



System Administrators Guide

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FCC Information:

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 in a residential installation. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with these 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 correct the interference by one of more of the following measures:

- 1) Reorient the antenna;**
- 2) Increase the separation between the affected equipment and the unit;**
- 3) Connect the affected equipment to an outlet on a different circuit from that which the receiver is connected to;**
- 4) Consult the dealer and/or experienced radio/TV technician for help.**

FCC ID: NCYM5800SBAP60

FCC ID: NCYM5800SBSUEXT

CANADA: 2945A12100

IMPORTANT NOTE:

Intentional or unintentional changes or modifications not expressly approved by the party responsible for compliance must not be made. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.

CONTENTS

1.	SCOPE	5
2.	SYSTEM OVERVIEW	5
2.1.	SOFTWARE SETUP WIZARDS	6
2.2.	SETUP USING TERMINAL EMULATION PROGRAM	6
2.3.	MAKING CHANGES TO SETTINGS VIA TELNET	6
2.4.	STEP BY STEP CONFIGURATION OF THE AP	6
2.5.	STEP BY STEP CONFIGURATION OF THE SU	9
3.	SITE PLANNING	12
3.1.	CELL CONFIGURATIONS	12
3.2.	SERVICE RANGE CONTROL	12
3.2.1.	Threshold control	12
3.2.2.	Service range control	12
3.2.3.	Power Leveling	13
3.3.	CHANNEL FLEXIBILITY	13
3.3.1.	Recommended Channel Plans	14
3.3.1.1.	Single Sector	14
3.3.1.2.	Six Sector (6 APs)	14
3.3.1.3.	Six Sector with 12 APs	15
3.4.	PATH LOSS PLANNING	15
3.4.1.	Free Space Loss (FSL)	16
3.4.2.	Signal Fading Factors	17
3.4.2.1.	Fresnel Zone Fading	17
3.4.2.2.	Earth Bulge	18
3.4.2.3.	Foliage Loss	18
3.4.2.4.	Signal Loss due to Rain	19
3.5.	AVAILABILITY	20
3.6.	SITE SURVEY	20
4.	INSTALLATION AND TROUBLESHOOTING	22
4.1.	SAFETY GUIDELINES	22
4.2.	INSTALLATION	22
4.2.1.	TOOLS REQUIRED	22
4.2.2.	INSTALLING THE AP	22
4.2.3.	INSTALLING THE SU	22
4.3.	ETHERNET CABLE RUN	22
4.4.	FIELD SUPPORT/ADMINISTRATION TOOLS	23
4.4.1.	Local Console Port	23
4.4.2.	Telnet support	23

4.4.3.	TFTP Support	23
4.4.4.	Firmware Updating	23
4.4.5.	Time stamping	24
4.4.6.	MIR Threshold	24
4.4.7.	Antenna Alignment	24
4.4.7.1.	RSSI LED indicator	24
4.4.7.2.	Using Console Port RSSI data	24
4.5.	TROUBLESHOOTING	25
5.	SUBSCRIBER DATABASE MANAGEMENT	29
6.	THEORY OF OPERATION	30
6.1.	Hardware	30
6.1.1.	5.8 GHz Direct Sequence Spread Spectrum.....	30
6.1.2.	Antenna Technology.....	30
6.2.	Software	30
6.2.1.	Adaptive Polling Protocol.....	30
7.	SPECIFICATIONS.....	32
7.1.	M5800S-AP-60 Specifications	32
7.2.	M5800S-SU-EXT Specifications.....	35
8.	Appendix: Firmware - Hardware Cross Reference	39

1. SCOPE

This document covers the setup, installation, and management of the Access5800 series broadband wireless access system. Sections 2 through 6 cover these items by function. Section 7 covers the detailed performance specifications.

2. SYSTEM OVERVIEW

The Access5800 wireless Internet access system is designed for sending and receiving Ethernet based data traffic where conventional wiring is impractical or when higher connection speeds are required. The system utilizes robust 5.8 GHz spread spectrum technology to reduce susceptibility to interference. The basic system consists of one M5800S-AP-60 access point (AP) and up to 512 M5800S-SU series subscriber units (SUs). The AP uses a proprietary polling mechanism to dynamically allocate bandwidth to the SUs on an as-needed basis based upon service level agreement (SLA) rules (CIR and MIR). The system has a maximum service radius of 10 miles line of sight (LOS) and a burst rate of 10 Mbits/second either upstream or downstream.

System components include

- M5800S-AP-60 Access Point (AP) with mounting pole
- M5800S-SU-EXT Subscriber Unit (SU)
- M5800S-SU Subscriber unit with internal antenna (SU)
- Junction Box for injecting power onto the Ethernet cable
- 20 Volt Wall Mount Power Adapter
- 2 Mounting Brackets with hardware (Included with AP or SU)
- AD5800-27-D Dish Antenna, wall/pole mount and Feedhorn (SU-EXT only)
- Dish Antenna Cables (Included with AD5800-27-D)
- CBLDAT-1 Serial Programming cable (Included with AP)

2.1. SOFTWARE SETUP WIZARDS

Configuration of the AP and SU units must be done prior to deployment. The serial port must be used to initially configure the units. After the IP address has been changed from default, the Ethernet port (using telnet) may also be used for further changes. It is recommended that the administrator obtain and use the software wizards for setting up the AP and SU via the serial port/Ethernet. They can be obtained at the Trango Broadband Wireless website www.trangobroadband.com.

2.2. SETUP USING TERMINAL EMULATION PROGRAM

Once familiar with the command set, users may set up or make configuration changes directly into the AP or SU using the serial port in conjunction with a terminal emulation program such as Hyperterminal™. The default baud rate for connecting to the AP or SU is fixed at 9600-N-8-1.

2.3. MAKING CHANGES TO SETTINGS VIA TELNET

Both AP and SU support Telnet. Once the IP address has been correctly set and the TCP/IP service turned on (SU only) the user may initiate a telnet session and execute commands. See the Command Set Reference Manual for details.

2.4. STEP BY STEP CONFIGURATION OF THE AP

Unpack the system carefully, saving the packing box for later use if necessary. Connect the power adapter to the junction box and one **8 conductor** straight through Ethernet patch cable to the AP. Connect the Serial programming cable CBLDAT-1 between the PC and the AP. Set the terminal settings on the PC to 9600-N-8-1 with no handshaking. Connect to the unit and verify that the prompt for the password comes up. Enter "sunstream" (v1.2 or earlier firmware) or "trango" (V1.3 and higher firmware). You are now ready to configure the radio settings.

- 1) Setting the Broadcast Packet filter

Default is ON. Set to OFF if blocking of broadcast packets is not required. DHCP will work with the filter on.

2) Setting the Channel Table

Default has the first six channels set to 5736, 5756, 5776, 5796, 5816 and 5836 MHz. All other locations are not set. Several channel plans are discussed in Section 3 to assist in overall system design. Add or adjust the channels as appropriate.

