MEASUREMENT/TECHNICAL REPORT

FCC Parts 2, 15, 24

Forem

FCC-ID: QTP-SCPA-PCS1900

S8000 45W EDGE / 60W GMSK PCS 1900 MHz
SCPA (single channel power amplifier)

January 10th, 2003

This report concerns (check one): Original grant __X__ Class II change____

Equipment type: SCPA (single channel power amplifier)
(ex.: computer, printer, modem, etc.)

Deferred grant request per 47 CFR 0.457(d)(1)(ii)? yes _____ no __X__

If yes, defer until: _____
date

Company Name agrees to notify the Commission by _____
Date
of the intended date of announcement of the product so that the grant can be issued on that date.

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Table of Contents Page

1 GENERAL INFORMATION 3
1.1 Product Description 3
1.2 Related Submittal(s)/Grant(s) 3
1.3 Tested System Details 5
1.4 Test Methodology..... 6
1.5 Test Facility..... 6
1.6 Test Equipment List 6

2 PRODUCT LABELING 7
Figure 2.1 FCC ID Label 7
Figure 2.2 Location of the Label on EUT 8

3 SYSTEM TEST CONFIGURATION..... 9
3.1 Justification..... 9
3.2 EUT Exercise Software 10
3.3 Special Accessories..... 11
3.4 Equipment Modifications..... 11
3.5 Configuration of the Tested System..... 12
Figure 3.1 Configuration of the Tested System..... 12

4 BLOCK DIAGRAM(S) OF THE EUT..... 13
4.1 Block Diagram Description..... 13
Figure 4.1 Block Diagram of the EUT.. 14

5 CONDUCTED AND RADIATED MEASUREMENT PHOTOS..... 15

6 PART 2 and PART 24 requirements..... 19

7 PART 15 requirements 38

8 PHOTOS OF TESTED EUT 41

1 GENERAL INFORMATION

1.1 Product Description

SCPA basic function consist in amplifying the level of a modulated RF signal, generated by the base station in which it is allocated, up to the RF power level of the whole transmitter.

SCPA amplifies the small signal delivered by the digital part of the base station up to a level 48dB higher (around 60000 higher) to be radiated by the Antenna.

SCPA is a stand-alone unit, mounted in a closed metal housing (for EMI containment) fitted with a suitable heat sink and provided with RF coaxial and DC and Multi-way connectors. It also includes its own DC/DC converter.

The main characteristics of this SCPA are :

- Range: 1930-1990 MHz
- Gain: 48 dB
- Modulation supported: GMSK (60W), 8-PSK (45W)
- Supply –48V +/- 20%
- Power consumption < 290W

Power Amplifier Module is rated for an average output power of 45 Watts with an EDGE signal and 60 Watts with a GMSK signal.

The power amplifier comply with the output spectrum due to modulation and switching transients specifications. RF signal to be amplified by the PA is an RF burst with a duration of 577 µs (including leading and trailing edges). The useful part of the burst, defined as the time during which the power level shall stay constant to ± 1dB accuracy, is 543 µs.

The alarms provided by the PA consist of :

- the temperature overload : the measured temperature is locally compared to a fixed limit by the PA
- the power supply current overload measured and compared to a fixed limit by the PA
- the DC/DC converter alarm : optional (depends on DC/DC converter type)
- the communication alarm
- the input overdrive PA shutdown alarm

The only components allowed to be located outside the module are the connectors.

1.2 Related Submittal(s)/Grant(s)

None

1.3 Tested System Details

The FCC IDs for all equipment, plus descriptions of all cables used in the tested system (including inserted cards, which have grants) are:

Model & Serial No.	FCC ID	Description	Cable Descriptions
E15Q40P09 C s/n 05082683		**S8000 45W EDGE / 60W GMSK PCS 1900 MHz (SCPA)**	**Unshielded power cord Shielded signal cables**

Connected to (remotes for radiated emissions tests):

Elind HL 1200W series S/n 2821/03	None	DC regulated power supply	Unshielded power cords
Agilent E4432B S/n GB40051310	None CE ISM 1-A, CSA	ESG-D series signal generator	Unshielded power cord Shielded signal cable
Forem P/N D14C01P34-00 S/n 01636806	None	Directional coupler	Shielded signal cables
Agilent E4406A S/n US40061643	None CE ISM 1-A, CSA	VSA series Transmitter tester	Unshielded power cord Shielded signal cables
Forem W21N01M02 S/n 02299467	None	RF load	Shielded signal cables

(1) EUT submitted for grant.

Forem Model B54J54M12 S/n /	None	BTS simulator	Shielded signal cables
Toshiba Satellite 4010 CDT S/n Z8790974E	DoC	Notebook	Unshielded power cord Shielded signal cables
Toshiba PA2450U S/n 0929806	None	AC adapter for noebook	Unshielded power cords

1.4 Test Methodology

Both conducted and radiated testing were performed according to the ANSI C63.4-1992 test procedures . Radiated testing was performed at an antenna to EUT distance of 3 meters.

1.5 Test Facility

TÜV ITALIA test site No. 3 – semi-anechoic chamber

The semi-anechoic chamber test site and conducted measurement facility used to collect the radiated data are located at Via Montalenghe 12, Scarmagno, Italy. This site has been fully described in a report dated May 12, 2000 submitted to your office, and accepted in a letter dated May 30, 2000 (registration Number: 90860)

1.6 Test equipment list:

Description	Model	serial No.	Cal due date
Test receiver	Rohde & Sch.ESH3	s/n 881364/012	10/03
Spectrum analyzer	HP 8568B+QP adapter	s/n 2601A02134	04/03
Spectrum analyzer	HP 8562A	s/n 3043A05627	10/03
LISN	Schwarzb.NNLA 8120	s/n 8120471A	02/03
Biconical antenna	Tensor 4104	s/n 2222	03/03
Log-periodic antenna	Electro-metrix LPA-25	s/n 1117	03/03
Double ridged guide H.	EMCO 3115	s/n 3572	11/03
Standard gain horn	Electro-metrix SH-50/60	s/n 2804	11/03
ESG-D signal gen.	Agilent E4432B	s/n GB40051310	02/03
VSA trasmit.tester	Agilent E4406A	s/n US40061643	01/03

2 PRODUCT LABELING

Figure 2.1 FCC ID Label

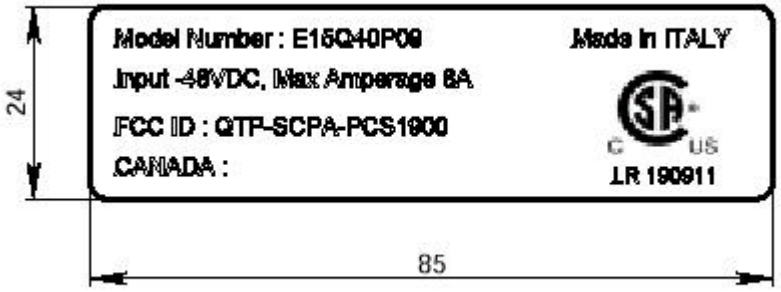
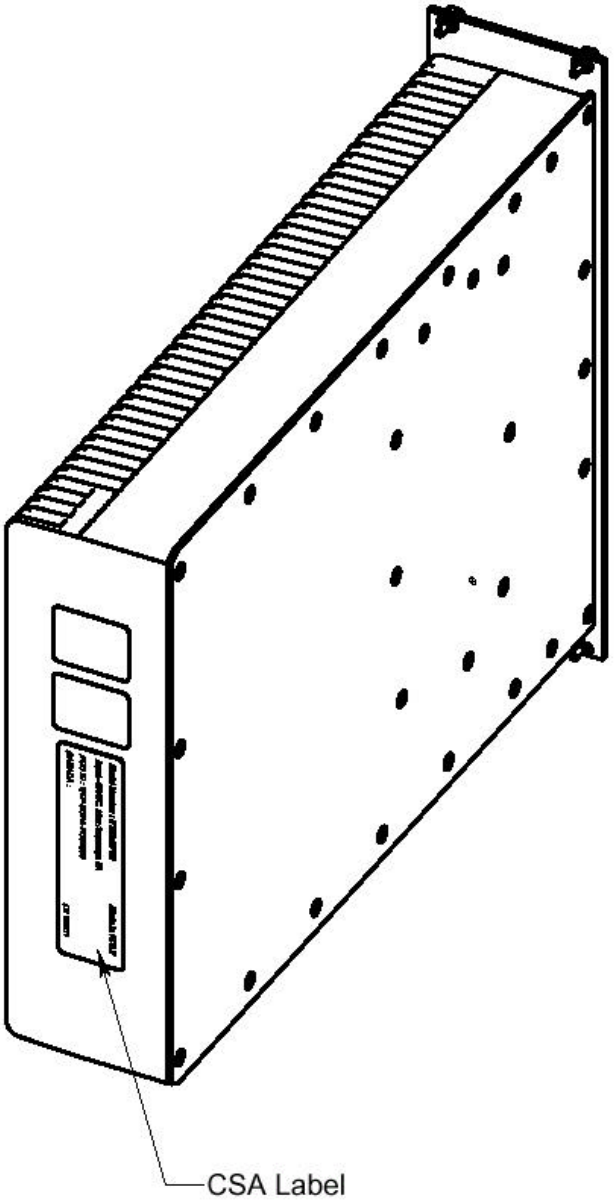


Figure 2.2 Location of the Label on EUT



3 SYSTEM TEST CONFIGURATION

3.1 Justification

The EUT was configured for testing in a typical fashion (as a customer would normally use it).
In order to simulate a real application , the EUT has been powered from an external power supply, the EUT RF input was connected to a remote signal generator which fed GMSK / EDGE modulated signal to EUT.
The EUT RF output was connected to an RF load; a VSA series transmitter tester was derived from the load through a directional coupler in order to verify the behaviour of EUT during tests.
The RS 485 port was connected through a BTS simulator to a notebook in order to monitor alarms and output power sensed by SCPA itself (powerbyte).
The device under test was functionally tested by monitoring RF and DC characteristics.
Functional test routines and/or diagnostic routines executed during tests on SCPA are listed below:

® Spectrum-emission mask – monitored with Agilent E4406A VSA series transmitter tester
® Output RF Power – monitored with Agilent E4406A VSA series transmitter tester
® Input Power – monitored with a digital multimeter
® Alarm status

Conducted emission testing was performed on –48Vdc power cable of EUT.

