

Globalstar

**Portable User Terminals (UT)
GSP-1600 & GSP-1610**

EMC TEST PLAN

Document No: 80-98441-1

Date..... 6th April 1999

Originator Paul Guckian

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1 INTRODUCTION

This test plan applies to the Globalstar Portable User Terminal's GSP-1600 & GSP-1610, manufactured by Qualcomm Incorporated for the Loral/Qualcomm Partnership (LQP). The Portable User Terminal (UT) is designed for use in the Globalstar Satellite Network system to make and receive calls and to send and receive computer data (future feature). The User Terminal (UT) is required to undergo a "Type Examination" in accordance with the European EMC Directive 89/336/EEC. The product specific standard supporting this directive is technical specification EN 300 831 V1.2.1 (1998-03)

2 PURPOSE

The purpose of the EMI emissions and immunity tests described herein is to define the test parameters/equipment configurations and to obtain the data required to demonstrate compliance with the European EMC Directive.

The following information is included in the test plan:

- a) Details of the Equipment Under Test (EUT): physical description, function and purpose within overall system, and description of operational interfaces and input/output circuits.
- b) A description of any additional input/output special test equipment (STE) used to exercise or monitor the performance of the EUT. This includes details of any planned operator intervention during the performance of the test. Description of special test software used to run/control EUT and STE during test.
- c) Test Layout, including cable lengths, layouts and bonding/grounding of EUT and STE. Location of test points. Discussion of differences and similarities between operational and test configurations.
- d) Definition of EUT modes of operation during emissions and immunity tests.
- e) Test Requirements, including specific limits and discussion of rationale for allocation of reduced/modified limits. Definition of EUT performance criteria monitored during EMI tests and details of the acceptable limits of degradation.
- f) Means of monitoring performance of EUT and criteria employed to determine test success or failure (pass/fail criteria).
- g) Reference to any special isolation required between the EUT and the test equipment to avoid unwanted coupling or influence on the test results, beyond that defined in individual test procedures.

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- h) Description of pre- and post-test functional checkout of EUT characteristics to ensure EUT is functioning normally both before and after EMI testing.

This test plan in no way detracts from or supersedes any contractual specifications placed upon the manufacturer by other organizations. It is assumed, for purposes of writing this test plan, that the EUT will be tested in an appropriate test chamber.

3 APPLICABLE DIRECTIVES & REGULATIONS

89/336/EEC European EMC Directive

Harmonized European Standards:

EN 300 831 V1.1.1 (1998-03), European Standard (Telecommunications Series), Electromagnetic compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) for Mobile Earth Stations (MES) used within Satellite Personal Communications Networks (S-PCN).

EN 50082-1:1992 Electromagnetic Compatibility - EMC Generic Immunity Standard, Part 1. Residential, Commercial, and Light Industry.

EN 55022:1994 Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment (ITE).

EN 61000-4-2:1995 Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 2: Electrostatic Discharge (ESD) Immunity Test

EN 61000-4-3:1996 Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 3: Radiated Radio-Frequency Electromagnetic Field Immunity Test

EN 61000-4-4:1995 Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 4: Electrical Fast Transient/ Burst Immunity Test

EN 61000-4-5:1995 (ENV 50142) Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 5: Surge Immunity Test

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EN 61000-4-6:1996 Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 6: Conducted Radio-Frequency Disturbances, due to Radiated RF Fields, Immunity Test

EN 61000-4-11: "Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – section 11: Voltage dips, short interruptions and voltage variations immunity testing".

ETS 300 342-1: November 1994 European Telecommunication Standard Radio Equipment and Systems (RES); Electro-Magnetic Compatibility (EMC) for European digital telecommunications system (GSM 900 MHz and 1800 MHz) Part 1: Mobile and portable radio and ancillary equipment.

4 TEST STRATEGY

The Equipment under test is comprised of a self-contained handheld satellite transceiver unit with battery attachment and an AC charging accessory (GSP-1220). See figure 4.1.

The User Terminal (UT) is designed for handheld operation and is powered from a battery attached to the rear housing of the UT. The UT can also be used with the GSP-1220 AC battery-charging accessory that operates over the following voltage range:

INPUT: AC100-240 V 50/60 Hz, 0.3A.

