

ANNEX A

TEST RESULTS

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TEST CONDITIONS

Power supply (V):

$$V_{\text{nominal}} = 3.8 \text{ Vdc}$$

Type of power supply = DC Voltage from rechargeable battery

Type of antenna = Integral antenna

Maximum Declared Gain for antenna= -3.0 dBi

Operating Temperature Range (°C):

$$T_n = -10 \text{ to } +55$$

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2441 MHz

Highest channel: 2480 MHz

The test set-up was made in accordance to the general provisions of ANSI C63.4.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to a Bluetooth signalling unit (Bluetooth test set) and to the spectrum analyser using a 6 dB power splitter and low loss RF cables with sma type connectors. The reading in the spectrum analyser is corrected taking into account the power splitter and cable loss.

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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The equipment under test was set up on a non-conductive (wooden) platform one meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

An additional horn antenna is used to control the equipment under test with the Bluetooth signalling unit (Bluetooth test set).

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Section 15.247 Subclause (a) (1). 20 dB Bandwidth and Carrier frequency separation**SPECIFICATION**

Frequency hopping system shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

RESULTS

20 dB Bandwidth (see next 3 plots).

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	813.63	817.63	837.67
Measurement uncertainty (kHz)	±11		

20 dB BANDWIDTH.

Lowest Channel: 2402 MHz.



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20 dB BANDWIDTH.

Middle Channel: 2441 MHz.



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20 dB BANDWIDTH.

Highest Channel: 2480 MHz.



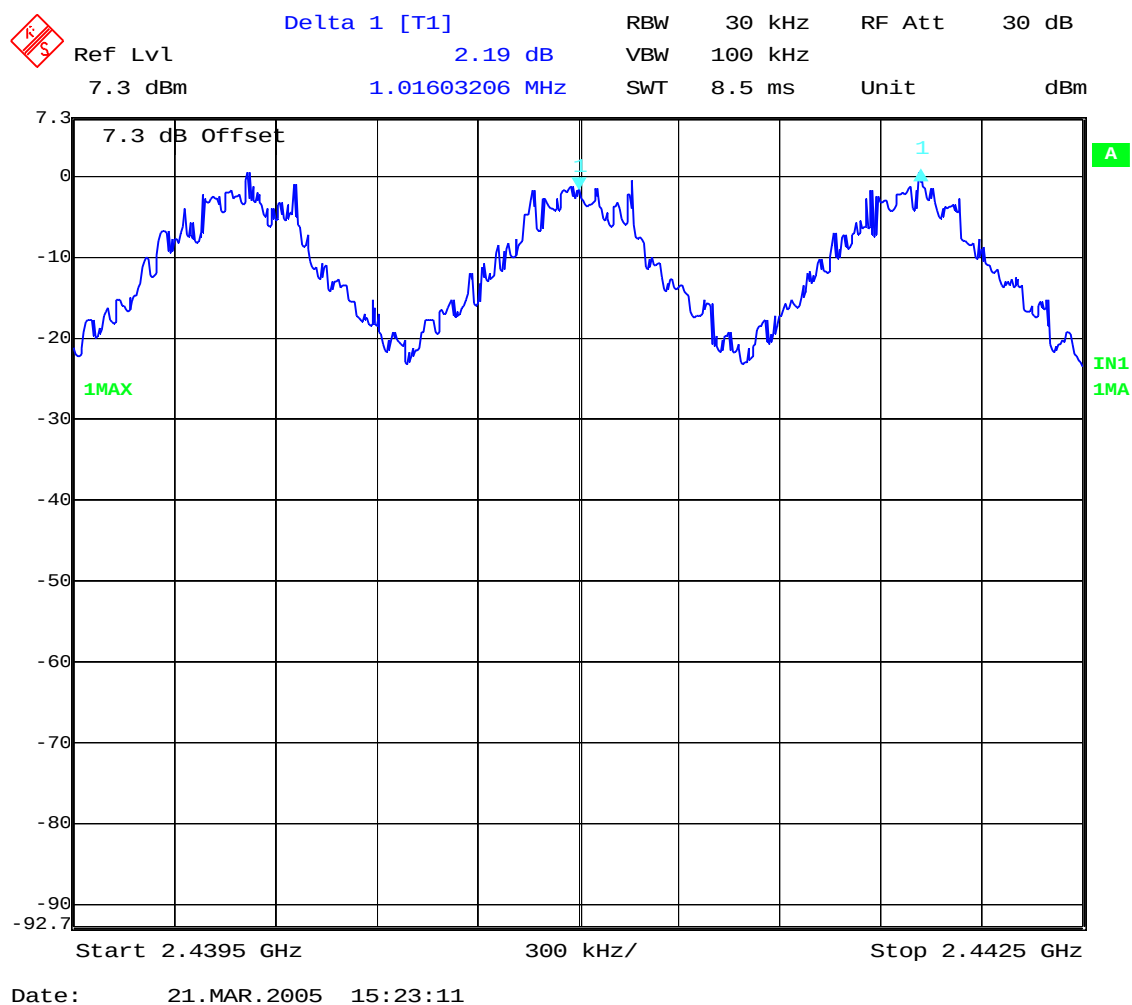
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Carrier frequency separation (see next plot).