3.2 EUT Exercise Software

Description
A Control logic is implemented in order to manage power amplifier. It is created around Atmel AVRMega 128 microcontroller.
Connection with BTS (base station containing SCPA) is obtained with a serial communication channel (RS485 interface), by which control messages, amplifier answers and burst synchronism are sent. Firmware is written in a Flash memory integrated in microcontroller and can be "in-field" updated with a download functionality.

Functions
Functions implemented in control logic are:

* data exchange with BTS according with a Nortel supervision protocol by serial asynchronous line.
* acquire alarm status.
* manage control and configuration data.
* manage internal test protocol.

SCPA was measured in Test mode configuration.
In Test mode the Power Amplifier is working with the same behaviour of normal operation mode, but without the burst syncronisation signal. In order to allow some control features and to monitor the alarms and measurement, a PC running a control program was connected to the Power Amplifier through the digital interface connector by mean of an interface that transform RS485 serial data to RS232.
SCPA during tests was configurated to amplify a low power RF signal to nominal output power (60W for GMSK and 45W for EDGE), communicating alarm status and internally sensed output power (by mean of a digital byte: powerbyte). This condition represent normal use (in-field) condition when integrated in BTS.

Test mode main characteristics:

Alarm monitor is on
Autoshutdown functionality is on
RF and DC characteristics are the same of Normal mode
Temperature and frequency compensation is on
Syncro signal in not needed

3.3 Special Accessories

None.

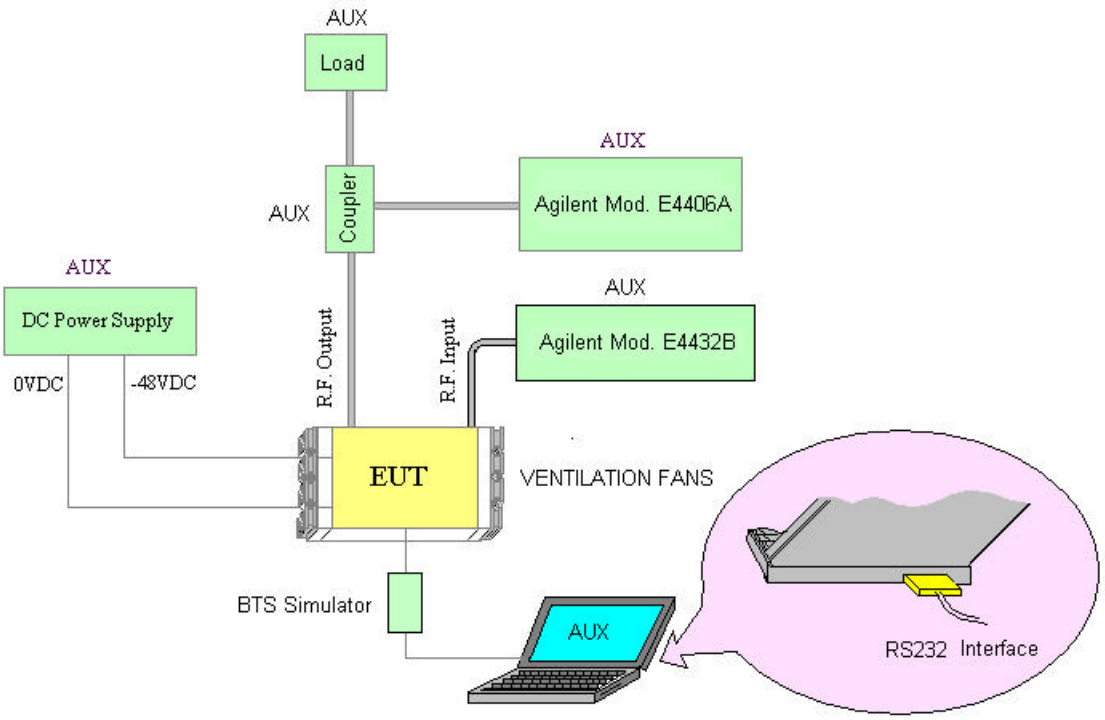
As shown in Figure 3.1 all interface cables used for compliance testing are shielded as readily available on the market.

3.4 Equipment Modifications

To achieve compliance to Class B levels, no changes were made during compliance testing.

3.5 Configuration of the Tested System

Figure 3.1 Configuration of the Tested System



4 BLOCK DIAGRAM(S) OF THE EUT

4.1 Block Diagram Description

Noise filter

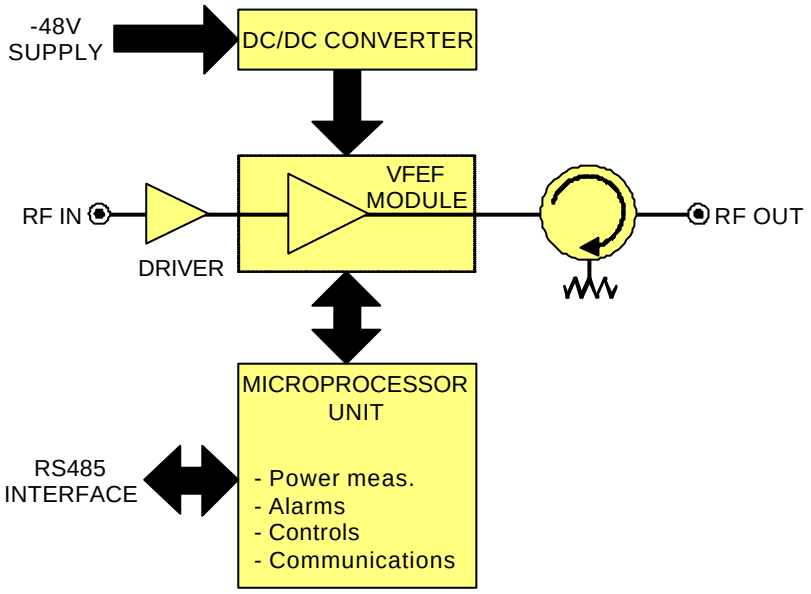
SCPA adopt a EMC filter to reach the specified conducted emission/immunity levels.
The filter is realized with these components:
two 473uH/14 A inductor-filter
four 1uF 200V Ceramic capacitor
three 10nF 1KV Ceramic capacitor
one 100nF 200V Ceramic capacitor

Preferred part list:
2 x 473µH/14A Inductor, Pulse Eng. model P0502
4 x 1µF/200V Ceramic cap., Vishay model VJ2225Y105KXCAC; AVX model 2225-PC105KAT1A
3 x 10nF/1kV Ceramic cap., SAYFER model 1812J1K00103MXT; AVX 1812AC103MAT00A
1 x 100nF/200V Ceramic cap., AVX 1206-1C-104-KAT2; PHILIPS 1206 2R 104K 0DB00

Inside SCPA the clock / frequency generated are:

- 8MHz clock for microcontroller
- 130kHz switching frequency of 310W DC DC converter
- 350kHz switching frequency of 25W DC DC converter
- 2,2kHz Power reading switching frequency 2,2KHz
- 2MHz SPI D/A clock
- 250kHz switch of +6V regulator
- 120kHz switch of -6V regulator VFEF
- 200kHz switch of -6V regulator CB

Fig. 4.1 - Block Diagram of the EUT



5 CONDUCTED AND RADIATED MEASUREMENT SETUP PHOTOS

See directory: “setup photos”

6 PART 2 and 24 requirements

TEMPERATURE AND HUMIDITY DURING TESTING
The temperature during testing was 21°C and the relative humidity 33%.

2.1033(c)(3) USER'S MANUAL
No manual is provided, EUT is constructed according to Nortel specification and is sold to Nortel company only.

2.1033 (c)(4) TYPE OF EMISSIONS
GXW, G7W

2.1033(c)(5) FREQUENCY RANGE
1930-1990 MHz

2.1033(c)(6) OPERATING POWER
GMSK 60W, EDGE 45W

2.1033(c)(7) MAXIMUM POWER RATING
60 Watts

2.1033(c)(8) DC VOLTAGES
The EUT is power at –48 Vdc.

2.1033(c)(9) TUNE-UP PROCEDURE
See directory: "operational description".

2.1033(c)(10) SCHEMATICS AND CIRCUITRY DESCRIPTION
See directory: "Part lists, schematics and layouts".

2.1033(c)(11) LABEL AND PLACEMENT
See paragraph 2 and directory: "Label".

2.1033(c)(12) SUBMITTAL PHOTOS
See directories: "Internal and external photos"

2.1033(c)(13) MODULATION INFORMATION
See directory: "operational description".

2.1033(c)(14)/2.1046/24.232(a) RF POWER OUTPUT

§24.2329(a) Power and antenna height limits.

