmitter by clicking the "Start Calibration" button and the following message will appear:



Your unit needs to calibrate its zero signal. The software used your input type and alpha information to compute the equivalent RTD resistance of the input zero value you specified and returned that value in this prompt. Click OK and this message is repeated in the system message window at the bottom of the screen. You need to adjust your input signal to the zero-input value noted. Because this input is a Pt 100Ω sensor, and 0°C is our input zero, our input signal should be precisely set to 100.00 ohms. Measure the corresponding output current and type the measured current in milliamps into the Measured Current Output field. Then click the "Go to Step 2" button.

2. After clicking "Go To Step 2", the following message will be displayed:



Now the unit needs to calibrate its gain to produce your full-scale endpoint. The software used your input type and alpha information to compute the equivalent RTD resistance of the input full-scale value you specified and returned that value in this prompt. Click OK and this message is repeated in the system message window at the bottom of the screen. You need to adjust your input signal to the full-scale input value noted. Measure the corresponding output current accurately and type the measured output current in milliamps into the Measured Current Output field. Then click the "Go to Step 3" button (only Pt RTD inputs will require a 3rd step).

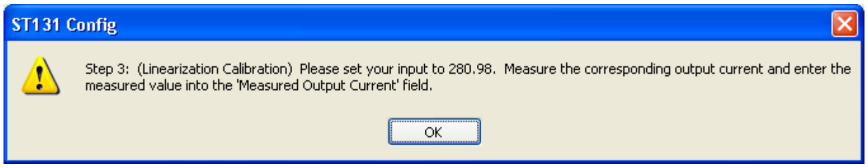
Note that at this point, your output signal will not be an accurate full-scale output (RTD Input), as linearization is OFF, and calibration has not been completed. The second step only sets the gain of the PGA amplifier to drive the full-scale output, but without RTD linearization turned on.

If your Input Type is Resistance, your calibration is complete after this step because no special linearization correction applies (your output is already linear with resistance). You simply need to click the Complete Calibration button to continue and your resistance transmitter should be calibrated.

CONFIGURATION STEP-BY-STEP

Zero & Full-Scale Calibration

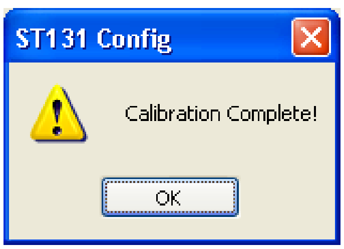
3. (Pt RTD Input only) After clicking “Go to Step 3”, the following message will be displayed:



Step 3 reads just like Step 2, except the RTD linearization circuit has been activated and your output signal shifts closer to your desired full-scale output level. Click OK and this message is repeated in the prompt window at the bottom of the screen. The transmitter needs your output reading with linearization enabled to adjust the RTD linearization correction current for the sensor excitation. You don’t need to readjust your input signal at this step, as it uses the same full-scale input from the prior step 2.

Simply measure your output signal and input the new measurement taken (note that it will be closer to the full-scale output than it was in step 2, as linearization is ON). Type the measured output current in milliamps into the Measured Current Output field. Then click the Complete Calibration button and the following message will appear (your output may shift slightly to reflect an adjustment to linearization):

of



At this point, the transmitter is calibrated. Click OK to continue. Check the accuracy a few other points. Note that if your input type is Pt RTD, your output will be linear with the input temperature, not the input resistance.

If your output appears imprecise, you may need to repeat calibration, but being very careful to take accurate measurements and enter the measured output currents correctly and using milliamps as your units. Make sure that you carefully drive the precise input signal resistances necessary for calibration. If measuring voltage across the output load resistance, make sure that you use the exact input resistance when calculating the current measured. Also, make sure that you have an adequate input span, as too-tight input spans will magnify error.

Refer to the following table when using a resistance substitution box to drive the input zero and full-scale signals. This contains the resistance values for the two most common Pt RTD alpha types. Optionally, you can determine resistances using an online calculator based on a different reference standard. For example, try the calculators at http://www.minco.com/tools/sensorcalc/ .