The hopping channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

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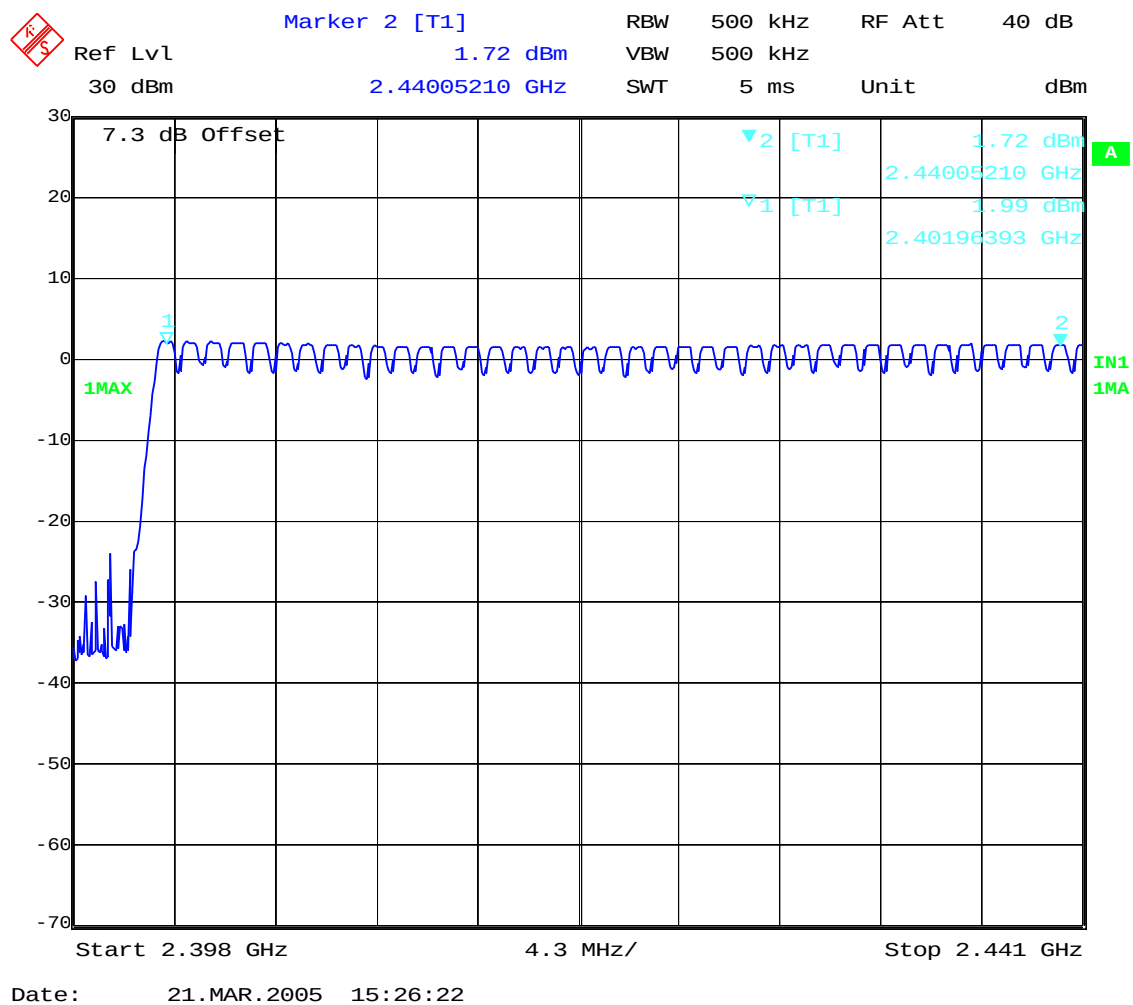
Section 15.247 Subclause (a) (1) (iii). Number of hopping channels

SPECIFICATION

Frequency hopping system in the 2400-2483.5 MHz band shall use at least 15 channels.