(a) Base stations are limited to 1640 watts peak equivalent isotropically radiated power (e.i.r.p.) with an antenna height up to 300 meters HAAT. See 24.53 for HAAT calculation method. Base station antenna heights may exceed 300 meters with a corresponding reduction in power; see Table 1 of this section. ***In no case may the peak output power of a base station transmitter exceed 100 watts.*** *The service area boundary limit and microwave protection criteria specified in §§24.236 and 24.237 apply.*

Setup: The EUT is placed on the test bench. The RF input port is connected to a generator. The RF output port id connected to a RF load and directional coupler. The EUT receives 48 VDC from a support power supply. The RF signal of EDGE and GMSK modulation, with the RF level adjusted to maintain 60W GMSK and 45W EDGE at the output of the EUT, is sent to the EUT via a signal generator. The EUT amplifies the signal and the output RF signal is loaded in to the RF load and a directional coupler. The output power is measured at the RF output port of the directional coupler with a spectrum analyzer. Range of measurement: Fundamental. Instrument setting: RBW=VBW=1 MHz. RF loss (40.5 dB) of the RF load and attenuator is compensated. The amplifier will not be commercially available with transmitting antenna provided hence the EIRP measurement will be determined by the installer of the final product.
The following table demonstrates the EUT is deemed compliant in pursuant of ***if in no case may the peak output power of a base station transmitter exceed 100 watts."*** of 24.2329(a) Power and antenna height limits requirement.

Measurement data:

Frequency (MHz)	Modulation	Measured power (dBm)	Measured power (watts)
1930.200	GMSK	47.78	60
1960	GMSK	47.78	60
1989.800	GMSK	47.78	60
1930.200	EDGE	46.53	45
1960	EDGE	46.53	45
1898.800	EDGE	46.53	45

2.1033(c)(14)/2.1047(a) MODULATION CHARACTERISTICS

Audio frequency responce

Not applicable to this unit

2.1033(c)(14)/2.1047(b) MODULATION CHARACTERISTICS

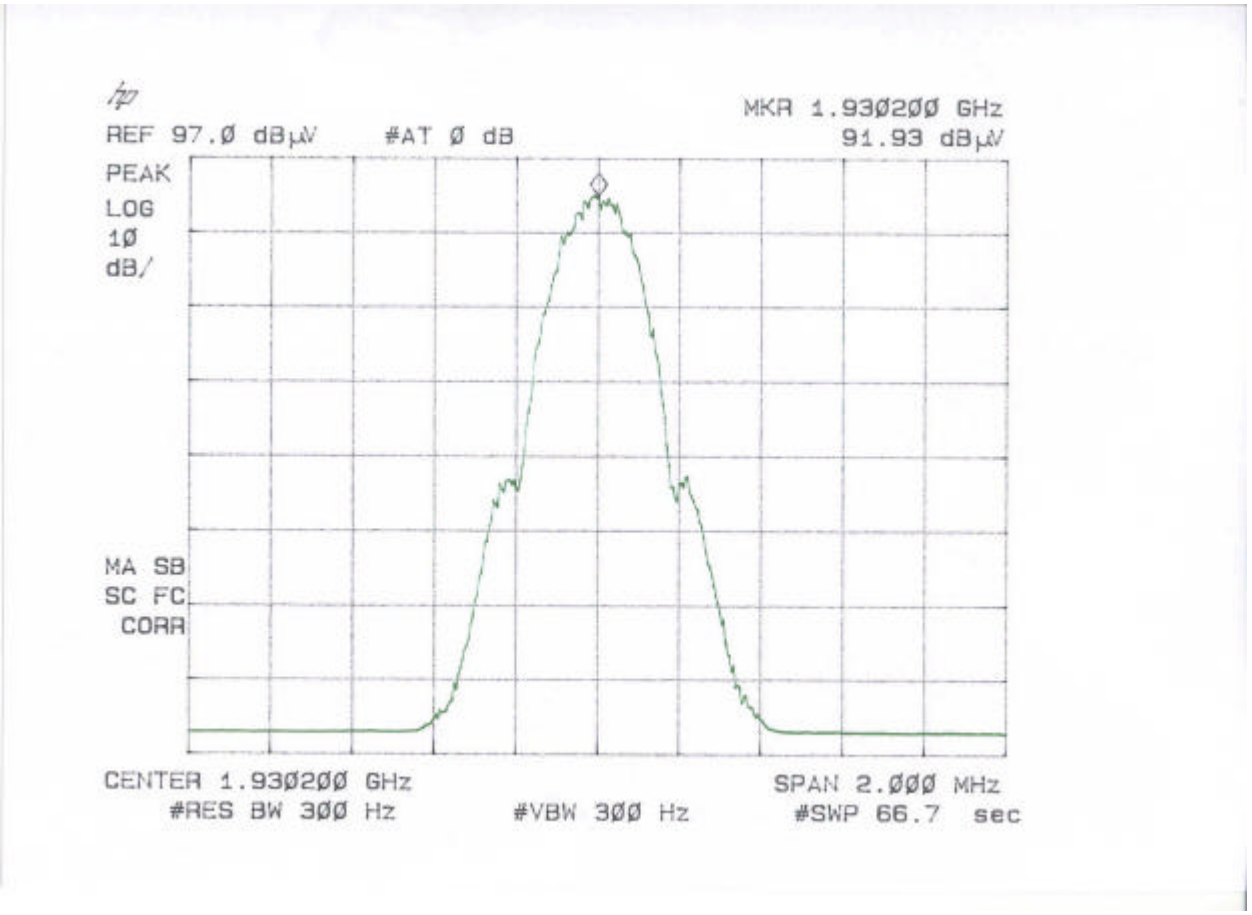
Modulation limiting response

Not applicable to this unit

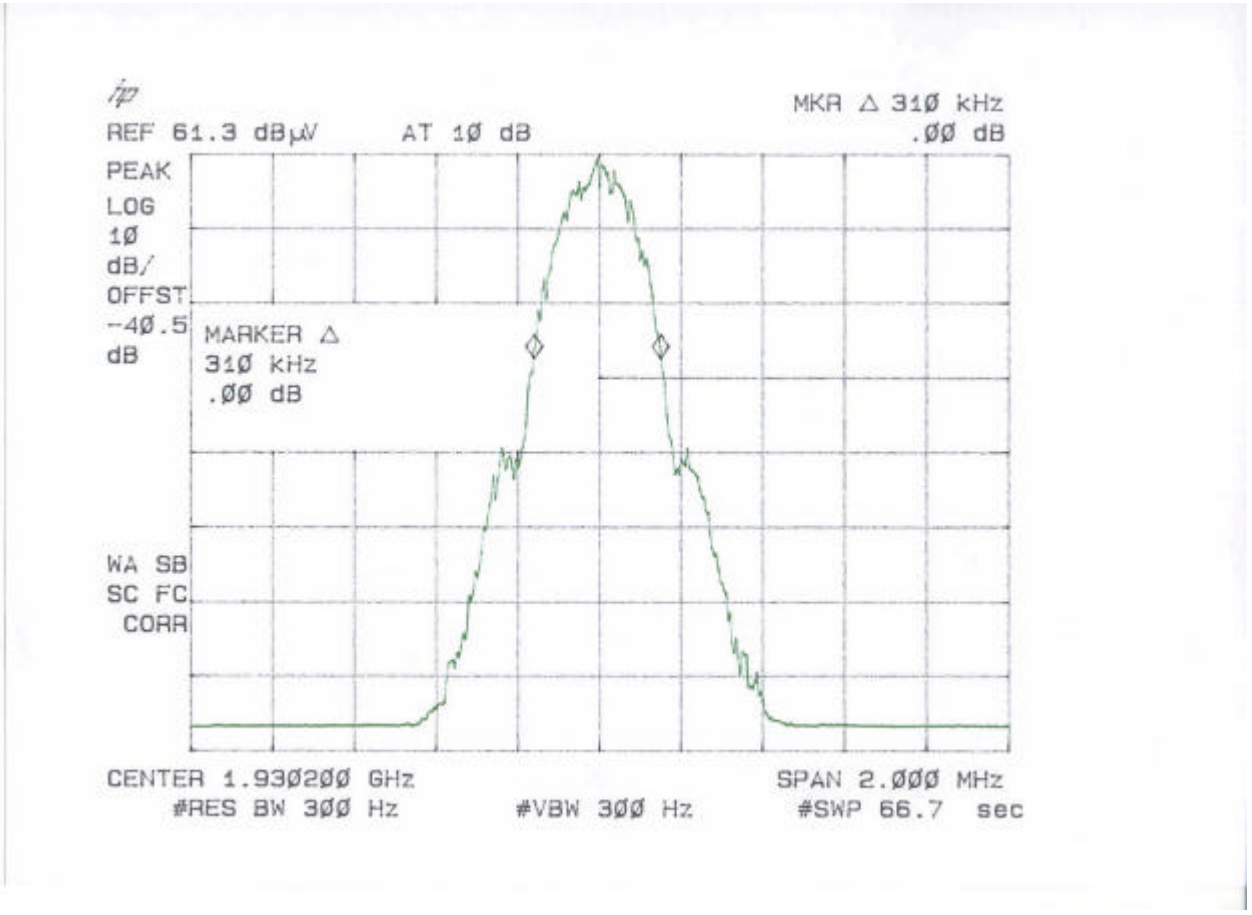
2.1033(c)(14)/2.1049(i) OCCUPIED BANDWIDTH

Setup: The EUT is placed on the test bench. The RF input port is connected to the generator. The RF output port is connected to a RF load and directional coupler. The EUT receives 48 VDC from a support power supply. The signal generator sends RF signal to the EUT. The EUT amplifies the signal and the RF signal is loaded in to the RF load and a directional coupler. The output power is monitored at the RF output port of the directional coupler. Range of measurement: Fundamental. Conducted power measurement measured with a Spectrum Analyzer at RF output port of the directional coupler. RF loss of 40.5 dB is compensated for. The input signal was measured at the output end of the signal generator.