3) Setting Date and Time for Real time clock

Factory set to USA Pacific Standard Time. This feature is not supported by the Wizard program and must be changed from a terminal emulation program.

4) Setting the default opmode

Factory set to *off*, this setting should only be changed after a site survey has been done and the access point is ready to be activated for service.

5) Setting the MIR Threshold

Default is 6 MBps.

6) Turning the MIR Threshold ON or OFF

Default is OFF.

7) Setting the Password

Default is *sunstream* for units with V1.2 or earlier firmware and *trango* for units loaded with V1.3 or later firmware.

8) Setting Remarks

Factory default is blank.

9) Setting the Receive signal level threshold

Default is -80 dBm. This feature is not supported by the Wizard program and must be changed from a terminal emulation program.

10) Setting the Target SU received signal level

Default is -60 dBm. This feature is not supported by the Wizard program and must be changed from a terminal emulation program.

11) Setting the Service range

Default is 10 miles

12) Setting the IP address

Default is 198.168.100.100

13) Setting the Access Point ID

Default is 1

14) Setting the Basestation ID

Default is 1

15) Turning TFTP service ON or OFF

Default is OFF

16) Turning Real Time Clock broadcasting ON or OFF

Default is OFF. Recommend leaving off since the feature is unused at this time.

17) Turning SU to SU communications ON or OFF

Default is OFF. If the feature is turned on, devices connected to SUs associated with a single AP may communicate. In addition to turning this feature on, the SUs involved must be in the same group. See the command reference (*sudb modify* command) for information on assigning group IDs to SUs. NOTE: Devices connected to group 0 SUs cannot communicate with each other through a single AP.

18) Setting the current channel and antenna polarization

Default is 5736 MHz (CH 1) Horizontal Polarization.

19) Setting the RF power output level

Default is +18 dBm.

20) Loading individual subscriber settings into the database

The AP contains a database that holds information on all the subscribers which are to be associated with the AP. Section 5 covers loading individual SUs into the database.

21) Loading a preconfigured subscriber text file database

If batch processing of the subscriber database is desired, the entire database may be uploaded to the AP at one time after modifications are made offline. Section 5 covers loading batch SUs into the database.

2.5. STEP BY STEP CONFIGURATION OF THE SU

Unpack the system carefully, saving the packing box for later use if necessary. Connect the power adapter to the junction box and one **8 conductor** straight through Ethernet patch cable to the SU. Connect the Serial programming cable CBLDAT-1 between the PC and the SU. Set the terminal settings on the PC to 9600-N-8-1 with no handshaking. Connect to the unit and verify that the prompt for the password comes up. Enter "sunstream" (v1.2 or earlier firmware) or "trango" (V1.3 and higher firmware). You are now ready to configure the radio settings.

1) Setup Auto Scan AP

Default is ON - The SU will search each channel and polarization in the AP Scan sequence looking for an AP that has the SU loaded into the AP database. If it is desired to stop the SU from scanning then turn off AP Scan.

2) Setting the Broadcast Packet filter

Default is OFF.

3) Setting the Channel Table

Default has first six channels set to 5736, 5756, 5776, 5796, 5816 and 5836 MHz. All other locations are not set.

4) Setting default Opmode

Factory set to *off.*, The unit must have the opmode changed to "SU" before the link will be established.

5) Setting the Password

Default is *sunstream* for units with V1.2 or earlier firmware and *trango* for units loaded with V1.3 or later firmware.

6) Setting Remarks

Factory default is blank

7) Setting SU ID

The SU ID is a number used to identify the SU in the Subscriber database residing in the AP. The SU ID must match a number in the database along with the MAC address before the AP will be able to establish communications with the SU.

8) Setting the IP address

Default is 198.168.100.100

9) Setting the Access Point ID

Default is 1

10) Setting the Basestation ID (baseid)

Default is 1. The baseid **MUST** match the AP that the SU will be communicating with.

11) Turning TFTP service ON or OFF.

Default is OFF. This feature is not supported by the Wizard program and must be changed from a terminal emulation program.

12) Setting AP channel scanning table

Default is channels 1 through 6 horizontal and vertical polarization. This table contains information that tells the SU what channels and polarizations to look for the AP on. The SU

will scan these channels and polarizations looking for an AP that is polling it's SU ID number. Once located, the SU will remain on that channel and let the AP begin the authentication process, eventually establishing a wireless link.

3. SITE PLANNING

3.1. CELL CONFIGURATIONS

The system is designed to support a hexagonal six sector cell design, with each sector containing 1 or 2 AP units. This cell design has a 360 degree coverage area and can support up to 6000 concurrent subscriber connections. Each sector uses a single antenna polarization which does not change and is opposite of the adjacent sectors. Section 3.3 below has more detail on assigning channels and polarizations to the sectors.

Other cell architectures are available, but should only be used after careful planning.

3.2. SERVICE RANGE CONTROL

Several features allow the control of the service range to prevent interference from distant cells or other sources, and to allow smaller cells in densely populated areas. Each is discussed below.

3.2.1. Threshold control

This feature limits the sensitivity of the receiver section of the radio, preventing the radio from "hearing" distant transmitters and attempting to lock to them. **This is one of the most powerful ways to avoid interference from other equipment operating in the same frequency band.**

3.2.2. Service range control

This feature reduces the time an AP will wait for a response from an SU, which makes it impossible for SUs located outside the range to establish communication with the AP. Also, the data throughput will increase slightly as the service range is reduced. Shorter range has a smaller receive window, improving resistance to interference. The target RSSI should be adjusted if this parameter is changed from the default. Also special attention must be paid to the antenna height used versus the service range.

3.2.3. Power Leveling

RF power leveling is a feature that is typically found in more elaborate mobile systems such as cellular CDMA networks. It does have great benefits for wireless broadband access systems and therefore was included in the Access5800 design. Using this feature, all SUs have their RF power output adjusted until the signal strength for each SU as received in the AP is roughly the same.

The key advantage is that the SUs close to a basestation AP on channel #1 that have their power turned down will not cause interference to an AP on channel #2 at the same basestation and vice-versa. Cell planning is made much easier since the adjacent channel interference is reduced significantly.

When the SU is powered on and begins to associate with an AP, the AP will run the unit through a routine in which it increases or decreases the SU RF power until the received power at the AP is as close to the target RSSI as possible.

3.3. CHANNEL FLEXIBILITY

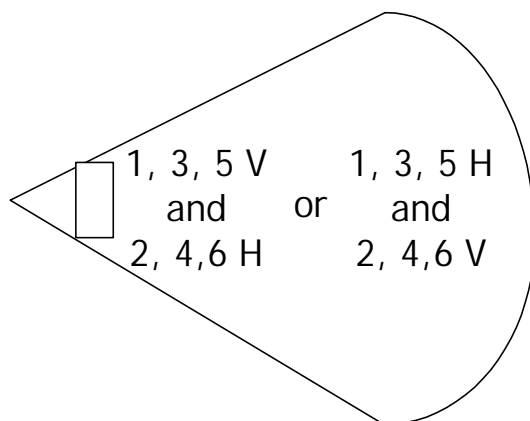
Since the AP channels may be changed remotely and the SU may be set up to automatically scan a programmable set of channels and polarizations, changing the channel and polarization of a given sector is very simple and may be done at any time with a minimum of down time.

