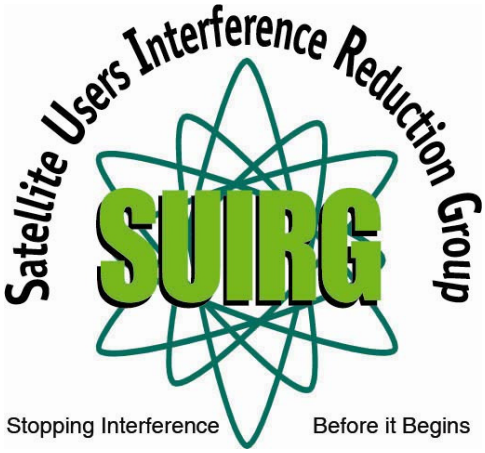

Test Plan & Procedures
for
Measurement of WiMAX to FSS Interference

[Addendum to SUIRG WiMax Field Test Report]

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Reviewed and approved by:

- SUIRG
- WBU/ISOG
- GVF
- NABA
- US Navy
- SAP-REG
- WTA

Test Plan and Procedures for Measurement of WiMAX to FSS Interference

Objective:

Measure the interference level generated by WiMAX transmission into a Fixed Satellite Service (FSS) satellite receiving station by taking measurements of C/N, BER and digital power of a test satellite channel. The testing was performed in 2 phases where during phase 1 the FSS antenna was fixed and a WiMAX subscriber unit was moved to several locations with various angles and distances to the FSS antenna. During Phase 2 the WiMAX base antenna was fixed at a height of 50 meters on a tower and the FSS antenna was moved to several locations with various angles and distances from the WiMAX antenna. Figure 1 shows the typical test set-up for both phases.

Test Equipment and Set Up

The following equipment was used during the test. The connection of test set up is shown in Figure 1. The specification of antenna system and WiMAX equipment are given in Appendix 1.

Item	Description	Manufacturer	Model
(a)	2.4-meter Diameter Antenna with C-band Dual Feed horn	Prodelin	Series 1244
(b)	LNA in 3.4 – 4.2 GHz Band	Vertex/RSI	LCC4S30
(c)	Down Converter	Novella SatComs	BD500 Series
(d)	Coupler	Narda	
(e)	WiMAX Base Station Equipment	Proxim	3500-B00-AM0 – MP.16 3500
(f)	WiMAX Base Station Panel Antenna	Proxim	3338-A00-120
(g)	WiMAX Subscriber Station Equipment	Proxim	3500-S00-AM0 – MP.16 3500
(h)	WiMAX Subscriber Station Antenna	Proxim	3437-A00-018
(i)	Portable Handheld GPS	GARMIN	GPS 45XL
(j)	Spectrum Analyzer	H/P-ESA	4407B
(k)	Digital Satellite Receiver	Tandberg	1260 Mpeg2-DVB
(l)	15” LCD Television Set	Polaroid	FLM-1511
(m)	Power Inverter		
(n)	Misc. cables & connectors		

Test Methodology

The interference effect to satellite signal reception from Satellite NSS 806 @ 319.5E was measured in this test during phase 1 and phase 2. The testing was done in two phases at two difference locations: Phase 1 was done in Punta Gorda, Florida where the WiMAX transmitter was located at several different locations while the FSS antenna remains fixed. Phase 2 was conducted in the Maryland and Virginia area where the WiMAX antenna was mounted on a tower at 50 meters and the FSS antenna moved to various distances and angles from the WiMAX antenna.

WiMAX frequencies used for the test are detailed in the following test procedure. The C/N, BER and digital power of a video program channel was measured directly at the LNA output. The data collected was reviewed and compared with that of theoretical analysis.

The following outlines the steps involved in the test. The detailed test procedures are provided in Appendix 1.

Phase 1- Punta Gorda, Florida

- A carrier was transmitted from a known location on Satellite NSS 806, utilizing various modulation and coding techniques.
- Aligned the satellite antenna to receive video program channel at 3,515 MHz.
- Measured at the D/C output the C/N, BER and digital power of the carrier @ 3,515 MHz to establish a baseline.
- Located the WiMAX transmitter at varying distances and angles relative to the satellite antenna using the GPS and make a measurement at each angle and distance.
- Adjusted the WiMAX transmitter to various frequencies and various output power levels.
- Measured the C/N, BER and digital power of the received signal at the D/C output and record the TV picture quality.
- Measured, with the spectrum analyzer, the WiMAX transmitter output power level within the immediate area of the C-Band antenna at the assigned WIMAX test frequency.

