Vulcan RFID Titanium User Guide

Version: 1.0
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Warning!

Please read this document in its entirety before operating Vulcan RFID Titanium, as equipment or personal damage may result from improper use.

Electrostatic Discharge (ESD) sensitive device!

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

In particular, the RF antenna ports may be susceptible to damage from ESD. Equipment failure can result if the antenna or communication ports are subjected to ESD. Standard ESD precautions should be taken during installation to avoid static discharge when handling or making connections to the antenna or communication ports. Environmental analysis should also be performed to ensure static is not building up on and around the antennas, possibly causing discharges during operation.

Device manipulation!

Any device, antenna or RF cable manipulation must be done with the RF switched off. It is recommended to disconnect the power plug before attempting any manipulation.

Lithium battery cell manipulation!

This device contains one CR2032 lithium battery cell unit (Renatta CR2032MRF). Risk of explosion if battery is replaced by an incorrect type. Dispose of used battery according to the instructions (See instructions in Disposal of the product below).

Indoor use only!

This device must only be connected to indoor PoE and/or Ethernet networks.

 Danger: Extreme caution must be taken

 Warning: Caution must be taken

 Informative Note

Disposal of the Product

Do not dispose of the product in municipal or household waste/recycling. Please be sure to comply with your federal, state, and local regulations regarding disposing and/or recycling of electronic products containing a Lithium battery.

⚠️ **Battery cells disposal**

According to Lithium battery cells manufacturer (Renatta Article Safety Data Sheet – Lithium Metal Batteries).[1]

Dispose battery cells in accordance with appropriate national and international regulations.

European Community: according to Directive 2012/19/EU on Waste Electrical and Electronic Equipment.
(WEEE), Annex VII, batteries have to be removed fromany separately collected WEEE. The removed batteries have to be treated according to the Battery directive 2006/66/EC European Waste Catalogue: 16 06 05 other batteries and accumulators

US:
Lithium batteries are neither specifically listed nor exempted from the Federal Environmental Protection Agency (US EPA) hazardous waste regulations. The only material of possible concern due to its reactivity is lithium metal. However, button cells contain so little lithium that they can be disposed of in the normal municipal waste stream.

_1 http://www.renata.com/fileadmin/downloads/techinfo/ASDS_Lithium_Metal_2016-05-27.pdf_

Contents

1.0 - Definitions, Symbols, and Abbreviations

1.1 - Definitions

For the purposes of this document, the following terms and definitions apply:

Band: Or Frequency band, is an interval in the frequency domain, delimited by a lower frequency and an upper frequency.

HTTP Request: An information request to an HTTP server.

Tag: Transponder that holds data and responds to an interrogation signal.

Embedded System: A computer system with a dedicated function within a larger mechanical or electrical system.

Embedded Development: Development of applications to run inside an embedded system.

UHF Reader: Reader that generates an interrogation signal and listens for responses.

USB Host: USB party that initiates communication with USB devices. A USB Host connector represents a connector in a Host computer, to be used to connect to USB devices.

USB Device: USB party that waits for communication from USB Hosts. A USB device connector represents a connector in a device, to be used to connect to USB Hosts.

Event: an outcome of a reader operation or GPIO operation (event examples: tag read, alarm detection, system error).

1.2 - Symbols

°C: Celsius Degrees

dBm: Decibel-milliwatts

Hz: Hertz

MHz: Megahertz

mA: Milliampere

µA : Microampere

V: Volt

W: Watt

1.3 - Abbreviations

For the purposes of this document, the following terms and definitions apply:

API Application Program Interface

ARM Advanced RISC Machine

DC Direct Current

DHCP Dynamic Host Configuration Protocol

GND Ground

GPI General-Purpose Input

GPO General-Purpose Output

GPIO General-Purpose Input/Output

HID Human Interface Device

HTTP HyperText Transfer Protocol

HW Hardware

IEEE Institute of Electrical and Electronics Engineers

IO Input/Output

ISO International Organization for Standardization

LAN Local Area Network

LED Light-Emitting Diode

MUX Multiplexer

PCB Printed Circuit Board

PoE Power over Ethernet

REST Representational State Transfer

RF Radio Frequency

RTC Real-time Clock

SMA SubMiniature version A

UHF Ultra High Frequency

USB Universal Serial Bus

2.0 - Introduction

2.1 - About this Guide

This guide describes the installation and operation of the Vulcan RFID Titanium.

This guide does not cover an introduction to RFID. For more information on the fundamentals of RFID, please see our Resources Page.

2.2 - Intended Audience

Intended readers of this guide are systems engineers and IT staff with an understanding of RFID and RFID systems management.

2.3 - Introduction to the Titanium

Vulcan RFID Titanium is a 4-port, high-power, high-performance UHF reader specially designed for hosting on-reader applications.

Vulcan RFID Titanium features:

- **On-board Linux computer:** program your own custom software solutions directly to the reader, saving the need and cost of an external computer

- 4 antenna ports

- Maximum transmit power: 31.5 dBm

- Maximum receive sensitivity: -85 dBm

- USB HID emulation (keyboard emulation)

- Controls up to 1024 antennas*, with multiplexers

- 2 x digital/analog inputs

- 2 x additional digital inputs

- 8 x digital outputs

- 4 x Direct LED connections (100 mA)

- 4 x GPO (lines 8 mA)

- 1 x relay enabled output

- Loudspeaker: 8 ohm/2 W

- Powers up external devices: non-isolated power output: 5 V, 200 mA (DC)

- Powered through PoE, 12 V -24 V power supply, or external battery

- Communications interface: Ethernet

*Please note that connecting one or more multiplexers single reader will result in significant power loss and extended cycle times. Testing is required to determine the optimal number of antenna connections for an application.

For a detailed specification table see "Appendix I. Detailed Specifications" on page 38.

2.4 – For RFID Implementors, Integrators, and Developers

Vulcan RFID Titanium can be operated with:

- **Vulcan RFID Connect**: A user-friendly web-based interface used to program the reader for a "set it and forget it" type configuration.

- **REST API**: A web-based API based on HTTP requests, which is very easy to integrate with an app or software program that can communicate with the reader over a network connection and perform pre-configured actions with the reader.

- **Java API**: A low-level API based on a Java library used to control the reader from a PC-hosted application.

3.0 – Hardware Overview

Titanium overview

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3.1 – Indicator LEDs

Indicator LEDs	
Power ON	Blue LED that indicates the system is properly powered.
Tx	Green LED that indicates the RFID module is transmitting data. *Data is any data (not only RFID) going out from the RFID module.*
Rx	Red LED that indicates the RFID module is receiving data.
Status	Orange LED that indicates the status of Vulcan RFID Connect software.
Ethernet Activity	Orange LED • On Ethernet connector
Ethernet Link	Green LED • On Ethernet connector

USB HID Status	Green LED
	• Flags whether there is a successful USB connection
	  • 2 flashes: there isn't a USB host connected
	  • 1 flash: there is a USB host connected

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Status LED Codes

Initialization: _|-|_____|-|_____|-|_____|-|_____

On pulses are 50 ms
Off pulses are 950 ms
Complete cycle is 1000 ms

OK: _|----------|_____|----------|_____|----------|_____

On pulses are 1000 ms
Off pulses are 1000 ms
Complete cycle is 2000 ms

HW error: _____|-|_____|-|_____|-|_____

On pulses are 100 ms
Off pulses are 1900 ms
Complete cycle is 2000 ms

Causes for HW error indication:
  • GPIO system initialization error
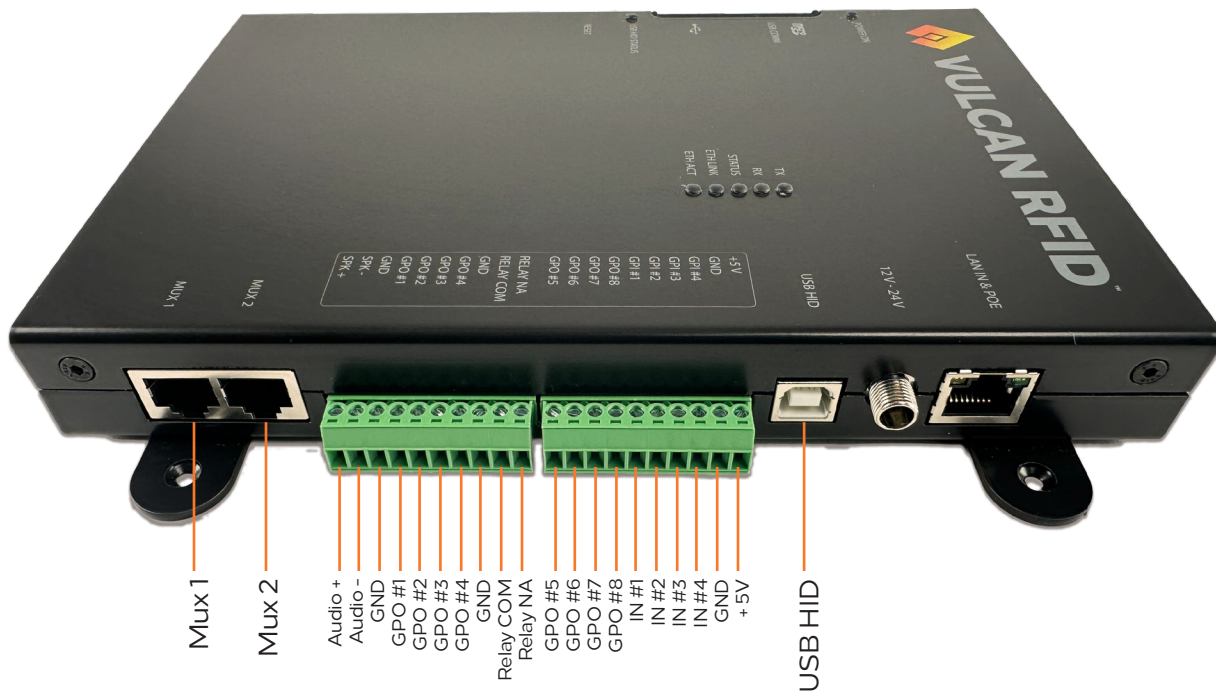 • Any other ARM module or controller board HW error