There are several rules that should be observed regarding channel planning.

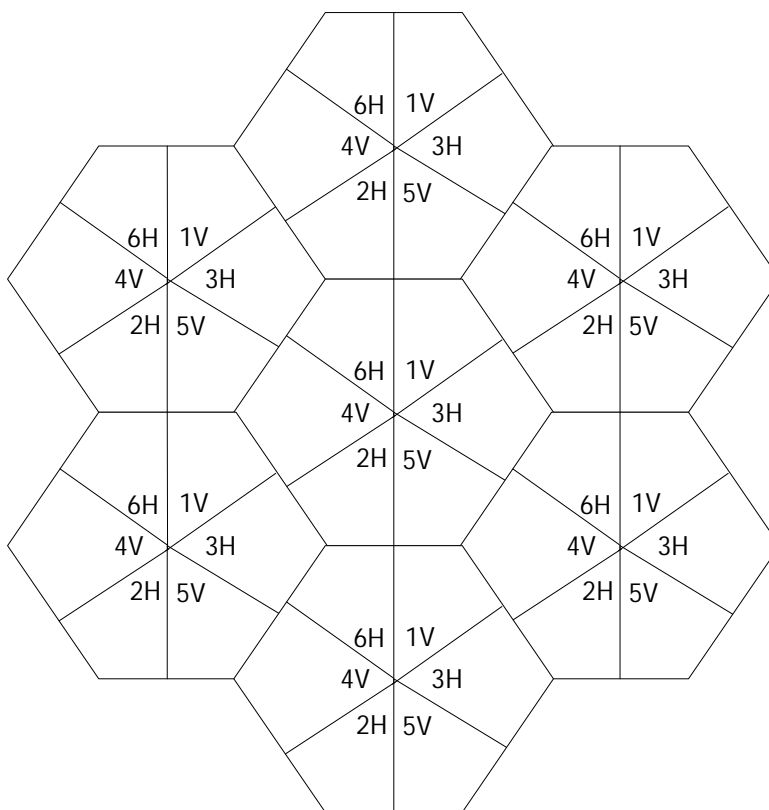
- 1) A minimum of 20 MHz should be used for channel spacing on the same polarization.
- 2) In the same sector always use a spacing of at least 26 MHz between channels for each AP if two or more APs are covering the same area.
- 3) Only reuse frequencies for APs on opposite polarizations that are mounted 180 ° relative to each other in the cell and well isolated.
Verify that the APs do not interfere with each other by running "cf2cf" on one AP while running site survey on the other. Increase separation distance if necessary, add physical shielding, or reduce each AP's RF power output.
- 4) Always align APs in adjacent cells so that they do not face each other directly.

3.3.1. Recommended Channel Plans

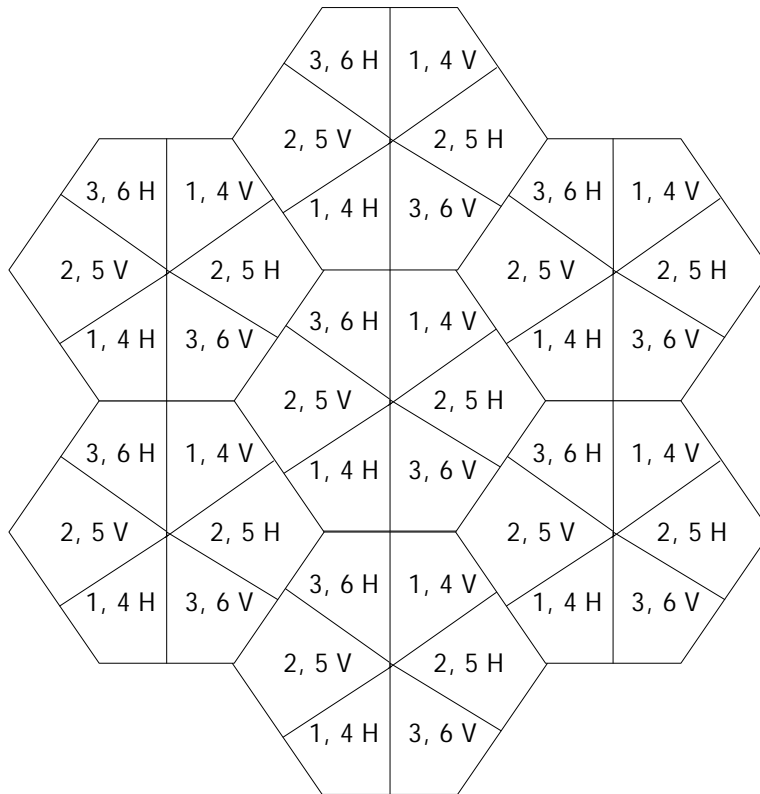
3.3.1.1. Single Sector



3.3.1.2. Six Sector (6 APs)



3.3.1.3. Six Sector with 12 APs



3.4. PATH LOSS PLANNING

This section addresses the planning of the radio link parameters between the AP and SU. The Access5800 system is designed for line-of-sight (LOS) AP to SU links up to 10 miles using the M5800S-SU-EXT with 27 dBi dish antenna with a fade margin allowance of 12 dB. Using the M5800S-SU (with internal antenna), the LOS range is 3.2 miles for a 12 dB fade margin.

The link budget is a summation of all system component gains and losses to determine if sufficient signal is present at the radio antenna for the link to perform properly. The link budget is calculated for each direction of the link. The general equations are as follow:

Required system gain = Free space loss (FSL) + fading margin allowance(FM)

Calculated system gain = Transmit antenna gain (dB) + transmit power (dBm) + receive antenna gain - receiver sensitivity (dBm) .

For the link to work properly **Calculated system gain** must be greater than or equal to the **Required system gain**.

Example:

For the M5800S AP to SU (with dish) 10 mile LOS link, the FSL is 132.11 dB from 3.4.1 below. We set the fade margin in this case at 12 dB to allow for rain only per Section 3.4.2 below.

The total required system gain is then $132.11 + 12 = 144.11$ dB

AP to SU:

Transmit Antenna:	17 dB
Transmit Power:	+18 dBm
Receive Antenna Gain:	27 dB
Receiver sensitivity:	-82 dBm

Calculated System Gain = 145 dB

SU to AP

Transmit Antenna:	27 dB
Transmit Power:	+18 dBm
Receive Antenna Gain:	17 dB
Receiver sensitivity:	-82 dBm

Calculated System Gain = 145 dB

Summary: The link will work since the calculated system gain is equal to the required system gain.

