

TEST REPORT

Report Number: 100129577LEX-001

Project Number: G100129577

Evaluation of the MTSMC-EV2 Family

Model Numbers: MTSMC-EV2-MI-GP; MTSMC-EV2-MI-IP; MTSMC-EV2-GP, MTSMC-EV2-IP, MTSMC-EV2-U

FCC ID: AU792U10E06831

FCC Part 22 Subpart H

FCC Part 24 Subpart E

For

Multi-Tech

Test Performed by:

Intertek
731 Enterprise Drive
Lexington, KY 40510

Test Authorized by:

Multi-Tech
2205 Woodale Drive
Mounds View, MN 55112

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1 JOB DESCRIPTION

1.1 Company Information

Company Information	
Manufacturer:	Multi-Tech
Address:	2205 Woodale Drive Mounds View MN 55112
Contact Name:	Terry Boe
Telephone Number:	(763) 717-5506

1.2 Test Sample Information

The model MTSMC-EV2-MI-GP, MTSMC-EV2-MIIP, MTSMC-EV2-GP, TSMC-EV2-IP and MTSMC-EV2-U have identical RF radio circuitry. The MTSMC-EV2-MI-GP is the base model and represents the MTSMC-EV2 product family as the fully loaded model with all the functionality of each device in the product family. The below table shows the model, functionality and comment of change as it would compare to the MTSMC-EV2-MI-GP the base or parent model.

All tests in this report were performed on a MTSMC-EV2-MI-GP sample.

Model	Functionality	Comment of change
MTSMC-EV2-MI-GP	EVDO, Serial and USB interface, GPIO, IP Stack and GPS	Base or Parent model
MTSMC-EV2-MI-IP	EVDO, Serial and USB interface, GPIO and IP Stack.	1. The GPS module is not integrated.
MTSMC-EV2-GP	EVDO, Serial interface, IP Stack and GPS	1. No USB interface. 2. GPIO interface pins are removed.
MTSMC-EV2-IP	EVDO, Serial interface, IP Stack	1. No USB interface. 2. GPIO interface pins are removed. 3. The GPS module is not integrated.
MTSMC-EV2-U	EVDO and USB interface	1. No Serial interface. 2. GPIO interface pins are removed. 3. IP stack is not integrated.. 4. The GPS module is not integrated

Test sample		
Model Number:	MTSMC-EV2-MI-GP	
Serial Number:	50840012K	
FCC ID:	AU792U10E06831	
Device Category:	Mobile	
RF Exposure Category:	General Population/Uncontrolled Environment	
Transmission Modes:	CDMA Cell	CDMA PCS
Frequency Range, MHz:	824MHz - 849MHz	1850MHz – 1910MHz
Maximum Conducted RF Output Power:	24.2dBm	23.69 dBm
Antenna Type:	Not Supplied	Not Supplied
Antenna Location:	Externally Mounted	Externally Mounted

1.3 System Support Equipment

Table 1-1 contains the details of the support equipment associated with the Equipment Under Test during the testing.

Table 1-1: System Support Equipment

Description	Manufacturer	Model Number	Serial Number
Antenna	Exceltek	C0081-ANG0002	Not Labeled
Universal AC/DC Power Adapter	GlobTek Inc.	GT-41052-1509	Not Labeled
Developer Board	Multi-Tech	MTSMI-UDK	13715952

1.4 Cables Used During Testing

Table 1-2 contains the details of the cables used during the testing.

Table 1-2: Interconnecting Cables Used During Testing

Cables					
Description	Length	Shielding	Ferrites	Connection	
				From	To
Power Cable	6 ft	No	Yes	AC/DC Power Converter	DC Input
Ethernet Cable	25 ft	No	No	Ethernet Port	Ethernet Switch
DB 25 Cable	6 ft	Yes	No	RS-232 Port	Unterminated
USB Cable	6 ft	Yes	No	USB Port	Unterminated
Speaker Cable	6 ft	No	No	Speaker Port	Speaker
Phone Cable	10 ft	No	No	ISDN Port	Unterminated
Phone Cable	10 ft	No	No	PSTN Port	Unterminated

1.5 System Block Diagram(s)

The diagrams below detail the interconnection of the EUT and its accessories during the testing.

Figure 1-1: Radiated Test Configuration

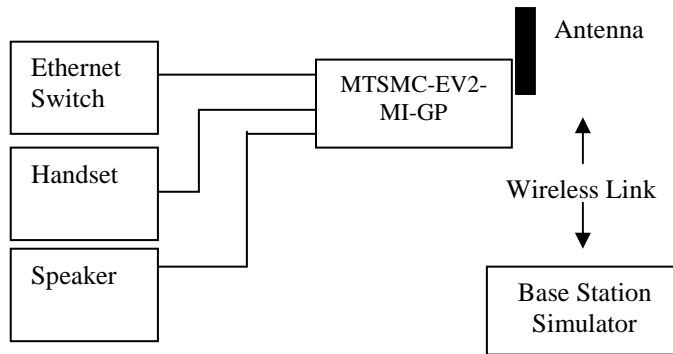
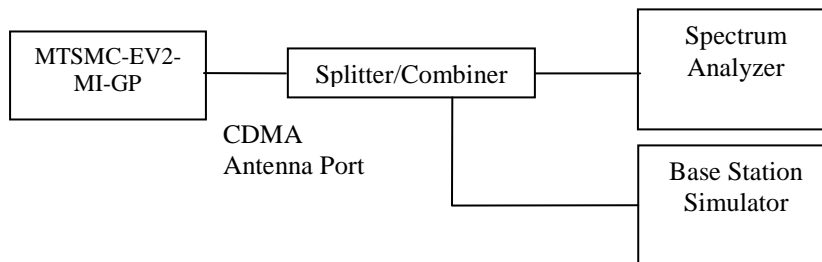


Figure 1-2: Conducted Test Configuration



1.6 Mode(s) of operation / Engineering Judgments

The MTSMC-EV2-MI-GP was powered by a universal AC/DC convertor connected to 120VAC.

For radiated testing in a representative cellular antenna was connected to the MTSMC-EV2-MI-GP. For conducted measurements the antenna was removed and a calibrated coaxial cable inserted between the antenna port and the measuring equipment (spectrum analyzer or base station simulator). A base station simulator was used to force the MTSMC-EV2-MI-GP to transmit at maximum output power.

2 EXECUTIVE SUMMARY

Testing performed for: Multi-Tech

Equipment Under Test: MTSMC-EV2-MI-GP

Receipt of Test Sample: 5/3/2010

Test Start Date: 5/3/2010

Test End Date: 5/7/2010

The MTSMC-EV2-MI-GP was compliant with the applicable requirements of Part §22H and Part §24E.

FCC RULE	DESCRIPTION OF TEST	RESULT	PAGE
§2.1046	RF Power Output	Compliant	10
§22.913, §24.232	ERP, EIRP	Compliant	11
§ 1.1310	Maximum Permissible Exposure (MPE) Calculations	Compliant	11
§2.1049 §22.917(b)(d) §24.238(a)	Occupied Bandwidth, Emissions Limitations	Compliant	13
§2.1051 §22.917(a) §24.238(a)	Out of Band Emissions at Antenna Terminals	Compliant	16
§2.1053 §22.917(a) §24.238(a)	Radiated Spurious Emissions	Compliant	24
§2.1055, §22.355, §24.235	Frequency Stability vs. Temperature Frequency Stability vs. Voltage	Compliant	26

2.1 Modifications required for compliance

No modifications were implemented by Intertek. All results in this report pertain to the un-modified sample provided to Intertek.

