USB Programmable, DIN Rail Mount, Passive I/O DC Current/Voltage Input Splitter with Dual Isolated 2-Wire 4-20mA Transmitter Outputs

Model SP236-0600, DC Current & Low DC Voltage Input
Model SP237-0600, DC ±1V/±10V Medium Voltage Input
Model SP238-0600, DC ±15V/±150V High Voltage Input

USER'S MANUAL

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Table of Contents

IMPORTANT SAFETY CONSIDERATIONS

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

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

This manual is for our 2-wire (loop-powered) SP200 model transmitters that convert a DC voltage or current input signal to dual isolated current output loops. However, if your application requires dual output 4-wire transmitters (w/ separate isolated DC power) that drive voltage/current outputs, please refer to similar SP300 series models. For thermocouple input signals, please refer to our SP233 (2-wire loop-powered) and SP333 (4-wire) models.

GETTING STARTED

DESCRIPTION

Symbols on equipment:

Means “Refer to User’s Manual (this manual) for additional information”

Model SP23x-0600 transmitters are ANSI/ISA Type II transmitters with dual isolated outputs, commonly referred to as signal splitters or repeaters. These units are designed to interface with a DC Current or DC voltage input signal, isolate the input, and separately modulate two isolated 2-wire current loops proportional to the input.

The SP236-0600 is designed for DC Current (0-20mA/4-20mA), and Low Voltage DC (±0.5V/0-500mV) input. The SP237-0600 is designed for medium voltage DC signals (±1V, ±5V, ±10V), and the SP238-0600 for large Voltage DC signals (±15V, ±75V, ±150V). All units are set up and calibrated using a wired USB connection to a Windows-based PC running configuration software (Windows 7 and later versions only), or an Android-based tablet or smartphone running our Agility mobile APP. Units provide an adjustable input range, input isolation, and variable input filtering.

Key Features

- **Digitally set up and calibrated via a wired USB connection to a Windows-based personal computer, or a wired USB-OTG connection to an Android tablet or smartphone.**
- **Thin 17.5mm wide enclosure for high-density DIN-rail mounting.**
- **Models support both process current input and DC voltage input. SP236 has separate inputs for 0-20mA/4-20mA/0-11.17mA/±1mA, and ±0.5V/0-500mV. SP237 has separate inputs for ranges up to ±1V, and ±10V. SP238 has separate inputs for high-level ranges up to ±15V, and ±150V.**
- **High measurement accuracy & linearity w/24-bit input & 16-bit output conversion.**
- **Adjustable input range and adjustable output ranges. Input and outputs can be scaled independently and the input may be scaled differently for each output.**
- **Extra output connection supports optional sourced output wire termination.**
- **Variable input filter adjustment.**
- **Normal or reverse acting output.**
- **Very low loop burden with terminal voltage down to 7V.**
- **Convenient two-wire loop power with non-polarized output connections. The input can be powered from either or both output loops and will function as a simple isolated transmitter or a signal splitter.**
- **Namur compliant loop current.**
- **Wide ambient temperature operation.**
- **Thoroughly tested and hardened for harsh environments.**
- **CE Approved & includes UL/cUL Class 1, Division 2 Approvals.**
- **FCC Conformity Class B.**
- **ATEX Certified for Explosive Atmospheres.**
  Ⓔx II 3 G Ex nA IIC T4 Gc -40°C ≤ Ta ≤ +80°C
  DEMKO 18 ATEX 2086X IECEx UL 18.0092X

Application

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

These transmitters are designed for high-density mounting on T-type DIN rails. Units may be mounted side-by-side on 17.5mm centers.

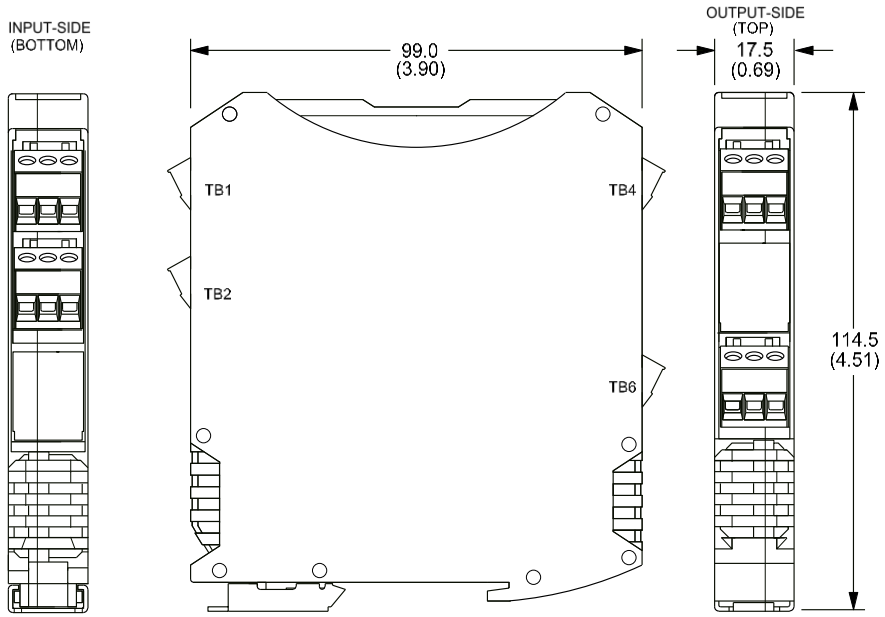
Models isolate current or voltage input signals and can mate with grounded or non-grounded sensors. They provide dual isolated 4-20mA output current loops that are linear with sensor current or voltage. A unique feature of these splitters is that the input and outputs can each be scaled independently, and you may even scale the input differently for each output.

The output signal is transmitted via dual two-wire, 4-20mA current loops. The two-wire current signals can be transmitted over long distances with high noise immunity. Its inherent live-zero 4mA offset current offers built-in output fault detection, should an output wire break. An extra connection screw at each output allow it to be optionally wired for a "sourced" 4-20mA output configuration (see Optional Output Wiring).

Mechanical Dimensions

Units may be mounted to 35mm "T" type DIN rail (35mm, type EN50022), and side-by-side on 0.69-inch centers.

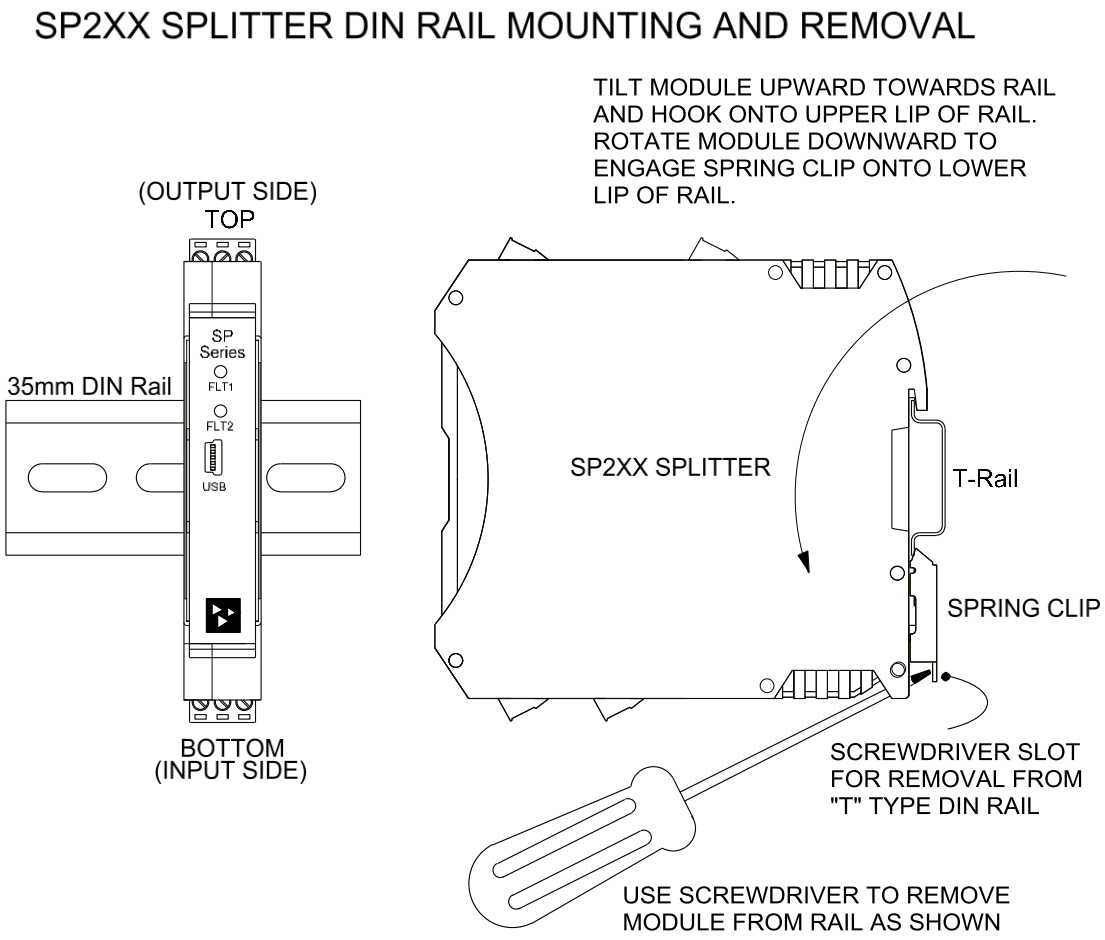
WARNING: *IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.*



DIMENSIONS ARE IN MILLIMETERS (INCHES)

DIN Rail Mounting & Removal

Refer to the following figure for attaching and removing a unit from the DIN rail. A spring-loaded DIN clip is located on the input side bottom. The opposite rounded edge at the bottom of the output side allows you to tilt the unit upward to lift it from the rail while prying the spring clip back with a screwdriver. To attach the module to T-type DIN rail, angle the top of the unit towards the rail and place the top groove of the module over the upper lip of the DIN rail. Firmly push the unit downward towards the rail until it snaps into place. To remove it from the DIN rail, first separate the input terminal blocks from the bottom side of the module to create a clearance to the DIN mounting area. You can use a screwdriver to pry the pluggable terminals out of their sockets. Next, while holding the module in place from above, insert a screwdriver into the lower path of the bottom of the module to the DIN rail clip and use it as a lever to force the DIN rail spring clip down while pulling the bottom of the module outward until it disengages from the rail. Then simply lift it from the rail.



ELECTRICAL CONNECTIONS

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

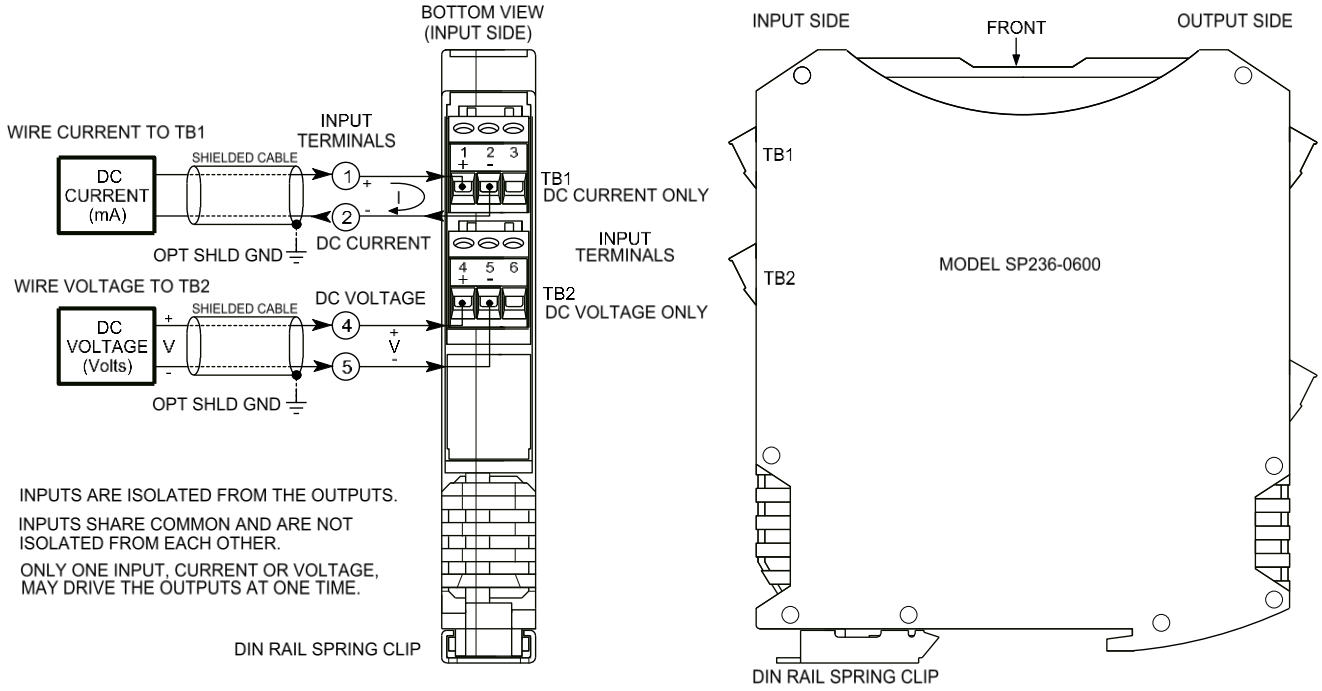
Wire terminals can accommodate 14–26 AWG (2.08–0.13mm^2) solid or stranded wire with a minimum temperature rating of 85°C. Input wiring may be shielded or unshielded type. Ideally, output wires should be twisted pair, or shielded twisted pair. Terminals are pluggable and can be removed from their sockets by prying outward from the top with a flat-head screwdriver blade. These models support two separate input ranges at TB1 and TB2. Only one input may drive the current outputs at one time. Strip back wire insulation 0.25-inch on each lead and insert the wire ends into the cage clamp connector of the terminal block. Use a screwdriver to tighten the screw by turning it in a clockwise direction to secure the wire (0.5-0.6Nm torque). Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. As a rule, output wires are normally separated from input wiring for safety, as well as for low noise pickup.
Important – End Stops: For hazardous location installations (Class I, Division 2 or ATEX / IECEx Zone 2), it should utilize two end stops (like Acromag 1027-222) to help secure modules to the DIN rail (not shown).

