PYXIS PRODUCT MANUAL

MiMOMax Wireless Ltd
Issue X – Month Year
Product Manual for Pyxis
Firmware version X

Disclaimer

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TABLE OF CONTENTS

1 ABBEVIATIONS AN ACRONYMS

AC	Alternating Current
ACMA	Australian Communications and Media Authority
ADC	Analogue to Digital Converter
ADPCM	Adaptive Differential Pulse Code Modulation
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
ANT	Antenna
BER	Bit Error Rate
BRU	Base Radio Unit
BW	Bandwidth
CAT	Category
CCMS	Configuration Control & Monitoring Software
CODECS	Coder Decoder
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CSV	Comma Separated Value
DAC	Digital to Analogue Converter
DC	Direct Current
DFE	Decision-Feedback Equalizer
DIF	Digital Interface
DPLXR	Duplexer
DPS	Digital Processing System
DRU	Diversity Radio Unit
DSP	Digital Signal Processing
DTE	Data Terminal Equipment
EF	Express Forward
EMC	Electromagnetic Compatibility
ERM	Electromagnetic Compatibility and Radio Spectrum Matters
ESD	Electrostatic Sensitive Device
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FIFO	First In, First Out
FPGA	Field-Programmable Gate Array
FTP	File Transfer Protocol
GND	Ground
GPS	Global Positioning System
GRE	Generic Routing Encapsulation
HPF	High Pass Filter
HSSI	High Speed Serial Interface
HTML	Hyper-Text Mark-Up Language
IF	Intermediate Frequency
IO	Input Output
IP	Internet Protocol
ITU	International Telecommunication Union
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LO	Local Oscillator
LPF	Low Pass Filter
LRU	Link Radio Unit
MAC	Media Access Control
MCAM	MiMOMax Cognisant Adaptive Modulation
MDAP	MiMOMax Data Acceleration Protocols
MDIX	Medium Dependent Interface Crossover
MDL	Multipoint Digital Link
MIB	Management Information Base
MIMO	Multi Input Multi Output
MRAP	MiMOMax Routing Adaptation Protocols
NDL	Network Digital Link
NIB	Network Interface Board
NTP	Network Time Protocol
OPV	Optimised Protection Variant
OSI	Open System Interconnection
OSPF	Open Shortest Path First
OTAC	Over the Air Configuration
OTAP	Over the Air Programming

PA	Power Amplifier
PC	Personal Computer
PCB	Printed Circuit Board
PECL	Positive Emitter-Coupled Logic
PIF	Power Interface
PIN	P-Type, Intrinsic, N-Type
PLL	Phase Locked Loop
PMR	Private Mobile Radio
PSU	Power Supply Unit
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keying
RF	Radio Frequency
RFI	Radio Frequency Interference
RRU	Remote Radio Unit
RSSI	Received Signal Strength Indication
RTP	Real-Time Protocol
RU	Radio Unit
RX	Receive
SCADA	Supervisory Control and Data Acquisition
SEPIC	Single Ended Primary Inductor Converter
SFE	Software Feature Enabler
SMB	Sub miniature Version B
SNMP	Simple Network Management Protocol
SPI	Serial Peripheral Interface
SS	Synchronous Serial
TCP	Transmission Control Protocol
TTR	Time to Repair
TX	Transmit
UART	Universal Asynchronous Receiver/Transmitter
UDP	User Datagram Protocol
UHF	Ultra High Frequency
USD	United States Dollar
VCO	Voltage Controlled Oscillator
VCTCXO	Voltage-Controlled Temperature-Compensated Crystal Oscillator
VRMS	Volts Root Mean Square
VRRP	Virtual Router Redundancy Protocol
VSWR	Voltage Standing Wave Ratio

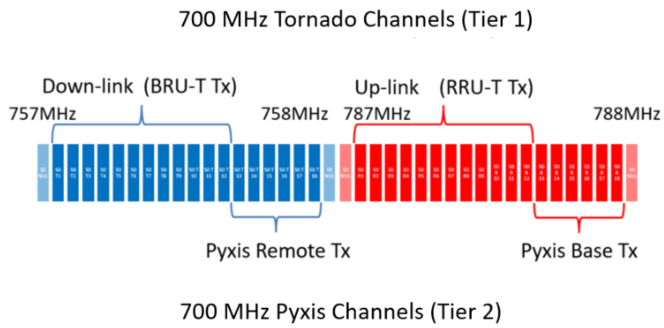
Conventions used in this manual

This indicates the following information is for reference purposes.

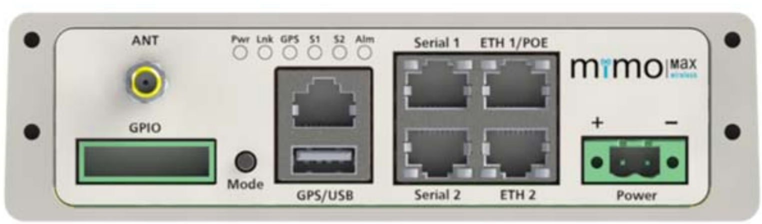
This indicates the following information is important and the user **MUST** take note.

2 PYXIS SYSTEM OVERVIEW

To complement MiMOMax's Tornado range of radios or as a standalone radio, the Pyxis radio system provides a low cost, high performance radio platform. When used with Tornado radios, Pyxis radios provide Tier 2 network connectivity from a selected set of Tier 1 Tornado remote locations to end points in the near vicinity. This is achieved by having Pyxis bases (BRU-P) co-located with Tier 1 Tornado remote radios (RRU-T) and connected via a wired Ethernet connection. Pyxis BRU-P's provide a wireless connection to a number of Pyxis remotes (RRU-P) that in turn provide connectivity via RTUs at a variety of plant types, including Advanced Solar Inverters. To reach difficult to access sites the RRU-P radio can operate in a store and forward mode to forward data to and from another RRU-P. (The Pyxis radios operate within the same 2 x 1MHz blocks of 700 MHz spectrum as used by the Tier 1 network, although typically within 6-8 channels set aside for the Tier 2 operation). The Pyxis radios utilize two-frequency TDD, and to facilitate relay operation, can switch between transmit in either the upper or lower MHz block.

