USB Programmable, DIN Rail Mount, DC-Powered Signal Splitters w/ DC Current/Voltage Input and Dual Isolated Current or Voltage Outputs

Model SP336-0700, DC Current & Low DC Voltage Input
Model SP337-0700, DC ±1V/±10V Medium Voltage Input
Model SP338-0700, DC ±15V/±150V High Voltage Input

USER'S MANUAL

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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.

This manual is for 4-wire (separate isolated power) SP300 transmitters that convert DC voltage and current signals to dual isolated voltage or current output signals. To split microBlox (uB) module inputs similarly, please refer to our uBSP-P-1 model. If your application requires dual 2-wire (loop-powered) outputs instead, please refer to similar SP200 series models. For thermocouple input signals, please refer to our SP333 (4-wire) and SP233 (2-wire loop-powered) models.

GETTING STARTED

DESCRIPTION

Symbols on equipment:

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

The SP33X-0700 models are modeled after ANSI/ISA Type IV transmitters, but with dual isolated outputs, and are commonly referred to as signal splitters or repeaters. These units are designed to interface with DC current or voltage sensors depending on the model, isolate the input signal, and modulate two isolated DC outputs that may output current or voltage. Units are set up, calibrated, and rescaled using configuration software and a USB connection to Windows-based PC’s (Windows 7 and later versions only), or using a USB-OTG cable to Android smartphones or tablets using the Agility mobile app. Units provide adjustable input and output ranges, dual output signals for voltage or current, three-way isolation, and variable input filtering.

Key Features

- **Digitally configured and calibrated w/ Windows software via USB, or a wired USB-OTG connection to Android smartphones or tablets.**
- **Thin 17.5mm wide enclosure for high-density DIN-rail mounting.**
- **Two models each have separate inputs for DC voltage in two ranges. The SP336 model has separate inputs for DC voltage and DC current.**
- **High measurement accuracy and linearity with 16-bit conversion.**
- **Adjustable/scalable input/output ranges.**
- **SP336 has DC Current Input for 0-20mA/4-20mA/0-11.17mA/±1mA and DC Voltage Input for ±0.5V/0-500mV. SP337 has separate DC Voltage inputs for up to ±1V, and ±10V. SP338 has separate DC Voltage input for high-level ranges to ±15V, and ±150V. I/O ranges are scalable.**
- **Dual tandem voltage and current output terminals support your choice of ±10V, ±5V, 0-10V, 0-5V, or 0-20mA, 4-20mA outputs at each output channel.**
- **Normal or Reverse Acting output.**
- **Variable digital input filter adjustment.**
- **Wide-range DC power input from 6-32V.**
- **Bussed power and/or redundant power ready.**
- **Wide ambient temperature operation from -40°C to +75°C.**
- **Thoroughly tested and hardened for harsh environments.**
- **CE Approved & includes UL/cUL Class 1, Division 2 approvals.**
- **FCC Conformity Class B.**
- **ATEX / IECEx Certified for Explosive Atmospheres.**
  Ⓔx II 3 G Ex nA IIC T4 Gc - 40ºC ≤ Ta ≤ +75ºC
  DEMKO 18 ATEX 2086X IECEx UL 18.0092X

Application

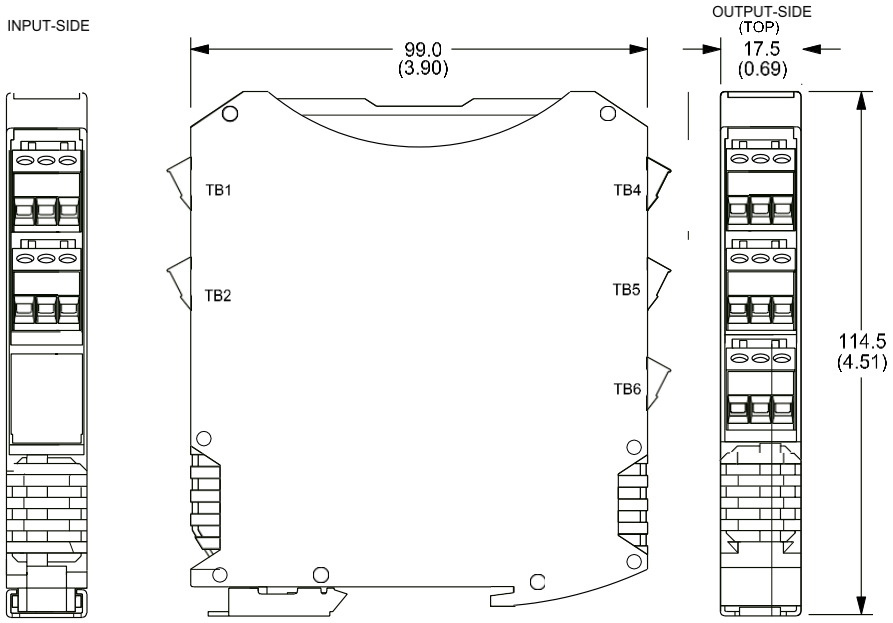
For additional information on these devices and related topics, please visit our web site at www.acromag.com.

These splitters are designed for high-density mounting on T-type DIN rails. Units may be mounted side-by-side on 0.7-inch (17.5mm) centers and support 6-32V DC power via terminals on the unit, or optionally via power wired to a DIN-rail bus connector. Models isolate current or voltage input signals and can mate with grounded or non-grounded sensors. They drive separately isolated outputs that drive current or voltage at each output channel with support for 0-20mA, 4-20mA, or ±10V, ±5V, 0-10V, and 0-5V output ranges.

Mechanical Dimensions

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

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

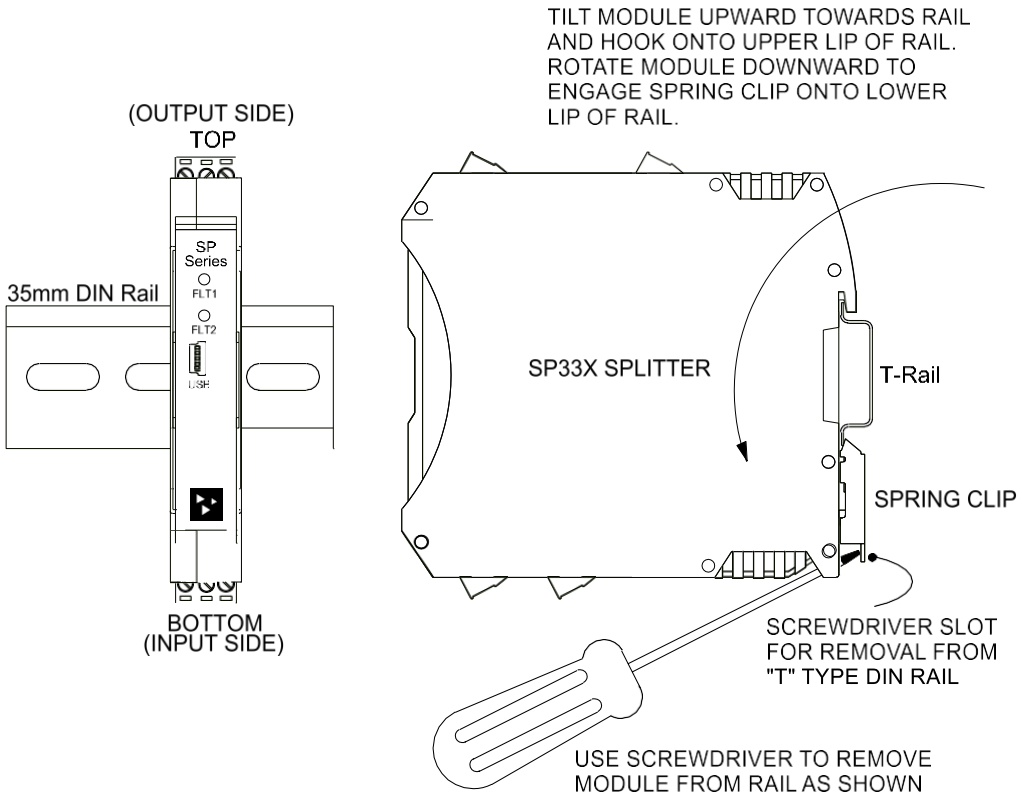


DIMENSIONS ARE IN MILLIMETERS (INCHES)

DIN Rail Mounting & Removal

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

SP33X SPLITTER DIN RAIL MOUNTING AND REMOVAL



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.

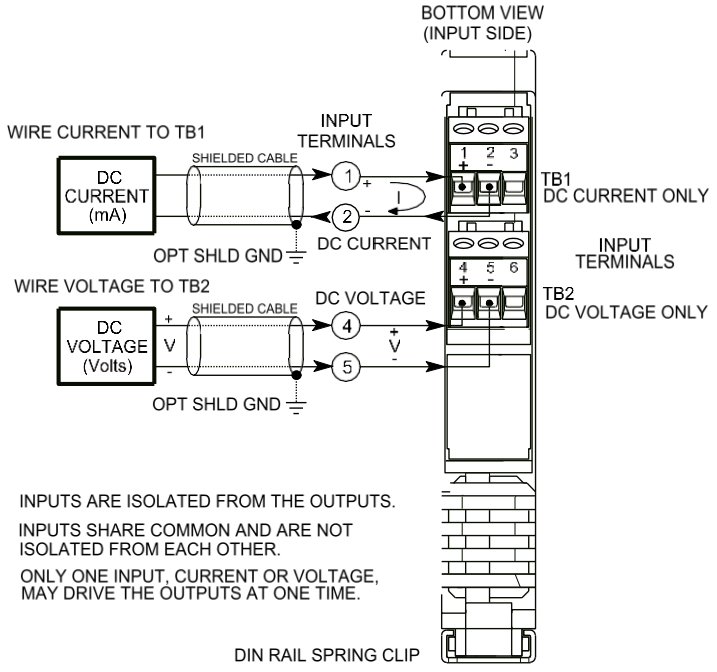
Wire terminals can accommodate 14–26 AWG (2.08–0.13mm^2) solid or stranded wire with a minimum temperature rating of 85°C. Input wiring may be shielded or unshielded type. Ideally, output wires should be twisted pair, or shielded twisted pair. Terminals are pluggable and can be removed from their sockets by prying outward from the top with a flat-head screwdriver blade. This model allows current input to be wired to TB1, and voltage input wired to TB2, but only one input may drive the output. 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).

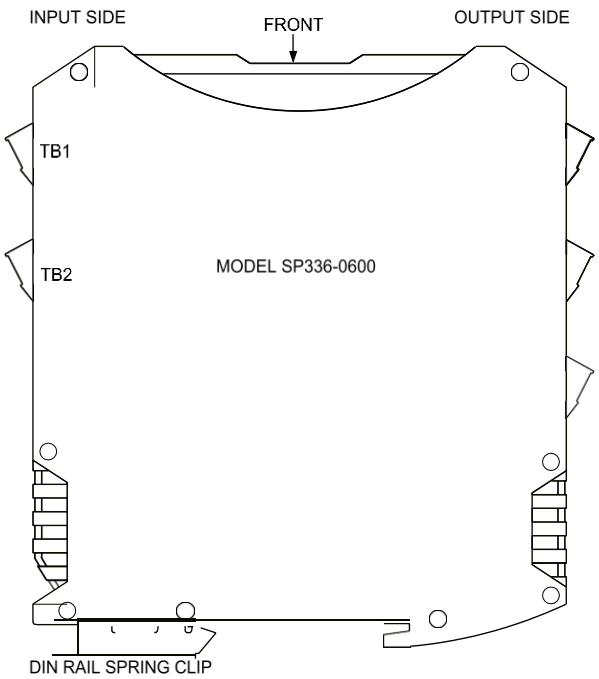
Sensor Input Connections

Sensor wires are wired directly to transmitter input terminals TB1 & TB2 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.