Note: Connector and cable losses are incorporated into the antenna gains above for simplification.

NOTE: The sensitivity specification of the M5800S radio is specified to be -82 dBm typical for a 1E-6 Bit Error Rate. This specification, however, will vary with the size of the Ethernet packet being transmitted. For small packets (ex. 64 bytes) such as URL requests, the sensitivity of the receiver section is about -87 dBm. For large packets (ex. 1600 bytes), the sensitivity is about -82 dBm worst case. This characteristic improves the fading margin for smaller packets. The packet size is determined by the Ethernet MAC layer and cannot be controlled or fragmented in the radio.

3.4.1. Free Space Loss (FSL)

Any RF signal will be attenuated as it travels through space according to the following equation:

$$\text{Loss}_{\text{fsl}} = 92.4 + 20\log(F) + 20\log(R)$$

Where: F = Frequency in GHz
R = range in km

Example:

For a 10 mile path at 5.8 GHz, the free space loss would be:

$$\text{Loss} = 92.4 + 20\log(5.8) + 20\log(10/.6) \text{ dB}$$

$$\text{Loss} = 132.11 \text{ dB}$$

The system gain must be greater than this loss for the link to work.

3.4.2. Signal Fading Factors

The following factors will add losses to the FSL loss and must be accounted for by adding fade margin

3.4.2.1. Fresnel Zone Fading

For a link to truly be line-of-sight, no objects such as buildings, cars, etc. or the ground may be within a certain height perpendicular to the line of sight path called the first fresnel (pronounced fray-nell) zone. This height of the fresnel zone H (in feet) is specified by the equation below.

$$H = 43.3 \times \sqrt{D/(4 \times F)}$$

where D = distance in miles between antennas
F = Frequency in GHz

Example:

For a 10 mile link at 5.8 GHz, the height of the Fresnel zone is

$$H = 43.3 \times \sqrt{10/(4 \times 5.8)}$$

$$H = 28.43 \text{ feet}$$

If 60 percent of the fresnel zone is free from obstructions the link will generally behave as a line of sight link.

Therefore, the direct path must have $.6 \times 28.43 = \mathbf{17 \text{ feet}}$ of clearance around it to achieve line of sight performance. Each antenna must be mounted this high above the ground plus the earth bulge height as described below.

3.4.2.2. Earth Bulge

For long links the curvature of the earth will may block the line of sight path unless the antennas at both ends of the link are positioned high enough above the ground. This height must be added to the fresnel zone height for each antenna.

$$H = D^2/8$$

Where: H = Earth bulge height in feet
D=distance between antennas in miles

Example:

For a 10 mile link, $H = 10^2/8 = 12.5$ feet

3.4.2.3. Foliage Loss

When trees and plant foliage are in the transmission path, the link is considered non-LOS and additional signal loss will be present. Since the seasonal density and moisture content of the plants, and other factors such as wind may change the losses, care must be used when planning a link through this type of environment.

FCC OET Bulletin 70 gives a generalized equation for foliage loss which is presented here **as a guideline only**. **It is imperative to verify that the system has sufficient fade margin for proper operation by conducting a field test when non-LOS links are involved.**

$$\text{Loss} = 0.2 F^{0.3} \times R^{0.6}$$

Where: F= Frequency in MHz
R= Depth of foliage transversed in meters

Example:

For 5.8 GHz and 10 meters of foliage depth (to estimate a typical distance of aiming through several trees towards a tower):

$$\text{Loss} = 0.2 \times 5800^{0.3} \times 10^{0.6} = 10.7 \text{ dB}$$

A fade margin of 12 dB in this case appears to be sufficient, but it is prudent to add more fading margin (on the order of 10 dB) to account for other signal

losses and verify the RSSI/throughput performance at the customer premises. This effectively reduces the range obtainable.

3.4.2.4. Signal Loss due to Rain

At 5.8 GHz, attenuation due to rain is roughly .25 dB/km for a rain rate of 100 mm/hr and .60 dB/km for a rain rate of 150 mm/hr per FCC OET bulletin 70.

For a 10 mile link the total loss would be :

For a 100mm/hr rain event, Loss = 0.25 dB/km X 1 km/0.6mile x 10 miles = 4.16 dB

For a 150mm/hr reain event, Loss = 0.60 dB/km X 1 km/0.6mile x 10 miles = 10.0 dB

3.5. AVAILABILITY

Availability of the link represents the percentage of the time that the link is working at or below a given bit error rate (BER). The table below shows the percentage of time the link is available versus total outage time per year (source: FCC OET Bulletin 70).

<u>AVAILABILITY</u>	<u>OUTAGE TIME PER YEAR</u>
99.9%	9 hours
99.99%	1 hour
99.999%	5 minutes
99.9999%	30 seconds

Availability is largely based upon the fade margin allowance specified versus the signal fading due to multipath, foliage, and weather effects. The fade margin must be greater than all signal fading losses for the link to be "available".

If the fading losses are greater than the fade margin the link is considered to be "unavailable", although a gradual degradation of the link quality will generally occur instead of the link being completely disabled.

For LOS links, availability is based mainly upon weather effects.

If the fade margin is greater than these losses, a link will be available during these rain events assuming no other impairments to the link have occurred such as misaligned antenna, etc.

The M5800S-SU-EXT with 27 dBi dish is designed to operate with a maximum radius of 10 miles using a fade margin of 12 dB, so it would still operate with no degradation during the example events discussed in 3.4.2.4 above.

In the continental United States, the southeastern part of the country is subject to an average of 5.26 minutes per year where the rain rate exceeds 150 mm/hr. If we assume that the fading losses will be greater than 12 dB during this time, the M5800S link will be "unavailable" for that time unless the fade margin is increased. This corresponds to an availability of 99.999%.

3.6. SITE SURVEY

After choosing the appropriate fading margin allowance and AP configuration, it is important to conduct a site survey. Both the AP and SU units have several commands to allow measurement of the RF spectrum and assist in the selection of channels for best operation. The basic procedure is as follows:

- 1) Install an AP in the desired location, aligned towards the desired coverage area.
- 2) With `opmode` off, run the "survey" command from the `ss` subdirectory. It may be useful to run this command for one entire day or run several passes during the course of a day to determine when interference may be occurring.
- 3) Analyze the results which show which channels and polarizations have the lowest received signal strength, indicating they are good candidates for usage.
- 4) Once a channel and polarization have been selected verify that the expected signal strength levels are being achieved with SUs in the coverage area.
- 5) Run the "cf2cf" test with an SU in the coverage area. Verify that there are no packets being lost except by the AP. Typical numbers vary with packet size and transmission distance, but as an example, with 1600 byte packets at under 1 mile, the numbers of packets received by both ends should be about 340. The AP should detect about 320 good packets. The HR and CR should all be zero. This indicates an error free link.
- 6) Adjust the `RSSItarget`, service range, `rfrxthreshold` as appropriate.
- 7) Activate service by changing `opmode` to AP.

