TDC

Theater Deployable Communications

Baseline Requirements Document

Mid-Range Radio Module (MMRM)
(v1)
Dec 2003

ESC/NI4T
5 Eglin Street
Hanscom AFB, MA 01731

Table of Contents

List of Figures

List of Tables

1.0 SCOPE

This requirements document establishes the performance, manufacture and test requirements for the Theater Deployable Communications (TDC) Mid-Range Radio Module (MMRM) v1.

2.0 APPLICABLE DOCUMENTS

To the extent specified herein, the following documents of latest current issue on the date of this Baseline Requirements Document, form a part of this document.

Table 1 - Standards and Applicable Documents

Document Number	Title
FIPS 197	Specificaiton for the Advanced Encryption Standard (AES) 26 Nov 2001
MIL-STD-810F	Environmental Test Methods
Air Force Document	TDC BRD for Transmission Kits
Air Force Document	TDC BRD for System Kits
Air Force Document	TDC Standards Document

3.0 REQUIREMENTS

3.1 Module and Kit Definitions

The elements of the Mid-Range Radio Module (MRRM), Baseband Module, Transceiver/ Antenna Control Module, Antenna/ Outdoor Unit, and Operations and Maintenance Computer, operate together to provide deployable non-secure and secure voice and data communications beyond line of site using forward troposcatter and diffraction modes of propogation. [The Operations and Maintenance Computer provides the laptop and software for configuring and managing the elements of the Baseband Module, Transceiver/Antenna Control Module and Antenna/Outdoor Unit.] The MMRM components are shown pictorially in Figure 1. They are described briefly in the Sections 3.1.1 through 3.1.4 to provide the context in which the TDC mid-range radio will operate.

3.1.1 Baseband Module (BM)

The Baseband Module can be located in a sheltered environment closer to the TDC ICAP equipment which provides the source and terminus for the communications traffic. The BM contains the baseband signal conditioning and combining equipment and functions as a multi-protocol interface between the various data inputs and the adaptive channel modem. The BM also encrypts the composite communications traffic for transmission security. The BM can be located near the Transceiver/Antenna Control Module (TACM) or remotely from it with the inter-connecting link using wire or optical fiber (up to 2 km) depending upon the separation. Elements of the BM are shown in Figure 2.