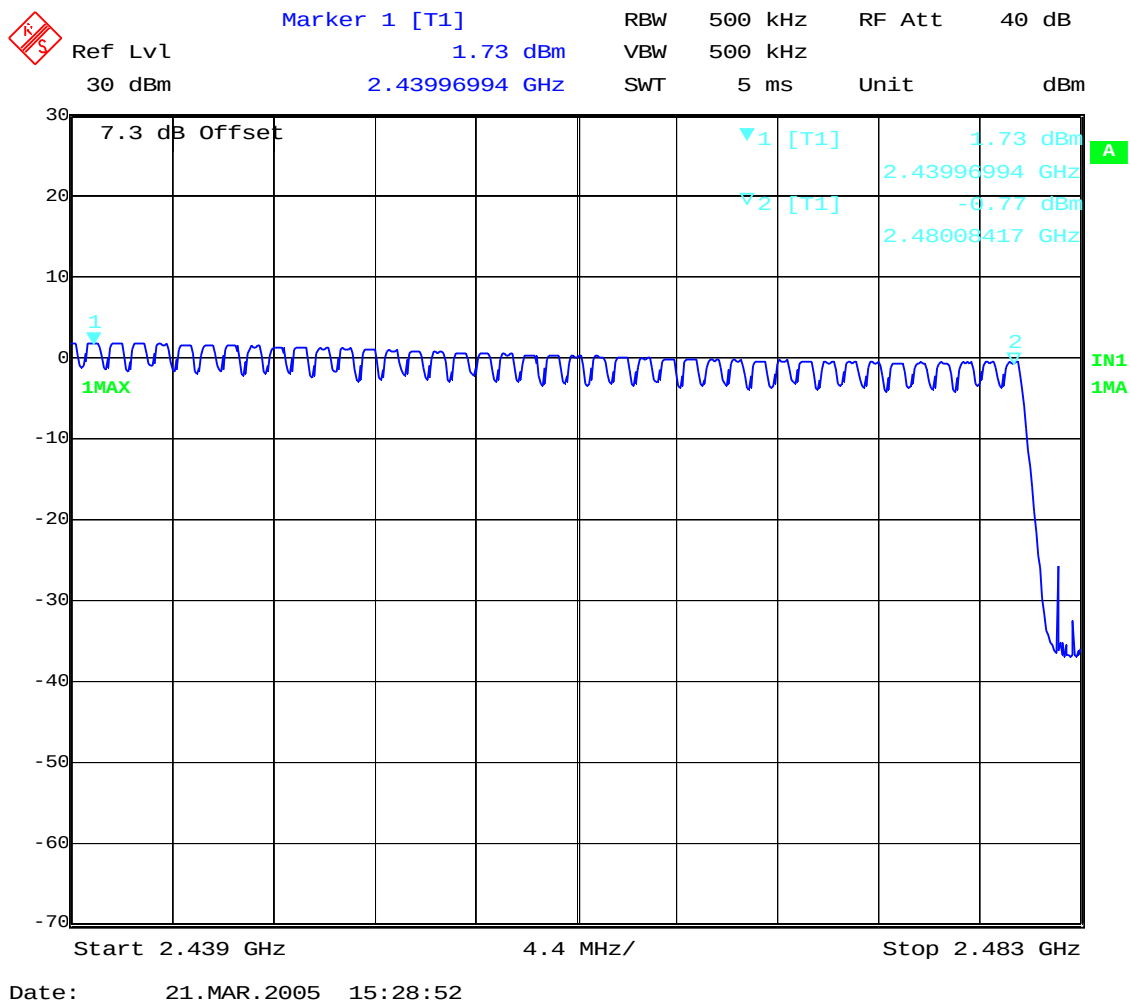
RESULTS

The number of hopping channels is 79 (see next two plots).



Number of hopping frequencies: 39

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Number of hopping frequencies: 40

Total number of hopping frequencies: 79

Verdict: PASS

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Section 15.247 Subclause (a) (1) (iii). Time of occupancy (Dwell Time)

SPECIFICATION

The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = $0.4 \times 79 = 31.6$ seconds.