3 TEST FACILITY

All testing was completed at the INTERTEK-Lexington location at 731 Enterprise Drive, Lexington Kentucky, 40510. The radiated emission test site is a 10-meter semi-anechoic chamber. The chamber meets the characteristics of CISPR 16-1 and ANSI C63.4. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters.



For radiated immunity testing, removable ferrite tiles are positioned between the transmitting antenna and the area occupied by the equipment under test. The remaining tests typically are performed outside the chamber on the conducting ground reference plane.

The Industry Canada filing number for this site is 2042M-1 The FCC registration number is 485103.

3.1 Test Equipment

Description	Manufacturer	Model Number	Serial Number	Calibration due date
Environmental Chamber	Thermotron	SM-8C	32692	4/30/2011
Signal Generator	HP	83620B	3614A00199	10/8/2010
Horn Antenna	EMCO	3115	6556	8/4/2010
Horn Antenna	Antenna Research	DRG-118/A	1086	7/3/2010
EMI Receiver	Rohde & Schwarz	ESI26	10887490.26	9/14/2010
Bilog Antenna	EMCO	3142C	00051864	12/24/2009
Preamplifier	Miteq	AFS44-00102000-30-10P-44	987410	6/17/2010
Digital Multimeter	Fluke	87	65920874	5/20/2010
Base Station Simulator	Rhode & Schwarz	CMU200	837198089	6/24/2010
Base Station Simulator	Agilent	8960 Series 10	GB47230114	8/13/2010

4 CONDUCTED RF POWER

FCC Rule: §2.1046

4.1 Test Procedure

The transmitter output was connected to a calibrated coaxial cable, the other end of which was connected to a Base Station Simulator. The Base Station Simulator was set to force the EUT to its maximum power setting. The EUT was placed into a call and the transmitter output was read off the base station simulator in dBm. The power output at the transmitter antenna port was determined by adding the value of the cable insertion loss to the base station simulator power reading.

Tests were performed at three frequencies (low, middle, and high channels) and on the highest power levels, which can be setup on the transmitters. The output power was measured in different radio configurations and service options. The worst case configuration was used for the remaining tests.

4.2 Test Results

The MTSMC-EV2-MI-GP met the RF power output requirements of FCC Part 22 Subpart H and FCC Part FCC Part 24 Subpart E. The test results are shown Table 4-1. The worst case radio configuration was reported as RC3/SO55.

Table 4-1 – Conducted RF Output Power

Configuration	CDMA Cell Band			CDMA PCS Band		
	Channel 1013	Channel 384	Channel 777	Channel 25	Channel 600	Channel 1175
RC1 SO2	23.2	23.81	23.51	23.07	22.97	22.42
RC3 SO2	23.08	23.61	23.22	22.8	22.82	22.35
RC4 SO2	23.13	23.67	23.46	23	22.84	22.33
RC1 SO55	23.1	23.67	23.17	22.89	22.73	22.67
RC3 SO55	23.92	24.2	24.03	23.69	23.49	23.53
RC2 SO9	23.02	23.71	23.41	22.91	22.8	22.67
RC3 SO32	23.17	23.71	23.25	22.97	23	23.3
1x EvDO Rev. 0 FTAP	23.91	24.11	23.9	23.41	23.2	23.24
1x EvDO Rev. 0 RTAP	23.88	24.15	23.91	23.43	23.27	23.45
1x EvDO Rev. A FTAP	23.72	24.03	23.79	23.32	23.12	23.01
1x EvDO Rev. A RTAP	23.82	23.76	23.79	23.42	23.16	23.06

5 RADIATED RF POWER

FCC Rule §22.913; The Effective Radiated Power (ERP) of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

FCC Rule §24.232; RSS-133 §6.2; The equivalent Isotropic Radiated Power (EIRP) must not exceed 2 Watts.

RSS-129 §9.1, RSS-133 (6.4)

5.1 Test Procedure

Since the device is not supplied with an antenna, the maximum allowed antenna gain is calculated using the maximum measured conducted output power.

Cell Band:

Gain (dBd) = ERP - Conducted Output Power (dBm)

Gain (dBd) = 32.1dBm - 24.2 dBm = 7.9 dBd = 10.05 dBi

PCS Band:

Gain (dBi) = EIRP - Conducted Output Power (dBm)

Gain (dBi) = 33dBm - 23.69 dBm = 9.31 dBi

5.2 Test Results

The MTSMC-EV2-MI-GP meets the radiated power requirements of FCC §22.913 and §24.232 when an antenna of no more than 7.9 dBd of gain in the cell band and no more than 9.31dBi of gain in the PCS band is used.

6 MAXIMUM PERMISSIBLE EXPOSURE (MPE) CALCULATIONS

The § 1.1310 Radiofrequency radiation exposure limits are listed in the table below.

	Frequency Range (MHz)	Power Density Limit (mW/cm²)
Limits for Occupational/Controlled Exposures	0.3-3.0	100
	3.0-30	900/ Frequency ²
	30-300	1.0
	300-1500	Frequency/300
	1500-100,000	5.0
Limits for General Population/Uncontrolled Exposure	0.3-1.34	100
	1.34-30	180/Frequency ²
	30-300	0.2
	300-1500	Frequency/1500
	1500-100,000	1.0

For CDMA Cell bands the limit for general population / uncontrolled exposure is calculated to be 0.55mW/cm²

For PCS band, the limit for general population / uncontrolled exposure is 1.0mW/cm²

6.1 Calculations

Since the MTSMC-EV2-MI-GP is not sold with an antenna, the EIRP is calculated from the conducted power in the previous section of this report. That radiated power is then used to calculate the MPE at a 20 cm distance using the following formula:

$$\text{Maximum RF Exposure at 20cm} = (\text{EIRP in mW}) / (4\text{Pi}(20\text{cm})^2)$$

Cell Band:

The maximum ERP for the cell band was 32.1 dBm. To convert this value to EIRP 2.15 is added to get an EIRP value of 34.25 dBm or 2660.7 mW

Substituting this into the equation above, we get a Maximum RF Exposure (MPE) at 20cm of:

$$\begin{aligned} \text{MPE at 20cm} &= 2660.7\text{mW} / (4\text{Pi}(20\text{cm})^2) \\ \text{MPE at 20cm} &= 0.53\text{mW/cm}^2 \end{aligned}$$

PCS Band:

The maximum EIRP for the PCS band was 33dBm.

Substituting this into the equation above, we get a Maximum RF Exposure (MPE) at 20cm of:

$$\begin{aligned} \text{MPE at 20cm} &= 2000 \text{ mW} / (4\text{Pi}(20\text{cm})^2) \\ \text{MPE at 20cm} &= 0.398\text{mW/cm}^2 \end{aligned}$$

6.2 Test Results

The worst case MPE at 20cm of 0.53 mW/cm² is less than the 0.55 mW/cm² limit for general population/uncontrolled exposure shown in the table above for the cell band. For the PCS band, the worst case MPE at 20cm of 0.398mW/cm² is less than the 1 mW/cm² limit.

