Tropos 1410 Integration Guide

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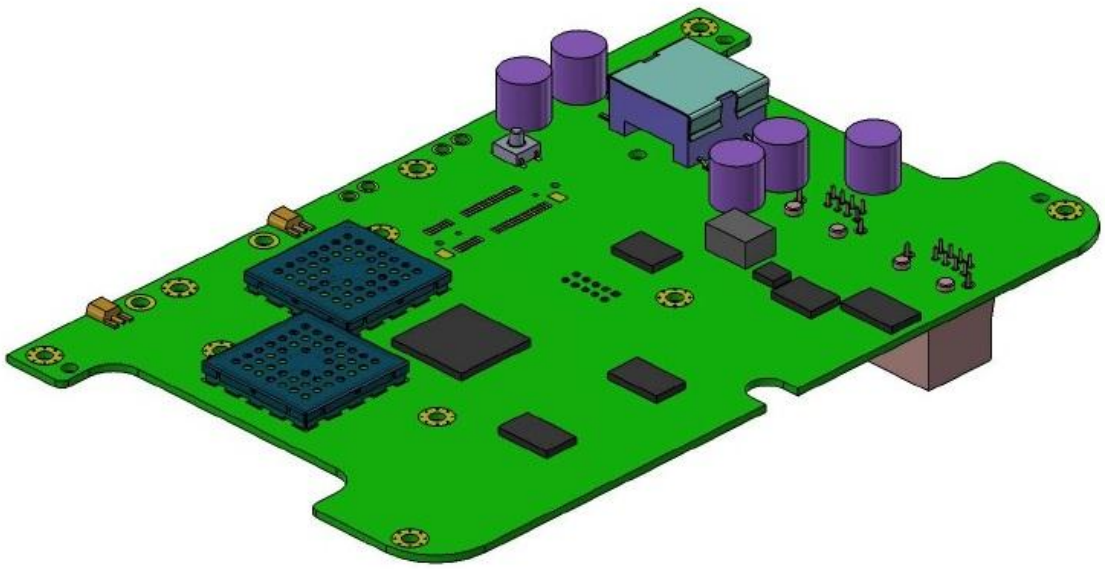

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FCC Notice to Users and Operators

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 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 when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their own expense. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by using one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase separation between the equipment and receiver.
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician.

This Part 15 radio device operates on a non-interference basis with other devices operating at this frequency. Any changes or modification to said product not expressly approved by Tropos Networks could void the user's authority to operate this device.

Industry Canada Notice to users and operators:

This Class B digital apparatus meets all requirements of the Canadian Interference Causing Equipment Regulations. 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.

Cet appareillage numérique de la classe B répond à toutes les exigences de l'interférence canadienne causant des réglements d'équipement. L'opération est sujette aux deux conditions suivantes : (1) cet dispositif peut ne pas causer l'interférence nocive, et (2) ce dispositif doit accepter n'importe quelle interférence reçue, y compris l'interférence qui peut causer l'opération peu désirée.

This device has been designed to operate with the antennas listed. Antennas not included or having a gain greater than 7.4 dBi in the 2.4 GHz band are strictly prohibited for use with this device. The required antenna impedance is 50 Ohms.

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.

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 permitted for successful communication.

Required labeling

The Federal Communications Commission (FCC) and Industry Canada (IC) require equipment that contains a Tropos 1410 to have a label on the outside of the product that shows the FCC and IC ID numbers. The label should say the following:

Contains:

FCC ID: P9J-142402

IC: 4751A-142402

Introduction

The Tropos 1410 is a compact, single-radio board designed to be integrated into devices that participate in a Tropos mesh network. The Tropos 1410 allows large mesh networks to be built economically, delivering mesh coverage and wireless- or wired-client connectivity for Smart Grid and other multi-use applications. The Tropos 1410 can be ordered and configured to operate in either of two modes:

- As a bridge (14101040B {FCC} or 14101042B {ETSI}): A Tropos 1401-B can act as a wireless-to-Ethernet or wireless-to-serial bridge to connect any Ethernet- or serial-enabled device to a Tropos mesh network or to any 802.11b/g/n access point. Bridge operation requires Tropos Software Release 7.9 or higher.
- As a full-functioned mesh router (14103040B {FCC} or 14103042B {ETSI}): In mesh mode, a Tropos 1410 can provide endpoint functions as well as support wireless clients and downstream mesh links. Mesh operation requires Tropos Software Release 8.1 or higher.