RESULTS

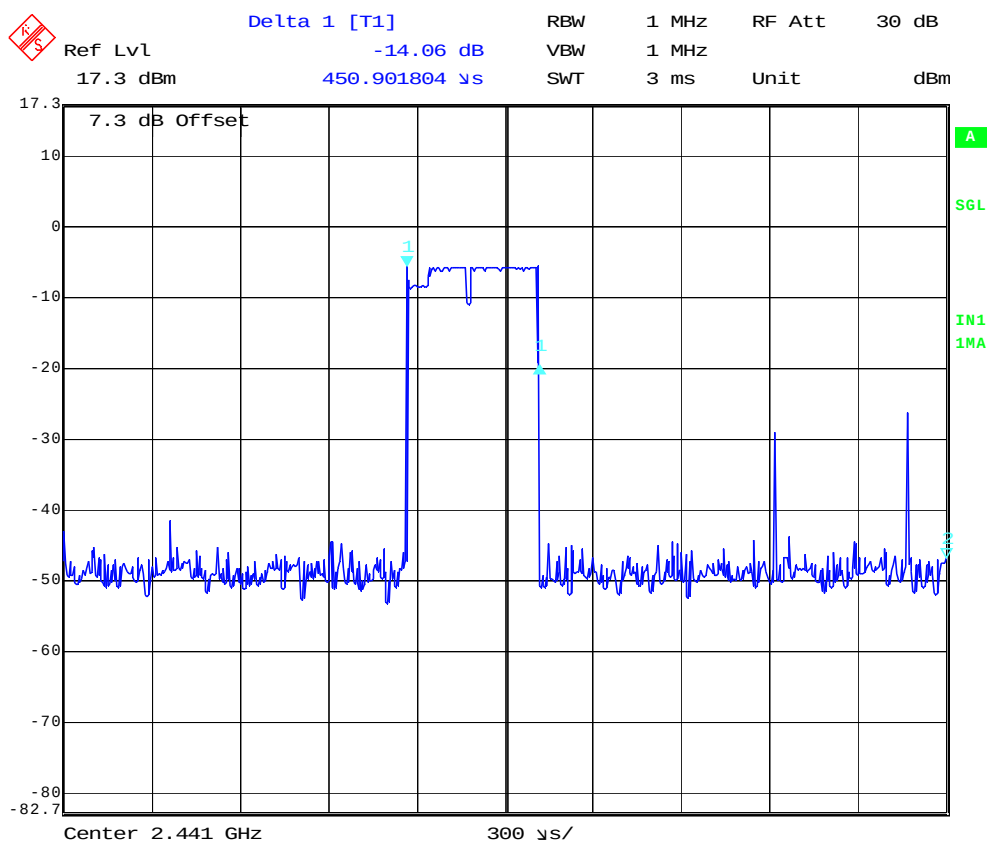
The equipment only supports 1 slot packet (DH1).

1. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH1.

The system makes worst case 1600 hops per second or 1 time slot has a length of $625\mu\text{s}$ with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case $1600/2 = 800$ hops per second with 79 channels. So you have each channel $800/79 = 10.13$ times per second and so for a period of $0.4 \times 79 = 31.6$ seconds you have $10.13 \times 31.6 = 320.11$ times of appearance .

Each Tx-time per appearance is $450.9\mu\text{s}$ (see next plot).

So we have $320.11 \times 450.9\mu\text{s} = 144.34\text{ ms}$ per 31.6 seconds.



Date: 21.MAR.2005 15:39:07

Verdict: PASS

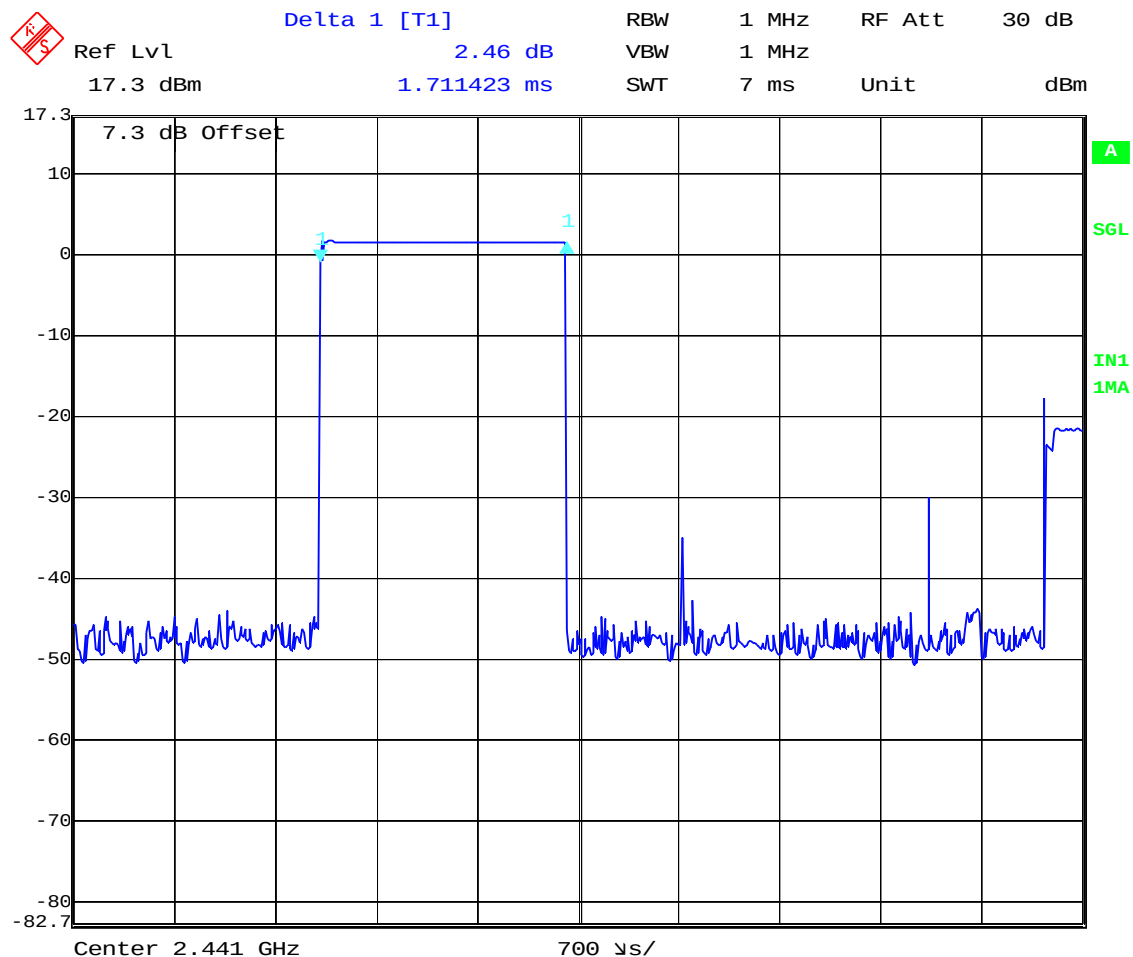
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2. TIME OF OCCUPANCY (DWEELL TIME) FOR PACKET TYPE DH3.