Input Connections

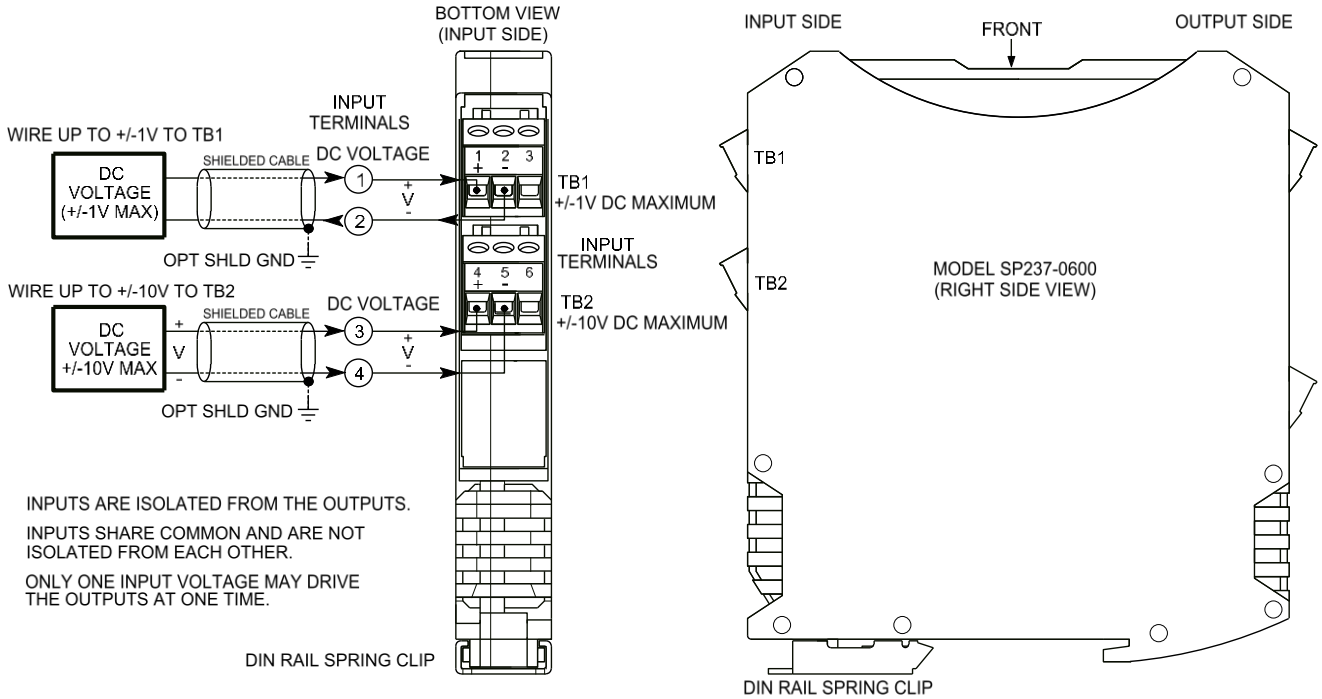
Sensor wires are wired directly to transmitter input terminals at the bottom of the module (the spring-loaded DIN clip side), as shown in the connection drawing below. Observe proper polarity when making input connections.

- **Transmitter input signal is isolated from each output**. One or both outputs may power the input allowing it to be used as a single channel transmitter or signal splitter.
- **Only one input, current or voltage, may drive the outputs at one time**.
- **The input may be rescaled differently for each output.**
- **SP236 DC Current is wired to the upper terminal block TB1** and D**C Voltage is wired to the lower terminal block TB2**.
- **SP237 ±1V DC maximum is wired to the upper terminal TB1 and ±10V DC maximum is wired to the lower terminal block TB2**.
- **SP238 ±15V DC maximum is wired to the upper terminal TB1 and ±150V DC maximum is wired to the lower terminal block TB2**.
- **Inputs are polarized ±.** The positive input is on the left and labeled "+", and the negative input is to its right. Observe proper polarity. See connection figures below.

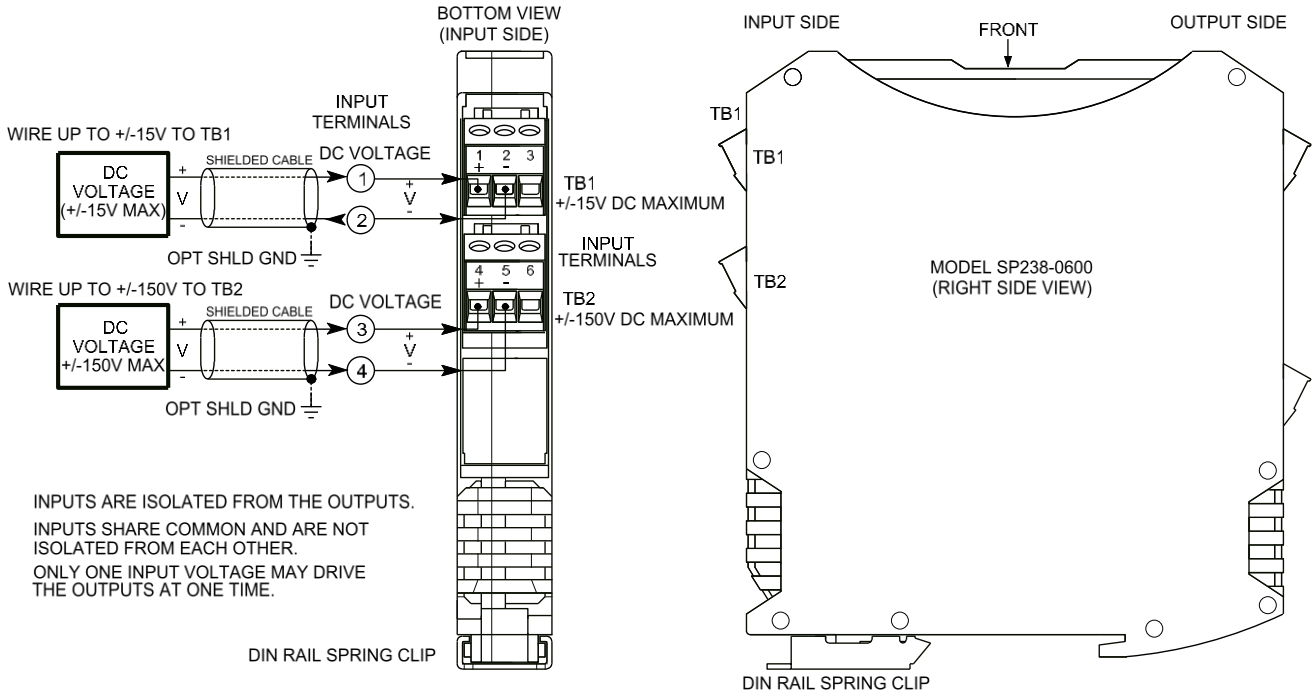
MODEL SP236-0600 INPUT SENSOR WIRING
DC CURRENT AND DC MILLIVOLTAGE INPUT



MODEL SP237-0600 INPUT SENSOR WIRING
MEDIUM DC VOLTAGE INPUT



MODEL SP238-0600 INPUT SIGNAL WIRING
HIGH-LEVEL DC VOLTAGE INPUT

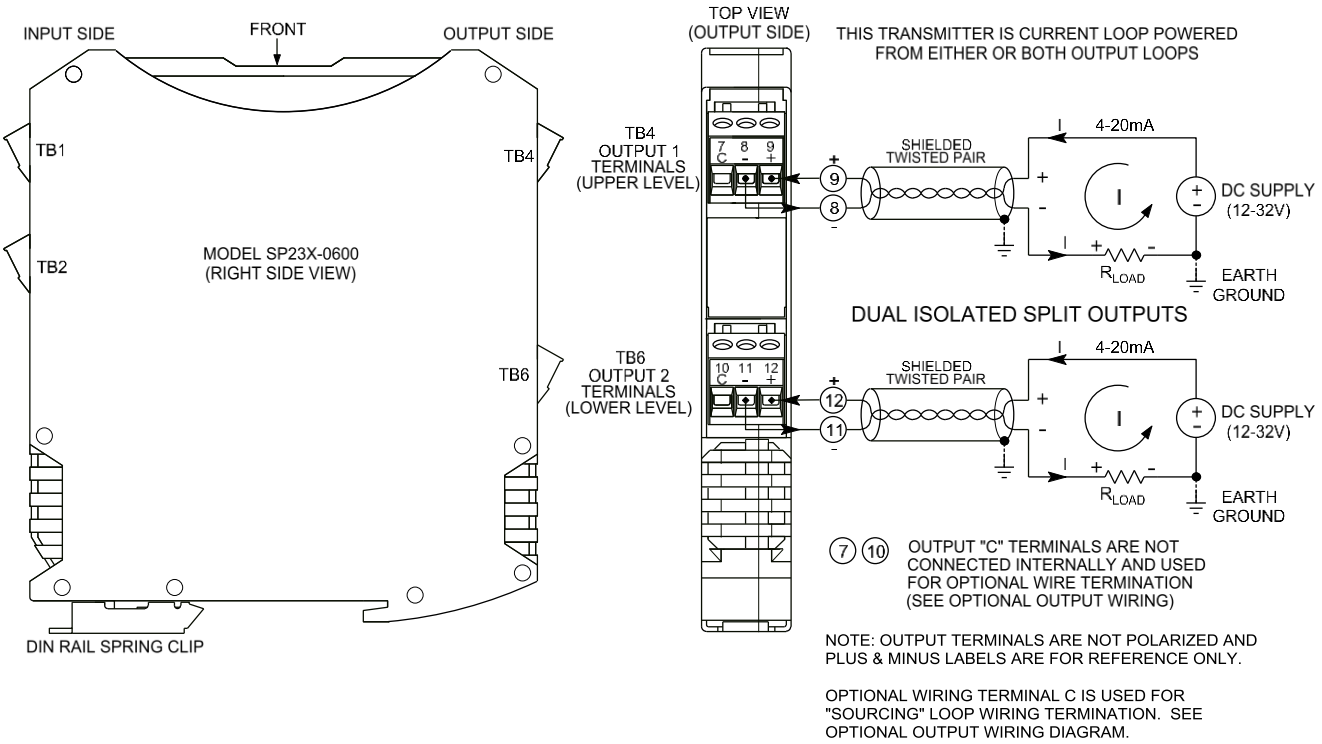


Output/Power Connections

This transmitter has dual ANSI/ISA Type 2 outputs in which the unit's power and output signal share the same two leads, and each splitter output has a "floating" connection with respect to earth ground. Connect a DC power supply and load in series in each of the two-wire output loops as shown in the drawings that follow.

- Passive output connections are not polarized. The output + and – designations are for reference only with current normally input to Output+ and returned via Output- (current sinking). Either or both output loops may power the input.
- Loop supply voltages should be from 7-32V DC with the minimum voltage level adjusted to supply over-range current to the loop load, load plus 7V MIN across the transmitter, plus any transmission line drop.
- Variation in power supply voltage between the 7V minimum required and 32V maximum allowed, has negligible effect on transmitter accuracy.
- Variation in load resistance has negligible effect on output accuracy if the loop supply voltage level is set correctly for the load resistance.
- Note the traditional placement of earth ground in the current loop. Output Earth ground is normally applied at the loop power supply minus terminal. Each 2-wire transmitter output varies off this ground by the voltage drop in the load resistance and lead-wire of the loop.

MODEL SP23X-0600 OUTPUTS/POWER WIRING
TRADITIONAL LOOP-POWERED "SINKING OUTPUT" CONNECTIONS



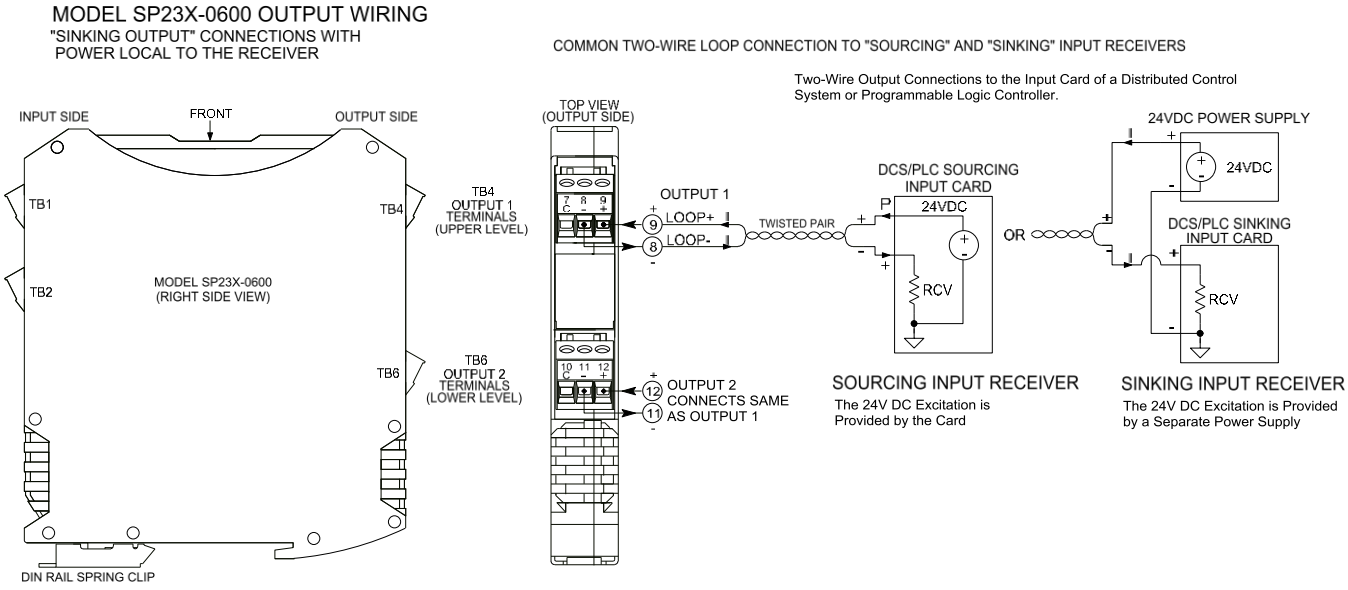
Output/Power Connections…

The traditional loop-powered 2-wire “sinking” output connections are shown above. Shielded twisted-pair wiring is often used at the outputs to connect the longest distance between the field transmitter and the remote receivers as shown. Each output of this transmitter is isolated and fluctuates relative to earth ground by the voltage drop in the output load and connection wire. This makes it flexible in the way it connects to various “Receiver” devices.