The Tropos 1410 is optimized for embedded applications. While other Tropos routers are stand-alone devices, the Tropos 1410 is designed to be integrated into other devices. For example, a Tropos 1410 can be integrated into a pole-mounted transformer, enabling the transformer to communicate health and power quality data as well as function as a node in the mesh network.

Examples of devices that can use a Tropos 1410 for communications into a Smart Grid or Smart City infrastructure are:

- transformers
- fuel cell control units
- thermal energy storage units
- control units for reclosers, regulators, switch gear and capacitor banks
- electric vehicle chargers
- solar power inverters and controls
- intelligent traffic signals
- parking kiosks

Connectivity to wired and wireless clients

The Tropos 1410 supports both Ethernet and serial communications (RS-232 or RS-485, configurable) for client devices. The serial interfaces support the DNP3 protocol. Connection to these ports is through RJ-45 connectors. One RJ-45 connector supports the Ethernet port and power, and the second RJ-45 connector supports the serial interfaces and power (wiring diagrams for the RJ-45 connectors are shown in Figure 1).

When operating in mesh mode the Tropos 1410 can support wireless clients. A wireless client can be any device that supports 802.11b/g/n communications, including electric power distribution devices such as reclosers, capacitor banks, and voltage regulators, and video cameras used for security or traffic monitoring. Virtually any communicating device can be connected to the Tropos 1410.

Security

The Tropos 1410 supports a high level of network security, including the following functions:

- IPSec VPNs with tunnels to wired client interfaces using AES
- Encryption: open, WEP, TKIP, AES-CCM
- FIPS 140-2 Level 2 compliant
- Multiple BSSIDs & ESSIDs (ESSID suppression)
- Password and Certificate-based HTTPS and SSH Remote Access
- Authentication: WPA, WPA2, 802.11i, RADIUS, 802.1x (includes EAP-TLS, EAP-TTLS, PEAP)
- AES encryption of mesh and control traffic
- NERC-CIP 002-0009 compliant
- HTTPS-based remote access
- Evil Twin Detection and Reporting
- Integrated firewall:
  - Packet filtering based on TCP port, protocol, SA, DA
  - Peer-to-Peer Blocking
  - Client Access Control Lists
  - VPN filtering
  - Router Access Control
  - Denial of Service Attack Detection

Tropos Control network management

The Tropos 1410 is managed by Tropos' industry leading network management, monitoring and control application, Tropos Control. Tropos Control allows the network operator to monitor network performance in real time and perform complex tasks such as network reconfiguration. It can function in a stand-alone configuration or as part of a larger network management system using SNMP.

Integrating the Tropos 1410

Integration of the Tropos 1410 requires the physical installation of the unit in a safe and reliable manner; the correct powering the unit; the correct connection of the data interfaces and the correct connection of the antennas. The following sections describe these steps. Figure 1 is an outline drawing of the Tropos 1410 showing the location of components referred to in the following sections.