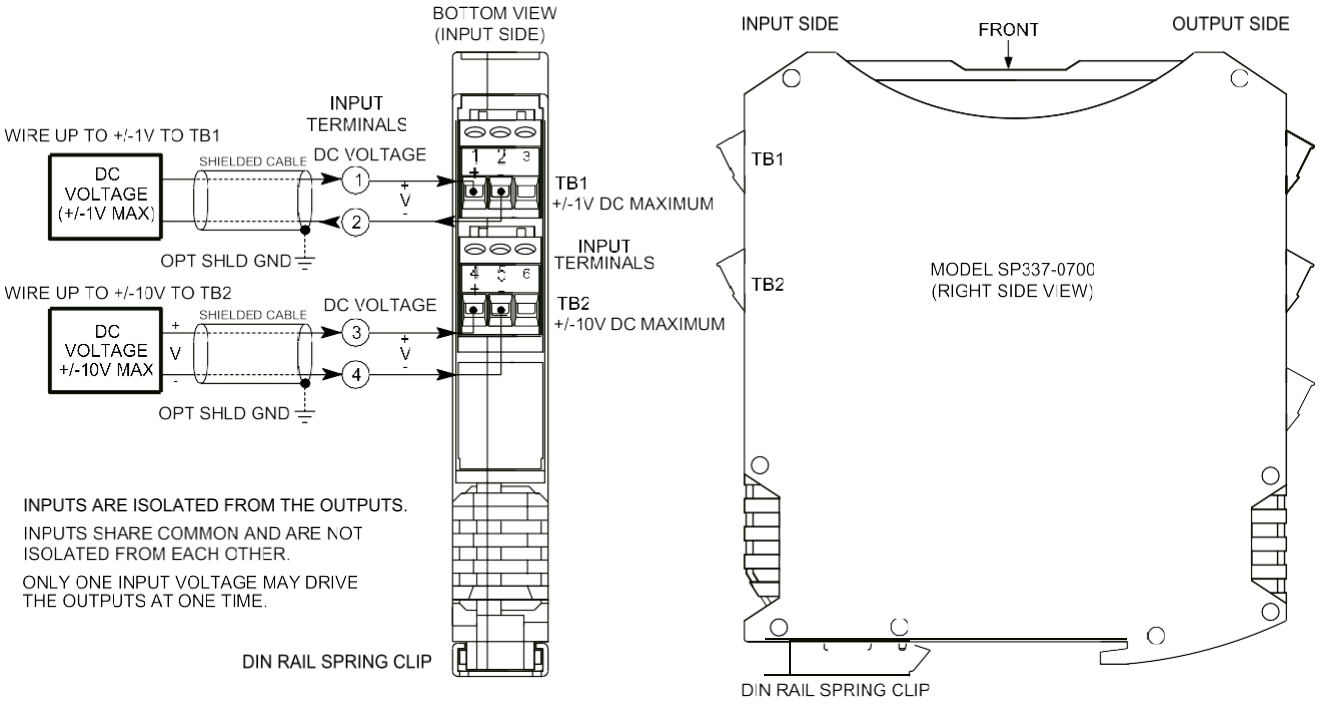
- **Transmitter input signal is isolated from each output channel and one input, current or voltage, drives both outputs at one time**. An output may drive current or voltage (on separate terminals that share RTN). The input may be scaled differently for each output.
- **Input is polarized ±, observe proper polarity.** The positive input is on the left and labeled "+", and the negative input is to its right. See connection figure below per input model.
- **SP336 ±20mA DC Current is wired to the upper terminal block TB1 and ±0.5VDC is wired to the lower terminal block TB2**.
- **SP337 ±1V DC maximum is wired to the upper terminal TB1 and ±10V DC maximum is wired to the lower terminal block TB2**.
- **SP338 ±15V DC maximum is wired to the upper terminal TB1 and ±150V DC maximum is wired to the lower terminal block TB2**.

MODEL SP336-0700 INPUT SENSOR WIRING
DC CURRENT AND DC MILLIVOLTAGE INPUT

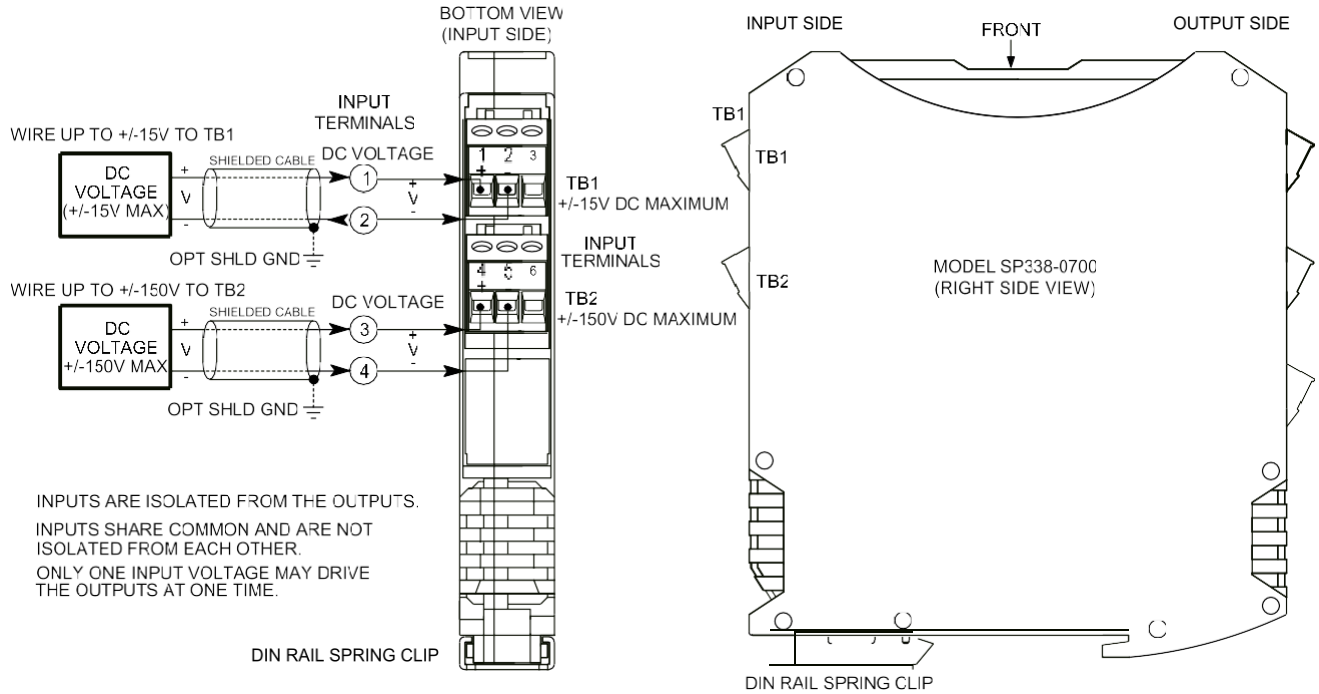




MODEL SP337-0700 INPUT SENSOR WIRING
MEDIUM DC VOLTAGE INPUT



MODEL SP338-0700 INPUT SIGNAL WIRING
HIGH-LEVEL DC VOLTAGE INPUT

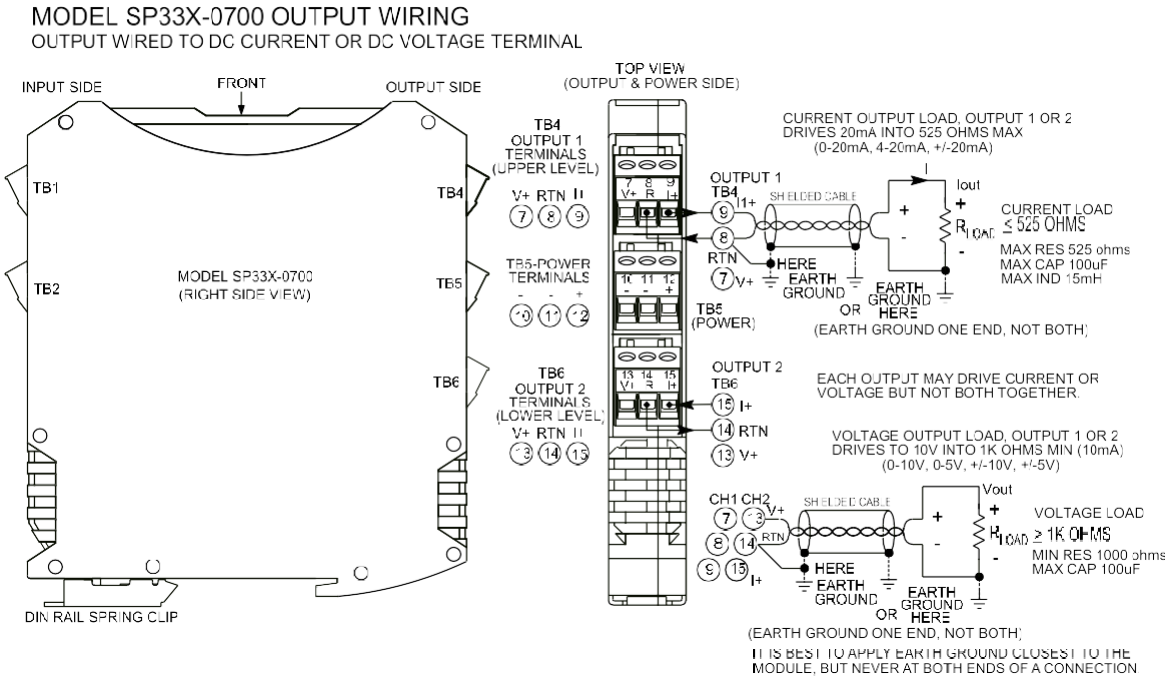


Output Connections

(To DC Current or Voltage Terminals)

This transmitter is modeled after ANSI/ISA Type 4 transmitters, except with two outputs, and with unit power separate from the input and each output circuit.

- **Output connections are polarized.** Tandem current and voltage output terminals at each isolated output channel share an output return (RTN). Current output is sourced from I Out+ and returned to RTN. Voltage output is sourced positive at V Out+ with respect to RTN. Only one channel output terminal (voltage or current) may be loaded at a time.
- **Variations in load resistance have negligible effect on output accuracy** when load limits are respected with respect to output type (see below).



Observe proper polarity. Note that twisted-pair wiring is often used to connect the longest distance between each field transmitter output and the remote load as shown above. Additionally, shielded twisted pair wiring is recommended for best results. An output connection to earth ground at each output return will help protect the circuit from damage in noisy environments.