CONFIGURATION STEP-BY-STEP

Zero & Full-Scale Calibration

Note: For Pt385 (Platinum), alpha = 0.00385Ω/Ω/ºC using the European curve reference, ITS-90. For Pt391 (Platinum), Alpha = 0.00391 Ω/Ω/ºC using reference 11-100. Alpha (α) is used to identify the particular RTD curve. Alpha (α) is used to identify the RTD curve and its value is derived by dividing the sensor resistance at 100ºC (boiling point of water) minus the sensor resistance at 0ºC (freezing point of water), by the sensor resistance at 0ºC, then by 100ºC (α = [R100ºC - R0ºC] / R0ºC/ 100ºC). For Pt 100Ω, this is 38.5Ω/100.0Ω/ 100ºC, or 0.00385Ω/Ω/ºC.

The configuration software will allow you to select the curve required for your application (i.e. your alpha value). It uses this value to calculate the corresponding input resistance required during calibration, which it returns to you in calibration prompt messages.

Platinum RTD Resistance Versus Temperature

	Temperature in Ohms	
TEMP	**100Ω Platinum RTD**	
°C	**Pt385 (α=0.00385)**	**Pt391 (α=0.00391)**
- 200	18.52	17.26
- 150	39.72	38.79
- 100	60.26	59.64
- 50	80.31	80.00
- 40	84.27	84.03
- 30	88.22	88.04
- 20	92.16	92.04
- 10	96.09	96.02
0	100.00	100.00
+ 10	103.90	103.96
+ 20	107.79	107.91
+ 30	111.67	111.86
+ 40	115.54	115.78
+ 50	119.40	119.70
+ 100	138.51	139.11
+ 150	157.33	158.22
+ 200	175.86	177.04
+ 250	194.10	195.57
+ 300	212.05	213.81
+ 350	229.72	231.76
+ 400	247.09	249.41
+ 450	264.18	266.77
+ 500	280.98	283.84
+ 550	297.49	300.61
+ 600	313.71	317.09
+ 650	329.64	333.29
+ 700	345.28	349.18
+ 750	360.64	364.79
+ 800	375.70	380.10
+ 850	390.48	395.12

Note: Shaded values fall outside the supported zero range for the ST131.

Select The <u>Over/Under-Scale Thresholds & Alarm Levels</u>…

This unit allows you to select over-scale and under-scale output range thresholds which determine the linear operating range of your output. They also indirectly define the upscale & downscale alarm/error limits. The downscale detent will be set to a current level ~0.4mA below the under-scale threshold. The upscale detent will be set approximately 1.0mA above the over-scale threshold. In this way, a lead break or open sensor fault can be easily discerned from simply an over-range or under-range input signal.

The range of adjustment for the under & over-scale thresholds is calibrated at the factory and indicated via the “Min” and “Max” value fields adjacent to the slide controls. Note that the threshold levels can vary as much as 10% of span between units for the same digital setting, and this will be reflected by differing values for Min and Max between units. The Min/Max limits of adjustment are calibrated at the factory.

CAUTION: For a low resistance or shorted load, and a high loop supply voltage, excessive over-range current does drive excessive power dissipation in the output pass transistor of the transmitter and will cause the unit to get warm. This could be troublesome at elevated ambient temperatures and in hazardous environments, particularly for output currents near 30mA.

- Use the **Under-Range Limit** slide control to select an approximate under-scale threshold. You have <u>8 levels</u> of under-scale threshold adjustment between Min & Max, typically between 2.1mA and 3.6mA. Your selection will be indicated in the field just above the control.
- Use the **Over-Range Limit** slide control to select an approximate over-scale threshold. You have <u>16 levels</u> of over-scale threshold adjustment between Min & Max, typically between 21mA and 30mA. Your selection will be indicated in the field just above the control.

After making your adjustments, click the “Submit O/U Configuration” button to write your adjustments to non-volatile transmitter EEPROM memory.

The linear operating range of your output is now defined between the limits you specified. Your under-scale and over-scale thresholds also indirectly correspond to a linear operating region that usually extends outside of the input zero and full-scale limits you specified. Additionally, the sensor fault/break detent output levels are set outside the linear operating region so that you can discern them from simply an over-range or under-range input signal.

