



FCC test report

Applicant:	Bose Corporation. The Mountain Framingham MA 01701
Product:	Homewide Wireless Audio Link
Test Laboratory:	Bose DCE EMC Laboratories 1 New York Avenue Framingham, MA 01701



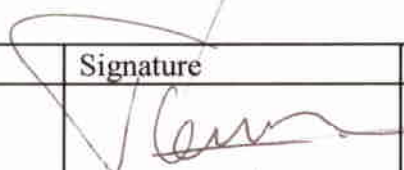
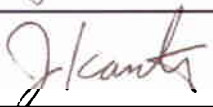
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1. Certification.

Product Type:	Wireless Audio Link
Product Name/part number:	Wireless Audio link , AL81, AR1
Applicant:	Bose Corporation 100 The Mountain Road Framingham, MA 01701
Applied standard(s)	47 CFR 15.247
Test Laboratory:	Bose Corporation 1 New York Avenue Framingham, MA 01701
Site registration	FCC: A2LA accredited site, A2LA cert # 1514 IC: 3232A
Report issue date:	4/7/05

	Print Name	Signature	Date
Product tested by:	Peter Boers		4/7/05
Report reviewed by:	Jon Kanter		4/7/05



2. Test result summary

Applied standard: 47CFR15 subpart B and C			
Paragraph	Requirement	Result	Comment
	The device shall have a label containing the 2 part FCC statement defined in 15.19(3)	Complies	See Label exhibit
	Information to the use shall caution the user that changes or modifications could void the user's authority to operate the device	Complies	See OG
	Frequency range of measurement shall cover the 10 th harmonic or 40GHz whichever is lower	Complies	Measurements of the transmitter section are made up to 25GHz.
	Measurements below 1GHz are made with CISPR QP and Average Detectors as appropriate. Above 1GHz a 1MHz RBW and an average detector is used. A peak detector limit 20dB above the average limit is implied.	Complies	See section 4
	Conducted emissions on the AC mains shall not exceed the limits as defined in 47CFR15.107	Complies	Margin of >20 dB to the limit. See section 4.1 for detail
	Radiated emissions from the incidental radiator part of the device shall not exceed the limits as defined in 15.109(a)	Complies	Margin of 19 dB to the limit. See section 4.2 for detail
	Digitally modulated systems with a 6dB bandwidth of at least 500kHz	Complies	Occupied Bandwidth of 1.55 MHz minimum. See section 4.4 for detail
15.247 (b) 3	For digitally modulated systems, a maximum peak conducted output power of 1W	Complies	Conducted output power is 24.8 dBm (302 mW) maximum. See section 4.3 for detail.
15.247 (b) 4	The conducted output power is based on antenna's with a gain of not more than 6dBi	Complies	Antenna gain determined by comparing conducted power and radiated field is < 6dB



	If a higher gain antenna is used, the allowable output power is reduced by the amount the antenna gain exceeds 6dBi	Not Applicable	
15.247 (d)	In any 100kHz bandwidth outside the operating band, the output power shall be 20dB below the in-band spectral density	Complies	See section 4.8 and 4.9
15.247 (d)	In addition, emissions falling within restricted bands as defined in 15.201(a) must comply with limits 15.209(a)	Complies	See section 4.5 for detail
15.247(e)	For digitally modulated systems, the spectral density shall not exceed 8dBm in any 3 kHz bandwidth	Complies	See section 4.6 for detail
	The same method of determining conducted output power shall be used for spectral power density.	Complies	Output power and spectral density measured with an average detector.
15.247(f)	Hybrid systems with the digital modulation turned off shall have an average time occupancy on any frequency not exceeding 0.4 seconds	Complies	See section 4.10
	With the frequency hopping part turned off, a hybrid system shall meet the requirements of 15.247(d)	Complies	See section 4.7 for detail
15.247(i)	Systems operating under this part shall not expose the public to radio frequency levels in excess of the FCC's guidelines	Complies	See section 4.12
	Frequency stability shall be such that the fundamental modulation products do not fall in any restricted bands	Complies	See section 4.11



3. General Information

The product is a wireless audio link, capable of transmitting 2 channels of stereo-audio controlled by the Boselink ® protocol. A master unit can transmit to up to 5 slave units.

The unit operates as a hybrid transmitter under FCC part 15.247, using frequency hopping and digital modulation. The hop channels are dynamically selected depending on channel quality as reported back by the slave unit(s). The number of channels used can range from a minimum of 24 to a maximum of 75. The channels overlap and are spaced at 864 kHz intervals in the 2400 – 2480 MHz band. The top 3.5 MHz is not used in order to meet the emission limits in the restricted band from 2483.5 to 2500 MHz.

The master-slave pair operates in duplex mode on the same frequency. The transmitter sends a frame of data for 500us at a repetition rate of 620us. The slave(s) report back on the quality of the received audio in the remaining 120us.

4. Test results

4.1. Conducted Emissions

Requirement:

Frequency	Limits of conducted interference	
	Av Detector	QP detector
0.15 – 0.5 MHz	66 to 56* dBµV	56 to 46* dBµV
0.5 – 5 MHz	56 dBµV	46 dBµV
5 – 30 MHz	60 dBµV	50 dBµV

* level changes with the log of the frequency

Test Setup:

ANSI C63.4 is used as the reference standard for testing of the unintentional radiator part of the device. The device is placed on a 80 high non-conductive table and positioned 40 cm from a vertical ground reference plane. Conducted interference is

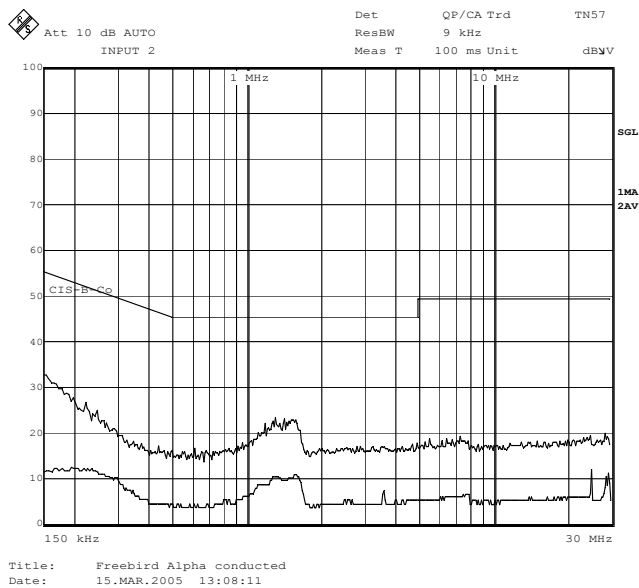


measured on the AC mains via a $50\mu\text{H}$ / 50Ω LISN and a CISPR-16 compliant receiver. The maximum emission of either the phase or neutral conductor is recorded.

