

# GPIO Deployment Guide

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**ENTERPRISE, CORE, PRO, SA+ AND SA  
EXTREME**



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### Caution

Reader antennas should be positioned so that personnel in the area for prolonged periods may safely remain at least 31 cm (12.2 in) in an uncontrolled environment from the antenna's surface. See FCC OET Bulletin 56 "Hazards of radio frequency and electromagnetic fields" and Bulletin 65 "Human exposure to radio frequency electromagnetic fields."

### Vorsicht

Reader Antennen sollten so positioniert werden, dass das Personal im Bereich über einen längeren Zeitraum kann sicher bleiben mindestens 31 cm (12.2 Zoll) entfernt von der Antenne Oberfläche, in einer unkontrollierten Umgebung. Siehe FCC OET Bulletin 56 "Gefahren der Radiofrequenz und elektromagnetische Felder" und Bulletin 65 "Human Exposition gegenüber hochfrequenten elektromagnetischen Feldern."

## Revision History

Version	Author	Date	Changes
<b>1.0</b>		2017	Initial Document
<b>1.1</b>		2018	
<b>1.2</b>		2018	
<b>1.3</b>	Robert Ma	2019-05-01	Add SensArray Gen2 and Extreme GPIO definitions
<b>1.4</b>	Jo Major	2020-2-14	Add clarification and examples. Anode/Cathode discussion with figures.
<b>V2.0- V2.1</b>			Minor updates
<b>V2.2</b>	N. Mitchell	2021-11-12	Updated Copyright
<b>V2.3</b>	Jo Major . Neil Mitchell	2022-01-31	Correct Extreme GPIO, Consolidation of document
<b>V2.4</b>	Neil Mitchell	2022-03-08	Updated Extreme GPIO cable color coding.

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## Introduction

This Hardware Setup Guide provides instructions for installing and operating the GPIO connection on the following units:

- Enterprise, Core, Pro, SA+ and SA
- Extreme

This document is designed for use by RFID system integrators, IT networking professionals, and software developers - those who wish to develop RFID, networking solutions, and agile power deliver systems to take full advantage of the unique capabilities of the SensArray.

At SensThys.com, the user can find substantial additional information about RFID.

- **User Guide** – an overview of the interfaces for the SensArray, including General Purpose Input/Output (GPIO), POE, SMA outputs for antennas, DC power input, POE inputs.
- **Upgrade Guide** – instructions for the user to upgrade the firmware of the SensArray while in field operation. The SensArray can be upgraded through any Ethernet port on the unit.
- **Developer's Guides** – Programming Interfaces and Example Code.

## Safety Advisory

This guide discusses wiring electrical devices to the readers GPIO ports. The voltage levels that are supplied from the readers are limited to 24VDC. Although this voltage level is generally not a hazard, under some conditions it could provide a significant shock. Also, wiring devices live could generate unusual current paths between the reader and your external equipment before ground and voltage connections are set up properly, possibly resulting in harm to the reader or your equipment.

## SAFETY WARNING

***Power down the reader device and all equipment you are connecting to the GPIO port before doing the wiring!***

## GPIO on Enterprise/Core/Pro/SA+/SA

### Interface Specifications

Feature	Specification
GPIO (incl. Input power, output power)	4 input, 4 output; 24VDC supplied by reader Pin 11 GND Pin 12 Connection for external 24VDC Pin 1 GND Pin 2

### GPIO General Description

This integrated reader contains a 24V power supply! Gone is the need for extra power supplies and the dreaded GPIO box.

The SA, SA+ and Pro model provide up to 15W of power, the Core and Enterprise provides up to 30W of power to drive those GPIO devices.

The GPIO port provides four control inputs and four outputs. The SA, SA+ and Pro models are electrically isolated. The Core and Enterprise feature optical isolation on all ports. When operational both the input and output pins are fully interfaced to the electrical systems.

The GPIO operation contains three general aspects. These include power sourcing, accepting digital signals through one of the inputs, and turning external devices on and off through the outputs.

The electrical configuration of the Enterprise, CORE, Pro, SA+ and SA is **COMMON ANODE**.

### GPIO Pinout

The GPIO information in this chapter is for the following models: Enterprise, Core, Pro, SA+ and SA.

The main differences in GPIO functionality between these models are:

- Enterprise Input and Output pins are opto-isolated.
- On the Enterprise and Core, the internal power can provide up to 30 W of GPIO output power, while the SA, SA+ and Pro can only provide 15W.

The pinout assignments for the GPIO below:

Pin Number	Pin Description
Pin 1	External VCC, $V < 24V$
Pin 2	External ground
Pin 3	Output 1
Pin 4	Output 2
Pin 5	Output 3
Pin 6	Output 4
Pin 7	Input 1 ( $V < 1 VDC = "0"$ , $5 < V < 24VDC = "1"$ )
Pin 8	Input 2 ( $V < 1 VDC = "0"$ , $5 < V < 24VDC = "1"$ )
Pin 9	Input 3 ( $V < 1 VDC = "0"$ , $5 < V < 24VDC = "1"$ )
Pin 10	Input 4 ( $V < 1 VDC = "0"$ , $5 < V < 24VDC = "1"$ )
Pin 11	24VDC, $I_{max} = 1.2A$ for Enterprise and Core, 0.6 A for Pro, SA+ and SA
Pin 12	External ground

Table 2: GPIO Pins



Figure 1 The GPIO port, labeled "I/O"

Wires, recommended solid 20-26 AWG, are inserted into the round openings. To remove the wires, a small tool is inserted into the rectangular slot above, allowing the wired to be easily pulled out. Pin 1 is marked at the far left.

