S1 RFID Reader Installation Guide

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Linux (GPLv2)	U-Boot (SPDX-License-Identifier: GPL-2.0+)
Atmel (Copyright (c) 2014 Atmel Corporation. All rights reserved.)	Texas Instruments Processor SDK (multiple licenses, see website)
Libwebsockets (MIT License)	Paho MQTT (Eclipse Public License v 1.0)
json-c (MIT License)	

See Clairvoyant's website for an archive of all open source licenses and code on the S1.

https://www.clairvoyant-technology.com/

FCC AND INDUSTRY CANADA REGULATORY COMPLIANCE

Changes and Modifications (FCC 15.21)

Changes or modifications not expressly approved by Clairvoyant Technology, Inc. could void the user's authority to operate the equipment.

Compliance Statement (FCC 15.19 and Industry Canada)

This device complies 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.

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.

2. This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1. L'appareil ne doit pas produire de brouillage;

2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Class B Digital Device (FCC 15.105)

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

RF Exposure Compliance Information

To ensure compliance with FCC and ISED RF exposure requirements this device must be installed to provide a minimum of 35 cm between the antennas and people.

Pour garantir la conformité aux exigences d'exposition RF de la FCC et d'ISED Canada, cet appareil doit être installé de manière à laisser un minimum de 35 cm entre l'antenne et les personnes.

Antenna Compliance

This radio transmitter (23676-S1) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio (23676-S1) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Right-Hand Circularly Polarized Antenna, 9dBi maximum gain, 50 Ohms impedance (professional installation only)

Right-Hand Circularly Polarized Antenna, 6.15dBi maximum gain, 50 Ohms impedance

CONVENTIONS

The following conventions are used in this manual:

`Bold courier` font indicates code entered by the user

`(values)` within parentheses indicate parameters

`(`*`values`*`)` in italics indicate user defined variables.

`<n>` indicates a variable number used in a function that can apply to several different devices such as antennas or I/O ports.

WARNING: Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION: Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury or property damage.

ATTENTION: This yellow symbol indicates that the device is susceptible to Electro Static Discharge and appropriate precautions must be taken to avoid equipment damage.

NOTICE: NOTICE advises the reader that a condition can be created by a particular action that can cause equipment damage or result in equipment operation that violates regulatory requirements.

PRODUCT USE

Factors beyond Clairvoyant Technology's control and within the installer and user's knowledge and control can affect the performance of this Product. Given the factors that can affect the performance of this Product, the user is solely responsible for evaluating if it is fit for a specific application.

Warranty, Limited Remedy, and Disclaimer: Unless a different warranty is specifically stated on the applicable Product packaging, literature, terms of sale or software license agreement, Clairvoyant Technology warrants that (i) the Product will be free from substantial defects in material and workmanship under normal use and service for one (1) year from the original date of purchase, and (ii) for software Products, for ninety (90) days from the original date of purchase, the software will materially perform the functions described in the accompanying documentation. Clairvoyant Technology makes no other warranties or conditions, express or implied, including, but not limited to, any implied warranty or condition of merchantability or fitness for a particular purpose or any implied warranty or condition arising out of a course of dealing, custom or usage of trade. If the Product does not conform to this warranty, then at Clairvoyant Technology's option, the Product will be repaired or replaced.

Limitation of Liability: Except where prohibited by law, Clairvoyant Technology will not be liable for any loss or damage arising from this product, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, including warranty, contract, negligence or strict liability.

1 HARDWARE

1.1 OVERVIEW

The S1 radio frequency identification (RFID) reader is shown in FIGURE 1.

The S1 is a multiprotocol RFID reader which is available in variants for worldwide regulatory regions within the range of 840-960 MHz.

FIGURE 1: S1 RFID Reader

2 SAFETY

2.1 INTENDED USE

The S1 Reader is intended for use within enterprise applications, such as inventory and asset tracking for retailers, supply chains, automated factories, and fulfillment centers. It is expected that all users be fully trained in the safe operation of this device.

Use in any other application has not been evaluated by Clairvoyant Technology and may lead to an unsafe condition.