Results:

No measurable emissions within 20 dB of the limit were found.
Measurement covered 150 kHz to 30 MHz, QP and Average detector.

Raw data



Title: Freebird Alpha conducted
Date: 15.MAR.2005 13:08:11



4.2. Radiated Emissions, Incidental radiator

Requirement:

Radiated emissions from the unintentional part of the device shall not exceed the following fieldstrength at a distance of 3 meters from the product

Frequency	Detector	Limit
30 – 88 MHz	QP	40 dB μ V/m
88 – 216 MHz	QP	43.5 dB μ V/m
216 -960 MHz	QP	46 dB μ V/m
960 -1000 MHz	QP	54 dB μ V/m
Above 1 GHz	Average	54 dB μ V/m
	Peak	74 dB μ V/m

Test Methodology:

ANSI C63.4 is used as the reference standard for testing of the unintentional radiator part of the device. The device is placed on a non-conductive, 80 cm high table. The linearly polarized measurement antenna is placed 3 meters from the device. The device is rotated and the antenna height is varied from 1 to 4 meters. Measurements are made with both Horizontal and Vertical polarizations of the antenna.

The frequency range investigated is from 30 MHz to 1GHz for devices with a internal clock frequency not exceeding 108 MHz, up to 5 GHz for devices with higher internal clocks.

A CISPR16 compliant receiver and Quasi peak detector is used below 1GHz, an Average and Peak detector with a 1 MHz bandwidth is used above 1 GHz.

Cable configuration:

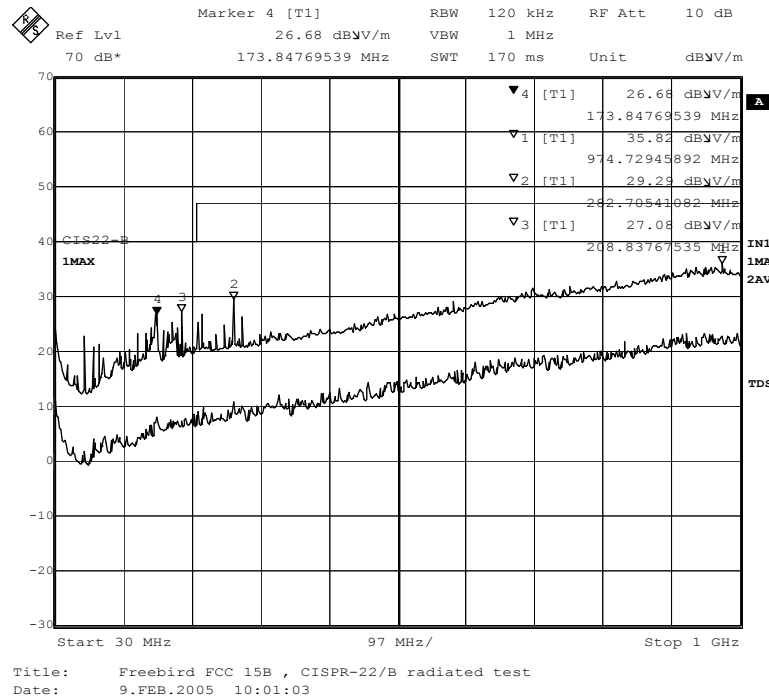
The Master unit has two Boselink ports and a DC connector for the AC adaptor plug. The two Boselink ports are wired in parallel allowing for a daisy chain connection. Normal use consists of using the Master-Slave pair as a replacement for a single Boselink cable, and the unit(s) were tested in this mode.



Results:

Freq	CISPR QP	FCC		
	Level @	15.109		
Frequenc	3m	limit	Margi	Comment
y [MHz]	dBuV/m	dBuV/m	n dB	
175.405	23.7	43.5	-19.8	
237.785	21.5	46	-24.5	
All other emission > 20 dB below the limit				

Pre-scan data:



Sample correction factor calculation:

Measured value + cable loss + Antenna Factor + distance correction = reported level
 $30 \text{ dBuV} + 3.1 \text{ dB} + 8.7 \text{ dB/m} + 0 = 41.8 \text{ dBuV/m}$

Measurements are made at the limit distance for FCC part 15 (3 meters).

Antenna and cable factors are incorporated in internal correction factor tables in the R&S ESIB40.



4.3. Transmitter Output power

Requirement:

15.247(b): The output power for a digitally modulated transmitter shall not exceed 1 Watt. For each dB that the gain of the transmit antenna exceed 6dBi, the output power of the transmitter shall be reduced correspondingly.

Test process:

The transmitter is operated at nominal voltage and temperature. The frequency hopping function is stopped, and power is measured at the low end, mid and high end of the frequency range. The commands to achieve this are: DMF, TX xx. Where xx is the channel.

The Spectrum Analyzer bandwidth is set to larger than the transmitter occupied bandwidth, and the detector mode to average, trace display to max hold. The EUT is rotated along all three axis and the maximum value is recorded. Out of this maximum fieldstrength the EIRP is calculated using the formula $30.P = E^2R^2$

The integral antenna is replaced with a connector, and the output power is measured with a thermal RF probe as well as a Spectrum Analyzer (for further correlation with other measurements).

Results:

		Low Band	Mid Band	High Band
	Carrier Frequency [MHz]	2401.92	2439.936	2478.816
1	Field Strength [dBμV/m] unit rotated over 3 axis, 5 MHz RBW, av det.	123.39	123.88	123.21
2	Calculated EIRP [dBm]	28.16	28.65	27.98
3	Measured power Wmeter [dBm]	24.20	24.14	23.99
4	Measured power, SA, 5MHz RBW [dBm], av det	24.83	24.77	24.70
5	Implied Antenna Gain [dB] ([2] – [4])	3.43	3.88	3.28



4.4. Transmitter Bandwidth

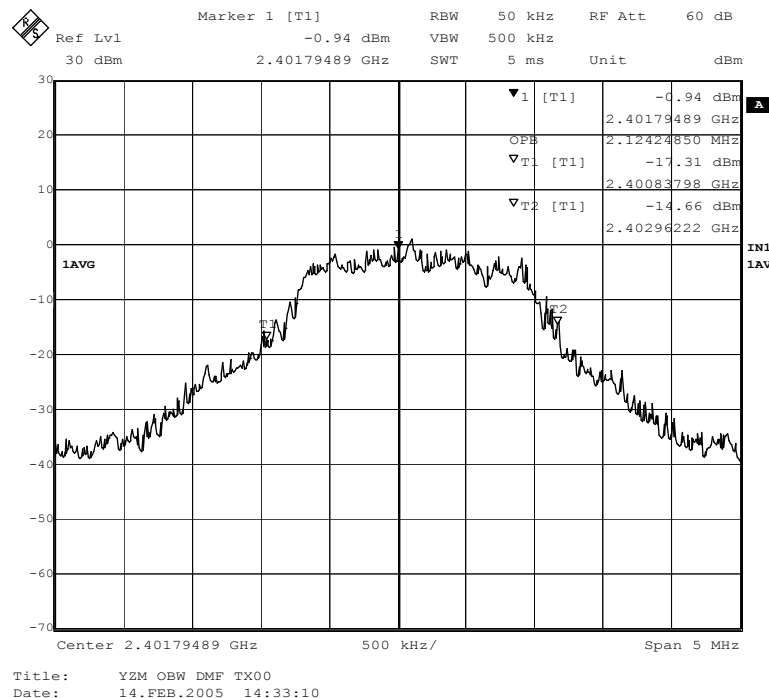
Requirement: 15.247(a) digitally modulated systems with a 6dB bandwidth of at least 500 kHz.