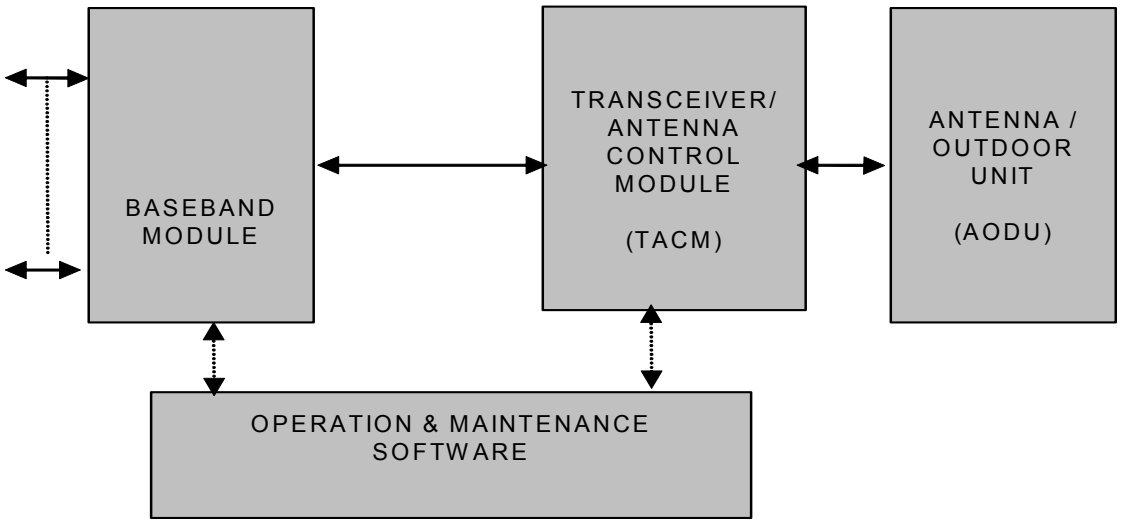

Figure 1 - Mid-Range Radio Components

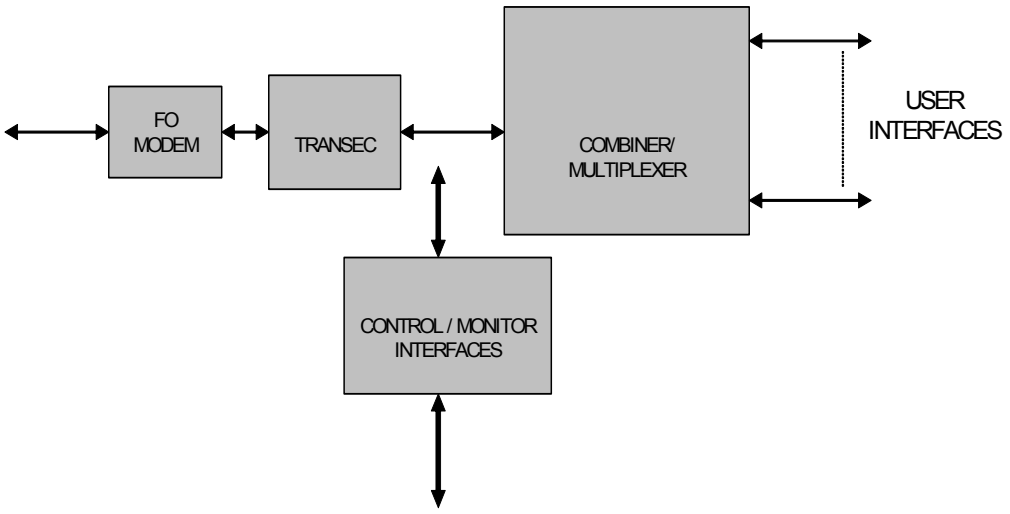

Figure 2 - Baseband Module Internal Elements

3.1.2 Transceiver/Antenna Control Module

The Transciever/Antenna Control Module (TACM) converts the composite digital communications data stream into radio frequency (RF) signals for transmission and converts the received RF signals into a single digital data stream. The TACM also provides control of the antenna azimuth and elevation ponting. The TACM contains the adaptive channel modem, frequency converters, and antenna controller. The TACM interfaces with the Antenna/Outdoor Unit (AODU) via coaxial cable and with the BM via wireline or optical fiber (up to 2 km) depending upon the separation between them. Internal elements of the TACM Module are shown in Figure 3.