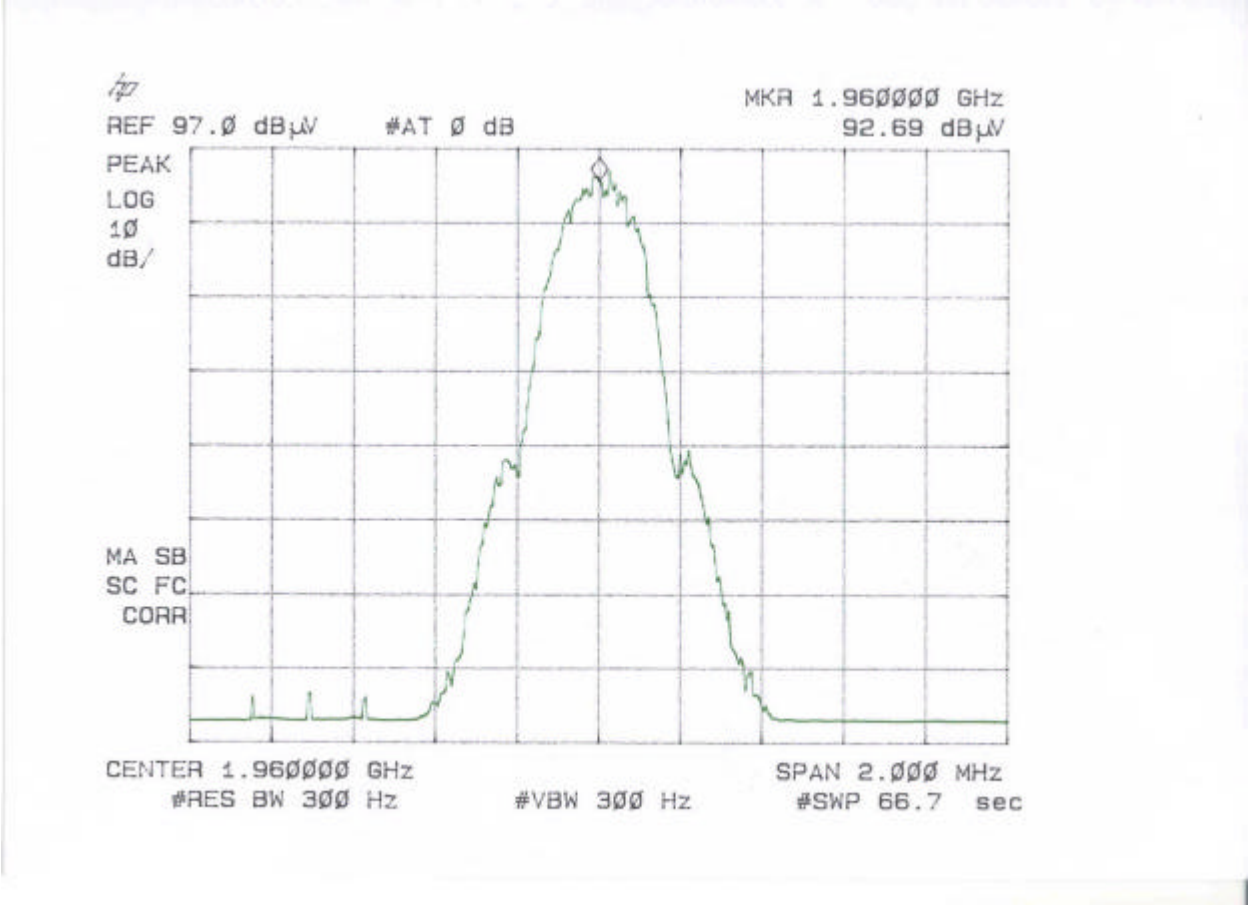
Occupied bandwidth 1930.2 GMSK input plot



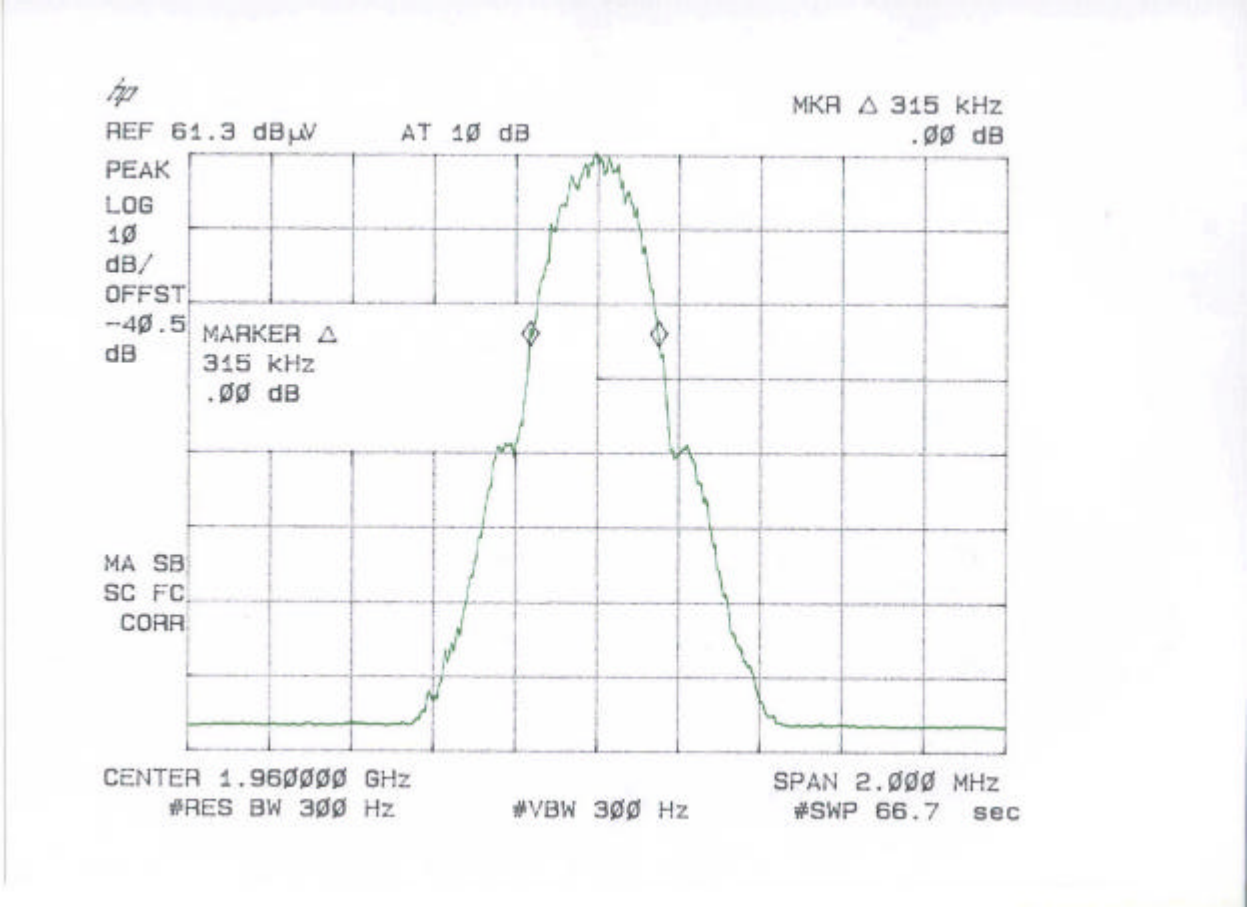
Occupied bandwidth 1930.2 GMSK output plot