Test setup: Spectrum analyzer with the RBW about 3% of the expected OBW, span to be about 2 - 3 times the expected OBW.

Summary:

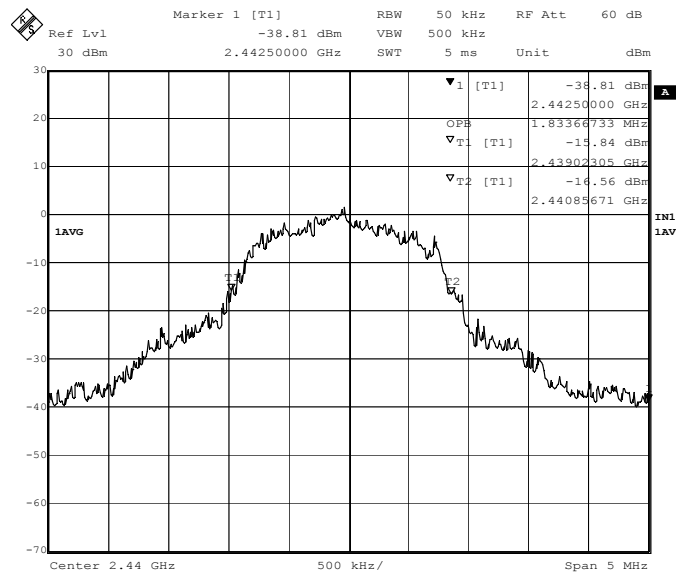
Frequency	Measured BW	Requirement	Result
2.4011 GHz	2.124 MHz	> 500 kHz	Pass
2.4405 GHz	1.833 MHz	> 500 kHz	Pass
2.4786 GHz	1.551 MHz	> 500 kHz	Pass

Test data: Low band, Carrier 2.40113226 GHz, 6dB BW = 2.124Hz



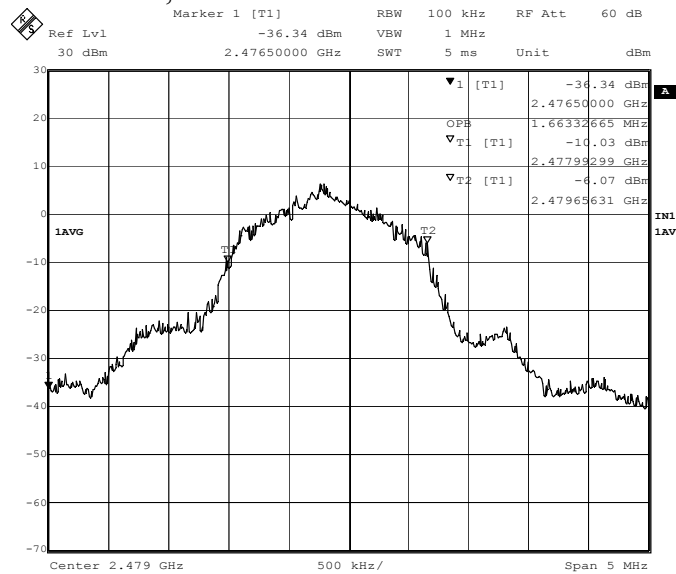


Mid Band, carrier 2440.25 MHz, OPBW is 1.833 MHz



Title: YZM OBW DMF TX40
Date: 14.FEB.2005 14:31:23

High Band, carrier 2478.6 MHz, OPBW is 1.663 MHz



Title: YZM OBW DMF TX79
Date: 14.FEB.2005 14:28:33



4.5. Restricted bands

Requirement:

15.247(d) In addition, emissions falling within restricted bands as defined in 15.201(a) must comply with limits 15.209(a)

For the harmonics of a transmitter operating in the 2400 – 2483.5 MHz band, the following restricted bands are of relevance (measurements are made up to the 10th harmonic, or for a 2.48 GHz transmitter up to 25 GHz).:

2483.5 – 2500 MHz	4.5 - 5.15 GHz	7.25 – 7.75 GHz
10.6 - 12.7GHz	14.47 – 14.5 GHz	22.01 – 23.12
23.6 – 24 GHz		

Test methodology:

The transmitter is programmed to carrier-non hopping, non-modulated (single frequency) and tuned to the low, mid or high band, at the same frequencies as used for the output power measurement. The known harmonics of the transmitter are measured at 1 meter from the product and extrapolated back to the 3 meter limit using a 1/R fall-off (9.5 dB). A 20 dB higher limit for peak measurements (1 MHz BW) is applicable. The resolution bandwidth of the SA may be reduced for average detector measurements in order to obtain the required sensitivity. This is justified because the nature of the transmitted signal is known to be an unmodulated carrier.

Test results:

Preliminary conducted output power measurements. The 54 dB μ V/m @ 3 meter limit for the restricted bands amounts to an EIRP limit of -41.23 dBm.



Conducted carrier test	Frequency	Level	Frequency		Frequency	
	[MHz]	dBm	[MHz]		[MHz]	dBm
Carrier	2401.92	24.1	2439.94	24.2	2478.80	24.23
2 nd Harmonic	4803.84	-35.6	4879.87	-34.2	4957.60	-33.8
3 rd Harmonic	7205.76	-57.5	7319.81	-56.7	7436.40	-56.7
4 th Harmonic	9607.68	-70.3	9759.74	-68.7	9915.20	-65.4
5 th Harmonic	12009.60	-50.3	12199.68	-48.9	12394.01	-48.1
6 th Harmonic	14411.52	-44.1	14639.62	-45.5	14872.81	-48
7 th Harmonic	16813.44	-52.6	17079.55	-67.3	17351.61	-74
8 th Harmonic	19215.36	-69.6	19519.49	-74.5	19830.41	-70
9 th Harmonic	21617.28	-80	21959.42	<-88	22309.21	<-80
10 th Harmonic	24019.20	<-80	24399.36	-80.5	24788.01	-70

Radiated measurements are made in the anechoic room with an Antenna – EUT distance of 3 or 1 meter. For 1 meter measurements, the measured values are adjusted by a 1/R correction factor (-9.5 dB) to account for the distance scaling. Measurements the unmodulated carrier may be made with a reduced bandwidth in order to increase the signal to noise ratio of the instrumentation. Reported values of the peak detector data (broadband noise) may reflect instrumentation noise floor readings rather than product emissions.