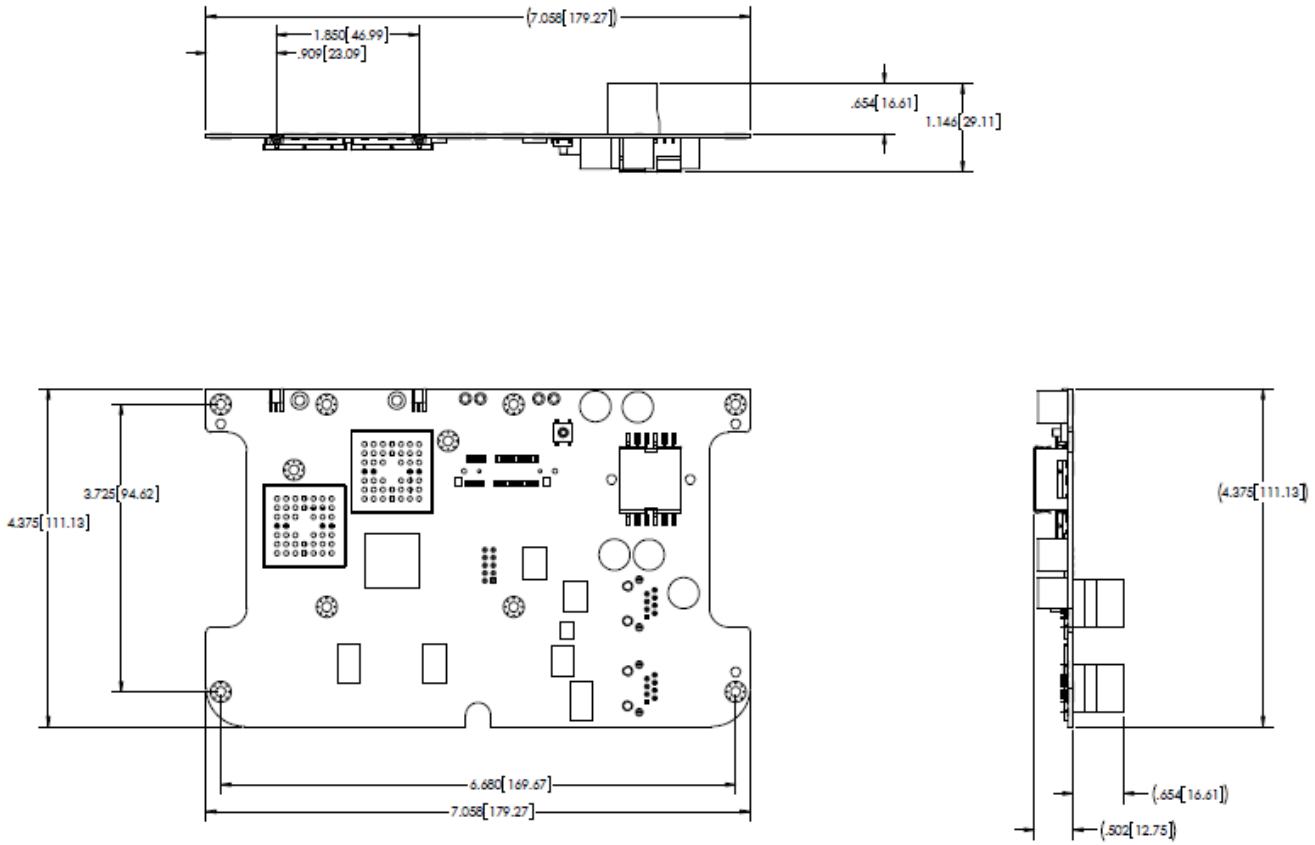

Figure 1

Tropos 1410 Components and Dimensions

Handling the Tropos 1410 circuit board

Certain components used in the Tropos 1410 are sensitive to static electricity and can be damaged by its discharge. The Tropos 1410 should be handled only in an ESD safe work area. The purpose of an ESD safe work area is to prevent damage to sensitive components from spikes and static discharges. These areas must be designed and maintained to prevent ESD damage.

The Tropos 1410 circuit board assembly must always be handled at properly designated work areas.

Stacking of Tropos 1410 circuit boards should be avoided to prevent physical damage.

Work areas should be kept clean and neat. Tropos 1410 circuit board assemblies should be handled by the edges. Avoid touching the circuits or components.