Phase 2- Maryland and Virginia Area along the Potomac River

- A carrier was transmitted from a known location on Satellite NSS 806, utilizing various modulation and coding techniques.
- Aligned the satellite antenna to receive video program channel at 3,515 MHz.
- Measured at the D/C output the C/N, BER and digital power of the carrier @ 3,515 MHz to established a baseline.
- Located the WiMAX transmitter antenna at an elevation of 50 meters on a tower.
- Made measurements at the FSS antenna at varying distances and angles relative to the WiMAX antenna.
- Adjusted the WiMAX transmitter to various frequencies and various output power levels.
- Measured the C/N, BER and digital power of the received signal at the D/C output and recorded the TV picture quality.
- Measured, with the spectrum analyzer, the WiMAX transmitter output power level within the immediate area of the C-Band antenna using a unity gain handheld antenna at the assigned WIMAX test frequency.

Test General Notes

1. This procedure was verified and agreed upon by the following organizations:
   - SUIRG: Satellite Users Interference Reduction Group
   - WBU-ISOG: World Broadcasting Union – Inter Satellite Operations Group
   - GVF: Global VSAT Forum
   - SAP-REG Satellite Action Plan Regulatory Working Group
   - NABA: North American Broadcasters Association
   - US Navy: NSWC Dahlgren
   - WTA: World Teleport Association

2. The entire testing process could be witnessed by any interested party involved in the Satellite Industry.

3. The "TV Picture Quality" result was based on the following:
   - Grade 1: Excellent Broadcast quality
   - Grade 2: Occasional Blocking, poor BER
   - Grade 3: Frequent Blocking, Emergency Broadcasts only
   - Grade 4: Unusable

4. Procedural steps A—J were to be repeated upon the insertion of the band pass filter to address the problem of LNA saturation; however, the LNA never saturated.

5. Spectrum Plots from the Analyzer were taken at every point during procedure using the following settings:
   - Span: 50Mhz
   - RBW: 100Khz
   - VBW: 1Khz
   - 5dB/div (or a more applicable as deemed necessary during the test)
   - Max hold or Video Averaging Techniques may be used if deemed necessary

6. Data Sheet Definitions
   - Site ID: Remote terminal location where measurements were made
   - Nominal C/I_0 @ LNA: Carrier to Interference Ratio at LNA output with no WiMAX Carrier present.
   - TV Picture Quality: See note 3
   - C/N (dB) WiMAX: Carrier to Noise Ratio of WiMAX transmit carrier
   - RX BER: Receive Bit Error Rate as measured by the receiver
   - C/I (d/B) LNA: Carrier to Interference Ratio @ LNA output with WiMAX carrier present
   - $\triangle$ I @ LNA: Difference in Interference level with and without WiMAX carrier present