HW RFID module error: _|-|__|-|__|-|__|-|__|-|__|-|__|-|__|-|__|-|__|-|__|-|__|-|__|-|__

On pulses are 100 ms
Off pulses are 100 ms
Complete cycle is 200 ms

Causes for HW error indication:
  • Unable to connect to RFID module

3.2 - Ports

Front Connections (GPIO Connectivity)

MUX 1 RJ45 connector for use with a compatible multiplexer

MUX 2 RJ45 connector for use with a compatible multiplexer

SPK+ / SPK- Speaker output connector
- 8 ohm speaker
- Maximum power 2 watt

GPO #1 General purpose output specifically designed to drive a LED bar. Can also drive other external hardware.
- 5 V (DC)
- Current limited to 100 mA

GPO #2 General purpose output specifically designed to drive a LED bar. Can also drive other external hardware.
- 5 V (DC)
- Current limited to 100 mA

GPO #3 General purpose output specifically designed to drive a LED bar. Can also drive other external hardware.
- 5 V (DC)
- Current limited to 100 mA

GPO #4 General purpose output specifically designed to drive a LED bar. Can also drive other external hardware.
- 5 V (DC)
- Current limited to 100 mA

GND / +5 V Access the system GND and + 5 V
- 200 mA maximum current.

The +5 V can be enabled/disabled by the use of the GPO#7 line.

Relay COM / Relay NA General purpose output digital line connected internally to a relay. It can be used as a dry contact to drive external devices.

GPO #5 General purpose output digital line
- 5 V (DC)
- 8 mA maximum current

GPO #6 General purpose output digital line
- 5 V (DC)
- 8 mA maximum current

GPO #7 General purpose output digital line
- 5 V (DC)
- 8 mA maximum current

GPO #8 General purpose output digital line
- 5 V (DC)
- 8 mA maximum current

GPI#1 General purpose digital/analog digital line
- 30 V high level input voltage

GPI#2 General purpose digital/analog digital line
- 30 V high level input voltage

GPI#3 General purpose digital/analog digital line
- 30 V high level input voltage

GPI#4 General purpose digital/analog digital line
- 30 V high level input voltage

USB HID USB HID Type B connector. To be connected to a PC.

RF Connections

RF #4   RF #3   RF #2   RF #1

RF Connections

RF #1 RF output port #1 SMA female connector.

RF #2 RF output port #2 SMA female connector.

RF #3 RF output port #3 SMA female connector.

RF #4 RF output port #4 SMA female connector.

Other Ports

Other Ports	
Reset	Reset to factory defaults push button
USB Type A	USB (Type–A) Host 3 • Accepts USB memory sticks • Accepts USB Wi–Fi dongle
USB COMM	USB Micro port used to access the reader directly for troubleshooting purposes
Micro SD slot	Micro SD Slot Maintenance only port 4

3.3 – On-Board Sensors and Transducers

3.3.1 – Sensors

Available Sensors	Units	Description
+5 V power supply voltage	V (volts)	The internal +5 V switched power supply voltage.
System consumption	W (watts)	The approximate global system consumption.
GPI #1	V (volts)	The voltage of the GPI #1 input line.
GPI #2	V (volts)	The voltage of the GPI #2 input line.

3.3.2 – Transducers

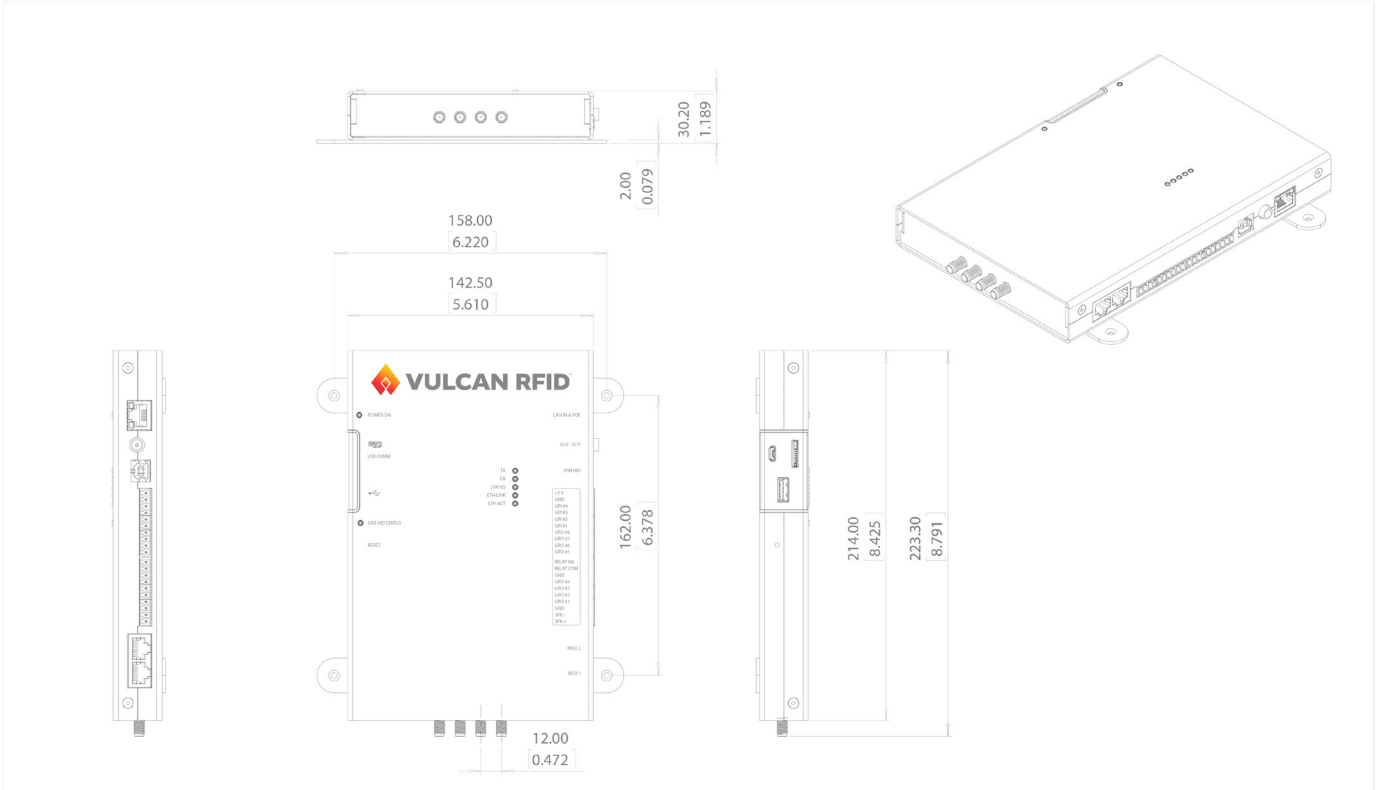| Available Transducers	Description
Buzzer	On-board buzzer controlled by API.
Speaker	2W (8 ohm) audio amplifier accessed through one of the IO ports.

3 Use only with USB dongles without USB cables

4 Use this port only for maintenance or troubleshooting operations

4.0 - Installation

4.1 - Mechanical Specification

4.2 - Power Requirements

4.2.1 - Conducted Power

Region	Conducted Power	Power Step
ETSI	5 dBm – 31.5 dBm	0.5 dBm
FCC	5 dBm – 31.5 dBm[5]	0.5 dBm
Japan	5 dBm – 30 dBm	0.5 dBm

5 Operation at power level above 30 dBm requires professional installation to correctly set the conducted power for the RF cable and antenna selected.

4.3 - Connecting Antennas and Cables

4.3.1 - Authorized Antennas

Titanium can be operated with the antennas in the following table or antennas with a maximum gain of 6 dBiL (8 dBiC) and a required antenna impedance of 50 ohms.

All Vulcan RFID antennas with a SKU beginning with VUL-ADAN are compatible.

Antennas with a gain greater than 6 dBiL are strictly prohibited for use with the Titanium.

4.3.2 - Authorized Cables

The Titanium is compatible with any Vulcan RFID coaxial cable.

Vulcan RFID can provide custom cables of any length and connector combination. Contact us at info@vulcanRFID.com for more information.

4.3.3 - Choosing Maximum Power

The maximum conducted power for a given installation is given by:

RFmax [6] =   36 dBm – Antenna gain (dBiL) + Cable insertion Loss (dB) + ESD protection [7]

To find the correct loss for your cable, please see our Cable Loss Chart.

For example, when using the Vulcan RFID p33 Antenna (SKU: VUL-ADAN-P33US-FRSMA-200) with a 5-foot 195 Series cable:

RFmax = 36 dBm – 8.0 dBiL + (0.2+5*0.13) dB + 0.5 dB = 29.35 dBm

The maximum conducted power should be set at 29 dBm.

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6 Japanese maximum conducted power is 30 dBm regardless of the antenna and cable combination.
7 ESD protection is an on-board RF filter that introduces a fixed loss of 0.5 dB.