In most installations, the output loop power supply will be local to either the transmitter, or local to the remote receiver of the loop. Common receiver devices may include the input channel of a Programmable Logic Controller (PLC), a Distributed Control System (DCS), or a panel meter. Some receiver devices already provide excitation for the transmitter loop and these are referred to as “sourcing inputs”. Other receivers that do not provide loop excitation are referred to as “sinking” inputs, and these will require that a separate power supply connect within the loop. These types of receivers are depicted in the figures on the next two pages

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.

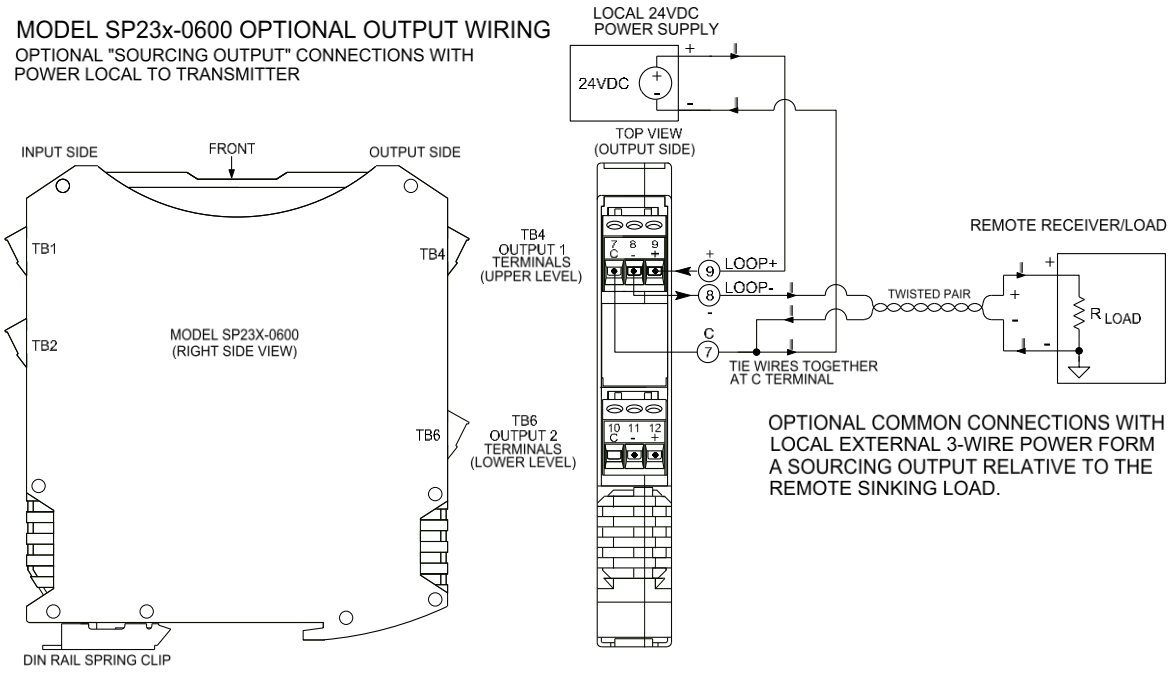


TIP - Ripple & Noise: Place additional capacitance at the load to help reduce the 60Hz/120Hz ripple sometimes present in industrial applications. For large 60Hz ripple, connect an external 1uF or larger capacitor directly across the load to reduce excess ripple. For sensitive applications with high-speed acquisition at the load, high frequency noise may be reduced significantly by placing a 0.1uF or 0.01uF capacitor directly across the load, and as close to the load as possible (this may also raise RF immunity).

TIP - Inductive Loads: If either two-wire current loops include 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(s) and this will typically cure the problem.

Output/Power Connections…

This model includes an extra termination screw at each output marked “C” which is intended to provide a convenient tie point for a “sourcing” wiring variation as shown below. The C terminals do not connect to the internal circuit. Use of this terminal in your wiring scheme allows you to connect external power local to the transmitter and form a “sourcing” entity from this “sinking” output as shown below.



Earth Ground Connections

IMPORTANT: A USB isolator is recommended when configuring or calibrating a unit to avoid the ground loop that occurs if your input signal is also earth grounded (A PC commonly ties earth ground to its USB port signal and shield ground, which is held in common to the input circuit ground of this transmitter).

The unit housing is plastic and does not require an earth ground connection to itself. If the module is mounted in a metal housing, an earth ground wire connection to that metal housing’s ground terminal (green screw) is usually required using suitable wire per applicable codes. As a rule of good practice, isolated circuits are normally earth grounded at one point. See the Electrical Connections Drawing for Output/Power connections and note the traditional position of earth ground for a two-wire output current loop. That is, earth ground is normally applied at the output loop power minus terminal and in common with the loop load or loop receiver minus. The Type II transmitter output terminals will have a “floating” connection relative to earth ground and their potential varies with the voltage drop in the load and connection wire. Circuits wired to isolated analog inputs should be earth grounded as reflected in their input connection diagram. Ground connections noted are recommended for best results and help protect the unit and its isolated circuitry by giving it a low impedance path to ground for shunting destructive transient energy away from sensitive module circuitry.

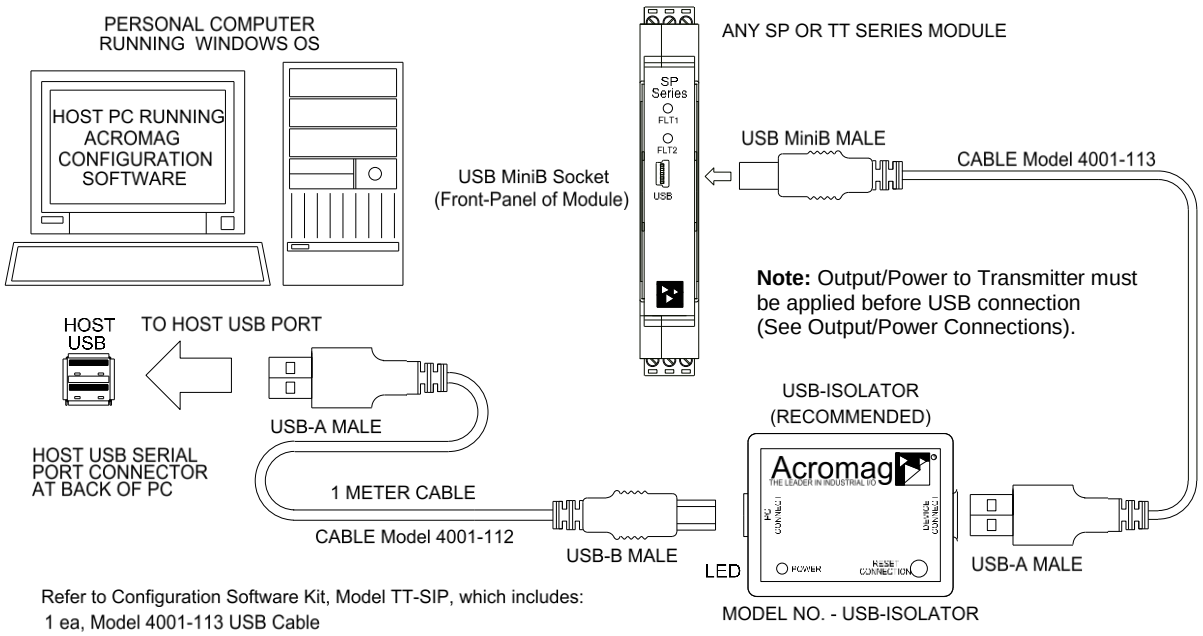
Respect the traditional position of earth ground in a two-wire current loop and avoid inadvertent connections to earth ground at other points in the same loop, which would drive ground loops and negatively affect operation.

USB Connections

Splitter is set up, configured, & calibrated via configuration software that runs on a Windows-based PC connected via USB (Windows 7 or later required), or a USB connection to a compatible Android-based tablet or smartphone with our Agility mobile APP installed. Refer to the drawing below to connect your PC or laptop to the splitter for reconfiguration and calibration using this software (the optional connection to an Android smartphone or tablet would typically not require the use of an isolator, because those devices are battery powered).

SP/TT SERIES USB TRANSMITTER CONNECTIONS

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



Refer to Configuration Software Kit, Model TT-SIP, which includes:
1 ea, Model 4001-113 USB Cable
1 ea, Model 4001-112 USB Cable
1 ea, Model USB-ISOLATOR
1 ea, Model 5040-944 TT CDROM Software

NOTE: YOU DO NOT HAVE TO USE A USB ISOLATOR IF YOU ARE INSTEAD USING A BATTERY-POWERED LAPTOP WITH NO CONNECTION TO EARTH GROUND TO CONFIGURE THE MODULE.

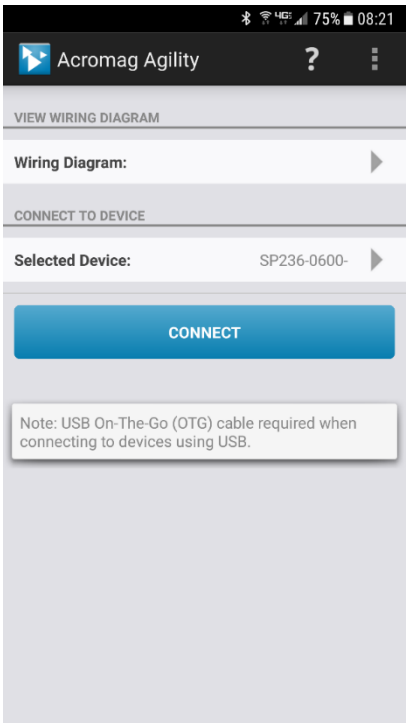
WARNING: The intent of mating USB with this transmitter is so that it can be conveniently set up and calibrated in a safe area, then installed in the field which may be in a hazardous area. Do not attempt to connect a PC or laptop to this unit while installed in a hazardous area, as USB energy levels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

- **USB Signal Isolation is 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 <u>and</u> Loop Power** - This transmitter draws power from both the current loop and from USB during set up.

IMPORTANT: USB logic signals to the unit are referenced to the potential of its internal signal ground. This ground is held in common with the USB ground and shield ground. The potential of a transmitter's current output pin (output minus) relative to earth ground varies with the load current and resistance (net IR drop). Without isolation, IR drop would drive a potential difference between the normally grounded current loop and grounded USB connection at the PC, causing a ground loop that would inhibit set up & calibration, or may even damage the transmitter. It is recommended you use an isolated USB connection. Alternatively, you could avoid using an isolator if a battery powered laptop was used to connect to the transmitter, and the laptop has no earth ground connection, either directly or via a connected peripheral.

CONFIGURATION SOFTWARE

Quick Overview – Android Reconfiguration

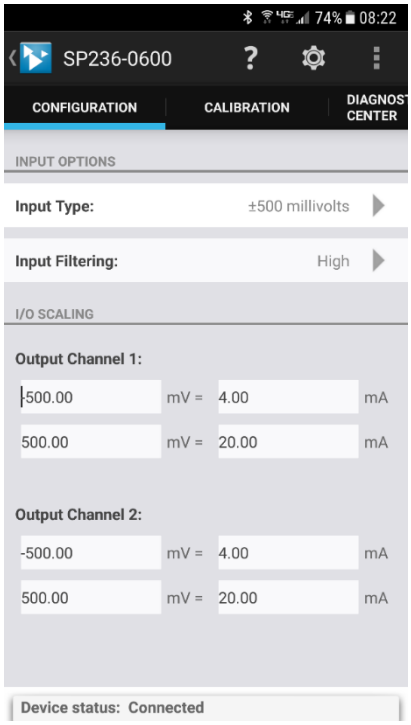


This splitter can be configured & calibrated via the Acromag Agility™ Config Tool App. This software app can be downloaded free of charge from the Google Play store at play.google.com and is compatible with Android devices that use Ice Cream Sandwich (4.0) or later OS.

To connect to this splitter, a USB OTG (On-The-Go) cable (Acromag 5028-565) and USB A to Mini-B cable (Acromag 4001-113) are also required. When you start the app, the initial Agility Connection screen at left will be presented and if you have also connected a module using a USB OTG cable, your module will be listed in the "Selected Device:" field of the Connection screen as shown.

The ability to select other devices only applies to Bluetooth devices which also utilize this app. Tap the **[CONNECT]** button to open communication with the device indicated to the right of "Selected Device" and move to the main portion of the app shown in the second screen at left. Note Android requires user permission to access external hardware--If the Device List displays "No Device Permission", select the device and when prompted to give permission to access the USB device, and tap **[OK].**

If you wish to view a wiring diagram for your splitter model, tap the arrow next to "Wiring Diagram". You may swipe left or right to view more diagrams.



The main screen also has three icons across the top: an Acromag logo w/connected model indicated, a question mark, a gear icon, and three vertical dots. These icons access additional features of this software as follows:

This icon located in the top left-hand corner of most app screens serves as a Home button, which when tapped will return you to the Connection page of the app from subsequent pages.