2.2 INSTALLATION AND SERVICE WARNINGS

⚠ WARNING: To reduce the risks associated with hazardous voltage, fire and impact:

- Installation and service activities must follow all applicable building and electrical codes.
- Inspect all system components at least every 6 months.

2.2.1 Power Supply Caution

⚠ WARNING: To reduce the risks associated with hazardous voltage and fire:

- Always disconnect the system power before any installation, maintenance, service or modification work.
- Ensure that it cannot be re-connected inadvertently.
- Power supply and cables must be properly fused.
- If necessary, a manually controlled disconnecting element must be used to disengage from supply mains.
- All output lines must be rated for the power supply output current and must be connected with the correct polarity.
- Do not block vents on power supply.
- Do not introduce any object into the power supply.
- Keep power supply away from fire and water.

2.2.2 Reader Caution

⚠ WARNING: To reduce the risks associated with hazardous voltage and fire:

- Always disconnect AC power from the power supply unit when connecting or disconnecting components of the system.
- System modification and service by Clairvoyant Technology authorized personnel only.

⚠ WARNING: To reduce the risks associated with hazardous voltage and nonionizing radiation exposure:

- Do not modify or attempt to service the Reader System. Return to Clairvoyant Technology authorized service centers for repair or service. There are no user serviceable parts.

⚠ WARNING: To reduce the risks associated with non-ionizing radiation exposure and property damage:

- Always turn off the RF from the antenna before cleaning, inspecting, service or repair.

⚠ WARNING: To reduce the risks associated with electromagnetic interference:

- Use only the antennas described in this manual or equivalent substitutes.

⚠ WARNING: To reduce the risks associated with hazardous temperature and fire related to the power supply:

- Do not cover ventilation holes in power supply.
- Leave sufficient space around the power supply for cooling.
- Do not mount directly above a heat source.
- Disconnect unit from power before installation, maintenance, service, or modification.
- Do not use in wet or damp locations.
- Do not use near flames.
- Always disconnect AC power from the power supply unit when connecting or disconnecting components of the system.

⚠ WARNING: To reduce the risks associated with hazardous voltage:

- Replace damaged components only with Clairvoyant Technology designated replacement parts.
- Use only the power supply specified by Clairvoyant Technology

⚠ WARNING: To reduce the risks associated with fire and explosion:

- Do not install in a hazardous location.

⚠ WARNING: To reduce the risks associated with impact:

- Any mounting surface must be able to support a minimum static load of equal to the maximum weight of the reader plus any additional live load due to environmental conditions.

⚠ WARNING: To reduce the risks associated with impact, muscle strain and abrasions:

- Use appropriate PPE and follow safe workplace practices during installation.

⚠ CAUTION: To reduce the risks associated with hot surfaces and reader performance:

- Do not paint the reader, antenna(s), and power supply any color.

⚠ CAUTION: To reduce the risk associated with rough edges:

- Wear appropriate gloves when handling the reader and antenna mounting hardware.

⚠ CAUTION: To reduce the risks associated with environmental contamination:

- Dispose of all system components in accordance with applicable local and government regulations, including removal of button battery, prior to disposal.

NOTICE:

- Do not use solvents or harsh cleaners on the readers or antennas.

2.3 RF Safety

NOTICE:

The S1 Reader is equipped with eight (8) external RF ports.

To prevent reader damage, a 50-ohm load or a functional UHF antenna must be connected to all ports that the reader has been configured to use. Unused external RF ports do not require a 50-ohm load or antenna to be connected.

The maximum external antenna cable length is 10 meters.

2.4 Electrostatic Discharge (ESD)

ATTENTION: S1 Reader antenna ports may be susceptible to damage from static discharge or other high voltage. Use proper Electrostatic Discharge (ESD) precautions to avoid static discharge when handling or making connections to the S1 Reader antenna or communication ports. Equipment failure can result if the antenna or communication ports are subjected to ESD.

3 INSTALLATION

3.1 MECHANICAL

The S1 Reader is housed in an aluminum enclosure shown in FIGURE 2.

NOTICE: The ingress protection (IP) rating against water and dust for the S1 reader is IP53. To achieve this maximum IP rating the S1 reader must be mounted vertically with the input / output panel facing down as shown in FIGURE 2.