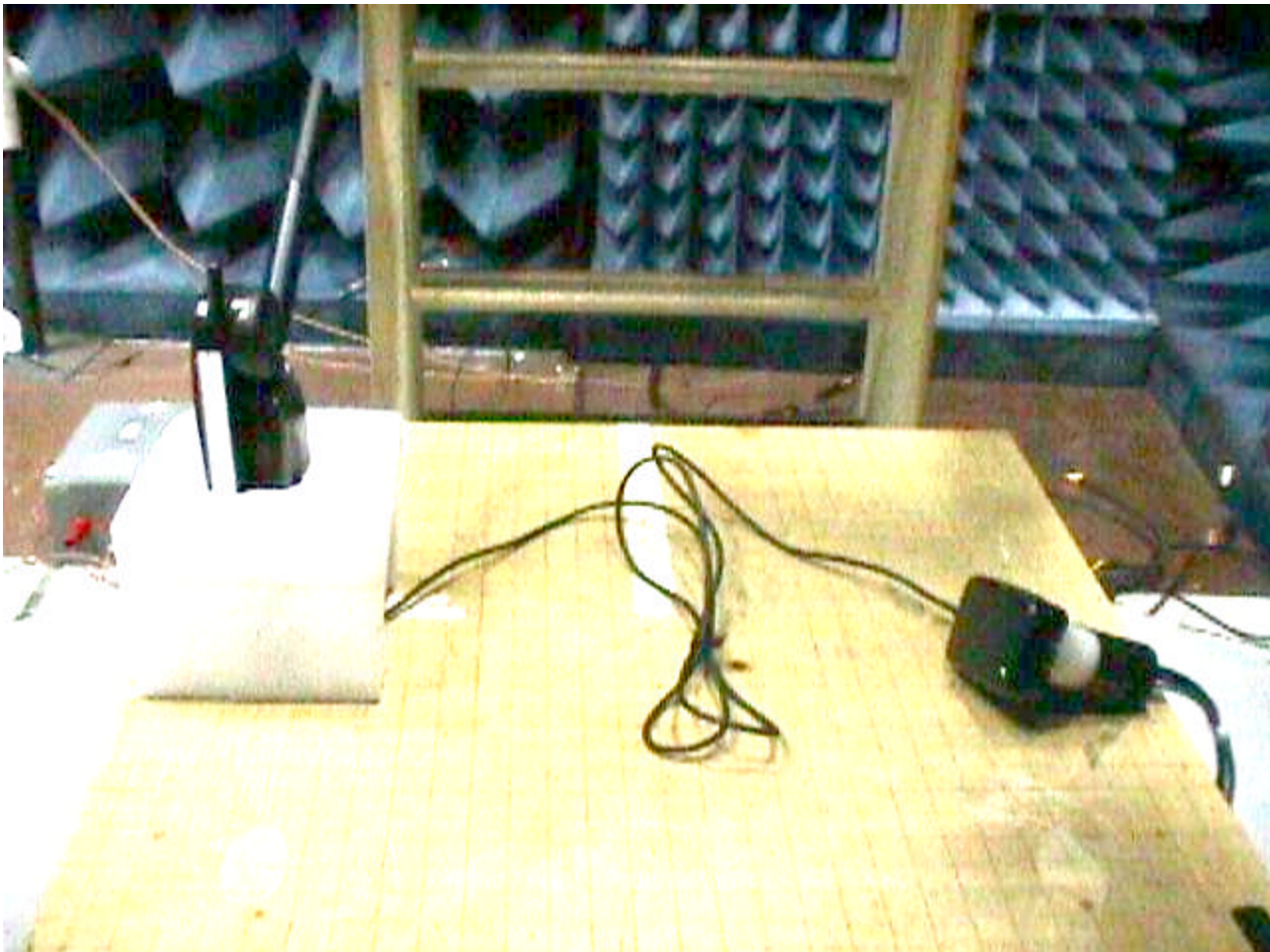
Special test equipment (Anritsu MT8803G Globalstar User Terminal Tester) used to exercise and monitor the performance of the Portable UT is located outside the EMC Lab semi-anechoic test chamber.

The UT equipment will be mounted in the test facility in an installation representative manner and in accordance with the User guide (contained in the UT presentation box).

When testing for conducted and radiated emissions using the AC charger GSP-1220 (provided) the AC supply to the charger would be provided through a Line Impedance Stabilizing Network (LISN).

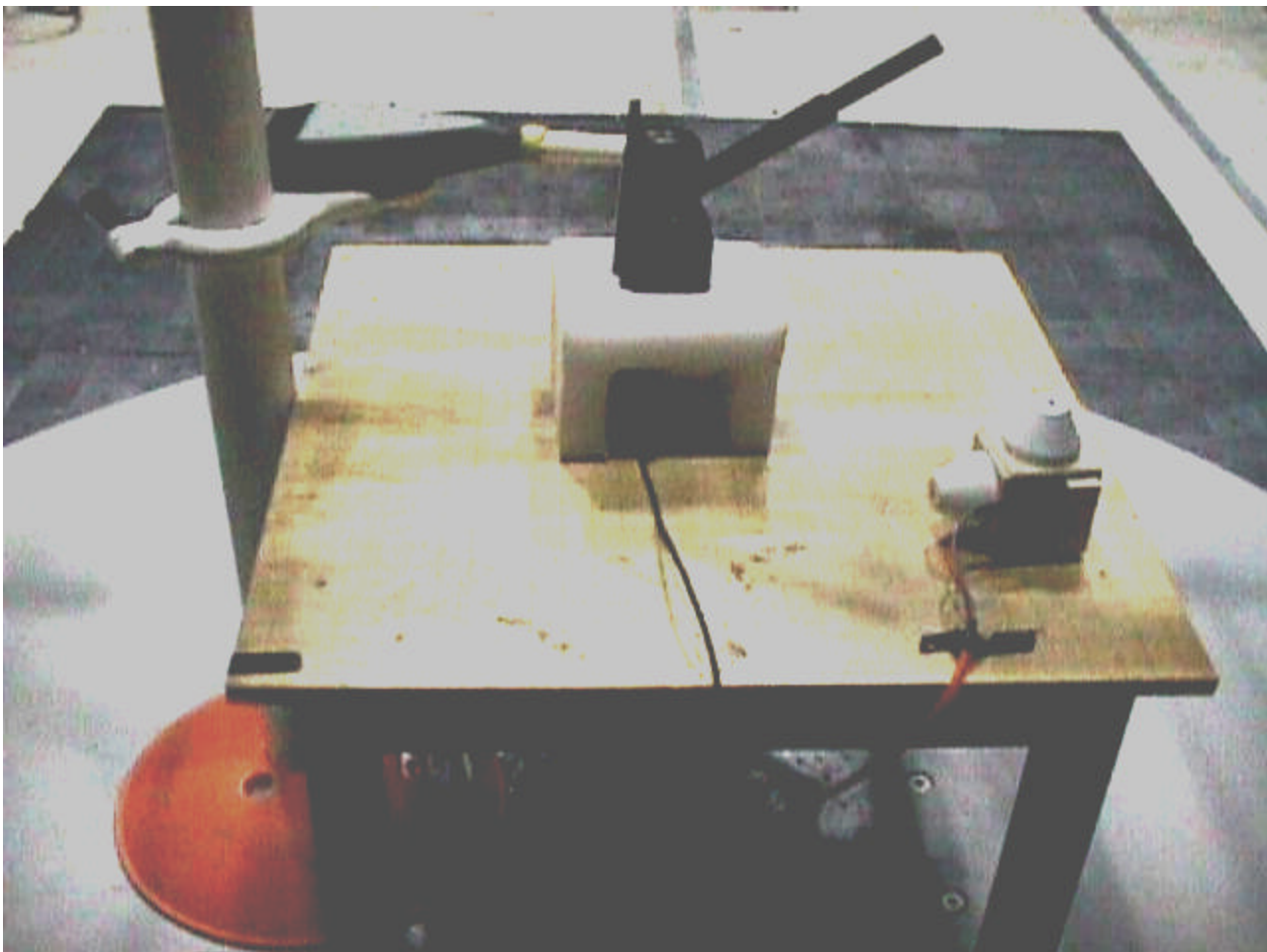
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Figure 4-1. Physical Test Configuration in Test Chamber