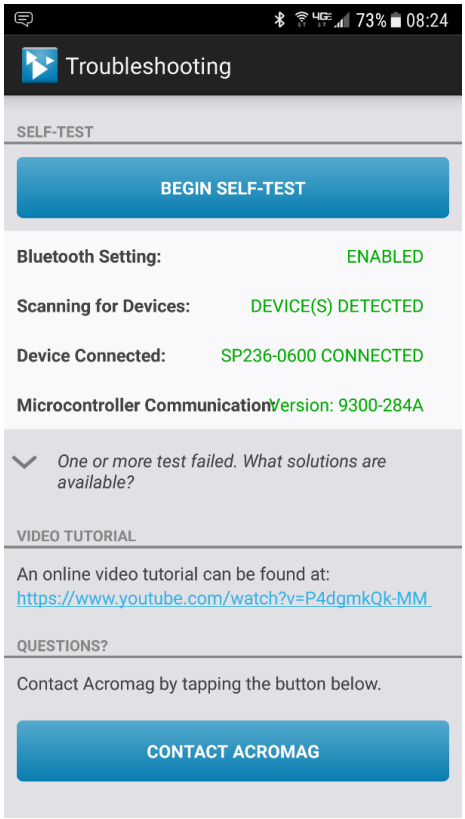
Tapping the question mark will access a Self-Test utility useful for testing your device connection.

Tapping the Gear/Settings icon will access a Utility Page to do a device Reboot, Reset Factory Calibration, or restore factory Settings.

Tapping this icon will return "About" & "Contact Acromag" Information.

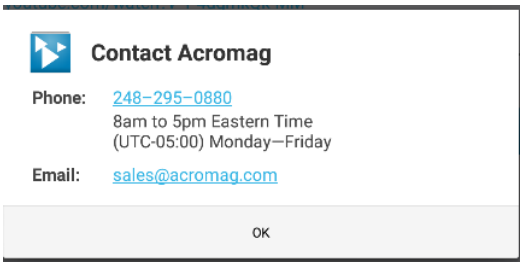
A short description of what each icon does follows:

Quick Overview – Android Reconfiguration...continued



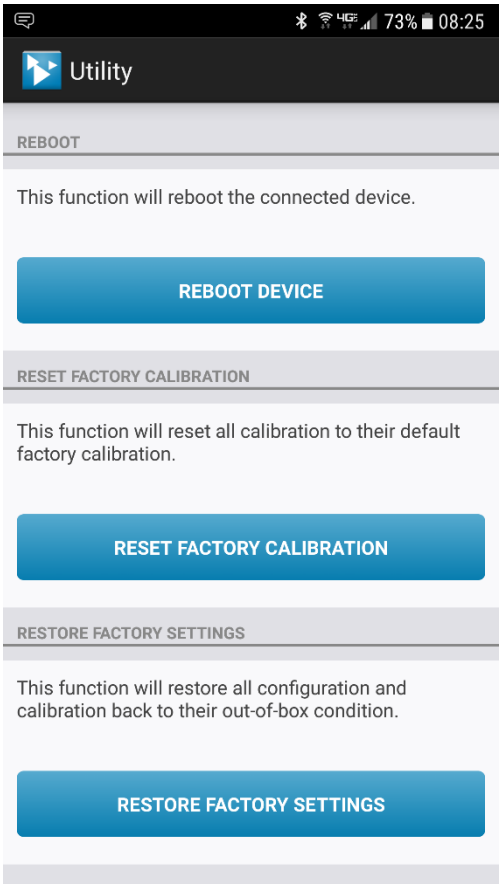
The HELP area of the application invokes a Self-Test feature that can be used to determine if your smart phone or tablet has its Bluetooth wireless technology enabled (useful for uB applications), whether any modules can be detected by rescanning, whether a device is connected, and whether the microcontroller of the connected module is operational. You simply tap **[BEGIN SELF-TEST]** to perform the diagnostic exchange and review the results returned. If one or more tests indicate Failed, you can also tap the down arrow message below the self-test report to access additional information regarding failed tests. Optionally, you can review an online video tutorial on working with the unit by tapping the Video Tutorial URL line.

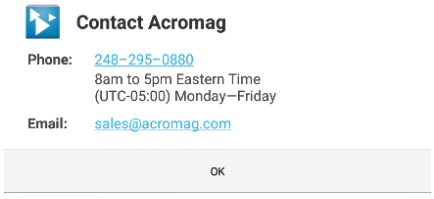
Or, if you wish to contact Acromag for assistance, you can tap the **[CONTACT ACROMAG]** bar to obtain the phone and email information window shown below for talking to Acromag directly (the same information is also obtained via the menu dotted action bar icon and "Contact Acromag" selection).



You may also refer to the Troubleshooting Table in this manual which lists common issues related to working with these splitters and some recommended remedies.

Quick Overview – Android Reconfiguration...continued





Tap the **[Gear]** icon in the Action bar to access the Utility Page shown at left. Utilize these features if you if you encounter erratic behavior with your splitter and need to get out of trouble, perhaps if you ever inadvertently misconfigure or improperly calibrate a splitter.

You can tap **[REBOOT DEVICE]** on this page to reset/restart the connected splitter, perhaps if it ever appears to freeze, or exhibits erratic operation. This is akin to a power-on reset of the splitter.

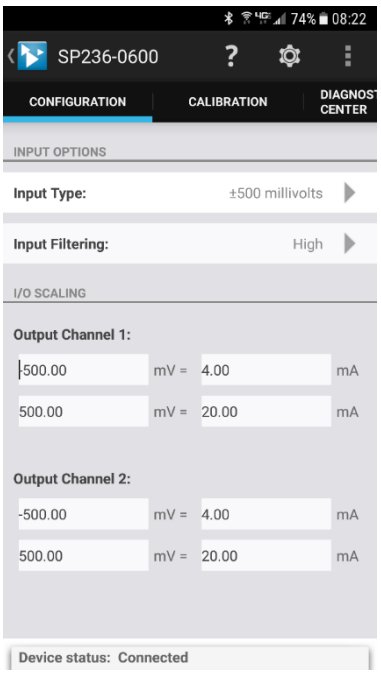
You can tap **[RESET FACTORY CALIBRATION]** to get out of trouble if you ever miscalibrate a splitter (this only affects splitter calibration).

You can tap **[RESTORE FACTORY SETTINGS]** to get out of trouble if you ever misconfigure or miscalibrate a transmitter (this affects both splitter calibration and configuration). You can also use this feature to de-commission a splitter.

If you tap the right-most dotted Menu icon of the action bar at the top right of your screen, you will get a selection menu for “About” information on this software application, and “Contact Acromag” for contact information, both shown at left

Below the icons of the top line are file three tabs: Configuration, Calibration, and Diagnostic Center, each of which are described in the following pages.

Quick Overview – Android Reconfiguration...continued



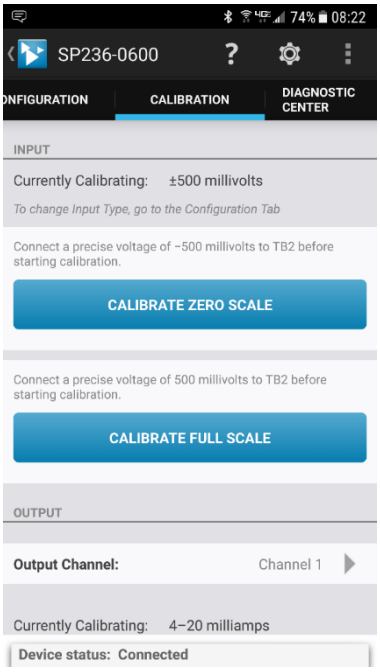
Input/Output Configuration

The I/O Configuration screen is shown at left and is used to Configure your splitter Input and Output. You can set your input type/range, input digital filtering level, rescale each output, and even scale the input differently for each output via this screen.

Note that if your unit is connected when you select this tab, the app automatically reads your splitter's current I/O and scaling information and displays it.

Likewise, changing any option on this page sends the changes to the splitter immediately.

Note that the Device Status is indicated at the bottom of all pages and will report if changes were sent successfully (Connected).



Input Calibration

If you have setup your unit and encounter excessive error, you may click the Calibration tab to display the Calibration control screen shown at left, which presents Input calibration controls first, followed by Output calibration controls as you scroll down the page.

IMPORTANT: The splitter has already had its input & output channels factory calibrated with high precision. If you attempt to recalibrate the input or outputs, you may degrade its performance if done improperly, or by using low grade equipment. Consider recalibration carefully.

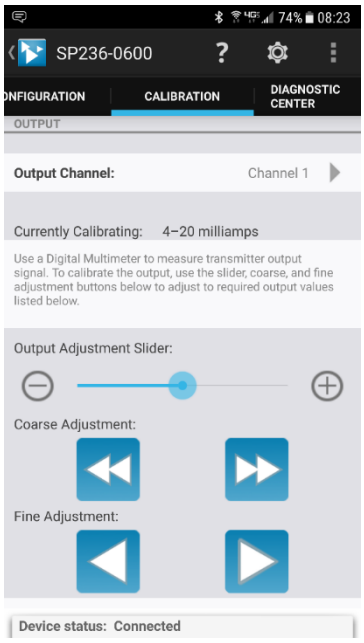
The selected input range being calibrated is indicated at the top. The software does not use your scaled sub-range zero to calibrate, but the zero of the nominal range selected. Some sub-ranges have their calibration extrapolated from the calibration of a larger native range. Calibrate the largest native range first to keep its recalibration from over-writing any sub-range calibration. These splitters have two input terminals specific to input ranges--be sure to connect your input signal to the proper terminals.

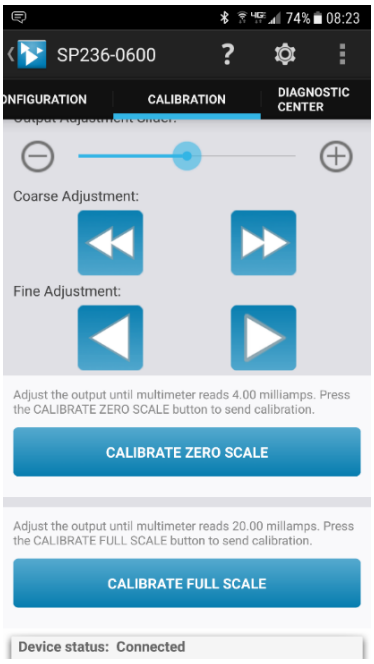
For input zero calibration, connect a precise input signal level for the zero of your range, then tap the **[CALIBRATE INPUT ZERO]** button one time to set the input ADC level to its input range zero (0%) point.

For full-scale calibration, connect a precise input signal level for the full-scale value of your range, then tap **[CALIBRATE INPUT FULL-SCALE]** one time to set the input ADC level to its input range full-scale (100%).

The device status at the bottom of the page will report if the calibration was sent successfully.

Quick Overview – Android Reconfiguration...continued





Output Calibration (Each of Two Outputs)
Scroll down the Calibration page to access the Output Calibration controls: output channel selector, adjustment controls, and the **[CALIBRATE OUTPUT ZERO]** and **[CALIBRATE OUTPUT FULL-SCALE]** buttons.

First select the Output channel to calibrate, and its output range will be displayed along with some instructions on how to proceed.

For Output Zero calibration, use the output adjustment slider and the coarse and fine adjustment controls to precisely set your output zero level while precisely monitoring your output signal. Be sure to use a meter with an accuracy at least 4x greater than the signal you are measuring for best results. Note that the output adjustment controls temporarily remove control of the output from the input to accomplish calibration (control of the output level returns to the input signal after 30 seconds).

Once your output level is precisely set to its zero point (4.000mA for this splitter), tap the **[CALIBRATE OUTPUT ZERO]** button one time to set the output DAC level (its corresponding digital count) to correspond to the zero (0%) of your output range.

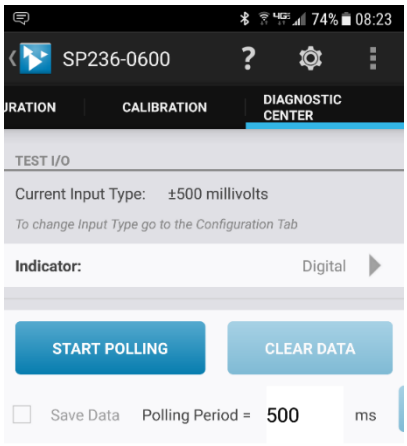
For Full-Scale calibration, use the output adjustment slider and the coarse and fine adjustment controls to precisely set your output full-scale level while precisely monitoring your output signal. Be sure to use a meter with an accuracy at least 4x greater than the signal you are measuring for best results. Note that the output adjustment controls temporarily remove control of the output from the input level to accomplish calibration (control of the output level returns to the input signal after 30 seconds).

Once your output level is precisely set to its full-scale level (20.000mA for this splitter), tap the **[CALIBRATE OUTPUT FULL-SCALE]** button one time to set the output DAC level (its corresponding digital count) to correspond to the full-scale (100%) level of the output range.

Repeat the Output Calibration of zero and full-scale for the second output as required by selecting the opposite channel.

If following calibration, your output acts erratic or appears imprecise, you may need to repeat input or output calibration, being very careful to take accurate measurements and input correct signal levels. If you are measuring voltage across an output load resistance to measure the current level (recommended), make sure that you use exact resistance when calculating the measured loop current. When rescaling I/O, make sure that you have adequate I/O span, as “too-tight” input or output spans will have diminished resolution and magnify error.

Quick Overview – Android Reconfiguration...continued



Performing Diagnostics (Polling & Trending the Input)

The Diagnostic Center screen tab is shown at left and used to verify input (ADC) operation of your splitter. This page can be used to poll the input data and display its value or graph the input data and trend its value. The input type currently set is shown at the top of the screen (the input value, not the scaled input value is polled).

Select the Indicator pointer to set your desired indication to “Digital” (value) or “Graph” (trend).

You can specify a polling period to set the interval between polled readings by over-typing the value in the Polling Period field.

Start polling the input by tapping the **[START POLLING]** button.