As detailed in Table 1 above, Pin 11, the second from the right of the picture above, can be used to source 24VDC. Either Pin 2 or Pin 12 can be used as the ground.

Note that in determining whether you can use the internal 24VDC, you also must look at the overall power consumed by other devices in the reader network as well as the power consumed by the RF radio when reading tags. If this greater than the available power, you

can use an external power supply to drive your external devices. You just need to connect the positive side of your DC voltage supply to Pin 1 and the ground side to Pin 2 or Pin 12.

## Power Sourcing

To use the GPIO, the reader should be connected to external ground via pins 2 and/or 12. These pins are internally connected within the reader.

External devices can be powered in two different ways.

1. External devices can be powered from the reader. This power can be delivered to the external device via pin 11, which provides a switched 24 VDC to a maximum of 600 mA. Users should bear in mind that using power from the reader decreases the amount of power that can be provided to other POE or GPIO devices. See Figure 2 below.
2. External devices can be powered by an external power supply, with the reader controlling the devices. To use an external power source, connect the +24VDC to Pin 1 and ground to Pin 2 or Pin 12. See Figure 3 below.

In this situation the power consumed by the external devices does not reduce the power that the reader can provide. Note, external power sources do not provide power to POE devices.

Pin 1 provides TVS surge protection and can help prevent surges in the 24 VDC supply from being passed onto external devices.

## Inputs - State of External Devices

Users may provide input signals to the reader via the GPIO inputs.

- A signal is considered a “1” if the voltage at the input pin is between 5V and the 24V upper rail.
- A signal will be treated as a “0” if the voltage at the input pin is between 0 and 3.3V. Signals between 3.3V and 5V are not recommended. These analog “on” voltage ranges are detected by circuitry within the reader, and then presented as true digital signals to the microprocessor.

*The input connections at Pins 7 through Pin 10 are addressed as Input 1 through Input 4, respectively. See Table 1 below.*

There is no linkage between the inputs and outputs. Each input or output operates independently from other inputs and output.



## Outputs - Control of External Devices

The function of the four output pins is to provide a switch to ground. The concept of switching on the ground side may be counter-intuitive, please carefully look at the various wiring diagrams.

- When the output is “off”, the switch is open, and no current can flow into the output pin.
- When the output is “on”, the switch is closed and current may flow directly into the output pin.

*The output connections at Pins 3 through Pin 6 are addressed as Output 1 through Output 4, respectively. See Table 1 below.*

## Examples -- Enterprise, Core, Pro, SA+ and SA

### Outputs with *internal 24V*

In this example, the output pin 5 is used to turn on or off a load, such as a light or a motion sensor. The 24VDC is used to power the load, so that an external power supply is not needed.

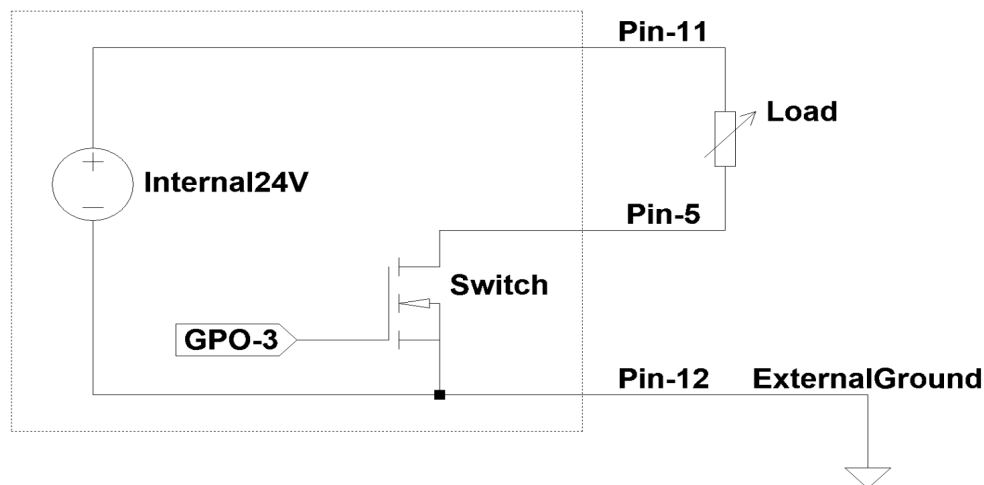


Figure 2: Using the GPIO to control an external device powered by 24VDC Internal supply

Figure 2 illustrates a load that is powered by the Internal 24VDC supply connected via Pin 11 of the GPIO connector. Pin 5 is used to control turning on or off the load. In this case, the circuit is set up to flow current through the load into Pin 5 External Output “3”.