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Figure 4.2 General Radiated Immunity Setup



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5 TECHNICAL DESCRIPTION

5.1 EUT Overview

The Portable User Terminal uses the latest digital wireless technology, Code Division Multiple Access (CDMA) to deliver superior performance for personal communication needs. There are 2 versions of the handheld portable:

1. The Single Mode Portable UT GSP-1610. This UT is designed only to operate in the Globalstar Satellite network with transmission in the 1.6 GHz band and receiving in the 2.4 GHz band.
2. The Tri Mode Portable UT GSP-1600. This UT is designed to operate with multiple wireless networks namely AMPS, CDMA and Globalstar.

From a design perspective and with respect to the Globalstar function the UT's are very similar. They use the same Satellite antenna design and digital circuit card assembly (CCA) with a depopulated version of the RF circuit card assembly used in the single mode UT. All other UT components are identical e.g LCD panel, microphone, plastic housing.

As defined in the UT User Guide, the UT must be kept within the line of sight of passing satellites and so it is unlikely that the UT will work inside a vehicle, a building, or in an area where the line of sight is obstructed. As a result of this operational requirement it is understood that all immunity testing, which involves the use of the AC charging accessory, **may** be performed with the UT in "Power Save" mode and with the antenna stowed. Alternatively it can be assumed that the charging unit can be used as an alternative power supply for UT normal operation and therefore perform all immunity and emission testing with the UT configured with the charger accessory and operating in a "Voice Call Mode". Unless otherwise stated in the test report, all testing will be performed on an EUT, which comprises the UT and its AC charging accessory.

5.2 Frequencies in EUT Internal and I/O Circuits

Table 5-1 and 5-2 lists the basic operational frequencies and UT switching power frequencies. Because many/most of the signals are digital, significant amplitude harmonics of the digital fundamental frequencies will be present, as represented by the first 5 harmonic frequencies of those signals in the table.

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5.1 UT Frequency Table

No.	Frequency Fundamental		Digital/Switching Harmonics				RF	Dig	Signal
			2nd Harmonic	3rd Harmonic	4th Harmonic	5th Harmonic			
1	1.2	kHz	2.4	3.6	4.8	6			- One-Eighth Rate CDMA Voice - Half Rate CDMA Voice - Full Rate CDMA Voice
2	4.8	kHz	9.6	14.4	19.2	24			
3	9.6	kHz	19.2	28.8	38.4	48			
4	370	kHz	740	1110	1480	1850	•		General Switcher, 4.0 / 5.0 VDC (Nominal freq.)
	360-390	kHz Range					•		Range of switching frequencies
5	8	kHz	16	24	32	40			- Voice Sync and CODEC Voice Sample Rate 38.4 kbps (3.6864 MHz/96) RS-485 Diff. Serial Com. Data 115.2 kbps DM port RS-232 TX/RX Data - TCXO / 4 TX data Clock and +/- Clocks from GUM to BB2 - ChipX8 Clock and RX data from BB2 - Digital Bus Max Data Rate (Osc./4) - DSP Resonator TCXO (Master Oscillator) - Processor CPU (Osc./2) - DSP (2 X Res.) - Processor Oscillator
6	19.2	kHz	38.4	57.6	76.8	96			
7	57.6	kHz	115.2	172.8	230.4	288			
8	4.92	MHz	9.84	14.76	19.68	24.6	•		
9	9.8304	MHz	19.6608	29.4912	39.3216	49.152	•		
10	12.288	MHz	24.576	36.864	49.152	61.44			
11	16.67	MHz	33.34	50.01	66.68	83.35			
12	19.68	MHz	39.36	59.04	78.72	98.4	•		
13	24.576	MHz	49.152	73.728	98.304	122.88			
14	33.34	MHz	66.68	100.02	133.36	166.7			
15	49.152	MHz	98.304	147.456	196.608	245.76			
16	130.38	MHz	260.76	391.14	521.52	651.9	•		TX IF RX IF TX-IF LO RX-IF LO
17	224.88	MHz	449.76	674.64	899.52	1124.4	•		
18	260.76	MHz	521.52	782.28	1043.04	1303.8	•		
19	449.76	MHz	899.52	1349.28	1799.04	2248.8	•		
20	1487.73	MHz	2975.46	4463.19	5950.92	7438.65	•		RF-TX LO
	1480.35 - 1495.11	MHz Range					•		Range of RF-TX LO
21	1618.11	MHz	3236.22	4854.33	6472.44	8090.55	•		TX Channel 7
	1610 - 1626.5	MHz Range					•		Range of TX Signal
22	2266.89	MHz	4533.78	6800.67	9067.56	11334.45	•		RF-RX LO
	2259.51 - 2274.27	MHz Range					•		Range of RF-RX LO
23	2491.77	MHz	4983.54	7475.31	9967.08	12458.85	•		RX Channel 7
	2483.5 - 2500	MHz Range					•		Range of RX Signal

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Table 5-2. Tri-Mode UT Frequency Table