7 EMISSION LIMITATIONS, OCCUPIED BANDWIDTH

CFR 47 §2.1049: The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

7.1 Test Procedure

In both CDMA 800 and 1900 modes the antenna port of the EUT was connected to a spectrum analyzer using a calibrated coaxial cable and power divider. The EUT was placed into a call using base station simulator. The base station simulator was set to force the EUT to its maximum power setting. The occupied bandwidth function of the analyzer was used to automatically generate the occupied bandwidth plots below.

7.2 Test Results

The following is the occupied bandwidth data for the MTSMC-EV2-MI-GP .

Figure 7-1: Occupied Bandwidth – Cell Channel 384

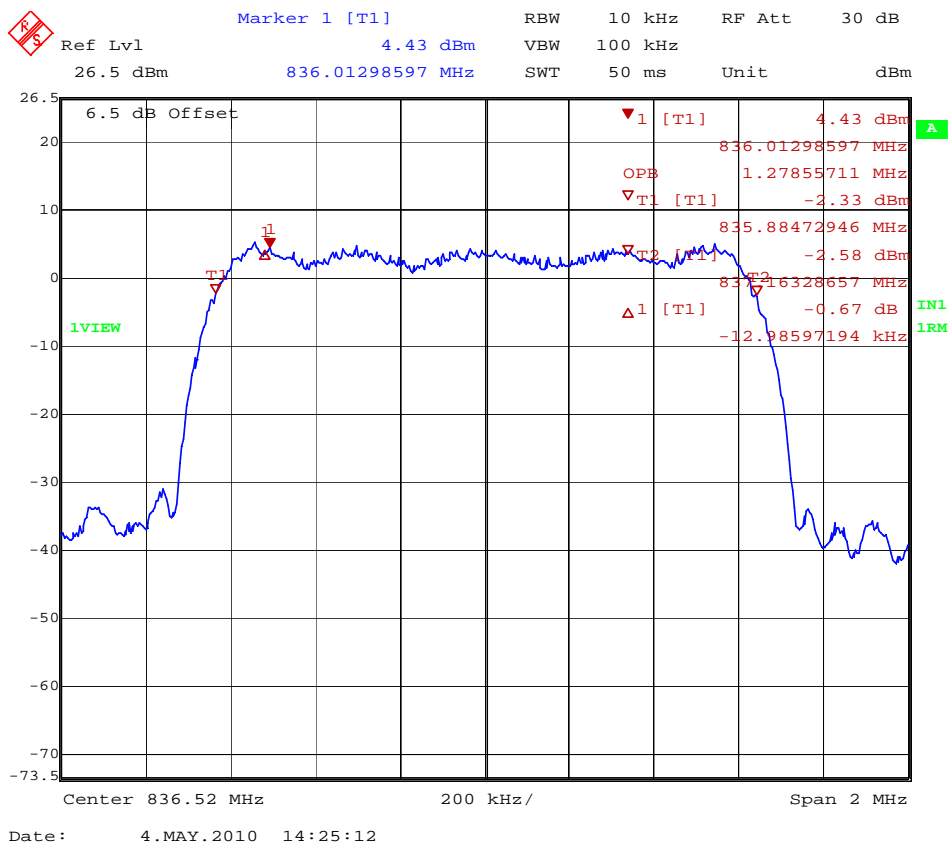
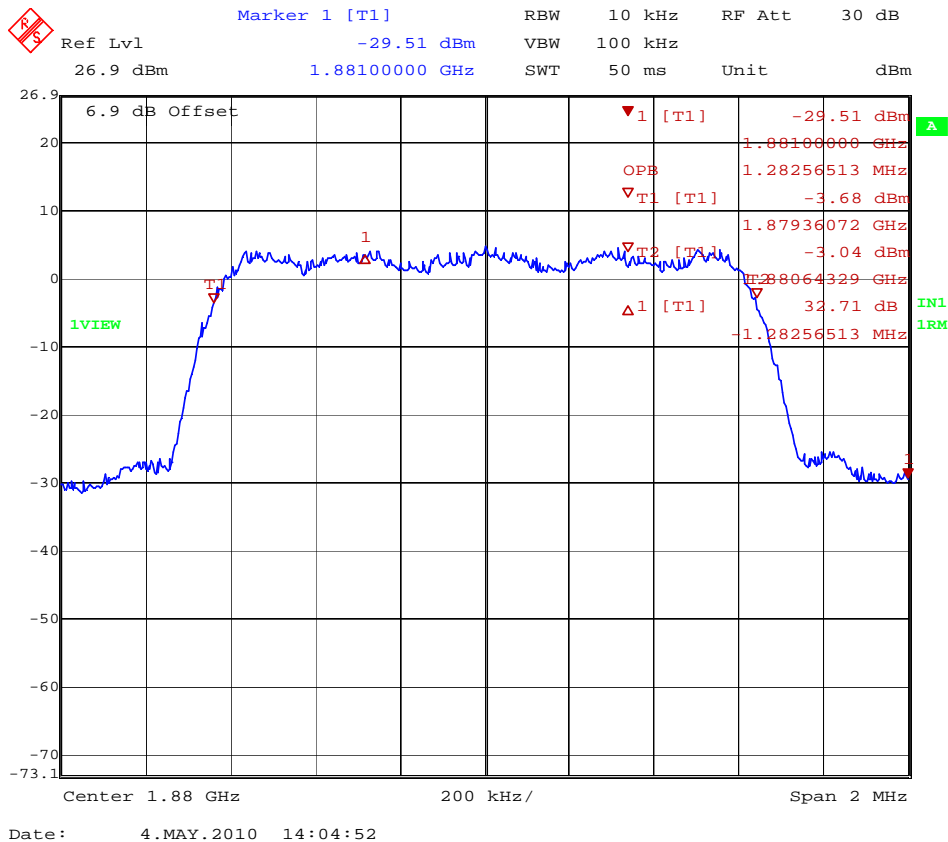


Figure 7-2: Occupied Bandwidth – PCS Channel 600



8 OUT OF BAND EMISSION AT ANTENNA TERMINALS

FCC §2.1049, FCC §2.1051, §22.917(a), FCC §24.238(a)