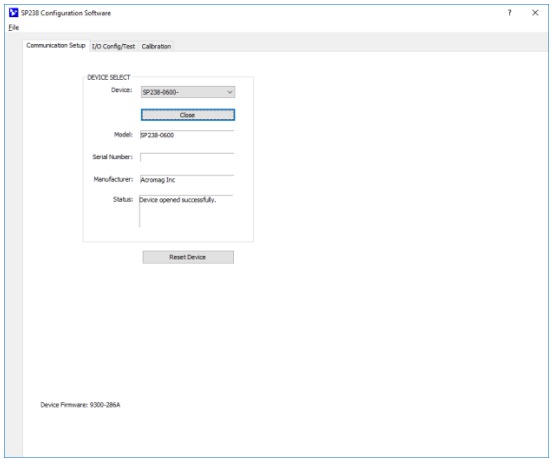
Clear the polling data by tapping **[CLEAR DATA].**

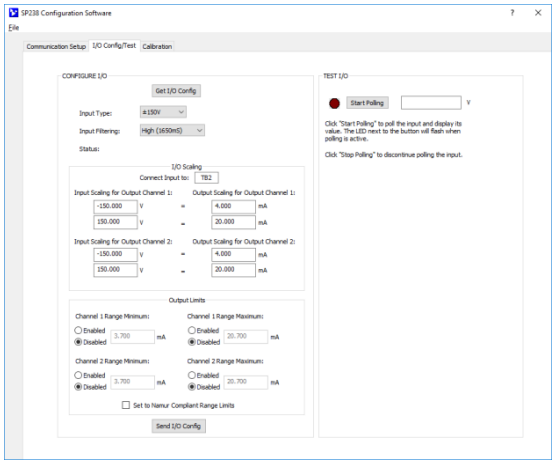
Check the “Save Data” box if you wish to log the polled values to a CSV (Comma Separated Value) data file for reference.

Note the Communication Status of the device is indicated at the bottom of the screen.

Quick Overview – Windows

*Click **"Open"** to connect to the SP236-0600 and your screen will look like:*





For detailed configuration and calibration procedures, see the Operation Step-By-Step section of the Technical Reference on page 22 of this manual.

In addition to the Android Agility mobile app, this splitter can be optionally configured and calibrated via its USB Configuration Software and a USB connection to a Windows 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 TT-SIP (see Accessories section). For the SP236 model, look for program SP236Config.exe. This software is compatible with Windows 7 or later versions of the Windows operating system.

The initial configuration software screen for the SP238 model is shown at left after clicking [Open] to open communication with a connected module. The Configuration screen is divided into three pages as follows: Communication Set up, I/O Config/Test, and Calibration. A short description of each of these pages follows.

Communication Setup– First Select/Connect to Unit Here

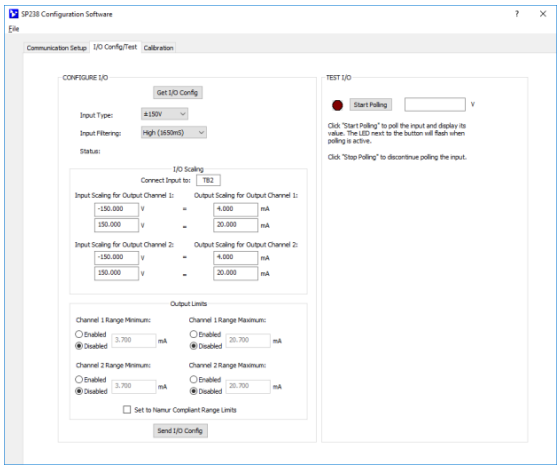
- Select from connected transmitters using the Device scroll field and Open/Close communications with them.
- Display the Model, Serial Number, and Manufacturer of the connected transmitter, and report connection Status, or reset a connected unit.

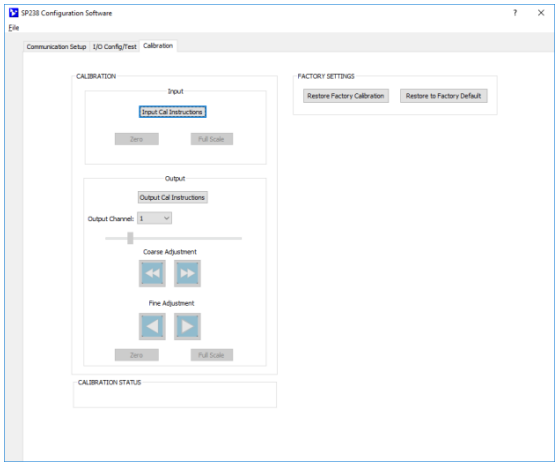
This section is used to select a connected transmitter, open/close communications with it, or reset it. Device connection Status is also indicated here, along with the connected transmitter's Model, Serial Number, & Manufacturer.

I/O Config/Test – Reconfigure and/or Test the Unit Here

- You can click the **[Get I/O Config]** button to retrieve the I/O configuration of the currently connected transmitter.
- Select the Input Range for the model. For an SP236, you can select current ranges ±20mA, 0-20mA, 4-20mA, 0-11.17mA, or ±1mA for inputs at TB1, or voltage ranges of ±0.5V and 0-500mV for inputs at TB2.
- Set the level of digital filtering to High, Medium, or Low. Note that the corresponding I/O response time will vary with filter selection to 1200ms, 150ms, and 50ms respectively.
- View the unit's communication status in the Status field.
- Use the I/O Scaling fields to specify the specific input range endpoints that are to correspond to the 4mA and 20mA output endpoints of each output. You can scale the input differently for each output.
- You may set your own output range limits or enable Namur limits that differentiate fault levels from over and under range detents.
- Last, after making I/O changes, send your settings to the unit by clicking the **[Send I/O Config]** button and following the on-screen prompts.

Quick Overview - Windows..





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

TEST I/O - Optionally, Verify Unit Operation Here

After making CONFIGURE I/O changes, I/O Scaling, setting Output limits, and Sending your configuration to the unit, you can TEST I/O and Start/Stop Polling the input channel, as required to check your input readings.

- Click **[Start Polling]** to periodically read your input channel and validate its operation. Click **[Stop Polling]** to stop polling the input channel. Note the simulated red lamp left of the button flashes slowly when the software is polling the input channel.

CALIBRATION - Calibrate the Input and/or Output if Needed

The unit has already been factory calibrated, but if you encounter excessive error, you can click the Calibration tab to display the Calibration control page shown in the screen at left. To calibrate the Input or Output stage of this model, simply click the respective Input or Output "Instructions" button to get started and follow the on-screen prompts.

Input…
Set the Input Range to calibrate on the I/O Config/Test page and click **[Send I/O Config]** before attempting calibration. On the Calibration page, click the **[Input Cal Instructions]** button to begin input calibration.

When you click the **[Zero]** or **[Full Scale]** buttons of CALIBRATION - Input, you will be prompted to apply a current at TB1, or voltage level at TB2. Once you have applied the signal to the correct input terminals, click **[OK]** of the prompt to calibrate it and follow the on-screen instructions.

Output…
Click **[Output Cal Instructions]** to begin output calibration. You will be prompted to adjust the input as required to drive the output to precisely 4.000mA (Zero), or 20.000mA (Full-Scale). Once the output is set to zero or full-scale, you simply click the corresponding **[Zero]** or **[Full-Scale]** button of CALIBRATION – Output to set the output zero or full-scale endpoint.

Factory Settings (In Case of Trouble or for Sanitation Purposes)

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

You can click **[Restore ...]** buttons if you misconfigure or improperly calibrate a transmitter such that its operation appears erratic.

Calibration Status (Bottom of Screen)

- Displays communication status messages for the calibration process.

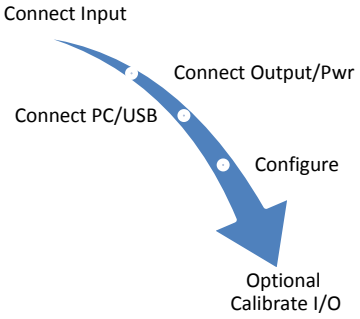
The CALIBRATION STATUS field at the bottom of the screen will display status messages relative to calibration.

TECHNICAL REFERENCE

OPERATION STEP-BY-STEP

Connections

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

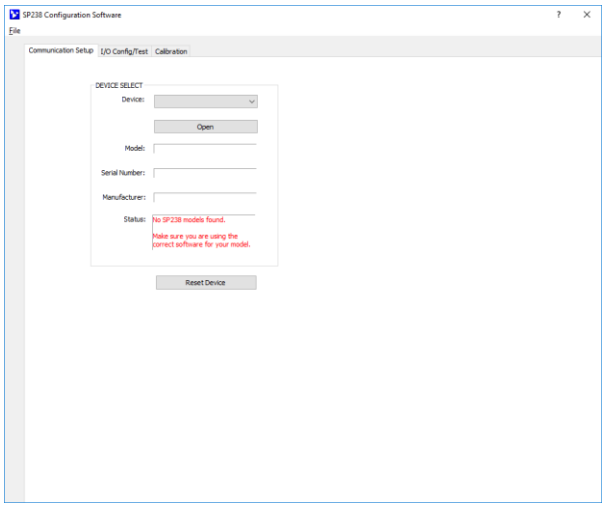


Note: The input signal source and the output meter must be accurate beyond the unit specifications, or better than ±0.1%. A good rule of thumb is to ensure that your equipment accuracy be four times better than the rated accuracy you are trying to achieve with this splitter.

1. **Connect Input:** Refer to Input Connections on page 7-9 for your model. For SP236 models, connect a precision current source to TB1, or a precision voltage source to TB2, applicable to your application input range. Your signal source must be adjustable to the nominal range zero and full-scale values.
2. **Connect Output/Power (each Output):** Refer to Output/Power Connection of page 10 and wire an output current loop to the transmitter as illustrated. You will need to measure the output current accurately at each output to calibrate the unit. You could connect a current meter in series in each output loop to read the loop current directly (not recommended). Alternatively, you could simply connect a voltmeter across a series connected precision load resistor in each loop, and accurately read the output current as a function of the IR voltage drop produced in the resistor (recommended). In any case, be sure to power each loop with a voltage that is minimally greater than the 7V 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.
   Loop Power Supply Voltage: Make sure your voltage level is at least 7V plus 0.020*load_resistance. Ideally, it should be great enough to drive fault current levels into your load (i.e. up to 7V+ 0.02x*Rload, assuming line drop is negligible and the maximum possible over-range is considered). Always apply power to at least one output loop even when connected to USB.
3. **Connect to PC via isolated USB:** Refer to USB Connection on page 13 and connect the splitter to the PC using a USB isolator and cables provided in the Configuration Kit TT-SIP. Optionally, you could instead connect the unit to an Android smartphone or tablet running the Agility mobile app with a USB-OTG cable.

   Now that you have made your input, output/power, and USB connections, and applied power to your output loops, you can execute the SP236Config.exe, SP237Config.exe, or SP238Config.exe software per your splitter model to begin configuration of your unit (this software is compatible with Windows 7 or later versions of the Windows operating system), or start the Agility mobile app (Android only).

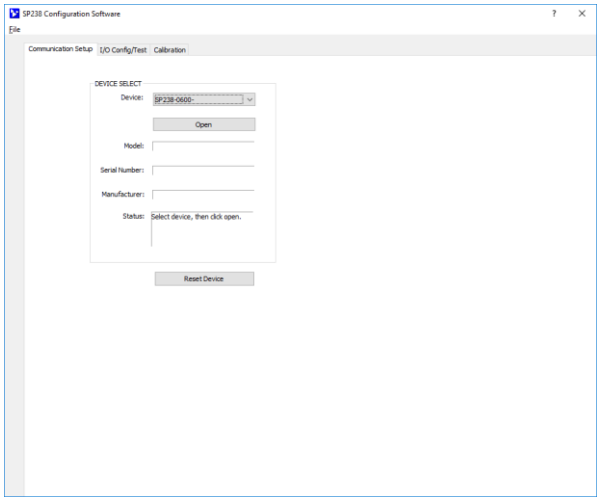
Configuration



After executing the Acromag Configuration software for your model, a screen like that shown at left will appear **if you have not already connected to your transmitter via USB** (note fields are blank and red status message appears).

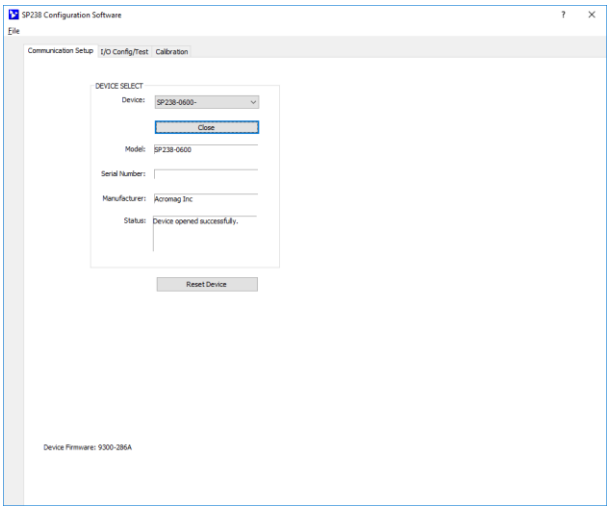
Connect your Windows PC to the unit via USB and its model-serial information will appear in the Device select scroll field as shown in the second screen at left.

If you are connected to more than one unit via a USB hub, you can use the Device scroll field to select another unit using the serial number suffix of the Device Model to discern one unit from another.