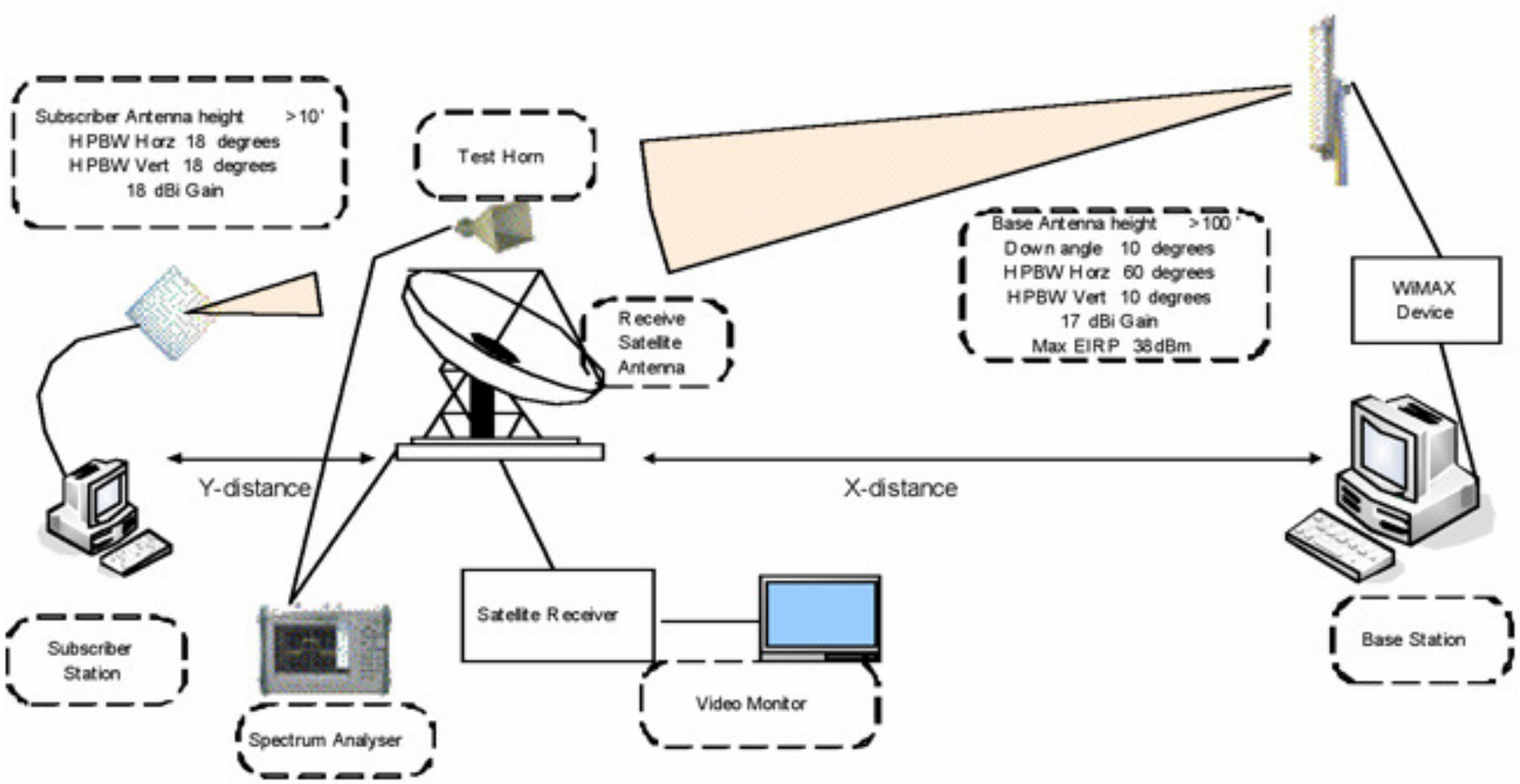

Figure 1: *Typical test set-up*

Test Procedures

Phase 1

Phase 1 was conducted in Punta Gorda, Florida where the WiMAX transmitter was located on a mobile platform (consisting a boat and an automobile) at a slightly elevated level of about 4 meters while the FSS antenna remained at a fixed location.

Punta Gorda is a residential community of canals and single level homes. The geography of this community allowed the WiMAX system to be located at various distances and angles to the FSS antenna through the use of a boat and an automobile (see figure 2 for picture of FSS antenna and remote test site locations). The Phase 1 testing process encompassed:

- A video carrier transmitted from the SES owned facility at Manassas, Virginia on satellite NSS 806, with the following operating parameters: Symbol Rate: 6532 Ksymbols, QPSK, FEC ¾
- The satellite FSS antenna was aligned to receive the video test transmission at 3,515 MHz
- The receive C/N of the test video carrier was approximately +10 dB
- The BER and digital power of the carrier were measured at the output of the Block Down Converter to establish a baseline measurement
- The WiMAX transmitter and omni-directional antenna were fixed to a mobile platform
- Various measurements were taken while the WiMAX transmitter was relocated to varying distances and angles relative to the satellite FSS antenna
- Both frequency and power level adjustments were made to the WiMAX transmitter
- Both C/N and BER values along with picture quality and spectrum analyzer measurements were also taken at the output of the block down converter
- The final test during phase 1 utilized a directional WiMAX antenna with 18 dB gain

