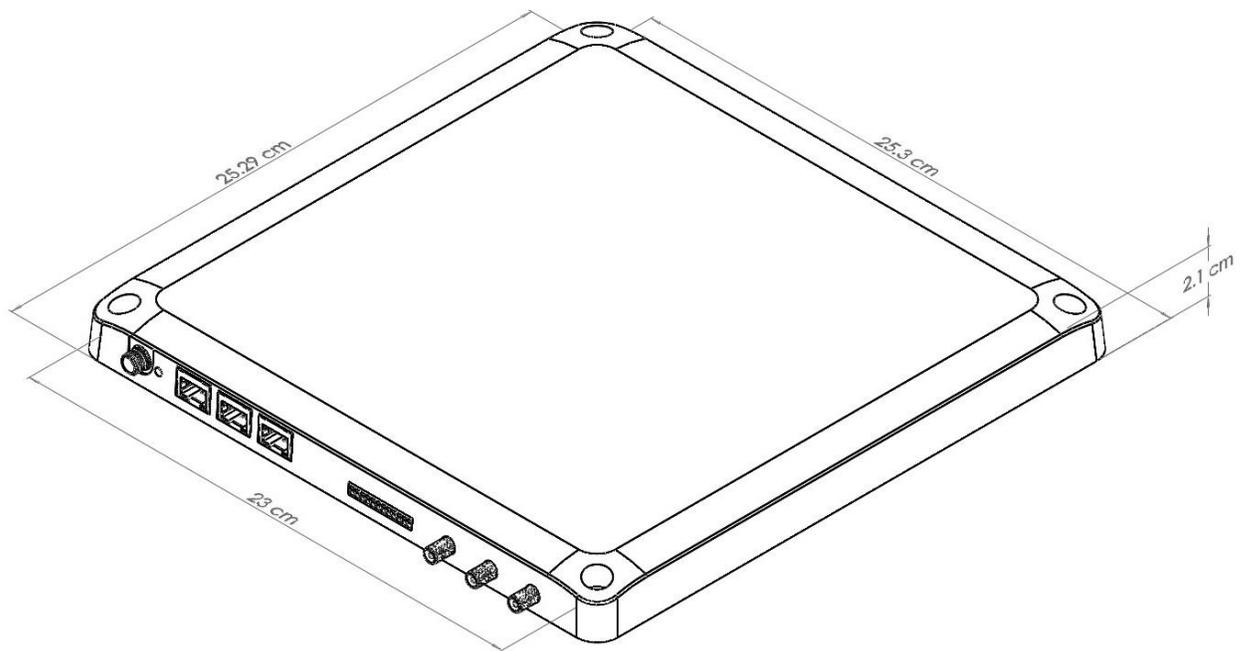


GPIO Deployment Guide

SENSARRAY+



Legal Notices

Copyright ©2017-2018 SensThys Inc. All rights reserved.

SensThys has intellectual property rights relating to technology embodied in the products described in this document, including without limitation certain patents or patent pending applications in the U.S. or other countries. This document and the products to which it pertains are distributed under licenses restricting their use, copying, distribution and de-compilation. No part of this product documentation may be reproduced in any form or by any means without the prior written consent of SensThys Corporation and its licensors, if any. Third party software is copyrighted and licensed from Licensors. SensThys, SensArray and other graphics, logos, and service names used in this document are trademarks of SensThys in the U.S. and other countries. All other trademarks are the property of their respective owners. U.S. Government approval required when exporting the product described in this documentation.

Federal Acquisitions: Commercial Software -- Government Users Subject to Standard License Terms and Conditions. U.S. Government: If this Software is being acquired by or on behalf of the U.S. Government or by a U.S. Government prime contractor or subcontractor (at any tier), then the Government's rights in the Software and accompanying documentation shall be only as set forth in this license; this is in accordance with 48 C.F.R. 227.7201 through 227.7202-4 (for Department of Defense (DoD) acquisitions) and with 48 C.F.R. 2.101 and 12.212 (for non-DoD acquisitions).

DOCUMENTATION IS PROVIDED "AS IS" AND ALL EXPRESS OR IMPLIED CONDITIONS, REPRESENTATIONS AND WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT ARE HEREBY DISCLAIMED, EXCEPT TO THE EXTENT THAT SUCH DISCLAIMERS ARE HELD TO BE LEGALLY INVALID.

FCC Compliance

This equipment has been tested and found to comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any change or modification to this product voids the user's authority to operate per FCC Part 15 Subpart A. Section 15.21 regulations.