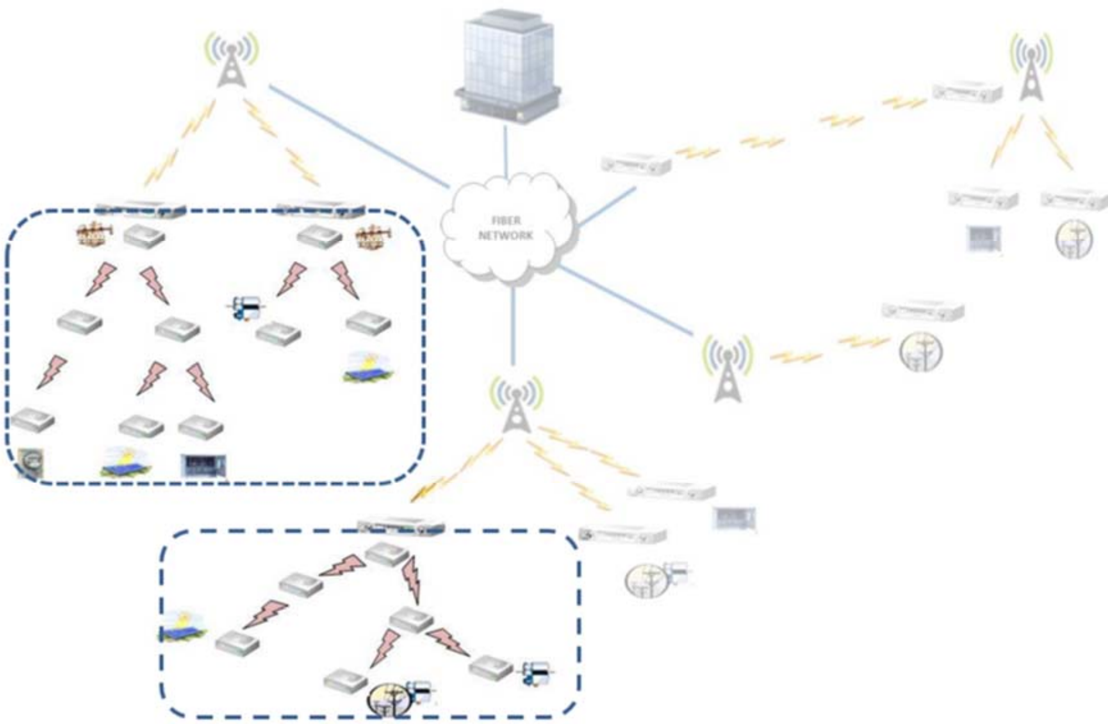


Operating in either the 400-520MHz or 757-788MHz Licensed Spectrums, Pyxis provides an economical solution to your SCADA needs, utilising PTP/PTMP tree structures to connect to devices at the periphery of your network



Pyxis Radio

2.1 TYPICAL TIER 2 PYXIS NETWORK

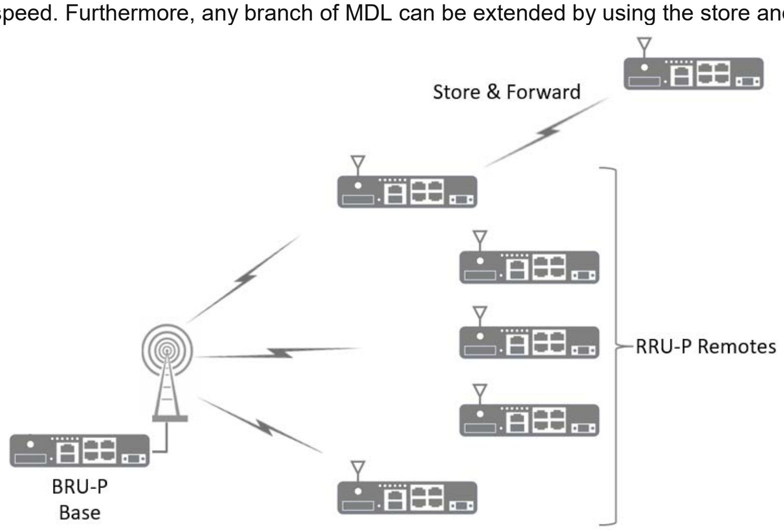


2.2 MULTIPOINT DIGITAL LINKS (MDL)

The MiMOMax Pyxis MDL is a highly reliable and robust point-to-multipoint wireless linking solution designed for mission-critical Supervisory Control and Data Acquisition (SCADA) and Telemetry applications. It consists of one or more Base Radio Units (BRUs) that support up to 250 Remote Radio Units (RRUs).

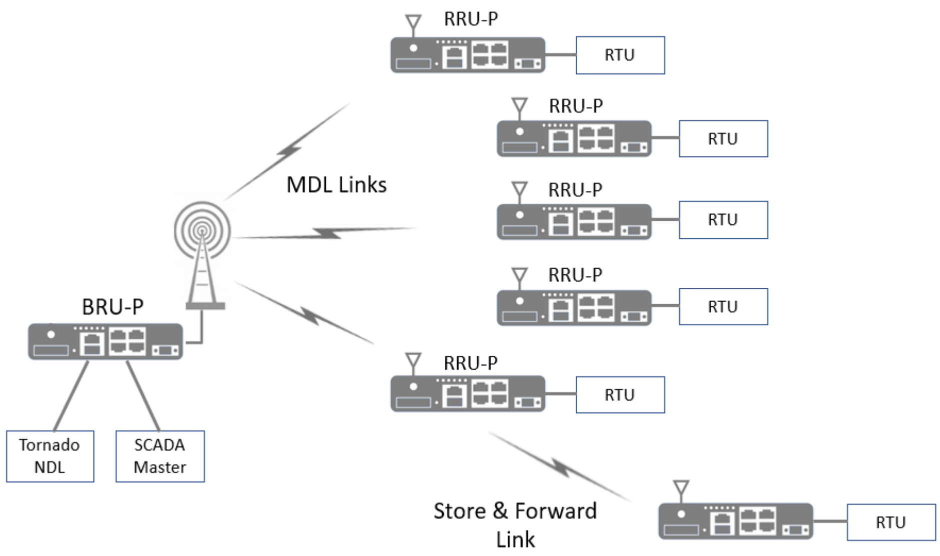
The MiMOMax MDL supports both native IP and legacy Asynchronous Serial RS232 Remote Terminal Units (RTUs) by means of optional embedded Terminal Server software. A number of interfaces are available to support various applications.

Very high system gains, and good receiver sensitivities mean that it is possible to achieve paths in excess of 100kms from high radio sites at full speed. Furthermore, any branch of MDL can be extended by using the store and forward mode.



Basic Point-to-Multi-Point Linking Diagram

SCADA networks can use MDL links to connect remote RTUs to the central SCADA master. For difficult terrains or very long paths the store and forward mode can be used.



SCADA Network Example FIX ANTENNA RADIO PICTURE

3 SAFETY WARNINGS

3.1 MODIFICATIONS

NOTE: THE GRANTEE IS NOT RESPONSIBLE FOR ANY CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY THE PARTY RESPONSIBLE FOR COMPLIANCE. SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

3.2 TRANSMITTER ANTENNA

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada.

Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée quivalente (p.i.r.e.) ne dépassepas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

3.3 SAFETY DISTANCE

Minimum Safe Distance from Antenna: To comply with safety requirements for human RF exposure in the USA, Canada and other countries, no person shall be permitted to remain in the vicinity of the antenna of an operational MiMOMax Pyxis system at distances closer than the following:

General Public / Uncontrolled Use: 0.2m when using an 4dbi Omni Antenna or 0.25m with an 6dbi Omni Antenna with MiMOMax 700MHz Pyxis radio.