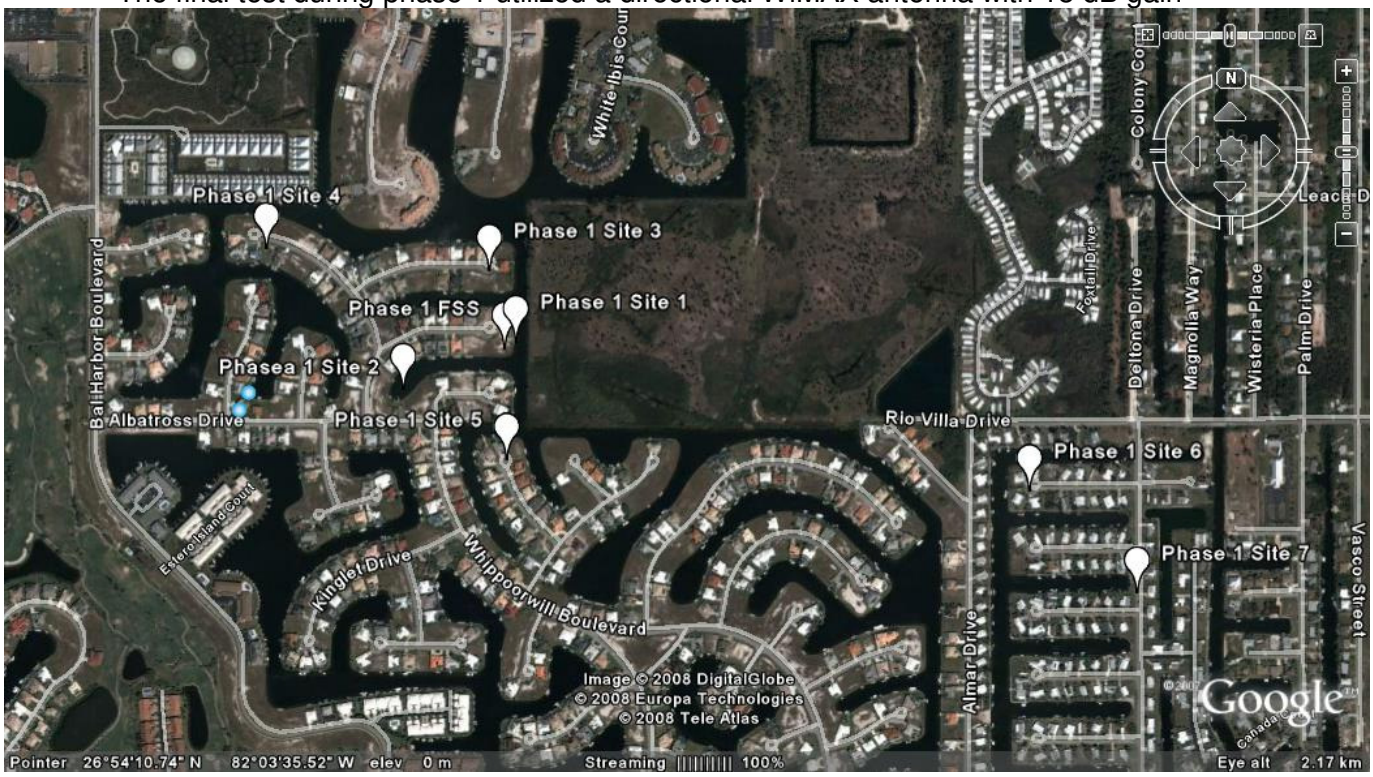

Figure 2: *Phase 1 Test Location Final Sites*

Phase 1: FSS Antenna and Remote WiMAX Test Locations

FSS Antenna Location	**N26°54'13.6" W82°03'47.8"**

As the measurement process continued it became apparent that some pre-selected sites would not have provided any usable information and that additional locations were defined to provided additional data to support previous measurements. As a result, the sites as defined in the above chart were the actual measurement sites.

Phase 2

The Maryland and Virginia areas along the shores of the Potomac River allowed for longer distance testing while maintaining a direct line-of-sight between the WiMAX antenna and the FSS system (see figure 3 for picture of FSS antenna test set-up location and figure 4 for the water tower where the WiMAX hub antenna was installed). Figure 5 provides an overview of the Phase 2 sites including the water tower and the 2 FSS test sites identified as short and long to distinguish the distances of 3.5 km and 12 km, respectively.

Figure 3: *Phase 2 WiMAX antenna location*

Figure 4: Phase 2 test locations

Phase 2 Antenna Locations

WiMAX antenna on Water Tower	N38°20'12" W77°12'32"
FSS Antenna Short	N38°21'58" W77°13'11"
FSS Antenna Long	N38°23'47" W77°19'03"

The Phase 2 testing process encompassed:

- A carrier transmitted from an SES owned facility in Manassas, Virginia on the NSS 806 satellite @ 319.5 East, with the following operating parameters: Symbol Rate: 6532 Ksymbols, QPSK, FEC ¾
- The WiMAX antenna and hub transmit equipment were located on a water tower (approximately 50 meters elevation) along the shores of the Potomac River in Northern Virginia
- The satellite FSS antenna was mounted onto a mobile platform and aligned at the various locations to receive the test carrier at 3,515 MHz
- The receive C/N of the test carrier was approximately 10 dB
- The BER and digital power of the carrier were measured at the output of the Block Down Converter to establish a baseline measurement
- The FSS antenna was relocated to varying distances and angles relative to the WiMAX antenna and a measurement was made at each location

Operational Test Procedures

Tests were conducted using various different operational modes as described below:

Step #	Operational Test Procedure						
	Satellite Name & Orbital Location: NSS 806						
	Align the satellite antenna to receive video carrier at 3,510 MHz and measure.						
A1	Set the WiMAX transmitter to transmit : MHz						
		a) 3400	b) 3450	c) 3500	d) 3550	e) 3600	
A2	Set the output of the WIMAX transmitter to: dBm						
		a) 5	b) 10	c) 15	d) 20	e) 25	
A3	Locate the WIMAX transmitter from Satellite Antenna: Meters						
		a) 20	b) 75	c) 150	d) 300	e) 500	f) 1000
A4	Nominal angle of WIMAX transmitter towards FSS antenna dependent upon available locations. Degrees						
		a) 0	b) 45	c) 90	d) 135	e) 180	

For the purposes of this test, particular attention was paid to the following:

i. Output level from the WIMAX transmitter (A2)
ii. Distance of the WIMX transmitter from the Satellite antenna.(A3)
iii. Angle of WIMAX transmitter from Satellite antenna bore sight (A4)

If required, testing will also be conducted using different transmit frequencies from the WIMAX transmitter.