FIGURE 2: Mounting for IP53

⚠ CAUTION: Any mounting surface must be able to support a minimum static load of 2.0 pounds (0.9 kg) plus any additional live load due to environmental conditions and cable attachments without tension relief.

FIGURE 3 provides mounting dimensions. The enclosure features integrated mounting holes and an M4 ground slug. The mounting hole dimensions are shown in FIGURE 4.

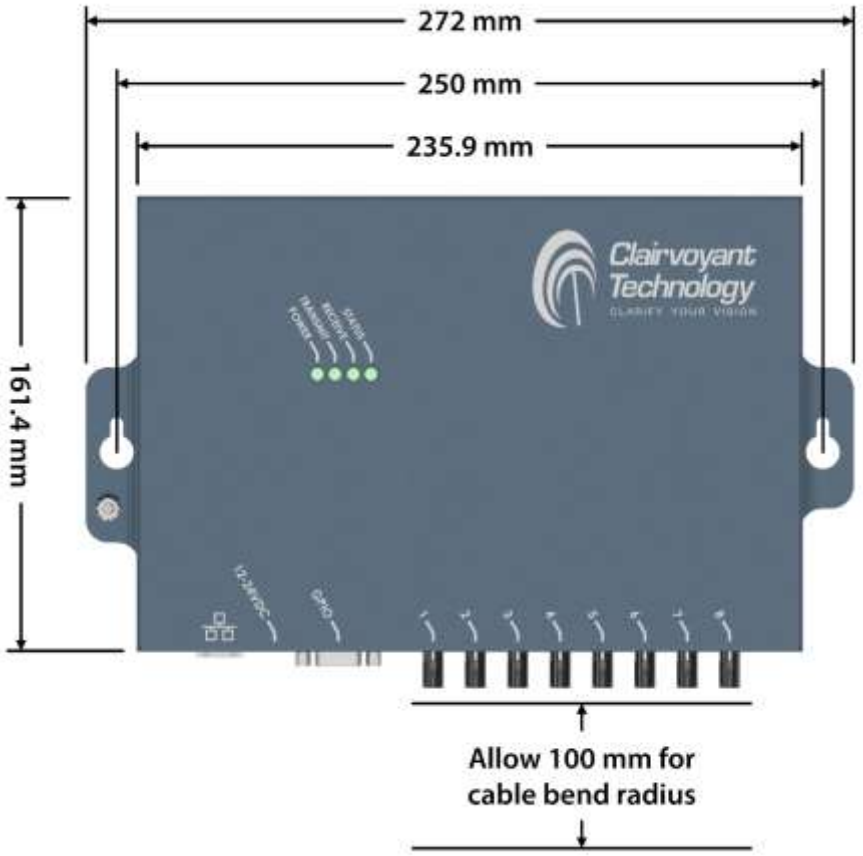


FIGURE 3: Dimensions for S1 Reader and Mounting Holes

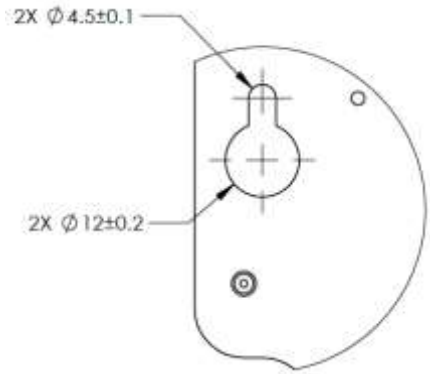


FIGURE 4: Dimensions for mounting hardware

To mount the S1 Reader, perform the following steps:

1. Prepare the mounting area.
2. Allow at least 100mm clearance for cable bend radius of external antenna cables.
3. Mount the reader using two Mcmaster-Carr part number 90305A112 screws. These are 1 inch drywall screws.
4. Attach the interface cables (see next sections).
5. Optionally connect external antenna cables or hubs.
6. Adjust the angle of the antennas and tighten the hardware.

3.1.1 Altitude

This product is for use up to 3000 meters. Above 2000 meters operating temperature is 50°C.