The above distances are based on procedures defined by regulatory standards for equipment operating at maximum power and 100% duty cycle with a person located directly in front of the antenna in the main radiation lobe.

3.4 FCC RF EXPOSURE STATEMENT

The transmitter must not be co-located or operated in conjunction with any other antenna or transmitter. The equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 25cm between the radiator and any part of your body.

3.5 ELECTRICAL SAFETY CABLE SCREENING

Equipment connected to the protective earthing of the building installation through the mains connection or through other equipment with a connection to protective earthing - and to a cable distribution system using coaxial cable, may in some circumstances create a fire hazard. Connection to a cable distribution system has therefore to be provided through a device providing electrical isolation below a certain frequency range (galvanic isolator, see EN 60728-11).

NOTE: In Norway, due to regulation for installations of cable distribution systems, and in Sweden, a galvanic isolator shall provide electrical insulation below 5 MHz. The insulation shall withstand a dielectric strength of 1,5 kV r.m.s., 50 Hz or 60 Hz, for 1 min.

Utstyr som er koplet til beskyttelsesjord via nettplugg og/eller via annet jordtilkoplet utstyr - og er tilkoplet et kabel-TV nett, kan forårsake brannfare. For å unngå dette skal det ved tilkopling av utstyret til kabel-TV nettet installeres en galvanisk isolator mellom utstyret og kabel-TV nettet.

Utrustning som är kopplad till skyddsjord via jordat vägguttag och/eller via annan utrustning och samtidigt är kopplad till kabel-TV nät kan i vissa fall medfõra risk fõr brand. Fõr att undvika detta skall vid anslutning av utrustningen till kabel-TV nät galvanisk isolator finnas mellan utrustningen och kabel-TV nätet.

3.6 MAINS CONNECTION

The Mains connection of the supply providing the DC supply to the MiMOMax Pyxis unit shall be either:

- PERMANENTLY CONNECTED EQUIPMENT.
- PLUGGABLE EQUIPMENT TYPE B.
- Or equipment intended to be used in a RESTRICTED ACCESS LOCATION where equipotential bonding has been applied and which has provision for a permanently connected PROTECTIVE EARTHING CONDUCTOR and is provided with instructions for the installation of that conductor by a SERVICE PERSON.

3.7 FCC 15.19 STATEMENT

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.

3.8 FCC 15.105(B) STATEMENT

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.

4 PYXIS RADIO UNIT OVERVIEW

MiMOMax Pyxis radios consist of the following modules.

- Digital Processing System (DPS)
- Transceiver (TRCVR)

These modules are described in detail in the sections that follow.

User data (Ethernet or serial) passes from the various interfaces into the Digital Processing System (DPS) where sophisticated processing takes place to code the data into frames for transmission.

The transceiver generates the transmit signal and amplifies it to the set power level. On the receive path, the radio signals are picked up by the antenna and into the receiver module. The receiver selects the radio frequency to receive and mixes the signal down to and IF. This IF signal is then demodulated, and frames are reconstructed into the user data.

4.1 DIGITAL PROCESSING SYSTEM

The DPS is the heart of the radio unit. It provides an accurate and stable 40MHz system reference clock from which all the required digital clocks and RF local oscillator frequencies for transmit and receive functions are derived. It processes signals that have been transmitted or received and provides overall control and monitoring to the rest of the system via the built-in Configuration, Control and Management Software CCMS and Command Line Interface, CLi software. Power supplies are also provided by the DPS.

4.1.1 Power supply

The power supply operates off a 10.5 to 60 VDC input and generates stable 13.2V, 5.5V, 5.0V, 3.3V, 2.5V,1.8V 1.2V and 23V internal power supply rails, that all the other circuitry runs off. The input of the power supply is isolated from the rest of the circuitry and the chassis. Input voltage monitoring is provided via CCMS and CLi.

4.1.2 Central Processor Unit

An ARM Cortex A8 based microcontroller is used as the CPU in the DPS board. It uses a reference clock of 26MHz. The CPU provides external device connectivity through the built-in and external peripherals.

The CPU runs a Linux embedded operating system which provides various services such as scheduling, process management, memory management, device and resource management, TCP/IP stacks and inter-networking, applications, user interface, system configuration and control etc. An integral part of the Linux operating system is the MiMOMax specific network driver, which configures the radio unit as a standard Ethernet device.

4.1.3 FPGA

An Altera Cyclone IV Field Programmable Gate Array is used to implement the radio interface.

4.1.4 Reference & Clock Synthesisers

The main system reference clock consists of a low-noise, voltage-controlled, temperature-compensated, crystal oscillator (VCTCXO) operating at 40MHz. Factory calibration of this oscillator against an external GPS or other frequency reference is provided by means of a DAC which adjusts the VCTCXO DC control voltage to set the frequency precisely to 40.0MHz. The VCTCXO may also be phase-locked to an external 10 MHz reference if required. If the external reference input is not in use the internal reference divided down to 10 MHz can be provided as an output. External reference in/out is provided via an isolated differential connection on the GPIO connector.

The 40MHz output from the VCTCXO is buffered and distributed to provide low-noise differential reference signals for the transmitter and receiver local oscillators and the FPGA.

The 40MHz output from the VCTCXO also feeds a PLL IC which generates a 25MHz clock for the Ethernet controller.

4.1.5 Dual Ethernet

The Ethernet is provided via a three-port managed Ethernet switch, one port is the internal connection to the CPU, and the other two ports are available on the RJ45 connectors labelled 'Eth1' and 'Eth2' on the front panel. The Ethernet ports are both 10/100BASE-Tx ports, supporting full and half duplex, flow control, auto MDI-X and auto negotiation.

4.1.6 Dual Serial

The two serial ports, 'Serial 1' and 'Serial 2' on the front panel, operate as RS232 or RS485 ports.

4.1.7 GPIO

Four GPIO ports are provided, these are able to be open collector digital outputs capable of withstanding 70 VDC, and sinking up to 100mA. Or they can be used as either digital or analogue input ports, making use of a 12-bit Analogue to Digital converter. The direction and mode of each can be set independently.

4.1.8 Alarm

A single set of voltage free change over contacts are provided as an alarm indication, these are current limited to 750mA. The alarm port is also on the GPIO connector.

4.1.9 Front Panel LEDs

LEDs on the front panel indicate Power, RF link status and Alarm.