A DH3 Packet need 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case $1600/4 = 400$ hops per second with 79 channels. So you have each channel $400/79 = 5.1$ times per second and so for a period of $0.4 \times 79 = 31.6$ seconds you have $5.1 \times 31.6 = 161.16$ times of appearance .

Each Tx-time per appearance is 1.71 ms (see next plot).

So we have $161.16 \times 1.71 \text{ ms} = 275.58 \text{ ms}$ per 31.6 seconds.

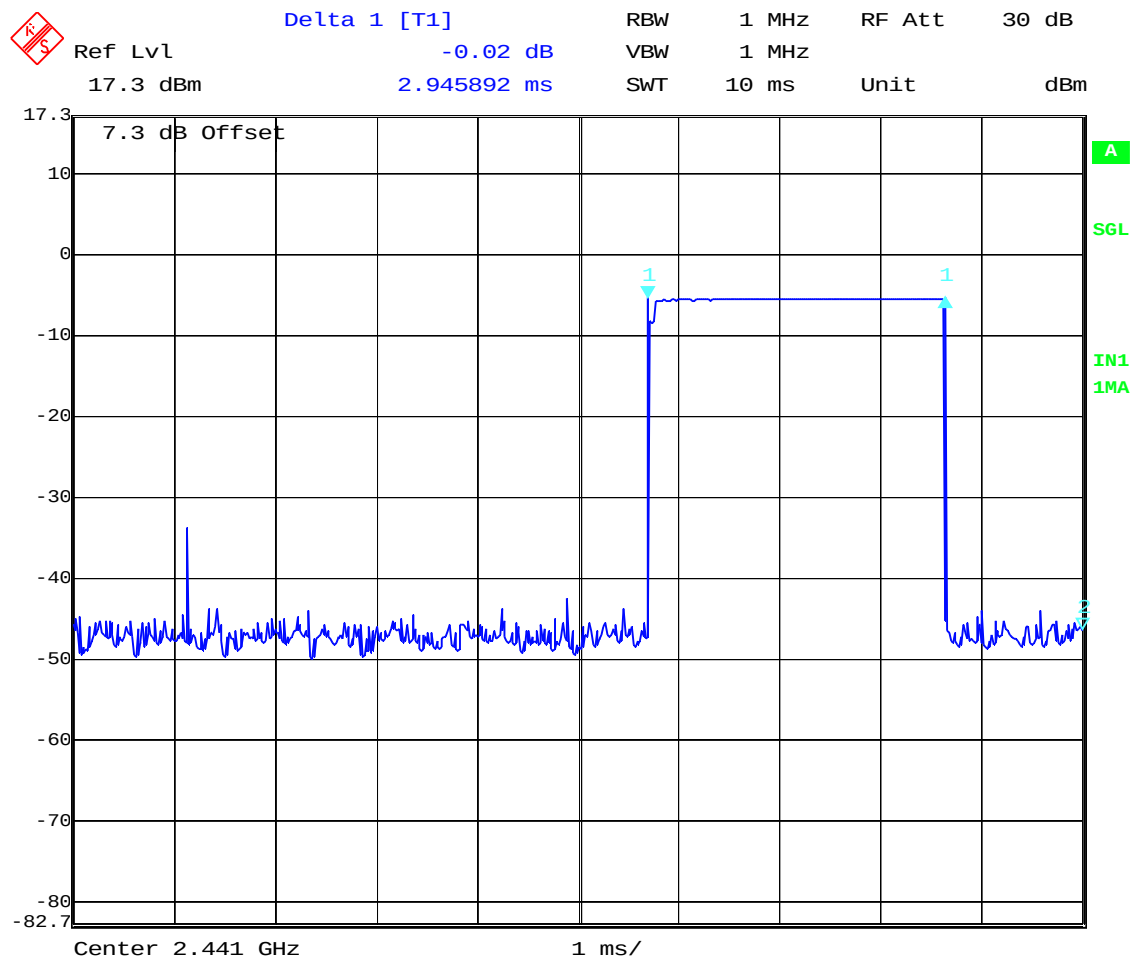


3. TIME OF OCCUPANCY (DWEELL TIME) FOR PACKET TYPE DH5.

A DH5 Packet need 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case $1600/6 = 266.67$ hops per second with 79 channels. So you have each channel $266.67/79 = 3.37$ times per second and so for a period of $0.4 \times 79 = 31.6$ seconds you have $3.37 \times 31.6 = 106.49$ times of appearance .

Each Tx-time per appearance is 2.95 ms (see next plot).

So we have $106.49 \times 2.95 \text{ ms} = 314.14 \text{ ms}$ per 31.6 seconds.



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Verdict: PASS

