



IP-based
Broadband Wireless Access (BWA) System

605-0000-716 Rev 02

MicroMAX

System OverView

User's Guide



Connecting the World

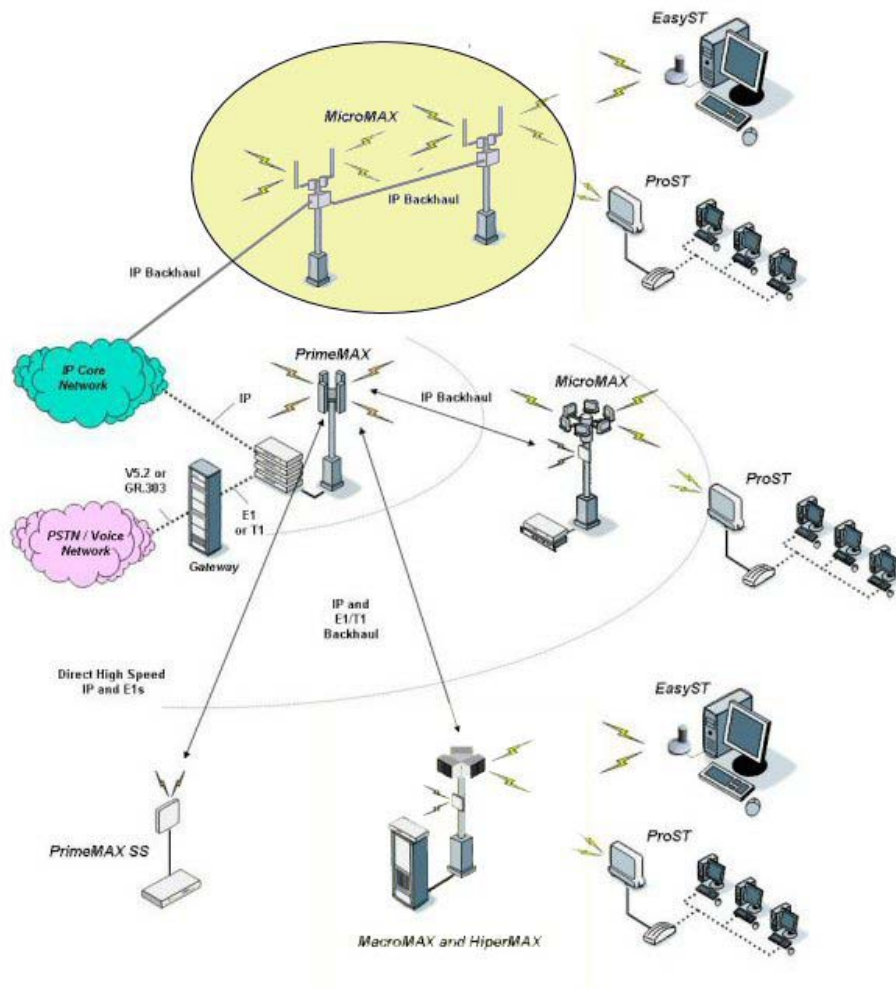
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SYSTEM OVERVIEW

MicroMAX-SDR is a highly upgradeable Micro-cell base station, with a pole/roof mounted radio system and antennae. It forms part of the AS.MAX portfolio of WiMAX network infrastructure equipment. The diagram below shows MicroMAX-SDR deployed as part of an AS.MAX network. It is compatible with the Airspan EasyST and ProST subscriber terminals and other manufacturers CPE that is fully WiMAX compliant.



MicroMAX-SDR Base Station Operation

The MicroMAX-SDR is designed to be located on utility poles or roof tops providing point to multi-point WiMAX coverage from an all outdoor base station over micro-cellular ranges to various CPE types.

The MicroMAX-SDR product is a highly upgradeable micro-Base station, utilizing a software defined radio (SDR) to enable complete upgradeability of the MAC and PHY. MicroMAX-SDR is designed for rooftop or pole mounted deployment. The use of separate antennas enables transmit and receive gain diversity techniques to be utilized, which increases link budget capability. The MicroMAX-SDR supports both 802.16-2004 for fixed and nomadic applications, as well as providing a platform for future software upgrades to support WiMAX 802.16e based profiles for portable and mobile applications.

A MicroMAX-SDR Base Station consists of the following components:

- 1x Software Defined Radio (SDR) (including SDR boards plus PSU for SDR + SCRTs)
- 2x Single Channel RF Transceiver (SCRT)
- 2x Antenna (customer supplied)

MicroMAX-SDR Architecture Overview

The MicroMAX-SDR Base station consists of a Software Defined Radio (SDR) which includes the baseband and optional GPS module within a single environmentally protected enclosure. The SDR is connected to two Single Channel RF Transceivers (SCRF).

SDR Baseband Sub-system:

The baseband sub-system, used within the MicroMAX-SDR Base station, uses the same technology as the baseband blade fitted within the HiperMAX Base station.

The MicroMAX-SDR modem's architecture is based on configurable elements, allowing implementation of a software defined radio, which ensures changes in specification can be adopted without the need to change the basic hardware construction. Using the approach based on configurable elements, the MicroMAX-SDR Base station can be upgraded from the 802.16-2004 WiMAX standard to the proposed 802.16e WiMAX standard through the simple process of upgrading the system software. The PHY processing is implemented using picoChip technology, whereas the MAC is implemented within two PowerPC processors.

The GPS receiver is a factory build option which is part of the SDR and used to synchronise Tx & Rx timing between base stations. This is not built into standard SDRs.

Single Channel Radio Transceiver (SCRT) RF Subsystem Module:

The RF subsystem contains two RF, LNA and PA modules for transmit and receive, that provide either two individually distinguishable sectors or a single sector with diversity. The RF subsystem connects directly to the baseband module. The SCRT subsystem connects to the SDR using fibre optic Cable.