4.2 RECEIVER RF/IF SECTIONS

The receiver line up consists of one RF, mixer, IF and backend transceiver IC stage and shares the front end LPF and RF connector with the transmitter section, which works in TDD mode. RF input to the receiver is by means of the radio front panel-mounted 50Ω SMA connector and through the build in LPF, which gives rejection to the image signals. A LPF placed after a RF switch distributes the input RF signal to the receiver front end in the receiving time slot and outputs the transmitter RF signal to the antenna in the transmitting time slot alternatively. A specific synthesizer and local oscillator feeds the Rx mixer. Descriptions below set forth the details of receiver stages.

4.2.1 Front End

The receiver Front End consists of a RF saw filter, LNA and post-LNA bandpass filter. Incoming signals are fed through two switchable RF saw filters, which have band pass response centred at the low and high frequency bands that the Pyxis radio operates at. The saw filters provide effective rejection of out-of-band frequencies beyond the centre frequency (approximately +/-3MHz). Following the filter, is the receiver Low Noise Amplifier (LNA). This is followed by a fixed image reject filter (band pass filter) to remove noise attributed to the LNA as the majority of image rejection comes from the front end.

4.2.2 Mixer and LO Buffer

The RF signal from the front end is converted down to an Intermediate Frequency (IF) by means of a mixer and LO Buffer.

4.2.3 IF and Backend Transceiver IC

The signal from the mixer directly feeds an IF amplifier. It passes to a 169.2MHz IF SAW filter which has a 70KHz pass band and gives sufficient rejection to out-of-band signals beyond the centre frequency +/- 100KHz. The primary rejection of adjacent channels is provided by a programmable DSP channel filter in the backend transceiver IC further down the receive chain.

Following the IF filter a single to balance converter circuit feeds the IF signal to an integrated transceiver IC that has a built in IF amplifier, AGC stage, internal 2nd LO, ADC and baseband digital signal processor, which eventually demodulate the received signal to user data.

4.2.4 Receiver Local Oscillator

The receiver local oscillator consists of a programmable fractional-N phase-locked loop (PLL) frequency synthesiser, using a stable reference frequency from an internal 40MHz temperature-compensated crystal oscillator located on the digital PCB. The required local oscillator frequency (i.e. receive frequency minus 169.2MHz) is programmed by the units central processing system which controls the synthesiser via a 3-wire serial interface bus. The frequency is settable in 5 kHz increments (2.5KHz is optional).

The synthesiser control loop incorporates a low noise op-amp active filter and level shifter, the output of which feeds the voltage-controlled oscillator (VCO). The VCO uses a LC resonator tuned by a high-Q varicap diodes to minimise phase noise and jitter. The required local oscillator frequency ranges from 587.8MHz to 618.8MHz.

The output of the VCO passes through an RF cascade buffer IC, which amplifies the low-level signal from the VCO whilst providing high reverse isolation to minimise any variations in VCO loading. The output feeds the receiver mixer.

4.3 TRANSMITTER RF/IF SECTIONS

The transmitter line up consists of an IF transceiver IC, up converter mixer, band pass filter, channel SAW filter, buffer IC, stepped attenuator and RF PAs stages. The stepped attenuator settings are controlled by software via a DAC chipset to achieve user configured RF power levels. A transmitter specific PLL synthesizer and local oscillator feeds the mixer to up convert the IF signal from the transceiver IC to RF. The RF signal is then amplified by the PA stages and fed to a LPF through the T/R switch and output to the SMA antenna connector.

4.3.1 Forward Signal Path

The transmitter employs a fixed frequency 'direct IF' from the backend transceiver IC, and with a single up conversion to the final RF. Following the mixer, a 9th order bandpass filter rejects most of the wide span spurious signals including the image and high order mixing products. Two switchable RF SAW filters based on the RF frequency give additional rejection to the close band spurious signals. The adjustment of transmitter gain is provided by a 4.0 - 36.0dB stepped attenuator programmable in 0.2dB steps. Power amplification follows consisting of devices biased to provide a class AB type amplifier for 4GFSK/2GFSK modulation in TDD mode. After the LPF, a directional coupler on the output provides a sample of the forward and reverse signal to two log type RF detectors respectively. The PA bias is controlled via DAC outputs that are programmed by a software control loop, which tracks the PA temperature and compensates the biased current over temperature. An ADC channel measures the driver and final PA temperature by a temperature sensor placed close to the PA. Another two ADC channels monitor the forward and reverse power by sampling the output of RF sensors. A software power control loop tracks the power and adjusts the step attenuator in real time to maintain a constant RF power level over varying conditions. Power reduction is introduced automatically by the power control loop to prevent the transmitter devices being damaged when the radio is meeting high VSWR or the PA temperature is measured higher than a predefined limit (typically 90 Deg C) in extreme conditions.

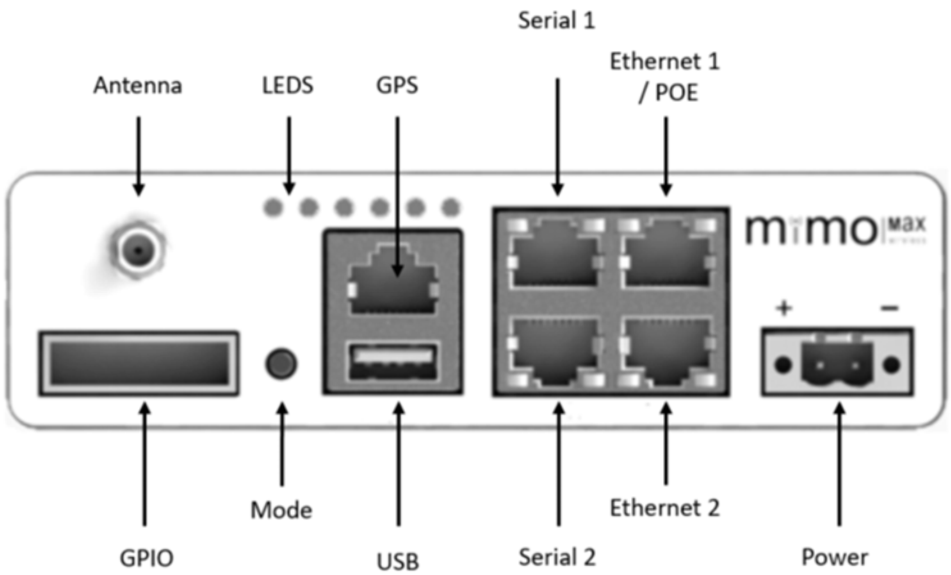
4.3.2 Transmitter Local Oscillator

The transmitter local oscillator is identical to the receiver LO. The required local oscillator frequency (i.e. transmit frequency minus TX IF) is programmed via a serial interface bus from the CPU on the digital board. The LO frequency can be set in 5 kHz increments (2.5KHz is optional).

The output of the VCO passes through an RF cascade buffer IC, which amplifies the low-level signal from the VCO whilst providing high reverse isolation to minimise any variations in the VCO loading. The output feeds the transmitter mixer.

The diagram below describes each of the different connectors and functionality.