Sample of Test Procedures and Measurement Data Sheet

I. Test Configuration: A1B1C1: WIMAX transmitter **3400 MHz @ 5 dBm** w/ 20 meter distance and various angles

Step #	Procedures
	Align the satellite antenna to receive @ 3,510 MHz and take measurement.
A1	**Set the WIMAX transmitter to transmit 3400 MHz**
B1	**Set the output of the WIMAX transmitter to 5 dBm**
C1	**Locate the WIMAX transmitter 20 meters from Satellite Antenna**
D1-4	Angle of WIMAX transmitter towards FSS antenna- Test site IDs A1, A2, A3, A4
E	Measure Results and record below

Results					
Site ID	TV Picture Quality	C/N (dB) WIMAX	BER Rx Signal	C/N (dB) LNA	WiMAX power @ Satellite Antenna (dBm)
A1					
A2					
A3					
A4					

Test Configuration A1B2C1: WIMAX transmitter @ **10 dBm** w/ 20 meter distance and various angles

Results					
Site ID	TV Picture Quality	C/N (dB) WIMAX	BER Rx Signal	C/N (dB) LNA	WiMAX power @ Satellite Antenna (dBm)
A1					
A2					
A3					
A4					

Test Configuration A1B3C1: WIMAX transmitter @ **15 dBm** w/ 20 meter distance and various angles

Results					
Site ID	TV Picture Quality	C/N (dB) WIMAX	BER Rx Signal	C/N (dB) LNA	WiMAX power @ Satellite Antenna (dBm)
A1					
A2					
A3					
A4					

Test Configuration A1B4C1: WIMAX transmitter @ **20 dBm** w/ 20 meter distance and various angles

Results					
Site ID	TV Picture Quality	C/N (dB) WIMAX	BER Rx Signal	C/N (dB) LNA	WiMAX power @ Satellite Antenna (dBm)
A1					
A2					
A3					
A4					

Test Configuration A1B5C1: WIMAX transmitter @ **25 dBm** w/ 20 meter distance and various angles

Results					
Site ID	TV Picture Quality	C/N (dB) WIMAX	BER Rx Signal	C/N (dB) LNA	WiMAX power @ Satellite Antenna (dBm)
A1					
A2					
A3					

APPENDIX 1: Equipment Specifications

Appendix 1A: Antenna System Equipment Specifications

1A-1: Receive 2.4 meter FSS Antenna (Prodelin Model 1244)

See specification sheet Annex 1C.

1a-1.1 Receive FSS Antenna subsystems:

1a-1.1.1 C-band Dual Feed horn

1a-1.1.1.2 C-Band down-converter (Novella SatComs Model – BD511)
See specification sheets Annex 1D

1a-1.1.1.3 LNA in 3.4 – 4.2 GHz Band (Model – Vertex/RSI LCC4S30)
See specification sheets Annex 1E.

1A-2: WiMAX Base Station Panel Antenna (Proxim Model 3338-A00-120)
Description: Outdoor 13 dBi, 120° Sector antenna for the 3.3-3.8 GHz frequency range. The 13 dBi, 120° Sector antenna is ideally suited for use with the MP.16 3500 base station.

Specifications:

Electrical	
Part Number	3437-A00-018
Frequency Range	3300 MHz - 3800 MHz
VSWR	1.7:1 (max)
Gain	13 dBi
Polarization	Vertical
HPBW/horizontal	120°
Downtilt	8°
Power Handling	6W
Impedance	50 Ohm
Connect or Type	N-type Female
Mechanical & Environmental Specifications	
Dimensions	500 x 200 x 30 mm
Weight	1.5 Kg
Temperature Range	-45°C to 70° C
Humidity	144h @ 95%
Survival wind speed	220 Km/hr
Lightning Protection	DC Grounded
Radome Color	Gray, White
Radome Material	Plastic

1A-3: WiMAX Subscriber Station Panel Antenna (Proxim Wireless Tsunami WiMAX MP.16 3437 Outdoor, 18 dBi Flat Panel Subscriber Antenna)

Description: Outdoor, 18 dBi Flat Panel antenna for the 3.3-3.7 GHz frequency range. The 18 dBi Flat Panel antenna is for use with the Proxim MP.16 3500 subscriber station.