You should check your under-scale and over-scale threshold levels. For example, you could disconnect an RTD lead to check your O/U alarm limits, which should be ~0.4mA below the under-scale threshold for a downscale break, or 1mA above your over-scale threshold for an upscale break.

CONFIGURATION STEP-BY-STEP

Over-Scale & Under-Scale Thresholds

TIP – Namur Limits: For Namur compliant output limits, you generally need to produce a linear output range from 3.8mA to 20.5mA and have a failure high limit greater than or equal to 22.5mA, and a failure low limit less than or equal to 3.6mA.

TIP – Error Detection: Note that a checksum error can be distinguished at the output signal from a lead break error by selecting an under-scale limit that is greater than the minimum threshold setting. This is because a checksum error always sends the output signal to a level that is 0.4mA below the lowest threshold setting until reset (~1.8mA). If you select an under-scale threshold value greater than the minimum, then you ensure that the downscale alarm level limit (0.4mA below the threshold) does not overlap with the checksum error level indication.

CONFIGURATION STEP-BY-STEP

Break Detection

Select Upscale or Downscale Lead Break Detection…

Upon sensor burnout or a broken sensor lead, you can select **"Downscale"** to send the output current to the under-scale alarm limit, which is ~0.4mA less than the under-scale threshold. Otherwise, you can select **"Upscale"** to send the output to the over-scale alarm limit, which is ~1mA above the over-scale threshold. By using alarm levels outside of a defined linear operating range, a lead break or open sensor can be easily discerned from an over-range or under-range input signal by noting its current level.

Read Status & Reset Unit

(Optional) Read Status & Reset Unit…

You can use the **"Read Status"** button to display fault status information relative to the input signal. The fault status error level will be indicated in the "Fault Status:" message field, and any additional diagnostic information will be displayed in the message window at the bottom of the screen. Possible fault status levels and diagnostic messages are indicated below:

FLT LEVEL	FAULT INDICATION
0 or None	Normal Operation, No Faults
1*	IN- Exceeds Positive Limit
2*	IN- Exceeds Negative Limit
3	IN+ Exceeds Positive Limit
4	IN+ Exceeds Negative Limit
5	IN+ Exceeds Positive Limit & IN- Exceeds Positive Limit
6	IN+ Exceeds Positive Limit & IN- Exceeds Negative Limit
7	IN+ Exceeds Negative Limit & IN- Exceeds Positive Limit
8	IN+ Exceeds Negative Limit & IN- Exceeds Negative Limit
ELSE	"Error Reading Unit. Check Connections and try again."

***Note:** A two-wire sensor input cannot correctly register IN- errors, as this always requires a third lead to the sensor. A break in IN- will return Fault Level 3, the same as a break in IN+. If an IN- error is flagged with a two-wire sensor, it is referring to the short jumper wire placed between terminals 3 & 4 of the unit, which supplants the third sensor lead for two-wire input connections. Failure to install this jumper for 2-wire sensors will drive error level 5 (see below).

Normally, after clicking "Read Status", No Faults will be indicated and "Read Complete! Normal Operation, inputs in range" will be displayed in the message bar. For a 3-wire sensor, a break in the IN+ lead will return "Fault Code:3 (Positive Input Exceeds Positive Limit)". A break in the IN- lead will return "Fault Code: 1 (Negative Input exceeds Positive Limit)". A break in the third lead that connects to terminal 4 will return "Fault Code: 5 (Positive Input exceeds positive Limit and Negative Input exceeds Positive Limit)". For a 2-wire sensor, a break in the IN+ lead and/or IN- will return "Fault Code:3 (Positive Input Exceeds Positive Limit). A missing jumper between terminals 3 & 4 of the transmitter will return "Fault Code: 5 (Positive Input exceeds positive Limit and Negative Input exceeds Positive Limit)". The following table summarizes the Fault Levels returned for a break or open in each of the input leads.