Warning: Do not power up the radio unit without a load (attenuator or antenna) connected to antenna connection. Damage to the radio may occur otherwise.



4.4 Power Requirements

4.4.1 Voltage Range

The operating input voltage range of the power supply is 10.5 to 60 VDC. This means that the voltage must not rise above 60 VDC under idle conditions or fall below 10.5 VDC at full load.

4.4.2 Static Power Per Input

The typical power drawn when the transmitter is active is about 6W at 50% duty cycle or 8W at 100% duty cycle. The power drawn via the internal switching regulators is nearly independent of supply voltage, except for some additional converter loss at the top end of the voltage range, so that the input current to the RU is almost inversely proportional to supply voltage, e.g. approximately 2.4A at 10.5V or 0.5A at 56V This needs to be considered when the power source is remote from the RU and cable loss is a factor.

Input Source Voltage (S)	Average Current in Amperes = Iavg = 25/S	Circuit Breaker Current in Amperes = Imcb = 1.5*Iavg
10.5 Volts	0.57 Amps	0.85 Amps
24 Volts	0.25 Amps	0.37 Amps
48 Volts	0.13 Amps	0.18 Amps
56 Volts	0.1Amps	0.15 Amps

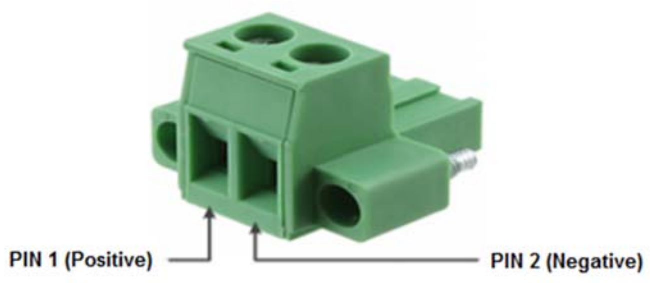
Current draw

4.4.3 Starting Current

As long as the power supply can supply the static power it should be able to provide sufficient current during start-up.

4.4.4 Supply Polarity (Isolated Power Supply)

Both the positive and negative connections of the power supply are isolated from the case and other circuitry. The power cable is wired to pin 1 (positive) and Pin 2 (negative) of each connector, which employs screw terminal contacts.



Power supply connector

4.4.5 Grounding

The radio unit case must be grounded through an external earth strap. Any of the unused mounting screw points can be used with an appropriate star washed. Generally, this is done to the local rack frame, which in turn should be part of a well-designed station grounding system. This internal grounding is designed for EMC and transient protection currents.

4.4.6 Supply Noise

Regardless of the EMC provisions in the equipment, power wiring from the DC source should not be shared with other equipment that may introduce excessive noise. Nor should the power cables to the unit be run alongside cables that connect to other equipment that may produce high current noise or transients, e.g. power relays.

4.4.7 Operating from AC Mains:

AC-DC ‘desktop’ power supplies are available from MiMOMax with the required power.

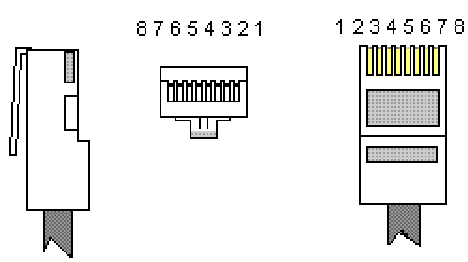
4.5 ETHERNET 1 AND 2

Two shielded RJ45 sockets provide the Ethernet connections to ethernet 1 and 2. Ethernet 1 has POE (Power Over Ethernet) support and is compatible with IEEE802.3AT. Shielded cable is not normally required. The Ethernet ports are both 10/100BASE-Tx ports, supporting full and half duplex, flow control, auto MDI-X and auto negotiation

4.6 SERIAL 1 AND 2

Two shielded RJ45 sockets provide serial port connection. These ports operate via a terminal server application.

The RS232 pin out is as per the EIA/TIA-561 standard and as per the MiMoMax Tornado Radio



4.6.1 RS232 pin out is as per the table below.

Signal Name	Pin number	Direction
Tx Data	6	In to radio
Rx Data	5	Out of radio
CTS	7	Out of Radio
RTS	8	In to Radio
Ground	4	n/a

4.6.2 RS485 full duplex pin out is as per the table below.

Signal Name	Pin number	Direction
Tx Data n	6	In to radio
Rx Data p	5	Out of radio
Rx Data p	7	Out of Radio
Tx Data p	8	In to Radio
Ground	4	n/a

4.6.3 RS485 half duplex pin out is as per the table below.

Signal Name	Pin number	Direction
Tx/Rx Data n	6	In/out of radio
Do not connect	5	Unused
Do not connect	7	Unused
Tx/Rx Data p	8	In/Out of Radio
Ground	4	n/a

4.7 GPIO/ALARM/REF

The GPIO alarm and reference in/out signals are available via a 10-pin connector on the front of the radio.

4.7.1 Configuration of the GPIO

Configuring of the GPIO should be performed using CCMS.

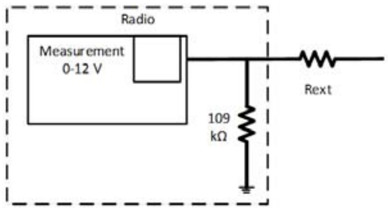
- The alarm provides both open and closed in alarm contacts and is isolated from the rest of the radio circuitry.
- The External reference input/output is an isolated differential pair.

4.7.2 GPIO as analog input:

- The GPIO signals are all referenced to the Radio ground. Their linear range is 0-12V, but they will survive up to 60V. An external series resister can be used to provide a higher linear range using the following formula.

Rext = (Vmax - 12)*109k/12

- Where Vmax is the maximum voltage that will be measured, 109k is the input impedance, and Rext is an external series resister between the voltage being measured and the radio's GPIO pin. Remember to round the resister value up to the nearest resistor value above the calculated value.
- Next use the GPIO input calibration process to calibrate the system through the external resistor. This process will be based on a known voltage before the resistor.

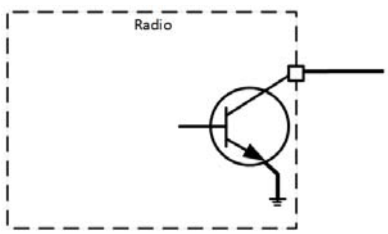


GPIO Input Circuit

It is recommended that the radio is calibrated on the bench before installation

4.7.3 GPIO as Digital Output:

- The GPIO pins provide an open collector output, which can be used to drive a relay or generate a level. The current can be up to 100 mA.



GPIO Output Circuit

4.7.4 GPIO Pin Out

Signal Name	Pin number
Ext Ref n	1
Ext Ref p	2
GPIO Ground (Radio Ground)	3
GPIO_4	4
GPIO_3	5
GPIO_2	6
GPIO_1	7
Open in Alarm	8
Alarm Comm	9
Closed in Alarm	10

4.8 USB

An A-type USB connector provides the connection to the USB host port. (software support in future).