External Antennas:

Any suitable external antenna can be used with the MicroMAX-SDR Base station. These include omni, as well as directional antennas. The antennas can also be vertically or horizontally polarized.

MicroMAX-SDR Antenna Options

- Base Station Antenna Options:
 - 2x 60 degree Sector
 - 2x 90 degree Sector
 - 2x 120 degree Sector
 - 2x 180 degree Sector
 - 2x Omni-Directional (360 deg)
- Vertically polarised for all
- Horizontally polarised available for some sector angles – not recommended for a network consisting of indoor CPE.

TECHNICAL OVERVIEW

Employed Multi-path and Delay-Spread Mitigation Techniques

MicroMAX-SDR utilizes the cyclic prefix duration included in 802.16 to cater for delay spread and effects of multi-path. Guard ratios of between $\frac{1}{4}$ and $\frac{1}{32}$ are programmable resulting in peak delay spread immunity between 2us and 16us respectively for a 3.5MHz channel bandwidth.

802.16e standard will introduce the OFDMA access method. This allows the system to restrict certain tones within the OFDM waveform to any individual subscriber unit. By avoiding null traffic channels due to deep fading and/or narrowband interference, the system provides optimum performance in a multi-path environment. OFDMA enjoys the finest granularity and better uplink power efficiency than traditional OFDM/TDMA systems. Radio resource allocation is implemented at the base station and users are notified of the channel assignment through a multiple access protocol. MicroMAX-SDR is upgradeable to 802.16e via a software upgrade.

Benefits of using Orthogonal Frequency Division Multiple Access

- In the uplink each subscriber is assigned 1 to 59 sub-channels. when assigned sub-channels, a subscriber concentrates its power on these sub-channels.
- It solves the Multipath problem and reduces Multipath Interference
- It has high Spectral efficiency
- It supports smart antenna technology: Smart antennas provide greater capacity and performance benefits than standard antennas because they can be used to customize and fine-tune antenna coverage patterns that match the traffic conditions in a wireless network or that are better suited for complex radio frequency (RF) environments. Furthermore, smart antennas provide maximum flexibility by enabling wireless network operators to change antenna patterns to adjust to the changing traffic or RF conditions in the network.
- RX/TX antenna diversity
- Space Time Coding (STC)
- It is an efficient modulation
- QPSK, QAM16, QAM64 per sub carrier
- FEC rates ranging from $\frac{1}{2}$ to $\frac{3}{4}$
- Guard intervals of $\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{1}{4}$
- Supports adaptive modulation on a per subchannel basis
- The efficient use of pilots minimizes requirement for preambles for channel estimation
- External, narrow band interference is rejected through frequency domain processing
- External, burst interference is rejected by virtue of the OFDMA symbol length and the per sub-channel interleaving
- Inter-cell interference is mitigated by use different sub-carriers in sub-channels

Spectral Efficiency

The network spectral efficiencies for MicroMAX-SDR, MicroMAX-SDR and HiperMAX assuming 3.5MHz FDD channels are as follows:

Mod/FEC	Gross Throughput (Mb/s)		Occupied Bandwidth (Mhz)	Spectral Efficiency (b/s/Hz) per RF Channel
	Downlink	Uplink		
64QAM3/4	13.1	13.1	3.5	3.7
64QAM1/2	11.5	11.6	3.5	3.3
16QAM3/4	8.7	8.7	3.5	2.5
16QAM1/2	5.8	5.8	3.5	1.7
QPSK3/4	4.4	4.4	3.5	1.3
QPSK1/2	2.9	2.9	3.5	0.8
BPSK1/2	1.4	1.4	3.5	0.4

Note: Figures above are based on Gross throughput. Maximum achievable net throughput is in the region of 85% of gross downlink throughput and 75% of gross uplink throughput which is required to accommodate overhead including Pre-amble, DL&UL Maps, DLFP and Mid-amble.

Adaptive Modulation

Adaptive modulation techniques, for maximizing system throughput by monitoring link quality and selecting the highest usable adaptive burst profile, are used throughout the MicroMAX-SDR product range. Within each burst, data transmitted over the air is padded with redundant information to make it more resistant to errors introduced by interference. The coding rate is the ratio of user-data to the total data transmitted (which includes redundant error correction data). Protocol features allow for adaptive modulation to be employed in both downlink and uplink. Modulations ranging BPSK 1/2 to 64QAM 3/4 may be employed.

Burst Profiling

All MicroMAX-SDR Base Stations, operating using FDD or TDD in the downlink and uplink support burst profiles which are adaptive on a per terminal basis. Burst profiles are used to define modulation and FEC levels using the DCD and UCD messaging schemes and are invoked through downlink and uplink MAP messaging. RF link control functions within the Base station and the ST continuously monitor receiver SNR and adapt modulation accordingly.

STC

Space Time Coding is a method of transmit diversity using two antennas, is used within the MicroMAX-SDR product. This mode may be used to improve link robustness.

MRC

Maximal-ratio combining is a form of diversity combiner in which (a) the signals from each channel are added together, (b) the gain of each channel is adjusted to ensure each channel is proportional to the rms signal level in each channel and inversely proportional to the mean square noise level in that channel, and (c) the same proportionality constant is used for all channels.

Software Defined Radio using picoChip

MicroMAX-SDR Base stations are fully upgradeable and future-proof due to the use of picoChip technology. PicoChip provides high performance processing arrays which have been optimized for use within the wireless industry. This enables the complete radio and digital signal processing functions to be soft-defined within devices which have replaced the need to incorporate inflexible FPGA and ASIC silicon. PicoChip devices are fully reprogrammable to allow

the 802.16 PHY to be completely upgraded, through the use of a simple software download, as the WiMAX standard evolves. Using picoChip, the ASMAX MicroMAX-SDR Base stations will always remain compliant with this emerging standard.