Out of Band Emissions: The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

8.1 Test Procedure

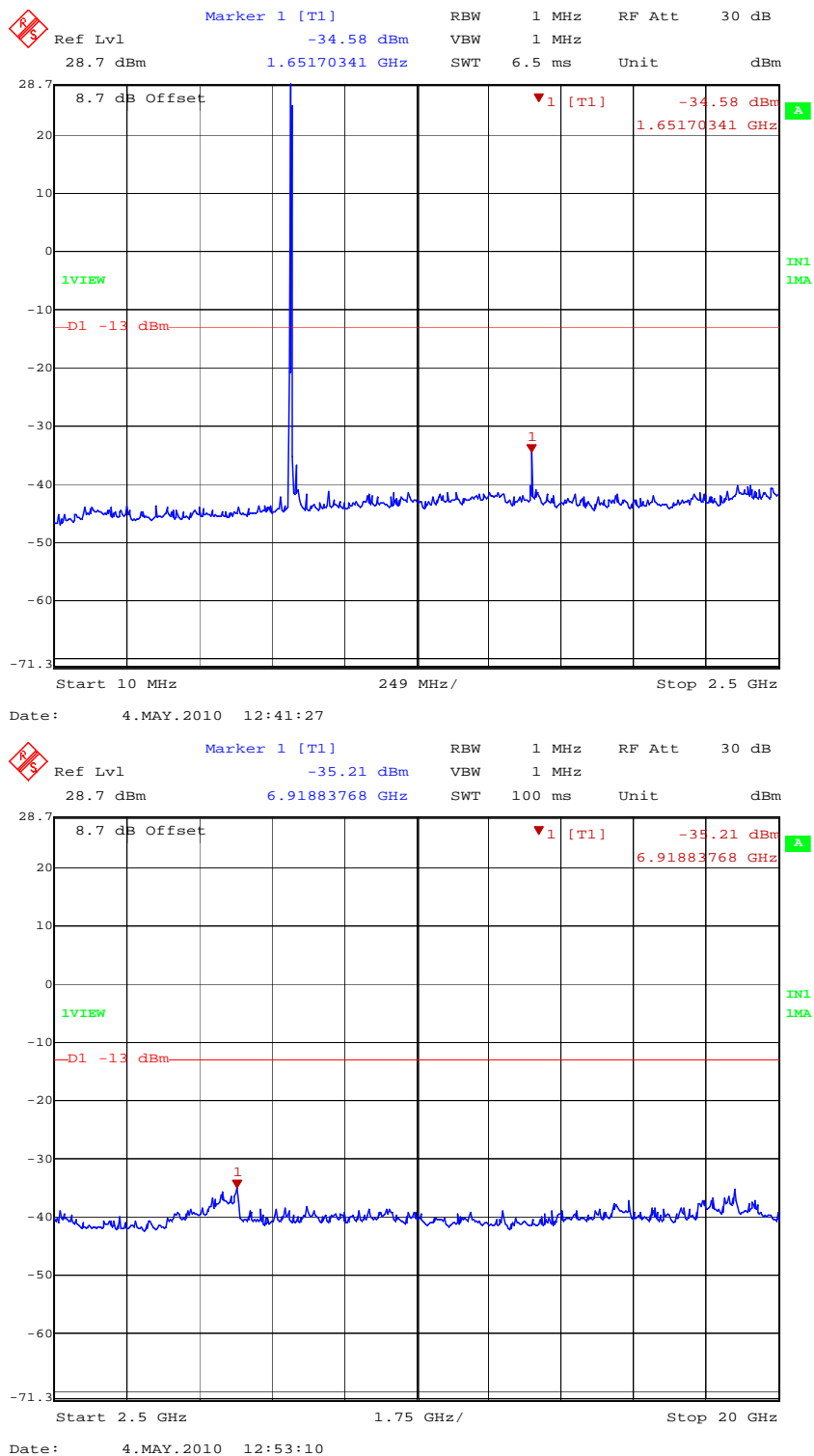
Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater for the Cellular band and 1 MHz or greater in the PCS band. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The Base Station Simulator was set to force the EUT to its maximum power setting. The resolution bandwidth of the spectrum analyzer was set at 1 MHz. Sufficient scans were taken to show the out of band Emissions if any up to 10th harmonic.

8.2 Test Results

The MTSMC-EV2-MI-GP met the out of band emission at antenna terminal requirements.

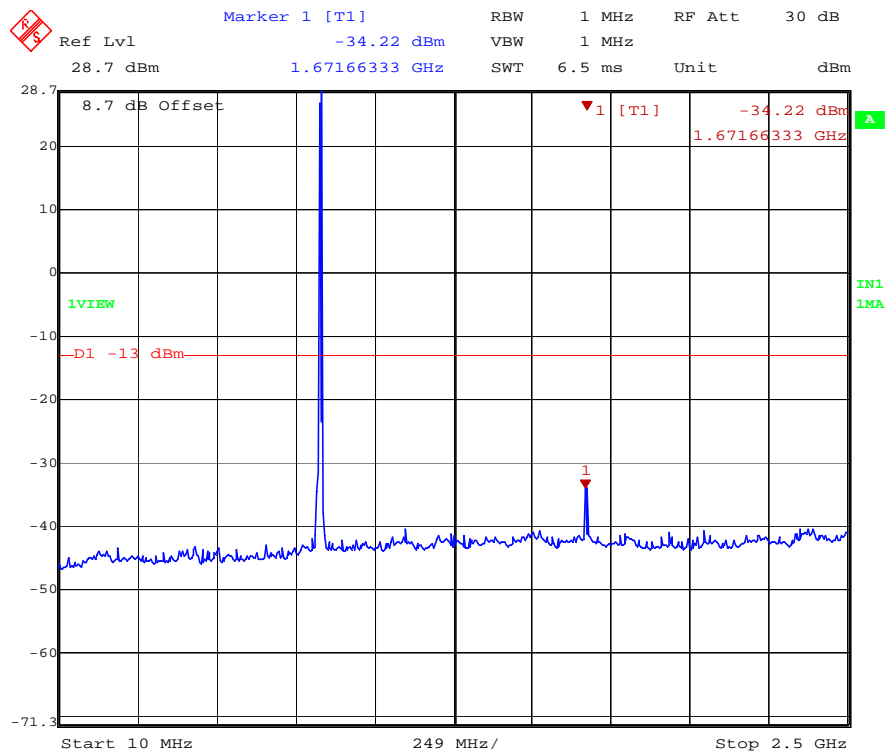
Figure 8-1: Out of band emissions at antenna terminals – CDMA Cell Channel 1013



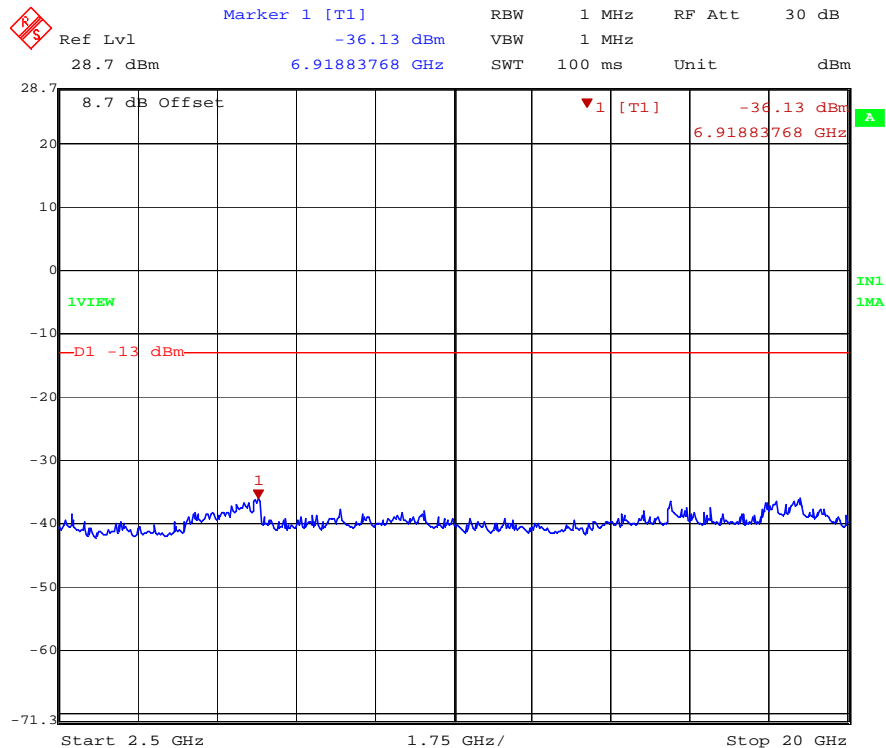
Evaluation For: Multi-Tech
 Model No: MTSMC-EV2-MI-GP