4.9 GPS

Connector for GPS antenna. Supports GPS NMEA 0183 connectivity for auto discovery into the NMS system. Used for establishing the radios coordinates during radio commissioning.

4.10 LED BEHAVIOUR

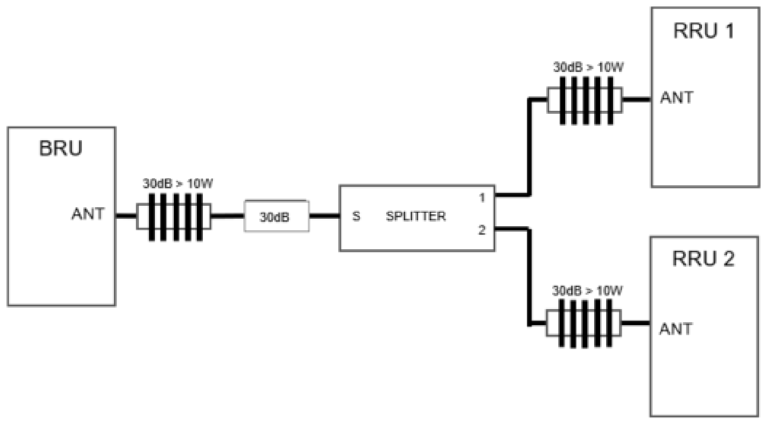
The LEDs have multi functionality and indicate

- Pwr – Indicates that unit has DC power connected and is powered on
- Lnk – (BRU-P) The link is always up
- Lnk – (RRU-P) Flashing indicates the radio is in auto scan / discovery mode and is searching for best Pyxis base radio
- Lnk – (RRU-P) Solid indicates the unit has acquired suitable Pyxis Base radio and is communicating
- Lnk – (RRU-P) Off indicates unit has lost communications with Base radio after 500 ms of no transactions to / from a Pyxis base radio.
- GPS – Flashing indicates GPS antenna connected and is searching for GPS Lock (In auto mode)
- GPS – Solid indicates either manual mode or GPS lock and co-ordinates sent to NMS in auto mode
- GPS – Off indicates no GPS connected in auto mode.
- S1 – Radio status and traffic activities.
- S1 – Flashing indicates unit is obtaining IP address in DHCP mode
- S1 – Solid indicates either Static IP or IP obtained in DHCP mode
- S2 – Reserved. Unused at the moment
- Alm – During boot up the LED is lit solid. Once boot up is complete, the LED will only be lit when the radio is in an Alarm state.

5 RADIO SETUP AND CONFIGURATION

The radio units can be interconnected for bench-based testing or configuration. Attenuators with the appropriate value and power handling must be used. The diagram below shows the interconnection of attenuators, cables and splitters for a standard bench test.

Note: If a MDL system with only one RRU is desired then the splitter and second RRU can be omitted. MiMOMax can supply a splitter that provides 4 ports and ~30dB attenuation.

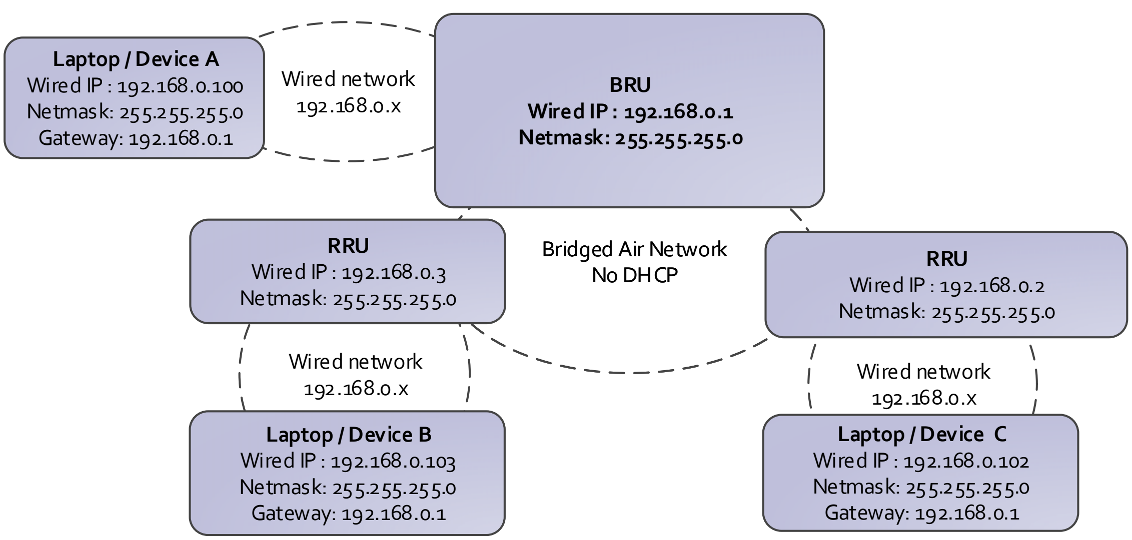


Recommended equipment:
3x high power attenuators (30 dB, >10 W)
1x low power attenuators (30dB)
1x splitters
Sufficient cables and adaptors to connect the above devices to the radio units

5.1 TESTING THE NETWORK SETUP

Once the RF setup has been completed the radio units can be powered up, networking on associated devices configured and the units logged into. Refer to the label located on the underside of the radio unit to identify the configured IP address and subnet mask. The diagram below shows an example of the network in Bridged mode. We generally recommend setting up MDL in Bridged mode because the network settings are simpler however it depends on your IP planning for the multipoint network.

First, we connect to each radio unit locally. To do this, configure the IP address, subnet mask and gateway of the connected device or laptop. It is crucial that the laptops/devices are on the same subnet as the Pyxis radios and also that their gateway is set to the Pyxis's IP address. This means you will need to reconfigure the IP information if moving the laptop between radio units.