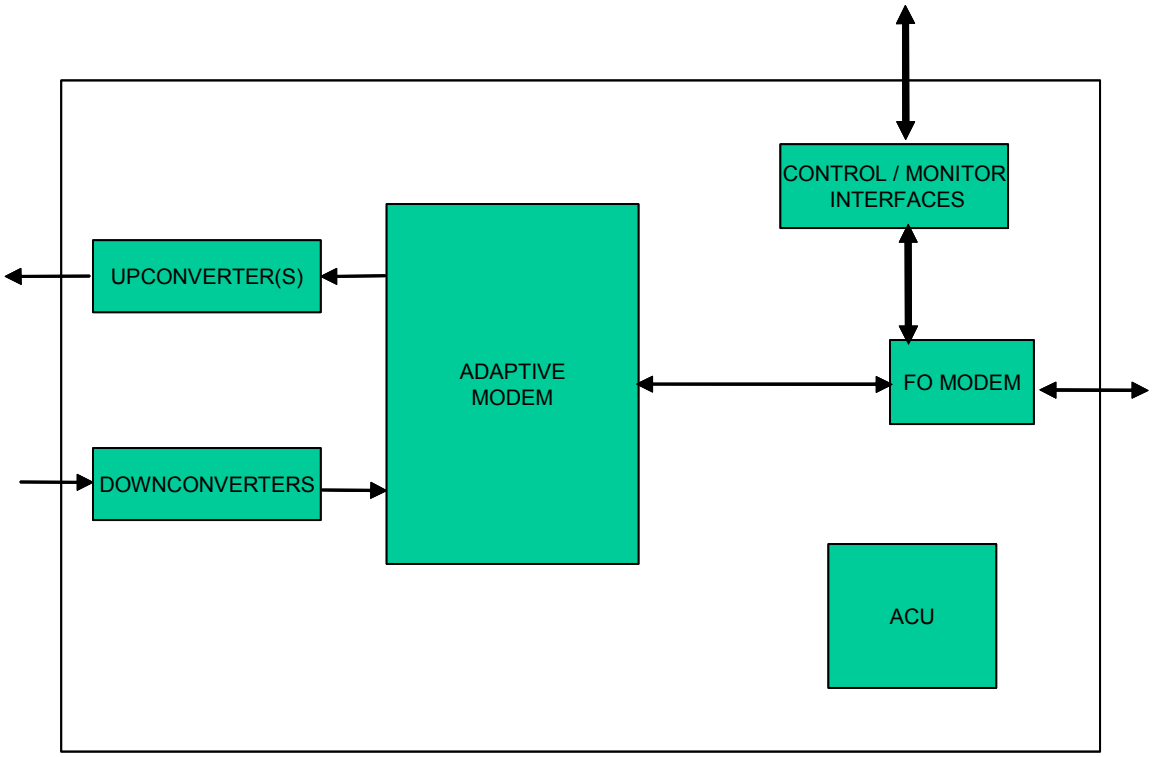

Figure 3 - Transceiver/Antenna Control Module Internal Elements

3.1.3 Antenna /Outdoor Unit (AODU)

The Antenna/Outdoor Unit (AODU) consists of a single reflector type antenna with associated feed(s) and filters, low-noise amplifier(s), power amplifiers, antenna positioner, and a mobile/ transportable pedestal/mast. The antenna/mast provides sufficient elevation of the antenna above the ground to mitigate foreground effects and clearance of near in obstacles while achieving the required elevation angle. Elements of the AODU are shown in Figure 4.

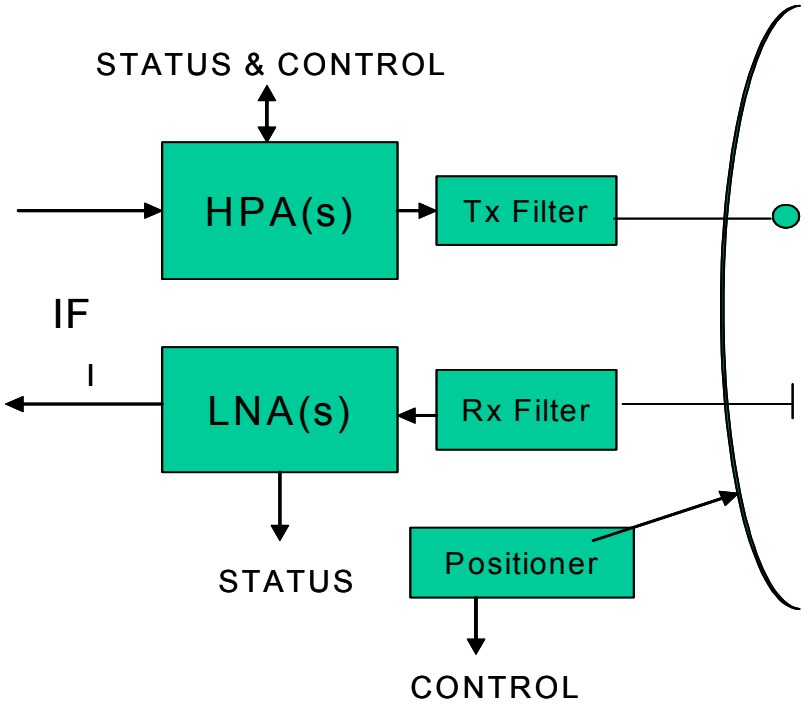

Figure 4 - Antenna/ODU Elements

3.1.4 Operations and Maintenance Computer (OMC)

The Operations and Maintenance Computer contains a laptop computer which interfaces to the Baseband Module (BM) and, for local control, to the Transceiver/Antenna Conrol Module (TACM). It also interfaces with the TACM through the BM using the interconnecting link. The OMC runs software to configure, operate and manage the mid-range radio.