Specifications: Electrical	
Part Number	3437-A00-018
Frequency Range	3300 MHz - 3700 MHz
VSWR	1.5:1 (max)
Gain	18 dBi
Polarization	Linear, vertical
HPBW/horizontal	18°
HPBW/vertical	18°
Power Handling	20 W
Impedance	50 ohms
Connector Type	N-type Female
Mechanical & Environmental	
Dimensions	305 x 305 x 25 mm
Weight	1.5 Kg
Temperature Range	-40°C to 80° C
Humidity	95% @ 55° C
Survival wind speed	216 km/hr
Lightning Protection	DC Grounded
Radome Color	Gray - White
Radome Material	PC, V-2

APPENDIX 1B: WiMAX Base and Subscriber System Equipment Specifications

1.2.1 WiMAX Base Station (Proxim Tsunami 3500-B00-AMD) & Subscriber Station (Proxim Tsunami 3500-S00-AM0) Technical Specifications

Equipment description: Consists of an all-outdoor, single sector base station and multiple subscriber configurations (integrated antenna or N-Connector for external antenna), the Tsunami MP.16 series offers a scalable, WiMAX certified system for the 3.5 GHz frequency band.

	Tsunami™ MP.16 Series Highlights
Product Model	MP.16 3500
Description	WiMAX Forum Certified™ products for 3.5 GHz frequency band
Applications	• Broadband last-mile access for metropolitan and rural areas • Voice, video and data transmission with optimal economics • Security and surveillance
Environments	• Service provider and municipal broadband networks • Security and surveillance
Key Features	Product complies with IEEE 802.16 - 2004 standard • WiMAX QoS for voice, voice, data • All-in-one, outdoor base station delivers scalable solution by allowing single sector deployments to grow into multi-sector deployments
SPECIFICATIONS	
Frequency Band	3.40 - 3.60 GHz
Wireless Protocol	802.16-2004
Data Rate	25.4 Mbps
QoS	802.16d QoS (WiMAX)
Security	• AES • Radius base authentication of subscribers based on MAC address
Form Factors	• Base: ODU, N-connector • Subscriber station: ODU, N-connector or Integrated 21 dBi Antenna

CONFIGURATIONS/ MODEL	3500-B00-AM0 – MP.16 3500 Base Station 3500-S00-AM0 – MP.16 3500 Subscriber Station
WIMAX COMPLIANCE	IEEE 802.16-2004 (WiMAX profile 3.5T1)
WARRANTY	1 Year Parts and Labor
FREQUENCY	3.4 GHz to 3.6 GHz
DUPLEXING MODE	TDD
CHANNEL BANDWIDTH	3.5 MHz and 7 MHz
INTEGRATED ANTENNA	Gain 18 dBi (3,500 dBi only)
ANTENNA PORT	Connector N-Female, 50 ohms
DATA COMMUNICATION PORT	Standard 10/100 Base-TX Ethernet, Manual/Auto Negotiate, Half/Full Duplex, RJ-45
SERIAL PORT / GPS PORT	RJ-45 Connector
NLOS & INTERFERENCE MITIGATION FEATURES	OFDM 256 FFT, Adaptive Modulation, FEC
OUTPUT POWER (AT ANTENNA PORT)	Up to 21 dBm User Attenuation Control: Maximum BS Output Power configurable to 5-21 in one dB step
MODULATION	

FRAME DURATION						
RADIO PERFORMANCE		Modulation & FEC	Rx Sensitivity (10^{-6})	Minimum C/I	Spectral Efficiency	Burst Data Rate, Mbps Tg/Tb = 1/16
	3.5 MHz	BPSK- 1/2	-95 dBm	4.5 dB	0.5 bps/Hz	1.4 Mbps
		QPSK- 1/2	-92 dBm	6.6 dB	1 bps/Hz	2.8 Mbps
		QPSK- 3/4	-90 dBm	8.9 dB	1.5 bps/Hz	4.2 Mbps
		16QAM- 1/2	-87 dBm	11.9 dB	2 bps/Hz	5.6 Mbps
		16QAM- 3/4	-84 dBm	15.2 dB	3 bps/Hz	8.5 Mbps
		64QAM- 2/3	-80 dBm	19.3 dB	4 bps/Hz	11.3 Mbps
		64QAM- 3/4	-78 dBm	21.3 dB	4.5 bps/Hz	12.7 Mbps
	7 MHz	BPSK- 1/2	-92 dBm	4.5 dB	0.5 bps/Hz	2.8 Mbps
		QPSK-1/2	-89 dBm	6.6 dB	1 bps/Hz	6.6 Mbps
		QPSK- 3/4	-87 dBm	8.9 dB	1.5 bps/Hz	8.5 Mbps
		16QAM- 1/2	-84 dBm	11.9 dB	2 bps/Hz	11.3 Mbps
		16QAM- 3/4	-81 dBm	15.2 dB	3 bps/Hz	16.9 Mbps
		64QAM- 2/3	-77 dBm	19.3 dB	4 bps/Hz	22.6 Mbps
		64QAM- 3/4	-75 dBm	21.3 dB	4.5 bps/Hz	25.4 Mbps
LOCAL MONITORING	Serial/CLI RJ45 Port; Logging feature which logs to serial port, flash, RAM, or a syslog server					
REMOTE MONITORING	Telnet/CLI, HTTP, TFTP; SNMP v1, v2 (MIBII, Proxim MIBs, Bridge MIB, RIPv2 MPB, 802.16 MIB, Ether like MIB)					
REMOTE MGMT ACCESS	Wired-LAN or over-the-air					
PASSWORD	Multi-Level Password (user, administrator, installer, factory, engineering)					
SUBSCRIBER AUTHENT	X509v3 digital certificate; Radius Authentication and Provisioning; MAC Address Table					
VLAN	Support for 802.1Q VLAN tagging and filtering; Support for transparent passing of 802.1Q-compliant VLAN tagged frames					