No.	Frequency Fundamental		Digital/Switching Harmonics				RF	Dig	Signal	
			2nd Harmonic	3rd Harmonic	4th Harmonic	5th Harmonic				
1	1.2	kHz	2.4	3.6	4.8	6			- One-Eighth Rate CDMA Voice - Half Rate CDMA Voice - Full Rate CDMA Voice	
2	4.8	kHz	9.6	14.4	19.2	24				
3	9.6	kHz	19.2	28.8	38.4	48				
4	370	kHz	740	1110	1480	1850	•		General Switcher, 4.0 / 5.0 VDC (Nominal freq.)	
	360-390	kHz Range					•		Range of switching frequencies	
5	8	kHz	16	24	32	40			- Voice Sync and CODEC Voice Sample Rate 38.4 kbps (3.6864 MHz/96) RS-485 Diff. Serial Com. Data 115.2 kbps DM port RS-232 TX/RX Data - TCXO / 4 TX data Clock and +/- Clocks from GUM to BB2 - ChipX8 Clock and RX data from BB2 - Digital Bus Max Data Rate (Osc./4) - DSP Resonator TCXO (Master Oscillator) - Processor CPU (Osc./2) - DSP (2 X Res.) - Processor Oscillator	
6	19.2	kHz	38.4	57.6	76.8	96				
7	57.6	kHz	115.2	172.8	230.4	288				
8	4.92	MHz	9.84	14.76	19.68	24.6	•			
9	9.8304	MHz	19.6608	29.4912	39.3216	49.152	•			
10	12.288	MHz	24.576	36.864	49.152	61.44				
11	16.67	MHz	33.34	50.01	66.68	83.35				
12	19.68	MHz	39.36	59.04	78.72	98.4	•			
13	24.576	MHz	49.152	73.728	98.304	122.88				
14	33.34	MHz	66.68	100.02	133.36	166.7				
15	49.152	MHz	98.304	147.456	196.608	245.76				
16	85.38	MHz	170.76	256.14	341.52	426.9	•			Cellular RX IF TX IF Cellular RX-IF LO Globalstar RX IF TX-IF LO Globalstar RX-IF LO
17	130.38	MHz	260.76	391.14	521.52	651.9	•			
18	170.76	MHz	341.52	512.28	683.04	853.8	•			
19	224.88	MHz	449.76	674.64	899.52	1124.4	•			
20	260.76	MHz	521.52	782.28	1043.04	1303.8	•			
21	449.76	MHz	899.52	1349.28	1799.04	2248.8	•			
22	833.50	MHz	1667	2500.5	3334	4167.5	•		Cellular TX Channel 283 Range of Cellular TX Signal	
	824.01 - 848.97	MHz Range					•			
23	878.5	MHz	1757	2635.5	3514	4392.5	•		Cellular RX Channel 283 Range of Cellular RX Signal	
	869.01 - 893.97	MHz Range					•			
24	963.50	MHz	1927	2890.5	3854	4817.5	•		Cellular RF-TX LO Range of Cellular RF-TX LO	
	954.01 - 978.97	MHz Range					•			
25	1008.50	MHz	2017	3025.5	4034	5042.5	•		Cellular RF-RX LO Range of RF-RX LO	
	999.01 - 1023.97	MHz Range					•			
26	1487.73	MHz	2975.46	4463.19	5950.92	7438.65	•		Globalstar RF-TX LO Range of Globalstar RF-TX LO	
	1480.35 - 1495.11	MHz Range					•			
27	1618.11	MHz	3236.22	4854.33	6472.44	8090.55	•		Globalstar TX Channel 7 Range of Globalstar TX Signal	
	1610 - 1626.5	MHz Range					•			
28	2266.89	MHz	4533.78	6800.67	9067.56	11334.45	•		Globalstar RF-RX LO Range of Globalstar RF-RX LO	
	2259.51 - 2274.27	MHz Range					•			
29	2491.77	MHz	4983.54	7475.31	9967.08	12458.85	•		Globalstar RX Channel 7 Range of Globalstar RX Signal	
	2483.5 - 2500	MHz Range					•			

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As shown in Table 5-2, the RF board LO frequencies are dependent on the input and output frequencies. Table 5-2 identifies the specific UT transmit and receive frequencies which have been selected for use during EMI testing, in both cases Channel 7, and their concomitant RF frequencies.

In each UT board there are core digital functions which produce periodic, relatively high current draw, events at set multiples of the digital clock periods. The synchronous switching frequencies so produced are fractions of the clock and oscillator frequencies in the EUT and are included in Table 5-1 and 5-2.

5.3 Test configuration

The UT fitted with an extended battery pack will be tested while connected to the AC charging accessory. The UT will be connected with the STE outside the test chamber/environment with an over the air link using a second test antenna . The set up and operation of the communications link will be performed using the Anritsu Globalstar UT Tester. The Anritsu tester will display the status of the communications link and certain transmission quality parameters and these will be monitored throughout the immunity testing.

5.4 Modes of Operation and Test Monitoring

For emissions testing, the Anritsu will establish a call with the UT and set up the communications link parameters as follows for the UT:

- Σ RX Channel Index 63 (Channel 7: Frequency: 2491.77 MHz)
- Σ TX Channel Index 250 (Channel 7: Frequency: 1618.11 MHz)
- Σ Transmit at the maximum rated power (Power Control Bits All 0's)
- Σ Service Option 2001 (Rate 9600) OR Voice Loopback Mode (S01)
- Σ Beam Monitor Power Set for -17.4dB Ec/Io value as read by UT Diagnostic Monitor (this sets the UT receive signal strength to a level seen in normal operation)

For immunity testing, the Anritsu will establish a call with the UT and set up the communications link parameters as follows:

- Σ Rx Channel 63 (Frequency: 2491.77MHz)

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- Σ Tx Channel 250 (Frequency: 1618.11 MHz)
- Σ Transmit at the maximum rated power (Power Control Bits All 0's)
- Σ Voice Loopback Mode (S01)
- Σ Beam Monitor Power Set for -17.4dB Ec/Io value as read by UT Diagnostic Monitor (this sets the UT receive signal strength to a level seen in normal operation)

For both immunity and emission testing the UT volume setting will be **Level 4** as shown on the display.