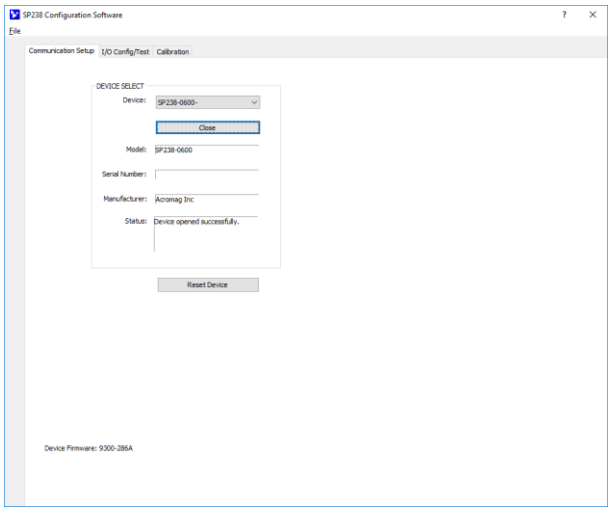


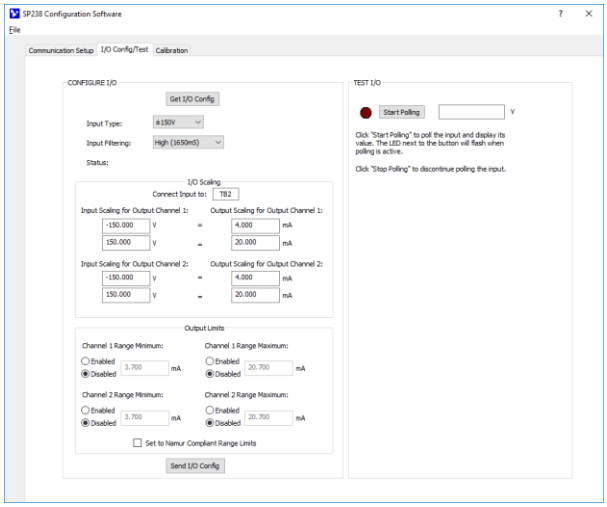
Once you have selected a device, click the **[Open]** button to open communication with the unit.

After clicking **[Open]**, the selected unit's Model, Serial Number, Manufacturer, and connection Status will be displayed as shown in the third screen at left.



Configuration…





After you connect USB and "Open" communication with a unit, the Status field indicates "Device opened successfully" as shown in first screen at left.

At this point, you can click the "I/O Config/Test" tab to begin configuring the unit, or to optionally test its operation.

> Note that you should already have loop power connected in each output loop of the transmitter. You will not be able to calibrate a unit or test it without loop power also applied to at least one output.

When you select "I/O Config/Test", the software retrieves the unit's current configuration and displays it in the I/O Config/Test page shown on the second screen at left. If you make changes to this screen, but do not Send them to the unit, you can retrieve the module's current configuration by clicking the **[Get I/O Config]** button at the top of this screen.

The SP23x models have two input terminals, each for a different input range. Only one input may drive the output current loop at one time and this is determined by your input range selection. On SP236 models, DC current input is wired to TB1 (upper terminal block), while DC voltage input is wired to TB2 (lower terminal block).

Select the Input Range…

For the SP236, you could select DC Current ranges of ±20mA, 0-20mA, 4-20mA, 0-11.17mA, or ±1mA, wired to TB1, or DC Voltage ranges of ±0.5V or 0-500mV wired to TB2.

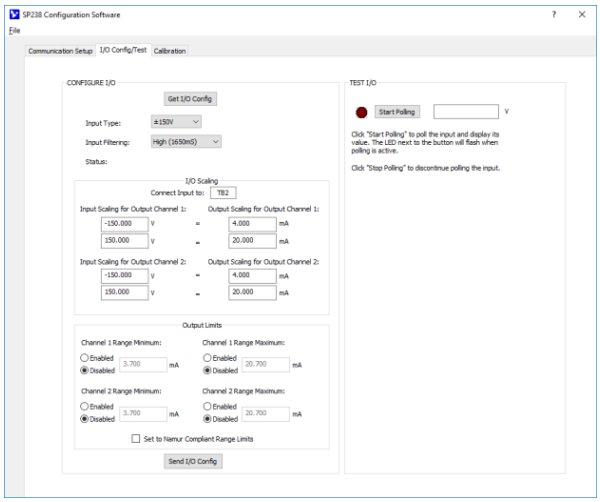
Note that the nominal input range you pick can be rescaled to the output, and can be scaled differently for each allowing you to use only a portion of the selected input range to drive the 4-20mA output current loop, if desired. However, resolution will decrease proportionally as you rescale the input smaller than the nominal input range. If you reduce the input range too far, this will reduce the signal resolution, magnify potential error, and degrade the signal-to-noise ratio of the input channel.

Select the Input Filtering…

You may select the level of digital filtering to apply to the input channel as Low, Medium, or High and their estimated I/O response times are indicated in parenthesis next to your filter selection. Note that higher filter levels result in lower average noise, but with a slower I/O response time.

The field settings refer the module's current configuration and the only way to preserve any changes is to either write it to the device via **[Send I/O Config]**, or by save it to a file by clicking **"File"** in the upper left-hand corner of the screen.

Configuration…



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

Select the Input/Output Scaling for each output…

This transmitter allows you to rescale its input and output ranges, and you can even rescale the input differently for each 4-20mA output. You must be careful not to reduce a nominal range too much, as resolution will be reduced by 1 bit each time you halve the range, potentially magnifying noise and error.

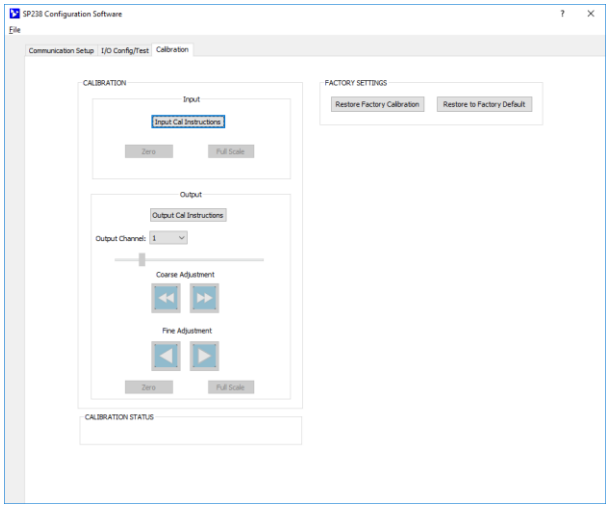
In the corresponding I/O Scaling field, set the input signal minimum/zero value to correspond to 4mA of output current, and the input signal maximum/full-scale value to correspond to 20mA of output current. Note that some under and over-range is built into each range selection. You can optionally swap input levels to configure a reverse acting output response if desired.

If the input zero and full-scale points are chosen too close together, performance will be degraded.

Once you have made your configuration selections, click the **[Send I/O Config]** button to write them to the module. You can read the status of your communication with the module in the Configure I/O Status field. Alternately, you could click **"File"** in the upper left-hand corner to save the settings to a file on your PC, for reference later, or for duplicating your configuration on other modules.

At this point, you can test the module's operation by clicking the **[Start Polling]** button to trigger the software to periodically read the input and display its value in the field to the right of this button. Note the simulated lamp next to the button flashes slowly each time it samples the input. Click the **[Stop Polling]** button to stop polling the input channel before moving onto the next page.

Calibration (Optional)



CAUTION-Input Calibration: You must input values within your selected input range. Driving input levels outside of the selected input range will not be acceptable for calibration of zero or full-scale. Since input levels cannot be validated during field calibration, incorrect signal levels will produce an undesired output response.

This unit has already been factory calibrated. If you have configured your unit and encounter excessive error, you can click the Calibration tab to display the Calibration control page shown at left.

IMPORTANT: This unit has already had its input and output channels factory calibrated with a high level of precision. If you attempt to recalibrate the input or an output channel, you could degrade its performance if you do it improperly, or you use lower grade equipment. Consider your decision to recalibrate carefully.

Calibration of this is a two-part process initiated by clicking the respective Input or Output **[...Instructions]** button to get started and follow the on-screen prompts.

CALIBRATION - Input

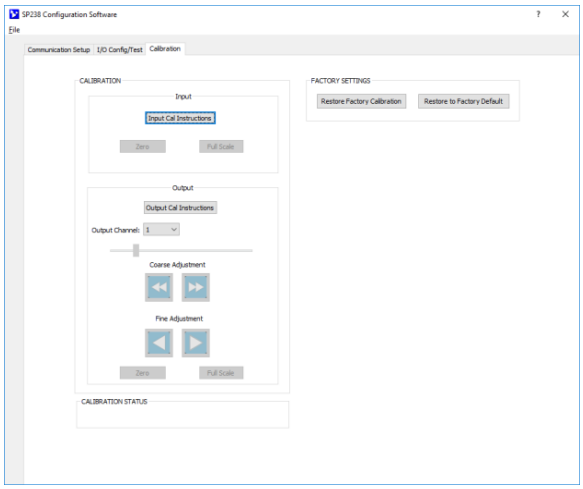
*Before attempting to recalibrate the input, first set the Input Range to calibrate from the "I/O Config/Test" page. Additionally, make sure you write your selections to the unit by clicking the **[Send I/O Config]** button of that page.*

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

For the SP236 example, click the Input **[Zero]** button and you will be prompted to input the minimum value of your selected input range at the appropriate input channel (note that it uses nominal range endpoints, not scaled range endpoints). If you have selected a DC Current range, you must drive -20mA, 0mA, 4mA, or -1mA at TB1 (the upper input terminal block), depending on the Input Range selected. If you have selected a DC voltage range, you would drive -0.5V or 0V to TB2 (the lower input terminal block). The software does not use your scaled zero, but the zero of the nominal input range selected. Once you input the zero precisely, click the **[OK]** button of the prompt to calibrate zero and then follow the on-screen prompt.

For SP236, click the Input **[Full-Scale]** button and you will be prompted to input the maximum value of your selected input range at the appropriate input channel. If you have selected a DC Current range, this will be 20mA or 1mA at TB1, depending on the Input Range selected. If you have selected a DC voltage range, this will be 0.5V at TB2. The software does not use your scaled full-scale, but the full-scale of the nominal input range selected. Once you input full-scale precisely, click the **[OK]** button of the prompt to calibrate full-scale and then follow the on-screen prompt.

Calibration…



CALIBRATION – Each Output

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

First adjust the input signal as necessary to drive the output current to precisely 4.000mA. Be sure to measure this level accurately or performance will be degraded. After driving the output to 4.000mA, click the Output **[Zero]** button of the Calibration Output section to calibrate the output zero level.

Next adjust the input signal as necessary to drive the output current to precisely 20.000mA. Be sure to measure this level accurately or performance will be degraded. After driving the output to 20.000mA, click the Output **[Full-Scale]** button of the Calibration Output section to calibrate the output full-scale level.

Repeat this process for the second output channel.

If following calibration, your output acts erratic or appears imprecise, you may need to repeat input or output calibration, being very careful to take accurate measurements and input correct signal levels. If you are measuring voltage across an output load resistance to measure the current level in an output (recommended), make sure that you use exact resistance when calculating the measured loop current. When rescaling, make sure that you have adequate input span, as "too-tight" input spans have diminished resolution and will magnify error.

Factory Settings

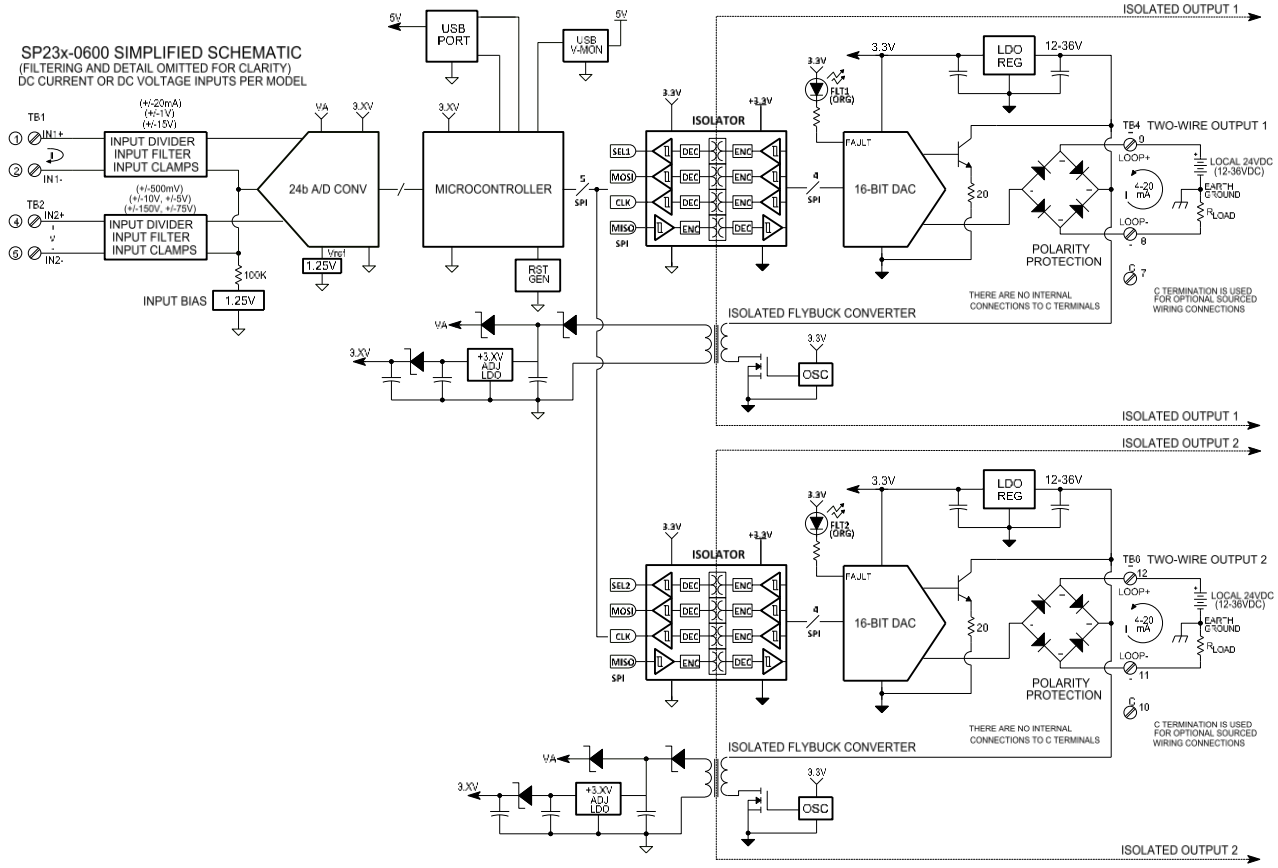
You can use the **[Restore Factory Calibration]** button to restore the transmitter's original factory calibration if you think you made an error during recalibration, have degraded its performance, or if the I/O channel appears erratic.