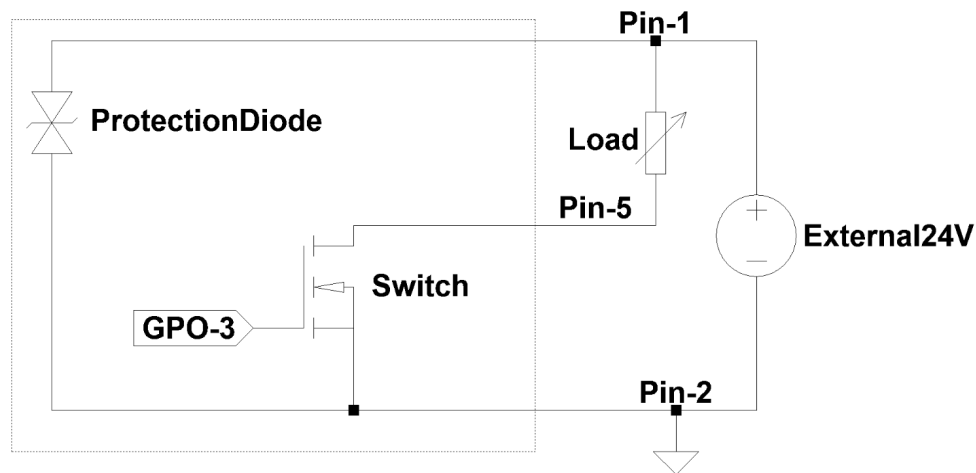
- When the switch is closed by the control signal GPO-3, current flows activating the load.
- When the switch is open, no current flows and the load will be inactive.

Note that Pin 12 is connected to an external ground in this figure.

However, if Pin 5 was connected to a control signal, that signal could open a path inside the load that would need the current return path back through Pin 12. In this case where Pin 5 is connected to a control signal, a pull-up or pull-down resistors will be needed to ensure that the control voltages are appropriate for activating and deactivating your device.

## Outputs with *external 24V*

In this example, the load is powered by an external 24VDC power supply. Pin 5 output is used to control turning on or off the load such as a light or a motion sensor. 24VDC is supplied to Pin1 of the SensArray and the load. Pin 2 ground is used in this case.



*Figure 3 Using the GPIO to control an external device powered by an external supply*

Figure 3 depicts the an external 24VDC supply connected to Pin 1 and external ground to Pin 2. An external load is supplied power by the external 24VDC source which has been also connected to Pin 1.

- The current path to ground for the accessory is in through Pin 5, through the switch controlled by GPO3, and back out to the accessory ground through Pin 2.
- When the microprocessor turns GPO3 “on”, it activates the switching FET, which effectively takes Pin 5 to ground, turning on the load device.
- When the microprocessor turns GPO3 “off”, no current flows and the load is inactive or off.

Note that in this case, the external 24VDC connected through Pin 1 is bridged to ground through a transient voltage suppression device to help reduce electronic noise in the circuit.

## Connection a PIR (Passive Infrared) to an input

Passive Infrared switches will detect infrared body signature, switch an output signal to indicate detection, and hold the “active” state until detection is cleared.

In this example, the PIR switch is powered by the reader via Pin 11 (Pin 12 gnd), and the status output is fed to the GPIO connector Pin 7 Input #1. This signal is then used by the reader to enable reading tags, as would be attached to the infrared emitter (body) that triggered the PIR switch in the first place.

When the PIR is inactive, Pin 7 will be “High”, or > 5 VDC, pulled up to V+ thru the 4k ohm resistor.

When the PIR is active, Pin 7 will be “Low”, or < 2.2 VDC , where V- from the PIR is shorted to gnd.