3.2 Electrical Connectors

ATTENTION: The S1 Reader antenna ports may be susceptible to damage from static discharge or other high voltage. Use proper Electrostatic Discharge (ESD) precautions to avoid static discharge when handling or making connections to the S1 Reader antenna or communication ports. Equipment failure can result if the antenna or communication ports are subjected to ESD.

FIGURE illustrates the complete set of interconnections for the reader. For a minimal installation only a single antenna connection and the LAN port connection to a PoE capable switch are needed.

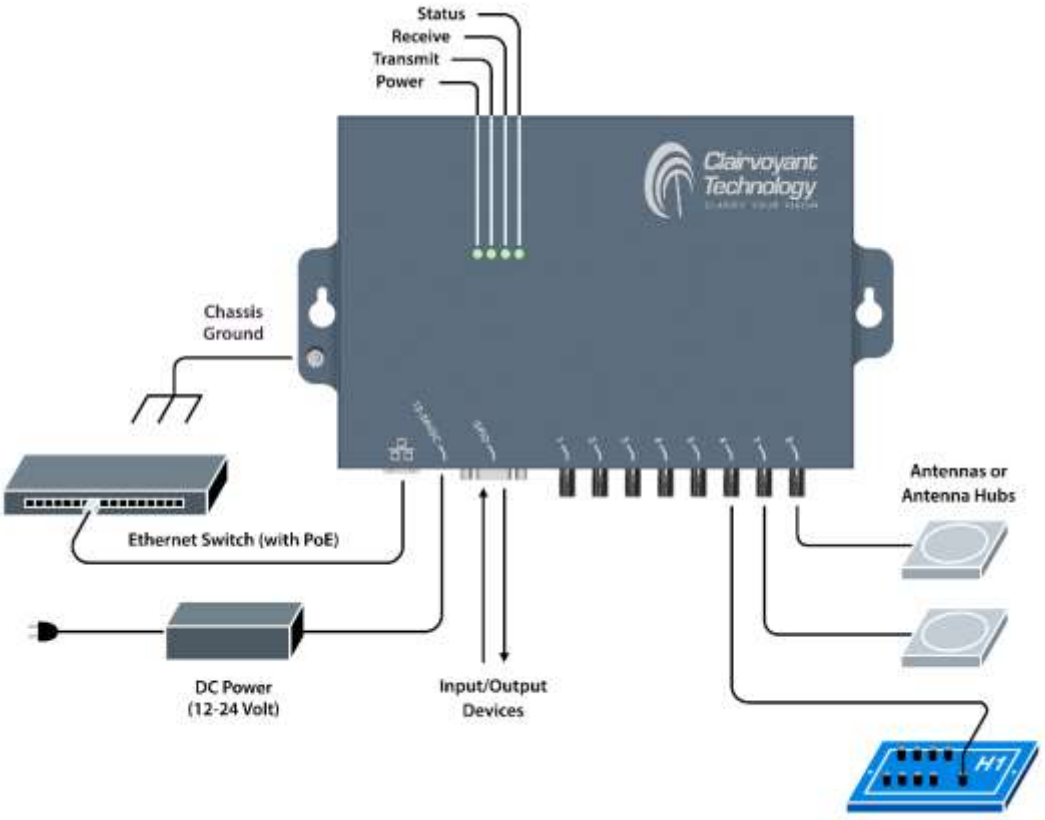


FIGURE 6: S1 Reader Connection Diagram

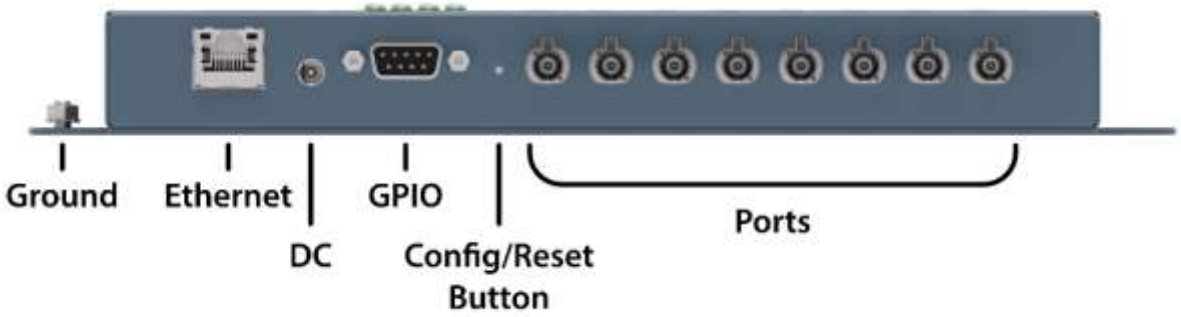


FIGURE 7: S1 Reader Connection Panel

3.2.1 Ethernet / PoE

The Ethernet connector is a standard RJ45 Ethernet jack supporting IEEE 802.3af power over ethernet (PoE). Support for PoE means DC supply and wiring can be eliminated.

External LAN/Ethernet cable may be standard Cat5 or similar Ethernet cables up to 300 meters.

ITE is to be connected only to PoE networks without routing to the outside plant.

3.2.2 Auxiliary DC Power

If PoE is not used, then DC power must be supplied through the auxiliary DC power connector. This connector is standard barrel plug with 5.5mm outer diameter, 2.5mm diameter, and 9.5mm length.

To be used with UL Listed I.T.E power supply rated 12-24Vdc, minimum 1.5A, LPS, IEC 60950-1 AM1+AM2 and/or IEC 62368-1 Power supply.

⚠ WARNING: The S1 Reader may draw up to 12.95 watts at the DC power connector input. The input voltage range is from 12 volts to 24 volts. It is recommended to use only power supplies certified for use with the S1 reader, specifically:

- Clairvoyant Technology's … DC brick supply
- Clairvoyant Technology's … PoE power injector

3.2.3 GPIO

The digital inputs and digital outputs are available through the GPIO connector. This connector is a DB9 Female Socket. The pinout is shown in FIGURE 8.

Pin	Signal	Pin	Signal
1	INPUT1	6	INPUT1 RETURN
2	INPUT2	7	INPUT2 RETURN
3	NC		
4	OUTPUT1	8	OUTPUT1 RETURN
5	OUTPUT2	9	OUTPUT2 RETURN

FIGURE 8: GPIO Connector Pinout

3.2.3.1 General Purpose Inputs