You can use the **[Restore to Factory Default]** button to return the unit to its original factory state (see Specifications Reference Test Conditions) and configuration settings. This does not restore calibration, only configuration. Alternately, this button can be used as a sanitation tool to restore the unit to its initial configuration.

Calibration Status

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

BLOCK DIAGRAM



How It Works

Key Points of Operation

- Unit is Loop Powered
- Input isolated from Outputs
- Outputs isolated from each other
- Input is Differential & Bipolar
- Voltage Input is separate from the current Input (SP236), or there are two separate voltage inputs of different ranges (SP237 & SP238).
- Output/Power Terminals are Not Polarized.
- Input circuit ground is common to USB ground.
- USB powers a portion of the input circuit when connected, but not the output.

This signal splitter uses a microcontroller and high-resolution A/D to convert the input signal to a digital SPI signal that is then isolated via a digital isolator and transmitted to a current DAC in each output. Power for the common isolated input side of the circuit is provided via an isolated flyback converter operating in parallel with each output loop. One or both output loops may power the input. Set up involves selecting the input type (Current or Voltage), a filter level, and scaling the input range endpoints to each output's range end points. Output scaling can be optionally done in reverse to produce a reverse acting output. You may even scale the input differently for each output. The maximum over-range output is approximately 24mA, the minimum under-range is 3.6mA. Refer to the block diagram to gain a better understanding of how this splitter works. Note the input/USB and each output/power circuit are isolated from each other. The USB port ground is common to the input circuit ground. The USB port ground of most PC's is also common to the USB cable shield and earth ground and input sensors could be grounded or ungrounded. For this reason, it is recommended that USB signals be isolated when connecting to a PC to prevent a ground loop from occurring between the PC earth ground and a grounded input sensor, which would have the negative effect of pulling the input bias supply to ground, clipping the negative portion of the bipolar input range.

TROUBLESHOOTING

Diagnostics Table

*Before attempting repair or replacement, be sure that all installation and configuration procedures have been followed and that the unit is wired properly. Verify that power is applied to the loop and that your loop power supply voltages are sufficient to supply over-scale current into the loads (MIN 0.020*Rload), plus 7V MIN 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's Application Engineers can provide further technical assistance if required. Repair services are also available from Acromag.

POSSIBLE CAUSE	POSSIBLE FIX
Software Does Not Detect Unit or Communication Set up Screen is Blank…	
USB is not connected between unit and host PC.	Verify USB cable from USB isolator is plugged into the unit and the isolator. Verify that USB cable from PC is also plugged into the PC USB port and into the isolator.
USB has not enumerated the device.	Use the reset button on the Acromag USB isolator to trigger renumeration of the splitter, or simply unplug and re-plug the USB cable to the splitter.
Communication or power was interrupted with USB connected and config software running.	Close the current connection with the software, then select and re-open the splitter for communication (or simply exit the Configuration software and reboot it).
Cannot Communicate with Splitter via USB…	
Unit fails to operate or exhibits an output shift…	
Output shifts off-range when you connect USB…	
A missing USB Isolator could cause a ground loop between a grounded input signal/sensor and earth ground at the connected Personal Computer's USB port.	Isolated splitters and transmitters can be used with grounded or ungrounded inputs, but you can only connect grounded sensors if the USB signals are also isolated. Without USB isolation, a ground loop is created between a grounded input and earth ground of the PC USB port. This module's input is biased 1.25V off input ground to allow it to process negative-going signals. Earth ground applied via the non-isolated USB connection with an earth grounded sensor would clip the input bias and truncate the negative signal range. It's best to connect to USB via a USB isolator for this reason and for increased safety and noise immunity. Use an isolator like the Acromag USB-ISOLATOR. Otherwise, use a battery powered laptop to configure the transmitter which does not normally earth ground its USB port.
Output is Erratic, Not operational, or at Wrong Value…	
Is your output loop power supply at the correct level for your load? Is Output Fault LED blinking?	Verify loop voltage and level in each output. Ideally, your supplies must be adequate to provide 7V MIN to the transmitter, plus the IR drop in the load, plus the IR drop in the lead wires, and all at the maximum loop current (>20mA).

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
Cannot Calibrate Input Channel…	
Is input wired properly?	Check that input is wired to correct ± input terminals using the correct polarity for your model.
Are you wired to the correct input terminals for your desired range?	TB1 and TB2 support different input ranges (refer to specifications).
Cannot Calibrate the Output or Cannot Test the Unit…	
Loop power ON to the unit?	The unit receives power from both USB (when connected), and the output loop power supplies. While you can configure a unit over USB without loop power applied, a loop power connection is required to test operation or calibrate the unit.
Unit drives a low current, but fails to drive higher output current...	
Loop supply voltage is too low to support current into the loop load or the loop load resistance is too large for the current level. Does the output fault LED blink at the higher current?	Check power voltage level. Make sure it is at least 7V plus 0.02x*Rload. If transmit distance is especially long, then it must have added voltage to support the IR drop in the wire. Ideally, the voltage should also have ample overhead to drive the load at the maximum upscale output current > 20mA.
Cannot Measure Input Voltage or Input Current…	
Your input may be wired to the wrong terminal.	On the SP236 for example, DC Current is input to TB1 (upper terminal block), while voltage is input to TB2 (lower terminal block). Only voltages up to ±1V may connect to TB1 of the SP237. If you mistakenly wire these lower voltage signals to TB2 of the SP237, your resolution will be poor as TB2 has a 12.52:1 divider at its input (TB1 is the upper terminal block). Likewise, if you connect ±10V or ±5V to TB1 of the SP237, you would drive it into over/under-range.
For input step, output appears to make 2 steps to reach its final value…	
For a step change in the input, the A/D typically needs two input samples to charge to its final level.	When you step the input signal, it takes two samples for the A/D to charge up to its final value, and this is evident when using a scope to examine the output transition in response to a step change at the input, which appears to make two steps to arrive at its final level.

Diagnostics Table…

Output goes above Over-Range (21mA) or below Under-Range Limit (3.6mA)...	
This indicates a fault condition and either the input signal is out of range, or a sensor lead has broken. It can also occur due to contention between earth ground at the PC USB port and the input sensor. A fully upscale signal can also indicate failed communication with the output DAC (firmware problem).	Check the input signal with respect to its range and reduce or increase it as required to drive the output current within its linear operating range. A fully upscale or down-scale signal can be driven by a sensor fault, such as an open or broken sensor lead. Check the wiring of your input sensor. If you are not isolating USB, check for a ground loop between a grounded sensor and earth ground of the PC USB port.
Output holds last value when I connect USB…	
Unit is awaiting initialization via its configuration software used to set it up, configure it, and calibrate it.	Boot the configuration software to regain operation. The USB port is intended for set up and configuration of the module and it should not be left connected to USB without also booting the USB software.
Output Fault (FLT) LED blinks...	
The corresponding output loop voltage is too low to support the loop load current, or the load resistance is too high for the loop supply voltage level. Note this LED will blink one time if loop power is turned off.	Check the corresponding output loop voltage level and wiring. Verify your output load resistance is less than R=(Vs-7)/0.02x. Note that an isolated 2-wire output is earth grounded at the Vs supply minus lead (load minus), not the transmitter output.

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 enclosure is not meant to be opened for access and can be damaged easily if snapped apart. Thus, it is highly recommended that a non-functioning transmitter be returned to Acromag for repair or replacement. Acromag has automated test equipment that thoroughly checks and calibrates the performance of each transmitter, and can restore firmware. Please refer to the Acromag Service Policy and Warranty Bulletins, or contact Acromag for complete details on how to obtain repair or replacement.

ACCESSORIES

Software Interface Package

Software Interface Package/Configuration Kit – Order TT-SIP

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

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

USB Isolator

USB Isolator – Order USB-ISOLATOR

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

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

USB A-B Cable

USB A-B Cable – Order 4001-112

USB A-B Cable 4001-112

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

USB A-mini B Cable

USB A-mini B Cable – Order 4001-113

- USB A-mini B Cable 4001-113

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

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

ACCESSORIES

USB OTG Cable

USB OTG Cable – Order 5028-565

- USB OTG Cable 5028-565

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

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

End Stops

Two End Stops – Order 4001-252

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

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

SPECIFICATIONS

Model Numbers

SP236-0600, DC I/V Input
SP237-0600, Nominal DC V Input
SP238-0600, High DC V Input

Signal Transmitter
Isolated DC Current/Voltage Input
Two-Wire Loop-Powered
CE Approved
UL/cUL Class 1, Div 2 approvals

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

These DIN-Mounted Series Splitters are intended for DC current or voltage input. The SP236 model prefix denotes a combination DC current and voltage input type, while the SP237 model prefix denotes a medium DC voltage input type, and the SP238 model prefix denotes a high-level DC voltage input type. The trailing "-0600" model suffix denotes 2-wire loop power with CE and UL/cUL Class 1, Division 2 Approvals. Models can be mounted on standard 35mm "T" Type DIN rail.

Optional factory calibration to your own specifications is ordered as a separate line item at time of purchase, and on a per unit basis. Factory calibration will require the specification of a nominal input range, input filter level, plus scaled input range zero/full-scale endpoints (for each output), and each output zero/full-scale range endpoints (you could specify a normal 4-20mA or reverse 20-4mA acting output).

A standard model without added custom factory calibration is calibrated by default for 4-20mA DC at TB1 (SP236), ±1V DC at TB1 (SP237), and ±15V DC at TB1 (SP238), with both splitter outputs mapped to 4.000mA zero and 20.000mA full-scale.

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

Input

These models have two separate inputs for current and/or voltage depending on the model, but only one input may drive the output at a time.

On SP236, DC current is input at TB1, and DC voltage at TB2. On SP237, ±1V DC is input at TB1, and ±10V at TB2. On the SP238, ±15V DC is input at TB1, and ±150V is input at TB2. Only one input, current or voltage, can drive the output loop at one time.

Input Reference Test Conditions: TB1: SP236 4 to 20mA current, SP237 ±1V, SP238 ±15V, TB2: SP236 ±0.5V; SP237 ±5V; SP238 ±150V, 25°C Ambient Temperature; 24V DC Loop Supply; 4-20mA each output and a 250Ω Load.
Input Range per Terminal: Each model has two separate input terminals TB1 & TB2, setup for different ranges, but only one input may drive the output at a time. The input A/D processes the input signal differentially. Input sub-ranges may have their calibration auto-extrapolated from the calibration of the larger native range, or they may be subsequently calibrated for greater accuracy. An input range may also be rescaled to drive the outputs using only a portion of the input range. The input may be scaled differently for each output.

MODEL	Input 1 at TB1	Input 2 at TB2
SP236	±1mA DC, ±20mA plus sub-ranges, 0-20mA, 4-20mA, 0 to 11.17mA. Uses a precision 24.9Ω current shunt to convert current to Vin.[1]	±0.5V plus sub-range 0-500mV. No resistive divider is present at TB2 and the input impedance is 15MΩ minimum.
SP237	±1V plus sub-range 0-1V, no resistive input divider.	±10V plus sub-ranges ±5V, 0-10V, and 0-5V DC. Uses an 86.6K/1084.6K input divider.
SP238	±15V plus sub-range, 0-15V DC. Uses a 56.2K/1054.2K divider.	±150V plus sub-ranges ±75V, 0-150V, 0-75V DC. Uses a 5.36K/1003.36K divider

[1]**Note:** An optional external sensor is required to monitor AC current signals for driving TB1 of the SP236 (see Acromag Model 5020-350). This toroidal sensor generates 0 to 11.17mA DC to drive the DC current input of this module with AC input current through its primary (see Table 2 of page for scaling the AC current by number of primary turns).

Input…

Analog to Digital Converter (A/D or ADC): 24-bit, Σ-Δ A/D converter, but only ~15.5-bits are used as the 24-bit signal is subsequently normalized to a bipolar range count of ±25000 to simplify I/O scaling (see Input Resolution below). Input ranges may be rescaled to smaller ranges to drive each 4-20mA output. The effective input resolution is proportionally diminished as you reduce input span below its nominal range by rescaling. You lose 1-bit every time you halve the range. Be careful not to diminish resolution below 12-bits minimum (1 part in 4096) for rated performance.
Input Resolution: The A/D in these splitters divides its input signal into parts calculated by subtracting endpoint A/D counts computed via (Vin*Gain/1.25)* 32768+32768. Vin is the voltage after applying the input divider and gain to the signal (see Table 1). Ranges that share the same gain are calibrated by extrapolating from their nominal input range calibration. Internally for simplification, the raw A/D counts indicated in Table 1 are normalized to ±25000/15.5 bits for ±100% (bipolar ranges), or 0-25000/14.5 bits for 0-100% (unipolar ranges), and the effective input resolution of a range will be the lesser of the raw resolution indicated in Table 1 or this normalized resolution. The effective resolution of an I/O conversion will be the lowest resolution of the A/D, its normalized value, or the output DAC (see Output). Output DAC resolution is 1 part in 43690 for 4-20mA output.