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Section 15.247 Subclause (b). Maximum peak output power and antenna gain**SPECIFICATION**

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt (30 dBm).

RESULTS

MAXIMUM PEAK OUTPUT POWER (CONDUCTED). See next plots.

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	2.04	1.48	-0.82
Measurement uncertainty (dB)	±1.5		

The maximum declared antenna gain for this device is -3.0 dBi, therefore the maximum theoretical peak radiated power (EIRP) in the three measurement channels for this device is -0.96 dBm or 0.80 mW.

The actual peak radiated power (EIRP) was measured for the lowest, middle and highest frequency (see next plots):

MAXIMUM PEAK OUTPUT POWER (RADIATED).

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Correction Factor (dB)	34.96	35.10	35.24
Maximum EIRP peak power (dBm)	-3.33	-4.08	-5.46
Measurement uncertainty (dB)	+1.98 / -1.75		

Declared peak gain: -3.0 dBi

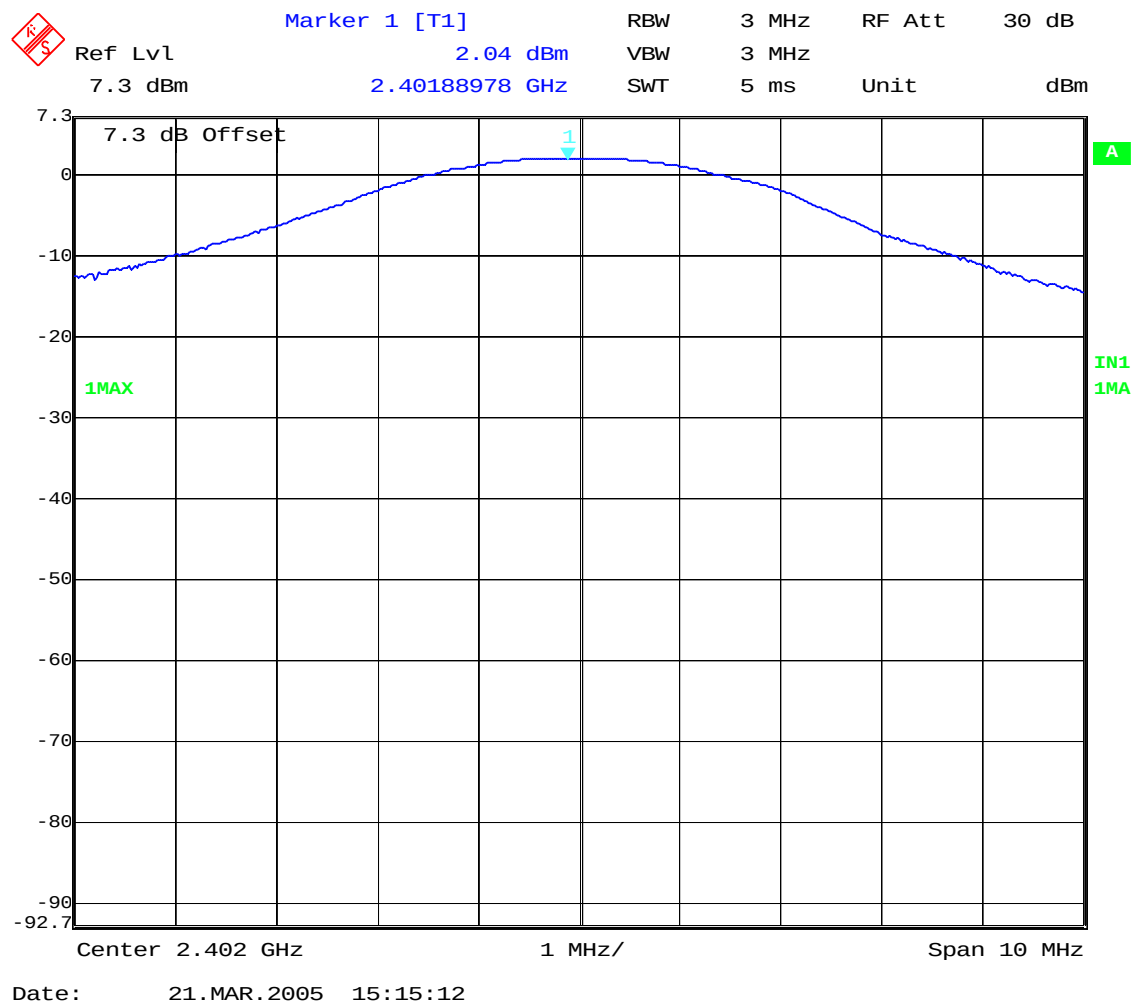
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