General purpose inputs are fully galvanic isolated, optically coupled inputs with an input voltage range of 5 volts to 24 volts.

3.2.3.2 General Purpose Outputs

General purpose outputs are fully galvanic isolated, solid state relays capable of carrying 1 amp with a maximum voltage of 24 volts across the terminals when inactive.

3.2.4 Config / Reset Button

Using a paper clip, depress the button on reboot according to the following rules to get the following results:

- Hold button for 3 seconds:
  - Reset config to factory defaults
- Hold button for 6 seconds:
  - Reset config to factory defaults
  - Enable DHCP (in case it was set to an incorrect static IP)
- Hold button for 12 seconds:
  - Reset config to factory defaults
  - Enable DHCP
  - Rollback firmware

After each period, the LEDs will blink orange, meaning both status and power red/green go on then off. As an indicator that you have held the button down long enough.

If you hold it for 3 seconds, the LEDs will blink. If you continue to hold it, it will blink again at 6 seconds, and so on.

3.2.5 External Antenna

The external antenna connector is a 50-ohm FAKRA jack. For FCC and Industry Canada environments approved external antennas are:

- Clairvoyant Technology's 7.5dBiC right hand circularly polarized patch antenna with a maximum linear gain of 6.15dBi. A minimum of 0.15dB cable loss is required for use of this antenna. This antenna is IP67 environmentally rated.
- Clairvoyant Technology's 9dBiC right hand circularly polarized patch antenna with a maximum linear gain of 9dBi. This antenna is IP67 environmentally rated. This antenna requires a minimum of 6dB cable loss if the reader is set to transmit full power. This antenna is for Professional Installation Option Only; see section 4.5.

3.3 GROUNDING

FIGURE 7 above shows the location of the "GND HOLE" for system grounding. The ground slug is M4.

4 INITIAL READER CONFIGURATION

4.1 ETHERNET

The reader defaults to using DHCP and will take on the IP address provided by the DHCP server. If there is no DHCP server it will obtain an IP address by negotiating with other network devices on the non-DHCP network. Typically, it will get an IP address in the 169.254.*.* space.