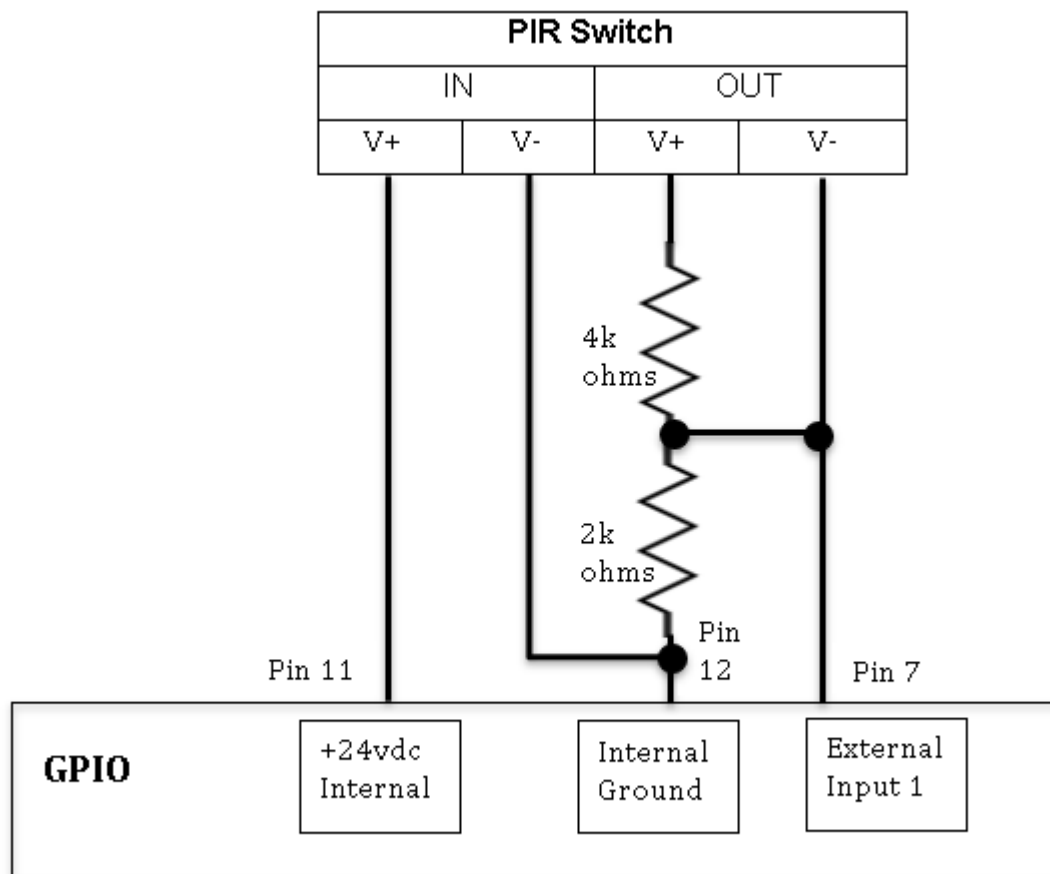


Figure 4 Wiring schematic with a PIR

## GPIO on Extreme

This section is specifically for the SensX Extreme reader.

The main differences in GPIO functionalities between the Extreme reader and the other SensArray readers are:

- The Extreme is **COMMON CATHODE**.
- Extreme reader has 2 input and 2 output pins, instead of 4 input and 4 output pins.
- The +24 vdc pin is a **VCC input voltage connection**, that is used as the rail for output “HI” on the GPIO output pins 2 and 4.

See Chapter 3 for examples of how to use the Output pins and 24VDC power supply, as well as programing the input and output GPIO lines.

## Digital Interface Specifications

Feature	Specification
GPIO (incl. Input power)	2 input, 2 output, optically isolated; +12 to 24VDC input and gnd; Rugged IP67 6-pin circular male pin connector with dust cap

## GPIO (General Purpose Input/Output) Connector

The SensX Extreme GPIO port provides two inputs and two outputs, which are all opto-isolated. The connector also has a pin for external ground and a pin for VDC to power the GPIO outputs, this voltage is referred to as VCC.

The pinout assignments for ground, power, the two inputs and two outputs are below.

### Input Behavior

If an input pin is <1V, that input is considered LOW. If an input pin is >5V it is HIGH.

Specifically, if Input 1 = 12V, then the Extreme system recognizes GPIO, INPUT 1 = HIGH.

## Output Behavior

The OUTPUTS are programmable within the Extreme. As an example, the Extreme can make an OUTPUT go high at a certain time, or when a tag temperature reaches a critical value, or when a certain set of conditions of INPUTS are met.

As an example, we can program the Extreme to take OUTPUT 1 high when a tag temperature goes above 80C, after 10PM, with two doors open (HIGH values on INPUTS 1 and 2) - this is effectively an "and" condition with four inputs.

As another example, we can take OUTPUT 2 high when INPUT 1 or INPUT 2 is HIGH.

The Extreme runs in Common Cathode configuration, meaning that when an OUTPUT is taken to HIGH, VCC is connected to that OUTPUT.

OUTPUT = LOW - OUTPUT PIN IS OPEN

OUTPUT = HIGH - VCC (from PIN 5) is provided to the OUTPUT

## GPIO Pin-out Specification

The pin-out of the GPIO is given below.

SensThys provides an optional connector cable which is fully IP67 when used with the Extreme. The wiring of the cable is as follows:

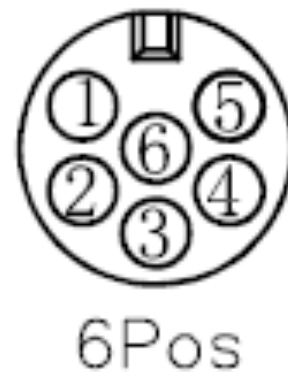
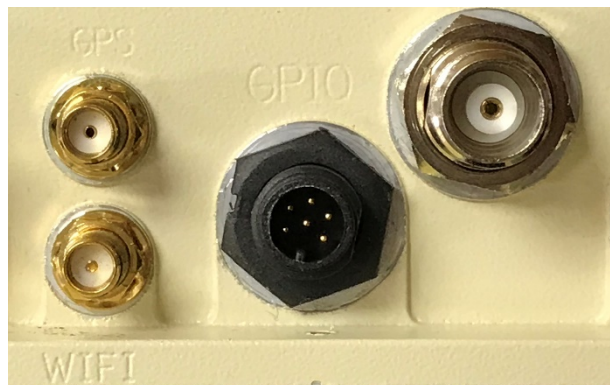