Another useful command to determine if any M5800S series APs are active in the area is the "apsearch" command. It can be run from either an AP or SU and will force the radio to listen for packets being transmitted from an AP, then report the results with signal strengths. See Command Set Reference Manual for more information.

4. INSTALLATION AND TROUBLESHOOTING

4.1. SAFETY GUIDELINES

Installation of antennas and radio equipment can be very dangerous. Use extreme caution when installing equipment near power lines. Electrostatic Discharge (ESD) protection should be used on any Ethernet cable entry into a building. APC provides equipment to accomplish this.

4.2. INSTALLATION

4.2.1. TOOLS REQUIRED

- 1) Adjustable crescent wrench
- 2) RJ45 crimp tool
- 3) RJ45 shielded connectors
- 4) 24 AWG 8 conductor shielded twisted pair cable
- 5) Philips screwdriver
- 6) Heatgun for heatshrink

4.2.2. INSTALLING THE AP

The elevation beamwidth of the AP is 10 degrees and the azimuth beamwidth is 60 degrees. A mounting arm has been provided to make adjustment of the elevation angle easy.

Since APs are typically installed on towers with other high power radio equipment nearby, it is especially important to ground the AP enclosure to a good earth ground. Attach a ground strap of 12 AWG stranded copper from the mounting bracket to the earth grounded mast

4.2.3. INSTALLING THE SU

The 3 dB elevation and azimuth beamwidth for the SU with dish antenna is 7 degrees. For the SU with internal antenna the beamwidth is 20 degrees. Precise alignment with the target AP is facilitated by the RSSI indicator on the bottom edge of the unit (look through the access door window). Contact Trango Broadband Wireless for other available mounting provisions.

4.3. ETHERNET CABLE RUN

It is recommended that only 24 AWG shielded twisted pair (STP) be used for the connection between the junction box and AP or SU. Using the 20 volt power adapter supplied with the unit, the max Ethernet cable distance from the Junction box to the AP or SU unit is 330 feet. Since power is sent over four of the unused conductors in the 8 conductor STP, the resistance is reduced significantly, reducing the voltage drop along the cable.

It is important to note that the shielded connectors at the junction box are not connected to the ground on the power adapter to avoid a ground loop. By using a static protection device on the Ethernet cable at the building entry any currents induced by lightning or static will be kept outside and routed to earth ground.

It is recommended that metal conduit be used over the STP if possible to prevent damage to the STP and add a measure of shielding.

4.4. FIELD SUPPORT/ADMINISTRATION TOOLS

4.4.1. Local Console Port

The local console port requires a special RJ11 to DB9 cable (CBLDAT-1) and is compatible with most terminal emulation programs. The serial port settings are 9600-N-8-1 with no hardware handshaking.

4.4.2. Telnet support

The AP and SU units support basic telnet. The current telnet implementation is somewhat limited in its capabilities. It works well for local area networks but may sometimes drop the connection for wide area connection due to the lack of support for error correction and dynamic routes.

4.4.3. TFTP Support

TFTP support is provided to allow upload of new firmware to the AP and SU units over Ethernet. The TFTP buffer must first be turned on and the file then loaded into the unit. The user manual and all firmware release notes explain how to update the firmware for both the AP and SU using TFTP.

4.4.4. Firmware Updating

The user manual and all firmware release notes explain how to update the firmware for both the AP and SU. A hardware -firmware cross reference is included at the end of this document to assist in determining the appropriate firmware for the hardware configuration you have.

4.4.5. Time stamping

The real time clock resides in the AP. It is always active and may be read to log events by third party management software. The real time clock may also be broadcast to SUs if required since they do not have a clock on board. Currently no third party software supports this feature. In general broadcasting to SUs is not necessary and may reduce payload traffic slightly

4.4.6. MIR Threshold

This feature allows improved latencies for CIR traffic by limiting the MIR traffic for ALL SUs. As an example, setting the MIR threshold to 6 Mbps will disallow users of MIR traffic from achieving rates greater than 6 Mbps, reserving the last 4 Mbps for CIR traffic. For heavily loaded sectors this feature can be useful, especially when many subscribers with low CIR and high MIR are loading the network. As an alternative, individual subscriber database entries may be modified if they continually load the network down. See the command refer

4.4.7. Antenna Alignment

Antenna alignment can be accomplished by either viewing the yellow RSSI LED in the unit or by connecting a connecting to the unit via the console. Each method is outlined below:

4.4.7.1. RSSI LED indicator

The yellow LED for the RSSI blinks with a longer duty cycle as the received signal strength increases. At -60 dBm, the LED will become solid yellow. Below -80 dBm the LED will turn off.

The LED is active in the SU at all times.

The LED is only active in the AP when the opmode is off.

Align the antenna left and right and then up and down until the yellow LED blinks with the greatest duty cycle or is solid. Tighten the antenna mounting hardware down when the optimal position is found.

Activate opmode SU.

4.4.7.2. Using Console Port RSSI data

To align an SU it is best to use the "rssi <channel #><polar>" command from the ss subdirectory with opmode off.

First, aim the antenna in the general direction of the AP and then turn the unit on by plugging in the Ethernet cable. Once the SU associates with the AP, the red LED will flash periodically indicating the SU is responding to the AP. This may take a few minutes depending on how many channels the SU has to scan through before it locates the AP.

Once the red LED is flashing, run the "rssi r" command and view the real time rssi value on the terminal. Adjust the antenna until the rssi is the highest (remember that -65 is a stronger signal than -70). Tighten the antenna mounting hardware down when the optimal position is found.

IMPORTANT- After aligning the antenna make sure to reboot the SU so that the AP re-levels the SU RF power for best performance.

4.5. TROUBLESHOOTING

Below are some possible sources of no link established:

Incorrect Ethernet wiring (crossover vs straight through)

Use straight through if connecting the junction box to the SU or AP. Use an 8 conductor 24 AWG straight through Cat 5 STP cable for junction box to switch connections. Use a crossover cable for junction box to PC NIC connections.

Power not present due to using only 4 conductor STP

Verify the "ODU" LED illuminates on the junction box. If not, check the cable from the junction box to the AP or SU - It must be 8 conductor Cat 5 24 AWG STP. Also verify the connection of the 20 Volt power adapter to the junction box. If connected properly, the "POWER" LED will illuminate, regardless of the connection status to the AP or SU.

Ethernet cable too long from Junction Box

The max length is 100 meters from the AP or SU to the Junction Box.

No entry of SU in database

Check SU database in AP and correct. Double check the MAC address of the SU as printed on the label on the back of the unit.

Base ID incorrect in SU

The baseid in the AP and the SU must be the same for the link to be established.