The reader can also be configured to obtain a static IP address as show in Section 4.1.2.

4.1.1 Discover S1 Readers

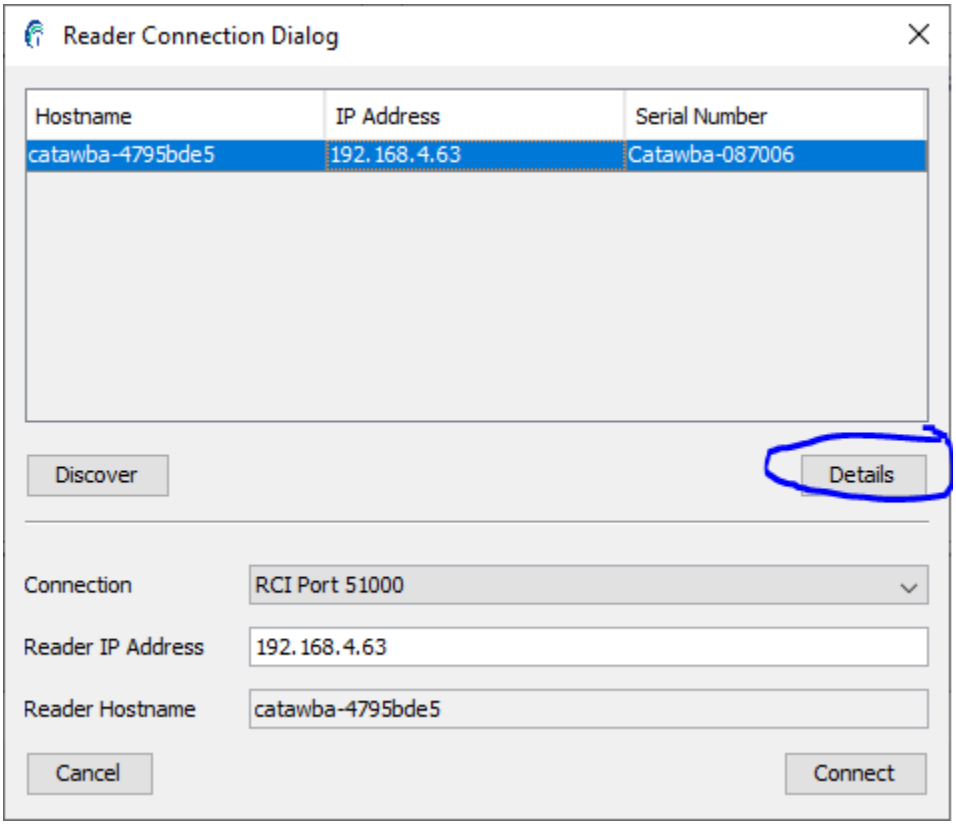
To "discover" the reader's IP address. You can use a Bonjour client like "avahi" or you can use the Clairvoyant Host Software tool. The available ports on the reader are described in the table in section 4.1.3.