3.2 Performance Requirements

3.2.1 Link Performance

The MRRM shall provide point-to-point transmission of digital voice and data traffic at rates up to 12 Mbps over distances between 50 and 150 miles using tropospheric scattering and diffraction modes as appropriate for a given geometry and path profile of a particular link using a single antenna. An average bit error rate of 10^{-9} is maintained with a link availability of .95 for the worst month in any climatic zone using a combination of explicit and implicit diversity techniques to counter the flat and frequency selective fading characteristics of the troposcatter channel. To reduce the required antenna size the MRRM shall operate in the regions of Ku-band allocated for fixed services.

3.2.2 Functional Requirements

3.2.2.1 Equipment Details

3.2.2.1.1 Baseband Module

The BM functions as a network processor containing ICAP compatible plug-in interfaces on the user side. It formats and multiplexes the data streams into an aggregate data stream which is bulk encrypted before it is transmitted to the adaptive channel.modem contained in the TACM. The connection to the TACM is user selectable by the operator as either wireline or multiple optical fiber carrying both the encrypted data traffic and encrypted control/monitoring data. The BM shall provide bulk encryption/decryption of the composite traffic using the Advanced Encryption Standard (AES) defined in FIPS-197. Provisions shall be made for optional encryption of the aggregate data through a KIV-19 encryption device. The ability to detect sync loss and to resync the KIV-19 shall be provided.

3.2.2.1.1.1 Data Interfaces

The BM shall provide the following types of interfaces:

- T/1fractional rate T1 and PRI/fractional PRI rate ports (copper and fiber)
- 100 Base TX or 100 Base FX Ethernet Ports
- EIA-530 ports

as defined in the TDC Standards documents. A Minimum of 8 interfaces shall be supported simultaneously (at least two of any type and up to 4 of any one type. A SNMP Ethernet interface (100 base TX) shall be provided for SNMP monitoring and management. A voice orderwire shall also be provided a defined path for accommodating IPV6 via Software / firmware field upgrades shall be provided.

3.2.2.1.2 Transceiver/Antenna Control Module

The TACM contains the adaptive modem, frequency converters and antenna control unit. It connects to the BM by either wireline or optical fiber and to the Antenna Kit via coaxial cable. The frequency converters in the TACM shall be tunable in 100 kHz steps. In addition to providing initial pointing of the antenna, the antenna control unit shall provide the means, either by itself or in concert with the adaptive modem, of compensating for changes in the common volume so as to maximize performance.

3.2.2.1.3 Operation & Maintenance Computer

The OMC Kit shall operate under a Windows 200x or Windows XP operating system and contain the software configuring and operating the MMRM and monitoring its status and performance. The OMC shall interface directly with the TACM for initial setup and configuration and shall interface with the BM for subsequent reconfiguration and operation. The OMC shall also be

capable of performing the same function remotely of the MMRM over a secure IP network. The OMC software shall be capable of supporting IPV6 (as supported by the host operating system).

3.2.2.1.3.1 Equipment Diagnostics

The OMC software shall include continuously running diagnostics to detect and report major faults in the BM, TACM and AODU Modules. The OMC shall include built-in diagnostics to aid the operator in isolating faults to the LRU level.

3.2.2.1.4 Timing

The MRRM shall accommodate line timing as well as contain a free-running timing mode with a +/-20 ppm accuracy. End to end jitter generation, including uncorrected effects of the medium, shall not exceed 0.020 UI rms. Jitter transfer shall be reduced by a minimum of 10 dB.

3.2.2.2 Prime Power

The MRRM modules and kits will operate from 100 to 130 VAC, 200 to 240 VAC, 50 to 60 Hz, single phase, and three-wire power. An IEC–320 C-20 male connector (or equivalent) for prime power shall be mounted on the Signal Entry Panel.of the BM, TACC, and AODU. An internal line transient suppressor (Marway 41355 or equivalent) shall be provided to minimize line variations and provide on-off power switching for each element within each module. The internal line transient suppressor shall be positioned to allow easy access to the individual power circuit.