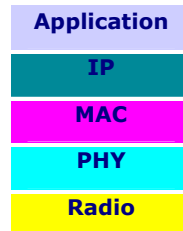
Key benefits of using picoChip within the MicroMAX-SDR Base stations:

- ▶ Software defined: Fully Scalable & Future Proof
- ▶ Full support for 802.16-2004 (256 OFDM PHY)
- ▶ Upgradeable to 802.16e to support hand held devices
- ▶ Support for 1X scalable PHY & OFDMA
- ▶ FDD or TDD; 3.5MHz / 7MHz / 10MHz
- ▶ Software defined RF (industry standard OBSAI RP3-01 interface)
- ▶ Advanced feature options: Smart antennas & diversity, SDMA

TRANSPORT OVERVIEW

PHY and MAC Layers

The IEEE 802.16 standard covers both the Media Access Control (MAC) and the physical (PHY) layers. The RF, PHY, and MAC layers control Link capacity and the MAC, IP, and Application Layers control system capacity.



AS.MAX product is packet based and supports any packets, including PPPoE, IPX, NetBIOS as well as IP and is designed for very high bit rates (up to 268 Mbps each way) of the broadband physical layer. The MAC layer organises the use of radio resources and allows terminals to be dynamically assigned uplink and downlink burst profiles according to their link conditions. This allows a trade-off between capacity and robustness in real-time while maintaining appropriate link availability. It performs link adaptation and Automatic Repeat Request (ARQ) functions to maintain target Bit Error Rates (BER) while maximizing the data throughput. The MAC layer also handles network entry for ST's that enter and leave the network, and it performs standard Protocol Data Unit (PDU) creation tasks. Finally, the MAC layer provides a convergence sub layer that supports packet-based network layers.

The 802.16 MAC uses a variable length Protocol Data Unit (PDU) along with a number of other concepts that greatly increase the efficiency of the standard. Multiple MAC PDUs may be concatenated into a single burst to save PHY overhead. Additionally, multiple Service Data Units (SDU) for the same service may be concatenated into a single MAC PDU, saving on MAC header overhead. Fragmentation allows very large SDUs to be sent across frame boundaries to guarantee the QoS of competing services. And, payload header suppression can be used to reduce the overhead caused by the redundant portions of SDU headers.

The MAC also provides Quality of Service (QoS) differentiation, using a self-correcting bandwidth request/grant scheme to eliminate the overhead and delay of acknowledgements, while simultaneously allowing better QoS handling than traditional acknowledged schemes.

Terminals have a variety of options available to them for requesting bandwidth depending upon the QoS and traffic parameters of their services. They can be polled individually or in groups. They can steal bandwidth already allocated to make requests for more. They can signal the need to be polled, and they can piggyback requests for bandwidth.

SECURITY OVERVIEW

Security

The AS.MAX security methods are derived from those defined by IEEE 802.16-2004. DES in cipher block chaining (CBC) mode and AES in counter CBC-MAC (CCM) mode (in future release) are used to encrypt the payload of MPDUs on transport and secondary management connections. The Privacy Key Management (PKM) protocol is used for certificate-based authorization of the SS and to perform secured transfer of keys between the BS and the SS. Since the encipherment process takes place over the payload of the MPDU, all the details of fragmentation, packing, grant requests and ARQ are hidden.

The PKM protocol is based on Public Key Infrastructure (PKI), which uses digital certificates and RSA public key methods to authenticate an SS to a BS. The SS provides its X.509 certificate to the BS, thus revealing its identity and public key to the BS. The BS returns an authorization key (AK) to the SS, encrypted by the SS public key using RSA algorithm. The SS can decrypt the AK using its private key. The authorization key is then used to derive key encryption key (KEK). The SS and BS, since they both know the AK can derive the same KEK.

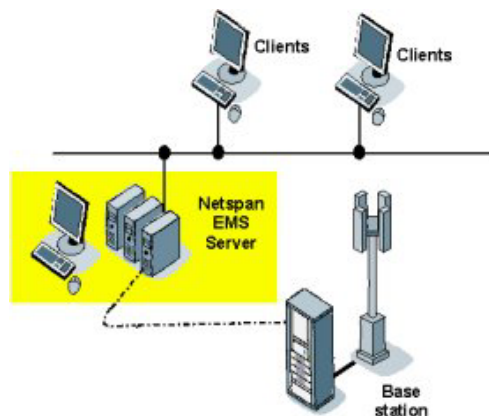
To transfer a traffic encryption key (TEK) from the BS to the SS, the TEK is encrypted using the KEK with 3-DES in EDE mode algorithm (when data is DES encrypted) or with AES in ECB mode algorithm (when data is AES encrypted).

SYSTEM MANAGEMENT

Management Options

The AS.MAX WiMAX compliant platform supports three management options:

- Local web based client management of individual system components
 - Used to configure small systems and networks
- Management via third party SNMP management tool
 - Uses standard WiMAX MIB
- Airspan's Netspan network management server
 - Already running numerous BWA networks worldwide
 - Based on Microsoft.net platform
 - Distributed server architecture support
 - Full system configuration, operation and maintenance via standard web client
 - SNMP API support
 - Uses standard WiMAX MIB for all configuration and O&M activities