4.1.2 Configure IP Address

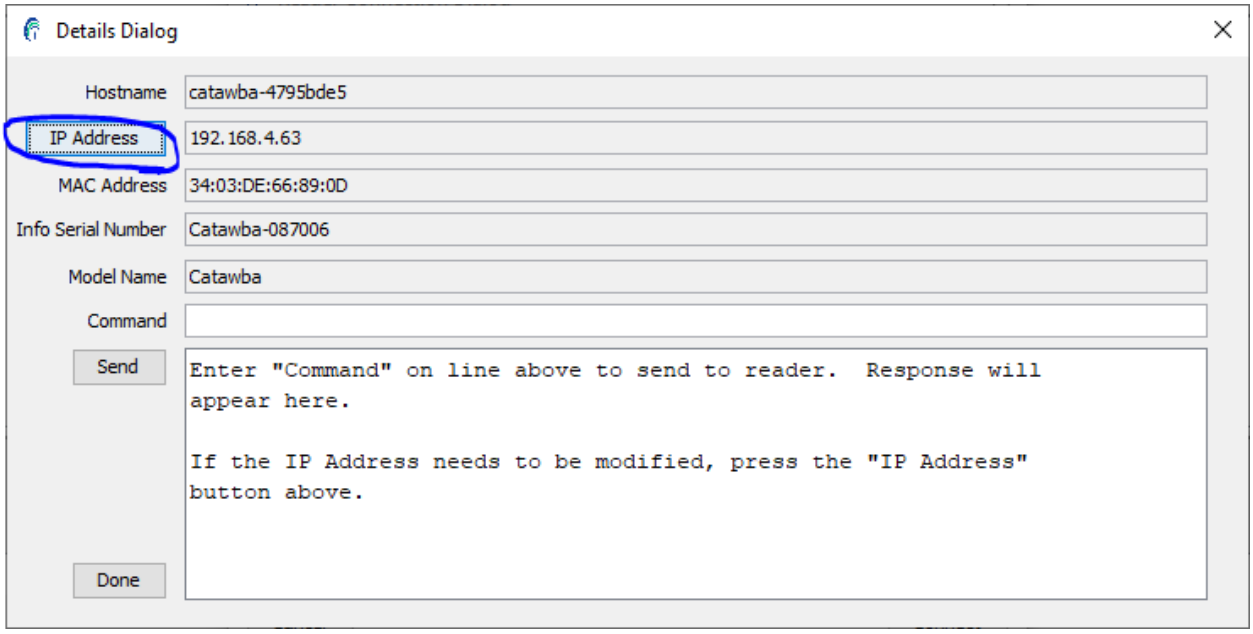
The Clairvoyant Host Software tool can be used to configure the IP address of the reader. This can be done via the "Reader Connection Dialog" after pressing "Discover". It can also be performed using the "Configure→IP Address" menu after connecting to a specific S1 reader.

4.1.2.1 Reader Connection Dialog

Changing the IP address via the "Reader Connection Dialog" can be done by clicking on the "Details" button after selecting the desired S1 reader to configure.

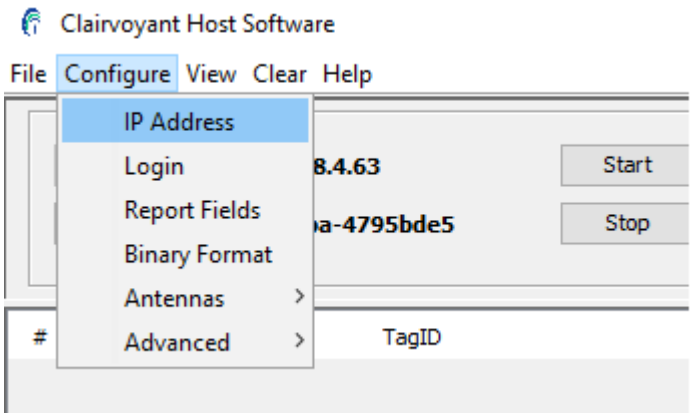


Pressing on “Details” presents the “Details Dialog”. Press IP Address from the “Details Dialog” to bring up the “Configure IP Address” dialog.



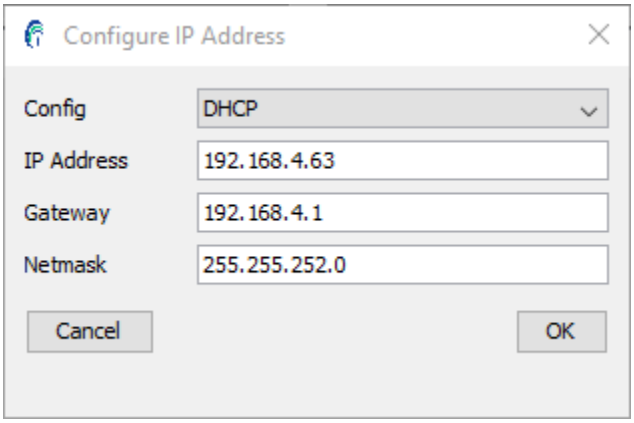
4.1.2.2 Configure Menu

Once the Clairvoyant Host Software tool is connected to an S1 reader, the “Configure” menu can be used to bring up the “Configure IP Address” dialog.



4.1.2.3 Configure IP Address Dialog

The ”Configure IP Address” dialog allows for a “DHCP” or “Static" configuration. If “Static” is selected, all three IP address values must be specified (IP Address, Gateway, Netmask).