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The same antenna with a cable of 17 feet:

RFmax = 36 dBm – 8.0 dBiL + (0.2 +17*0.13) dB + 0.5 dB = 30.91 dBm

The maximum conducted power should be set at 30.5 dBm [8].

4.3.4 - Antenna Connection

The Titanium can support up to four 50 ohm antennas without accessories such as a multiplexer. When connecting antennas:

  • Follow the antenna manufacturer instructions on antenna positioning.

⚠️ RF operation works by multiplexing the time between all connected and configured antennas.

⚠️ Titanium will not recognize antennas automatically. It must be configured to use connected antennas. See Operation chapter for more information.

⚠️ When connecting antennas, additional care must be taken to avoid damage due to ESD

4.4 – Power Options

The Titanium can be powered by:

  • PoE (Power Over Ethernet). Both PoE standards are supported:
    • IEEE 802.3af (equivalent to IEEE 802.3at Type I)
    • IEEE 802.3at Type II

  • 12 V – 24 V Power Supply
    • For 12V, 2A are required
    • For 24V, 1A is required

8 For operation in Japan, the maximum configurable power would be the maximum 30 dBm.

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4.5 – Network Connection

Communication happens through the LAN IN & PoE port.

There are two different 2 IP addresses:

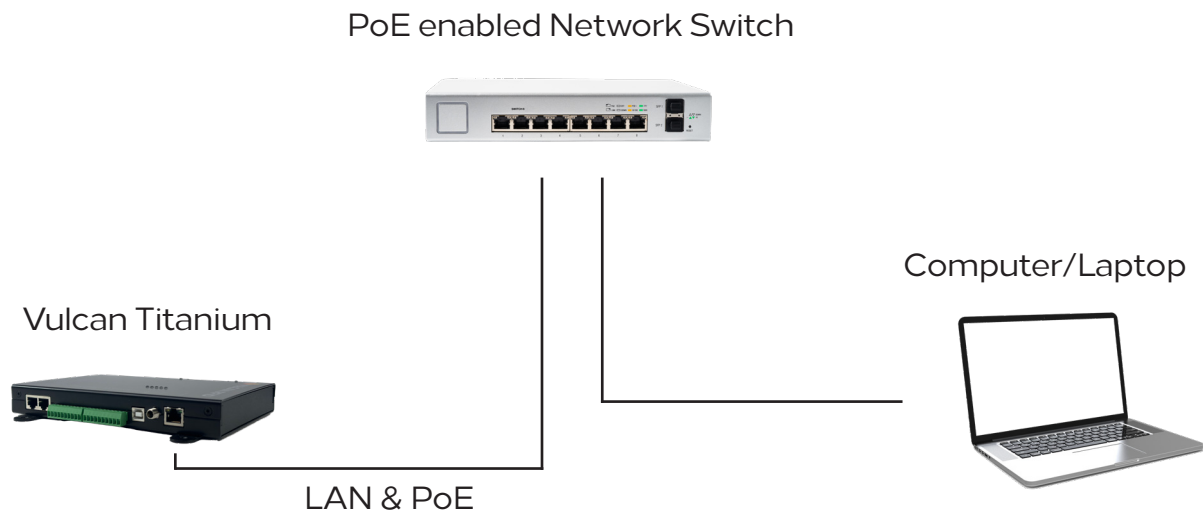• Primary (user defined): may be static or dynamic (DHCP).   DHCP by default

This means that the reader will obtain its IP address from whatever router it is connected to. Check with your IT deparent or your router settings for available IP address assignment.
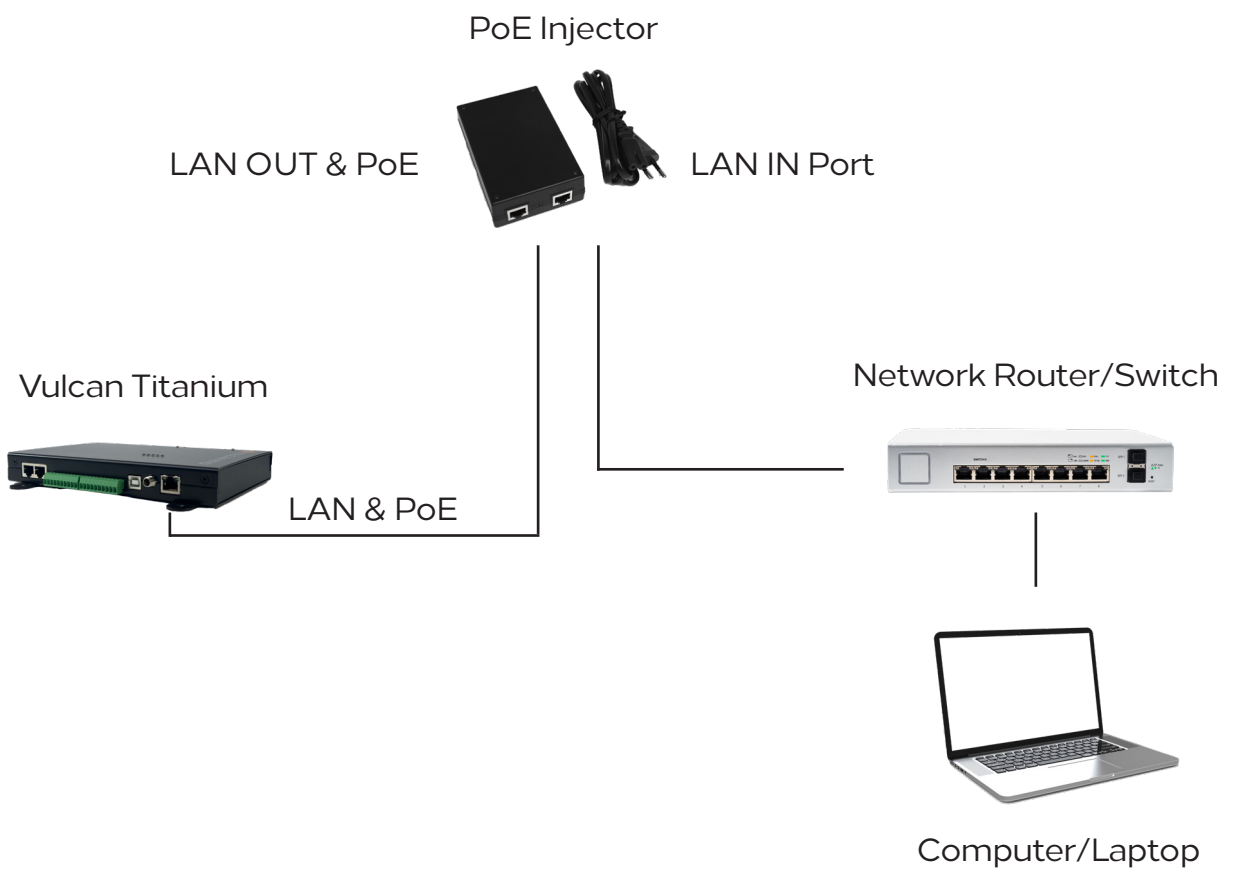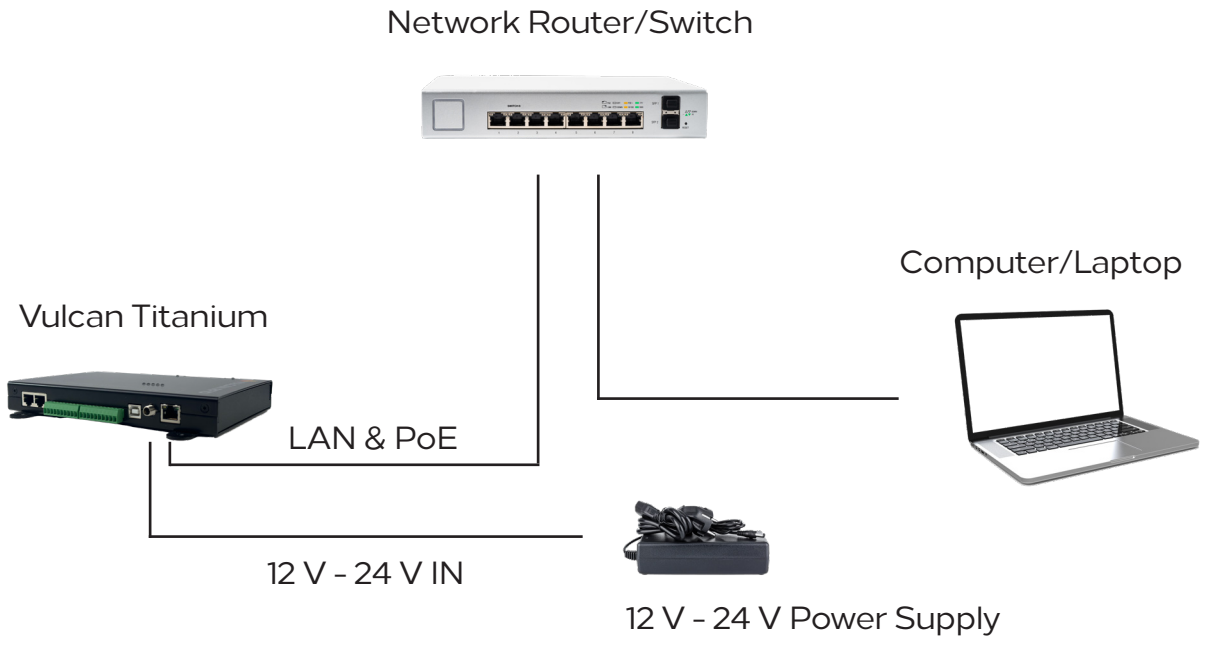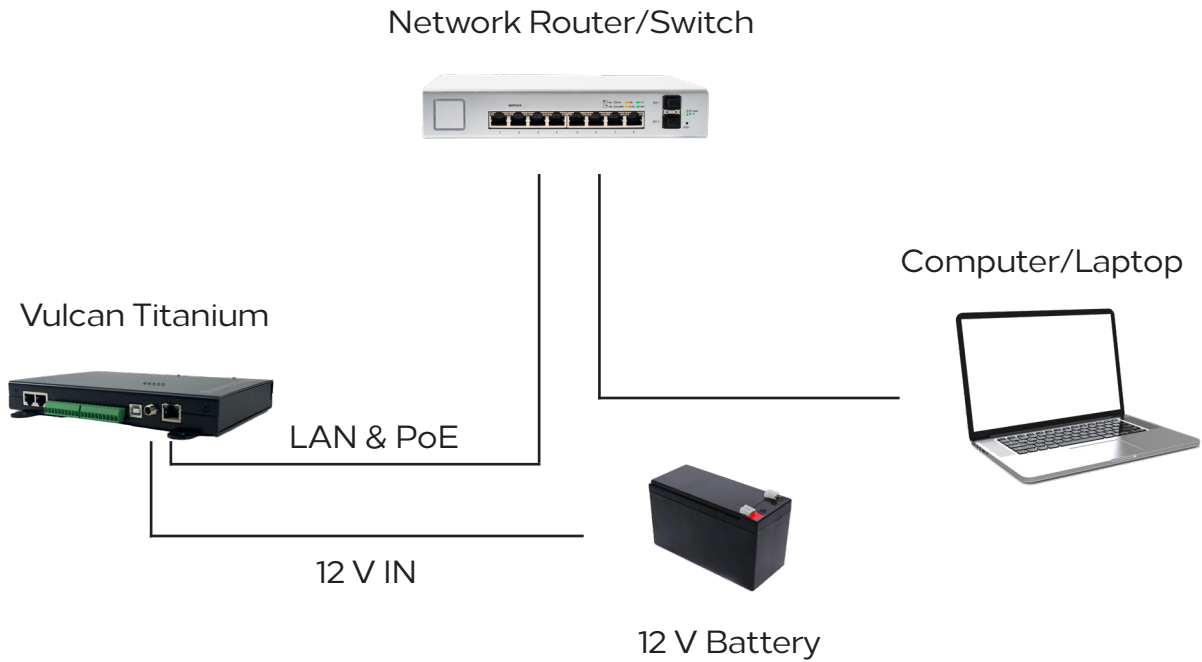
• Secondary: static IP address set to 172.31.61.2