Physical installation

The Tropos 1410 is a single board assembly. The board contains the processor, radio and connectors, and components for conditioning and monitoring power.

The Tropos 1410 board is 6.680” long x 4.375” wide, 1.146” high. There are four mounting holes on the Tropos 1410 designed for 4-40 screws (see Figure 1). The Tropos 1410 should be mounted on stand-offs or bosses so that there is a minimum of 0.5” of clearance on all sides of the unit.

Power

The Tropos 1410 requires 11-50 VDC power. This power is then regulated by the Tropos 1410. Power can be applied to the either the Ethernet or serial RJ-45 connector (see Figure 1). The pin assignments for these ports are shown in Tables 1 and 2.

The Tropos 1410 does not use 802.3af or 802.3at signaling.

Communications interfaces

The Tropos 1410 supports Ethernet, serial and USB connections. There are two RJ-45 connectors on the board. One is used for the Ethernet port. The other is used for the serial ports. There is one USB Type A receptacle on the board.

Ethernet

The Ethernet port supports the Ethernet signals and power, as shown in table 1, below.

pin	assignment	pin	assignment
1	TX +	5	Power +
2	TX -	6	RX -
3	RX +	7	Power -
4	Power +	8	Power -

Table 1: Ethernet Port Pin Assignments

Serial

The Tropos 1410 provides a dual serial interface on RJ-45 port 2. The integrator needs to configure the Tropos 1410 for either RS-232 or RS-485 operation as shown in the current version of the Tropos User Guide (user guides are available for specific Tropos software releases).

The serial interface can support multiple serial connections. The following configurations are supported:

- One RS-232 connection (option 1 in Table 2)
- One RS-485 connection (option 1 in Table 2)
- One RS-232 connection and one RS-485 connections (option 2 in Table 2)
- Two RS-232 connections (option 2 in Table 2)

The RJ-45 connector used for the serial ports has the pin assignments shown in Table 2, below:

pin	option 1 (one serial port)	option 2 (two serial ports)
1	RS232 TX or RS485 TXRX -	RS232 (port 2) TX or RS485 TXRX -
2	GND	GND
3	RS232 RX or RS485 TXRX +	RS232 (port 2) RX or RS485 TXRX +
4	Power +	not used
5	Power +	RS-232 (port 1) RX
6	not used	RS-232 (port 1) TX
7	Power -	not used
8	Power -	not used

Table 2: Serial Port Pin Assignments

Notes:

- When using option 1 above for one RS-232 port, the port must be configured for port 2 (see Tropos 1410 User Guide).
- When the connector is used to support two serial ports (option 2) the connector cannot support the power connections. In these cases power must be applied to the Ethernet port as shown in Table 1.
- The integrator must ensure that all cables have appropriate strain relief and do not place any stress on the Tropos 1410's connectors.

USB port

The Tropos 1410 is equipped with a USB interface accessible through a Type A receptacle on the board. Future software releases may provide support for devices such as GPS receivers.

Pushbutton Switch

One pushbutton switch is mounted on the Tropos 1410 (see Figure 2). Its function is:

- Software safe mode start. When SW 1 is depressed and held during the power on sequence the Tropos 1410 software will start in safe mode.

LEDs

One LEDs are installed on the Tropos 1410 (on the bottom of the board). Its function is:

- Blinks green when the radio is on.
- Solid green when the Tropos 1410 is connected to a network