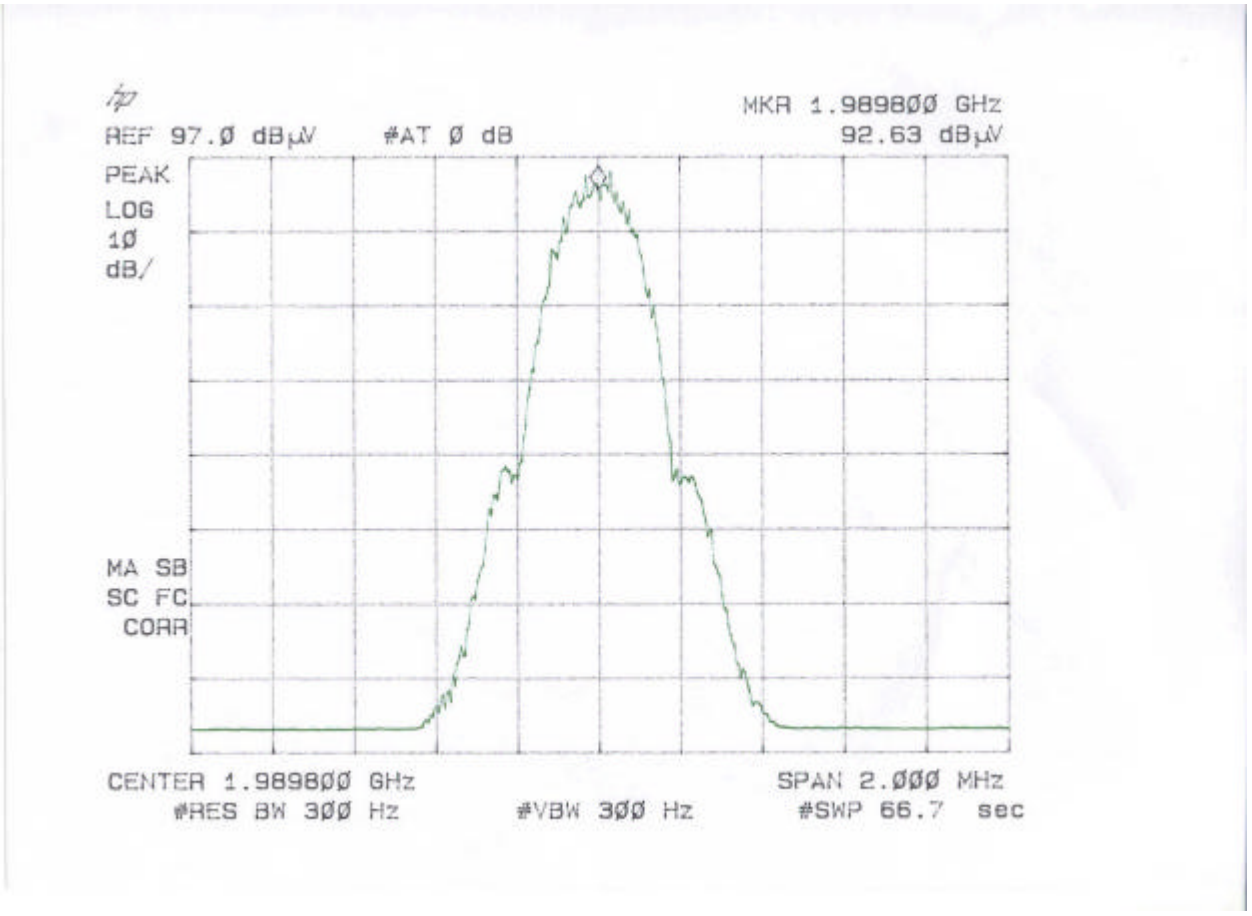
Occupied bandwidth 1960 GMSK input plot



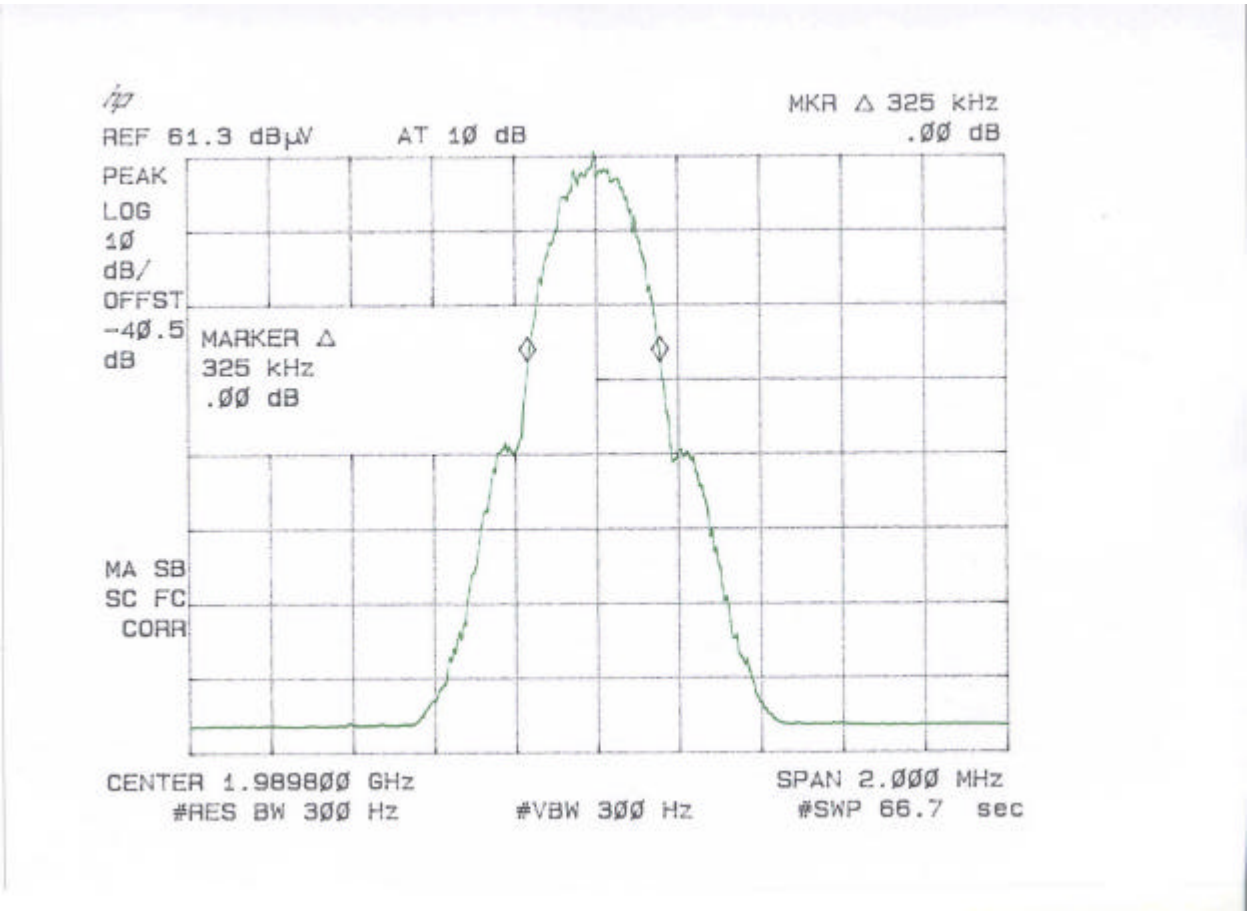
Occupied bandwidth 1960 GMSK output plot



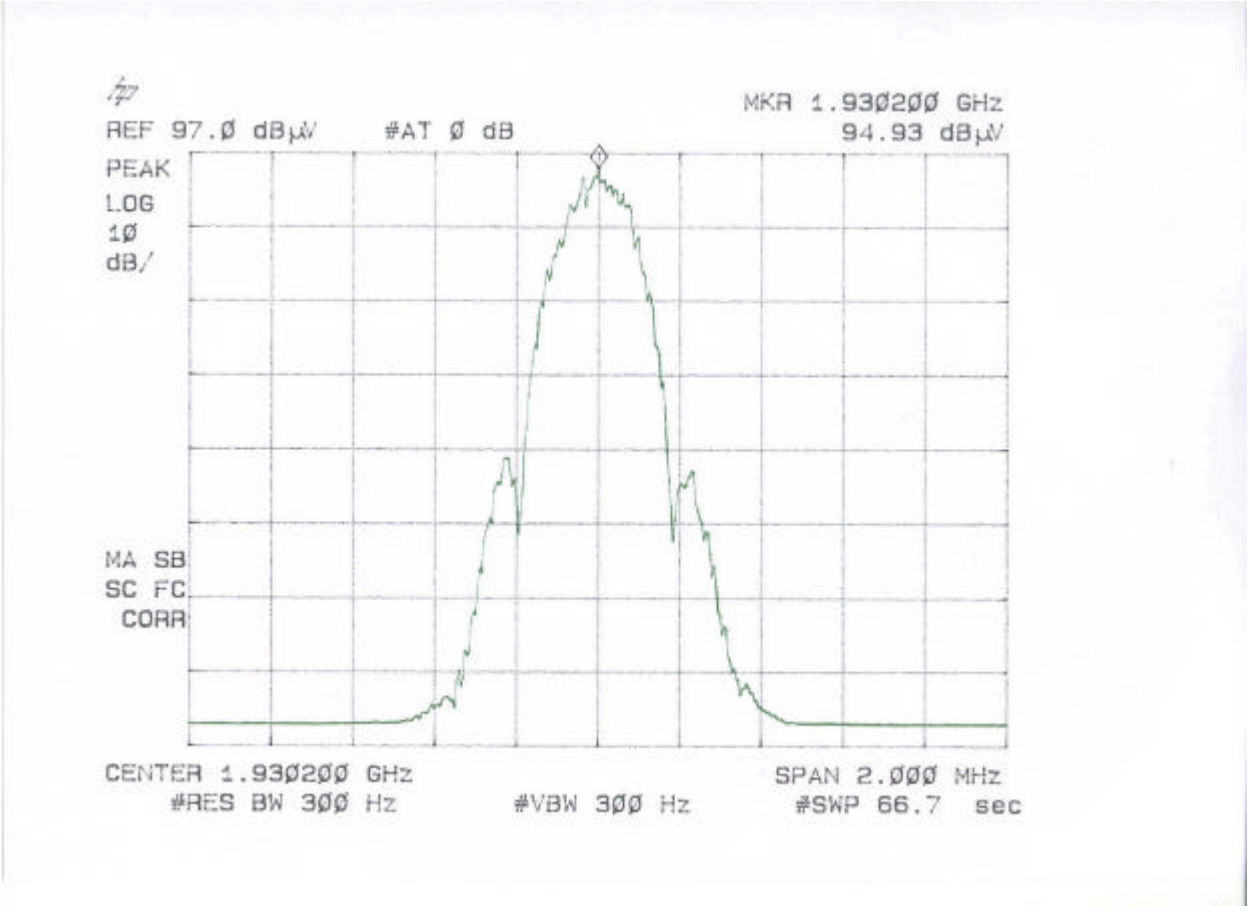
Occupied bandwidth 1989.8 GMSK input plot