If the reader fails to obtain its IP address from a router via DHCP, it will fall back to a static IP address (172.31.61.2). If the reader is connected directly to a PC, use this address to connect.

⚠️ All devices share the same secondary IP address. When connecting to a device through its secondary IP address, make sure no other devices exist in the reader-PC network.

The following diagrams show the network connection options for the Titanium:

PoE enabled Network Switch

Computer/Laptop

Vulcan Titanium

LAN & PoE

Network Router/Switch

Computer/Laptop

Vulcan Titanium

LAN & PoE

12 V – 24 V IN

12 V – 24 V Power Supply

PoE Injector

LAN OUT & PoE

LAN IN Port

Vulcan Titanium

Network Router/Switch

LAN & PoE

Computer/Laptop

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Network Router/Switch

Computer/Laptop

Vulcan Titanium

LAN & PoE

12 V IN

12 V Battery

5.0 - Operation

This chapter is focused on the configuration of the Titanium, including:

- Discovering and Connecting to the Titanium
- An Introduction and Overview of Vulcan RFID Connect
- Configuring the Titanium
- GPIO Information

5.1 - Introduction

Titanium configuration and operation is done through the Vulcan RFID Connect web application accessed through Chrome or Firefox web browsers.

- Vulcan RFID Connect comes installed on the Titanium
- Google Chrome or Mozilla Firefox is required for use

5.2 - Getting Started

5.2.1 - Connect Antennas

Prior to powering on the reader, connect one or more 50 ohm RFID antennas to the RF ports on the side of the reader.

⚠️ Before powering the Titanium for the first time, make sure the port RF#1 is connected to:

> •50 ohm antenna
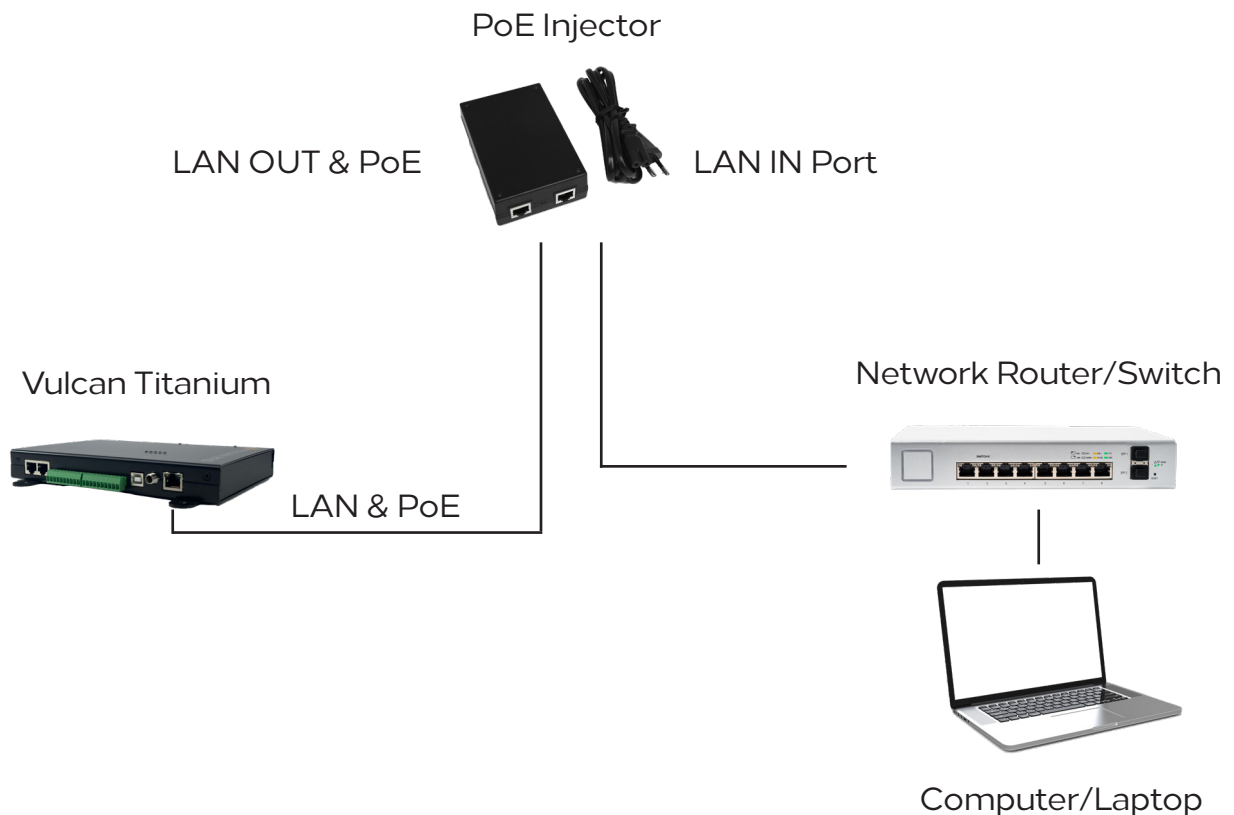> *or*
> •50 ohm terminator

⚠️ Never connect or disconnect an antenna while the Titanium is ON. Always power off the reader when connecting/disconnecting antennas.
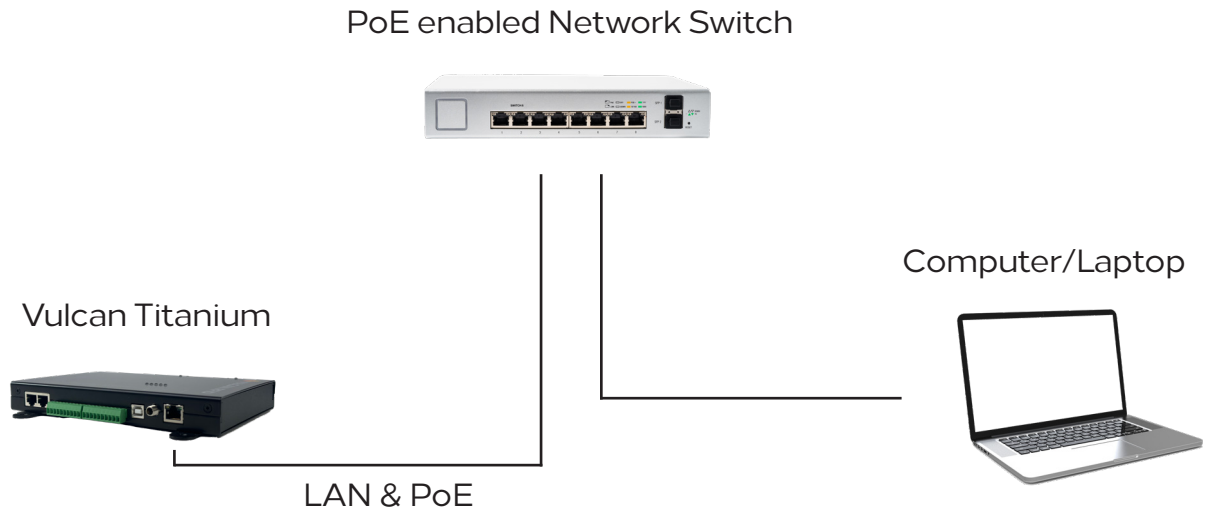
5.2.2 – Power the Titanium