FCC ID: AU792U10E06831

Figure 8-2: Out of band emissions at antenna terminals – CDMA Cell Channel 384



Date: 4.MAY.2010 12:40:49

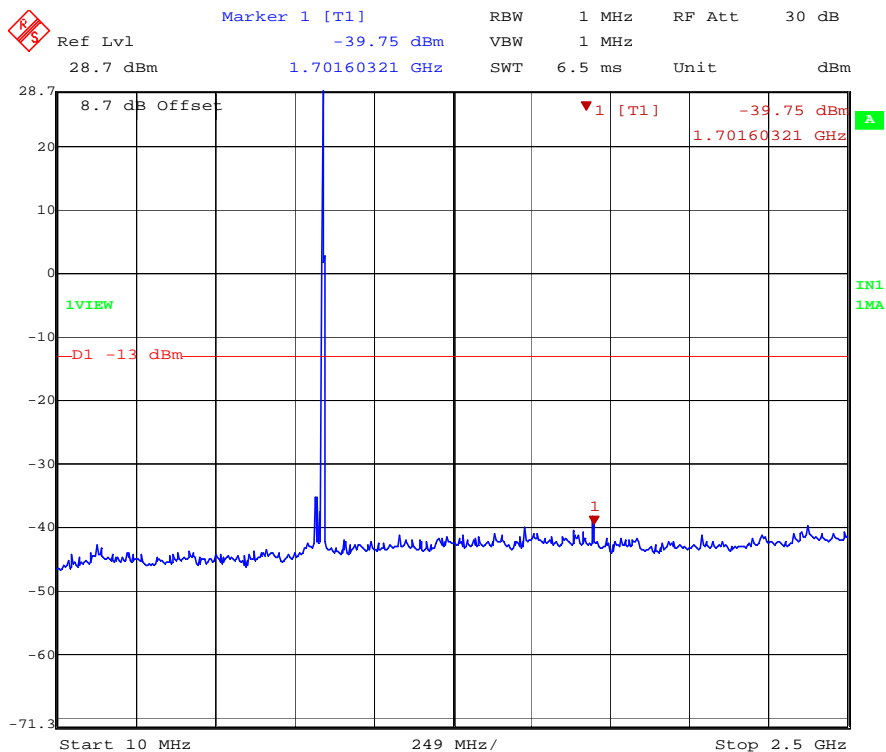


Date: 4.MAY.2010 12:52:19

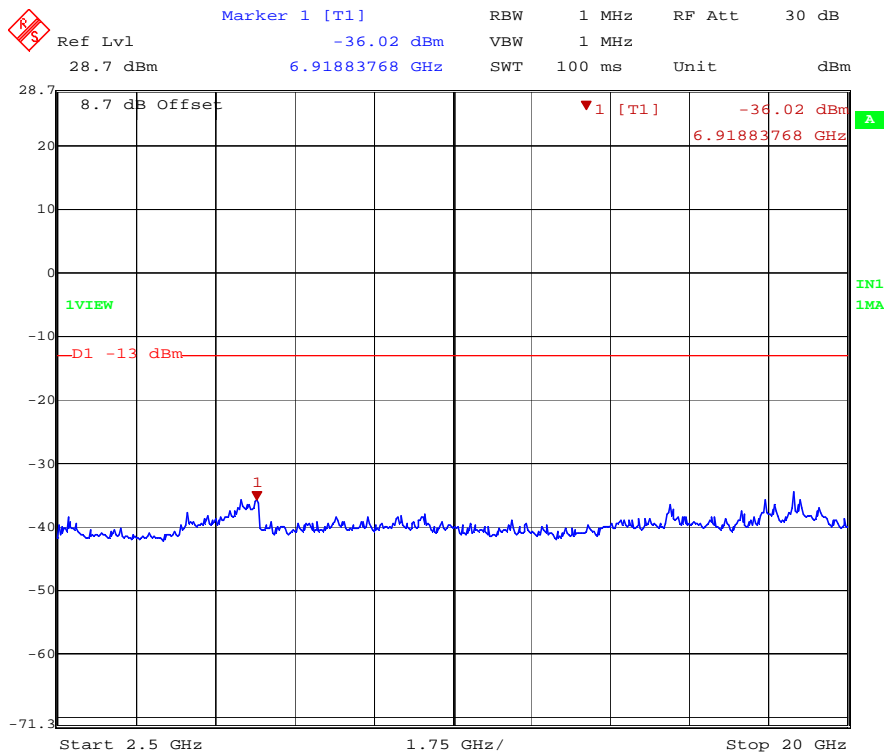
Evaluation For: Multi-Tech
 Model No: MTSMC-EV2-MI-GP