Figure 5 GPIO connector on Extreme

Pin	Assignment	Wire Color		Description
		Prior to Feb 2022	On or after Feb 2022	
1	Input 2	White	Orange	V<1, Low. 5-24V, High
2	Ext Ground	Black		Connect to external ground
3	Input 1	Blue		V<1, Low. 5-24V, High
4	Output 2	Yellow		When Output = "1", V (pin 4) = voltage at Pin 5 (VCC)
5	VCC	Red		Input Voltage (5-24V)
6	Output 1	Green	Brown	When Output = "1", V (pin 4) = voltage at Pin 5 (VCC)

Table 3: GPIO Pins for Extreme

## Configuring and Testing with the RFID Console

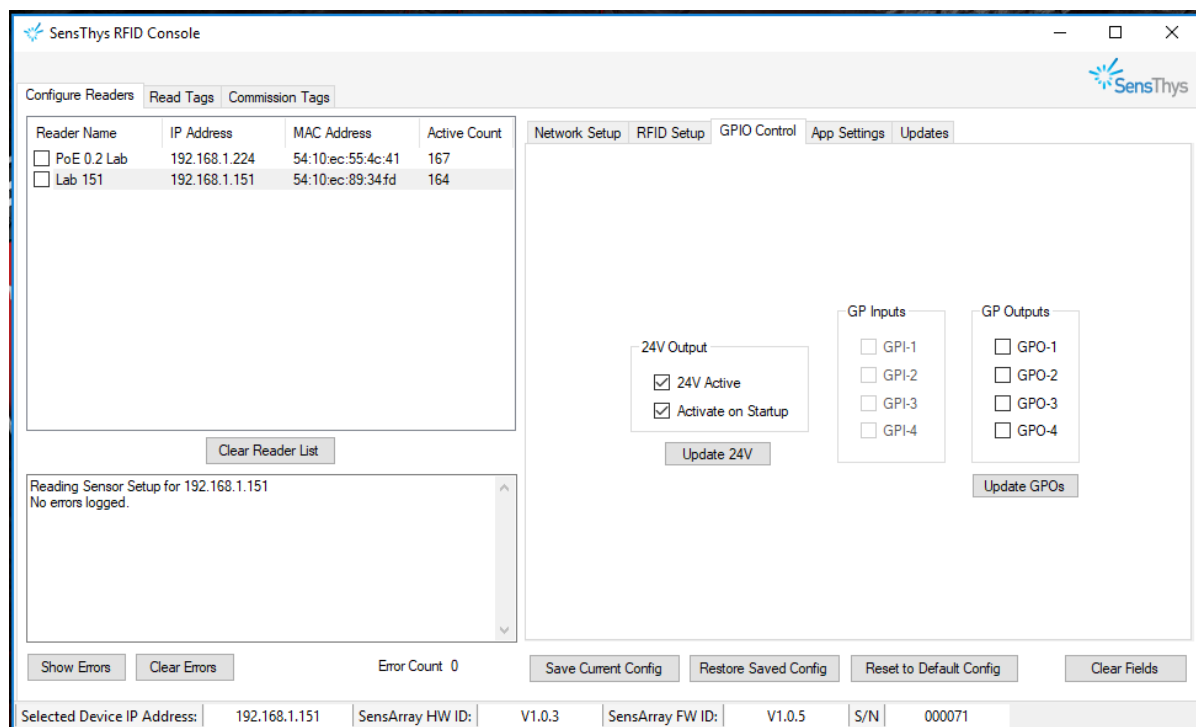


Figure 6 GPIO Control tab.

## Powering the 24VDC System

The readers can source 24VDC power through Pin 11. If you are going to use the reader to power GPIO accessories, you should start with the reader powered, but with nothing connected to the GPIO. Check the “24V Active” and “Activate on Startup” boxes, hit the “Update 24V”, and finally click “Save Current Config” on the GPIO tab.

Disconnect the power from your reader then connect your external ground to Pin 2. At this point the reader should be restarted.

## Testing your GPIO Input

It is quite simple to test your General-Purpose Inputs. To do so, simply click on the “Update GPOs” button below the “GP Outputs” section. The current state of each of the inputs will be read and displayed as unchecked if the voltage is low (below 3.3VDC) on the associated input line or checked if it is above 5VDC. Note that values between 3.3VDC and 5VDC will read but should be considered indeterminate relative to reliable operation of your system.

Once you have verified the current state of your GPIs, you should change the state of each input – preferably one at a time – and verify that each one correctly changes the associated checked item in the “GP Inputs” section. Note that a notification message is sent from the reader to the RFID Console application whenever general-purpose inputs change. The RFID Console receives the message and changes the check box that indicates the new state of the input (or inputs) that changed.

## Testing GPIO Output

Testing your General-Purpose Outputs proceeds along similar lines. Set up your hardware configuration, then check, or uncheck each associated check box in the GP Outputs group in the interface. After changing the check box, click the “Update GPOs” button to change the state of the output line. Observe whether your external device responds correctly when you activate or deactivate the output.

If you have difficulty when testing either the GPIs or the GPOs, be sure to check both the power supply connections as well as the connections to your external input or output devices. If those all appear correct and you still have problems, the next step is to use a multimeter and check voltage values for the inputs or outputs. As described above, the inputs must be below 3.3VDC to be off and above 5VDC (and below 24VDC) to be considered on. For GPOs, when the GPO is activated, the output line should be pulled to ground and when deactivated should pull up to your high voltage level.