Connect the Titanium to a power supply and wait until it beeps. It will take between 40 and 50 seconds to boot. Optionally, the Titanium can be connected to a router/switch to be configured, as explained in the following chapters.
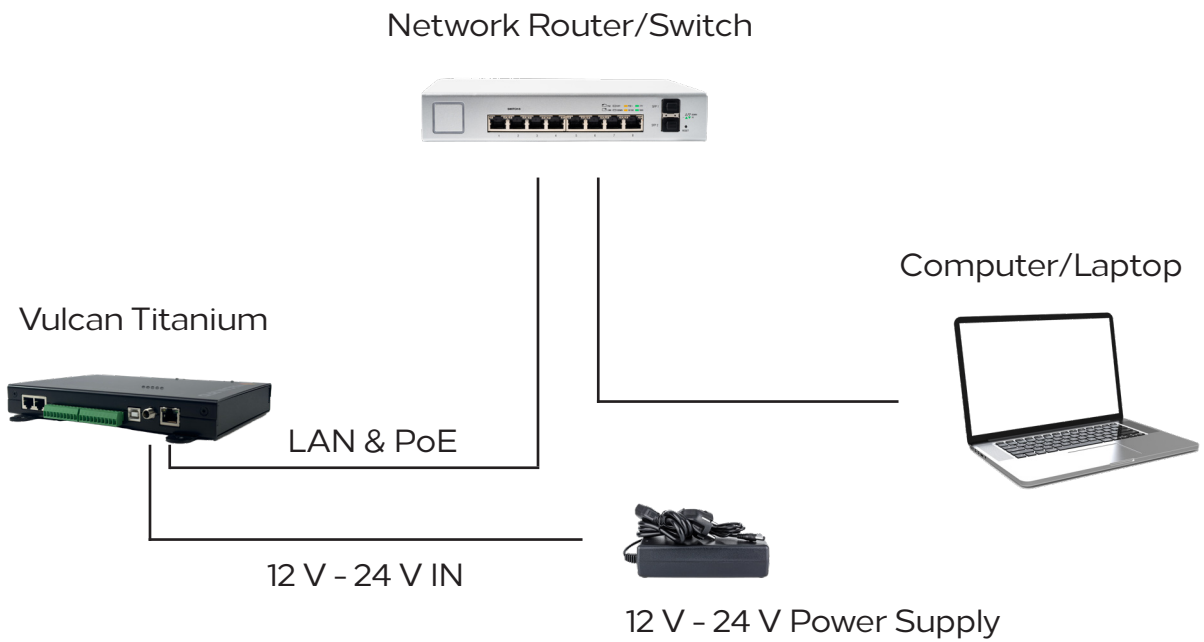
By using a PoE injector:

PoE Injector

LAN OUT & PoE

LAN IN Port

Vulcan Titanium

Network Router/Switch

LAN & PoE

Computer/Laptop

By using a PoE enabled switch:

PoE enabled Network Switch

Computer/Laptop

Vulcan Titanium

LAN & PoE

By using a power supply:

Network Router/Switch

Computer/Laptop

Vulcan Titanium

LAN & PoE

12 V – 24 V IN

12 V – 24 V Power Supply

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By using a battery:

Network Router/Switch

Computer/Laptop

Vulcan Titanium

LAN & PoE

12 V IN

12 V Battery
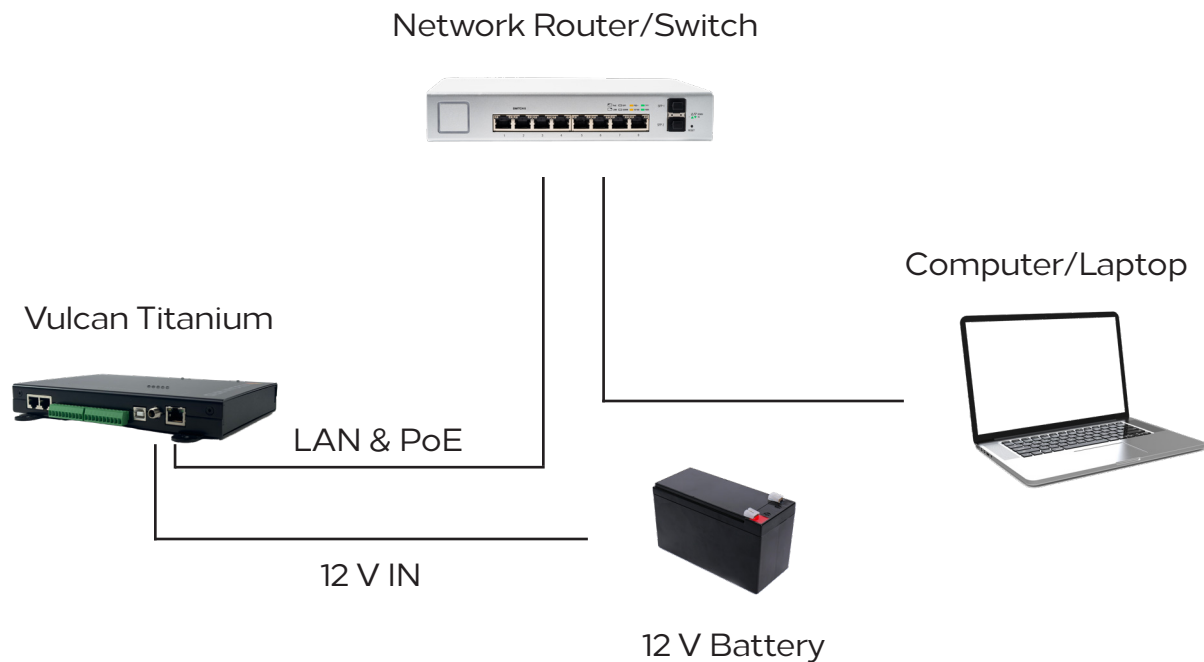
5.2.3 – Connect to the Network

For networks that support DHCP:

Using one of the above power methods will result in a successful network connection.

For networks that do not support DHCP:

Set a static IP address:

1. Log into Vulcan RFID Connect at IP address 172.31.61.2 (see 5.2.3.1)
2. Navigate to the Network & Time tab
3. Change Method from DCHP to Static and define the following:
   • IP address
   • Mask
   • Gateway
   • DNS addresses (optional): If not defined the reader won't be able to resolve domain names.
   • NTP Servers (optional): If not defined the reader won't be able to use synchronize date/time with Internet servers.
4. Click Save

5.2.4 - Configuration

5.2.4.1 - Logging Into Vulcan RFID Connect

Access Vulcan RFID Connect using one of the two methods:

Method 1: Open an approved web browser and enter the reader's IP address in the search bar.

To identify the reader's IP address, you will need to know what the IP address allocation pool is for your connected router. Consult your IT deparent for help finding this reader on your network. Alternatively, use method 2 instead.

Method 2: Open an approved web browser and go to http://VUL-TITANIUM-4PG-xxxx. local, replacing the x's with the last 4 characters of the reader's MAC address printed on the back of the reader.

The URL for the example shown above would be http://VUL-TITANIUM-4PG-DED0. local

Log in using the following credentials:

Username: admin

Password: admin

Now you will see the Vulcan RFID Connect dashboard:
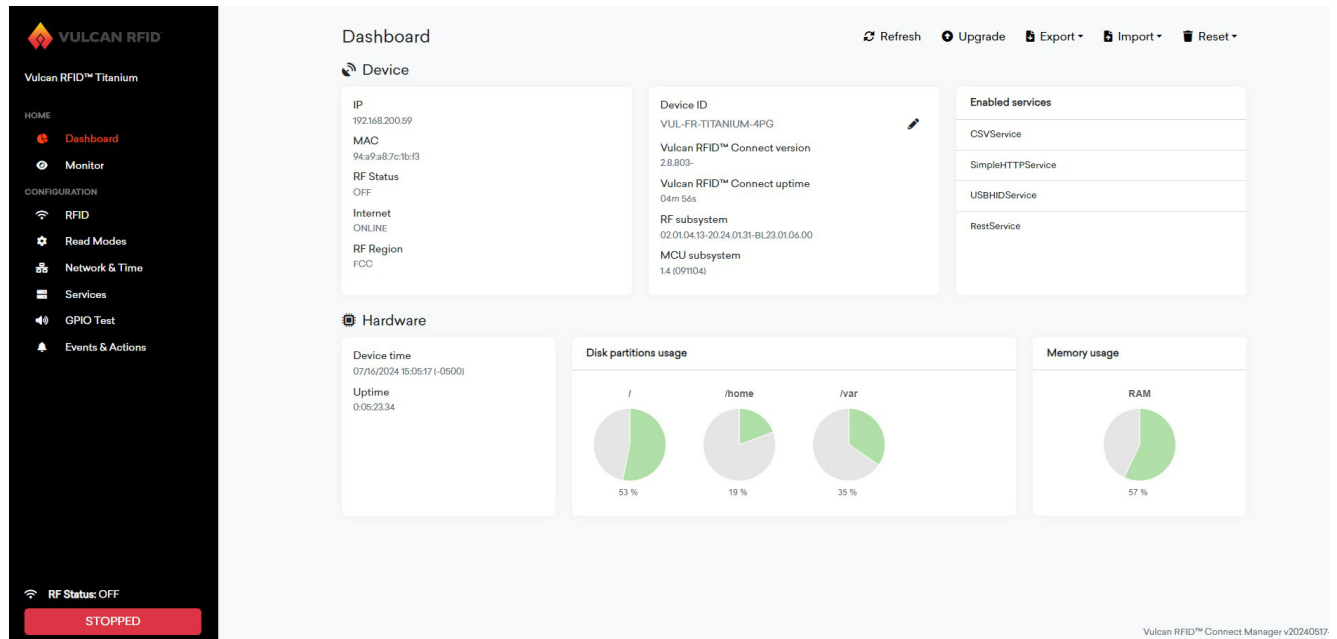
5.2.5 - Vulcan RFID Connect Overview

The following sections will cover a brief overview of Vulcan RFID Connect and its features. For an in-depth guide to Vulcan RFID Connect, please visit vulcanRFID.com/support or email info@vulcanRFID.com.