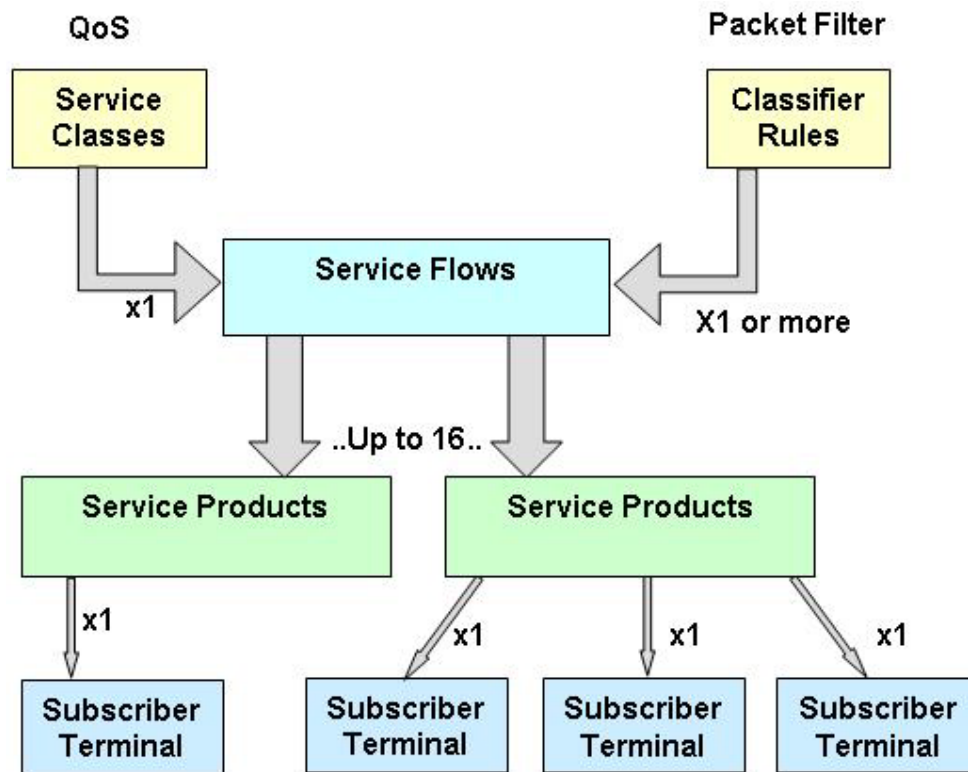


Server: Supports an SQL database for configuration & alarm storage with an option for 3rd party access direct to database via SNMP.

Client: Accessed via Internet Explorer or other compatible browser software and connects to the server via IP.

Service Provisioning within Netspan

As shown in the diagram below, Service Flows are assigned to a Subscriber Terminal (ST) by defining a 'Service Product'. Each Subscriber Terminal has a single Service Product to define the capacity and capability associated with the service delivered to each customer. Within the IEEE 802.16-2004 standard a Service Product can define up to sixteen Service Flows which provisions the types of service (web browsing, VoIP, FTP, etc) delivered via each Subscriber Terminal. Detailed QoS specification is defined within the Service Class and the filters which tag a level of QoS to a particular flag or packet type is defined within the Classifier Rules. A single QoS rule defined within the Service Class can be associated with one or more Classifier Rule(s).



QOS OVERVIEW

Applications of QoS within AS.MAX Networks

The AS.MAX platform provides a broadband connection which will support many and varied applications, some of which require specific performance guarantees to ensure the network sustains the subscriber's expectations regarding the viability and usability of the service. Such applications include:

- ▣ Voice telephony
- ▣ Video telephony
- ▣ Video streaming
- ▣ On-line gaming

To ensure a broadband network can credibly provide these services a viable quality of service policy needs to be implemented within the network. The AS.MAX network is fully compliant with the QoS requirements identified within the IEEE 802.16-2004 standard. Taking a voice telephony service as an example, the QoS facility implemented within the AS.MAX product range ensures the architecture can provide a subjective and measured quality in the control plane and the user plane that is comparable with traditional PSTNs based on analogue access and TDM-based digital exchanges. Specifically, QoS mechanisms built into the AS.MAX platform ensure the following characteristics, associated with a voice service delivered over a PSTN, are maintained:

- ▣ Call progress delays are comparable with those in the PSTN, including (but not limited to):
 - ▣ Off-hook to application of dial tone.
 - ▣ First dialed digit to removal of dial tone.
 - ▣ Completion of dialing to alert at the called end.
 - ▣ Completion of dialing to application of ringing tone at the calling end.
 - ▣ Completion of dialing to application of busy tone at the calling end.
- ▣ The probability of blocking call attempts for reasons other than exhaustion of resources is low.
- ▣ Once a call has been accepted, quality is comparable with the PSTN, including (but not limited to):
 - ▣ Probability of call cut-off.
 - ▣ Absolute voice-path latency.
 - ▣ Variance (jitter) in voice-path latency.
 - ▣ Non-linear distortion and/or signal-to-noise ratio.
 - ▣ Subjective voice quality measures such as Mean Opinion Score (MOS).
 - ▣ Compatibility with voice-band modems and facsimile machines.
 - ▣ Rate of impulse noise.
 - ▣ Probability of audio drop outs.
- ▣ Once a call has been accepted, subjective and measured quality is maintained regardless of:
 - ▣ Loading of the telephony service.
 - ▣ Overall loading of the AS.MAX network.

QoS Utilisation Overview

A packet scheduling algorithm is incorporated within the AS.MAX network which will support MIR, CIR and packet prioritization functionality, as well the specification of overall packet latency.

SINGLE CHANNEL RADIO TRANSCEIVER (SCRT)

Physical

Base Station SCRT (excl bracket): 340 x 270 x 140mm

Weight: 7.5kg maximum

Interfaces

SCRT Fibre Interface:

Weatherproof Fibre Optic Proprietary Connection Fibre interface is dependant upon SFP fitted (factory fit). Standard SFPs support 768MB/s fibre connections.