Next confirm network connectivity by pinging each radio unit from the connected laptop. If this is not successful, use ipconfig to check your networking settings. Once we have network connectivity with the local radio unit, type the appropriate IP address into your web browser to access the unit.

```
C:\>ipconfig

Windows IP Configuration


Ethernet adapter Local Area Connection 9:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::c5cd:db78:b35d:eecc%35
   IPv4 Address. . . . . . . . . . . : 192.168.0.15
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . :
```

```
C:\>ping 192.168.0.1

Pinging 192.168.0.1 with 32 bytes of data:
Reply from 192.168.0.1: bytes=32 time=1ms TTL=64
Reply from 192.168.0.1: bytes=32 time=1ms TTL=64
Reply from 192.168.0.1: bytes=32 time=1ms TTL=64
Reply from 192.168.0.1: bytes=32 time=1ms TTL=64

Ping statistics for 192.168.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

Ipconfig on the left (In this case the gateway has not been set properly!) and on the right Pinging 192.168.0.1 (the BRU) from Laptop A

You are now ready to log in, configure, and monitor the system.

6 SYSTEM CONFIGURATION USING CCMS AND CLI

CCMS is web-based software that enables you to connect to a MiMOMax radio unit using a web browser such as Internet Explorer, Firefox or Chrome. No application other than a web browser needs to be installed on your PC or laptop. The radio unit serves up the CCMS web pages. For a full list of functions please refer to MiMOMax's CCMS Manual.

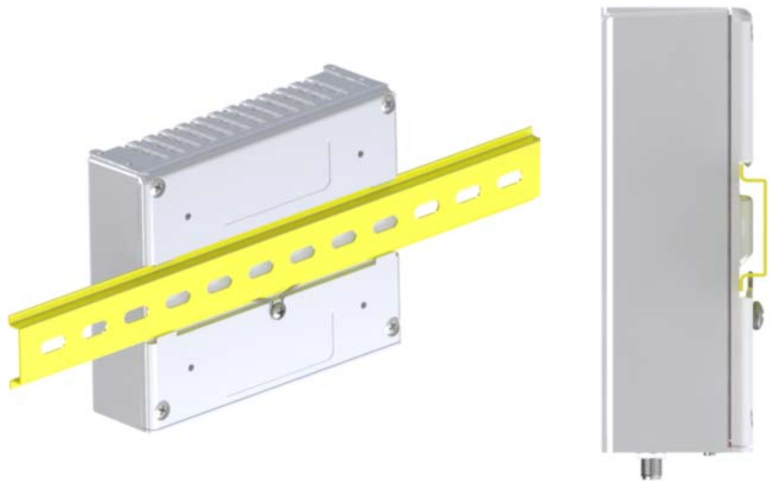
CLI is a command line interface used for configuring the radio over low bandwidth networks. For a full list of functions please refer to MiMOMax's Command Line Interface (CLI) Manual.

7 INSTALLATION

7.1 Mounting Solutions

Pyxis radios can be mounted in several different ways to meet the customers application. These include

7.1.1 Din rail mounting



Pyxis mounting on TS35 DIN Rail

7.1.2 Wall / surface mounting

Wall / Surface Mounting

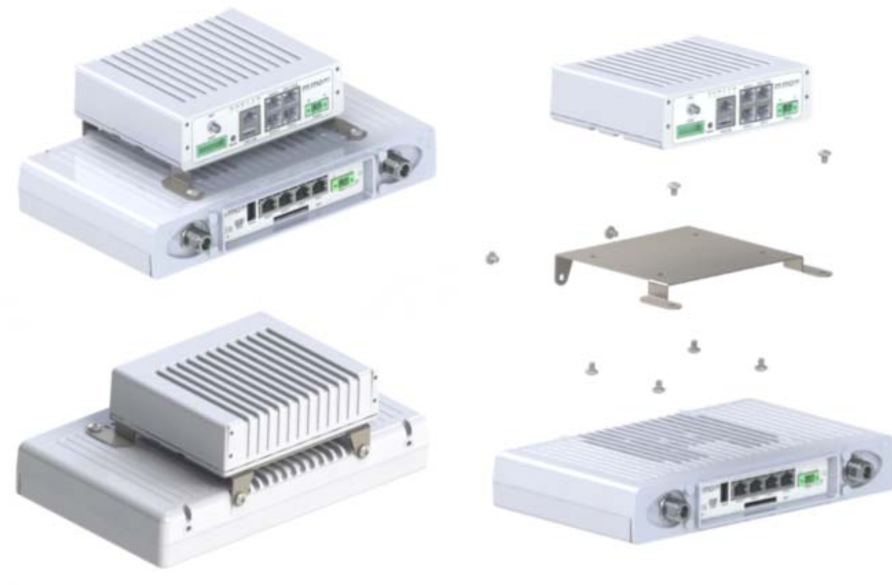
7.1.3 1U Rack mounting

1U Rack Mounting Option – 2 Pyxis configuration

7.1.4 1U Rack mounting with a Tornado radio

1U Rack Mounting Option – Pyxis + Tornado configuration

7.1.5 Tornado piggy back mounting



Tornado Piggyback Mounting Option

7.1.6 Mounting option Bill of Materials

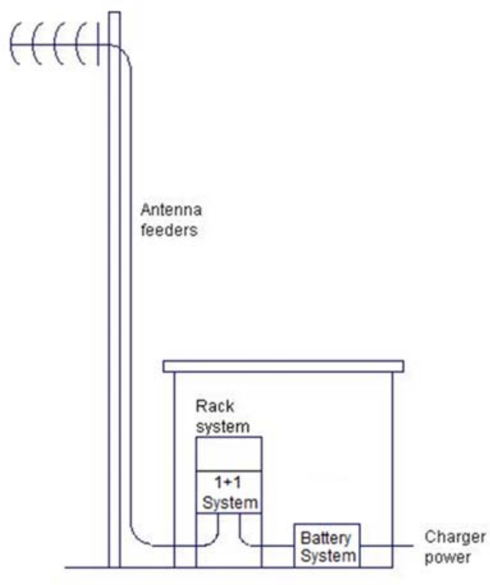
Description	MiMOMax Part Number
Din Rail mounting kit	ACC-MNT-DMP-01
Wall / Surface mount bracket	ACC-MNT-WMP-01
1U Mounting plate	ACC-MNT-RMM-001-0000
Tornado Piggyback mounting plate	ACC-MNT-PBP-01

7.2 INSTALLATION OF SOLUTION

A typical system installation for the Pyxis system is shown below which follows the same approach as when installing a single Tornado Radio solution. Regardless of the mounting configuration used, the appropriate site engineering must be undertaken. Site engineering must consider safety aspects such as grounding and lightening protection but also needs to take performance parameters such as antenna location, antenna separation and other RF sources. Please contact MiMOMax if more information in these areas is required.

Note: refer to section 7.2.1 for grounding and lightning protection considerations.

A comprehensive source of information and guidance on general site engineering issues has been published by ETSI: EG 200 053 v1.5.1, 2004/06 'Electromagnetic compatibility and Radio Spectrum Matters (ERM); Radio site engineering for radio equipment and systems'. It is highly recommended that this freely available ETSI document be studied in detail, in conjunction with this and the Pyxis Radio Unit manuals.



Typical pole and rack mounting options for the radio unit

7.2.1 Site Engineering

<u>For personal safety and equipment reliability reasons the following must be adhered to:</u>

7.2.1.1 **Power supply**

The equipment must be powered from a power supply complying with the requirements of IEC 60950-1 including compliance with sub clause 7.4 'Insulation between primary circuits and cable distribution systems'.