Using the Anritsu front panel, and the User Terminal diagnostic Monitor (UTDM) Software loaded in the support PC connected to the UT data port, these test modes are established in the following manner:

Boot up the Anritsu and the UTDM software in the support PC. In UTDM open the Call Proc and Finger windows. Press the Anritsu CALL PROC soft key (on the bottom row of the front panel). Using the cursor keypad select either service option SO2001 or SO1, with all 0's 9600 bps (should be default), for maximum power and duty cycle EUT transmission. Select transmit channel 7 and receive channel 7 (usual defaults). Input beam reference level should be set to -25 dBm and Primary Beam should initially be set to about -50 dBm .

Press the menu cursor (left arrow) key at the bottom right of the screen, to select Menu #2, then press the revealed Start softkey. The Call Proc status display in the upper right corner of the screen will cycle through idle, regist., and idle reg. When idle reg is displayed, press the NW Orig softkey (at the bottom of the screen). When the call is picked up the Call Proc status display will show Termination, then flash TC INIT, followed by Conversation when the link has been established between the Anritsu Tester and the EUT. The UTDM should now be displaying various parameters of the call. While viewing the Ec/Io reading on the UTDM, the Anritsu Primary Beam level is adjusted until Ec/Io shown in UTDM Finger window reaches -17.4 dB (typically the primary beam level is between -48 to -54 dBm to achieve the appropriate Ec/Io with the inverted UT antenna providing the RF interface to the Anritsu). This will set the receive level to a nominal level as seen by the UT during normal operation within the Globalstar network.

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To put the call into "Idle" mode press the NW Orig softkey and the Anritsu will change the call status from "conversation" to "idle register". If for some reason the call drops or the UT needs to be powered down then press stop and to start again re cycle the power on the UT and then start the Anritsu call. The call parameters set up in the Anritsu should reflect those referenced in the following document:

Σ Interference Testing Guidelines for the Globalstar User Terminals. Document No: 80-98390-1 , X1;

To put the UT into its "Power Save" mode press "Stop" on the Anritsu and store the UT satellite antenna.

For the conducted RF and radiated RF immunity tests, both of which employ 1 kHz sinusoidal modulated signal generators, 1 kHz audio rectification noise levels in the UT earpiece will be measured using a recording sound meter. With the Anritsu operating Service option 01 (voice loopback), measurement of the forward and reverse link audio rectification noise can be measured. Measured 1 kHz noise levels will be compared to the audio rectification pass fail criteria which have been established for Globalstar UT's: 59 dB SPL for portable UT's. The former criterion is based on that which has been specified for portable GSM phones, as described in ETS 300 342-1: November 1994 European Telecommunication Standard Radio Equipment and Systems (RES); Electro-Magnetic Compatibility (EMC) for European digital telecommunications system (GSM 900 MHz and 1800 MHz) Part 1: Mobile and portable radio and ancillary equipment.

The Anritsu can then be used to monitor the status of the call and using external power meters the UT tx power stability can be monitored.

Cycle time to completely run through the described digital functional sequence shall be much less than 1 second, such that a dwell time of 0.1 second shall in general be adequate for emissions and for digital immunity testing. For radiated and conducted immunity tests, a minimum dwell time of 3 seconds per stepped frequency shall be used in compliance with EN 6000-4-3 and EN 61000-4-6.

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6 PRE-REQUISITES FOR EQUIPMENT

All EMI and functional checkout tests described herein shall be performed on a production standard unit. All tests will be carried out on the same unit. A second sample test may be performed to confirm the EMC performance stability and to take into account production variations, in the event of small margins with respect to test limits.

6.1 Pre- and Post-Test Functional Checkout

A rigorous and detailed set of factory functional tests will be performed on all UT CCA's, on an individual card basis, prior to and immediately following completion of the EMI tests. In addition appropriate functional tests shall be run on the EUT as a whole, in its EMI test configuration with associated STE. This will ensure that the EUT has survived transport to the EMI Lab and is functioning properly prior to the start of EMI testing, and later that the equipment survived EMI testing (particularly immunity testing) and still functions properly after EMI testing.

The functional checkout tests in combination with detailed CCA factory tests provide a sufficiently detailed test of the EUT's functionality. More complete detail functional factory testing at the subsystem level is unnecessary.

At the start and completion of all tests the following functional tests should be performed:

1. Enable and Disable communications link using Anritsu tester (call originated at tester)
2. Check Rx power levels and Tx power levels of the UT using the User Terminal Diagnostic Monitor.
3. Check Key pad operation (dial numbers/softkeys/volume settings etc)
4. Enable voice loopback operation and check audio quality. Quality must not degrade between tests.

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7 EMI TEST PROGRAMME

This section discusses the source of the specific EMI test requirements applicable to the UT and presents the specific test requirements and applicable margins, and outlines the preferred test sequence, test lab physical environment conditions, and any special provisions for EMI-related testing of the EUT.

7.1 Introduction

EMI Requirements

The electromagnetic interference (EMI) test requirements defined herein are based on those specified in the European Telecommunications Institute (ETSI) developed EN 300 831 V1.1.1 (1998-03), European Standard (Telecommunications Series), Electromagnetic compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) for Mobile Earth Stations (MES) used within Satellite Personal Communications Networks (S-PCN). That encompasses fixed, mobile, and handheld portable Globalstar User Terminals (UT's).