## Programming the GPIOs

There are three interfaces for programming the GPIOs available in the RFID.dll API. You can find detailed documentation of the interfaces in the “GPIO and 24V Management Methods”



section of Appendix B in “The SensArray Programming Guide”. A brief overview of using these functions is provided here.

Note that the inputs are debounced in software, so you do not need to provide your own debouncing routine.

## Important Note

When the reader is reading tags while in a continuous inventory cycle, the only command that can be sent to the SensArray reader is the stop command. As a consequence, you cannot call the API method, `GetGPIOSetup()` discussed below, to determine the state of the general-purpose inputs. A UDP notification mechanism has been provided to inform your application when an input changes from on to off or vice versa. This notification is discussed in the section, “*GPI Notifications*” below.

### API Interfaces

As described above, you can configure the 24VDC setup through the RFID Console application. However, if you want to provide similar functionality through your application, you would use the `Get24VStatus()` and `Set24VStatus()` methods to do so. Also, if you want to have more control over when you activate the internal 24VDC supply from your application, you would use `Set24VStatus()` to do so.

If you want to query the current state of all of your GPIs and GPOs, you would use the `GetGPIOSetup()` method to do so. A call to this method returns a Byte whose bits provide the state of each of the 4 inputs and 4 outputs as follows  $[i_4, i_3, i_2, i_1, o_4, o_3, o_2, o_1]$  where  $i_n$  will be 1 if the input is high and 0 if it is low and  $o_n$  will be 0 if the output is not activated and 1 if it has been activated. As an example, if output 1 is high, output 2, 3 and 4 are low, input 3 is high, and inputs 1, 2, and 4 are low, the call to `GetGPIOSetup()` will return 0x41. Also, for completeness, output 1 is wired into pin 3, and input 3 is wired into pin 9.

To set the state of the GPOs, you use the method `SetGeneralPurposeOutputs()`. This method uses a set of bits similar to the value returned for `GetGPIOSetup()` described above. You send a Byte value as follows  $[0, 0, 0, 0, o_4, o_3, o_2, o_1]$  where  $o_n$  is set to 0 to deactivate the associated output and 1 if it is to be activated. Note that this is not a masked operation, so to change the state of an output, you should read the current state, change the value of the bits corresponding to the output(s) you want changed, then write the new data.

### GPI Notifications

To eliminate the need to poll the state of the General-Purpose Inputs from your application and to provide a way for your application to know when a GPI changes state, a notification message is broadcast to the local subnet on UDP port 3984. This notification is sent as soon as a change on any of the GPI input pins is detected. Once you receive this type of notification, your application can take the desired action which might include activating GPOs, starting tag read cycles, etc. Similarly, by listening for these messages during tag inventory cycles, your application can detect a change in an input that could trigger your application to send the command to stop the tag inventory process.

The format of the notification messages is as follows:

Bytes 1,2,4,9,14: Reserved for future use

Byte 3: Total message length in bytes = data length + 19. This should be 20 for a GPI change notification.

Bytes 5-8: The four bytes of the IP address of the reader sending the notice.  
IP Address = msg[4].msg[5].msg[6].msg[7]

Bytes 10-13: These 4 bytes provide a 32-bit value for the reader uptime in seconds from when the unit booted until the time this notification was sent.

Bytes 15-18: These 4 bytes can be reconstituted into a 32-bit value providing a sequence number for the notification. Since there can potentially be multiple paths from the reader to your application, this sequence number can be used to filter out duplicates.

Byte 19: The notification type. For GPI notifications, this value is 16 (hex 0x10)

Byte 20: This byte provides the new GPI state as follows [0, 0, 0, 0, i4, i3, i2, i1] where in is set to 0 when the input is low and 1 when the input is high.

## Troubleshooting

Why doesn't my light work? Buzzer is quiet?

The world of light stacks and GPIO devices is intriguing. At the lower end on the cost side, there are \$15 devices that you can purchase completely without any documentation. At the high side are \$200 IP67 devices with absolutely clear wiring schematics. At least spend enough money to get a clear schematic, it will save you lots of time.

There are three basic wiring configurations.

Common Anode → Enterprise, Core, Pro, SA+ and SA

All of the “high” sides of the various devices are connected to 24VDC.

The switching occurs on the ground side.