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PEAK OUTPUT POWER (CONDUCTED).

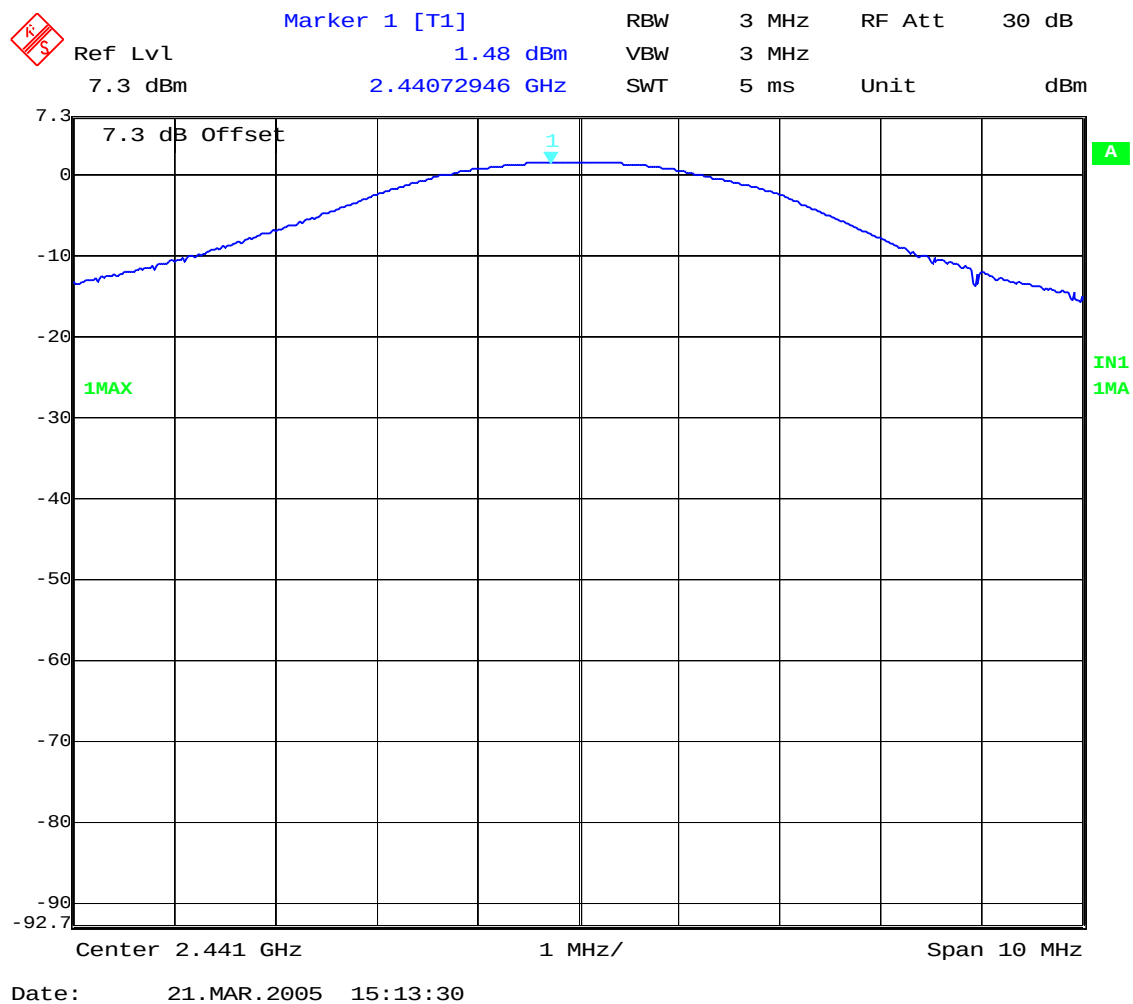
Lowest Channel: 2402 MHz.