LEAD BREAK	2-WIRE FAULT	3-WIRE FAULT	4-WIRE FAULT
#1, M	NA	NA	Not Flagged
#2, IN+	3	3	3
#3, IN-	3	1	1
#4, L	NA	5	5
3-4 Jumper	5	NA	NA

CONFIGURATION STEP-BY-STEP

You can use **"Reset Unit"** to reset the transmitter and cause it to revert to its power-up or last saved configuration. This will also clear a very rare checksum error, which can occur if the transmitter fails to read its configuration from the EEPROM properly, or if the EEPROM contents have been corrupted. A checksum error will also send the output current to 0.4mA below the lowest under-scale threshold setting, until reset via this control, or by toggling loop power OFF/ON. A persistent checksum error could indicate a defective transmitter.

Factory Settings

(Optional) Factory Settings…

You can use the "**Restore Factory Settings**" button to restore the transmitter configuration to the original factory state (see Specifications Reference Test Conditions), including the optional settings (over/under-scale & and break detection). This control provides a potential recovery path should the configuration ever become corrupted during recalibration, perhaps due to miscalibration. For example, if during calibration you break the USB connection before completing calibration, the EEPROM checksum value could be corrupted and this would inhibit normal operation. Alternately, this button can be used as a sanitation tool to restore the unit to its initial configuration. Note that the "Reset Unit" control of Unit Status sends the unit to its power-up or stored configuration, different from this control which sends the unit to its initial factory configuration.

SPECIFICATIONS

Model ST131-0600

Signal Transmitter
RTD Input
Non-Isolated
Two-Wire Loop-Powered
CE Approved
No SIL Approvals

Model ST131-0610

Adds UL/cUL Class 1, Division 2 approvals

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

Model Numbers:

ST13/Input-Isolation/Power/Approvals/SIL

ST13 is the model Series. The prefix "ST" denotes the "Smart Transmitter" family. The trailing "1" digit denotes an RTD input type. The "0" after the hyphen denotes non-isolated, the "6" that follows denotes 2-wire loop powered. The "0" or "1" following denotes CE Approvals Only, or CE and UL/cUL Class 1, Division 2 Approvals. The last "0" digit refers to No SIL Approvals. You can optionally request specific custom calibration.

ST131-0600 RTD Input, Non-Isolated, CE Approved, No SIL Certification
ST131-0610 Same as first but adds UL/cUL Class 1, Division 2 Approval

Note that ST131 models can optionally be ordered with factory calibration to your specifications. This is specified as a separate line item at time of purchase. Factory calibration requires selection of input type (Pt RTD or Resistance), sensor wiring (2-wire or 3/4-wire), Input Zero Value (-50°C, 0°C, or 0°F for Pt RTD, or Ohms for Resistance), Input Full-Scale (up to 850°C/1562°F or 900Ω), and Sensor Fault Detent (Upscale or Downscale). You can obtain form 8500-858 for specifying this calibration from our web site at www.acromag.com.

Standard models without custom calibration are instead calibrated by default for Pt100 RTD, α=0.00385 Ω/Ω/°C, 3-wire, 0°C to 200°C input, 4 to 20mA output, upscale fault detection.

Recalibration of any model will require use of an ST13C-SIP configuration kit ordered separately (see Accessories).

Models can be mounted in DIN Form B connection heads using the ST130-MTG mounting kit, or on DIN rail using the ST130-DIN kit. These kits are purchased separately (see Accessories).

SPECIFICATIONS
INPUT

Input Specifications

Input: RTD / Resistance

Input Configurable: For 100Ω Platinum RTD from -50°C to +850°C, or for linear resistance from 0Ω to 900Ω. Unit provides sensor excitation, linearization, lead-wire compensation (3-wire), and sensor fault/lead break detection. Consult factory for 1000Ω Pt RTD support.

Input Zero Adjust: For Pt RTD w/ 3 or 4-wire connection, select -50°C, 0°C, or 0°F. For Pt RTD w/2-wire Connection, input zero is fixed at 0°C. For Resistance input, zero is user-specified in ohms, 0Ω or 100Ω typical. Some zero values in ohms will not be acceptable and the software may prompt you to make adjustments.

Input Full-Scale Adjust: For Pt RTD, specify a full-scale temperature up to 850°C. For Resistance input, specify a resistance up to 900Ω. Minimum recommended span is 50°C (RTD), and 8Ω (Resistance).