Low band	Frequency	Field Strength (average)	Limit (average)	Field Strength (peak)	Limit (peak)	Margin
	[MHz]	dBμV/m	dBμV/m	dBμV/m	dBμV/m	[dB]
Carrier	2401.92	123.4				
2 nd Harmonic	4803.84	41.7	54	52.6	74	-12.3
3 rd Harmonic+	7205.76	40.2		*		
4 th Harmonic+	9607.68	37.75		*		
5 th Harmonic+	12009.60	32.7	54	*	74	-21.3
6 th Harmonic+	14411.52	39.6		*		
7 th Harmonic+	16813.44	31.7		*		
8 th Harmonic+	19215.36	<35	54	*	74	-19
9 th Harmonic+	21617.28	<35		*		
10 th Harmonic+	24019.20	<35		*		



Mid band	Frequency	Field Strength (average)	Limit (average)	Field Strength (peak)	Limit (peak)	Margin
	[MHz]	dB μ V/m	dB μ V/m	dB μ V/m	dB μ V/m	[dB]
Carrier	2439.94	123.9				
2 nd Harmonic	4879.87	47.4	54	52	74	-6.6
3 rd Harmonic+	7319.81	41.4	54	*	74	-12.6
4 th Harmonic+	9759.74	42.3		*		
5 th Harmonic+	12199.68	41	54	*	74	-13
6 th Harmonic+	14639.62	45.7		*		
7 th Harmonic+	17079.55	41.5		*		
8 th Harmonic+	19519.49	<35	54	*	74	-19
9 th Harmonic+	21959.42	<35		*		
10 th Harmonic+	24399.36	<35		*		

High band	Frequency	Field Strength (average)	Limit (average)	Field Strength (peak)	Limit (peak)	Margin
	[MHz]	dB μ V/m	dB μ V/m	dB μ V/m	dB μ V/m	[dB]
Carrier	2478.82	123.2				
2 nd Harmonic	4957.63	45.2	54	52	74	-8.8
3 rd Harmonic +	7436.45	39.8	54	*	74	-14.2
4 th Harmonic +	9915.26	40.8		*		
5 th Harmonic +	12394.08	40	54	*	74	-14
6 th Harmonic +	14872.90	46		*		
7 th Harmonic +	17351.71	42.1		*		
8 th Harmonic +	19830.53	<35		*		
9 th Harmonic +	22309.34	<35	54	*	74	-19
10 th Harmonic+	24788.16	<35		*		

* No meaningful data measured, instrumentation noise floor >10 dB below limit

+Measurement over 7 GHz were made with a reduced RBW ranging from 100kHz to 10 kHz. The instrumentation noise floor is below the spec limit of 54 dB μ V/m with a 1 MHz RBW and an average detector.

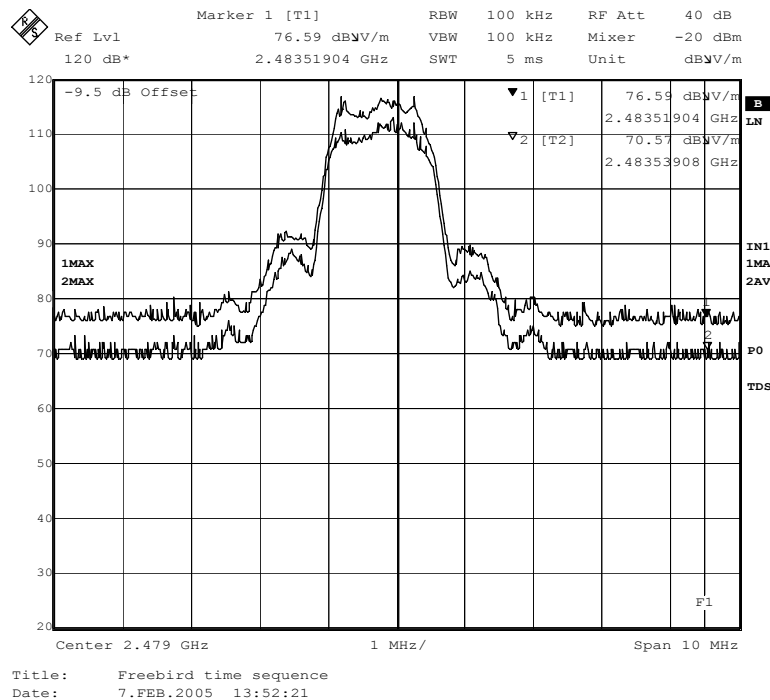


4.6. Band-edge measurement

Since the 2483.5 – 2500 MHz restricted band is adjacent to the highest used band by the transmitter, measurement are made with a reduced bandwidth (100kHz) to show that compliance with the 54dB μ V/m @ 3 meters limit in the restricted band. At this bandwidth the implied peak limit of 20dB above the average detector limit for broadband noise and the average limit for narrowband noise result in the same numerical value of 54 dB μ V/m .

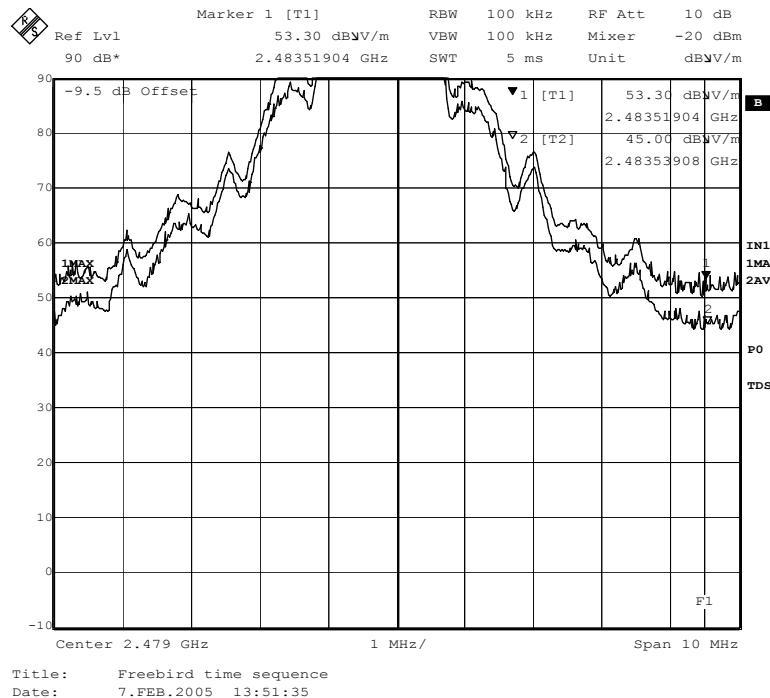
The transmitter is operated in the normal operational mode, random data sequence, with the hopping stopped in the highest channel (command HO 79.0)

Reference data: in-band measurement, 100 kHz RBW with peak and average trace detectors with the trace display in max-hold mode. Note that the restricted band values reflect the noise floor of the instrumentation.