Opmode off

Opmode must be turned on for both the AP and the SU for the link to be established.

Service Range setting in AP too low

Check and correct if necessary.

Receive RSSI threshold in AP too high

Reduce the threshold as appropriate.

SU Scan table setup incorrectly

Check channels and polarizations in scan table in SU. Verify that auto scanning is turned on in SU.

Antenna alignment

Verify antenna has not been inadvertently moved out of alignment.

SU firmware out of date

Check firmware-hardware cross-reference.

Failed to update the system settings after making changes.

Make changes again and save system settings.

Cannot Ping the SU

Verify wiring to PC or switch. Verify subnet mask on PC is set correctly. Make sure that opmode is "off".

Real time clock not working

Open the cover of the radio (12 screws) and replace the Battery with a model BR1225 lithium battery. Reset the time and date. Battery life is typically 5-10 years.

Telnet connection lost

The radio will disconnect the telnet session after 2 minutes if there is no activity from the remote terminal. Also, the telnet firmware in the AP and SU radios is a reduced implementation that may lose connection when the routing of packets changes during a session, as may happen over long geographical distances in some cases. The radio is unaffected in this case. Simply reconnect to the radio.

Radio reboots by itself

Both the AP and SU will reboot approximately every 41 days to reset the internal counters, making the link unavailable for about 15 seconds. While this will usually not be noticeable, it is recommended that the administrator schedule reboots during off-peak hours to minimize effects on customers. A scheduled reboot will prevent the automatic reboot from occurring as long as it is done at about a 30 day interval.

Any other type of reboot may indicate insufficient input voltage or overheating of the unit.

Erratic behavior of unit

Under out of spec temperature extremes, the unit may reboot or behave erratically. Verify the temperature of the unit in question. Use the **temp** command to obtain the temperature inside the unit.

Possible sources of degraded performance and corrective action:

Interference at the SU

If interference is suspected, run the "testrflink" command to verify that packets are being corrupted. If packets are being lost, some potential remedies to the problem are: Try a different channel or polarization, re-orient the SU antenna, look for sources of RF interference in the vicinity of the SU and remedy.

Interference at the AP

If interference is suspected, run the "testrflink" command to verify that packets are being corrupted. If packets are being lost, some potential remedies to the problem are: Change the receive threshold on the AP, Reduce the service range, try a different channel or polarization, re-orient the AP unit, Look for sources of RF interference in the vicinity of the AP and remedy. Potential sources are: Self interference from APs spaced too close to the

problem unit, intermodulation from high power out-of-band transmitters, and in-band Interference from other unlicensed equipment.

Also grounding of the AP may be the problem. Make sure that the AP is well grounded and that the Ethernet cable is shielded.

Poor signal strength

Verify that antenna alignment has not changed or that the signal path has not become blocked by foliage or vehicles. Wet foliage may create a problem as well. Also, verify that the antenna connectors are tight and installed correctly (V and H). The fade margin allowance may be too low. The rssi should read more than -75 dBm under normal conditions with default settings and errors can be expected below -82 dBm.

Poor data throughput

Run "testrflink" command to check for lost packets. If the tests are ok, verify the third party FTP program buffers and PC settings are set to the max size for a broadband connection and verify network card operation. Check the SU database entry for typographical errors. MIR threshold may also be on and set too low.

5. SUBSCRIBER DATABASE MANAGEMENT

This section covers the various methods of creating and maintaining a subscriber database for each AP.

To load an individual SU entry into the database, use the "sudb add" command.

To load a full database of SU entries into the AP database, the tftpd service must first be enabled by using the "tftpd on" command. The SU database file can then be loaded into the buffer by transferring the file as a text file using tftp. After the file is loaded the "sudb load" command can be executed and the database will be updated in RAM. To make the change permanent, use the "updateflash sudb" command.

Individual or batch changes to the subscriber database can be made at any time with the AP operating and will become active immediately after the "sudb load" command is run.

Details on the components of the SU database can be found in the Command Set Reference Manual. Other commands for deleting or modifying existing entries are available and detailed in the document.

6. THEORY OF OPERATION

This section discusses the theory of operation of the hardware and software portion of the AP and SU and is intended as a guide to assist the reader in understanding the system.

6.1. Hardware

6.1.1. 5.8 GHz Direct Sequence Spread Spectrum

By utilizing the same technology used for secure military communications, robustness against interference from other radio equipment is obtained. The method of spreading the data used by the M5800 product is similar to the field-proven technology used for wireless LANs.

The system will operate essentially error-free even with peak signal to interferer ratio of only 8.4 dB, allowing operation in noisy areas where other non spread spectrum modulation techniques may fail. Some technologies require peak signal to interferer ratios of at least 20 dB, which means that the interfering signal must be 20 dB less than the desired signal or data loss will occur.

6.1.2. Antenna Technology

Both the AP and SU use proprietary patch antenna technology that allows high gain in a small package, and is electronically switchable between horizontal and vertical polarization.

Trango Broadband chose linear polarization over circular polarization based on field results in high RF interference environments. Most deployed equipment uses linear polarized antennas in the 5.8 GHz band, for which circular polarization only can offer a 3 dB rejection. Linear antennas can offer rejection of 15 to 20 dB over those same linear antennas.

6.2. Software

6.2.1. Adaptive Polling Protocol

One of the major advantages of the Access5800 system is the ability of the AP to handle multiple SU connections and share the 10 MBPS data pipe efficiently according to provisioning rules set up by the administrator.

The AP unit acts as a hub in a star configuration wireless multipoint network supporting up to 512 subscriber units. The functional description of the protocol is as follows:

The AP unit, hardwired to a Point of Presence, polls each subscriber unit SU in a round robin format to determine if the SU has data to transfer. The SU only transmits the data "upstream" to the AP when the AP gives authorization via a transmit grant. The SU parses every "downstream" data packet from the AP and identifies packets intended for it.

Normally the administrator will first add the MAC address and ID number of the SU to the user database of the AP with which the SU will associate. Then, the SU will be installed by a technician at the subscriber premises.

When power is first applied to the SU, it will scan all the channels in its scantable, searching for an AP that is sending transmit grants for the SU. The SU will then stop on that channel and respond to the AP using maximum RF power. Before the AP can add the SU to the polling list, it must authenticate the SU by verifying the MAC address, and performing a ranging operation to the SU. This process involves sending a special command to the SU and getting an instantaneous reply from the SU.

Upon successfully locating and ranging the SU, The AP will then add the SU to the normal polling list and level the RF transmit power level from the SU to set a good signal-to-noise ratio at the AP.

The AP uses several parameters to determine how often each SU is polled for data, and the conditions of any data transfer, as follows:

- 1) Committed Information Rate (CIR)
- 2) Maximum Information Rate (MIR)
- 3) Priority
- 4) Poll response timeout

All the above parameters are set in the AP by the system administrator and cannot be controlled at the SU.