Accuracy/Linearity: Accuracy is dependent on the calibration region as shown in Table 1. Note that accuracy is generally better than ±0.1% of the calibrated range for regions below 500°C. For Platinum RTD input type, linearity and accuracy is optimum for calibrated spans within the region of -50° to +500°C.

Table 1: RTD Ranges and Accuracy

Input Type	α[1] Alpha	°C or Ω Spans in Range	Typical[3] Accuracy
Pt385 100Ω (IEC751 Amendment 2:1995)	1.385	-50°C up to 250°C	< ±0.05%
		-50°C up to 251-500°C	< ±0.1%
		-50°C up to 501-850°C	< ±0.2%
Pt3911 100Ω (Old JIS 1981)	1.3911	-50°C up to 250°C	< ±0.05%
		-50°C up to 251-500°C	< ±0.1%
		-50°C up to 501-850°C	< ±0.2%
Resistance (Linear)[2]	1.000	0-900Ω[2]	< ±0.1%

Notes (Table 1):

[1]Alpha (α) is used to identify the RTD curve and its value is derived by dividing the sensor resistance at 100°C (boiling point of water) minus the sensor resistance at 0ºC (freezing point of water), by the sensor resistance at 0°C, then by 100°C ($\alpha = [R_{100°C} - R_{0°C}] / R_{0°C} / 100°C$). For Pt 100Ω, this is 38.5Ω/100.0Ω/100°C, or 0.00385Ω/Ω/°C and represents the average change in resistance per ºC.

[2] The Zero of the range is a fixed choice of -50°, 0°C, or 0°F for 3-wire RTD. The 2-wire RTD input uses a fixed zero of 0°C.

[3] Rated accuracy applies for input spans greater than 50°C or 8Ω, and with a 16mA output span.

Reference Test Conditions: 100Ω Pt RTD, α=0.00385 Ω/Ω/°C, 0°C to 200°C input, 4-20mA output, Upscale break detection, ambient temperature = 25°C; power = 24V DC; R-Load = 250Ω.

Input Configuration: Three-wire w/ lead compensation, four-wire w/ 3-wire lead compensation, or two-wire w/o lead compensation.

Input Gain: PGA gain is adjustable for 6.25, 12.5, 25, 50, 100, 200, and 400 mV/mV. PGA output voltage sinks current through 6.34KΩ and a current gain of 50mA/mA is applied to that current at the output stage.

SPECIFICATIONS

Linearization Range: Digitally adjustable correction, 8-bit value (256 steps), at 3.9nA/mV per step (set to zero for linear resistance input). The maximum linearization coefficient is 0.99uA/mv (∆Iref/∆Vin). Additive to excitation current to accomplish linearization of Pt RTD inputs.
Excitation Currents: Utilizes dual current sources, one for each ± sensor lead, matched within ±0.2%. Set to 0.493mA typical, with less than 10ppm/°C drift over temperature (zero code level for each is between 0.480mA and 0.510mA). Digitally adjustable via Coarse and Fine DAC's with 256 steps of adjustment for each (7bits + sign bit). Coarse adjust is -195 to +195uA w/1.54uA/step. Fine adjust is -12.2 to +12.2uA with 96nA/step. Also adjusted via linearization feedback for Pt RTD input types (see below).
Lead-Wire Compensation: For balanced ± sensor leads (same size, length, & type) and only with 3 or 4-wire sensor connections. Recommended maximum lead resistance is 25Ω per lead.
Lead Resistance Effect: Output shift less than ±0.01% per ohm of lead resistance, with a max shift less than ±0.1% with up to 10Ω per ±lead.
Lead Break/Sensor Burnout Detection: Select output upscale or downscale detection. Alarm output level is indirectly programmed via the linear U/O threshold settings (see Output Fault Limits).
Input Filter Bandwidth: -3dB at 700Hz, typical, normal mode filter.
Input Response Time: Output completes transition within 500us, typ.
Input Bias Current: 50pA typical (PGA), ~doubling every +10°C.