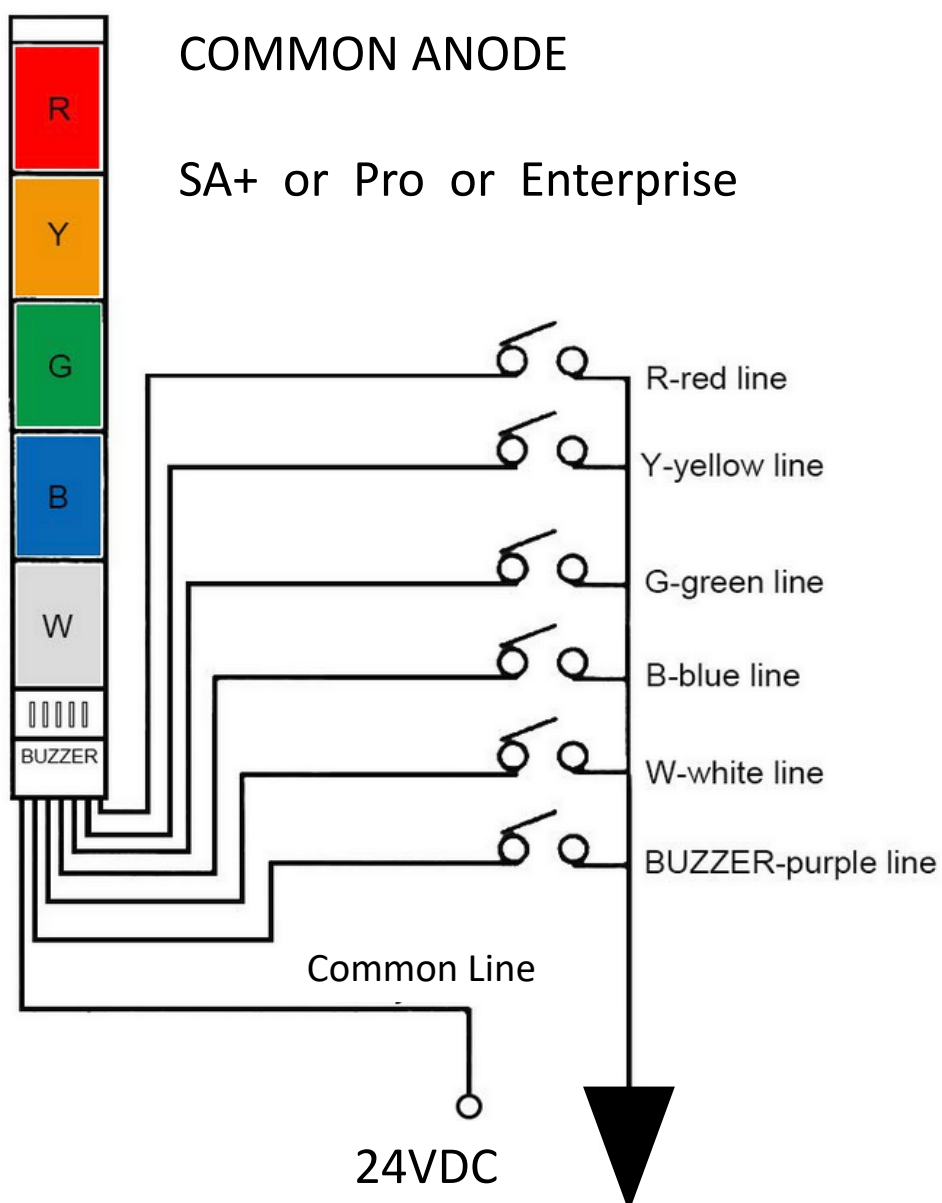


Figure 7 A COMMON ANODE configuration. This works for Enterprise, Pro or SA+.

*A common anode device will NOT work with Extreme.*

## Common Cathode → Extreme

All of the “low” sides of the various devices are connected to GROUND.

The switching occurs on the +24 VDC side.