It should also be noted that the MAC table located in the AP is dynamic and stores up to 2000 entries. There is no limitation on the number of IP addresses or hardware devices that an individual SU may have physically connected to it.

7. SPECIFICATIONS

7.1. M5800S-AP-60 Specifications

Transmitter Section

Radio Section:

Frequencies:

Storable Channels: 32 memory locations
Channel spacing: 5.736 to 5.836 GHz in 2 MHz increments
Default channels- Channel 1: 5.736 GHz
Channel 2: 5.756 GHz
Channel 3: 5.776 GHz
Channel 4: 5.796 GHz
Channel 5: 5.816 GHz
Channel 6: 5.836 GHz

RF Output Power: Max: +18 dBm +/- 2 dB
Min: -12 dBm +/- 2 dB

EIRP: +35 dBm with +17 dBi patch antenna
Freq. Stability: .000435 % PLL Stabilized (4.35 ppm) over temp
Freq. Plan: Single upconversion, 480 MHz IF
Modulated BW: 22 MHz (null to null, 20 dB)
2nd Harmonic atten: Per CFR47 part 15.247
LO Supression: Per CFR47 part 15.247
Symbol Rate: 1.375 MSPS
Modulation: 1 MBPS DBPSK for header, 11 MBPS CCK spread spectrum for payload

Data Input Section:

Buffer size: 128K Bytes
Data Rate (User): Up to 10 MBPS Sustained throughput
Format: 10/100 BaseT IEEE 802.3 Ethernet compliant
Ethernet packet: Up to 1600 byte long packets (supports VPN)

Power

Input Voltage:	Input voltage range at unit is 10.5 VDC to 21 VDC max Power is supplied on Ethernet cable using junction box provided with up to 330 foot 24 AWG STP cable.
Current Cons.:	540 mA in transmit mode at max power using 20 V standard adapter (10.8W) 670 mA in transmit mode with heater on using 20 V standard adapter (13.4W) 500 mA in receive mode using 20 V standard adapter (10 W)

Receiver Section

Radio Section:

Receive Frequencies

Default channel plan-	Channel 1: 5.736 GHz Channel 2: 5.756 GHz Channel 3: 5.776 GHz Channel 4: 5.796 GHz Channel 5: 5.816 GHz Channel 6: 5.836 GHz Channels 7-32: not programmed
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Cascade Noise Figure:	< 6 dB
Sensitivity: (1E10-6 BER)	- 82 dBm typical-1600 byte packet - 87 dBm typical-64 byte packet

Adj. Channel Rejection:	> 20 dB
Image Rejection:	> 60 dB
Frequency Plan:	Single conversion, IF at 480 MHz
Input compression point:	> -10 dBm

Data Section:

Buffer size:	128K Bytes
Data Rate (User):	10 MBPS Maximum sustained throughput typical
Format:	10/100 BaseT IEEE 802.3 Ethernet compliant
Ethernet packet:	Up to 1600 byte long packets (supports VPN)

Real Time Clock

Battery: Lithium 3 Volt model BR1225

Mechanical and Environmental

General

Material: Powdercoated aluminum base with polycarbonate radome
Size: 12.5" x 5" x 8" including mounting studs
Weight: 4 lb
Mounting: Pole mount

Connectors/Indicators

RF Output: Integral Dual pol antenna per Part 15C, 15.203.

FCC Compliance: The transmitter shall comply with the following:

FCC Part 15.247
FCC Part 15.207(a)
FCC Part 15B Class B digital device

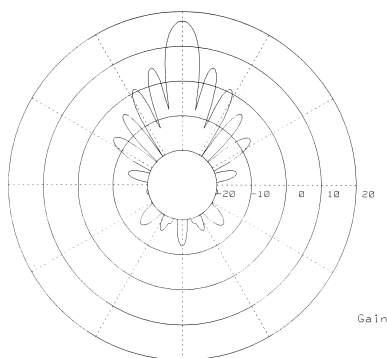
Serial Interface: RJ11 connector
LAN Interface: Shielded RJ45 connector
Power: Carried on 4 unused pins of Ethernet cable

Environmental

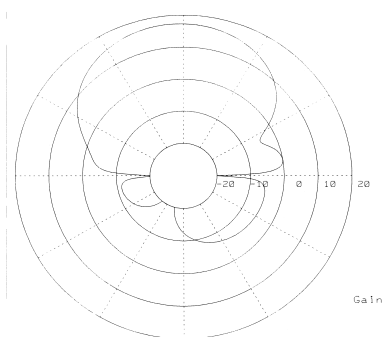
Operating Temp: -40 to 60 °C
Storage: -40 to 85 °C
Humidity: 100 % When sealed properly
NEMA Rating: NEMA 4
Shock: Sustain 3 axis drop from 5 feet

STANDARD ANTENNA (INTERNAL)

Type: Sectoral Patch Antenna
Polarization: Vertical, Horizontal electrically selectable
Frequency: 5.7 to 5.9 GHz
Gain: +17 dBiL
Az Beamwidth: 60 degrees typical (3 dB down)
El Beamwidth: >8 degrees (3 dB down)
Cross Pol: >15 dB
Front/Back Ratio: >30 DB as mounted in M5800SB-AP-60
VSWR: < 2.0:1 over Bandwidth
Wind Loading: 80 mph operational



AP Antenna Pattern Elevation



AP Antenna Pattern Azimuth

7.2. M5800S-SU Series Specifications

Transmitter Section

Radio Section:

Frequencies:

Storable Channels: 32 memory locations

Channel spacing: 5.736 to 5.836 GHz in 2 MHz increments

Default channel s- Channel 1: 5.736 GHz

Channel 2: 5.756 GHz

Channel 3: 5.776 GHz

Channel 4: 5.796 GHz

Channel 5: 5.816 GHz

Channel 6: 5.836 GHz

RF Output Power: Max: +18 dBm +/- 2 dB

Min: -12 dBm +/- 2 dB

EIRP:

-SU-EXT model: +45 dBm (30 Watts) with 27 dBi dish antenna
-SU model: +35 dBm (3.8 Watts) with 17 dBi patch antenna

Freq. Stability: .000435 % PLL Stabilized (4.35 ppm) over temp

Freq. Plan: Single upconversion, 480 MHz IF

Modulated BW: 22 MHz (null to null, 20 dB)

2nd Harmonic atten: Per CFR47 part 15.247

LO Supression: Per CFR47 part 15.247

Symbol Rate: 1.375 MSPS

Modulation: 1 MBPS DBPSK for header, 11 MBPS CCK spread spectrum for payload

Data Section:

Buffer size: 128K Bytes

Data Rate (User): Up to 10 MBPS Sustained throughput

Format: 10/100 BaseT IEEE 802.3 Ethernet compliant

Ethernet packet: Up to 1600 byte long packets

Power

Input Voltage: Input voltage range at unit is 10.5 VDC to 21 VDC max
Power is supplied on Ethernet cable using junction box provided with up to 330 foot 24 AWG STP cable.