3.2.2.3 Configuration Options

The MRRM shall allow for increased performance through the addition of space diversity by adding an additional AODU.

3.2.3 Physical Characteristics

3.2.3.1 Transit Cases

The BM and TAAC modules shall be housed in a man-transportable transit cases, in accordance with the TDC Standards Document.

3.2.3.2 Storage Space

The transit cases for the BM and TAAC Modules shall include storage pouches within each cover to contain cables, manuals, etc. that must be transported and used with the module, in accordance with the TDC Standards Document.

3.2.3.3 Lightning Protection

Leak off probe points shall be provided on the AODU assemblies. A continuous path shall exist from all probe points to ground.

3.2.3.4 Installation and Setup

The MRRM shall be configured to meet as set-up and teardown of 60 minutes maximum for each by two trainied operators. Set-up time shall be defined as the elapsed time from placement of the MRRM components to acquisition of the link.

3.2.3.5 Weight

The combined weight of all elements constituting the MRRM shall not exceed 2500 pounds. The weight of the BM and TAAC Modules, including all internally carried cables, manuals, etc., as well as any user installed or replaceable item shall meet the two-man (78 kg/174 lb.) lifting limits in accordance with the TDC Standards Document.

3.2.3.6 Marking

Markings shall be in accordance with the TDC Standards Document.

3.2.4 Reliability

The Mid-Range Radio Module, with its standard complement of LRUs, shall have a mean time between failure (MTBF) commensurate with similar commercial equipment in its class.

3.2.5 Maintainability

Maintainability characteristics will be part of the selection criteria for all hardware. Ease of maintenance, such as accessibility to Line Replaceable Units, fault detection/isolation software capability, and fault annunciation will be considered.

3.2.5.1 Mean Time Between Preventive Maintenance

The Mean Time Between Preventive Maintenance, during operation, is 30 days. The duration of preventive maintenance actions such as corrosion control, cleaning filters, etc., does not exceed 30 minutes.

3.2.6 Environmental Conditions

During storage, transport and operation the modules can withstand exposure to temperatures as shown in Table 2.

3.2.6.1 Temperature

Temperature characteristics for the major equipment components are shown in Table 2.

Table 2 - Module Temperature Characteristics

Equipment	Temperature (degrees C)	
	Operating	Non-Operating
Power Conditioner	0 – 45	TBD
Baseband Module (BM)	0 – 45	TBD
Transceiver/Antenna Control Module (TACM)	0 – 45	TBD
Antenna/Outdoor Unit (AODU)	-20 – 50	TBD
Operation and Maintenance Computer (OMC)	-25 – 50	TBD

3.2.6.2 Relative Humidity

Relative humidity characteristics for the major equipment components are shown in Table 3.

Table 3 - Module Humidity Characteristics

Equipment	Humidity
	Non-condensing
Power Conditioner	10 – 90%
Baseband Module (BM)	10 – 90%
Transceiver/Antenna Control Module (TACM)	10 – 100%
Antenna/Outdoor Unit (AODU)	up to – 100%
Operation and Maintenance Computer (OMC)	10 – 90%

3.2.6.3 Altitude

Altitude characteristics for the major equipment components are shown in Table 4.

Table 4 - Module Altitude Characteristics

Equipment	Altitude (feet)	
	Operating	Non-Operating
Baseband Module (BM)	8,000 feet	40,000 feet
Transceiver/Antenna Control Module (TACM)	8,000 feet	40,000 feet
Antenna/Outdoor Unit (AODU)	8,000 feet	40,000 feet
Operation and Maintenance Computer (OMC)	N/A	N/A

3.2.6.4 Sand and Dust

During storage and transport, the modules are protected when exposed to sand and dust in accordance with the best commercial practices for close proximity to operating aircraft. During

operation with covers removed, the modules can withstand sand and dust in accordance with the best commercial practices for natural conditions.

3.2.6.5 Shock

Module equipment racks are equipped with rubber shock isolation mounts and is protected from shocks induced during handling, setup and tear down. Modules and components can operate without degradation following exposure to the non-operating shock environment described by Method 516.5, Procedure VI (Bench Handling) of MIL STD 810F.