OUTPUT

Output Specifications

Output: 4-20mA DC
Output Range: 4 to 20mA DC nominal. An output zero from 3.5mA to 6mA, and an output full-scale from 16mA to 24mA may be optionally configured. The linear operating range including over-range is also digitally adjustable between the Under-scale & Over-scale limits selected. Over-scale limit is adjustable from ~20.5 to 30mA typical, and the under-scale limit is adjustable from ~2.1 to 3.6mA typical.
Output Zero Adjust: 4mA nominal, adjustable from 3.5mA to 6mA. Sets value corresponding to 0% of output and is adjusted independent of under-range threshold. Hardware uses digitally controlled (7bits + sign) coarse & fine DAC's with 256 steps of adjustment in each. Zero code output level is ~4.116mA. Coarse adjustment is 0.029mA/step with a typical coarse adjustment range from -3.77mA to +3.77mA at the output. Fine adjustment is 0.0018mA/step for an adjustment range of -236uA to +236uA at the output. Your effective adjustment range is additionally limited via the configuration software.
Output Full-Scale Adjust: 20mA, adjustable from 16-24mA independent of under and over-range thresholds. Sets value corresponding to 100% of output and adjusted independent of over-range threshold. Effective adjustment range is additionally limited via the configuration software.
Output Span: 4-20mA, nominal. Optionally, output zero from 3.5mA to 6mA and a full-scale from 16mA to 24mA may be configured. Span adjust is determined by PGA gain and sensor excitation with 3 methods of digital adjustment: PGA gain select, reference current coarse adjustment and fine adjustment. Span expressed as Io/Vin from the PGA to the output amp has an adjustment range of 49.3mA/V to 3150mA/V. Additionally, the linear operating range of the output may be extended via the under-scale and over-scale threshold settings set separately. Your effective adjustment range is additionally limited via the configuration software.

SPECIFICATIONS

Output Fault/Alarm Limits: Downscale fault level is ~0.4mA below the selected under-scale threshold, typical. Upscale fault level is ~1.0mA above the selected over-scale threshold, typical. The unit can be set for limits that comply with NAMUR NE43 recommendations
Output Compliance: 8.6V Minimum (transmitter). Will drive 15V typical, with a 24V supply and 20mA loop current.
Output Ripple: Less than ±0.1% of output span.
Output Limiting: Output current limit is programmable and limited to over-scale and under-scale threshold values that you configure less than or equal to 30mA. Actual over/under-range limit values are only approximate and may vary between units.

POWER

Power: 9-32VDC, SELV, 30mA Max. Class 2
Output Power Supply: 9-32V DC SELV (Safety Extra Low Voltage), 30mA maximum. The supply voltage across the transmitter must not 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 8.6V minimum to the transmitter terminals, plus any line drop. Ideally, your supply should drive over-scale and alarm current levels into the load (alarm level is 1mA above the over-scale threshold selected). Reverse polarity protection is included, as output terminals are bridge coupled and not polarized. The ± output polarity labels on the enclosure are for reference only.
CAUTION: *Do not exceed 36VDC peak to avoid damage to the unit. Terminal voltage at or above 8.6V minimum must be maintained across the unit during operation.*
Output Resolution: Not Applicable. Input signal is not digitized. The signal path is fully analog with digital controls for offset, excitation, and linearity. The effective adjustment resolution is approximately 12-bits for reference test conditions.
Output Response Time: For a step change in input signal, the output reaches 98% of final value in less than 500us typical, with a 250Ω load.
Output Load Resistance Effect: Less than ±0.005% of output span effect for ±100Ω change in load resistance.
Accuracy: Refer to Table 1 for relative accuracy referred to the input. Accuracy will vary with calibrated input and output span. Rated accuracy assumes 50°C minimum input span and 16mA output span. Accuracy includes the effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.
Ambient Temperature Effect: Better than ±0.008% per °C of input span or ±80ppm/°C, over the ambient temperature range for reference test conditions. Includes the combined effects of zero and span drift over temperature.
Power Supply Effect: Less than ±0.001% of output span effect per volt DC change.
Load Resistance Range Equation: R_{load} (Max) = (V_{supply} - 9V)/0.020A for full-scale output current (assuming negligible line drop). This does not account for over-scale or alarm current levels and you should adjust the denominator in this expression for your particular alarm current level. At 24V DC, R_{load} = 0-750Ω typical for 20mA of loop current and no line drop.
Note: Additional filtering at the load is recommended for sensitive applications with high-speed acquisition rates--high frequency noise may be reduced by placing a 0.1uF capacitor directly across the load. For

excessive 60Hz supply ripple, a 1uF or larger bulk capacitor is recommended at the load.