Current Cons.: 540 mA in transmit mode at max power using 20 V standard adapter (10.8W)
670 mA in transmit mode with heater on using 20 V standard adapter (13.4W)
500 mA in receive mode using 20 V standard adapter (10 W)

Receiver Section

Radio Section

Default channels- Channel 1: 5.736 GHz
Channel 2: 5.756 GHz
Channel 3: 5.776 GHz
Channel 4: 5.796 GHz

Channel 5: 5.816 GHz
Channel 6: 5.836 GHz
Channels 7-32: not programmed

Cascade Noise Figure: < 6 dB
Sensitivity:
(1E10-6 BER) - 82 dBm typical-1600 byte packet
- 87 dBm typical-64 byte packet

Adj. Channel Rejection: > 20 dB
Image Rejection: > 60 dB
Frequency Plan: Single conversion, IF at 480 MHz
LO stability: .00025% PLL stabilized (+/-2.5ppm)
over temperature range
Input compression point: > -10 dBm

Data Output Section:

Buffer size: 128K Bytes
Data Rate (User): 10 MBPS Maximum sustained throughput
Format: 10/100 BaseT IEEE 802.3 Ethernet compliant
Ethernet Protocols: TCP/IP, Telnet, TFTP, UDP

Mechanical and Environmental

General

Material: Powdercoated Aluminum base with polycarbonate radome

Size: 12.5" x5" x8" including mounting studs
Weight: 4 lb
Mounting: Grey steel pole mount provided

Connectors/Indicators

RF Output: Direct connect to antenna per Part 15C, 15.203.

FCC Compliance: The transceiver shall comply with the following: FCC Part 15.247
FCC Part 15.207(a)

Serial Interface: RJ11 connector
LAN Interface: Shielded RJ45 connector
Power: Carried on 4 unused pins of Ethernet cable

Environmental

Operating Temp:	-40 to 60 °C
Storage:	-40 to 85 °C
Humidity:	100 % When sealed properly
NEMA Rating:	NEMA 4
Shock:	Sustain 3 axis drop from 5 feet

STANDARD EXTERNAL POWER SUPPLY

20 Volt DC Power adapter and J-Box supplied with product.

Type:	Linear wallmount transformer
Input:	120 VAC
Output:	20 VDC +/- 1 V
Max current:	1200 mA at 20 V

STANDARD ANTENNA FOR M5800S-SU-EXT (EXTERNAL)

The unit is designed to operate with the AD5800-27-D dual linear polarized dish antenna.

Type:	Dish Antenna
Polarization:	Vertical, Horizontal electrically selectable
Frequency:	5.7 to 5.9 GHz
Gain:	+27 dBi
Az Beamwidth:	7°
EI Beamwidth:	7°
Cross Pol:	> 15dB
Front/Back Ratio:	> 30dB
VSWR:	2:1
Wind Loading:	80 mph operational

STANDARD ANTENNA FOR M5800S-SU (INTERNAL)

Type:	Patch Array Antenna
Polarization:	Vertical, Horizontal electrically selectable
Frequency:	5.7 to 5.9 GHz
Gain:	+17 +/- 1 dBiL
Az Beamwidth:	18 degrees (3 dB down)
EI Beamwidth:	18 degrees (3 dB down)
Cross Pol:	>15 dB
Front/Back Ratio:	>30 DB as mounted in M5800SB-SU
VSWR:	< 2.0:1 over Bandwidth

8. Appendix: Firmware - Hardware Cross Reference

<u>Hardware Model</u>	<u>Firmware Release</u>	<u>Firmware File</u>	<u>Release Date</u>
M5800SB-AP-60 Rev 1 SNs:00000001 to 00000030 SNs:00000034 to 00000055	Original Release	Main: APBR10B2V1d01091201.S19 FPGA: V01021E00.HEX Checksum: 665A44A9,xF75A64AF Wizard: Version 0.9	9/12/01
	Release 1.1	Main: AP_1p1H8000D01121804.S19 FPGA: V01021E00.HEX Checksum: 83B13657,x14B1565D Wizard: Version 1.0	12/19/01 12/20/01
	Release V1.2	Main: AP_1p2H8000D02021904.S19 FPGA: V01021E00.HEX Checksum: D0559882 Wizard: Version 1.1	
M5800SB-SU-EXT Rev 1 SNs:00100001 to 00100160	Original Release	Main: SUBR10B2V1D01091201.S19 FPGA: V01021E00.HEX Checksum: B4CBC240, 45CBE246 Wizard: Version 0.9	9/12/01
	Release 1.1	Main: SU_1p1H0000D01121804.S19 FPGA: V01021E00.HEX Checksum: 70DD0C9E, 01DD2CA4 Wizard: Version 0.9	12/19/01 12/20/01
	Release V1.2	Main: SU_1p2H0000D02021904.S19 FPGA: V01021E00.HEX Checksum: E6469741 Wizard: Version 1.1	
M5800S-AP-60 Rev A	Original Release V1.1	Main: AP_1p1H8001D01121804.S19 FPGA: V01021E00.HEX Checksum: D567E556 Wizard: Version 0.9	12/19/01 12/20/01

<u>Hardware Model</u>	<u>Firmware Release</u>	<u>Firmware File</u>	<u>Release Date</u>
M5800S-SU-EXT Rev A	Original Release V1.1	Main: SU_1p1H0001D01121804.S19	12/19/01
		FPGA: V01021E00.HEX Checksum: E6469741 Wizard: Version 0.9	12/20/01
M5800S-AP-60 Rev A M5800S-AP-60 Rev B	Release V1.2	Main: AP_1p2H8001D02021904.S19	3/18/02
		FPGA: V01021E00.HEX Checksum: D0559882 Wizard: Version 1.0	2/7/02
	Release V1.3	Main: AP_1p3H8001D02060301.S19	6/3/02
		FPGA: V01021E00.HEX Checksum: 47597210 Wizard: Version 1.1	5/31/02
	Release V1.41	Main: AP_1p41H8001D02090401.S19	9/5/02
		FPGA: V01021E00.HEX Checksum: DA28E7B7 Wizard: Version 1.1	5/31/02
M5800S-SU-EXT Rev A M5800S-SU-EXT Rev B M5800S-SU Rev B	Release V1.2	Main: SU_1p2H0001D02021904.S19	3/18/02
		FPGA: V01021E00.HEX Checksum: E6469741 Wizard: Version 1.0	2/7/02
	Release V1.3	Main: SU_1p3H0001D02060301.S19	6/3/02
		FPGA: V01021E00.HEX Checksum: 8F8EDE1 Wizard: Version 1.1	5/31/02
	Release V1.41	Main: SU_1p41H0001D02090401.S19	9/5/02
		FPGA: V01021E00.HEX Checksum: 0D0572EC Wizard: Version 1.1	5/31/02