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

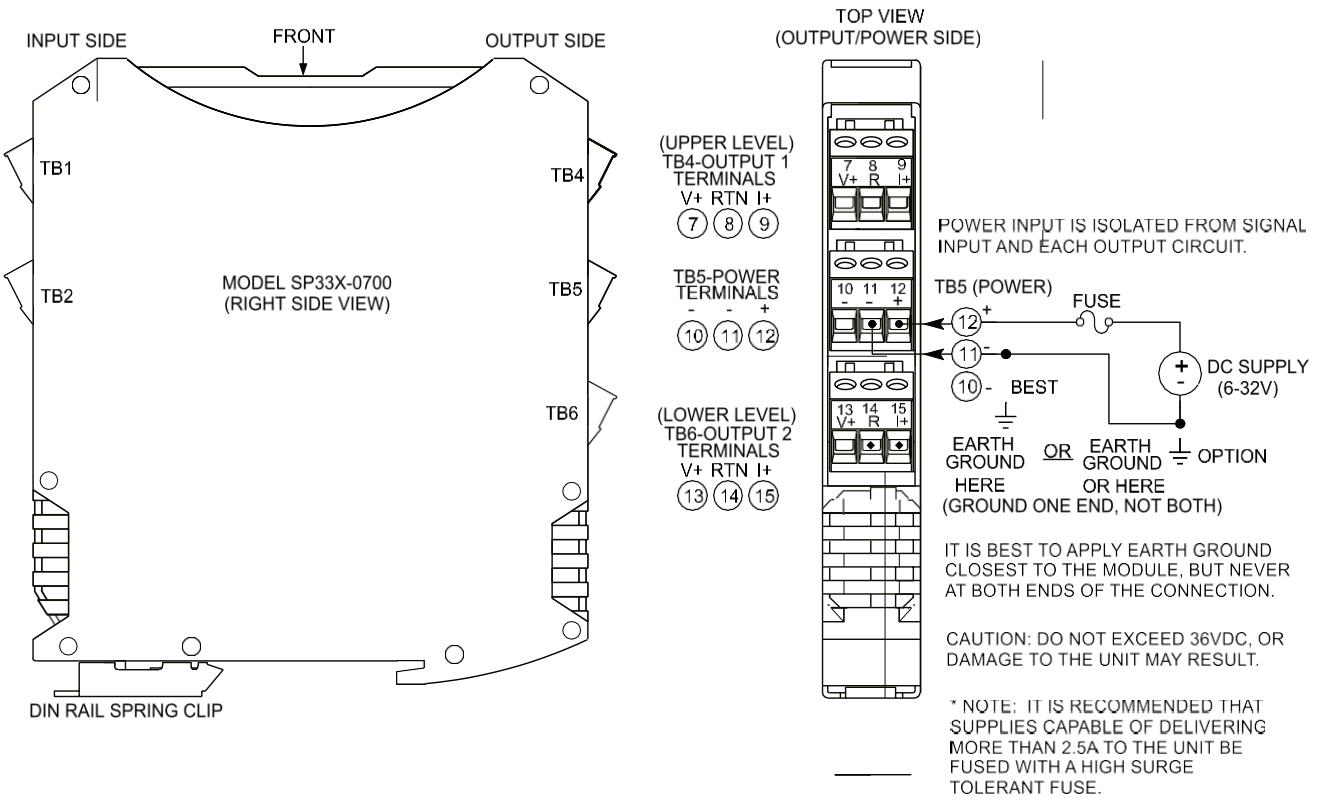
TIP - Ripple & Noise: Place additional capacitance at the load to help reduce the 60Hz/120Hz ripple sometimes present in industrial applications. For large 60Hz ripple, connect an external 1uF or larger capacitor directly across the load to reduce excess ripple. For sensitive applications with high-speed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

Power Connections

The unit is powered from 6-32V DC (36V DC peak) by connecting power as shown below. This transmitter can be optionally powered (or redundantly powered) via the DIN rail bus when coupled to an optional DIN rail bus connector (Acromag Model 1005-063) with a bus terminal block (Acromag 1005-220 or 1005-221). This optional power connection method can allow several modules to share a single power supply without wiring power to each power terminal block individually.

- Power connections are isolated from the input and each output. The supply voltage should be from 6-32V DC. This voltage must never exceed 36V DC peak, or damage to the unit may result.
- Variations in power supply voltage between the minimum required and 32V maximum, has negligible effect on transmitter accuracy.
- Note the placement of earth ground at power. The power cable shield and DC- should ideally be grounded closest to the module. The input and output circuit commons are capacitively coupled to earth ground at DC- through high-voltage isolation capacitors, offering some protection if their circuits happen to float relative to power (not recommended).

MODEL SP337-0700 POWER WIRING
UNIT IS DC-POWERED ONLY AT 6 TO 32VDC.



Power Connections…

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

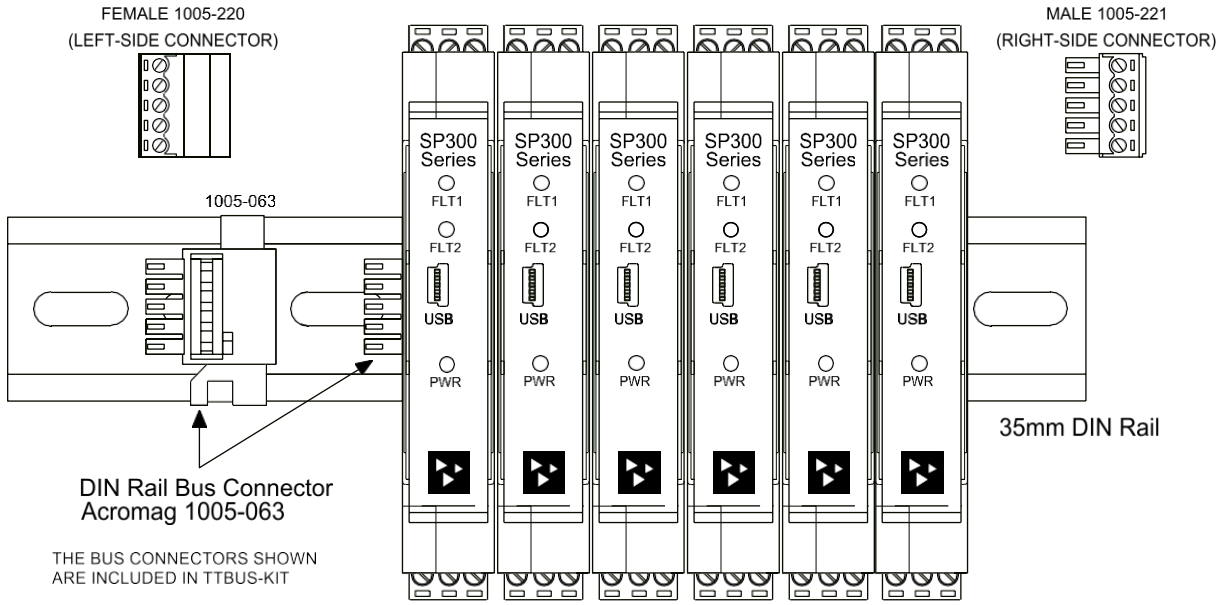
IMPORTANT – External Fuse: If unit is powered from a supply capable of delivering more than 2.5A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 2.5A or less (for example, see Bel Fuse MJS or RJS fuse types).

Optional Bus Power Connections

Power is normally wired to the TB5 terminals of the unit as shown on the previous page. However, this device is equipped to be optionally or redundantly powered via a DIN rail bus connector (Acromag 1005-063) mated to an optional plug-in terminal block (Acromag 1005-220 or 1005-221, depending on left side or right-side wire entry). Any power input via the bus connector is diode-coupled to the same point in the circuit as unit power connected at power terminal TB5. You could power multiple units by snapping them together along the DIN rail bus using connector 1005-063, then connecting a mating terminal block (select a left side or right-side connector, see figure below). While the intent of the bus power connector is to allow several units to conveniently share a single supply, you could also use the bus power connector to redundantly power units (with local power also applied at TB5), allowing a backup supply to maintain power to the units should the main supply at TB5 fail.

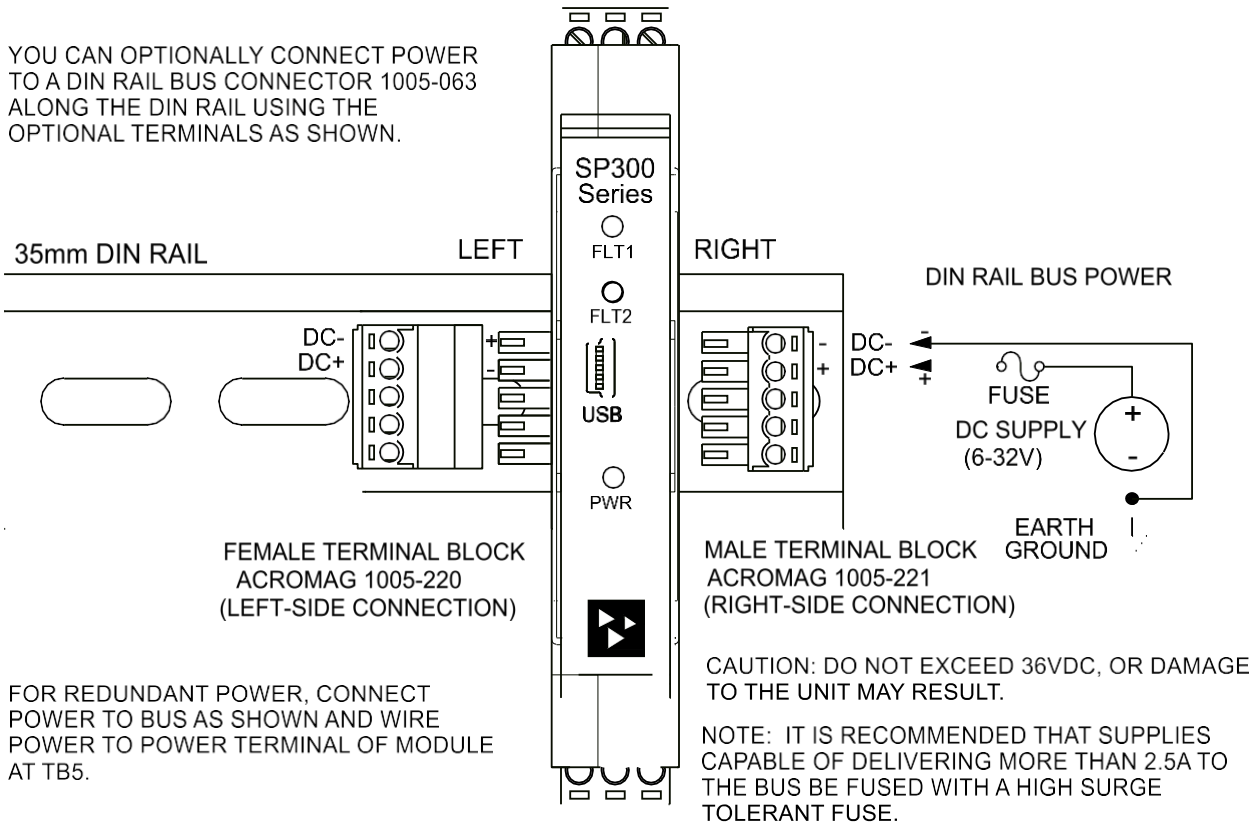
Acromag TTBUS-KIT connector kit contains bus connector 1005-063, plus left-side terminal 1005-220, and right-side terminal 1005-221, allowing units to snap together, side-by-side, along the DIN rail and share the power connection.

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



Optional Bus Power Connections…

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



Earth Ground Connections

The unit housing is plastic and does not require an earth ground connection. The internal input, each output, and power circuits are electrically isolated from each other, allowing these circuits to be individually earth grounded as indicated. If the transmitter is mounted in a metal housing, a ground wire connection is typically required for the enclosure and you should connect that metal enclosure's ground terminal (green screw) to earth ground using suitable wire per applicable codes. See the Electrical Connections Drawings for Input, Outputs, and Power, and note the position of earth ground for each isolated entity. The input and each output circuit return are internally shunted to earth ground applied at the power minus terminal via internal isolation capacitors.