SCRT Power Interface:

Weatherproof Proprietary Connection compatible with connector supplied as part of Airspan MicroMAX-SDR Installation Kit

RF Port:

Connector: N-Type Female

Impedance: 50ohms

Minimum In-band Return Loss:15dB

SOFTWARE DEFINED RADIO (SDR)



Physical

Base Station SDR: 355 x 430 x 165mm

Weight: 25kg maximum

Interfaces

Network Ethernet Interface:

IEEE 802.3 10bT/100bT auto switching RJ45 connections with weatherproof proprietary seal. **Note:** There is no physically separate Network Management port. Network Management Traffic can be separated using suitable VLAN tagging.

SDR Fibre Interface:

Weatherproof Fibre Optic Proprietary Connection Fibre interface is dependant upon SFP fitted (factory fit). Standard SFPs support 768MB/s fibre connections.

SDR Power out Interface:

Weatherproof Proprietary Connection compatible with connector supplied as part of Airspan MicroMAX-SDR Installation Kit

GPS Antenna:

GPS synchronisation is a factory build option for the SDR. Standard SDRs do not include the GPS option.

Connector: N-Type Female

Impedance: 50 ohms

AC Mains Power Input:

1m flying mains lead provided for connection to external junction box. 85V to 265V AC
47-63Hz Single Phase

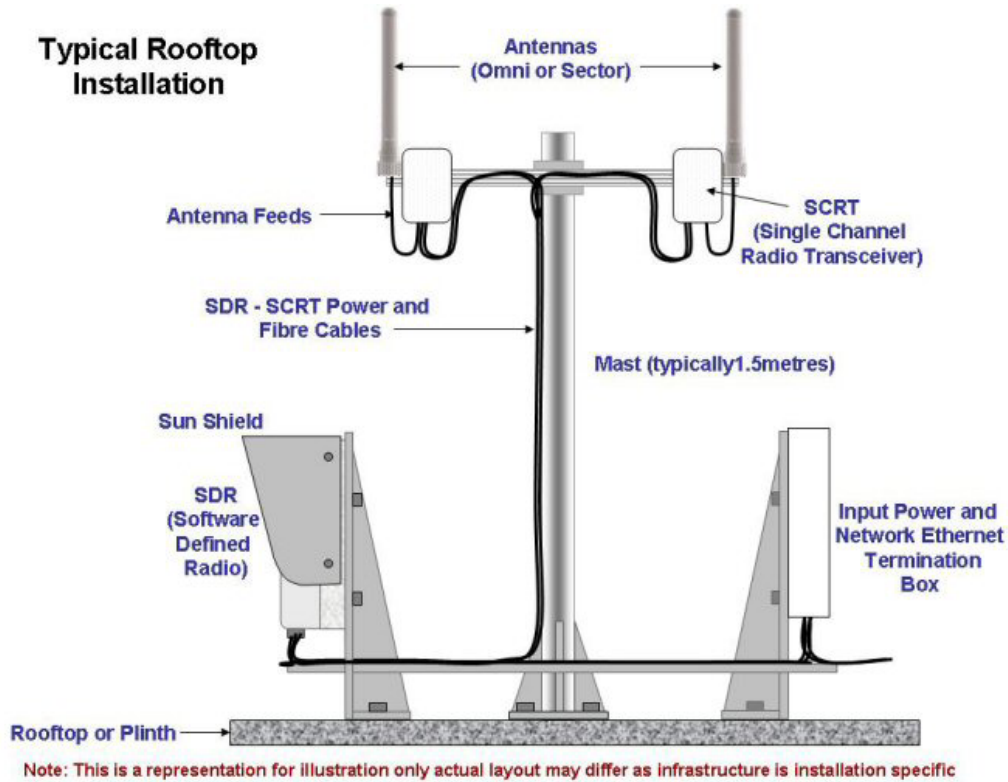
3 conductors as follows:

Connection	ALL COUNTRIES EXCEPT JAPAN	JAPAN
Earth (Ground)	Green/Yellow	RED:
Neutral (Cold)	Blue	WHITE:
Live (Hot)	Brown	BLACK:

Power Consumption (1xSDR + 2x SCRT): 220 Watts maximum

SYSTEM INSTALLATION

Typical Layout



MicroMAX-SDR uses two physically separate antennas to provide diversity on uplink and downlink:

Receive: Supports two path Maximum Ratio Combining (MRC)

Transmit: Transmit signals are delayed by a constant timing offset for diversity.

To optimise diversity performance, it is recommended that antennas are separated on the azimuth plane by between 10 and 20 wavelengths. At 4.9GHz, this equates to a separation of between 610 and 1220mm.

Note: Design and provision of the infrastructure is the responsibility of the Network Provider.

Installing the MicroMAX-SDR Enclosure

Tools Required

Tool	
1* Large Crosshead Screw driver	Phillips # 3 or Pozidrive # 3

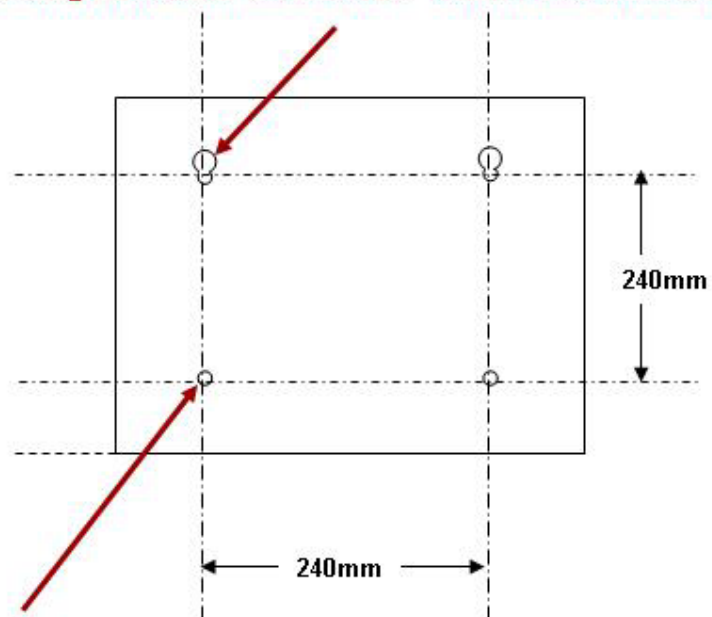
Parts Required

SDR Installation Kit per SDR consisting of:		
4* M8 Screws and Washers		
4* M8 Standoff Fittings		