The EMI test requirements specified in Table 7.1 have been simplified and have limits which have been tailored from those specified in EN 55022 (referenced in EN 300 831)

7.2 EMI Test Requirements and Margins

The EUT shall be tested for compliance with the EMI emissions requirements in Table 7-1 and the EMI immunity requirements in Table 7-2. The immunity requirements are based on the EN 61000-4 series of recommended immunity requirements.

Measurements shall be performed with transmitter and receiver circuitry active and working, with an appropriate band reject filter in front of the test instrumentation if required. A test should be performed on the pre-amp and receiver or spectrum analyzer to ensure the sensitive test instrumentation front end is not over-driven by the intentional radiated transmissions. A simulated forward and reverse link shall be established using a signal representative of the intended modulated waveform.

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Table 7-1. UT EMI Conducted and Radiated Emissions Test Requirements

Parameter	Emission s Limit	Limit Values (3)			Test Requirement Reference
1. Conducted Emissions Powerline Voltage (1)	Class B w. 4 dB Margin 150 kHz - 30 MHz	<u>Frequency</u> 150-500 kHz 500 kHz - 5 MHz 5-30 MHz	<u>Quasi-Peak</u> 66-56 dBuV 56 dBuV 60 dBuV	<u>Average</u> 56-46 dBuV 46 dBuV 50 dBuV	EN 300 831: EN 55022 (CISPR 22)
2. Radiated Emissions Electric Field (2)	Class B w. 4 dB Margin 30 MHz - 1 GHz	30 dBuV/m, 30-230 MHz 37dBuV/m, 230-1000 MHz			EN 300 831: EN 55022 (CISPR 22)

Notes:

1. Conducted emissions are required to be measured using quasi-peak detector, followed in the event of failure by average detector. Emissions from both power leads: 240V AC and Neutral shall be measured. Radiated emissions are required to be measured using quasi-peak detector, with both vertically and horizontally polarized antennas. Limit values listed are corrected for a 10 m test distance as discussed in Section 7.7 herein; they do not incorporate the 4 dB margin required.

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Table 7-2. Globalstar UT EMI Immunity Test Requirements

Parameter	Interference Source Description	Conditions (1, 2)	Test Requirement Reference
1. Radiated RF Field Immunity	3 V/m Requirement, , 80% modulation depth: 1 kHz sinusoidal 80 MHz to 1 GHz	Source antenna >3 m from EUT	EN 300 831 EN 61000-4-3
2. Electrostatic Discharge (ESD) Immunity	Contact Discharge: 4 kV Requirement, 8 kV Goal Air Discharge: 8 kV Requirement, 15 kV Goal	20 discharges, 3 per test point, $\pm$ polarities. Test points must be agreed to prior to test.	EN 300 831 EN 61000-4-2
3. Conducted RF Common Mode Disturbance Immunity	3 V RMS, 150kHz to 80 MHz, 80% modulation depth, 1 kHz sinusoidal modulation	Applied to power lines and control and signal lines (length $\geq$ 1 m)	EN 300 831 EN 61000-4-6
4. Electrical Fast Transient/ Burst (EFT) Immunity	Test Level: Control & Signal: ± 0.5 kV Rqmt, (5/50 ns) Test Level: DC Power Lines: ± 1 kV Rqmt, (5/50 ns)	Applied to power lines and control and signal lines (length $\geq$ 3 m)	EN 300 831 EN 61000-4-4
5. Surge Test	Test Level: 1 kV Open Circuit Voltage Common Mode. 0.5 kV Open Circuit Voltage Differential Mode.	Applied to AC mains lines.	EN300 831 EN 61000-4-5
6. Voltage dips and Interruptions	Voltage Dip corresponding to reduction of supply voltage of 30% for 10ms. Voltage Dip corresponding to reduction of supply voltage of 60% for 100ms. Voltage Interrupt corresponding to a reduction of the supply voltage of more than 95% for 5 000ms.	Applied to AC mains lines.	EN 300 831 EN 61000-4-11

Notes:

1. Recoverable upsets allowed if product performance specification is maintained.
2. Failure criteria as defined in Section 5.4 of this EMI Test Plan. Dwell time shall be 3 seconds.
3. ESD test level is to be approached incrementally in 2, 4, 8, kV sequence, halting test if EUT is upset.

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7.3 Test Sequence

The basic test sequence to be followed is the order listed in Tables 7-1 and 7-2, and as follows (EUT equipment and cabling layout is as described in Section 4, except where explicitly stated otherwise; emissions test dwell time is 100 ms and immunity test dwell times are 3 seconds, except where explicitly stated otherwise):

1. Conducted Emissions,
150 kHz - 30 MHz, 240 Volts AC Power and Return,
2. Radiated Emissions,
30 MHz - 1 GHz
3. Radiated Immunity,
80 MHz - 1 GHz
4. Conducted RF Disturbance Immunity, 150kHz - 80 MHz
5. EFT/Burst Immunity
6. ESD Immunity, Tables 7-4 and 7-5 ESD Test Points
7. Surge Immunity, Power Leads
8. Voltage dips and Interruptions

This test sequence was chosen to perform those tests with the highest potential for physical damage at the end of the planned test sequence (ESD and Surge).

7.4 EUT Upset Criteria

The standard failure mode criteria which may be applied to continuous EMI (radiated and conducted RF) immunity testing and to transient EMI (ESD, EFT, dips & Interrupts and Surge immunity) immunity testing are defined in the EN 300-831 UT Specific Test Standard and its supporting Basic Standards (listed in Section 3 herein). For reference purposes, those criteria are presented in Section 7.4.1. Application of these failure mode evaluation criteria to the EUT is discussed in Section 7.4.2.