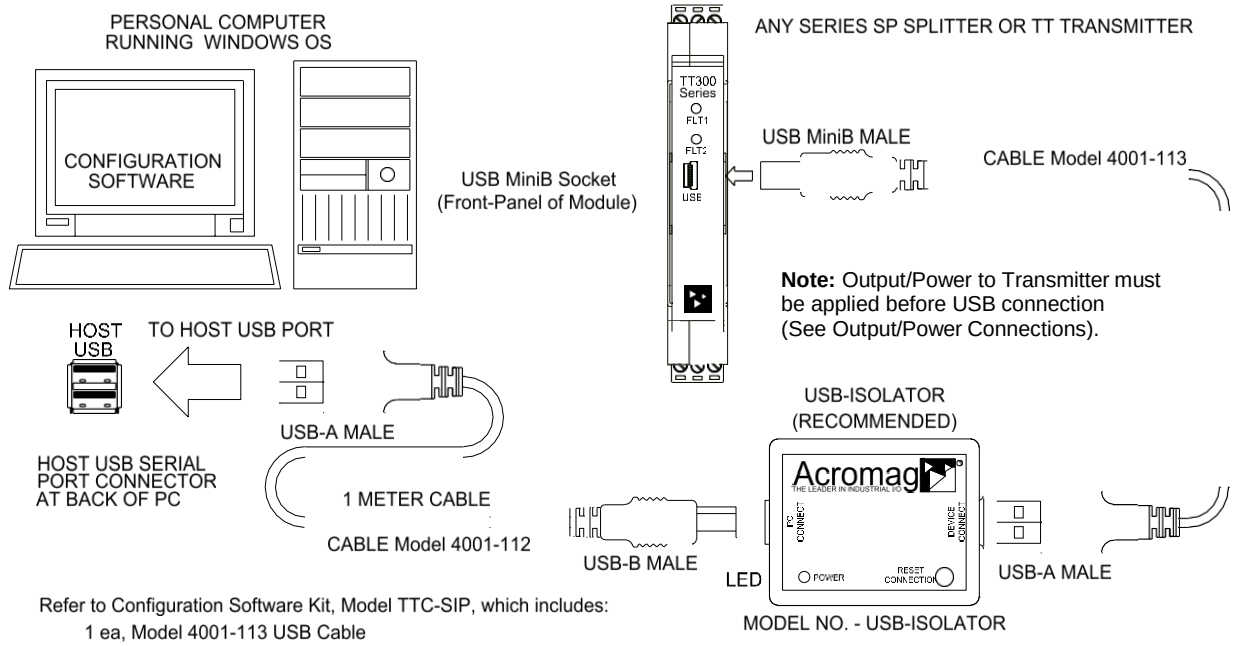
- Avoid inadvertent connections to earth ground at other points than those indicated, as this could drive ground loops and negatively affect operation.
- A USB isolator is recommended when configuring or calibrating a unit to avoid the ground loop that occurs if your input is also earth grounded (A PC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

USB Connections

This transmitter is configured and calibrated via configuration software that runs on a Windows-based PC connected to the unit via USB (Windows 7 or later required), or via a USB-OTG connection to an Android smartphone or tablet using the Acromag Agility mobile app. Refer to the drawing below to connect your PC or laptop to the transmitter to reconfigure or calibrate it using this software.

SP SERIES USB TRANSMITTER CONNECTIONS

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



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

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

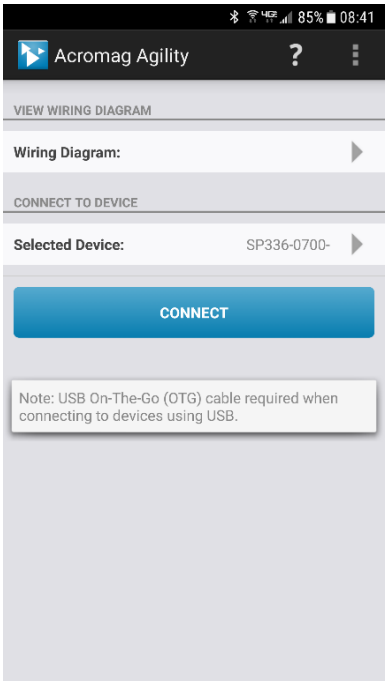
WARNING: The intent of mating USB with this transmitter is so that it can be conveniently set up and calibrated in a safe area, then installed in the field which may be in a hazardous area. Do not attempt to connect a PC or laptop to this unit while installed in a hazardous area, as USB energy levels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

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

IMPORTANT: USB logic signals to the transmitter are referenced to the potential of the transmitter's input circuit ground. This ground is held in common with USB ground and USB cable shield ground. Thus, an isolator is required when the input signal is grounded and the unit is connected to the USB port of an earth-grounded PC. You could avoid the use of an isolator if a battery powered laptop was instead used to connect to the transmitter, and the laptop had no other earth ground connection, either directly or indirectly via a connected peripheral.

CONFIGURATION SOFTWARE

Quick Overview – Android

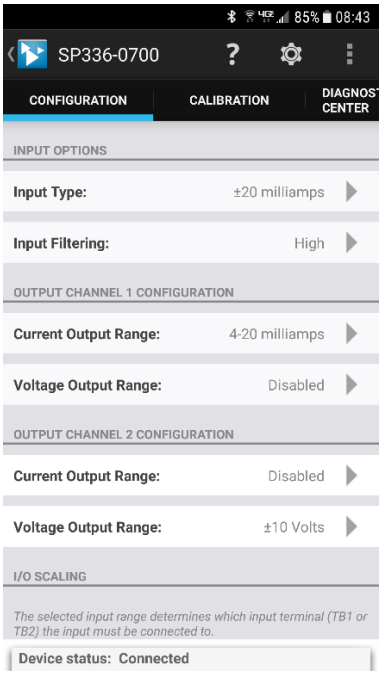


This transmitter/splitter can be setup & calibrated via the Acromag Agility™ Config Tool. This software APP can be downloaded free of charge from play.google.com. To connect to this transmitter, a USB OTG (On-The-Go) cable (5028-565) and USB A to Mini-B cable (4001-113) are required. This app is compatible with Android devices using Ice Cream Sandwich (4.0) or later.

The initial connection screen of the app is shown at left. Once a device is connected, the main portion of the app will launch. The screen is divided into three tabs for this model. A short description of each tab follows.

Connection Screen Set up – DEVICE SELECT (First Connect to Unit Here)

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



Configuration Tab – CONFIGURE I/O

- Once connected, the app will automatically read your transmitter and display its current configuration.
- Changing any option on this page will send the changes to the transmitter instantly. The device status at the bottom of the page will report if the changes were sent successfully.

Calibration Tab – (Calibrate the Input and/or Output if Needed)

- On screen instruction guides the set up to properly calibrate the transmitter. After completing instructions, tap the **[Calibrate]** button.
- The device status at the bottom of the page will report if the calibration was sent successfully.

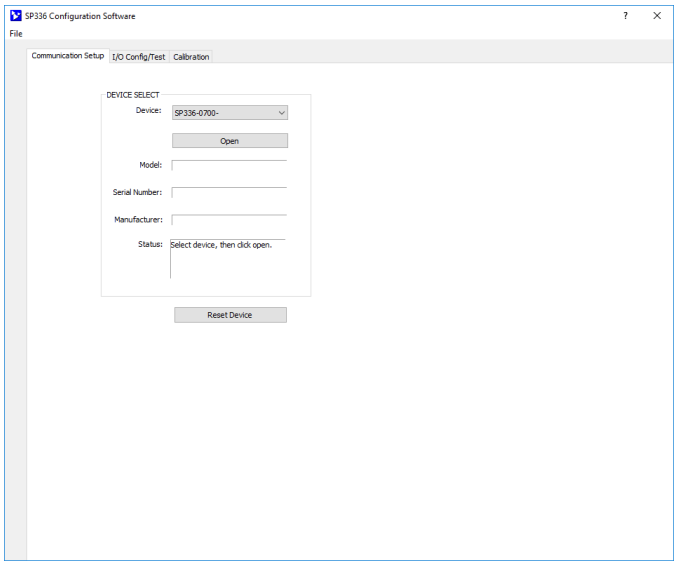
Diagnostic Center Tab – (Verify Input operation)

- Select the polling indicator by tapping the **[Indicator]** button.
- Start polling by tapping the **[Start Polling]** button.

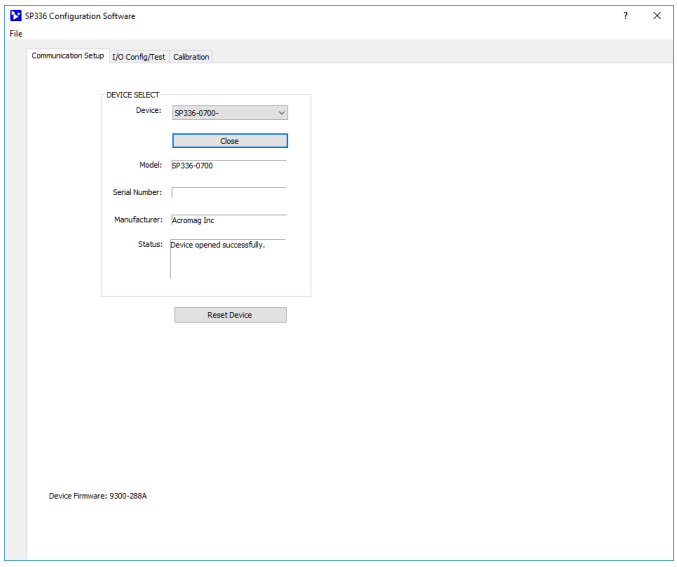
Utility Page – (Reboot or Restore Settings)

- Tap the **[Gear]** in the Action bar to access the Utility Page.
- You can tap the **[Restore/Reset Factory]** utility buttons to get out of trouble if you ever misconfigure or improperly calibrate a transmitter.

Quick Overview – Windows



*Click **"Open"** to connect to the SP336-0700 and your screen will like:*



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 again to point to a field or control to get a Help message pertaining to the item you pointed to.

This transmitter can be configured and calibrated via its USB Configuration Software and a USB connection to your Windows PC or laptop. The USB software can be downloaded free of charge from our web site at www.acromag.com, and included on a CDROM bundled with the Configuration Kit TT-SIP (see Accessories section). For this model, look for the program SP33XConfig.exe. This software is compatible with v7 or later versions of the Windows operating system.

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

Communication Set up (First Connect to Unit Here)

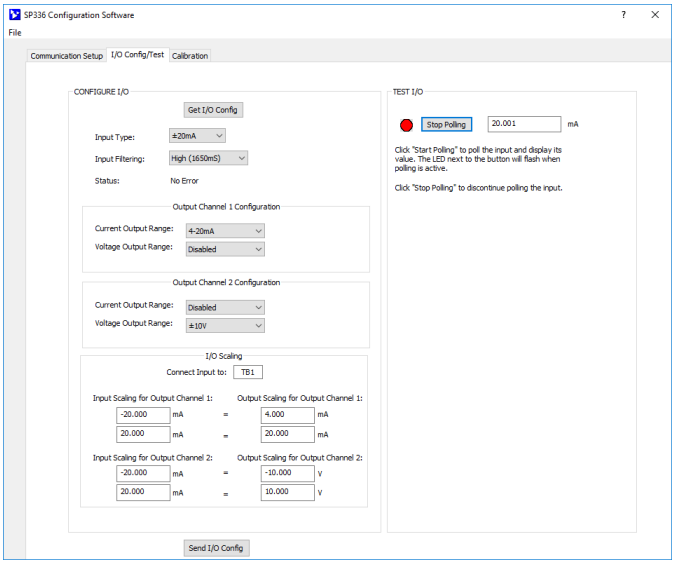
- Select from connected transmitters and Open/Close communication with them.
- Display the Model, Serial Number, and Manufacturer of the connected transmitter and report the status of communication with it.