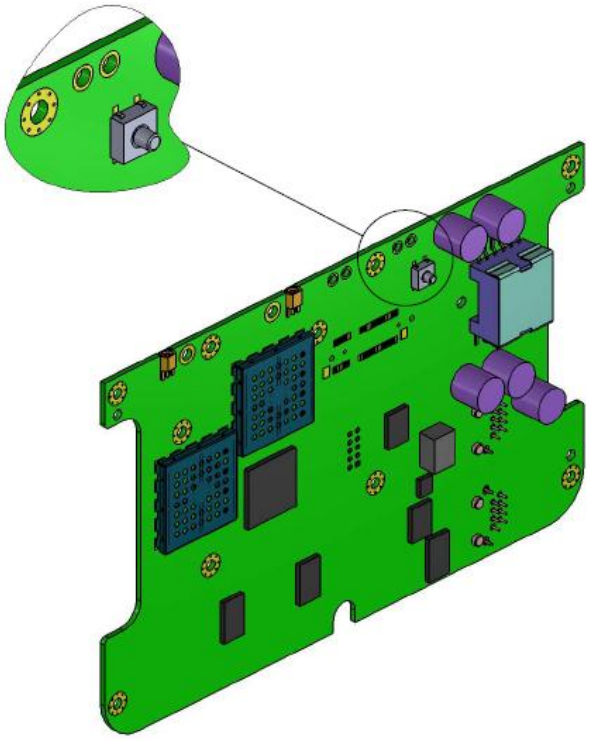

Figure 2

Switch Detail

Antennas

Antennas for the Tropos 1410 can be purchased from Tropos or sourced by the integrator. The Tropos 1410 is designed for use with two omni-directional antennas.

The Tropos 1410 is FCC and Industry Canada approved for use only with omni-directional antennas with a gain of 7.4 dBi or less. Please consult Tropos for any applications requiring other antennas.

In ETSI countries the typical maximum radiated power is +20dBm. 7.4dBi antennas can be used with an ETSI 1410. Consult local regulations for the specific country in which the product will be used.

The Tropos 1410 uses a 2x2 MIMO (multiple-input, multiple-output) antenna configuration. The use of two antennas is always recommended for optimal performance.

It is preferable to mount the antennas outside of the device enclosure, but antennas can be located inside of an enclosure if the enclosure is non-metallic. Antennas should be mounted as high as possible and can be mounted remotely from the device.

The standard antenna connectors on the Tropos 1410 board are MMCX connectors.

The connection from the antenna connectors on the Tropos 1410 and any antenna connectors on the device should be made with low-loss coaxial cable. Tropos recommends LMR-240 or better cable.

Configuration

Configuration of the Tropos 1410 is covered in the current version of the Tropos Router User Guide for Release 7.9 or higher.

Recommended Testing

Tropos recommends that the OEM integrator perform the following tests to validate the integration of the Tropos 1410 into their product. These are provided as guidelines to the OEM. Actual testing is the responsibility of the OEM.

Physical Installation and Packaging

1. Verify that the Tropos 1410 is installed in the enclosure in accordance with the assembly drawings and the installation guidelines and specifications provided in this document.
2. Verify that the antennas are properly connected to the SMA-antenna connectors.
3. Verify that the cable connecting the Tropos 1410 to the OEM equipment is properly installed.
4. Verify that the Tropos 1410 is powered when power is provided to the power supply board.
5. Verify that the external LED (if used) is properly wired and operates correctly.