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7.4.1 Failure Mode Evaluation Criteria

(1) Performance Criteria For Continuous Phenomena (CP)

- During each individual exposure in the test sequence it shall be verified by the STE that the communications link is maintained and that the quality of transmission observed is no worse than that described in para 7.4.2 of this plan.
- At the conclusion of the test:
 - The UT shall operate as intended with no loss of user control functions or stored data as declared by the applicant.
 - The communications link has been maintained during the test
 - The quality of transmission observed is no worse than that described in para 7.4.2 of this plan
- Under no circumstances shall the transmitter operate unintentionally.

As an additional customer requirement, the quality of transmission observed during testing, shall be no worse than that described in para 7.4.2 of this plan.

(2) Performance Criteria For Transient Phenomena (TP)

- During each individual exposure in the test sequence it shall be verified by the STE that the communications link is maintained and that the quality of transmission observed is no worse than that described in para 7.4.2 of this plan.
- At the conclusion of the test comprising a series of individual exposures it shall be verified that:
 - The UT shall operate as intended with no loss of user control functions or stored data as declared by the applicant.
 - The communications link has been maintained during the test
 - The quality of transmission observed is no worse than that described in para 7.4.2 of this plan
- Under no circumstances shall the transmitter operate unintentionally.

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7.4.2 Application of Failure Mode Criteria to EUT

The performance criteria applicable to each test (CP or TP) is defined in the respective test paragraphs in section 7.10.

The communication link is monitored by the Anristu Globalstar UT tester and continually displays the status of the link. A good link is represented by displaying "conversation" in the top right hand corner of the Anristsu display and if the communication link degrades, this status report will change to one of the following messages:

- Idle Register
- Idle
- Stop

The quality of the transmission is declared as follows:

- This is partially represented by the call status report, as the Anristsu is very unforgiving and will terminate the call if the call parameters are corrupted.
- Any noise (immunity tests) injected into the UT receiver will also result in a terminated call as the communications link has been set up (See para 5.4; Ec/Io ref) with the receiver exercised in its most sensitive range.
- The audio path in the forward and reverse direction should be monitored in accordance with Para 5.4 and the threshold level for this parameter has been declared as 59 dB SPL. (Simultaneous monitoring of the forward and reverse audio paths is possible at this time)
- UT software can send the forward link Frame Error Rate back to the Anristsu for continuous display. The following criteria applies:
 - In each test the FER shall not exceed 0.01 with 95%.confidence

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7.5 Equipment Configuration Documentation

Notes and photographic records of the layout, including the positioning of test instrumentation, where relevant, shall be made and provided along with the test data for inclusion in the test logbook. Sufficient photos shall be taken to clearly show plan, and front and rear elevation views of the EUT and its I/O cabling in the test chamber. (Photographs and notes shall be taken with an eye to providing sufficient detailed cable layout and EUT configuration definition to support a hypothetical major test failure troubleshooting investigation.)

7.6 Power Supplies and Cables

A 240 Volt ac 50 Hz power source must be available for AC charging accessory via LISN's within the test chamber and a similar supply must be available for the Anritsu Globalstar UT tester located outside the test environment.

All power, signal and control cables used for the system shall be of the type and length specified by the manufacturer or typical of the customer usage, as modified to accommodate the test configuration cable routing. These shall be connected and routed within the test chamber and on the turntable and cable support in accordance with standard installation practice insofar as possible.

Excessive cable lengths exterior to the turntable and cable support in the test chamber/environment shall be bundled in a **non-inductive manner** where appropriate, i.e. not in loops (unless unavoidable due to bend radii or other considerations), and shall be placed on the test chamber floor, parallel to the Antenna. Where cable loops must be used, the diameter of the loop for each cable will be documented in the Test Report.

7.7 Environment

The test environment shall be within the range specified by the manufacturer for the operational conditions for the equipment.

Temperature range	5°C to 40°C
Humidity	25% to 85% noncondensing

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7.8 Test Site Requirements

The conditions and layout of the test site are as given in the relevant Standard unless otherwise noted herein. Test equipment used shall preferentially be in accordance with CISPR publication 16.

Testing will be performed at either the Qualcomm Inc. EMC Test Facility in Qualcomm's Building X in San Diego, or at another accredited EMI test laboratory.

7.9 Emissions Test Constraints

7.9.1 Conducted Emissions.

EN 55022: 1994 Class B. Frequency range 150 kHz to 30 MHz. No change to the frequency range or limits is included or required. Tests shall be performed on the AC Live and Neutral Lines of the AC charging accessory GSP-1220 when connected to the UT. This test can be performed with the UT in a call mode where it will be drawing maximum current (Max Tx output power).

The frequency range 150 kHz to 30 MHz will be automatically scanned using a PEAK DETECTOR

Any amplitude that is above or within -6 dB of the specification level for the AVERAGE specification level will be investigated. The worst case frequencies will be chosen and the measurements at these frequencies will be repeated using a QUASI PEAK DETECTOR. Where levels measured using a QUASI PEAK DETECTOR still exceed the AVERAGE specification level but do not exceed the QUASI PEAK Specification Level, the AVERAGE DETECTOR shall be used.

7.9.2 Radiated Electric Field.

The system shall be tested in accordance with EN 55022: 1994 Class B.

The frequency range 30 MHz to 1 GHz will be automatically scanned using a PEAK DETECTOR, as discussed in Sections 5.4.

Any amplitude that is within -10 dB of the specification level will be investigated. Appropriate corrective action will be taken as is considered necessary. The worst case frequencies will be chosen and the measurements at these frequencies will be repeated

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using a QUASI PEAK DETECTOR. The antenna height and turntable position will be noted and included in the test report.

This test will be performed in both the Horizontal and Vertical Polarization of the antenna. The limits for Class B are formally referred to a 10 m or 3 m antenna distance. However these tests may be performed at a different distance, with the limit value adjusted for distance using the following equation. The limit value may then be changed, and recorded in the Test Report, by using the ratio:

$$\text{New limit in mV/m} = \text{Old limit in mV/m} \times 10(\text{m}) / \text{new distance (m)}.$$

For testing at a 3 meter test distance, this yields an emissions limit relaxation factor of 10 (20 dB) relative to the EN 55022 30 meter limit distance. Those correction factors have been used in calculating the 10 meter radiated emissions limit values in Table 7-1.