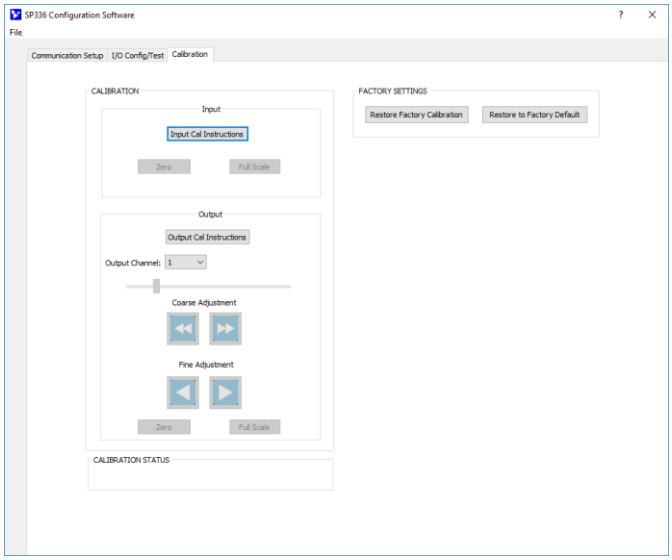
This section is used to select a connected transmitter, and open/close communication with it. Device connection Status is also indicated here, along with the connected transmitter's ID info (Product Name/serial, Manufacturer, & Serial Number).

I/O Config/Test (Configure 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. You can select current ranges ±20mA, 0-20mA, 4-20mA, 0-11.17mA, or ±1mA for current wired to TB1, or voltage ranges ±0.5V and 0-500mV for voltage wired to TB2.
- Set the level of digital filtering to High, Medium, Low, or None (No digital filter). The corresponding I/O response time varies with filter selection and is indicated in parenthesis next to your selection.
- Set the Output Range to ±10V, ±5V, 0-5V, 0-10V, ±20mA, 0-20mA, or 4-20mA.
- View the unit's configuration message status in the Status field.

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 again to point to a field or control to get a Help message pertaining to the item you pointed to.

I/O Config...continued

- Use the I/O Scaling fields to specify the specific input range endpoints that are to correspond to the output range zero and full-scale endpoints (some over/under-range is included).
- Last, after making I/O changes, send your settings to the unit by clicking the **[Send I/O Config]** button and follow the on-screen prompts.

For detailed configuration and calibration procedures, see the Operation Step-By-Step section of the Technical Reference on page 18 of this manual.

Test I/O (Optional, Verify Unit Operation Here)

After making I/O configuration changes, you can use the TEST I/O controls to start/stop polling the input channel to check your input readings.

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

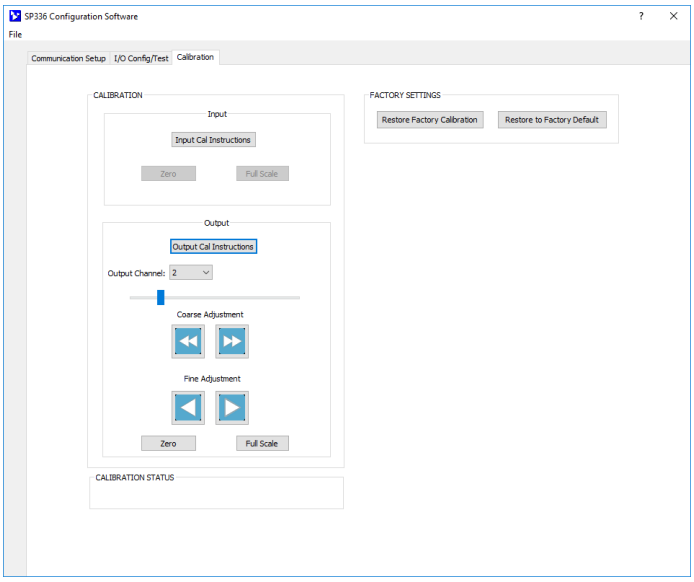
CALIBRATION (Calibrate Input or Output if Needed)

This unit has already been factory calibrated. If you encounter excessive error, you can choose to click the Calibration tab to display the Calibration control page shown in the second screen at left.

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

Note that only nominal I/O ranges are used for calibration, not your scaled I/O ranges. Always set the input filter as desired before calibrating the input.

Quick Overview – Windows...



CALIBRATION...continued

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

When you click the **[Zero]** or **[Full Scale]** buttons of the Input Calibration section, you will be prompted to apply a specific current level at TB1, or voltage level at TB2, depending on your selected input range. Once you have applied this signal to the correct input terminals, click the **[OK]** button of the prompt and follow the on-screen instructions to complete input calibration.

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

Factory Settings
(Use in Case of Trouble or for Sanitation Purposes)

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

You can click the “Restore Factory” buttons if you ever misconfigure or improperly calibrate a transmitter such that its operation appears erratic, or for sanitation purposes when decommissioning a module.

Calibration Status (Bottom of Screen)

- Displays communication status messages for the calibration process.

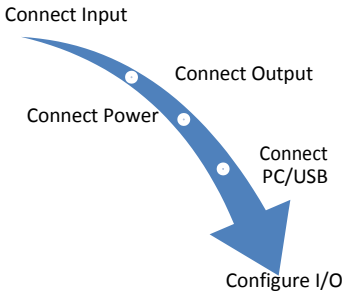
The CALIBRATION STATUS message bar at the bottom of the screen will display status messages relative to calibration.

TECHNICAL REFERENCE

OPERATION STEP-BY-STEP

Connections

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



Note: Your input source, output meters, and load resistors (current outputs) must be accurate beyond the unit specifications, or better than ±0.1%. A good rule of thumb is that your equipment accuracy should be four times better than the rated accuracy you are trying to achieve with this transmitter.

Calibration Connections:

1. **Connect Input:** Connect a precision current source to the TB1 input terminals (SP336 only), or a precision voltage source to the TB1 or TB2 input terminals as required for your input model/range. Your signal source must be adjustable to the nominal input range zero and full-scale levels. Observe proper polarity. For voltage input, use a voltage source with an output impedance of 100Ω or less. For best results, set the input filter as desired before calibrating an input.

2. **Connect to One Output, Voltage or Current of Each Output Channel:** Wire output loads to the unit appropriate for either current or voltage, as required by your application. You will need to measure output current or voltage accurately to calibrate the output. You could connect a current meter in series with the load to read the output current directly, or a digital volt meter in parallel with the load to measure output voltage. Alternatively, you could simply connect a voltmeter across a precision load resistor to accurately read output current as a function of the IR voltage drop produced in the load resistor (recommended for current outputs).

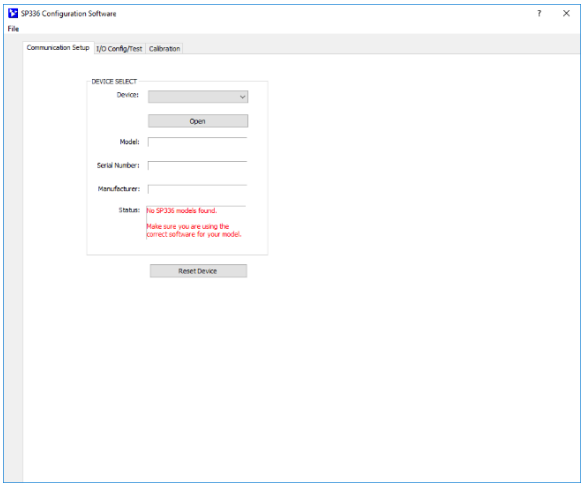
3. **Connect Power:** Wire 6-32VDC power to the unit at TB5 as shown in the Electrical Connections section. Optionally, you may wire power to the bus terminal as shown in the optional power connections drawing. But in either case, never exceed 36VDC peak, or damage to the unit may result.

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

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

   Now that you have made your connections and applied power, you can execute the SP33XConfig.exe software for your model to begin configuration of the unit (software is compatible with v7 or later versions of the Windows operating system).

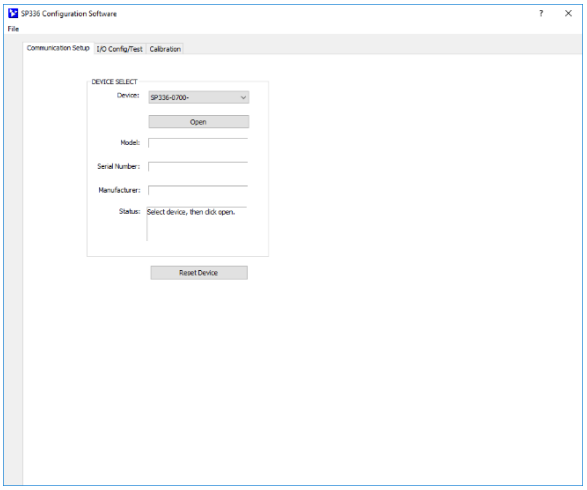
Configuration



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

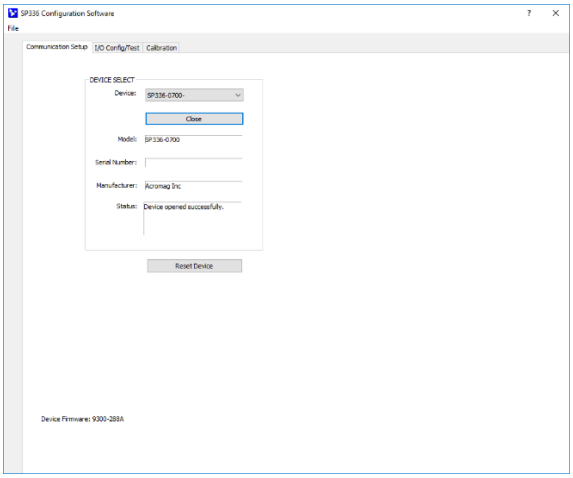
After executing the Acromag Configuration software for this model, the screen shown at left will appear, if you have not already connected to your transmitter via USB (note fields are blank under these conditions).

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



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

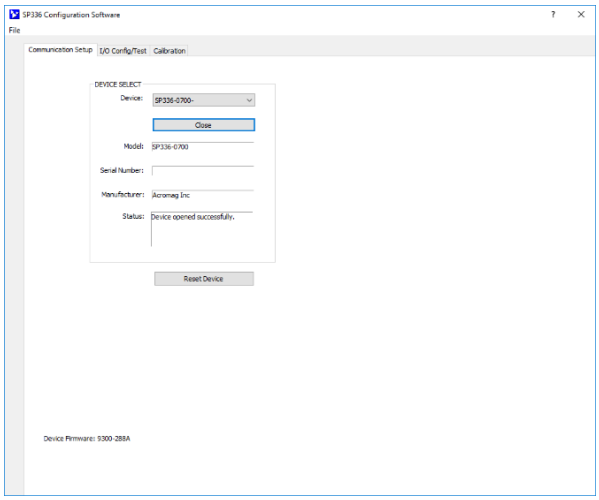
Once you have selected a device, click the **[Open]** button to open communication with the unit.

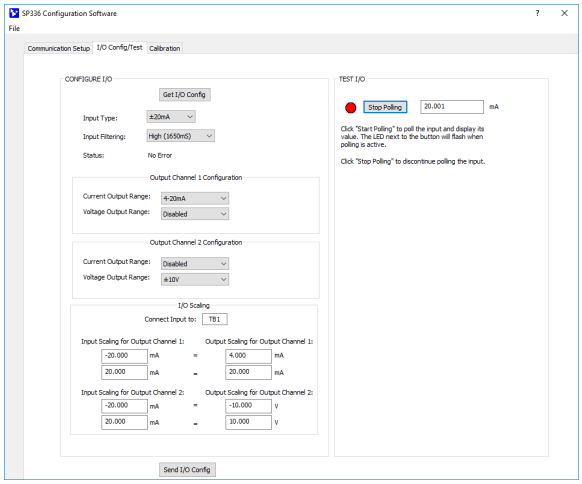


After clicking [Open], the selected unit's Model, Serial Number, Manufacturer, and connection status message will be displayed as shown in the first screen on the next page.

TIP: Always Close a connection with one device before selecting another device. Make sure you have the correct model software for the model you are configuring.