Figure 3 shows a typical test configuration

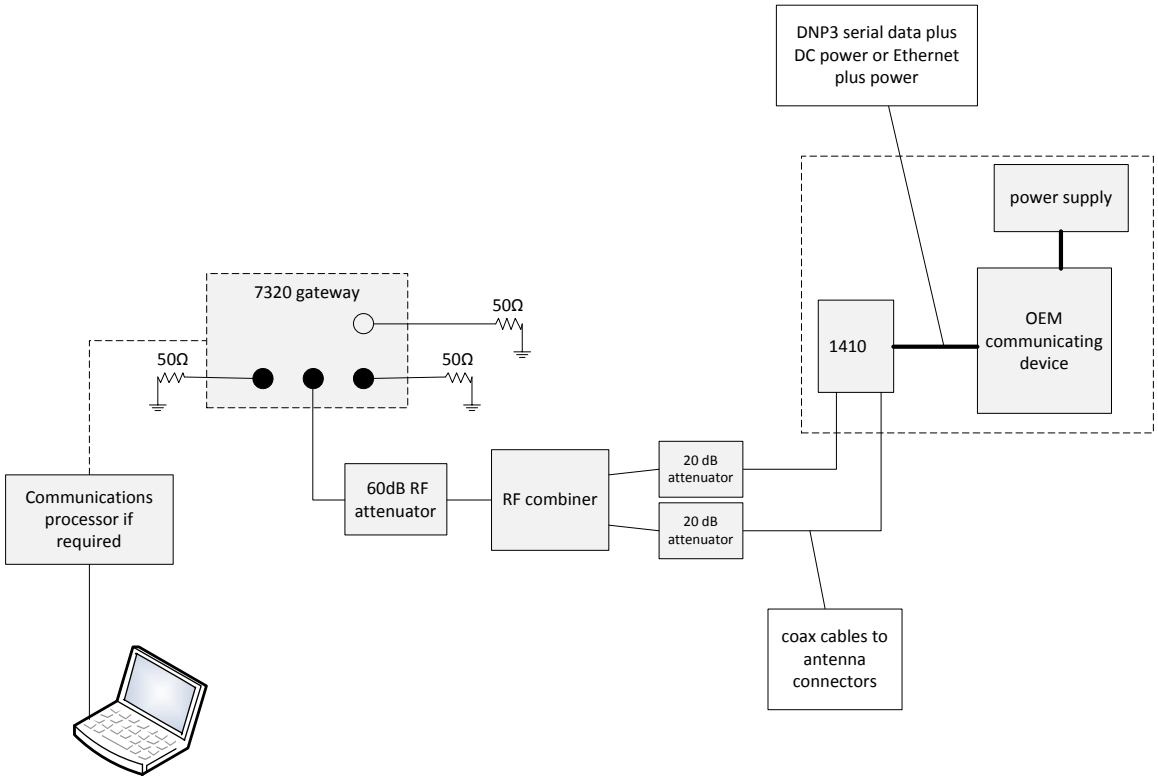

Figure 3

Typical Test Configuration

Communications and Connectivity Testing

Install an RF combiner and an attenuator as shown. Connect the attenuator to the center N-connector on the Tropos 7320 router that will function as the gateway.

Using the configuration shown in Figure 3, perform the following tests:

- Conduct a ping flood test from the computer to the Tropos 1410. Verify operation up to 25% duty cycle.
- Conduct tests from a communications controller (for example, a DNP3 master station) to the OEM equipment to for all supported commands.
- Verify that the console messages during Tropos 1410 boot up do not affect OEM equipment (reboot the Tropos 1410 multiple times consecutively).
- If serial communications is used verify that all the serial speeds (i.e. baud-rates 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200) on the Tropos 1410 work correctly with the OEM equipment.
- Verify that communications functionality does not get disrupted for extended period of time when a Tropos 1410 roams to a different Tropos router (in the same subnet when Tropos 1410 retains the same IP address).
- Verify that the Tropos 1410 reboots and upgrades do not disrupt the communications functionality and end-to-end connectivity. Communications should resume automatically after a reboot.
- Verify the Tropos 1410 status page in the Configurator displays valid DNP3 local/remote address and Tx/Rx packet information.
- Verify that the Tropos 1410 can be rebooted using the configurator (remotely) and with the reset button (locally).
- Verify the Tropos 1410 can be reached via its rescue interfaces (wireless wlan0 and Ethernet eth1) during standalone mode when it is not connected to any Tropos router.
- Verify the Tropos 1410 and its wired clients can be configured in static and DHCP modes.