Band-edge measurement, made at a 1 meter distance from the EUT, accounted for with a 9.5 dB offset for distance scaling to the limit. Average detector data shows a maximum value of 45 dB μ V/m in the restricted band. The peak detector shows a maximum value of 53.3 with a 100kHz bandwidth, or 73.3 dB μ V/m/MHz in the adjacent restricted band.





4.7. Transmitter Spectral Density

Requirement

15.247(e) For digitally modulated systems, the spectral density shall not exceed 8dBm in any 3 kHz bandwidth. The same method of determining conducted output power shall be used for spectral power density.

Test Setup:

Connectorized transmitter units are used for this test. A direct connection (with attenuators) is used for the spectral, density measurements. The transmitter hopping is stopped, and spectral density measurements are made in the same mode as the output power measurements. .

Transmitter commands: DMF, TX xx where xx denoted the channel.

The spectrum analyzer is set up for a span covering the whole occupied bandwidth of the transmitter, a RBW of 3 kHz, and automatic sweep time. The maximum spectral density area in the frequency display is selected , and the span is reduced to 120kHz and the sweep time is set to 40 seconds.

Results:

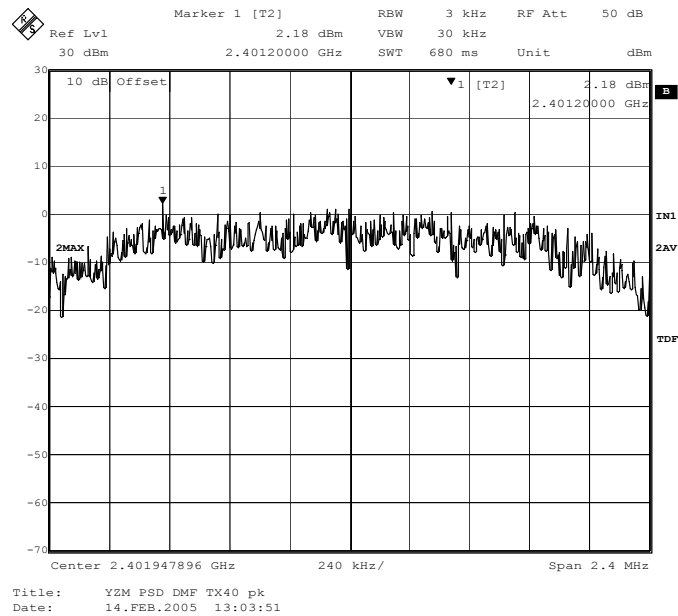
The peak value for the spectral density is 5.03 dBm/3kHz.

Band	PSD measured	Limit	Margin
Low	1.97	8 dBm	6.03 dB
Mid	2.88	8 dBm	5.12 dB
High	5.03	8 dBm	2.97 dB

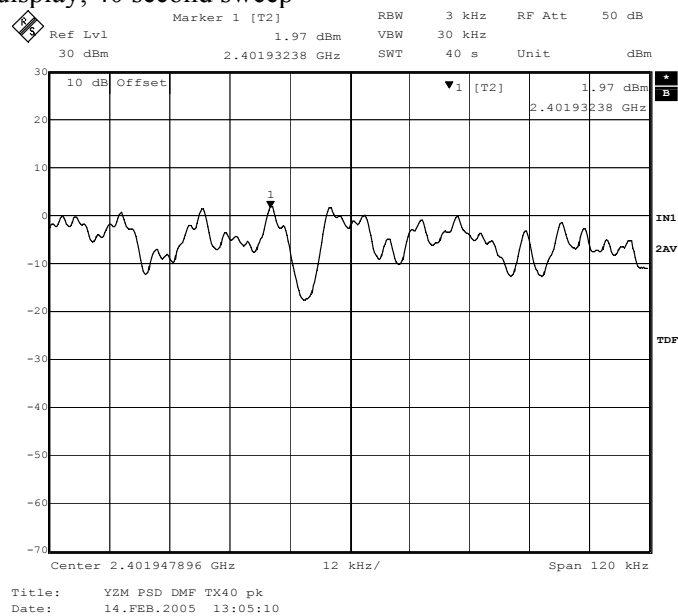


PSD detail test data as follows.

Low band full range display

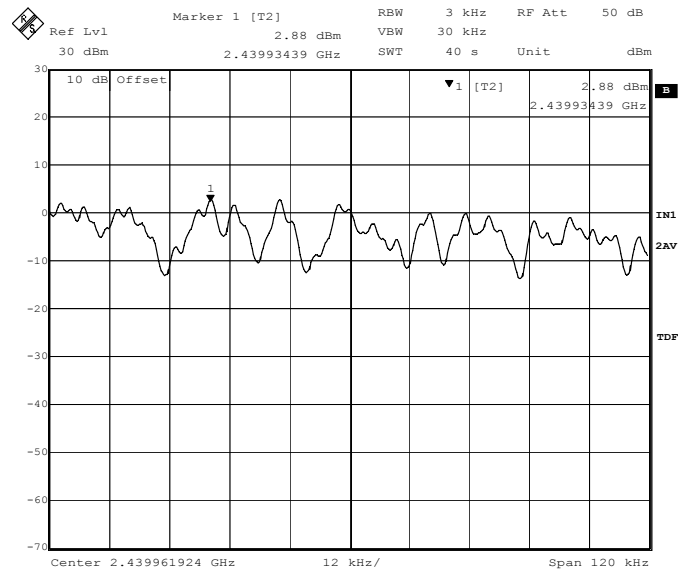


Low band detail display, 40 second sweep



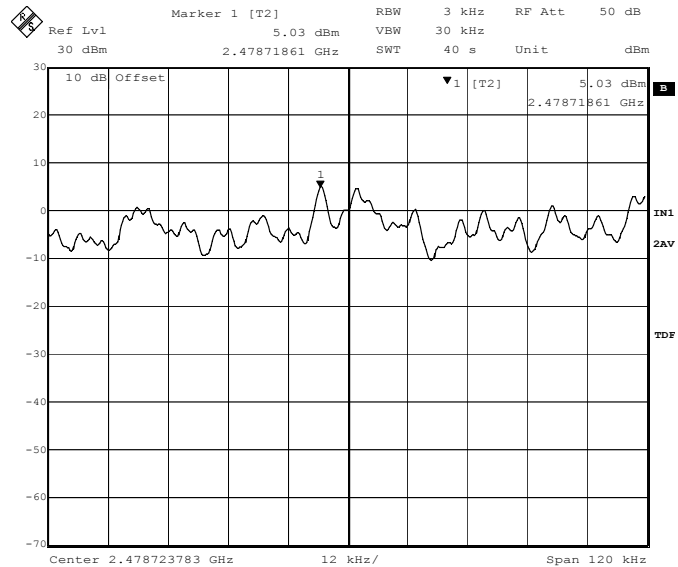


Mid band:



Title: YZM PSD DMF TX40 pk
Date: 14.FEB.2005 12:58:33

High Band:



Title: RYZM PSD DMF TX79 pk
Date: 14.FEB.2005 12:53:26



4.8. Hybrid systems

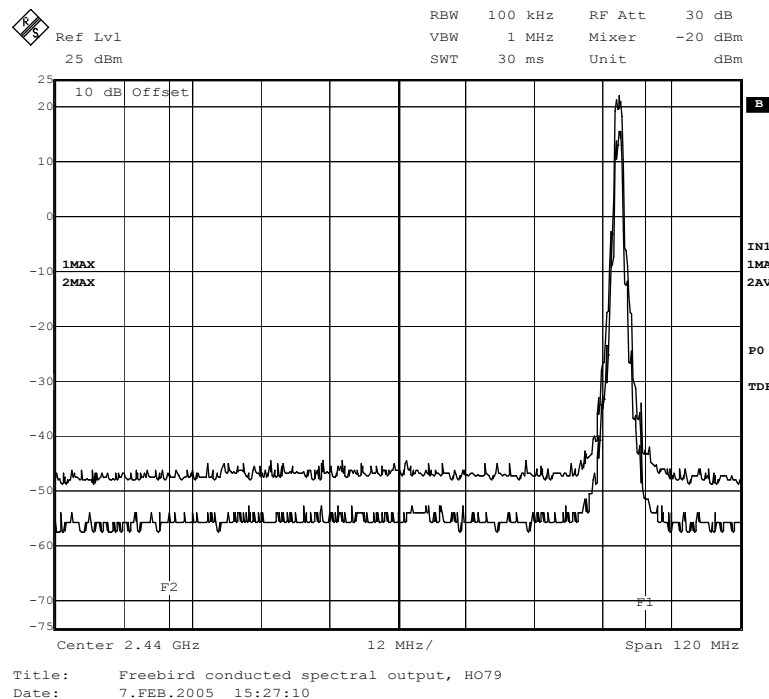
Requirement:

With the frequency hopping part turned off, a hybrid system shall meet the requirements of 15.247(d): In any 100 kHz bandwidth outside the frequency band of operation, the output power shall be at least 20dB below the maximum in-band power measured with the same bandwidth.

Results:

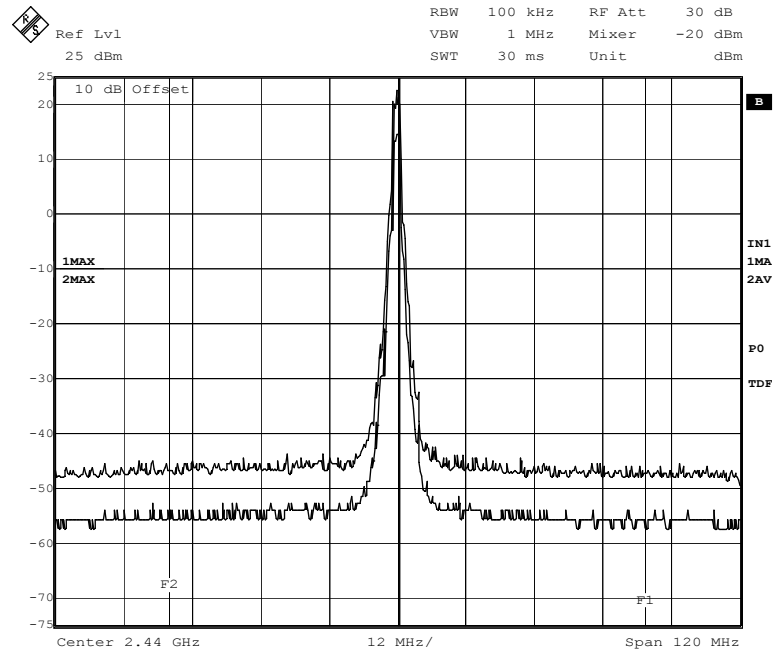
Spectrum scan, conducted. F2 is the lower edge, F1 is the higher edge of the authorized band (2400 - 2483.5 MHz). Hopping is stopped. Measurements made with average and peak detectors, max hold, modulation with a random signal.

Upper band



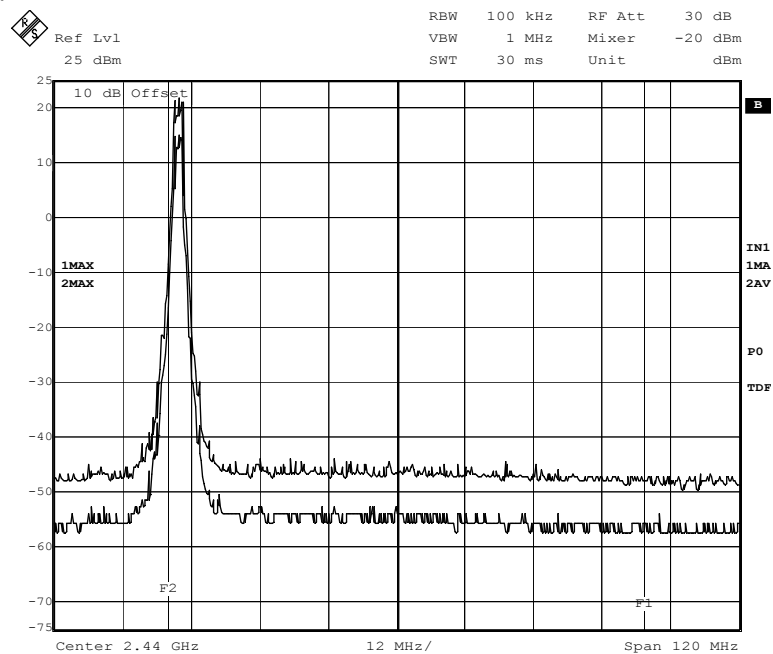


Mid band:



Title: Freebird conducted spectral output, HO79
Date: 7.FEB.2005 15:26:26

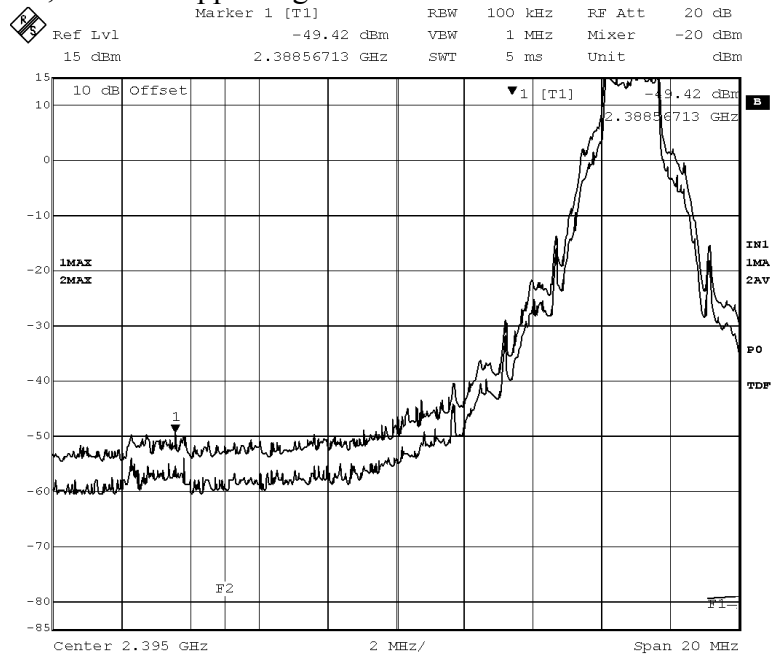
Lower band:



Title: Freebird conducted spectral output, HO79
Date: 7.FEB.2005 15:28:07



Low band detail, F2 is the upper edge of the 2360 – 2390 MHz restricted band.



Title: Freebird conducted spectral output
Date: 7 FEB 2005 15:16:10

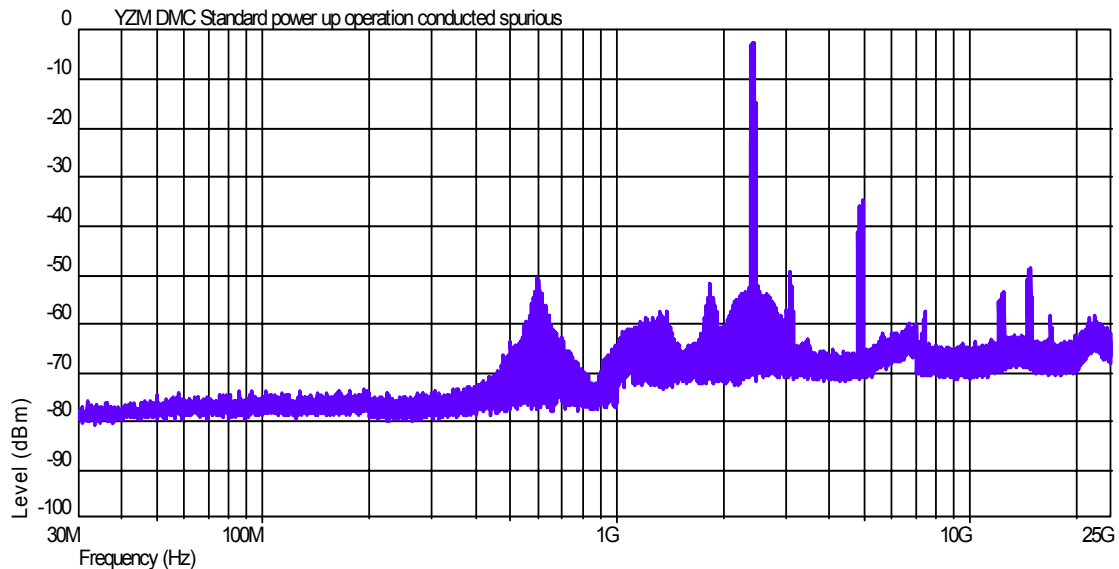


4.9. Spurious emissions

Initial conducted measurements were made on a connectorized unit in the range of 30MHz to 25 GHz for the transmitter set to “no hopping”, “full modulation” for the low band, mid band and high band setting.

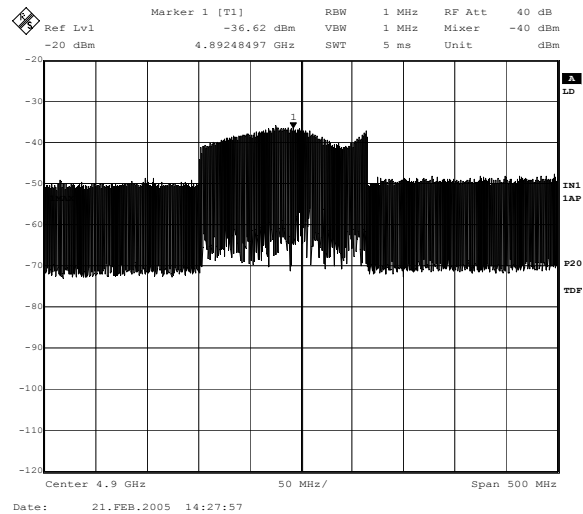
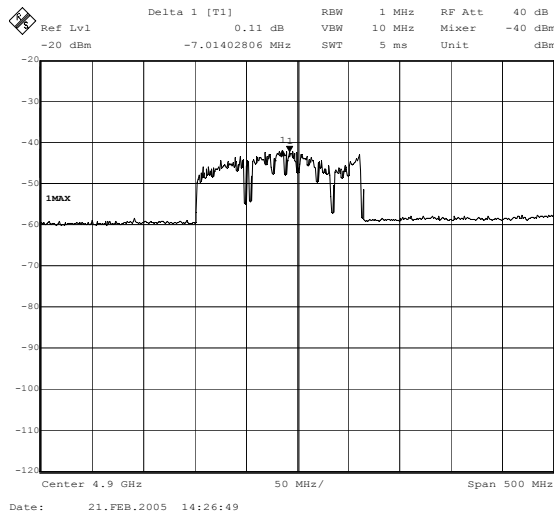
Test data show the obtained spectrum; note that the level of the carrier is inaccurate due to over ranging of the instrumentation.

Conducted spectrum plot with the transmitter in normal operation (hopping mode).