5.2.5.1 - Saving Configuration Changes

When the reader's configuration is changed, click the save button at the top of the page. This will make all changes persistent, even when the reader is powered off and back on again.
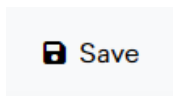
5.2.5.2 – Read Modes Tab

Read Modes

The Titanium features 2 different read modes:

1. Autonomous (default)

- AUTONOMOUS: The reader schedules antenna switching automatically between the available RF ports (1, 2, 3 or 4).
- AUTONOMOUS_TRACK_MISSING: Keeps a list of continuously read tags and generates an event when one of the controlled tags has left the field of view.
- SCAN: To be used at read points where the user needs information on tags passing through the field of view. Not designed to inventory static tags.

2. Sequential

- SEQUENTIAL: The reader waits for read commands.
- DYNAMIC_INVENTORY: Keeps track of tags in the field and generates TAG_ADD and TAG_REMOVED events when a tag enters/leaves the RF field.

5.2.5.3 – RFID Tab

RFID

The RFID tab is where you configure the reader's RFID parameters.

- Region: Select your country or region of operation.

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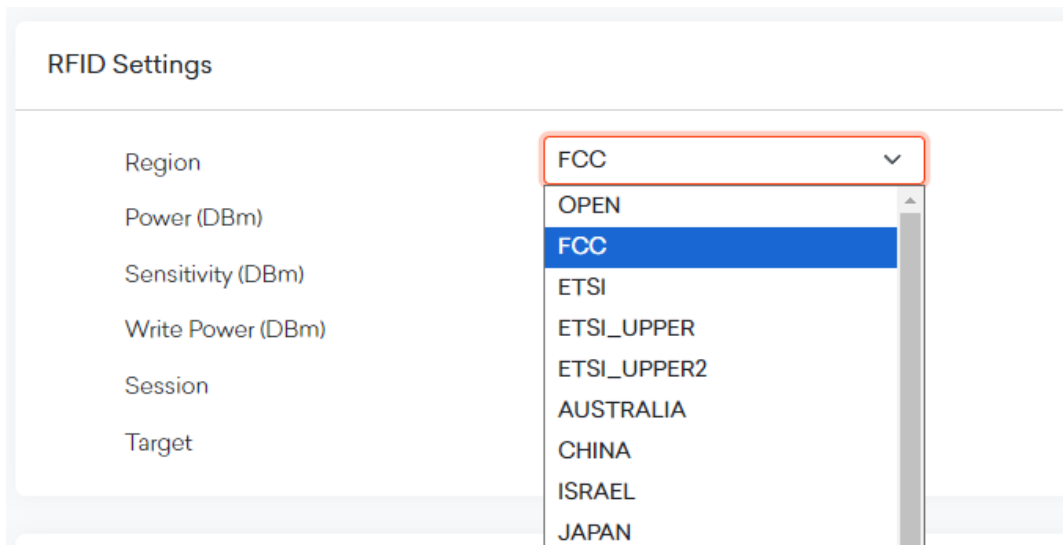
⚠️ Be sure to select the right region for your country or area.
Otherwise the system may not conform to your country or area regulations.

• **Power (dBm):** This correlates with how far away from the antenna a tag can be read. Knowing your antenna gain and cable loss will help you choose the best transmit power for your system (see 4.3.3).

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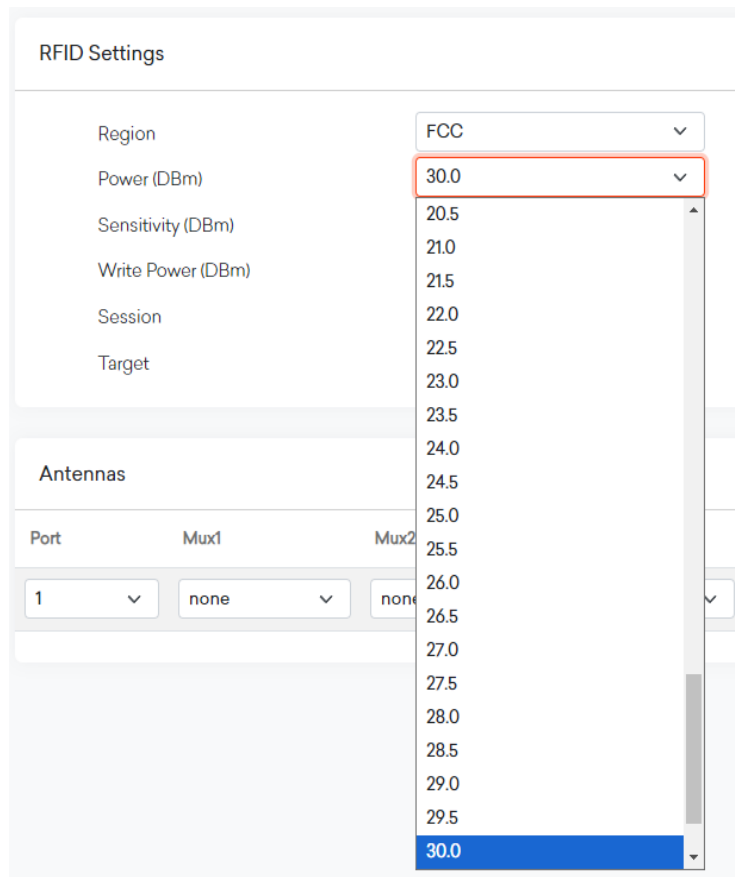
- **Sensitivity (dBm)**: Choose the desired reader sensitivity.

- **Antennas**: Each antenna has its own configuration

- **Port**: The port where the antenna is connected.

- **Mux1 port**: The multiplexer port. Only use this option when using a multiplexer that allows for more than 4 antennas to be connected to the reader. Otherwise, select "none".

- **Mux2 port**: The multiplexer port. Only use this option when using a multiplexer that allows for more than 4 antennas to be connected to the reader. Otherwise, select "none".

- **Power**: The transmit power for the antenna between 0 and 31.5 dBm (If "inherit" is selected, it will use the power chosen for the reader).

- **Sensitivity**: The maximum receive sensitivity for the antenna between -16 and -85 dBm (If "inherit" is selected, it will use the sensitivity chosen for the reader).

- **Location**: User-defined location of the antenna
- **Orientation**: Logical IN or OUT areas definition used when estimating the direction of the tags (more than one antenna needed). For example, if the system is set up in a doorway with an antenna on either side of the door, Orientation could be used to help determine the direction of movement of a tag.

5.2.5.4 - Monitor Tab

Here, the user can start and stop the reader's inventory and watch tags populate the screen live. This is helpful for testing the current RFID settings prior to deploying a solution and for making adjusents on the fly and seeing quick results of each change.

Monitor

STARTED — RF Status: ON, Status: RF_ON, Device mode: Autonomous, Read mode: AUTONOMOUS — 9 Current / 10 Total

EPC monitor Columns ▾ CSV

EPC	Port	Mux1	Mux2	Location	RSSI	Count	Phase	Time ▲
21000000	4	0	0	-	-67	1	17	13:48:37:742
10000000	4	0	0	-	-62	1	161	13:48:37:715
20000000	4	0	0	-	-66	1	117	13:48:37:668
00000000000000000010047	4	0	0	-	-76	1	106	13:48:37:645
22000000	4	0	0	-	-76	1	117	13:48:37:627
1a6e4d9c7839a4e458d84cd3	4	0	0	-	-73	1	112	13:48:37:553
303130534254440000000000	4	0	0	-	-73	1	29	13:48:37:493
1a4e4d9c7839a4e199be54a5	4	0	0	-	-74	1	24	13:48:37:407
1a1e4d9c7839a4e528fc5c11	4	0	0	-	-74	1	97	13:48:36:539

STOPPED: The reader is not transmitting power. Click the button to begin reading.

STARTED: The reader is transmitting power. Click the button to stop reading.

5.3 – General Purpose Input/Output

General Purpose Input/Output is generally used to send signals to external devices after specified triggers occur.

5.3.1 – GPIO Connectors

All required IO connectors are supplied with each unit.

The IO connectors are compatible with:

PHOENIX CONTACT / MC 1,5/10-G-3,81

And the counterpart aerial connectors are:

PHOENIX CONTACT / MC 1,5/10-ST-3,81

5.3.2 – GPIO Levels

⚠️ All GPIO lines are non-isolated. Special caution must be taken when using them.

All GPO lines: GPO#1, GPO#2, GPO#3, GPO#4, GPO#5, GPO#6, GPO#7, GPO#8 and the outputs in the MUX1 and MUX2 connectors are protected against the following conditions:

• **Short circuits:** all GPO lines can be short circuited.