7.2.1.2 **Grounding**

On site ground networks must be created in accordance with ITU-T Recommendation K.27: Protection against Interference; Bonding Configuration and Earthing inside a telecommunication building.

7.2.1.3 **Equipment location**

It is recommended that the radio unit is installed in a dry, dust-free room.

7.2.1.4 **Equipment ventilation**

A thermal study should be carried out for each site to check and ensure that thermal conditions within the enclosures do not go beyond the radio units operating limit. If the temperature of the site is known to exceed the operating limits of the unit, then the enclosure must have an air conditioning, or a forced air system installed to stabilise these excursions.

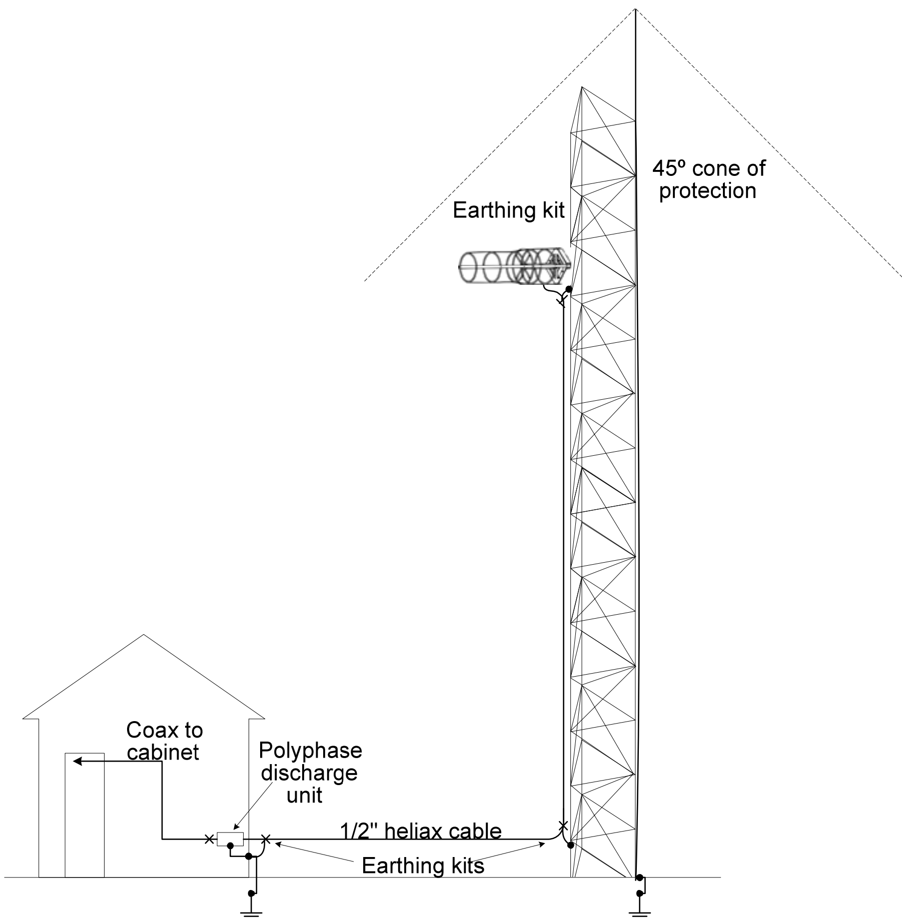
7.2.1.5 **Lightning protection**

Lightning protection is important to ensure the protection of the tower, antenna and the radio equipment hardware. The diagram below shows the point earthing concept recommended.

The technique recommended to protect the radio unit, antenna, feeder and tower uses earthing kits in strategic places. The key points are: adjacent to the feeder connector at the antenna, where the feeder leaves the base of the tower and where the feeder enters the building structure. If earthing kits supplies are limited or connection to an earth point is difficult, then order of importance of the earthing locations is as follows:

(a) For a top mounted antenna acting for lightning protection:
1. At antenna connection point.
2. At the tower base.
3. At the entry to the building.

(b) For a general mounting of antenna:
1. At the entry to the building.
2. At the tower base.
3. At the antenna connector.



Lightning Protection

A gas discharge unit is required to release high voltage charges developed between the cable inner and outer. There are two types available, a transmitting and a receiving variant. The transmitting variant is the larger. It is very important that these variants are not confused because the lower discharge potential rating for the receiver unit will be triggered by transmitting voltages. This will cause a high VSWR and poor performance.

8 SPECIFICATIONS

8.1 ELECTRICAL SPECIFICATION

Parameter	***Conditions***	***Min***	***Typical***	***Max***	***Units***
Power supply					
Input voltage	Normal operation	10.5		60	V
Total Power Consumption	Idle, Tx off		4	5	W
	Tx Active		8	9	W
Ethernet					
Tx Peak Differential voltage	100Base-Tx, 100 Ohm termination	0.95	1.00	1.05	V
Tx voltage symmetry	100Base-Tx, 100 Ohm termination	98	100	102	%
Tx Peak Differential voltage	10Base-T, 100 Ohm termination	1.54	1.75	1.96	V
Serial					
Output Voltage swing	Loaded with 3kOhms to ground	+/- 5	+/- 5.4		V
Output short circuit current		-60		+60	mA
Input Voltage		-18		+18	V
Input Low Threshold	Temperature ambient = +25	0.6	1.2		V
Input High Threshold	Temperature ambient = +25		1.5	2.0	V
GPIO					
Input voltage	Input	-0.3		60	V
Current Sinking Capability	Output driving low			100	mA
Input Impedance			109		kOhms
Alarm					
Input current (max)				300	mA
Switching voltage (max)				33	VDC
Reference input					
Level		-5		+20	dBm
Frequency			10		MHz
Reference output					
Level			0		dBm
Parameter	***Conditions***	***Min***	***Typical***	***Max***	***Units***
Frequency			10		MHz

8.2 PHYSICAL SPECIFICATION

Parameter	Value	Units
Pyxis Radio	0.77	Kg
Minimum Operating Temperature	-40	C
Maximum Operating Temperature	+65	C
Maximum Operating Humidity	95% Non-Condensing	%RH
Minimum Storage Temperature	-40	C
Maximum Storage Temperature	+80	C
Maximum Storage Humidity	95% Non-Condensing	%RH
Transportation - Packaged Weight	0.82	Kg
Transportation – Package Dimensions	Height = 51 Width = 266 Depth = 155	mm

8.4 COMPLIANCES

RF Bands	400-500MHz	757-758 & 787-788 MHz
Radio Performance	ACMA Spectrum Impact	FCC 47CFR part 27
	FCC 47CFR part 90	
	IC Canada	
	ETSI EN 300-113	
EMC	AS/NZS/CISPR22	FCC 47CFR part 15
	EN301 489	
	FCC 47CFR part 15	
Safety	IEC 60950-1: 2005, Am 1: 2009	IEC 60950-1: 2005, Am 1:2009

8.5 MECHANICAL DIMENSIONS