Industry Canada Compliance

This device complies with Industry Canada License-exempt RSS standards. Operation is subject to the following two conditions: (1) this device may not cause interference and (2) this device must accept any interference, including interference that may cause undesired operation of the device. This device has been designed to operate with a variety of different gain (dBi). The reader maximum output power is set by the gain of the antenna. Using an antenna having a higher gain is strictly prohibited per regulations of Industry Canada. In addition, using the reader at a power exceeding the maximum output power for a given antenna is also strictly prohibited. The required antenna impedance is 50 ohms. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

Conformité d'Industrie Canada

Cet appareil est conforme aux normes RSS exemptées de licence d'Industrie Canada. L'opération est soumise aux deux conditions suivantes: (1) cet appareil ne doit pas provoquer d'interférence et (2) cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil. Cet appareil a été conçu pour fonctionner avec une variété de gains différents (dBi). La puissance de sortie maximale du lecteur est définie par le gain de l'antenne. L'utilisation d'une antenne ayant un gain plus élevé est strictement interdite par règlement d'Industrie Canada. En outre, l'utilisation du lecteur à une puissance supérieure à la puissance de sortie maximale pour une antenne donnée est également strictement interdite. L'impédance d'antenne requise est de 50 ohms. Afin de réduire les interférences radio potentielles avec d'autres utilisateurs, le type d'antenne et son gain devraient être choisis de manière à ce que la puissance émise isotropiquement (EIRP) équivalente soit supérieure à celle requise pour une communication réussie.

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."



Table of Contents

LEGAL NOTICES	2
TABLE OF CONTENTS.....	3
CHAPTER 1 INTRODUCTION	4
Overview.....	5
Power Sourcing	5
Input Signals	5
Control of External Devices.....	6
Wiring the GPIO.....	8
Configuring and Testing with the RFID Console	9
Powering the 24VDC System	9
Testing your GPIOs	9
Programming the GPIOs	10
Important Note	10
API Interfaces	10
GPI Notifications	11

CHAPTER 1 Introduction

Congratulations on your selection of the SensArray platform! We have designed this equipment to be the foundation of next-generation IoT RFID systems. This is a highly integrated solution that fully supports your system integration and operation while reducing deployment cost. Let's get started!

This Hardware Setup Guide provides instructions for installing and operating the SensArray.

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, POE, SensArray and SensArray+.

- **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 SensArray+ GPIO ports. The voltage levels that are supplied from the SensArray+ 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 SensArray+ and your external equipment before ground and voltage connections are set up properly, possibly resulting in harm to the SensArray+ or your equipment.

SAFETY WARNING

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

Overview

GPIO (General Purpose Input/Output)

The SensArray+ GPIO port provides four control inputs and four outputs. The SensArray+ GPIO is not optically isolated, rather when operational it is fully interfaced to the electrical systems of the SensArray+. The electrical system is protected from external surges via protection circuitry on each input and output.

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.

Power Sourcing

To use the GPIO, the SensArray+ should be connected to external ground via pins 2 and/or 12.

Power to energize external devices can be sourced in two different ways.

First, external devices can be powered from the SensArray+. This power can be delivered to the external device via pin 11, which provides 24 VDC to a maximum of 600 mA. Users should bear in mind that using power from the SensArray+ decreases the amount of power that can be provided to other POE or GPIO devices connected to the SensArray+.

Alternatively, power for devices controlled by the SensArray+ can be provided by external power supplies. In this case the SensArray+ only controls the devices and the external power supply provides the power the devices connected to the GPIO. In this case the power consumed by the external devices does not reduce the power that the SensArray+ can provide. Note, though, power provided by external power supplies does not provide power to the POE system, i.e., external power sources cannot provide power to POE devices.

As an aside, if an external 24 VDC is used to power devices, the user may connect the positive output of the 24 VDC external supply to Pin 1. Pin 1 provides TVS surge protection and can help prevent surges in the 24 VDC supply from being passed onto external devices.

Input Signals

Users may provide input signals to the SensArray+ 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 SensArray+, 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.

For completeness, control signals to the SensArray microprocessor may be provided through the digital interfaces (one of the RJ45 ports) or through the GPIO. Either way, the signals are

routed to the central microprocessor and may be used to control accessories or the properties of the RFID reader.

Finally, there is no predetermined linkage between the inputs and outputs. Stated differently, if 10VDC is presented to Input 1 (7), the GPIO circuitry detects an “on” state and presents that “on” signal to the microprocessor. The microprocessor can be used to take action based upon Input 1, like triggering a read cycle when Input 1 is high or switching one or more of the GPO switches to allow conduction.