• **LED board polarity:** the LED boards can be connected with the reverse polarity without causing any damage either to the board or the LED board.

This table summarizes the GPI#1 input digital line characteristics:

GPI	Description	Min	Max
V_{IH}	High level input voltage	2 V	30 V
V_{IL}	Low level input voltage	0 V	0.6 V
V_{range}	Operation analog range	0 V	10 V
I_{LI}	Input current	–	560 µA 30 µA @ –3 VDC 50 µA @ 3 VDC 560 µA @ 30 VDC
V_I	Input voltage	0 V	30 V

This table summarizes the GPI#2 input digital line characteristics:

GPI	Description	Min	Max
V_{IH}	High level input voltage	2 V	30 V
V_{IL}	Low level input voltage	0 V	0.6 V
V_{range}	Operation analog range	0 V	10 V
I_{LI}	Input current	–	560 µA 30 µA @ –3 VDC 50 µA @ 3 VDC 560 µA @ 30 VDC
V_I	Input voltage	0 V	30 V

This table summarizes the GPI#3 and GPI#4 input digital line characteristics:

GPI	Description	Min	Max
V_{IH}	High level input voltage	2 V	30 V
V_{IL}	Low level input voltage	0 V	0.6 V
I_{LI}	Input current	–	560 µA 30 µA @ –3 VDC 50 µA @ 3 VDC 560 µA @ 30 VDC
V_I	Input voltage	0 V	30 V

This table summarizes the high power output digital lines (**GPO#1, GPO#2, GPO#3, GPO#4**) characteristics:

GPO	Description	Max
V_{OH}	High level output voltage	5 V[9]
V_{OL}	Low level output voltage	0.6 V
I_{max}	Maximum output current	100 mA

This table summarizes the output digital lines (**GPO#5, GPO#6, GPO#7, GPO#8 and MUX1 and MUX2** connector lines) characteristics:

| GPO	Description	Max
V_{OH}	High level output voltage	5 V
V_{OL}	Low level output voltage	0.6 V
I_{max}	Maximum output current	8 mA

9 – In case a voltage is applied accidentally to the GPO, the output resistor could be damaged. Other circuitry would remain unaffected.

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This table summarizes the relay characteristics:

Relay	Description	Min	Max
V$_I$	Input voltage	0 V	24 VDC / 0.5 A/ Resistive load

5.3.3 – GPI Read Triggers
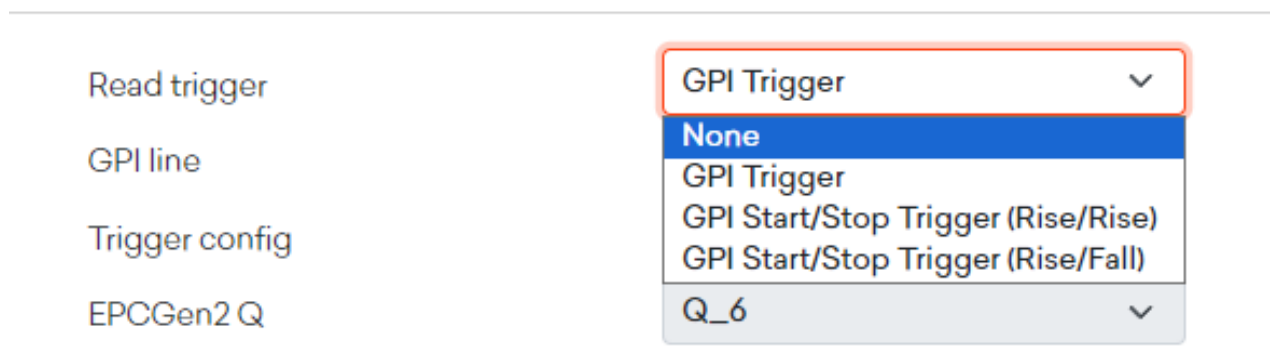
There are three modes available:

1. GPI Trigger: This mode starts the RF on all configured antennas for specified amount of time upon receiving rise events on the selected GPI line.

 • RF active time is set to 3500 ms (this can be changed in Advanced Trigger Configuration)

Rise events that occur while RF is on will reset the counter without stopping RF operation. Therefore, if rise events keep happening at smaller intervals than 3500 ms, the GPI will be constantly triggered and RF transmitting will never stop.

2. GPI Start/Stop Trigger (Rise/Rise): This mode starts the RF on all configured antennas on the first rise event on the selected GPI line. The RF is kept active until a new rise event is received.

3. GPI Start/Stop Trigger (Rise/Fall): This mode starts the RF on all configured antennas on the first rise event on the selected GPI line. The RF is kept active until a new fall event is received.

⚠️ Rise events must be followed with high condition of at least 70 ms.

Advanced Trigger Configuration:

Trigger config [   ]

The GPI Trigger also accepts advanced parameters. The advanced configuration allows:

- Linking a GPI rise event to a set of antennas
- Configuring several GPI rise events, each event linked to its set of antennas
- Defining the active RF time
- The GPI line value is ignored when using the Trigger config field

One possible configuration would be as follows:

{ "onTime":15000,"trigger":[{ "gpi":1,"conf":{ "antennas":"1,2"} } ,{ "gpi":2,"conf":

{ "antennas":"2"} }]}

The above configuration would:

- Start RF operation on antennas 1 and 2 on a GPI 1 rise event.
- Start RF operation on antenna 2 on a GPI 2 rise event.
- Define the active RF time to 15000 ms
- In case a rise event is detected while the RF is active, the antenna's linked to that rise event will be added to the currently running antennas.

⚠️ Rise events must be followed with high condition of at least 70 ms.

5.4 – Buzzer

The buzzer operates by switching the sound on and off according to user commands.
A single command controls the on and off period plus the total buzz time.
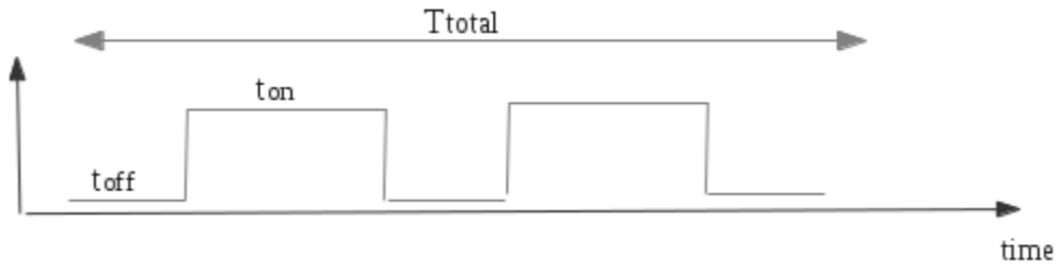
The buzzer is controlled by specifying 3 parameters:

On-board buzzer parameters	
T_{ON}	On period specified in milliseconds. *The minimum required time for the buzzer to sound is 200 ms. The maximum is 65 535 milliseconds.*
T_{Off}	Off period specified in milliseconds. *The minimum required time for the buzzer to stop is 100 ms. The maximum is 65 535 milliseconds.*
T_{total}	Total buzz time. *The maximum is 65 535 milliseconds.*

Configure the buzzer in the Events & Actions tab:

5.5 - Speaker

The speaker operation is similar to the buzzer, but the frequency of the played sound is controlled programmatically.

The speaker is controlled by specifying 5 parameters:

External Speaker Parameters	
T_{ON}	On period specified in milliseconds. *The maximum is 65 535 milliseconds.*
T_{Off}	Off period specified in milliseconds. *The maximum is 65 535 milliseconds.*
T_{total}	Total buzz time. *The maximum is 65 535 milliseconds.*
Frequency	The frequency in Hz. Possible frequency values are: 500Hz, 750 Hz, 1000 Hz, 1500 Hz, and 3000 Hz.
Volume	Adjustable volume Possible values are: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Configure the speaker in the **Events & Actions** tab:

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5.6 – Reset to Factory Defaults

It is possible to reset the system to factory defaults. Factory defaults settings mean:

- Any network settings are removed and the system is reverted to use DHCP as its default network setting. If the reader is connected to a static IP, resetting the reader to factory defaults will cause the reader to only be reachable at its default static IP address.

- Any persisted operation settings (Vulcan RFID Connect settings) are removed. Default settings are loaded.

To reset the system to factory defaults:

- Power the system and wait for the start-up beep
- Use a paper clip to press the reset button for at least 12 seconds
- The system will be restarted
- Wait for the start-up beep

⚠ The reset to factory procedure will not revert changes done directly into the device OS. A complete reset of the system is only achieved by re-flashing a complete image.

Appendix I. Detailed Specifications

Vulcan RFID Titanium Technical Data

Titanium Specifications	
Air Protocol Interface	EPCGlobal UHF Class 1 Gen 2/ ISO 18000-6C
Supported Regions	FCC (NA, SA) (902 - 928) MHz ETSI (EU, IN) (865.6 - 867.6) MHz MIC (KR) (910 - 914) MHz SRRC-MII (P.R.China) (920.125 – 924.875) MHz Argentina (AR) (915.0 – 928.0) MHz Australia (AU) (920.0 – 926.0) MHz Bangladesh (BD) (925.0 – 927.0) MHz New Zealand (NZ) (922.0 – 927.5) MHz Hong Kong (HK) (865.0 – 868.0) MHz Indonesia (ID) (923.0 – 925.0) MHz Israel (IS) (915.0 - 917.0) MHz Japan (JP) (916.8 - 920.8) MHz Macao (MO) (920.0 – 925.0) MHz Malaysia (MY) (919.0 – 923.0) MHz Philippines (PH) (918.0 – 920.0) MHz Russia (RU) (866.0 – 868.0) MHz Taiwan (TW) (922.0 – 928.0) MHz Thailand (TH) (920.0 – 925.0) MHz Singapore (SG) (920.0 – 925.0) MHz Vietnam (VN) (866.0 – 869.0) MHz Brazil (902 – 907.5) MHz (915 – 928) MHz by using channel selection Chile (916 – 928) MHz by using channel selection Peru (916 – 928) MHz by using channel selection Taiwan (922 – 928) MHz by using channel selection Open Region[10] (865 – 869) MHz and (902 – 928) MHz (by using channel selection)[11]

10 Open channel specified applies to ETSI/FCC versions. PRC versions open channel is defined between 840 to 845 MHz and 920 to 925 MHz.