QOS	Asymmetric Bandwidth: Uplink and Downlink CIR Control "committed information rate" per service flow Control: Uplink and Downlink MIR Control "maximum information rate" per service flow Packet Classification: 802.1D/802.1Q/802.1p priority, IPTOS, VLAN ID, IP source/destination address Capabilities: source/destination port, Ethernet source/destination address ,IP protocol, and Ether type Scheduling: Best Effort, Universal Grant Services, Traffic is scheduled per service flow, enabling min/max bandwidth, priority, jitter and latency control for voice, video and data	
	Outdoor Radio Unit (SS and BS)	**Indoor Power Injector**
OPERATING TEMPERATURE	-40° to +60°C	° to +40°C
WEIGHT	5.3 lbs	2.7 lbs
DIMENSIONS	Packaged (BS, SSR): 14.57 x 13.70 x 8.19 in	5.12 x 3.62 x 2.64 in
SAFETY STANDARDS	EN 60950 (CE) or CUL, VDE EN60950 or TUV.	UL 1950 D3; CSA 22.2 N0.950
EMI STANDARDS	RSS-210 (Canada), ETS EN 301 489-1, 301 021, TS2 (SS), ETS 301 02ETS 3021 085 CS2 (BS) .	Conduction: FCC docket 20780 curve "B"ETS 302 085 VDE 0871 curve" B Radiation: FCC class "B"
STATIONS	**BASE STATION:** Tsunami MP.16 Base Station Radio Indoor Subscriber Station Power Injector 4" Pole Mount Bracket Serial Dongle for Antenna Alignment Cable Termination Kit Quick Installation Guide CD-ROM containing User Documentation Indoor Base Station Power Injector	**SUBSCRIBER STATION:** Tsunami MP.16 Subscriber Radio (either with Type-N or Integrated Antenna) 4" Pole Mount Bracket Cable Termination Kit Power Cord (for Indoor Power Injector) Printed Quick Installation Guide
ACCESSORY AND SPARE KITS	Spare Power DC Injector (69823) Surge Arrestor 5 GHz - Standard-N Female to Female (5054-SURGE) POE (Power Over Ethernet) Surge Arrestor (70251);	

APPENDIX 1C: Prodelin Series 1244 Antenna System

Antenna Size:	2.4 M (8 ft.)
Operating Frequency Receive:	3.625 - 4.2 GHz
Midband Gain (+ .2dB) Receive:	38.0 dBi 38.0 dBi 47.6 dBi
Antenna Noise Temperature:	20° elevation 46 K
	30° elevation 45 K

Sidelobe Envelope, Co-Pol (dBi):

100λ / D	θ < 20°	29-25 Log θ dBi	29-25 Log θ dBi 29-25 Log θ dBi
20° < θ < 26.3°		- 3.5 dBi	- 3.5 dBi - 3.5 dBi
26.3° < θ < 48°		32 -25 Log θ dBi	32 -25 Log θ dBi 32 -25 Log θ dBi
θ > 48°		-10 dBi (averaged)	-10 dBi (averaged) -10 dBi (averaged)

Cross-Polarization:	-30 dB on axis N/A -30 dB within B.P.E.
Axial Ratio Receive:	N/A 1.3 VAR (2.28 dB) N/A
VSWR:	1.3:1 Max. 1.3:1 Max. 1.3:1 Max.
Reflector Material:	Glass Fiber Reinforced Polyester SMC
Antenna Optics:	Four Piece, Prime Focus, Offset Feed
Mast Pipe Size:	6" SCH 40 Pipe (6.62" OD) 16.80 cm.
Elevation Adjustment Range:	5° to 90° Continuous Fine Adjustment
Azimuth Adjustment Range:	+ 30° Fine, 360° Continuous
Mount Type:	Elevation over Azimuth
Shipping Specifications:	484 lbs. (218 kg.)
Wind Loading Operational:	50 mph (80 km/h)
Survival:	125 mph (201 km/h)
Temperature Operational:	-40° to 140° F (-40° to 60° C)
Survival:	-50° to 160° F (-46° to 71° C)
Rain Operational:	1/2" /hr
Survival:	2" /hr
Atmospheric Conditions:	Salt, Pollutants and Contaminants as Encountered in Coastal and Industrial Areas
Solar Radiation:	360 BTU/h/ft2