Configuration…





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

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

When you click the "I/O Config/Test" tab, the software retrieves the unit's current configuration and displays it like the second screen shown at left.

IMPORTANT: Note that these models have two input points. For the SP336, the first input is TB1 (upper terminal block of input side) for DC current only, and its second input is TB2 (the lower terminal block of the input side) for DC voltage only. For the SP337 & SP338, both TB1 & TB2 are intended for different ranges of DC voltage input. Your selected input range will determine which terminal block you wire your input to. Only one input may drive the output at one time.

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

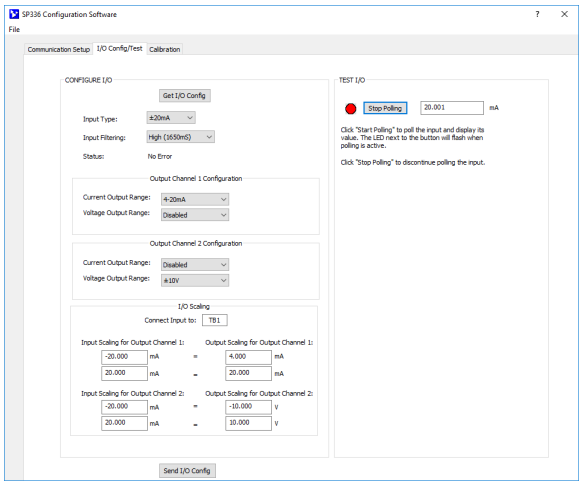
Note that if you make any changes to the selections indicated, the only way to preserve your changes is to write them to the device by clicking the **[Send I/O Config]** button after completing your selections, or to save them to a file by clicking **"File"** in the upper left-hand corner of the screen.

Select the Input Type/Range…

Input Range refers to the nominal input range. On the SP336, DC current inputs are wired to TB1 and support ranges ±20mA, 0-20mA, 4-20mA, 0-11.17mA, and ±1mA. DC voltage ranges are wired to TB2 and support nominal ranges ±0.5V or 0-500mV. The SP337 & SP338 support DC voltage ranges at TB1 and TB2.

Note that any input range you pick here can be rescaled to the output, allowing you to use only a portion of the selected input range to drive a current or voltage output, as desired. However, resolution will decrease proportionally as you rescale the input signal smaller than the nominal range. Each halving of the nominal range will reduce resolution by 1 bit. This can also magnify error, especially noticeable for very small input ranges which degrade the signal-to-noise ratio of the input and resolution of the analog-to-digital conversion.

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 Filtering…

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

Select the Output 1 and Output 2 Ranges…

This unit has both DC voltage and DC current output terminals at each output channel. Current Output Ranges are 0-20mA, 4-20mA, and Disabled, and the current output will drive up to 525Ω. Voltage Output Ranges are ±10V, ±5V, 0-10V, 0-5V, and Disabled, and the voltage output may drive 1KΩ or higher loads. Only one output, current or voltage may be loaded at one time.

Select the I/O Scaling…

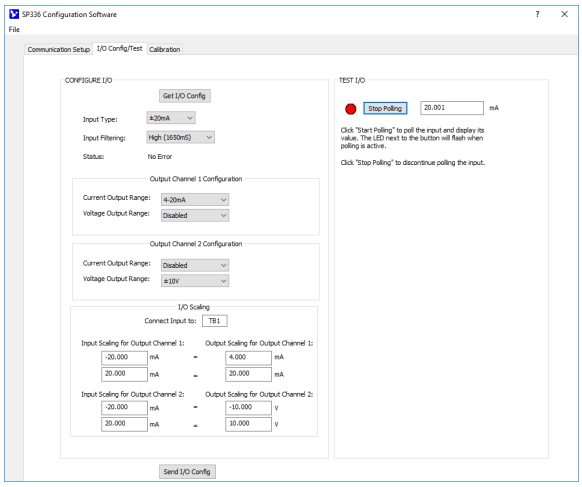
You may rescale a selected input range differently for each output channel and you could choose to use a smaller portion of the nominal input range to drive an output if desired. Likewise, you may rescale an output range. Be careful not to reduce an input or output range too much, as resolution will be proportionally diminished and noise/error magnified (each halving of range reduces respective resolution by 1 bit).

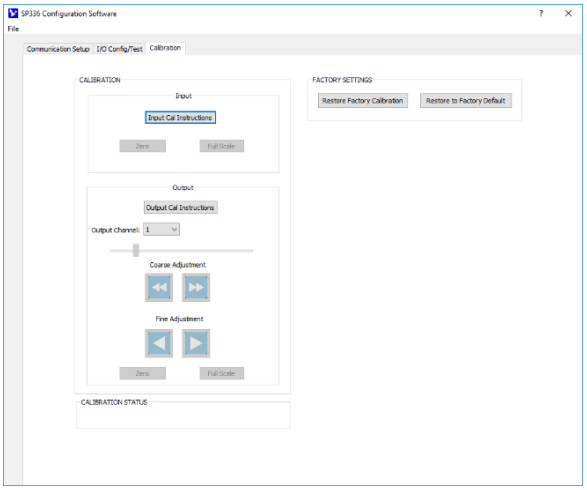
In the Input Scaling fields for each output, set the input signal minimum/zero value inside full range to correspond to the output range zero value (over/under-range included). Set the input signal maximum/full-scale value inside full range to correspond to the output range full-scale value. You may also rescale the output range similarly. You could optionally swap input levels to configure a reverse acting output response if desired. Note that some under and over-range is built into every I/O range selection and these limits vary by range.

If the scaled input/output 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 sent message to the unit in the "Status" field. Alternately, you could click **"File"** in the upper left corner to save the settings to a file on your PC, for later reference.

Calibration (Optional)





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

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

Once you have configured the unit, you may install it in the field, as the unit has already been factory calibrated. If you later encounter excessive error, you can choose to click the **Calibration** tab to display the Calibration control page shown at lower left.

IMPORTANT: The unit has already had input and output channels factory calibrated with a high level of precision. If you attempt to recalibrate an input/output channel, you could degrade its performance if it is not done properly, or it is done using lower grade equipment. Consider your decision to recalibrate carefully. Set the input filter as desired before calibrating the input.

Calibration of this model is a simple two-part process initiated by simply clicking the Input Cal or Output Cal **"...Instructions"** button to begin and then follow the on-screen prompts to continue.

CALIBRATION – Input

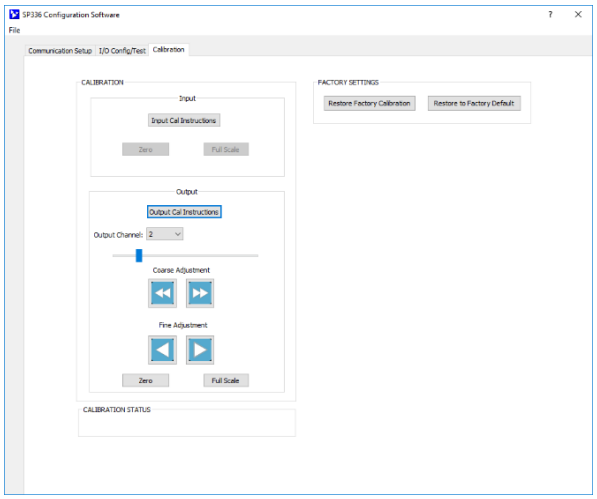
Before attempting input calibration, set the nominal Input Range and input filter on the "I/O Config/Test" page to calibrate and make sure you write your selection to the unit by clicking ***[Send I/O Config].*** *Wire your input source to TB1 if DC current input (SP336), or TB2 if DC voltage input.*

After setting the input range, click **[Input Cal Instructions]** button to begin input calibration and enable the Input [Zero] and [Full-Scale] buttons.

Click the Input **[Zero]** and you will be prompted to input the minimum value of your selected input range at the appropriate input channel. For DC current or voltage, this will be the range minimum at the input terminal and varies with the Input Range selected (calibration does not use the scaled range zero, but the zero of the nominal input range selected). Once you input the zero precisely, click the **[OK]** button and follow the on-screen prompt to calibrate zero.

Click the Input **[Full-Scale]** and you will be prompted to input the full-scale value of your selected input range at the appropriate input channel. For DC current or voltage, this will be the range minimum at the input terminal and varies with the Input Range selected (calibration does not use the scaled range zero, but the zero of the nominal input range selected). Once you input full-scale precisely, click the **[OK]** button and follow the on-screen prompt to calibrate full-scale.

Calibration…



CALIBRATION – Each Output Separately

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

First adjust your input signal as necessary to drive the output signal to precisely the nominal output zero of your selected output range (i.e. -20.000mA, 0mA, 4.000mA, -10V, -5V, or 0V, depending on the output range setting). Be sure to measure this output level accurately, or performance will be degraded. After driving the output to precisely output range zero, click the Output **[Zero]** button of the Calibration Output section to calibrate the output zero signal level.

Next adjust your input signal as necessary to drive the output signal to precisely the nominal full-scale of your selected output range (i.e. 20.000mA, 5V, or 10V, depending on the output range setting). Be sure to measure this output level accurately, or performance will be degraded. After driving the output to precisely output range full-scale, click the Output **[Full-Scale]** button of the Calibration Output section to calibrate the output full-scale signal level.

If 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. For current outputs, if you are measuring a voltage across an output load resistance, make sure that you use the exact load resistance when calculating the load current being measured. When rescaling your input to a smaller sub-range, make sure that you still have adequate input span, as too-tight input spans have diminished resolution and will magnify error.

Factory Settings

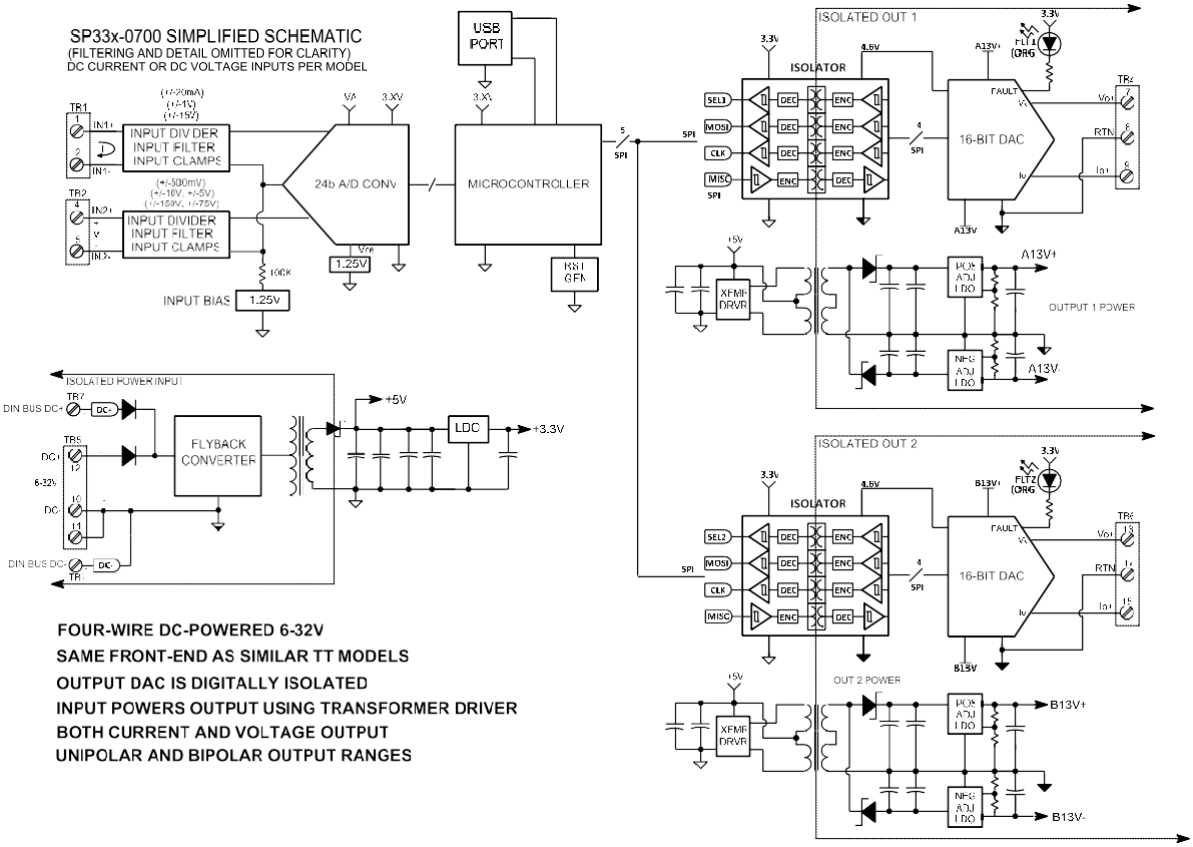
You can use the **[Restore Factory Calibration]** button to restore the transmitter's original factory calibration if you think you made an error during recalibration, degraded its performance, or the I/O channel appears erratic.