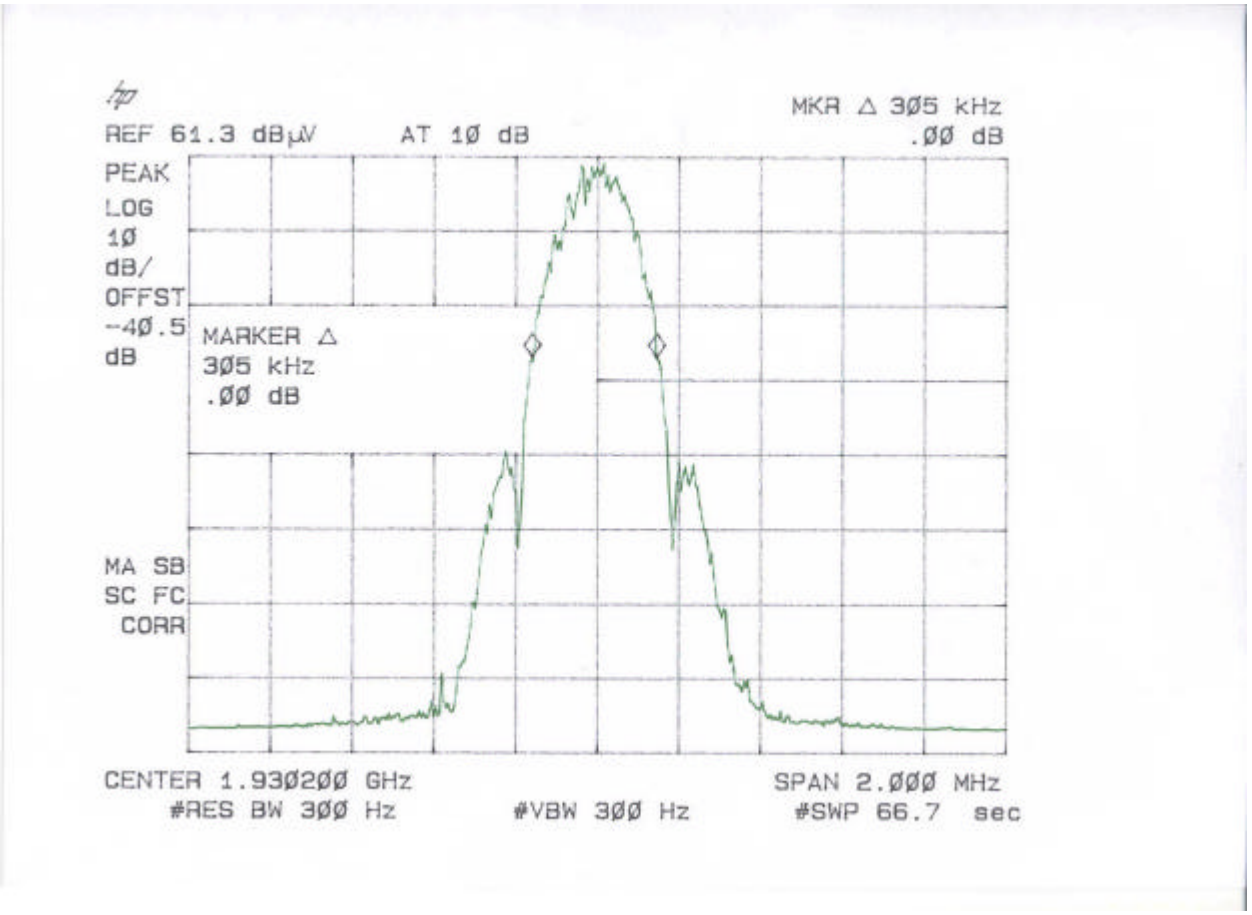
Occupied bandwidth 1989.8 GMSK output plot



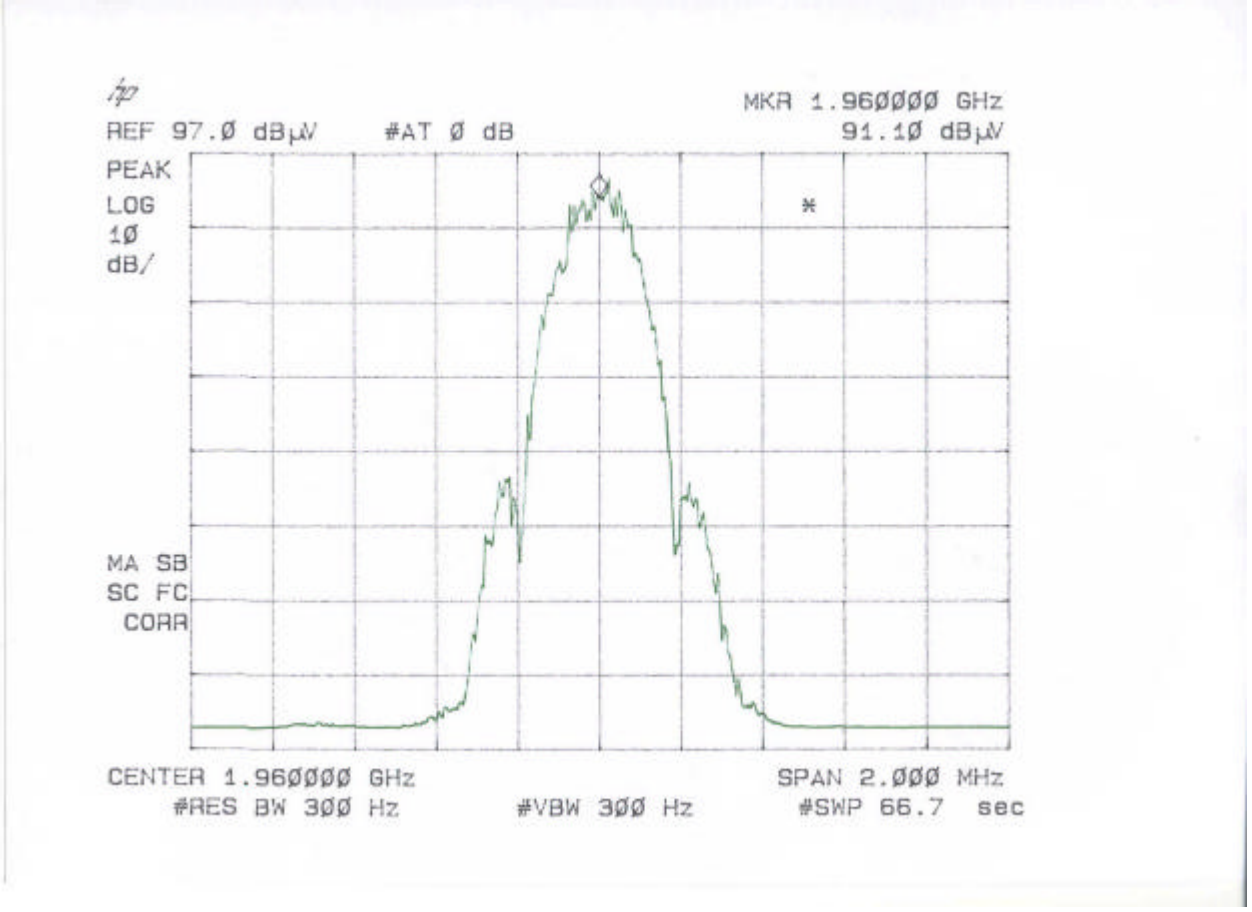
Occupied bandwidth 1930.2 EDGE input plot



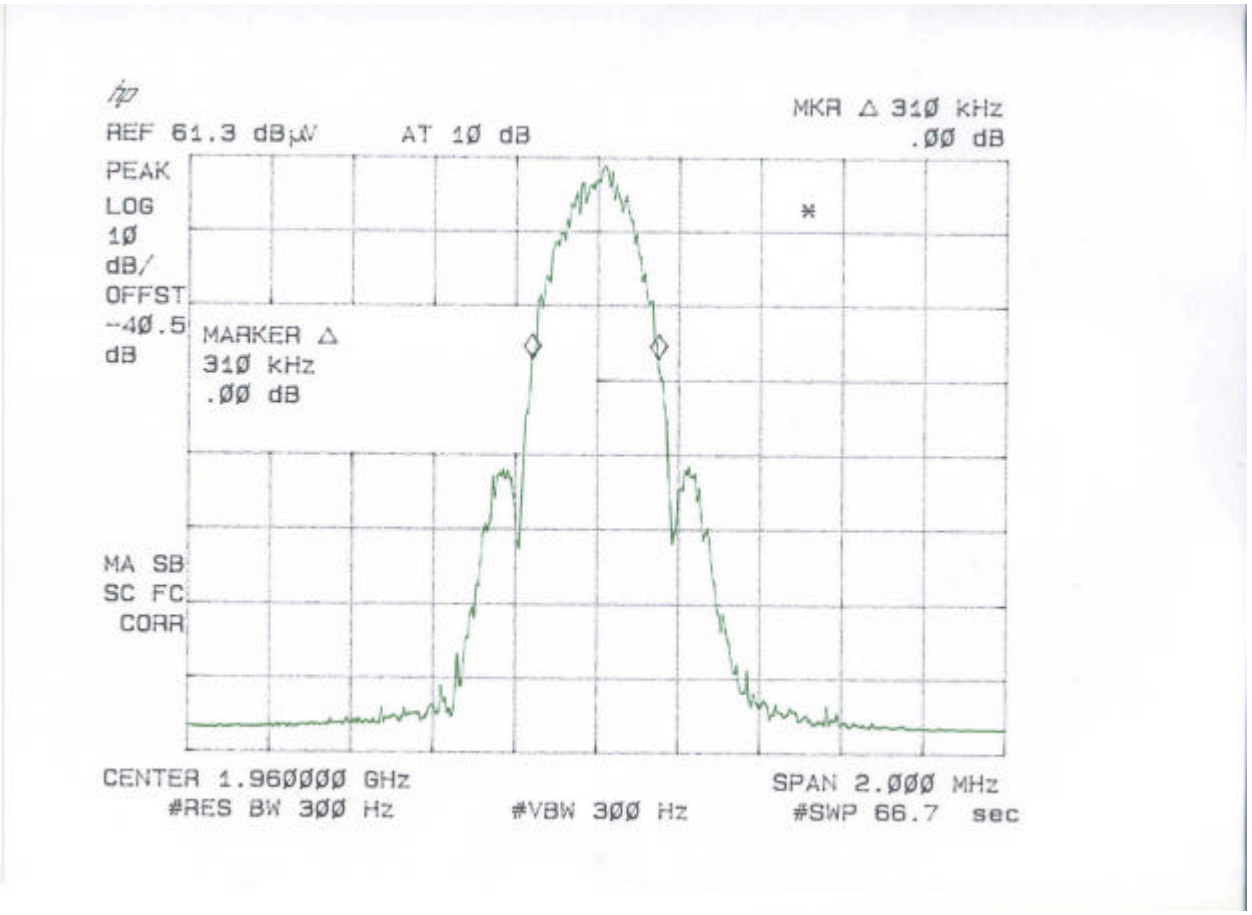
Occupied bandwidth 1930.2 EDGE output plot