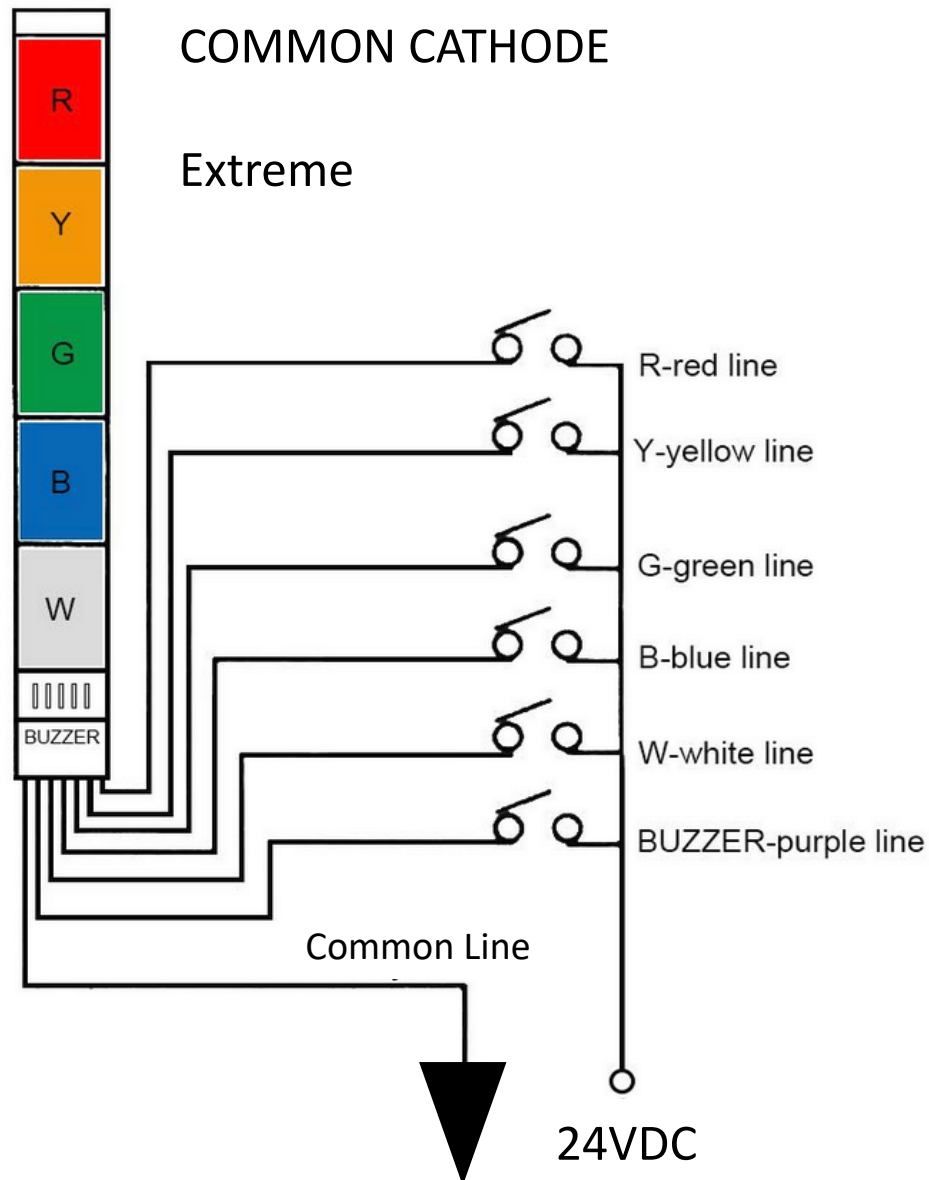
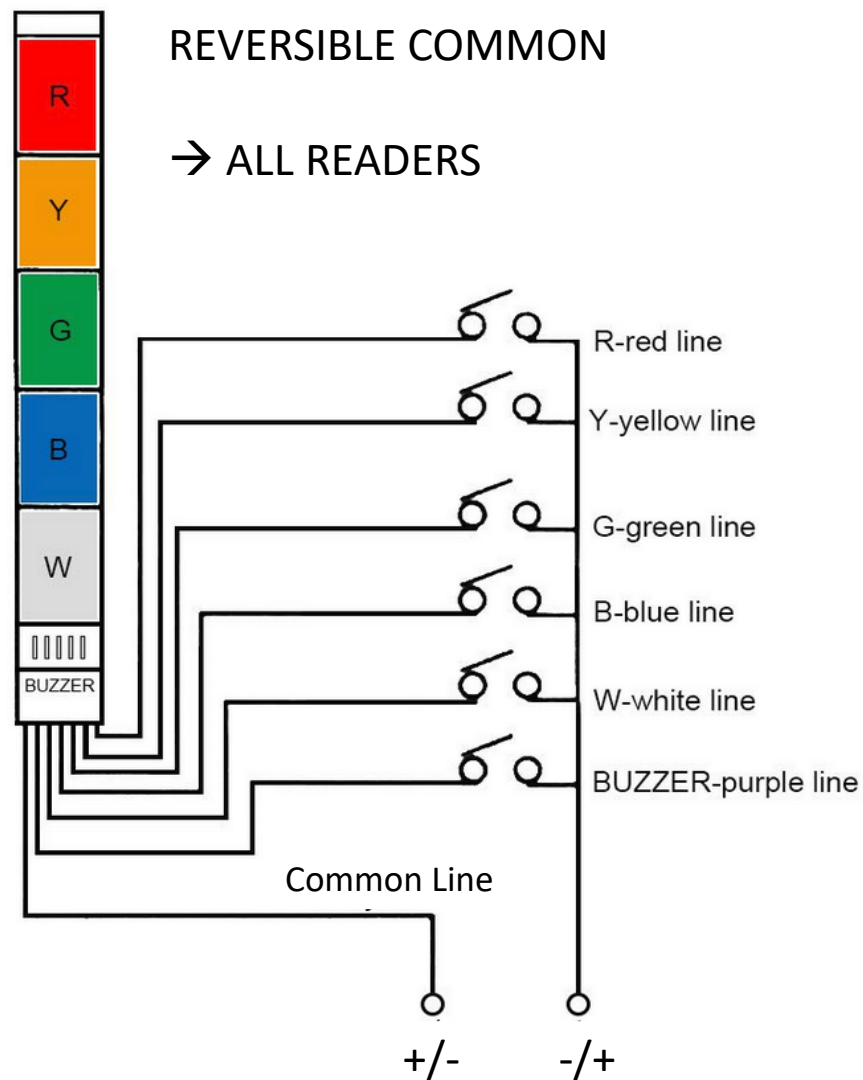


Figure 8 A COMMON CATHODE configuration. This works with Extreme.

*A common cathode device will NOT work with SensArray+, Pro or Enterprise.*

## Reversible Common Cathode or Anode → All

Either the “low” or “high” sides of the various devices are connected to each other.  
The switching then occurs on the “other” side.



*Figure 9 A REVERSIBLE COMMON configuration. This can work with all SensThys readers.*