MicroMAX-SDR Mounting Plate

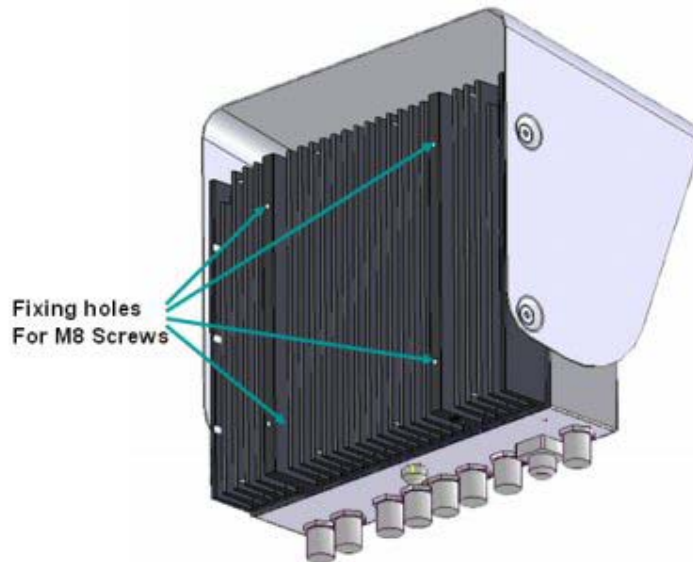
The SDR enclosure is fitted on to the Mounting Plate (Not provided by Airspan). The mounting should be drilled as shown below.

Mounting Hole 8mm Clearance + 16mm Head Clearance

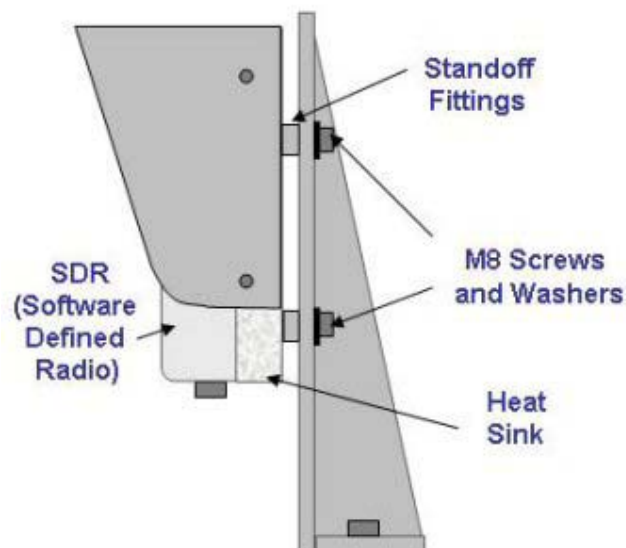


Mounting Hole 8mm Clearance

Mounting the MicroMAX-SDR



1. Screw the four standoff fittings into the 8mm mounting holes on the heat sink of the SDR enclosure.
2. Loosely place two of the M8 screws and washers into the two standoff fittings at the top of the SDR enclosure.
3. Lift the enclosure and place the screws through the head clearance holes and lower the unit so that the top mounting holes retain the unit. **Note:** This unit weighs 25kg take care when lifting.
4. Screw the bottom two the M8 screws and washers into the two standoff fittings at the bottom of the SDR enclosure.
5. Tighten all fixing screws.



Mounting the SCRT

SDR CONNECTIONS

Power Input

85V to 265V AC 47-63Hz Single Phase. The power input is via a plug and a 1m lead. The three conductors are as follows:

Connection	ALL COUNTRIES EXCEPT JAPAN	JAPAN
Earth (Ground)	Green/Yellow	RED:
Neutral (Cold)	Blue	WHITE:
Live (Hot)	Brown	BLACK:

Power Output

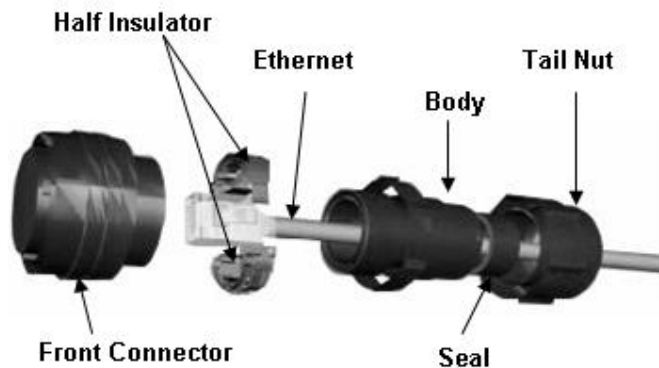
Each SCRT is provided with a 3 metre 48 volt power cable terminated with a male connector at one end and a female connector at the other. The male connector attaches to the SDR and the female connector attaches to the SCRT.

Optic Interface

Each SCRT is provided with a 3 metre optical fibre cable, ready terminated with optical connectors. Unscrew the protective dust cap and screw the fibre optic cable in place.