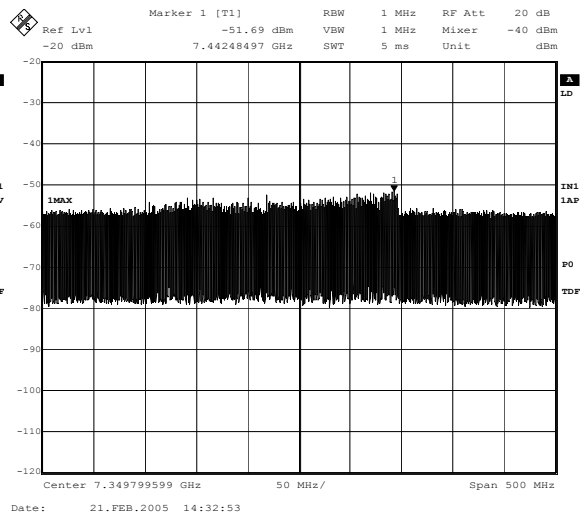
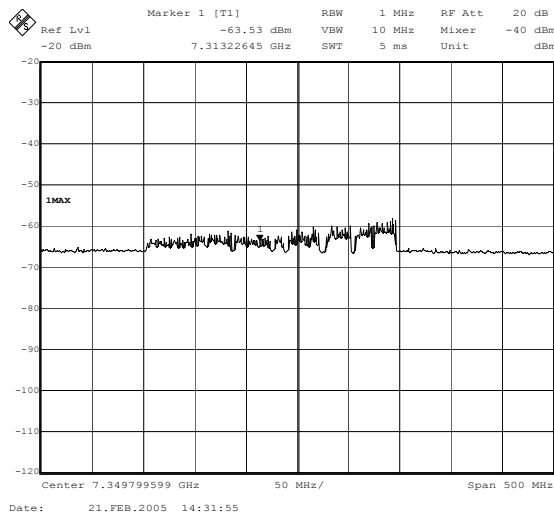




Detail spectrum plot in average and peak detector mode for the 2nd harmonic range



Detail spectrum plot in average and peak detector mode for the 3rd harmonic range



Note that the restricted band limit of 54 dBuV/m at 3 meters equates to an EIRP of -41.3 dBm, and that all harmonics fall below these limits.



Radiated measurements were made at 1 meter distance to increase equipment sensitivity with respect to the limit. An scale-offset of 10dB was applied to the spectrum analyzer to account for the distance scaling from 3 meters to 1 meter. Measurements were made with H and V polarization with the transmitter operating over its full hop set.

No data above the instrumentation sensitivity could be obtained in the normal operational mode of the transmitter. Only with the hopping stopped could (narrowband) measurements of the carrier be made. Data shown in section 4.5.



4.10. Frequency hopping

Requirement:

15.247(f): Hybrid systems with the digital modulation turned off shall have average time occupancy on any frequency not exceeding 0.4 seconds

Transmitter hopping design:

The transmitter sends information out in packets, based on symbols with a duration of 673 ns. Three possible packet formations are:

- 1) Sync packet – 1590 symbols
- 2) Feedback packet from the slave unit – 1494 symbols over 8 slave units
- 3) Normal packet – 769 symbols

For the first 142 symbols in each packet, the transmitter is “off”, for internal relocking. The transmitter changes hop frequency according to a predetermined schedule every packet. The channel selection algorithm is based on the channel quality as reported back by the slave units. A minimum of 24 channels and a maximum of 75 channels, spaced at 864 kHz will be used.

Based on the above, the longest occupancy at any one channel frequency – based on the transmission of a sync packet – is for $1590 - 142 = 1448$ symbols or 0.9745 milliseconds. The minimum number of hopping channels (24) multiplied by 0.4 amounts to 9.6 seconds. Within that timeframe 8972 sync packets could hypothetically be transmitted, of which $1/24^{\text{th}}$ could theoretically be on the same channel frequency – resulting in a total time occupancy on a given channel of 364.3 ms. This meets the requirement for an average time occupancy in each channel of 0.4 seconds.



4.11. Transmitter Frequency stability

Requirement:

Technically not required, however need to substantiate that the unit stays in the allocated band over temperature and voltage.

Test Setup:

The transmitter is setup in a non-hopping, carrier only mode and placed in a temperature chamber. The output is monitored with a spectrum analyzer with sufficient accuracy in the frequency readout to provide meaningful data in terms of frequency accuracy.

The transmitter supply voltage (mains) is varied +/- 15% from nominal and the temperature is varied from -20 to +50 degrees Celsius. The transmitter temperature is allowed to stabilize at each test point.

Test results

Operating voltage:

Operating Voltage	Frequency [Hz]	Deviation [ppm]
nominal	2401893657	
-15%	*	
+15%	*	

* Less than 100 Hz change

Operating temperature

Degrees Celsius	Frequency [Hz]	Deviation [ppm]
-30	2401878149	6
-20	2401889500	2
-10	2401895671	-1
0	2401897430	-2
10	2401896615	-1
nominal (20)	2401893657	
30	2401892210	1
40	2401890918	1
50	2401891460	1
60		



4.12. RF exposure

Requirement:

15.247(i) Systems operating under this part shall not expose the public to radio frequency levels in excess of the FCC's guidelines. Reference OET65

Result:

The maximum measured EIRP from the transmitter is 28.65 dBm or 732 mW in the artificial "always on" mode of the transmitter. Ignoring any transmitter based duty cycle factors, and using the formula

$$S = \frac{\text{EIRP}}{4\pi R^2} \text{ from FCC OET Guide 65 results in a calculated power density of}$$

1 mW/cm² at a distance of 7.6 cm from the antenna.

The product is a table top device, a "mobile" device as defined in FCC OET65 supplement C, for which a separation distance of 20 cm is normally maintained between the antenna and the body of the user or nearby persons.

Conclusion:

This device, when operated as intended, does not expose the public to radio frequency levels in excess of the FCC's guidelines.



5. Test Equipment

Test Instruments:

TN #		Cal due
600	EMCO 3810/2 LISN	6/9/2005
698	Emco 3142B Biconilog 26MHz-2GHz	11/8/2006
616	Hewlett Packard 87405A Pre-amp 10MHz to 3GHz	4/24/2005
1233	Spectrum Analyzer: Rohde & Schwartz ESIB40	12/27/2005
576	cable for anechoic room	4/24/2005
577	cable for anechoic room	4/24/2005
1294	RF probe: Rohde & Schwartz NRV-Z51	1/3/2006
1293	RF Wattmeter: Rohde & Schwartz NRVS	1/3/2006
1233	Spectrum Analyzer: Rohde & Schwartz ESIB40	12/27/2005
478	EMCO 3115, Ridge Guided Horn 1-18 GHz	5/26/2006
727	AR AT4003 standard gain horn antenna, 4 – 8 GHz	7/11/2005
728	AR AT4004 standard gain horn antenna , 8 – 18 GHz	7/11/2005
1307	ETS 3160-09 standard gain horn antenna , 18- 26.5 GHz	11/10/2005
	Cable TN1277-10, 10dB SMA attenuator, Cable TN1277-03, VHP	-



Appendix.

Appendix a:
Test setup photographs

Appendix b
Product photographs

Appendix c:
Product Manual

Appendix d:
Transmitter schematics