FCC ID: AU792U10E06831

Figure 8-3: Out of band emissions at antenna terminals – CDMA Cell Channel 777



Date: 4.MAY.2010 12:42:08

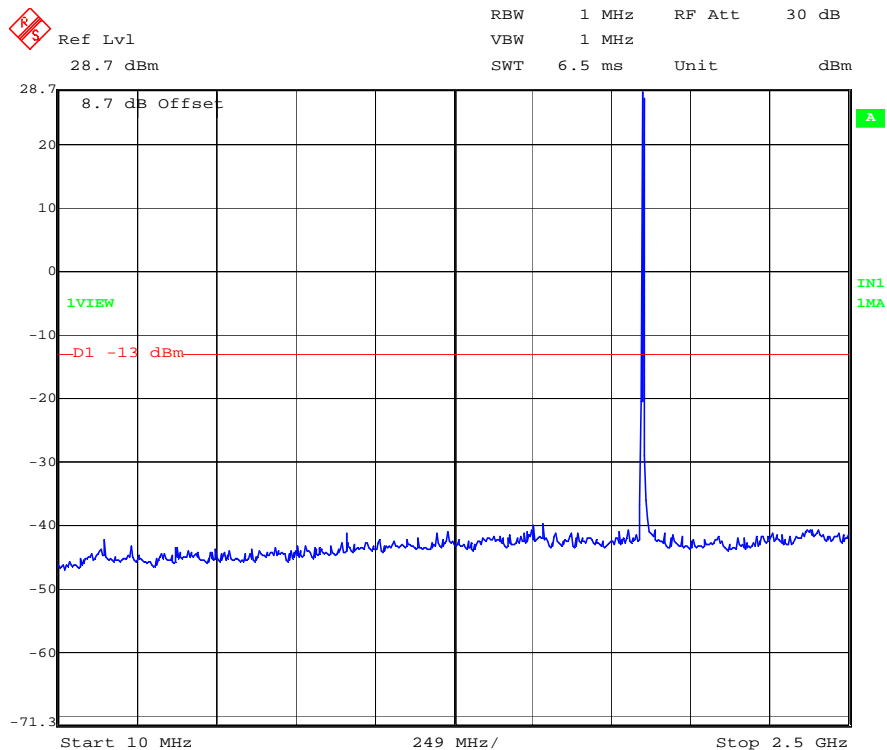


Date: 4.MAY.2010 12:51:30

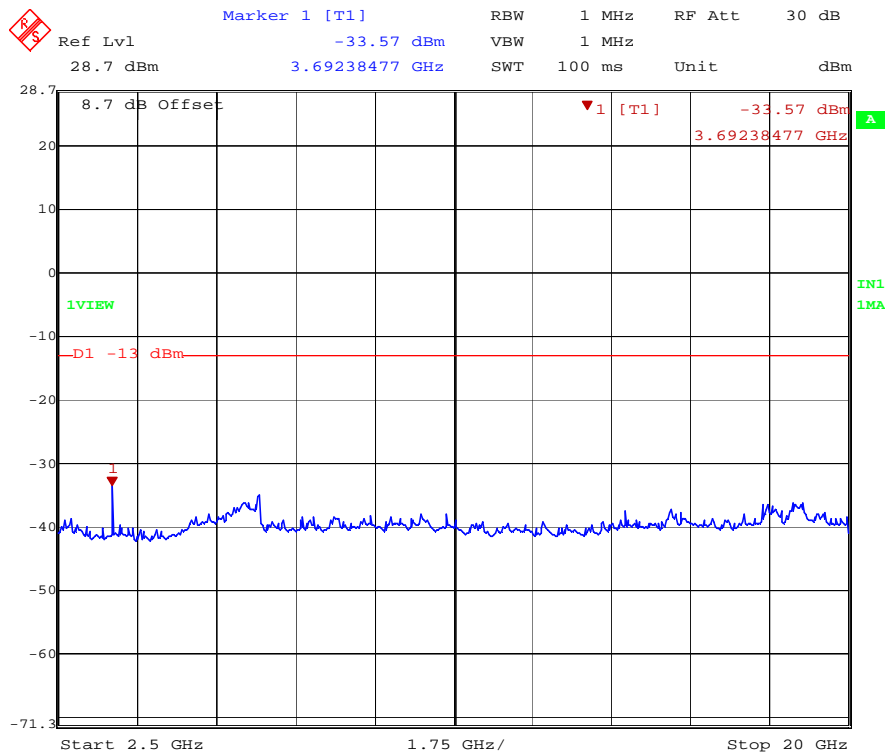
Evaluation For: Multi-Tech
 Model No: MTSMC-EV2-MI-GP