USB Interface

Includes a USB socket for temporary connection to a PC or laptop for the purpose of setup and reconfiguration. During reconfiguration and calibration, the transmitter receives power from both the USB port and the output loop, and both power sources must be present to calibrate the unit.

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. Consult factory for a low speed (1.5Mbps) version if required.

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

USB Connector: 5-pin, Mini USB B-type socket, Molex #5000751517.

PIN	DEFINITION
1	+5V Power (Includes Inrush Current Limiting)
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.

Inrush Current Limiting: Unit includes series inrush current limiting at its USB power connection.

Cable Length/Connection Distance: 5.0 meters maximum.

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

SPECIFICATIONS

IMPORTANT – USB Isolation is recommended: The transmitter digital ground is connected in common to USB power/signal ground and shield ground and will make connection to earth ground when directly connected to the USB port of a Personal Computer without the use of an isolator. Failure to connect without isolation would force a potential difference between earth ground at the PC and the earth ground normally applied in a properly grounded two-wire current loop. This would drive an inadvertent ground loop that will interfere with operation and could damage the unit. For this reason, USB isolation is strongly recommended when connecting to a PC. Otherwise, in the absence of USB isolation, a battery powered laptop could be used to connect to the unit, as the laptop does not normally connect to earth ground.

Agency Approvals

Safety Approvals: Model ST131-0610 is UL Listed (USA & Canada) suitable for use in Class I, Division 2, Groups A, B, C, D Hazardous Locations, or Nonhazardous Locations only.

ATEX Certified

ATEX Certified: Model ST131-0610 is ATEX Certified for Explosive Atmospheres per ATEX Directive 94/9/EC which complies with standards BS EN 60079-0:2012 & BS EN 60079-15:2010.

Ex II 3 G Ex nA IIC T4 Gc -40ºC ≤ Ta ≤ +80ºC

DEMKO 13 ATEX 1113348X

X = Special Conditions

1) Must be installed in an ATEX Certified enclosure with a minimum ingress protection rating of at least IP54 and used in an environment of not more than pollution degree 2.
2) Enclosure must have a door or cover accessible only by the use of a tool.
3) Provisions shall be made to prevent the rated voltages from being exceeded by the transient disturbances of more than 140% of the peak rated voltage.

SPECIFICATIONS

Enclosure & Physical

General purpose plastic enclosure intended to be mounted in DIN Form B connection heads. Optionally, a DIN rail adapter is available for mountable to 35mm "T-type" DIN rail, or G-Type DIN rail.

Dimensions: Diameter = 44.5mm (1.752 inches), Height = 23.4mm (0.921 inches). Refer to Mechanical Dimensions drawing. Conforms to DIN 43 729 Form B size requirements.

I/O Connectors: Barrier strip type, captive screw terminals; wire range: AWG #14-28 solid or stranded.

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

Case Material: Self-extinguishing polycarbonate ABS plastic, UL94 V-0 rated base material, color blue. USB dust cap material is Santoprene, 251-70W232, color red.

Terminal Material: Captive 4-40 threaded steel screw and 0.040 inch thick Phosphor-Bronze terminal material.

Circuit Board: Military grade fire-retardant epoxy glass per IPC-4101/98 with humi-seal conformal coating.

DIN-Rail Mounting: The unit can be optionally mounted to 35x15mm, T-type DIN rails using optional ST130-DIN DIN-rail mounting adapter kit. Refer to the Mounting & Dimensions 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).

Long-Term Stability/Recalibration: Units normally maintain their calibration over very long periods of time without requiring periodic readjustment. Small shifts in adjustment due to component ageing are normal and may occur over time, usually during the first year of service. Other shifts in adjustment may be attributed to shock or vibration, and environmental influences. It is recommended that calibration be initially rechecked after 18 months of service, then successively as required by your company's maintenance schedule. Typically, user calibration schedules are developed with consideration of the application environment, required accuracy, and historical performance. Modules exposed to extreme hot or cold ambient temperatures, and/or noisy electrical environments, may require more frequent calibration checks.