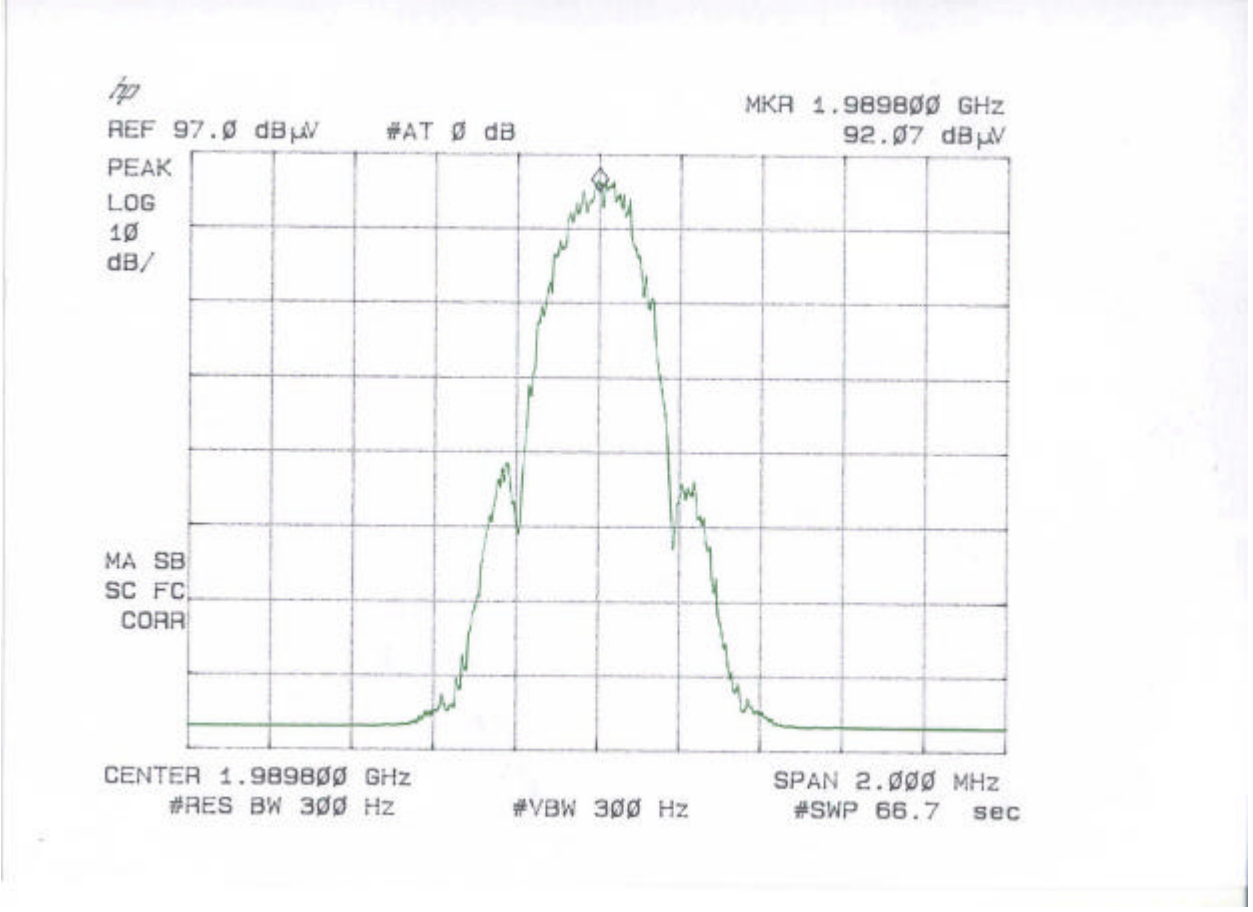
Occupied bandwidth 1960 EDGE input plot



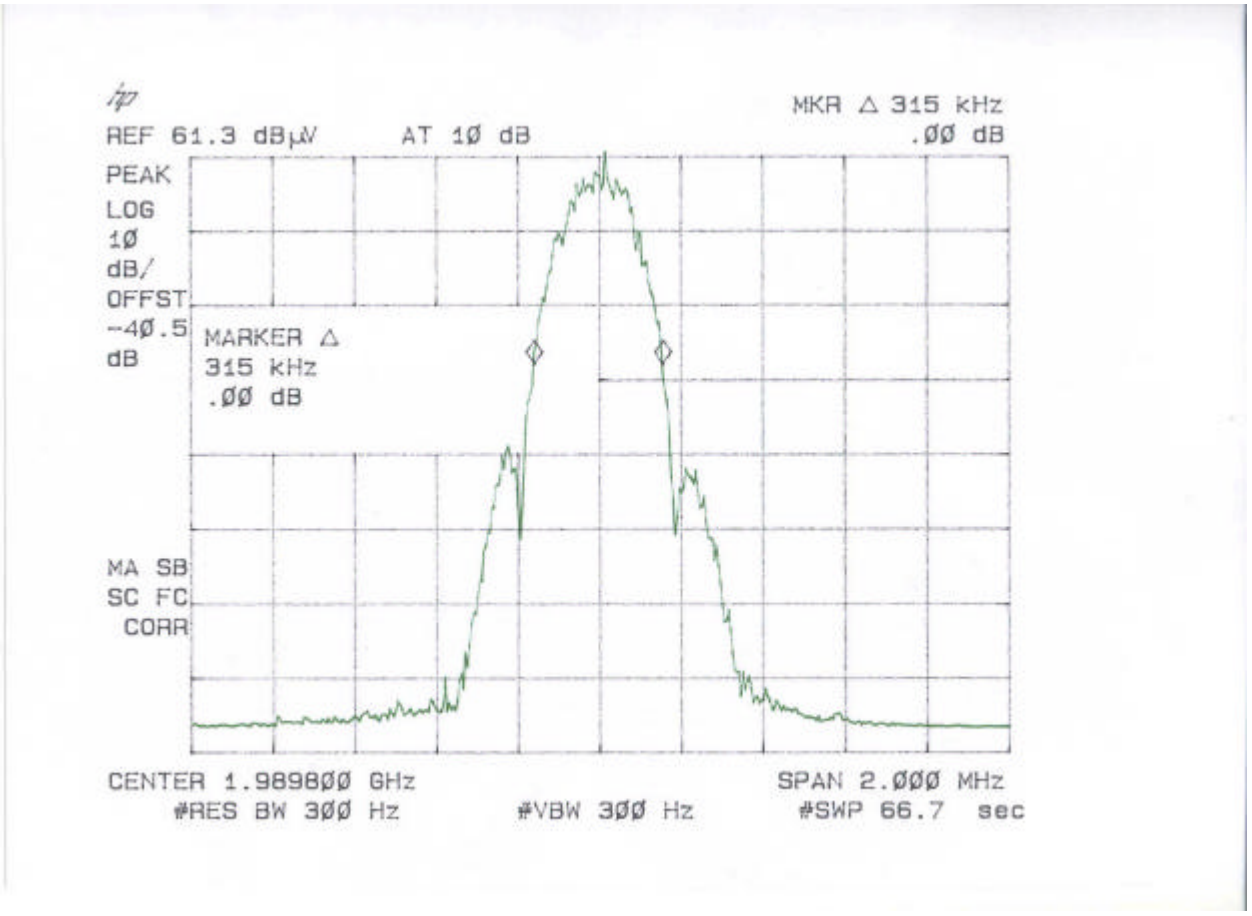
Occupied bandwidth 1960 EDGE output plot



Occupied bandwidth 1989.8 EDGE input plot



Occupied bandwidth 1989.8 EDGE output plot



2.1033(c)(14)/2.1051/24.238(a) SPURIOUS EMISSIONS AT ANTENNA TERMINAL

§24.238(a); The magnitude of each spurious and harmonic emission that can be detected when the equipment is operated under conditions specified in the instruction manual and/or alignment procedure, shall not be less than 43+10 log (mean output power in watts) dBc below the mean power output outside a licensee's frequency block.