Environmental Tests

1. High and low temperature tests
    - The OEM equipment should be temperature tested, but within the specified temperature range of the Tropos 1410
2. Cold start tests
    - Start up tests at the low rated operating temperature
3. Humidity tests
    - The OEM equipment should be humidity tested to its specifications, but within the specified humidity range of the Tropos 1410
4. Temperature cycle tests per OEM requirements
5. Vibration tests per OEM requirements
6. Line voltage test
    - Operation between the specified input power range of the OEM equipment

7. Surge test per OEM specifications
    - Voltage transient test per OEM specifications

Safety and Servicing Information

The Federal Communications Commission (FCC) with its action in ET Docket 96-8 has adopted a safety standard for human exposure to RF electromagnetic energy emitted by FCC certified equipment. The Tropos 1410 meets the uncontrolled environmental limits found in OET-65 and ANSI C95.1, 1991. Proper operation of this device according to the instructions found in this manual will result in user exposure that is substantially below the FCC recommended limits.

To comply with FCC, Industry Canada and other national RF exposure safety requirements the antennas for this device must be installed to provide a separation distance of at least 20 cm from persons and shall not be co-located with other transmitting antennas except as shown in FCC/IC multi-transmitter guidelines.

Safety Guidelines

- Follow these guidelines to ensure safe operation of the router:
- Do not touch or move the antennas while the unit is transmitting or receiving.
- Do not hold any component containing a radio such that the antenna is very close to or touching any exposed parts of the body, especially the face or eyes, while transmitting.
- Do not operate the radio or attempt to transmit data unless the antenna is connected; otherwise, the radio may be damaged.
- Use in specific environments:
    - Do not operate a portable transmitter near unshielded blasting caps or in an explosive environment unless it is a type especially qualified for such use.
    - The use of wireless devices in hazardous locations is limited to the constraints posed by the safety directors of such environments.
    - The use of wireless devices on airplanes is governed by the Federal Aviation Administration (FAA).
    - The use of wireless devices in hospitals is restricted to the limits set forth by each hospital.

Servicing the Tropos 1410

The Tropos 1410 has no user serviceable parts. For any service-related issues, contact Tropos Customer Support (support@tropos.com).

Specifications

Wireless

protocols supported	802.11 b/g/n
frequency band	2.400-2.483 GHz
modulation (802.11b)	DSSS (DBPSK, DQPSK, CCK)
modulation (802.11g/n)	OFDM (64-QAM, 16-QAM, QPSK, BPSK)
media access protocol	CSMA/CA with ACK
TX power	FCC: 12-27 dBm set in 1 dB units ETSI: 5-20 dBm set in 1 dB units
RX sensitivity	-97 dBm at 1 Mbps
multi-antenna system	2 TX, 2 RX MIMO
Radio ID	FCC: P9J-14240H IC: 4751A-14240H

Networking

compatibility	802.11b/g/n
VLAN support	802q, ESSID and IP based tagging
addressing	static and dynamic addressing for wireless and wired clients
quality of service (QoS)	• 802.11e WMM • 802.p/q with 4 queues per VLAN and ESSID • 802.p and DSCP

Wired Interfaces

Ethernet	one 10/100Base-T
Serial	• one RS-232 or • two RS-232 or • one RS-485 or • one RS232 and one RS485 • DNP3
USB	one USB
connectors	• two RJ-45(Ethernet and serial) • one USB Type A

Power

unregulated input	11-55 VDC
power consumption	3 W typical

Security

authentication	WPA, WPA2, 802.11i, RADIUS, 802.1x (includes EAP-TLS, EAP-TTLS, PEAP)
encryption	AES-128 (FIPS 140-2 compliant)

Physical

operating temperature	-40 °C to +75 °C / -40 °F to +167 °F
storage temperature	-40 °C to +85 °C / -40 °F to +185 °F
shock / vibration	ETSI 300-19-2-4; T41.E class 4M3
dimensions	6.680” L x 3.4.375” W x 1.146” H
weight	8 oz
antenna connectors	2 MMCX
antenna protection	integrated
electrical fast transient immunity	EN61000-4-3 level 2
EMC field immunity	EN61000-4-2 level 2
ESD immunity	EN61000-4-2 (contact); level 3 (air)