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

Isolation: Input & output are not isolated from each other for this model. Model is intended to interface with insulated/non-grounded sensors.

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).

Operating Shock & Vibration Immunity: Sinusoidal Vibration: 5G, 5-500 Hz, in 3 axis at 2 hours/axis per IEC60068-2-6. Random Vibration: 5G-rms, 5-500 Hz, in 3 axis at 2 hours/axis per IEC60068-2-64. Mechanical Shock: 30g at 11ms half-sine shock pulses and 50g at 3ms half-sine shock pulses in each direction along 3 axis (18 shocks), per IEC60068-2-27.

EMC – CE Marked

Electromagnetic Interference Immunity (EMI): The transmitter output has demonstrated resistance to inadvertent output shifts beyond ±0.25% of span, under the influence of EMI from switching solenoids, commutator motors, and drill motors.

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

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.

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.

Note: This is a Class B product.

Reliability Prediction

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

Temperature	ST131-06X0
25ºC	2,860,453 hrs
40ºC	2,177,677 hrs

SPECIFICATIONS

Configuration Controls (Software Configuration Only via USB)

This transmitter produces an analog output current proportional to a sensor input based on the voltage measured across the sensor resistance. No switches or potentiometers are used to make adjustments to this transmitter. Its analog output level and behavior is instead determined via register values stored in non-volatile EEPROM memory in the transmitter. The contents of these registers are automatically uploaded at power-up and will determine excitation, amplifier gain, zero offset, linearization, and other options of the embedded ASIC. The contents of these registers are programmed 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 the contents of these registers. All register information is stored in non-volatile EEPROM memory, except for Control Register 1, the Fault Status Register, and the Checksum Register. All control registers are read/write capable except for the Fault Status Register.

Refer to Configuration Step-by-Step of this manual for detailed information on available software control of this model.

ACCESSORIES

Software Interface Package/Configuration Kit – Order ST13C-SIP

- USB Signal Isolator
- USB A-B Cable 4001-112
- USB A-mini B Cable 4001-113

- Configuration Software CDROM 5039-312

This kit contains all the essential elements for configuring ST130 Smart 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.

ACCESSORIES

Transmitter Mounting Kit – Order ST130-MTG

- M4 Mounting Screw 1010-456, 2pcs
- 6-32 Mounting Screw 1010-443, 2pcs
- Relief Spring 1011-358, 2pcs

This kit contains two M4 mounting screws and relief springs for mounting this transmitter in DIN Form B Connection Heads. Two 6-32 screws are included for non-compliant DIN Form B Connection Heads with English threads. The M4 screws in this kit are of a special design that is semi-captive to the ST130 enclosure. Order 1 kit per transmitter.

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 ST131C-SIP (see above).

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 ST13C-SIP Software Interface Package and also with the isolator model USB-ISOLATOR.

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 ST130 transmitter. It is normally included in ST13C-SIP.

Series ST DIN Rail Adapter – Order ST130-DIN

- DIN Rail Adapter 1027-187
- M4 Mounting Screw 1010-456, 2pcs
- Relief Spring 1011-358, 2pcs

This is a DIN rail bracket with mounting screws that connect to the ST130 Smart Transmitter to allow it to be snapped onto 35mm T-type DIN rail, or G-type DIN Rail. The screws and springs of this kit are the same as those provided in Transmitter Mounting Kit ST130-MTG.

NOTES:

Revision History

The following table shows the revision history for this document:

Release Date	Version	EGR/DOC	Description of Revision
15 OCT 13	J	BC/ARP	Update manual for clarity. (ECN 13F005)
20 NOV 13	K	FJM/ARP	Change Default State Configuration. (ECN 13L001)
03 DEC 13	J	FJM/ARP	Change back to Rev J; incorrect manual on ECN 13L001 (should have been 8500896 Rev H to J).
08 APR 2019	K	FJM/ARP	Added Long-Term Stability/Recalibration section.