After pressing "OK" button, the IP address configuration will be sent to the S1 reader.

Note, if "Static" is selected and the IP address / Gateway / Netmask are not configured properly for the network in which the S1 reader resides, the S1 reader will lose communication over the network.

In the case where an S1 reader is improperly configured and cannot be communicated with over TCP, the "Reader Connection Dialog" can be used to reconfigure the IP address properly if the S1 reader is available on the same subnet as the PC where the Clairvoyant Host Software tool is running. This tool utilizes multicast to perform this function and improperly configured IP addresses can be fixed.

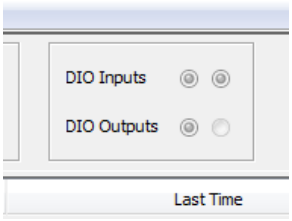
4.1.3 IP Interfaces

Interface	Description
TCP Port 51000	RCI Port (Configurable)
TCP Port 51100	RCI SSL Port (Configurable)
TCP Port 80	Web Interface (Can be disabled)
TCP Port 443	SSL Web Interface (Can be disabled)
Syslog	Outputs to a remote UDP Port 514
TCP Port 3334	Firmware Update Port (Automatically used by Web and GUI)
UDP Port 3333	Discovery port (Multicast IP addresses 239.192.7.1 and 239.192.7.2)
NTP	Network Time Protocol Client
Bonjour	Discovery protocol

4.2 DIGITAL I/O

There are two digital inputs and two digital outputs that can be used to either trigger the reader to enter or leave active mode or to perform other user operations. Please see the RAIN Communication Interface (RCI) documentation on the Clairvoyant website for more information.

The digital I/O can be monitored, and the output can be changed via the Clairvoyant Host Software tool at the top frame of the GUI on the right-hand side:



A dark shaded circle means the status of the Input/Output is a “high” and “low” otherwise. To change the state of the Output, please double click on the circle corresponding to the output that needs to be changed.

4.3 ANTENNAS

The antennas can be configured via the RAIN Communication Interface (RCI). Please see the RCI documentation for more information.

The antennas can be configured with the Clairvoyant Host Software tool via the “Configure” and then the “Antennas” menu.

4.4 LED FUNCTIONALITY

4.4.1 Normal Operation

- In standby mode (not actively transmitting)
  - Power LED = Green
  - Transmit LED = Off
  - Receive LED = Off
  - Status LED = Green
- Transmitting, but no tags are in field
  - Power LED = Green
  - Transmit LED = Green
  - Receive LED = Off
  - Status LED = Green
    - Notice the Transmit LED is green now
- Transmitting, and receiving tag reads constantly

- Power LED = Green
- Transmit LED = Green
- Receive LED = Green
- Status LED = Green
    - Notice Receive LED is solid on

- Transmitting, and receiving tag reads intermittently
    - Power LED = Green
    - Transmit LED = Green
    - Receive LED = Blinking Green
    - Status LED = Green
        - Notice Receive LED will blink intermittently when tags are read

4.4.2 Failure Conditions

- Status LED
    - Green when status is good
    - Orange when status is warning
    - Red when status is error
- Transmitter LED
    - Off when not actively transmitting
    - Green when actively transmitting
    - Red when there is a transmitter fault

4.5 Professional Installation

For installations requiring the S1 to conduct higher transmit power than 1 watt and/or require antenna's with maximum linear gain higher than 6dB must use the S1's High-Power option. The High-Power option provides a professional installation configuration allowing the entry of antenna gains and cable losses. With this option the reader will be capable of conducting more than 1 watt – as high as 33dBm can be conducted out of the S1 antenna ports to compensate for cable losses and antenna gains to achieve the maximum FCC part 15 and Industry Canada RSS-247 radiated level of 36dBm EIRP.

The S1 reader is limited to 33dBm output maximum through both hardware and software mechanisms. The reader's output power is always limited to a maximum of 33dBm, regardless of how much cable loss or antenna gain are specified by the professional installer.

If a professional installation is required, please add the Professional Installation License to the order at time of purchase, or the feature can be added later via field upgrade.

5 Contact Information

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