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

Calibration Status

This field displays calibration status messages like "No Error", "Transfer Error", and "Timeout Error" during calibration. If you encounter a Transfer or Timeout Error, your calibration did not complete and you may have to repeat the calibration process.

BLOCK DIAGRAM



How It Works

Key Points of Operation

- Unit is DC powered and power is Isolated.
- Input is Differential
- Dual Isolated Output Channels with tandem current and voltage output terminals.
- Input circuit ground is common to USB ground.

This transmitter uses a 32-bit microcontroller and a high-resolution 24-bit A/D to digitize the input signal and communicate to each output DAC via an SPI bus using digital isolators. This signal is transmitted to 16-bit output DACs which drive separate voltage and current terminals with a shared return. Each output range is user-configured. Power for the isolated input and isolated output circuits is provided via an isolated fly-back converter that operates on voltage wired to the power terminals at TB5, or wired to optional bus power terminals along the DIN rail. Set up involves selecting the input range (current or voltage), selecting the output range at each output (current or voltage), selecting a filter level, and scaling your input range endpoints to each output range zero/full-scale endpoints. I/O scaling can also be done in reverse to produce a reverse acting output signal. Refer to the block diagram above to gain a better understanding of transmitter operation.

The input/USB, each output, and power circuits are isolated from each other. This unit does not draw power from USB. The USB port ground is common to the input circuit ground. The USB port ground of most PC's is also common to the USB cable shield and earth ground. Input sensors could be grounded or ungrounded. For this reason, it is recommended that USB signals be isolated when connected to a PC to prevent a ground loop from occurring between the PC earth ground and a grounded input sensor, which would have the negative effect of pulling the input bias supply to ground and clipping any negative range.

TROUBLESHOOTING

Diagnostics Table

Before attempting repair or replacement, be sure that all installation and configuration procedures have been followed and that the unit is wired properly. Verify that power is applied to the unit and that your supply voltage is at least 7V. Verify that your load is appropriate to your output type, current or voltage

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

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

POSSIBLE CAUSE	POSSIBLE FIX
Cannot Communicate with Unit via USB…	
Output shifts off-range when you connect USB…	
Output Erratic, Not operational, or at Wrong Value…	
Unit fails to operate or exhibits an output shift…	
A missing USB Isolator could cause a ground loop between a grounded input sensor and earth ground at the connected Personal Computer's USB port.	Without USB isolation, a ground loop is possible between a grounded input and earth ground of the PC USB port. The input to this model is normally biased up 1.25V off input ground to process negative-going signals. A grounded signal source could inadvertently short this bias to earth ground and clip the negative input range with a non-isolated USB connection. For this reason and for increased safety and noise immunity, it is best to connect to USB via a USB isolator. Use an isolator like the Acromag USB-ISOLATOR. Otherwise, use a battery powered laptop to configure the transmitter, which does not normally earth ground its USB port.
Software Fails to Detect Transmitter…	
Bad USB Connection	Recheck USB Cable Connection.
(Agility) Your smart device needs permission to connect to the Acromag splitter the first time.	When you first connect to your smart device, it will prompt for permission. Be sure to give your permission or Agility will not discern your device connection. You may have to unplug/replug the USB connection to your tablet/phone to get this prompt.
USB has not enumerated the device.	Use the reset button on the Acromag USB isolator to trigger renumeration of the unit, or simply unplug and re-plug the USB cable to the splitter.
Communication or power was interrupted while USB was connected and configuration 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).
For an input step, the output appears to make 2 steps to reach its final value…	
For a step change in the input, the A/D needs 2 input samples to charge to its final level.	When you step the input, it takes two samples for the A/D to charge to its final output level, evident when using a scope to examine the output transition in response to an input step change, which appears to make two steps in its transition to its final level.

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
Output goes right to Over-Range (105%) or Under-Range Limit…	
This indicates that either the input signal is out of range, scaling is incorrect, or a sensor lead has broken. It can also occur due to contention between earth ground at the PC USB port and the input sensor.	Check the input signal and adjust it as required to drive the output to within its linear operating range. A fully upscale or down-scale signal can be driven by a sensor fault, such as an open/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.
Cannot Calibrate Input Channel…	
Is input wired properly?	Check that input is wired to ± input terminals using correct polarity.
Changing Input Filter Setting Affects Input Calibration…	
You may note a small shift in the input reading when changing the input filter setting.	An input should be calibrated at the desired filter setting. For best results, set the input filter as desired before calibrating the input.
Cannot Measure Input Voltage or Current…	
Have you wired the input to the correct terminals for the range selection?	DC Current is input to TB1 (upper block), while voltage is input to TB2 (lower block). Make sure that you are wired to the proper input per your signal type.
Output Noise Seems Excessive…	
Scaled input or output range is too small.	Scaling the input/output to very small spans diminishes I/O resolution and signal to noise ratio, potentially magnifying error. Every halving of the nominal range reduces resolution by 1-bit. Increase the I/O span.
An orange output fault LED is ON...	
The corresponding current output load is too large to drive it accurately or is an open-circuit, or the output driver has over-heated.	Indicates the current output load is open circuit or its load is too large to maintain output accuracy (≤525Ω), or the IC die temperature has exceeded 142°C (resets upon cooling below 124°C). It may also occur if the loop supply voltage is too low to support the load.

Service & Repair Assistance

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

ACCESSORIES

Software Interface Package

Software Interface Package/Configuration Kit – Order TT-SIP

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

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

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 SP33x splitter. It is normally included in TT-SIP.

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

USB OTG Cable

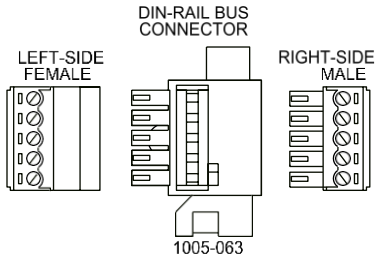
USB OTG Cable – Order 5028-565

- USB OTG Cable 5028-565

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

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

DIN Rail Bus Connector Kit



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

This kit contains one each of the following terminals

- DIN Rail Bus Connector 1005-063 for 17.5mm TT/SP Modules.
- Left Side terminal block, female connector 1005-220.
- Right Side terminal block, male connector 1005-221.
- Two End Stops for 35 mm DIN Rails 1027-222 (not shown).

Series SP splitters are shipped with their bus port plugged. Remove this plug and insert DIN Rail Bus Connector 1005-063 shown at left, which allows multiple units to snap together. Then add a left-side or right-side terminal block to connect the bus to power. These terminals can be used to optionally (or redundantly) drive power to Series TT or SP modules via the DIN rail bus connector, and allowing modules to neatly and conveniently share a connection to Power. Two end stops 1027-222 are used to secure the terminal block and module for hazardous location installations and are not shown.

End Stops

Two End Stops – Order 4001-252

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

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

SPECIFICATIONS

Model Number

Model SP33X-0700

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

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

The SP336 model prefix denotes a combination DC current and DC voltage input type of the DIN-Mounted Series SP33x Splitter family. The SP337 model prefix denotes a nominal DC voltage input type, and the SP338 model prefix denotes a high-level DC voltage input type. The trailing "-0700" model suffix denotes 4-wire power with CE and UL/cUL Class 1, Division 2 Approvals included.

Optional factory calibration to your own specification is ordered as a separate line item at time of purchase, and on a per unit basis. Factory calibration will require the specification of nominal input range, filter level, each output range, scaled input range zero, and scaled input range full-scale. You can also specify a normal or reverse acting output.

A standard model without adding custom factory calibration is calibrated by default for 4-20mA DC at TB1 (SP336), ±1V DC at TB1 (SP337), or ±15V DC at TB1 (SP338), and both splitter outputs mapped to 4 to 20mA outputs normally acting, and with medium input filter selection.

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

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

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 SP336, DC current is input at TB1, and DC voltage at TB2. On SP337, ±1V DC is input at TB1, and ±10V at TB2. On the SP338, ±15V DC is input at TB1, and ±150V is input at TB2.

Input Reference Test Conditions: TB1: SP336 4 to 20mA current, SP337 ±1V, SP338 ±15V, TB2: SP336 ±0.5V; SP337 ±5V; SP338 ±150V, or ±0.5V input at TB2; 4-20mA output into a 250Ω load; 25°C Ambient; and 24V DC Supply.
Input Range per Terminal: Each model has separate input channels at TB1 & TB2, but only one input may drive the output at a time. The input may be scaled differently for each output channel. Nominal ranges indicated below may be rescaled to drive outputs using only a portion of the input range. The input signal is processed differentially by the A/D converter. Note that resolution decreases and error increases as nominal input ranges are rescaled smaller.

MODEL	Input 1 at TB1	Input 2 at TB2
SP336	±20mA, 0 to 20mA, 4-20mA, 0 to 11.17mA, & ±1mA DC. Uses a precision 24.9Ω current shunt resistor to convert to Vin.[1]	-0.5V to +0.5V, or 0 to 500mV. No resistive divider is present at TB2 and its input impedance is 15MΩ minimum.
SP337	±1V, 0-1V, no divider	±10V, ±5V, 0-10V, and 0-5V DC. Uses an 86.6K/1084.6K divider.
SP338	±15V, 0-15V DC. Uses a 56.2K/1054.2K divider.	±150V/±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 input to TB1 of the SP336 (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 1 of next page for scaling the AC current by number of primary turns).