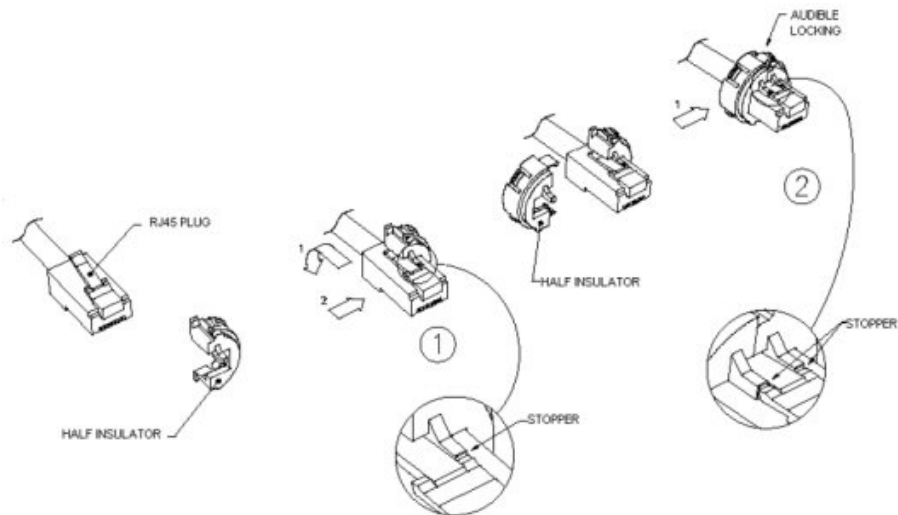
Ethernet

The Ethernet cable is connected to the SDR using a standard RJ45 connector protected by a harsh environment protective casing.



Assembly of Connector

1. Terminate the Ethernet cable with an RJ45 connector plug.
2. Pass the RJ45 plug through the tail nut, seal and body of the environmental connector.
3. Place the half insulators around the RJ45 connector plug as shown below .
 - a) Push down the cordset latch on the RJ45 connector
 - b) Place one of half of the insulators onto the RJ45
 - c) Place the second half of the insulator to meet the first half. Push firmly together until an audible click indicates that they are locked.



4. Feed back the cable so that the retainers fit onto the body of the environmental connector.
5. Tighten the tail nut on to the body forcing the seal to compress around the cable.



6. Screw the front connector onto the body of the environmental connector.



7. Push the assembled connector on to the Ethernet socket of the SDR.

SCRT CONNECTIONS

Power Input

Each SCRT is provided with a 3 metre 48 volt power cable terminated with a male connector at one end and a female connector at the other. The female connector attaches to the SCRT and the male connector attaches to the SDR .

Optic Interface

Each SCRT is provided with a 3 metre optical fibre cable, ready terminated with optical connectors. Unscrew the protective dust cap and screw the fibre optic cable in place.

GENERAL

WARNINGS AND CAUTIONS

1. DISCLAIMER

Every effort has been made to ensure the accuracy of the material provided herein; however, Airspan Networks Inc. assumes no responsibility regarding the use of the material. Additionally, Airspan Networks Inc. makes no representations or warranties, either expressed or implied, regarding the contents of this product. Airspan Networks Inc. shall not be liable for any misuse regarding this product.

1.1 Safety Warnings

1. Read this User Manual and follow all operating and safety instructions.
2. Keep all product information for future reference.
3. This product is supplied with a grounding power plug. Do not defeat this important safety feature.
4. Always replace the fuse with the correct type and current rating.
5. Position the power cord to avoid possible damage; do not overload wall outlets.
6. Do not place this product on or near a direct heat source, and avoid placing objects on the terminal.
7. Do not operate this device near water or in a wet location.
8. Use only a damp cloth for cleaning. Do not use liquid or aerosol cleaners. Disconnect the power before cleaning.
9. Protect the terminal by disconnecting the power if not used for long periods.
10. Mount the terminal in a Telco rack on a stable horizontal surface.
11. The radio antenna units must not be located near power lines or other electrical power circuits.
12. The radio transceiver must be properly grounded to protect against power surges and accumulated static electricity. It is the user's responsibility to install this device in accordance with the local electrical codes: correct installation procedures for grounding of the transceiver unit, mast, lead-in wire and discharge unit, location of discharge unit, size of grounding conductors and connection requirements for grounding electrodes.
13. Installation of the transceiver and antenna must be contracted to a professional installer.
14. Disconnect Device. The socket outlet shall be installed near the equipment , easily accessible and will act as the disconnect for the MacroMax.
15. When installed in the final configuration, the product must comply with the applicable Safety Standards and regulatory requirements of the country in which it is installed. If necessary, consult with the appropriate regulatory agencies and inspection authorities to ensure compliance.

1.2 Important Warning Symbols

The following symbols may be encountered during installation or troubleshooting. These warning symbols mean danger. Bodily injury may result if you are not aware of the safety hazards involved in working with electrical equipment and radio transmitters. Familiarize yourself with standard safety practices before continuing.



Electro-Magnetic Radiation



High Voltage

1.3 Important Service Information

1. Refer all repairs to qualified service personnel. Do not remove the covers or modify any part of this device, as this will void the warranty.
2. Disconnect the power to this product and return it for service if the following conditions apply:
 - a. The terminal does not function after following the operating instructions outlined in this manual.
 - b. Liquid has been spilled, a foreign object is inside, or the terminal has been exposed to rain.
 - c. The product has been dropped or the housing is damaged.
3. Locate the serial number of the terminal, antenna, and transceiver and record these on your registration card for future reference. Use the space below to affix serial number stickers. Also record the MAC address, located on the back of the terminal.

1.4 CAUTION

Any modifications to this device not expressly authorised by the manufacturer could void the user's authority to operate this device.

Responsible party for compliance is:

David Mann, Airspan Networks Inc., Cambridge House, Oxford Rd, Uxbridge, Middlesex, England, UB8 1UN. Telephone (44) 1 895 467450.

1.5 Lightning Protection

WARNING: The following notes are general recommendations for the system. The wireless equipment should be installed by a qualified professional installer and must follow local and national codes for electrical grounding and safety. Failure to meet safety requirements and/or use of non-standard practices and procedures could result in personal injury and damage to equipment. A direct lightning strike may cause serious damage even if these guidelines are followed.