FCC ID: AU792U10E06831

Figure 8-4: Out of band emissions at antenna terminals – CDMA PCS Channel 25



Date: 4.MAY.2010 12:43:00

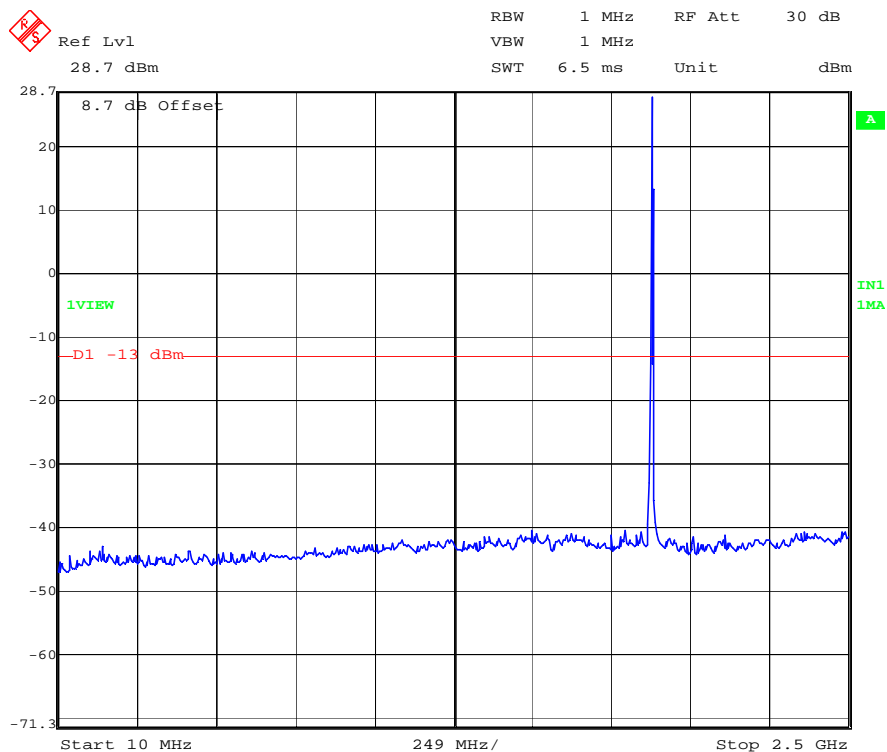


Date: 4.MAY.2010 12:50:37

Evaluation For: Multi-Tech
 Model No: MTSMC-EV2-MI-GP

FCC ID: AU792U10E06831

Figure 8-5: Out of band emissions at antenna terminals – CDMA PCS Channel 600



Date: 4.MAY.2010 12:43:39

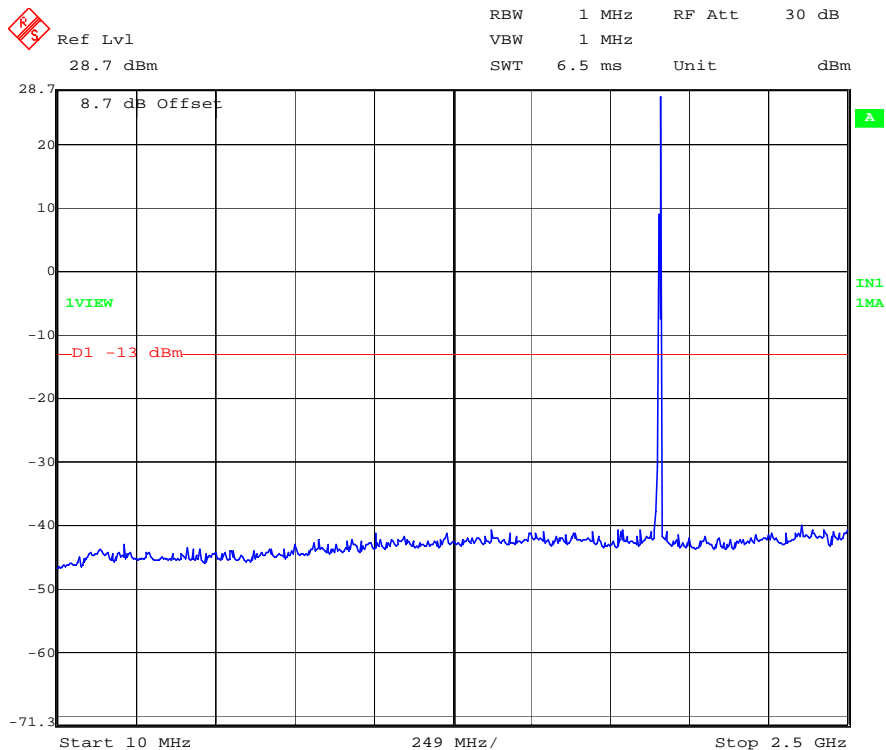


Date: 4.MAY.2010 12:48:51

Evaluation For: Multi-Tech
 Model No: MTSMC-EV2-MI-GP

FCC ID: AU792U10E06831

Figure 8-6: Out of band emissions at antenna terminals – CDMA PCS Channel 1175



Date: 4.MAY.2010 12:44:16



Date: 4.MAY.2010 12:47:36

Evaluation For: Multi-Tech
 Model No: MTSMC-EV2-MI-GP

FCC ID: AU792U10E06831

Figure 8-7: Emissions within 1 MHz of band edge, CDMA 800 Channel 1013

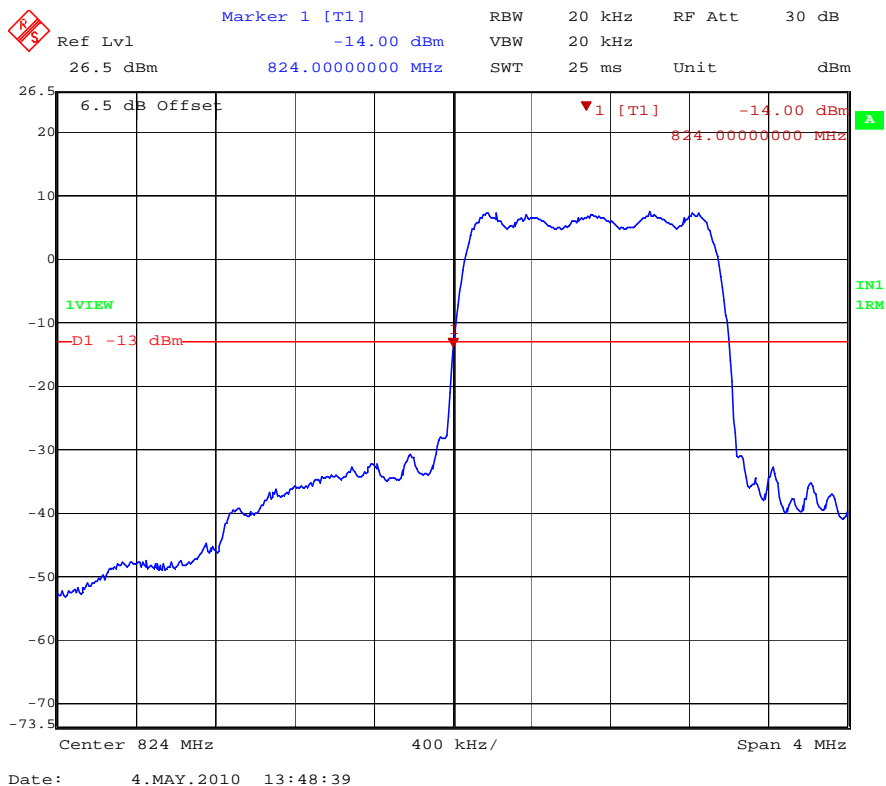
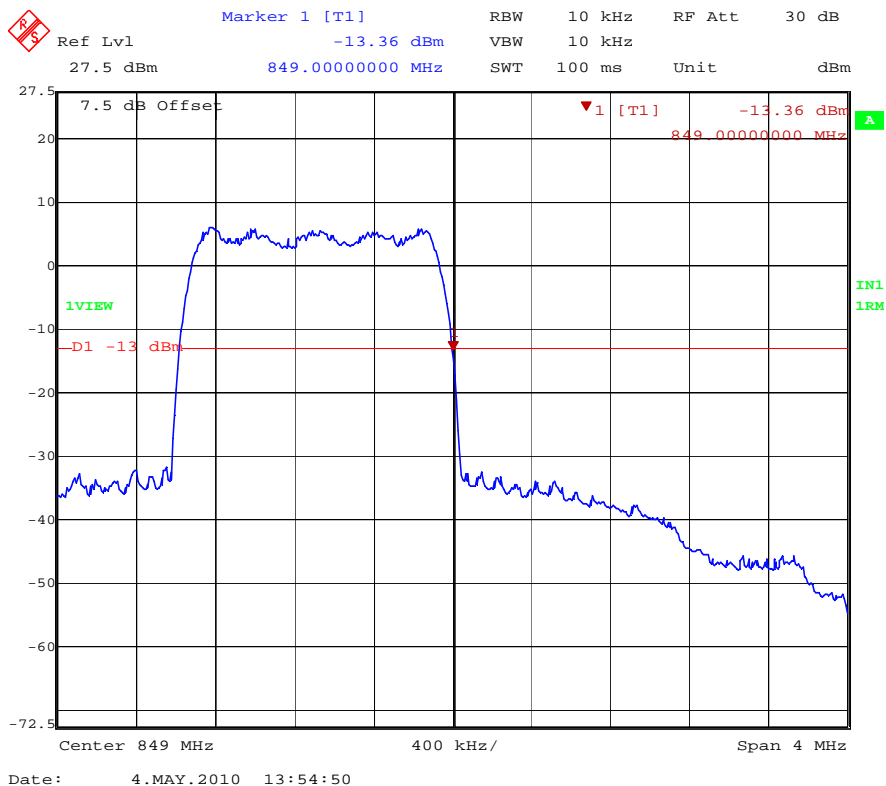


Figure 8-8: Emissions within 1 MHz of band edge, CDMA 800 Channel 777



Evaluation For: Multi-Tech
 Model No: MTSMC-EV2-MI-GP

FCC ID: AU792U10E06831

Figure 8-9: Emissions within 1 MHz of band edge, CDMA 1900 Channel 25

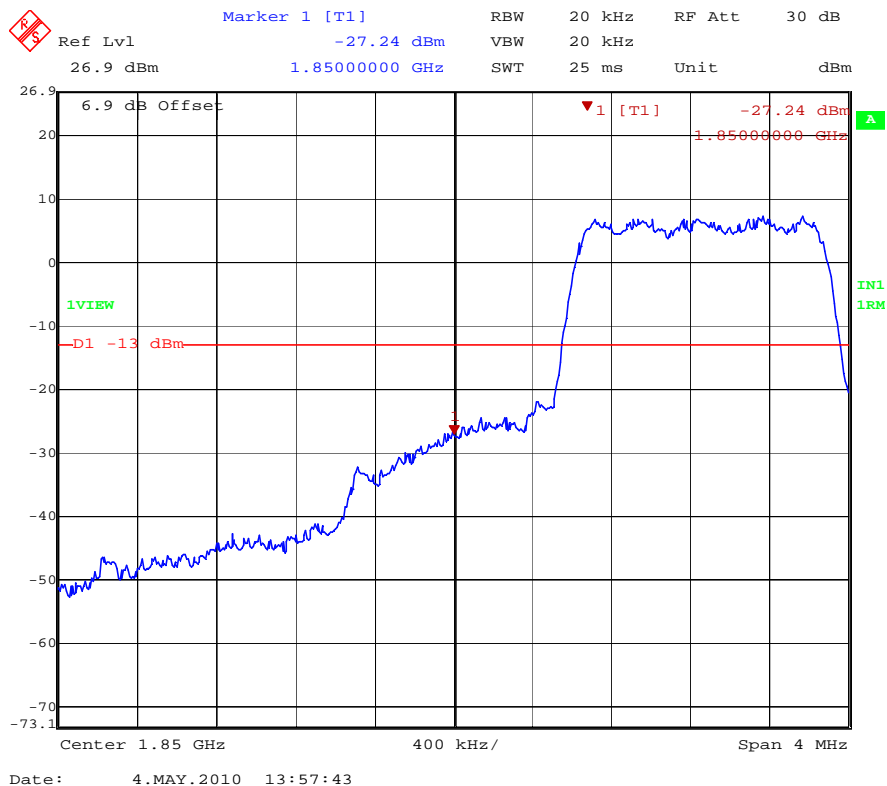


Figure 8-10: Emissions within 1 MHz of band edge, CDMA 1900 Channel 1175



9 RADIATED SPURIOUS EMISSIONS

FCC §2.1053

9.1 Test Procedure

The EUT was placed on a non-conductive turntable. The measurement antenna was placed at a distance of 3 meters from the EUT. The Base Station Simulator was set to force the EUT to its maximum power setting. During the tests, the antenna height and EUT azimuth were varied in order to identify the maximum level of emissions from the EUT.