Input...continued

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

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

Input Impedance: SP336 24.9Ω minimum at TB1 (current-shunt), and 15MΩ minimum at TB2 (no resistor divider is present at TB2 which is directly connects to ADC); SP337 15MΩ minimum at TB1 (no resistor divider), and 1084.6KΩ at TB2 (a 12.5:1 resistive divider is present at TB2); SP338 1054.2KΩ at TB1 (an 18.758:1 resistive divider is present at TB1), and 1003.36KΩ at TB2 (a 187.194:1 resistive divider is present at TB2).
Input Overvoltage Protection: Inputs include Bipolar Transient Voltage Suppressers (TVS) with 5.6V clamp level typical (SP336), 14V working, and 18V clamp level typical and 14V working (SP337), and 220V working voltage typical (SP338). All inputs to ADC also include differential input diode clamping, capacitive filtering, and series resistance.
Input Filter: Normal mode RC filtering, plus digital filtering, optimized and fixed per input range and filter selection within the Σ-Δ ADC. See Normal Mode Noise Rejection and Output Response Time.
Noise Rejection (Common Mode): Varies with input and filter selection between no filter and high filter and assumes a 100Ω input unbalance as follows (typical):

MODEL	NO FILTER	HIGH FILTER
SP336	**105dB**	**139dB**
SP337	**83dB**	**133dB**
SP338	**75dB**	**91dB**

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

	TYPICAL 60Hz REJECTION PER INPUT & INPUT FILTER			
IN RANGE (±MAX)	**NONE**	**LOW**	**MED**	**HIGH**
SP336 TB1 (±20mA)	4.2dB	10dB	> 80dB	> 80dB
SP336 TB2 (±0.5V)	7dB	25dB	> 80dB	> 80dB
SP337 TB1 (±1V)	1.1dB	11dB	> 80dB	> 80dB
SP337 TB2 (±10V)	21dB	37dB	> 80dB	> 80dB
SP338 TB1 (±15V)	17dB	34dB	> 80dB	> 80dB
SP338 TB2 (±150V)	15dB	31dB	> 80dB	> 80dB

Input...continued

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

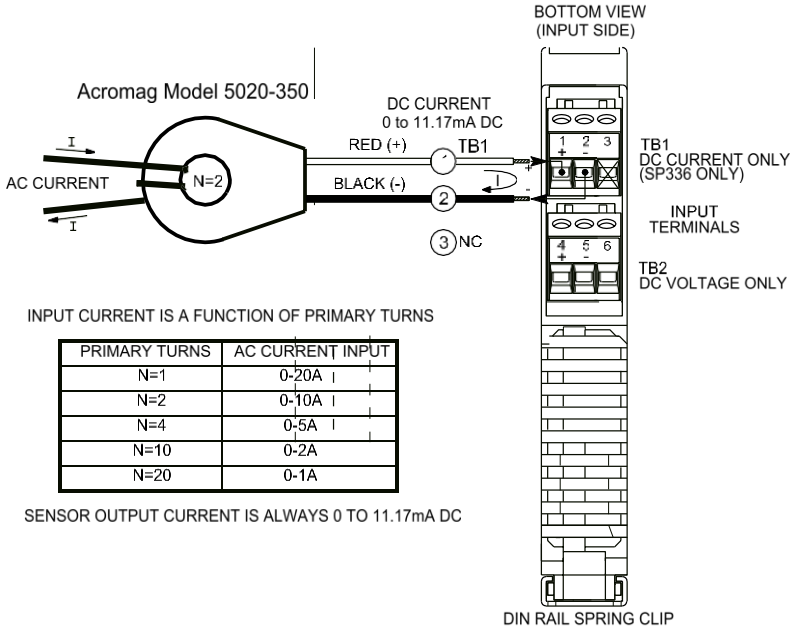
SPx36 INPUT RANGE	xDIVIDER	xGAIN	A/D INPUT RESOLUTION[1]
-20mA to +20mA (TB1)	24.9Ω Shunt	2	6658 to 58878 or 1/52220
0 to 20mA (TB1)	24.9Ω Shunt	2	32768 to 58878 or 1/26110
4 to 20mA (TB1)	24.9Ω Shunt	2	37990 to 58878 or 1/20888
0 to 11.17mA (TB1)	24.9Ω Shunt	2	32768 to 47350 or 1/14582
-1mA to +1mA (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**.

Optional AC Current Sensor (Model 5020-350, for AC Current IN to SP336 at TB1): Optional sensor can be connected to TB1 of the SP336 model for AC current sensing and is a toroidal instrument transformer that converts the sinusoidal 50-60Hz AC current signal into low level 0 to 11.17mA DC. The input 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 a SP336 module, it also facilitates AC current input isolation from the ADC voltage input, as well as redundant input isolation with respect to each output of this transmitter.

Input...continued

MODEL SP336-0700 WIRING TO AC CURRENT SENSOR



INPUT CURRENT IS A FUNCTION OF PRIMARY TURNS

PRIMARY TURNS	AC CURRENT INPUT
N=1	0-20A
N=2	0-10A
N=4	0-5A
N=10	0-2A
N=20	0-1A

SENSOR OUTPUT CURRENT IS ALWAYS 0 TO 11.17mA DC

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 process current input terminals at TB1 of this module, as shown above (current input to input+ and returned via input-).

Table 2: Optional AC Current Sensor Turns & Range (for SP336 Model Only)		
AC Current Input Range	**Primary Turns**	**Sensor Output (Red/Black)**
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	"

AC Input Burden: A function of the wire gauge resistance used for primary turns (the current carrying wire being monitored).
AC Current Sensor to Transmitter Wiring Distance: 400 feet maximum for 18 gage wiring. Other wire gauges can be used if the resistance of both wires is less than 5Ω.
AC Input Overload: The AC current 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 output channel has separate voltage and current output terminals that share a return terminal. Only one output signal, voltage or current, may be loaded per output channel at one time. Supported output ranges with over-range are shown in Table 3 below.
Output Resolution: Each output is driven by a 16-bit voltage/current DAC, Texas Instruments DAC8760IPWPR. The resolution per nominal output range is indicated in the Table 3 below. Note that nominal ranges may be rescaled in the unit and resolution will drop 1 bit for every halving of the range. The actual I/O resolution of a unit will be the lowest resolution of the input A/D, and output D/A relative to the selected/scaled I/O range.

16-bit DAC COUNT	TABLE 3: OUTPUT RANGES AND RESOLUTION w/OVER-RANGE					
	Voltage Output				Current Output	
	0-5V	**0-10V**	**±5V**	**±10V**	**0-20mA**	**4-20mA**
0	**0V**	**0V**	-5.5V	-11V	**0mA**	0mA
2979			**-5.0V**	**-10V**		
10923					4mA	**4mA**
54612					**20mA**	**20mA**
59577	**5.0V**	**10.0V**				
62556			**+5.0V**	**+10V**		
65535	5.5V	11.0V	+5.5V	+11V	24mA	24mA
RES	**1/59577**	**1/59577**	**1/59577**	**1/59577**	**1/54612**	**1/43689**
1 lsb	83.925uV	167.8uV	167.8uV	335.7uV	0.34132uA	0.34132uA
%Span	0.001678%				0.001707%	0.002133%

Output Accuracy: Better than ±0.05% of span, typical, and ±0.1% maximum, with nominal input and output ranges. This includes the effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.
Output Noise/Ripple: Less than ±0.1% of output span, typical.
Note (High Speed Acquisition): Additional filtering at the load is recommended for sensitive applications with high-speed acquisition rates. For excessive 60Hz supply ripple with current output, a 1uF or larger bulk capacitor is recommended at the load. High frequency noise is often reduced or eliminated by placing a 0.1uF or 0.01uF capacitor directly across the load (this can also raise RF immunity).
IMPORTANT: Input and output ranges may be rescaled to ranges smaller than nominal, which can increase potential error as resolution and signal-to-noise ratio are diminished for small I/O spans. In general, rated accuracy can be achieved for effective I/O resolution equal or greater than 12-bit (1/4096).
Output Load: The voltage output can drive loads down to 1KΩ minimum. The current output can drive 21mA DC into 0-525Ω.
Output Ambient Temperature Drift: Better than ±80ppm/°C (±0.0080%/°C) over the ambient temperature range. This includes the combined effect of zero and span drift for reference test conditions (see Input Specifications).
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 500Ω load with the input set to No filter, Low filter, Medium filter, and High filter.

Output...continued

INPUT FILTER	OUT RESPONSE TIME TO 98% OF TRANSITION (TYPICAL)		
	SP336	SP337	SP338
NONE	28ms	11ms	39ms
LOW	34ms	38ms	59ms
MEDIUM	115ms	121ms	158ms
HIGH	1060ms	1050ms	1168ms

USB Interface

USB MINI-B socket for temporary connection to a PC or laptop for configuration and calibration purposes. USB isolation is required when input is connected to a grounded input sensor (see "IMPORTANT" below). During reconfiguration & recalibration, the transmitter receives its power from its DC power connection (via DIN rail bus or power terminal TB5), not USB. As such, you must connect power to the unit when you connect USB.

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.

Cable Length/Connection Distance: 5.0meters maximum.

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

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

USB PIN	DEFINITION
1	+5V Power (Transient Protected, but not used by the module)
2	Differential Data (+)
3	Differential Data (-)
4	NC – Not Connected
5[1]	Power Ground (Connects directly to Signal Ground)
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 Required: The input of this unit is isolated from both outputs and may be connected to grounded or un-grounded input sensors, but the input circuit ground connects 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 if you do not use an isolator. Failure to connect USB without isolation would short the 1.25V input bias supply to input ground if the sensor is also earth grounded, interfering with operation, truncating the negative input range, and possibly shifting the output. For this reason, USB isolation is strongly recommended when connecting to a PC. In the absence of USB isolation when connected to a grounded input sensor, a battery powered laptop could be used to connect to the unit instead, as the laptop does not normally connect to earth ground.

Power

Power Supply (Connect at TB5 or via DIN Rail Bus Terminal): 6-32V DC SELV (Safety Extra Low Voltage), 1.5W maximum. Observe proper polarity. Reverse voltage protection is included. Current draw varies with power voltage as follows (currents indicated assume maximum load with both current outputs driving 20mA into 500Ω).

SUPPLY	SP33X-0700 CURRENT CONSUMPTION
6V	221mA Typical / 250mA Max
12V	105mA Typical / 125mA Max
15V	84mA Typical / 100mA Max
24V	53mA Typical / 62mA Max
32V	41mA Typical / 46mA Max

CAUTION: *Do not exceed 36VDC peak to avoid damage to the unit. Terminal voltage at or above 6V minimum must be maintained across the unit during operation.*
Power Supply Effect: Less than ±0.001% of output span effect per volt DC change.

Enclosure & Physical

General purpose plastic enclosure for mounting on 35mm "T-type" DIN rail.
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.
Unit Weight: 0.35 pounds (0.16 Kg).
Dimensions: Width = 17.5mm (0.69 inches), Length = 114.5mm (4.51 inches), Depth = 99.0mm (3.90 inches). Refer to Mechanical Dimensions drawing.
I/O Connectors: Removable plug-in type terminal blocks rated for 12A/250V; AWG #26-12, stranded or solid copper wire.
Program Connector: 5-pin, Mini USB B-type socket, Hirose UX60-MB-5S8.
DIN-Rail Mounting: Unit is normally mounted to 35x15mm, T-type DIN rails. Refer to the DIN Rail Mounting & Removal section for more details.

LED Indicators (Front-Panel)

Power PWR (Green) – Channel Green ON indicates power is applied to unit (this LED is sourced from isolated internal 3.3V rail).

Fault FLT - Channel Output (Orange, Each Output, FLT1 & FLT2) - Orange FLT LED per output channel. ON indicates current output is open circuit, or the corresponding current output load resistance is too high to drive accurate current to it (load resistance is greater than 550Ω). ON may also indicate over-temperature if the output driver die temperature has exceeded 142°C.

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 +75°C (-40°F to +167°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Isolation: Input/USB, each output, and power circuits are all isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). Complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.

Environmental...continued

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.
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).
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 / IECEx Certified: The SP33x-0700 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 ≤ +75°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 than IP 54 and only accessible with the use of a tool in accordance with EN/IEC 60079-15.
3) Transient protection shall 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 or USB-OTG

This transmitter drives dual tandem analog output current and voltage channels proportional to a single sensor input based on the differential voltage measurement across the sensor (a voltage sourced from TB1 or TB2 depending on the range selection), or across a 24.9Ω current shunt resistor (for current input at TB1 of SP336). No switches or potentiometers are used to adjust this transmitter. Its behavior as an isolated signal amplifier/transducer is determined via programmed variables set using a temporary USB connection to a host computer or laptop running a Windows-compatible configuration software program specific to the transmitter model. This software provides the framework for digital control of all configuration and calibration parameters, and this information is stored in non-volatile memory.

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

Revision History

The following table show the revision history for this document:

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