APPENDIX 1D: Novella SatComs BD511 C-band Block Down Converter

INPUT SPECIFICATION		Options
1. Frequency range:	3.4 to 4.2GHz	
2. Connector:	SMA	N-type
3. Impedance:	50Ω	
4. Return loss:	≥20dB	
OUTPUT SPECIFICATION		
5. Frequency range:	950 to 1,750MHz (check model	
6. Connector:	SMA	N-type
7. Impedance:	50Ω	
8. Return loss:	15dB typical	≥20dB (*)
9. 1dB compression point:	+10dBm	
10. Third order intercept::	+20dBm	
TRANSFER CHARACTERISTICS		
11. Gain:	25d	
12. Gain ripple: over ±20MHz:	≤1dB p.t.p.	
over input band:	≤3dB p.t.p	
13. Gain 0°C to 50°C:	±1d	
14. Gain slope:	≤0.02dB/MH	
15. Noise figure:	16dB typical	
LOCAL OSCILLATOR		
16. Local oscillator frequency:	5.15GHz	
17. Frequency stability, 0°C to 50°C:	2 x 10^{-7}	Option 1: 10^{-7} Option 2: 10^{-8} Option 3: 3×10^{-9}
18. External reference:	10MHz, 0dBm	5MHz, 0dBm
SPURIOUS		
19. Image rejection:	>75dB	
20. In-band spurious (at 0dBm	<-60dBc	
21. Out of band Spurious:	≤-40dBm	
PHASE NOISE		
22. 10Hz:	<-45dBc/Hz	
23. 100Hz:	<-70dBc/Hz	
24. 1kHz:	<-80dBc/Hz	
25. 10kHz:	<-85dBc/Hz	
26. 100kHz:	<-95dBc/Hz	
27. 1MHz:	<-110dBc/Hz	
28. Mains related:	<-60dBc	
MISCELLANEOUS		
29. Power supply:	115V/230V ±10% 50/60Hz ±10%, 30VA	
30. Temperature: Operating:	0° to 50°C	
Storage:	-40° to 85°C	
31. Relative humidity: Operating:	0 to 90%	
Storage:	0 to 95%	
32. Summary alarm:	NO and NC dry relay contacts via rear mounted	
33. Summary alarm	Front panel LED	

.

APPENDIX 1E: Vertex LNA Specifications, LC-4000 Series

Parameter	Notes	Min	Nom./Typ.[a]	Max	Units
Frequency Range	Band "C" Band "D"	3.6 3.4		4.2 4.2	GHz GHz
Gain		60	64	66	dB
Gain Flatness	Full band Per 40 MHz			±0.5 ±0.2	dB dB
VSWR	Input Output		1.20 1.20	1.25 1.50	:1 :1
Noise Temperature[b]	At +23 °C Versus temperature		See Table 2	See Table 1	
Power Output at 1 dB compression	Standard Option 2	+10	+15		dBm dBm
3rd Order Output Intercept Point	Standard Option 2	+20 +20 +30	+22 +26 +32		dBm dBm
Group Delay per 40 MHz	Linear Parabolic Ripple			0.01 0.001	ns/MHz ns/MHz^2 ns p-p
AM/PM Conversion	-5 dBm output power			0.1	°/dB
Gain Stability (Constant Temp)	Short term (10 min) Medium term (24 hrs) Long term (1 week)			0.05 ±0.1 ±0.2	dB dB dB
Gain Stability	Versus temperature			±0.5	dB per °C
Maximum Input Power	Damage threshold Desens. threshold, 5.825-6.425 GHz		-0.05		dBm dBm
Connectors	Input Output Power		CPR 229G Flange Type N Female MS3112E10-6P (mate supplied)	0 -10	
Power Requirements	Voltage Current, standard Current, with Option 2	12	15	24	V mA mA
Operating Temperature			140	180	°C

Notes:

A: When there is only one entry on a line, the Nom/Typ column is a nominal value; otherwise it is a typical value. Typical values are intended to illustrate typical performance, but are not guaranteed.

B: Maximum noise temperature at +23 °C at any frequency in the specified band.

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For more information visit www.suirg.org or email info@suirg.org