The frequency range up to tenth harmonic was investigated for each of three fundamental frequencies (low, middle, and high channels) in each operating band. Once spurious emissions were identified, the power of the emission was determined using the substitution method described in TIA-603-B section 2.2.12 (Radiated Spurious Emissions).

The spurious emissions attenuation was calculated as the difference between radiated power at the fundamental frequency and at the spurious emissions frequency.

9.2 Test Results

The MTSMC-EV2-MI-GP met the field strength of spurious radiation requirements of FCC §2.1053. See *Table 9-1* for radiated spurious emissions results.

Table 9-1: Radiated Spurious Emissions

EUT Mode	TX Channel	Polarity	Spurious Emission Frequency	Device Reading (dBuV)	Signal Generator Output (dBm)	Cable Loss (dB)	Tx Antenna Gain (dBi)	Tx Antenna Gain (dBd)	Radiated Power (dBm)	Limit (dBm)	Margin (dB)
CDMA Cell	1013	V	1649.4	30.55	-42.2	3.5	9.1	6.96	-38.74	-13	-25.74
CDMA Cell	1013	H	1649.4	31.08	-41.7	3.5	9.3	7.16	-38.04	-13	-25.04
CDMA Cell	384	V	1673.04	29.63	-43.3	3.5	9.2	7.06	-39.74	-13	-26.74
CDMA Cell	777	V	1696.62	29.63	-42.8	3.4	9.4	7.26	-38.94	-13	-25.94
CDMA Cell	777	H	1696.62	27.45	-45.9	3.4	9.3	7.16	-42.14	-13	-29.14
CDMA PCS	25	V	3702.5	63.33	-36.2	6.1	9.0	6.86	-35.44	-13	-22.44
CDMA PCS	25	H	3702.5	57.16	-44.1	6.1	9.32	7.18	-43.02	-13	-30.02
CDMA PCS	25	V	5553.75	46.95	-49	7.3	10.8	8.66	-47.64	-13	-34.64
CDMA PCS	25	V	7405	43.20	-41.5	11.1	9.8	7.66	-44.94	-13	-31.94
CDMA PCS	25	H	7405	41.27	-47.8	11.1	9.8	7.66	-51.24	-13	-38.24
CDMA PCS	600	V	3760	61.09	-37.8	6.0	9.6	7.46	-36.34	-13	-23.34
CDMA PCS	600	H	3760	53.81	-47.7	6	10.1	7.96	-45.74	-13	-32.74
CDMA PCS	600	V	5640	48.00	-44.6	7.1	11.2	9.06	-42.64	-13	-29.64
CDMA PCS	600	H	5640	42.33	-54.6	7.1	11.3	9.16	-52.54	-13	-39.54
CDMA PCS	600	V	7520	42.10	-42.8	11	9.9	7.76	-46.04	-13	-33.04
CDMA PCS	600	V	9400	37.08	-50.1	9.7	10.9	8.76	-51.04	-13	-38.04
CDMA PCS	1175	V	3817.5	64.90	-31.8	6	10.1	7.96	-29.84	-13	-16.84
CDMA PCS	1175	H	3817.5	56.18	-39.9	6	10.5	8.36	-37.54	-13	-24.54
CDMA PCS	1175	V	5726.25	44.99	-45.8	7	11.4	9.26	-43.54	-13	-30.54
CDMA PCS	1175	H	5726.25	43.10	-54.7	7	11.4	9.26	-52.44	-13	-39.44
CDMA PCS	1175	V	7635	40.77	-48.9	10	10.1	7.96	-50.94	-13	-37.94

10 FREQUENCY STABILITY VS TEMPERATURE

FCC §2.1055, FCC §22.355, FCC §24.235

Frequency tolerance: 2.5ppm

10.1 Test Procedure

The equipment under test was connected to an AC/DC power supply and the RF output was connected to a CMU-200 Base Station Simulator. The Base Station Simulator was set to force the EUT to its maximum power setting. The EUT was placed inside the temperature chamber. The power leads and RF output cable exited the chamber through an opening made for that purpose. After the temperature stabilized for approximately 30 minutes, the frequency error was read from the base station simulator.

An external DC power supply was connected to the the equipment under test. The Base Station Simulator was set to force the EUT to its maximum power setting. The voltage was set to 115% of the nominal value and was then decreased to lowest dc operating point. The output frequency error was recorded for each voltage.

10.2 Test Results

The MTSMC-EV2-MI-GP met the frequency stability requirements of FCC §2.1055, FCC §22.355 and FCC §24.235. The test results are located in Table 10-1.

Table 10-1: Frequency Error (ppm) vs. Temperature & Voltage – Cell Band

Operating Frequency: 836,520,000 Hz
Channel: 384
Reference Voltage: 5 VDC
Deviation Limit: 2.5 ppm

Voltage (%)	Power (VDC)	Temp	Frequency Error	Deviation (%)	Deviation (ppm)
100%	9	-30	6.18	0.0000007	0.0074
100%	9	-20	8.97	0.0000011	0.0107
100%	9	-10	4.27	0.0000005	0.0051
100%	9	0	3.18	0.0000004	0.0038
100%	9	10	2.62	0.0000003	0.0031
100%	9	20	3.74	0.0000004	0.0045
100%	9	30	4.62	0.0000006	0.0055
100%	9	40	5.6	0.0000007	0.0067
100%	9	50	7.18	0.0000009	0.0086
115%	10.35	20	4.21	0.0000005	0.0050
Operating Endpoint	7.65	20	3.98	0.0000005	0.0048

Table 10-2: Frequency Error (ppm) vs. Temperature & Voltage – PCS Band

Operating Frequency: 1,880,000,000 Hz
Channel: 600
Reference Voltage: 5 VDC
Deviation Limit: 2.5 ppm

Voltage (%)	Power (VDC)	Temp	Frequency Error	Deviation (%)	Deviation (ppm)
100%	9	-30	10.93	0.0000006	0.0058
100%	9	-20	11.61	0.0000006	0.0062
100%	9	-10	13.94	0.0000007	0.0074
100%	9	0	5.3	0.0000003	0.0028
100%	9	10	5.38	0.0000003	0.0029
100%	9	20	7.76	0.0000004	0.0041
100%	9	30	7.52	0.0000004	0.0040
100%	9	40	10.77	0.0000006	0.0057
100%	9	50	12.99	0.0000007	0.0069
115%	10.35	20	7.82	0.0000004	0.0042
Operating Endpoint	7.65	20	7.69	0.0000004	0.0041