11 Band is defined as a carrier sub-set from FCC. There is no specific Surface Acoustic Wave (SAW) filter for the band. Given the maximum conducted power there shouldn't be problems with local regulation.

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RF Connections	Four 50 ohm SMA connectors for mono-static antennas
RF Power	Programmable from 5 dBm to 31.5 dBm in 0.5 dBm steps. (Maximum power may have to be reduced to meet regulatory limits)
Max Tag Read Distance	Up to 9 m (33 feet) with 6 dBi gain antennas (read distance depends strongly on tags used)
Max Tag Read Throughput	Up to 400 tags/s[12]

Data Communications	Ethernet
	    • IEEE 802.3 up to 100 Mbps
	
	Maintenance only port[13]
	    • USB Type B connector as an alternative to the Ethernet communications port in case the Ethernet interface is not available. When the USB port is connected, a virtual Ethernet interface will be created in the host computer.
	
	USB HID (USB Type-B connector)
	    • USB HID hardware emulation
	
	Wi-Fi
	    • Through a USB dongle[14] connected to the USB Type-A connector.

Other Ports	Micro SD slot
	Maintenance only port[15]
	
	USB (Type-A) Client[16]
	    • Accepts USB memory sticks
	    • Accepts USB Wi-Fi dongle

12 Only achieved by using certain EPCgen2 settings

13 Use this port only for maintenance or troubleshooting operations

14 Wi-Fi USB dongle not included

15 Use this port only for maintenance or troubleshooting operations

16 Use only with USB dongles without USB cables

Power Supply	Power Over Ethernet (PoE):
	  • IEEE 802.3af and 802.3at (Type I & Type II)
	  • Power consumption: Class 3
	
	Power supply from 11 to 24 V (DC)
	  • 11 V (DC) @ 2A
	  • 24 V (DC) @ 1A
	
	On-board battery for RTC chip (CR2032)

Battery Operation	The system is specifically designed for battery assisted operation.
	  • Protects lead batteries by disconnecting the system when the battery level is beyond a threshold. [17]
	  • Scheduler to activate/deactivate the system [18]
	  • Very low consumption in sleep mode: < 160 uA [19]

Output Power	5 V (DC) @ 100 mA non-isolated power supply to feed external devices and circuitry.
On-board Sensors and Actuators	Buzzer Aux Power Supply Voltage[20] Aux Power Supply Temperature 5 Vcc Voltage [21] Power consumption [22] IN1 Voltage [23] IN2 Voltage [24] RTC chip to keep Date &Time between reboots. Battery life time more than 10 years in power off mode.

17 Requires configuration. Default configuration does not disconnect automatically lead batteries.

18 Requires configuration

19 Available in future FW releases

20 Can be used to monitor battery voltage level

21 Measures the internal 5 V

22 Measures the approximate consumption of the device without taking into account the efficiency of the internal switched-mode power supply.

23 Measures the voltage value at the Input line #1

24 Measures the voltage value at the Input line #2

On-board LED Indicators	LED ON (Blue LED) LED status (Orange LED) LED M6e Rx line (Green LED): UART Rx line between the CPU and the RFID module LED M6e Tx line (Red LED): UART Tx line between the CPU and the RFID module LED Micro Status (Green LED): status of the internal micro- processor that handles USB HID emulation and battery control.

Inputs	2 x digital input (IN3 and IN4)
	    • Non isolated
	    • 0 VDC to 30 V (DC)
	
	2 x digital/analog input
	    •10 bits resolution
	    •Inputs accepted in the range:
	    • 0 V – 3 V (IN 1)
	    • 0 V – 10 V (IN2 2)
	
	Digital/analog inputs allow digital and analogic inputs by using the same physical line.
	
	In case IN 1 uses an input level above 3 V, the AD measure will be always '1'.
	
	For example: an input value in the range [2 – 8V] must be connected to IN2 with the big range. While an input range of [0 – 1 V] can be queried in both IN1 & IN2 inputs, although IN1 will provide better resolution.

|	
Outputs	4 x digital outputs (higher power): • Non isolated • Maximum output current 100 mA 4 x digital outputs (low power): • Non isolated • Maximum output current 8 mA 1 x relay output: • OUT6 • Powered by OMRON G5V-1 5DC • Usage • 24 VDC / 0.5 A / Resistive load Other outputs: • Loudspeaker: 8 ohm / 2 W • 2 x RJ45 to directly connect to other devices, such as multiplexer
Power Consumption	Idle consumption < 3 W Max consumption (@31.5 dBm) < 14 W[25] The maximum consumption is measured without external loads and without Wi-Fi.
Temperature	–20 °C to +55 °C[26]

25 A PoE type I can handle the device at the given operation: maximum RF power and all LED outputs connected. It may not handle external loads and/or Wi-Fi operation.
26 The reader can be operated at full power and at 100 % duty cycle at an ambient temperature of 40 °C.
At higher temperatures, it may be required to reduce the conducted power / duty cycle to avoid the reader automatic protection system to stop the RF module.

The maximum operating temperature for IEC 62328-1 is 40 °C.

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Appendix II. Connectors Detailed Specification
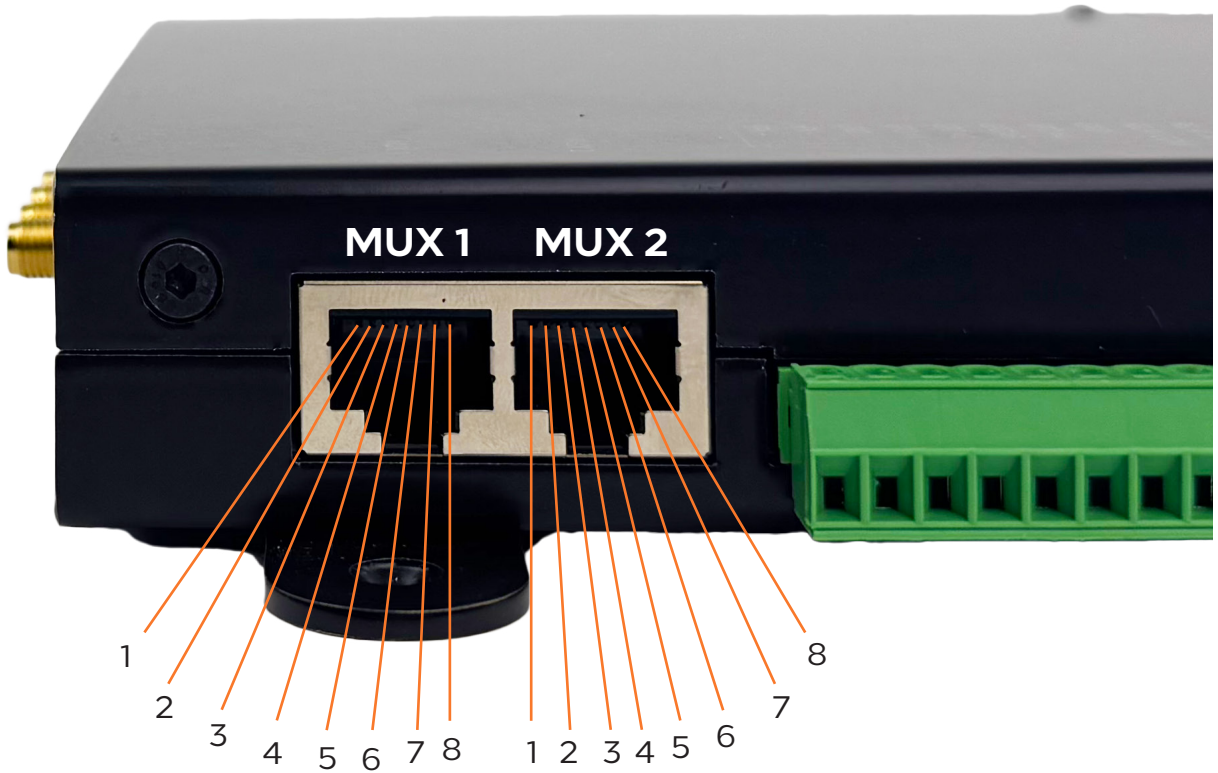
5.7.1 - MUX1 and MUX2 Connectors

The table below summarize MUX1 connector pin-out:

#1	GPO #1
#2	GPO #2
#3	GPO #3
#4	+5 V (non-isolated)
#5	+5 V (non-isolated)
#6	GPO #4
#7	GND
#8	GND

The table below summarize MUX2 connector pin-out:

#1	GPO #5
#2	GPO #6
#3	GPO #7
#4	+5 V (non-isolated)
#5	+5 V (non-isolated)
#6	GPO #8
#7	GND
#8	GND

For more information on the Vulcan RFID Titanium UHF RFID Reader, please visit vulcanRFID. com/support or contact us at info@vulcanRFID.com.