Control of External Devices

The function of the outputs is to provide a switch to ground. 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.

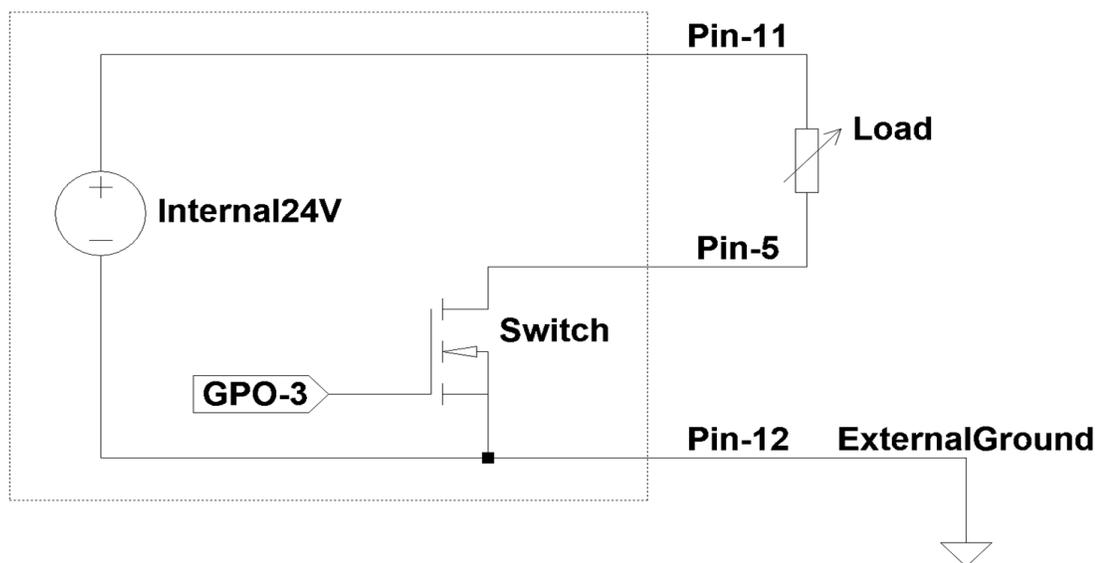


Figure 1 Using the GPIO to control an external device powered by 24V Internal supply

Figure 1 illustrates a load that is powered by the Internal 24VDC supply connected via Pin 11 of the GPIO connector. In this case, the circuit is set up to flow current through the load into Pin 5. 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 we show Pin 12 connected to an external ground in this figure. In this case, that connection would not be needed. 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. It is also worth recognizing that if Pin 5 is connected to a control signal, you will need to provide pull-up or pull-down resistors to ensure that the control voltages are appropriate for activating and deactivating your device.

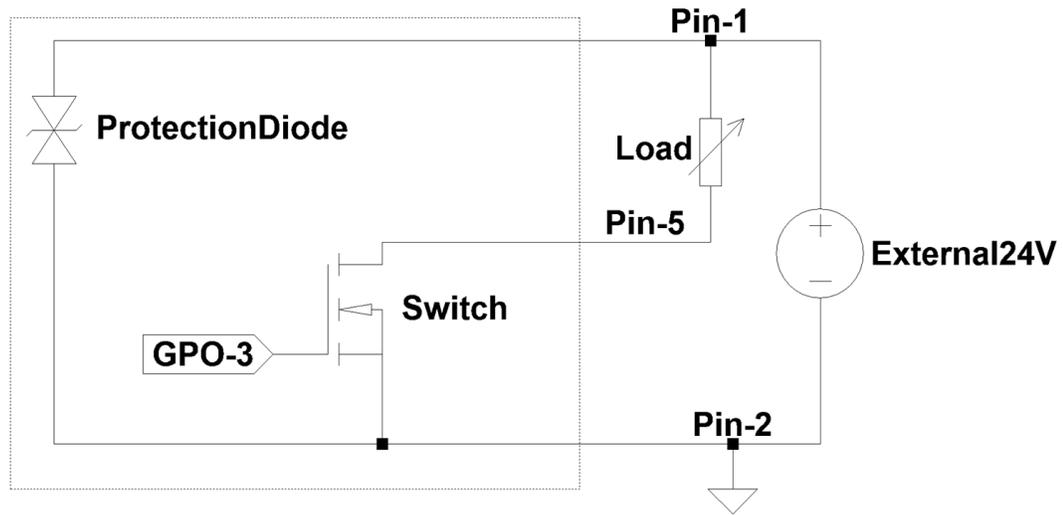


Figure 2 Using the GPIO to control an external device powered by an external supply

Figure 2 depicts the connection of the GPIO to an external 24VDC supply (Pin 1) and external ground (Pin 2). An external accessory is supplied power by the external 24VDC source which has been 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.