GMSK modulation
Power Amplifier Mean Power = 60 Watts (47.8 dBm)
43 + 10 log (60 Watts) = 60.8 dB
Out-of-Band and Band-Edges emissions must be attenuated by the following amount:
47.8 dBm – 60.8 dB = -13dBm (or 94 dBuV)

EDGE modulation
Power Amplifier Mean Power = 45 Watts (46.5 dBm)
43 + 10 log (45 Watts) = 59.5 dB
Out-of-Band and Band-Edges emissions must be attenuated by the following amount:
46.5 dBm – 59.5 dB = -13dBm (or 94 dBuV)

Setup: The EUT is placed on the test bench. The RF input port is connected to an amplifier. The RF output port is connected to a RF load and directional coupler. The EUT receives 48 VDC from a support power supply. The signal generator sends RF signal to the EUT. The EUT amplifies the signal and the RF signal is loaded in to the RF load and a directional coupler. A PCS band pass filter is placed between the load and the directional coupler. The spurious emission is monitored at the RF output port of the directional coupler with a spectrum analyzer. Tx Freq: 1930 to 1990MHz. Modulation: GMSK or EDGE. Frequency range of measurement = 30 MHz – 20 GHz. Frequency 30 MHz - 1000 MHz, RBW 120 kHz, VBW 120 kHz; 1000 MHz - 20,000 MHz, RBW 1 MHz, VBW 1 MHz.

GMSK modulation 60W

Low channel 1930.200 MHz

Frequency (MHz)	Amplitude (dBuV)	Limit (dBuV)
3860.4	88	94

Mid channel 1960 MHz

Frequency (MHz)	Amplitude (dBuV)	Limit (dBuV)
3920	91	94

High channel 1989.800 MHz

Frequency (MHz)	Amplitude (dBuV)	Limit (dBuV)
3979.8	91.33	94

No other emissions detected.

EDGE modulation 45W

Low channel 1930.200 MHz

Frequency (MHz)	Amplitude (dBuV)	Limit (dBuV)
3860.4	88.3	94

Mid channel 1960 MHz

Frequency (MHz)	Amplitude (dBuV)	Limit (dBuV)
3920	90.3	94

High channel 1989.800 MHz

Frequency (MHz)	Amplitude (dBuV)	Limit (dBuV)
3979.8	90.8	94

No other emissions detected.

2.1033(c)(14)/2.1053/24.238(a) - FIELD STRENGTH OF SPURIOUS RADIATION

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A calibration of the testplace has been done to get the attenuation between the EUT and the receiving antenna. For calibration the EUT is replaced by a Tx-antenna with known gain . The receiving antennas and the distances to Tx-antenna are the same as used with measurements on EUT. Measured on several frequency points the Rx-antenna input level and calculated the max air attenuation between Tx-antenna and Rx-antenna for the worst case.
The resulting calibration curve gives the reference with which the actual measured values with the EUT have been recalculated.
Measurements have been done in vertical and horizontal polarization of antenna.

Additional equipment used for substitution method:

Description	Model	serial No.	Cal due date
Signal generator	Rohde & Sch.SWM05	s/n 863605/014	10/03
Biconical antenna	EMCO 3110 B	s/n 1910	08/03
Log-periodic antenna	EMCO 3146 A	s/n 1305	10/03
Double ridged guide H.	EMCO 3115	s/n 4151	11/03

No emission detected above 6.03 GHz.

GMSK modulation 60W

Low channel 1930.200 MHz

Frequency (GHz)	Polarization V/H	Measured value (dBm)	Correction factor (dB)	Corrected reading (dBm)	Limit (dBm)
0.0535	V	-92.3	22	-70.3	-13
3.920	V	-88.8	36.6	-52.2	-13
5.85	H	-74.5	39.2	-35.3	-13

Mid channel 1960 MHz

Frequency (GHz)	Polarization V/H	Measured value (dBm)	Correction factor (dB)	Corrected reading (dBm)	Limit (dBm)
0.0535	V	-92.3	22	-70.3	-13
5.94	H	-85.2	39.2	-48.6	-13

High channel 1989.800 MHz

Frequency (GHz)	Polarization V/H	Measured value (dBm)	Correction factor (dB)	Corrected reading (dBm)	Limit (dBm)
0.0535	V	-92.3	22	-70.3	-13
4.01	V	-88.4	36.6	-51.8	-13
6.03	H	-84.7	39.2	-45.5	-13

No other emissions detected.

EDGE modulation 45W

Low channel 1930.200 MHz

Frequency (GHz)	Polarization V/H	Measured value (dBm)	Correction factor (dB)	Corrected reading (dBm)	Limit (dBm)
0.0535	V	-94.3	22	-72.3	-13
3.920	V	-90.2	36.6	-53.6	-13
5.85	H	-70.7	39.2	-31.5	-13

Mid channel 1960 MHz

Frequency (GHz)	Polarization V/H	Measured value (dBm)	Correction factor (dB)	Corrected reading (dBm)	Limit (dBm)
0.0535	V	-94.3	22	-72.3	-13
3.96	V	-90.3	36.6	-53.7	-13
5.94	H	-82.7	39.2	-43.5	-13

High channel 1989.800 MHz

Frequency (GHz)	Polarization V/H	Measured value (dBm)	Correction factor (dB)	Corrected reading (dBm)	Limit (dBm)
0.0535	V	-94.3	22	-72.3	-13
4.01	V	-88.4	36.6	-51.8	-13
6.03	H	-81.1	39.2	-41.9	-13

No other emissions detected.

2.1033(c)(14)/2.1055 - FREQUENCY STABILITY
Not applicable to this unit.

2.1091 - MPE CALCULATIONS

Fundamental Operating Frequency: 1930-1990 MHz

Maximum Rated Output Power: 60.0 Watts
Measured Output Power: 64.50 Watts

MPE Limit in accordance with 1.1310(b): Limits for general population/uncontrolled exposure
MPE Limit for 1930-1990 MHz = 1 mW/cm^2 (10 W/m^2)

Power Output (Watts)	Power Density Limit (mW/cm^2)	Minimum Distance (Meters)

Power density (W/m^2) $= \frac{30xP_t xG}{d^2 xZ_0}$

60	1	0.69

P_t = Power Delivered to the Antenna G = Antenna Gain
d = Distance in meters Zo = Impedance of Free Space

The typical antennas to be used with the EUT are structure mount antennas which under normal operation has an antenna height of at least 5 meters. As can be seen from the MPE result, this device passes the limit specified in 1.1310 at a distance of 0.69 meter.

Calculation:

$d = \sqrt{\frac{30x60x1}{10x377}}$ = 0.69 meter

7 PART 15 requirements

7.1 CONDUCTED EMISSION DATA (15.107)

Tests of the worst case configuration (GMSK modulation).

The conducted tests are performed with a receiver in quasi-peak mode.

	Frequency (MHz)	Measured* (dBµV)	QP limit (dBµV)	AV Limit (dBµV)
-48Vdc	0.15	49	66	56
	0.17	43	64.9	54.9
	0.25	50	61.6	51.6
	17.2	42	60	50
	19.3	42	60	50
	23.6	40	60	50
-0Vdc	0.15	49	66	56
	0.17	42	64.9	54.9
	0.25	50	61.6	51.6
	17.2	41	60	50
	19.3	41	60	50
	23.6	41	60	50

* All readings are quasi-peak

Test Personnel:

Tester Signature G. Mecchia Date December 13, 2002

Typed/Printed Name Giuseppe MECCHIA .

7.2 RADIATED EMISSION DATA (15.109)

- **frequency range 30MHz – 1 GHz**

Tests of the worst case configuration (GMSK modulation).

The following data list the significant emission frequencies, measured levels, correction factors (including cable and antenna corrections), the corrected reading, plus the limit. Field strenght calculation is given in paragraph 7.3.

Judgement: Passed by 14 dB

Frequency (MHz)	Polarity (V/H)	Receiver* Reading (dBµV)	Correction Factor (dB/m)	Corrected Reading (dBµV/m)	3 Meter Limit (dBµV/m)
30	V	8.2	10.3	18.5	40
53.5	V	14.7	11.3	26	40
160.2	V	1.3	16.4	17.7	43.5
190.5	H	0.6	18.6	19.2	43.5
268.8	V	6.8	15.5	22.3	46
736.8	V	0.2	26.3	26.5	46
908	H	0.3	28.9	29.2	46

* below 1GHz readings are quasi-peak, with an IF bandwidth of 120 kHz,

Test Personnel:

Tester Signature - G. Mecchia Date December 11, 2002

Typed/Printed Name Giuseppe MECCHIA .

7.3 Field Strength Calculation

7.2.1 The field strength is calculated by adding the Antenna and Cable Factor to the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF

where

FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

Assume a receiver reading of 14.7 dBμV is obtained. The Antenna and Cable Factor of 11.3 is added, giving a field strength of 26 dBμV/m. The 26 dBμV/m value was mathematically converted to its corresponding level in μV/m.

FS = 14.7 + 11.3 = 26 dBμV/m

Level in μV/m = Common Antilogarithm [(26 dBμV/m)/20]= 20 μV/m

8 PHOTOS OF TESTED EUT

Fig. 8.1 Upper view
Fig. 8.2 Lower view
Fig. 8.3 Front panel
Fig. 8.4 EUT partially disassembled
Fig. 8.5 Internal view without cover
Fig. 8.6 Driver and TLA boards removed
Fig. 8.7 Power suuply/driver board – component side
Fig. 8.8 Power suuply/driver board – foil side
Fig. 8.9 PLK 4316 Pit , DC converter – component side
Fig. 8.10 PLK 4316 Pit , DC converter – lower side
Fig. 8.11 TLA 0362 – upper side
Fig. 8.12 TLA 0362 – lower side / TLA 0364 component side
Fig. 8.13 TLA 0364 – lower side
Fig. 8.14 Output circuit – component side
Fig. 8.15 Output circuit – foil side
Fig. 8.16 Interconnection board – component side
Fig. 8.17 Interconnection board – foil side