7.10 Immunity Test Constraints

The basis of the conformity requirements for UT immunity is the European Telecommunication Standard, EN 300 831 V1.1.1 (1997-12), Radio Equipment and Systems (RES); Electromagnetic Compatibility (EMC) for Mobile Earth Stations (MES) used within Satellite Personal Communications Networks (S-PCN) operating in the 1.6/2.5 GHz and 2 GHz frequency bands. The frequency ranges and limits for the equipment tested is as listed in the Standards.

Where a susceptibility is noticed the threshold level shall be determined. This will basically be achieved by decreasing the level of interference by up to 10 dB or until the effect vanishes and then slowly increasing the disturbance level until the effect reappears. This latter level shall be noted as the threshold level of susceptibility.

The performance criteria to be applied are defined in Section 10 below. Specific failure modes shall be further described in the test report, which is compiled following the completion of the test program.

7.10.1 Radiated RF Field Immunity

The EUT shall be tested in accordance with EN 61000-4-3:1995, to the limits defined in Table 7-2. Performance criteria CP is applicable to this test.

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For the 80-1000 MHz frequency range the antenna test distance shall be at least 1 meter from the face of the EUT. The test may be performed with the EUT at 0 deg azimuth to the antenna only or repeated at 4 azimuth positions of the EUT with respect to the antenna (0, 90,180 & 270 deg) if the test laboratory considers that a single position does not fully illuminate the EUT.

This test will be performed with the UT in a “call” mode and then repeated with the UT in “idle” mode as controlled by the Anritsu Globalstar UT tester. In “idle” mode the UT will be monitored to ensure that the transmitter does not operate unintentionally.

7.10.2 ESD Immunity

The EUT shall be tested in accordance with EN 61000-4-2:1995. While Contact Discharge testing is the preferred test method, the discharge types specified for each test point in Table 7-3 have been defined taking into account the nature of the contact surface and the threat which is to be simulated. Thus contact discharge is restricted to conductive surfaces. The higher voltage air discharges are used on non-conductive surfaces and in the vicinity of exposed connector pins. Protective coatings, which are intended to provide insulation, shall not be penetrated by the contact discharge tip.

The ESD test points are defined in Table 7-3. A minimum of 10 discharges of each polarity shall be applied in the vicinity of each test point, to the limits defined in Table 7-2. Performance criteria TP is applicable to this test. Test points shall be identified with a description of the type and number of discharges applied and any effects noted.

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Table 7-3 UT ESD Test Points

No.	General Location	Discharge Type	Notes
1	Keypad: Keys 1, 5, #, Pwr, Send, End & both "soft" keys.	AIR	
2	LCD Panel: All four corners	AIR	
3	SIM Module Area	AIR	
4	Volume Keys on side of housing	AIR	
5	Antenna Back Housing screw.	AIR	
6	Terrestrial Antenna Housing (Tri Mode GSP-1600 Only)	AIR	
7	Data/Charging Port at base of UT	AIR	With and Without Charging Accessory Connected
8	Seam Area between front and back UT housing	AIR	

7.10.3 Conducted RF Disturbance Immunity

The EUT shall be tested in accordance with EN 61000-4-6:1995. The current probe used for RF disturbance injection shall be placed around the AC charging accessory cable while it is connected to the UT. Performance criteria CP is applicable to this test.

7.10.4 EFT/Burst Immunity

The EUT shall be tested in accordance with EN 61000-4-4:1995. Performance criteria TP is applicable to this test.

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The CDN shall be employed to EFT test the UT AC charging accessory cable while it is connected to the UT.

7.10.5 Surge Immunity

The EUT shall be tested in accordance with EN 61000-4-5:1995

The CDN shall be employed to Surge test the UT AC charging accessory cable while it is connected to the UT. Performance criteria TP is applicable to this test.

7.10.6 Voltage Dip & Interruptions

The UT shall be tested in accordance with EN 61000-4-11.

The test is applicable to the UT AC charging accessory cable while it is connected to the UT. Performance criteria TP is applicable to this test.

8 UPSET MONITORING

The monitoring of the UT performance will be performed by the Anritsu Globalstar UT tester plus supporting equipment in the form of an RF Power meter and Audio Analyser. The use of this equipment and the monitored parameters are discussed in para's 5.4 and 7.4 of this plan.

9 TEST REPORT

The test report to be completed following the tests shall contain at least the following details:

- (i) Full identification of EUT including manufacturer, unit and sub-unit serial numbers (all CCA's), details of cables (including drawing numbers of cable drawings defining construction details) and other auxiliary equipment (STE) used.

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- (ii) Physical arrangement of the test set-up, including photographs where appropriate.
- (iii) List of tests carried out, methods and procedures used and the sequence in which the test were carried out.
- (iv) Description of any deviation or departure from tests or test methods specified in this test plan or the laboratory test procedure, with a justification for same.
- (v) Complete and unabridged test results.
- (vi) Details of test instrumentation including calibration dates and calibration due dates.
- (vii) Details of any failure(s) with actions taken or to be taken to identify and/or remedy such failure.
- (viii) Identity of test and supervisory personnel, including an authorized signature for the report.
- (ix) Record of the physical environment, including ambient temperature and relative humidity during the tests
- (x) Dates of the testing.
- (xi) Description of any unusual events noted in the test lab vicinity that might have bearing on EMI test results or the final condition of the EUT and STE (e.g. building power failure or surge, shaker table use during test, fire alarm, fire, etc.)

A copy of the EMI test report shall be forwarded to the Qualcomm Inc. EMC & Regulatory Manager (Globalstar Project).