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

SensArray+ GPIO Pin-out

Pin 1	Up to 24VDC External
Pin 2	External ground
Pin 3	External Output 1
Pin 4	External Output 2
Pin 5	External Output 3
Pin 6	External Output 4
Pin 7	External Input 1 (High is 5-24VDC)
Pin 8	External Input 2 (High is 5-24VDC)
Pin 9	External Input 3 (High is 5-24VDC)
Pin 10	External Input 4 (High is 5-24VDC)
Pin 11	+24VDC Internal (maximum sourcing current 600 mA)
Pin 12	Internal ground

Table 1 GPIO Pinout

Wiring the GPIO



Figure 3 The GPIO port.

Wires, recommended 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 wires 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. The maximum power that can be provided to GPIO devices is 9.6W (24VDC * 0.6A). Note that in determining whether you can use the 24VDC, you also must look at the overall power consumed by other devices in the SensArray+ 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.

Configuring and Testing with the RFID Console

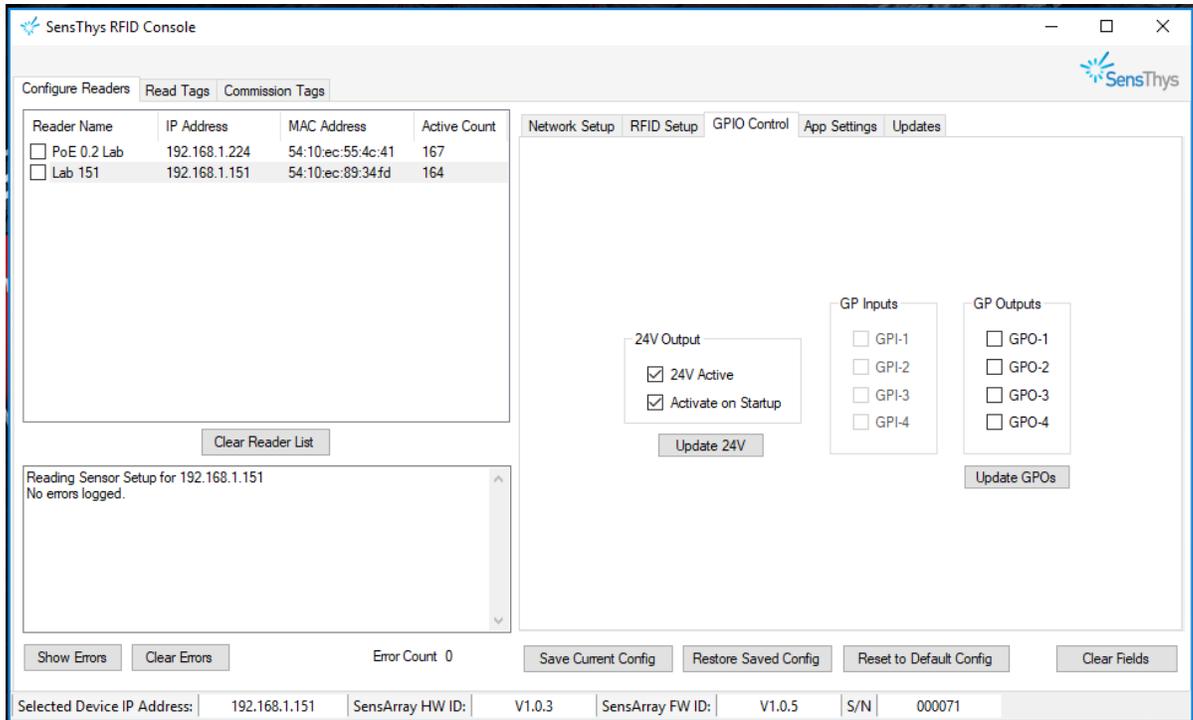


Figure 4 GPIO Control tab.

Powering the 24VDC System

The SensArray+ can source 24VDC power through Pin 11. If you are going to use the SensArray+ to power GPIO accessories, you should start with the SensArray+ 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 SensArray+, then connect your external ground to Pin 2. At this point the SensArray+ should be restarted.

Testing your GPIOs

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 SensArray+ 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 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 pull out your 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 you 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, o4, o3, o2, o1]` 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 i_n is set to 0 when the input is low and 1 when the input is high.