All outdoor wireless equipment is susceptible to lightning damage from a direct hit or induced current from a near strike. Lightning protection and grounding practices in local and national electrical codes serve to minimize equipment damage, service outages, and serious injury. Reasons for lightning damage are summarized as:

- Poorly grounded tower/antenna sites that can conduct high lightning strike energy into equipment.
- Lack of properly installed lightning protection equipment that can cause equipment failures from lightning induced currents.

A lightning protection system provides a means by which the energy may enter earth without passing through and damaging parts of a structure. A lightning protection system does not prevent lightning from striking; it provides a means for controlling it and preventing damage by providing a low resistance path for the discharge of energy to travel safely to ground. Improperly grounded connections are also a source of noise that can cause sensitive equipment to malfunction.

A good tower grounding system disperses most of the surge energy from a tower strike away from the building and equipment. The remaining energy on the RF cable shield and center conductor can be directed safely to ground by using a lightning arrestor in series with the RF cable.

To limit the equipment damage due to a lightning strike, the following practices are recommended for the wireless system:

- Provide direct grounding from the antenna mounting bracket, the radio and antenna and the lightning arrestors to the same ground point at the base of the tower or a ground bus on the building. Use the grounding screws on the antenna bracket and the radio and antenna for terminating the ground wires.

- Install one RF lightning protector between the radio and antenna in series with the RF cable.
- A lightning arrestor in series with the RF cable at the point of entry to the building.
- Install a lightning arrestor in series with the IF cable at the transceiver on the tower/mast.
- The AC wall outlet ground for the MacroMAX terminal must be connected to the same grounding system as the radio and antenna lightning protectors.

1.6 FCC RF Exposure

FCC Maximum Permissible Exposure (MPE) limits for equipment operating in the frequency range 1500 – 100,000 MHz is 1.0 mW/cm².

Following installation and commissioning, the safe distance from the antenna is the greater of:

20cm

Or

r cm, where $r = \sqrt{(PG/4\pi S)}$

P: power input to antenna in mW = 166mW

G: numeric gain of antenna relative to isotropic radiator

S: power density in mW/cm² = 1 mW/cm²

Therefore, safe distance from the antenna shall be the greater of

20 cm or $\sqrt{(13.21 \cdot G)}$ cm.

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REVISIONS

Revision Level	Date	Main Changes
01	25-9-2005	Initial Document
02	18-10-2005	AC cable colour code for ROW added

GLOSSARY

A

AAS : Adaptive antenna system (see Introduction for further details)

AP : Access point

API : Application programmers interface

ATCA : Advanced telecommunications computing architecture

B

BE : Best effort scheduling service for requesting uplink bandwidth

BER : Bit error rate

BS : Base station

BWA : Broadband wireless access

C

CIR : Committed information rate used to specify the guaranteed data rate to the customer.

CPE : Customer premises equipment (interchangeable with ST)

D

DCD : Downlink channel descriptor

DFS : Dynamic frequency selection (see Introduction for further details)

DL : Downlink

DLFP : Downlink frame prefix

E

E1 : ITU term for a 2Mb/s pulse code modulated transmission link

EIRP : Effective isotropic radiated power

F

FCH : Frame control header

FDD : Frequency division duplex

FEC : Forward error correction

FFT : Fast Fourier transform used to convert a signal from the time domain into the frequency domain

H

H-FDD : Half duplex FDD

I

IAD : Integrated access device

IP : Internet protocol

K

Kb/s : Kilobits per second

M

MAC : The next layer up from the PHY, known as the media access controller

Mb/s : Megabits per second

MIB : Management interface block

MIMO : Multiple-in, multiple-out

MIR : Maximum information rate used to specify the maximum data throughput to a customer.

MRC : Maximal-ratio combining

N

NLOS : None line of sight radio propagation path

NRTP : Non real time polling is similar to real time polling but is used to request uplink bandwidth less regularly

O

O&M : Operations and maintenance

ODU : Out door unit associated with a ST

OFDM : Orthogonal frequency division multiplexing

P

PHY : The physical layer associated with the WiMAX interconnection stack

PMP : Point to multipoint radio systems architecture

PoE : Point to point protocol over Ethernet

PtP : Point to point radio systems architecture

Q

QoS : Quality of service, which is used to specify level of data throughput

R

REC : Radio equipment controller

RTP : Real time polling allows a service flow to request uplink bandwidth at regular intervals

Rx : Receiver

S

SDMA : Space division multiple access is a technique which makes it possible to increase the capacity of a cellular mobile radio system by taking advantage of spatial separation between users

SDR : Software defined radio

SF : Service flow

SME : Small to medium sized enterprise

SNMP : Simple network management protocol

SNR : Signal to noise

SOFDMA : Scaleable orthogonal frequency division multiplexing

SoHo : Small office/home office

SS : Subscriber station (interchangeable with CPE or ST)

ST : Subscriber terminal (interchangeable with CPE or SS)

STC : Space time coding

T

T1 : North American standard 1.56Mb/s pulse code modulated transmission link

TDD : Time division duplex

TDM : Time division multiplexing

Tx : Transmitter

U

UCD : Uplink channel descriptor

UGS : Unsolicited grant service used to provide fixed bandwidth slots on the uplink for an ST to transmit data at regular intervals. The bandwidth should be used by the UGS SF, however the final decision of which SF (if any) uses the bandwidth slot is made by the ST.

V

VoIP : Voice over Internet protocol

W

WiMAX : WiMAX is a wireless industry coalition whose members are organized to advance IEEE 802.16 standards for broadband wireless access (BWA) networks.

WipLL : Wireless Internet protocol in the local loop product range currently available and offered by Airspan.

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