Table 1: SP INPUT RESOLUTION PER INPUT RANGE/MODEL

SPx36 INPUT RANGE	xDIVIDER	xGAIN	A/D INPUT RESOLUTION[1]
-20mA to +20mA (TB1)	24.9Ω Shunt	2	6658 to 58878 or 1/52220
0 to 20mA (TB1)	24.9Ω Shunt	2	32768 to 58878 or 1/26110
4 to 20mA (TB1)	24.9Ω Shunt	2	37990 to 58878 or 1/20888
0 to 11.17mA (TB1)	24.9Ω Shunt	2	32768 to 47350 or 1/14582
-1mA to +1mA (TB1)	24.9Ω Shunt	32	11880 to 53656 or 1/41776
-0.5V to +0.5V DC (TB2)	NONE	2	6554 to 58982 or 1/52428
0 to 500mV DC (TB2)	NONE	2	32768 to 58982 or 1/26214
SPx37 INPUT RANGE	**xDIVIDER**	**xGAIN**	**A/D INPUT RESOLUTION[1]**
-1V to +1V DC (TB1)	NONE	1	6554 to 58982 or 1/52428
0 to 1 DC (TB1)	NONE	1	32768 to 58982 or 1/26214
-10V to +10V DC (TB2)	86.6K/1084.6K	1	16023 to 53699 1/41862
-5V to +5V DC (TB2)	86.6K/1084.6K	1	22302 to 43233 or 1/20931
0 to 10V DC (TB2)	86.6K/1084.6K	1	32768 to 53699 or 1/20931
0 to 5V DC (TB2)	86.6K/1084.6K	1	32768 to 43233 or 1/10465
SPx38 INPUT RANGE	**xDIVIDER**	**xGAIN**	**A/D INPUT RESOLUTION[1]**
-15V to +15V DC (TB1)	56.2K/1054.2K	1	11805 to 53730 or 1/41925
0 to 15V DC (TB1)	56.2K/1054.2K	1	32768 to 53730 or 1/20962
-150V to 150V DC (TB2)	5.36K/1003.36K	1	11762 to 53774 or 1/42012
-75V to +75V DC (TB2)	5.36K/1003.36K	1	22265 to 43271 or 1/21006
0-150V DC (TB2)	5.36K/1003.36K	1	32768 to 53774 or 1/21006
0 to 75V DC (TB2)	5.36K/1003.36K	1	32768 to 43271 or 1/10503

[1]**Note: AD_count = (Vin*Gain/1.25) * 32768+32768**.

Input…

Input Calibration: From the factory, sub-ranges of major input ranges at a terminal are automatically calibrated via extrapolation from the calibration of the major range to save time (except ±1mA of SP236 where the gain changes). However, specific sub-ranges may be calibrated independently to increase precision. To prevent the subsequent calibration of a range from stepping on the calibration of a sub-range, calibrate the smaller input range after its major range.

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS) at TB1 & TB2, 5.6V clamp level typical (SP236), 14V working and 30V clamp level typical (SP237), 220V working voltage, typical (SP238). Input also includes differential input diode clamping, capacitive filtering, and series resistance, which varies per model.

Input Filter: Normal mode filtering, plus digital filtering, optimized and fixed per input range within the Σ-Δ ADC.

Noise Rejection (Common Mode): Refer to table below and note CMR varies by model with input filter selection between no filter and high filter. Data is typical with 100Ω input unbalance.

MODEL	NO FILTER	HIGH FILTER
SP236	126dB	139dB
SP237	101dB	133dB
SP238	98dB	109dB

Input Impedance: Refer to DIVIDER of Table 1. The input dividers are chosen to reduce the magnitude of the input below ±1V to drive an A/D with a maximum ±1.25V bipolar input range and 16-bit conversion. Note corresponding impedance as follows: SP236: 25Ω at TB1, 15MΩ at TB2; SP237: 15MΩ minimum at TB1 (no resistor divider), and 1084.6KΩ at TB2 (a 12.5:1 divider is present at TB2); SP238 1003.36KΩ minimum at TB1 (an 18.758:1 divider is present at TB1), and 1054.2KΩ at TB2 (a 187.194:1 divider is present at TB2).

Optional AC Current Sensor (Model 5020-350, For AC Input to TB1 of SP236 only): A toroidal instrument transformer that converts sinusoidal 50-60Hz AC current into low level DC milliamperes of 0 to 11.17mA for connection to TB1 of the SP236 model for AC current input. The AC current range is a function of the number of turns placed through the toroid as shown in Table 2 below. This sensor is isolated and requires no calibration or adjustment. When used with the SP236 module, it also facilitates AC current input isolation from the DC input, and redundant current input isolation with respect to the output of this transmitter.

Table 2: Optional AC Current Sensor Turns & Range

AC Current Input	Primary Turns	Sensor Output (Red/Black Wires)
0 to 20A AC	1	0 to 11.17mA DC
0 to 10A AC	2	"
0 to 5A AC	4	"
0 to 2A AC	10	"
0 to 1A AC	20	"

The output wires of this sensor are polarized with red as (+) plus and black as (-) minus. Normally these output wires are attached to one end of a user supplied cable, while the other end connects to the DC current input at TB1.

AC Input Burden: A function of the wire gauge resistance used for primary turns (the current carrying wire being monitored).

Input…

AC Current Sensor to Transmitter Wiring Distance: 400 feet maximum for 18 AWG. Other wire gages can be used if the total resistance of both wires is less than 5Ω.

AC Input Overload: The sensor will withstand overload conditions as follows:

- 20 times full scale for 0.01 seconds.
- 10 times full scale for 0.1 seconds.
- 5 times full scale for 1.0 second.

Output

Output Range (Each): 4 to 20mA DC nominal, with linear under-range capability down to ~3.7mA, and over-range up to ~20.7mA (w/ range truncated to Namur NE 43 limits). Each output signal is linear with respect to the DC current or voltage applied at the input terminals of the model (SP236 models optionally support AC input current at TB1 when wired for use with Acromag AC Current Sensor 5020-350).

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

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

Note – High Speed Acquisition: Additional filtering at the load is recommended for sensitive applications with high-speed acquisition rates. For excessive 60Hz supply ripple, a 1uF or larger capacitor is recommended at the load. High frequency noise may be reduced or eliminated by placing a 0.1uF or 0.01uF capacitor directly across the load (this can also raise RF immunity).

Output Ambient Temperature Effect: The combined effect of zero and span drift over temperature is better than ±0.008% of span per °C (±80ppm/°C) over the full ambient temperature range for reference test conditions (see Input Specifications).

Output DAC Resolution: A 16-bit current DAC with current approximated via 24mA*COUNT/65536 (see table below). For a 4-20mA output range, we have an output resolution of 54613-10923, or 1 part in 43690. The range limits are normally truncated to Namur limits near ~3.7mA (low) and ~20.7mA (upper), which allows you to discern an upscale or downscale lead break condition apart from the linear operating range. The effective I/O resolution of this transmitter will be the lowest resolution of either the input, or the output.

I-LOOP = 24mA*COUNT/65536	COUNT = 65536*I-LOOP/24mA
3.7mA	10103
4.0mA	**10923**
12mA	32768
20mA	**54613**
20.7mA	56525
23.9996mA	65535

Output…

Output Response Time: The maximum time measured for the output signal to reach 98% of its transition for a step change in the input driving current output to a 250Ω load with a 24V supply and with the input set to No filter, Low filter, Medium filter, and High filter.

	RESPONSE TIME TO 98% OF TRANSITION (TYPICAL)		
FILTER	**SP236**	**SP237**	**SP238**
NONE	17ms	13ms	88ms
LOW	41ms	34ms	100ms
MEDIUM	138ms	133ms	237ms
HIGH	1142ms	956ms	1762ms

CAUTION: *Do not exceed 36VDC peak to avoid damage to the unit. Terminal voltage at/above 7V minimum must be maintained across the output during operation.*

Output Power Supply: Loop powered from 7-32V DC SELV (Safety Extra Low Voltage), 24mA maximum. The voltage across the output must never exceed 36V, even with a shorted load. Set this level to provide a minimum of 21mA over-range current to the load (0.021*R typical), plus 7V across the output terminals, plus any interim line drop. Reverse polarity protection is inherent as output terminals are not polarized (± output labels of enclosure are for reference only).

Output Power Supply Effect: Less than ±0.001% of output span effect per volt DC of supply change within rated limits for load.

Output Compliance and Load Resistance Equation: 7V minimum is required for transmitter. Unit will drive up to 17V to a load with a 24V loop supply and 20mA of loop current (800Ω), assuming negligible line drop. Compute R_{load} (Max) = (V_{supply} - 7V)/0.021A for 21mA output current. Refer to the following table:

V_{supply} Volts	Max R_{load} w/21mA & No Line Drop
10V	143Ω
12V	238Ω
18V	524Ω
24V	810Ω
32V	1190Ω

Output Load Resistance Effect: Less than ±0.001% of output span effect for a ±100Ω change in load resistance.

USB Interface

Unit includes a USB socket for temporary connection to a PC or laptop for set up and reconfiguration (or optionally to a USB-OTG cable connected to an Android smartphone or tablet). USB isolation is required when connected to a grounded input sensor or driver (see note below). During reconfiguration and calibration, the transmitter receives power from both the USB port and the output loop. Both power sources must be present to calibrate the unit.

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

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

Transient Protection: Adds transient voltage protection on USB power & data lines.

Inrush Current Limiting: Includes series inrush current limiting at USB power.

Cable Length/Connection Distance: 5.0meters maximum.

USB Interface…

Driver: No special drivers required. Uses the built-in USB Human Interface Device (HID) drivers of the Windows Operating System (Windows XP or later versions only).
USB Connector: 5-pin, Mini USB B-type socket, Molex 67503-1020.

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.

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

Enclosure & Physical

General purpose plastic enclosure for mounting on 35mm "T-type" DIN rail.
Dimensions: Width = 17.5mm (0.69 inches), Length = 114.5mm (4.51 inches), Depth = 99.0mm (3.90 inches). Refer to Mechanical Dimensions drawing.
I/O Connectors: Removable plug-in type terminal blocks rated for 12A/250V; AWG #26-12, stranded or solid copper wire.
Program Connector: USB Mini B-type, 5-pin. See USB Interface.
Case Material: Self-extinguishing polyamide, UL94 V-0 rated, color light gray. General purpose NEMA Type 1 enclosure.
Circuit Board: Military grade fire-retardant epoxy glass per IPC-4101/98.
DIN-Rail Mounting: Unit is normally mounted to 35x15mm, T-type DIN rails. Refer to the DIN Rail Mounting & Removal section for more details.
Shipping Weight: 0.5 pounds (0.22 Kg) packed.

LED Indicators

Output Fault LED Indicators (Red, Each Output, FLT1 & FLT2) - Red FLT LED per output loop. Blinking red continuously indicates the corresponding output load resistance is too high to modulate loop current accurately, or the loop voltage level is too low to drive the loop resistance at the desired current level. OFF is normal, blinks for fault, or blinks once if the loop power is lost or the loop is opened.

Environmental

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

Operating Temperature: -40°C to +80°C (-40°F to +176°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Isolation: Input/USB and the output/power circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). This complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.
Installation Category: Suitable for installation in a Pollution Degree 2 environment with an Installation Category (Over-voltage Category) II rating per IEC 1010-1 (1990).
Shock & Vibration Immunity: Conforms to: IEC 60068-2-6: 10-500 Hz, 4G, 2 Hours/axis, for sinusoidal vibration; IEC 60068-2-64: 10-500 Hz, 4G-rms, 2 Hours/axis, for random vibration, and IEC 60068-2-27: 25G, 11ms Half-sine, 18 shocks at 6 orientations, for mechanical shock.

Electromagnetic Compatibility (EMC)

Minimum Immunity per BS EN 61000-6-1:

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

This is a Class B Product with Emissions per BS EN 61000-6-3:

1) Enclosure Port, per CISPR 16.
2) Low Voltage AC Mains Port, per CISPR 14, 16.
3) DC Power Port, per CISPR 16.
4) Telecom / Network Port, per CISPR 22.

Agency Approvals

Electromagnetic Compatibility (EMC): CE Marked, per EMC Directive 2014/30/EU.

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

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

ATEX Certified: The SP23x-0600 models are ATEX / IECEx Certified for Explosive Atmospheres per ATEX Directive 2014/34/EU which complies with standards IEC 60079-0 Edition 6, IEC 60079-15 Edition 4, EN 60079-0:2012+A11:2013, and EN 60079-15:2010.

Ex II 3 G Ex nA IIC T4 Gc -40°C ≤ Ta ≤ +80°C
DEMKO 18 ATEX 2086**X**
IECEx UL 18.0092**X**

X = Special Conditions

1) The equipment shall only be used in an area of not more than pollution degree 2, as defined in EN/IEC 60664-1.
2) The equipment shall be installed in an enclosure that provides a degree of protection not less that IP 54 and only accessible with the use of a tool in accordance with EN/IEC 60079-15
3) Transient protection should be provided set to a level not exceeding 140% of the peak rated voltage value at the supply terminals to the equipment.

Reliability Prediction

Reliability Prediction

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

Temperature	MTBF (Hours)	MTBF (Years)	Failure Rate (FIT)
25°C	TBD hrs	TBD years	TBD
40°C	TBD hrs	TBD years	TBD

Configuration Controls

Software Configuration Only via USB/Windows or USB-OTG/Android & Agility

This transmitter drives analog output current in dual 2-wire loops proportional to a sensor input based on the differential voltage measurement across the sensor for sensor voltage input at TB1 or TB2, or the differential voltage measure across its 24.9Ω current shunt resistor for a current input at TB1 (SP236 only). No switches or potentiometers are used to make adjustment to this transmitter. Its behavior as an isolated signal amplifier/transducer is determined via programmed variables set using a temporary USB connection to a host computer or laptop running a Windows-compatible configuration software program specific to the transmitter model, or a wired USB-OTG connection to an Android smartphone or tablet running Agility. The USB software or Agility app provides the framework for digital control of all configuration and calibration parameters, which are stored in non-volatile memory of the unit.

LED Indicators, Red FLT1 & FLT2

Red FLT LED per output loop. Blinking red continuously indicates the corresponding output load resistance is too high to drive its current accurately, or the loop voltage level is too low to drive the loop resistance at the desired current level. OFF is normal and LED will blink once if loop power is lost or the loop is opened.

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

Revision History

The following table shows the revision history for this document:

Release Date	Version	EGR/DOC	Description of Revision
16 FEB 2018	A	BC/MO	Initial Release Version.
27 NOV 2018	B	CAP/ARP	Added UL / ATEX / IECEx / FCC statements.