3.2.6.6 Vibration

The modules are equipped with rubber shock isolation mounts so that the modules can withstand the vibration encountered while being transported by commercial and military airlift, sealift and vehicular (over unimproved roads) systems. MIL-STD-810F, Method 514.5, Procedure I, Categories 4, 7 and 8. applies; alternative procedures may be substituted after TDC Program Office approval.

3.2.6.7 Wind

The Antenna/ODU shall operate without degradation in performance with steady state wind speeds up to 45 mph in any direction and gusting up to 60 mph.

3.3 Design and Construction

3.3.1 Material Parts and Processes

This module is built to good commercial practices. Mechanical and electrical interchangeability exists between like systems, subsystems, assemblies, subassemblies and replaceable parts.

3.3.2 Safety

This module shall not present a safety, fire or health hazard to personnel.

3.3.2.1 Electrical Safety

This module is designed to eliminate the hazard to personnel of inadvertent lethal voltage contact. All electrical conductors carrying voltages in excess of 70 volts shall be insulated to prevent contact or covered by a protective barrier. All removable protective barriers shall be interlocked to automatically disconnect power behind the barrier upon removal or clearly marked with a warning label that indicates the voltage potential that will be encountered behind the barrier. All warning labels shall remain visible after the cover has been removed.

3.3.2.2 Mechanical Safety

Sharp surfaces shall have protective covers or other suitable features to minimize injury where personnel are likely to be exposed to such surfaces.

3.4 Logistics

This module accommodates a two level maintenance concept: organizational (Air Force personnel) and depot (contractor personnel). Removal and replacement of an LRU is defined at the organizational level and any needed repair of the LRU is defined at the depot level. Any special test or support equipment required to effect removal or replacement of an LRU at the organizational level can be provided as part of the module. No more than two persons shall be required to remove or replace an LRU.

An LRU is defined as the lowest element of the module which can be isolated to be faulty through inspection; built-in test; technical manuals; TDC system performance; spares substitution; or other diagnostic aid approved by the Government for organizational level maintenance, exclusive of expendables such as fuses, lamps and LEDs. An LRU is defined at the card/module level or higher.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General

The quality assurance program includes tests and other evaluations to the extent specified herein. The quality assurance program is designed to verify the electrical, mechanical and functional characteristics of each module. The purpose is to ensure that each module complies with or performs better than the requirements specified herein.

4.2 Responsibility for Inspection

Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements and may use his own or any other facilities suitable for the performance of the inspection requirements. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to the prescribed requirements.

4.3 Product Qualification Test (PQT)

Inspections, analyses, demonstrations and tests were used to verify compliance of Section 3 of this specification on the initial module.

4.3.1 Production Acceptance Test (PAT)

Each MMRM delivered to the Government undergoes a Production Acceptance Test (PAT) as identified in Table 5. The acceptance test verifies that the module interfaces are operating properly prior to delivery to the Government. The SSM Acceptance Test Procedure governs the performance of the PAT.

4.3.2 Verification Cross-Reference Matrix (VCRM)

Table 5 provides a list of each Section 3 requirement and the verification method to be used. The following paragraphs define the codes employed in the VCRM. Unless otherwise noted, where more than one verification method is shown, one method or a combination of methods may be used to show compliance.

4.3.3 Not Required (N/R)

This method indicates that verification is not required because the paragraph is a title, heading, general introductory paragraph or statement of a goal and contains no “shall” or “must” statements.

4.3.4 Inspection

Inspection is a method of verification of the module performance or characteristics by examination of the equipment or associated documentation. Inspections are conducted with the use of inspection tools, measurement devices, visual means and comparison. Most inspections

apply to verification of requirements associated with physical characteristics such as size, weight, appearance, adherence to specified standards and engineering practices, quality design, and construction supported with quality documentation. Inspections also include the auditing of manufacturer's data that verifies the performance of non-developmental items that comprise the TDC module. Inspections may occur during any assembly stage of the unit under test.

4.3.5 Analysis

Analysis is a method of verification through technical evaluation of calculations, computations, models, analytical solutions, use of studies, reduced data, and/or representative data to determine that the item conforms to the specified requirements.

4.3.6 Demonstration

Demonstration is a method of verification whereby the properties, characteristics and parameters of the item are determined by observation alone and without the use of instrumentation for quantitative measurements. This method is used when a requirement does not contain a specific numerical parameter, which must be measured. Demonstrations may occur during verification of a unit under test at any assembly stage. Pass/fail criteria are simple yes/no indications of functional performance since no quantitative values are specified.

4.3.7 Test

Test is a method to verify that a specified requirement is met by thoroughly exercising the applicable item under specified conditions and by using the appropriate instrumentation in accordance with test procedures. This method requires the use of laboratory equipment, simulators, or services to verify compliance to the specified requirements. This method is used when it is practicable to make direct or indirect measurement of a specified numerical parameter to verify compliance with a requirement. Tests may occur during verification of a unit at any assembly stage. Actual measured values are recorded, and pass/fail is determined by comparing the measured value with the specified value. Measurement accuracy shall be precise enough to ensure that the measured value is within the specified tolerance.

Table 5 - Verification Cross Reference Matrix

		Verification Method					
			PQT				
Paragraph	Title	N/R	Inspect	Analysis	Demo	Test	ATP
3.	REQUIREMENTS	X					
3.1	Module Definition	X					
3.1.1	Baseband Module(BM)	X					
3.1.2	Transceiver/antennaCcontrol Module (TACM)	X					
3.1.3	Antenna/OutdoorUnit (AODU)	X					

Table 5 - Verification Cross Reference Matrix

Paragraph	Title	Verification Method					
			PQT				
		N/R	Inspect	Analysis	Demo	Test	ATP
3.1.4	Operations & Maintenance Computer (OMC)	X					
3.2	Performance Requirements	X					
3.2.1	Link Performance					X	
3.2.2	Functional Requirements	X					
3.2.2.1	Equipment Details	X					
3.2.2.1.1	Baseband Module (BM)				X		X
3.2.2.1.1.1	Data Interfaces				X		X
3.2.2.1.2	Transceiver/Antenna Control Module (TACM)				X		X
3.2.2.1.3	Operations Maintenace Compueter (OMC)				X		X
3..2.2.1.3.1	Equipment Diagnostics				X		X
3.2.2.1.4	Timing					X	
3.2.2.2	Prime Power					X	X
3.2.2.3	Configuration Options				X		
3.2.3	Physical Characteristics	X					
3.2.3.1	Transit Case		X				X
3.2.3.2	Storage Space		X				X
3.2.3.3	Lightning Protection				X		
3.2.3.4	Setup and Teardown				X		
3.2.3.3	Weight					X	
3.2.3.4	Marking		X				
3.2.4	Cables and Accessories				X		X
3.2.5	Reliability			X			
3.2.6	Maintainability			X			
3.2.6.1	Mean Time Between Preventive Maintenance			X			
3.2.7	Environmental Conditions	X					
3.2.8.1	Temperature					X	
3.2.8.2	Relative Humidity			X			
3.2.8.3	Altitude			X			
3.2.8.4	Sand and Dust			X			
3.2.8.5	Shock					X	
3.2.8.6	Vibration					X	
3.3	Design and Construction	X					
3.3.1	Materials Parts and Processes			X			

Table 5 - Verification Cross Reference Matrix

Paragraph	Title	Verification Method					
			PQT				
		N/R	Inspect	Analysis	Demo	Test	ATP
3.3.2	Safety	X					
3.3.2.1	Electrical Safety			X		X	
3.2.2.2	Mechanical Safety		X	X			
3.4	Logistics			X			

5.0 PREPARATION FOR DELIVERY

Each module shall be packaged for shipment and the package marked in accordance with the requirements of the contract under which the module is ordered.

6.0 BASELINE CONFIGURATION

6.1 Equipment

To be supplied by contractor.

6.2 Elevation Drawings

To be supplied by contractor.

6.3 Cable Diagrams

To be supplied by contractor.

6.4 Interconnect Diagram

To be supplied by contractor.