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PEAK OUTPUT POWER (CONDUCTED).

Middle Channel: 2441 MHz.



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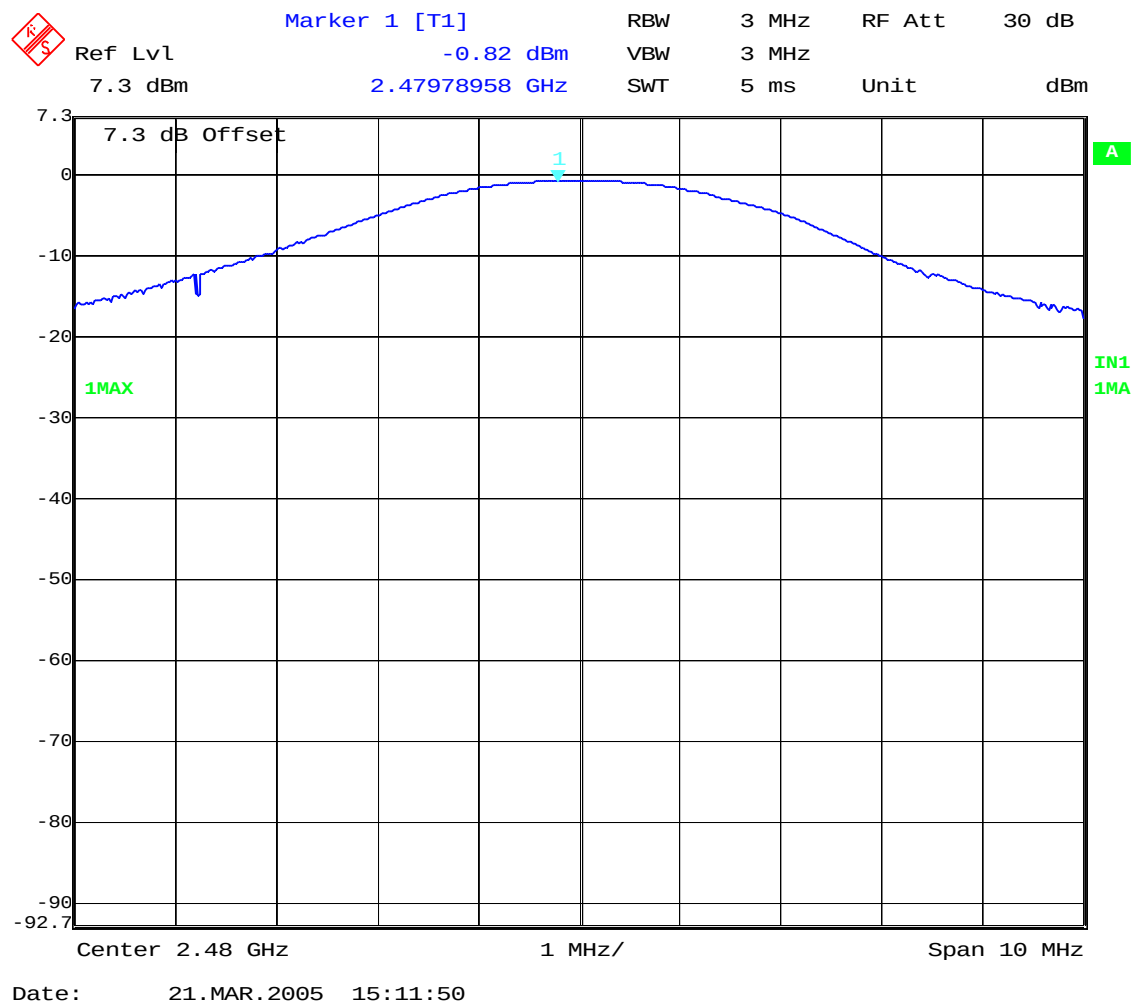
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PEAK OUTPUT POWER (CONDUCTED).

Highest Channel: 2480 MHz.



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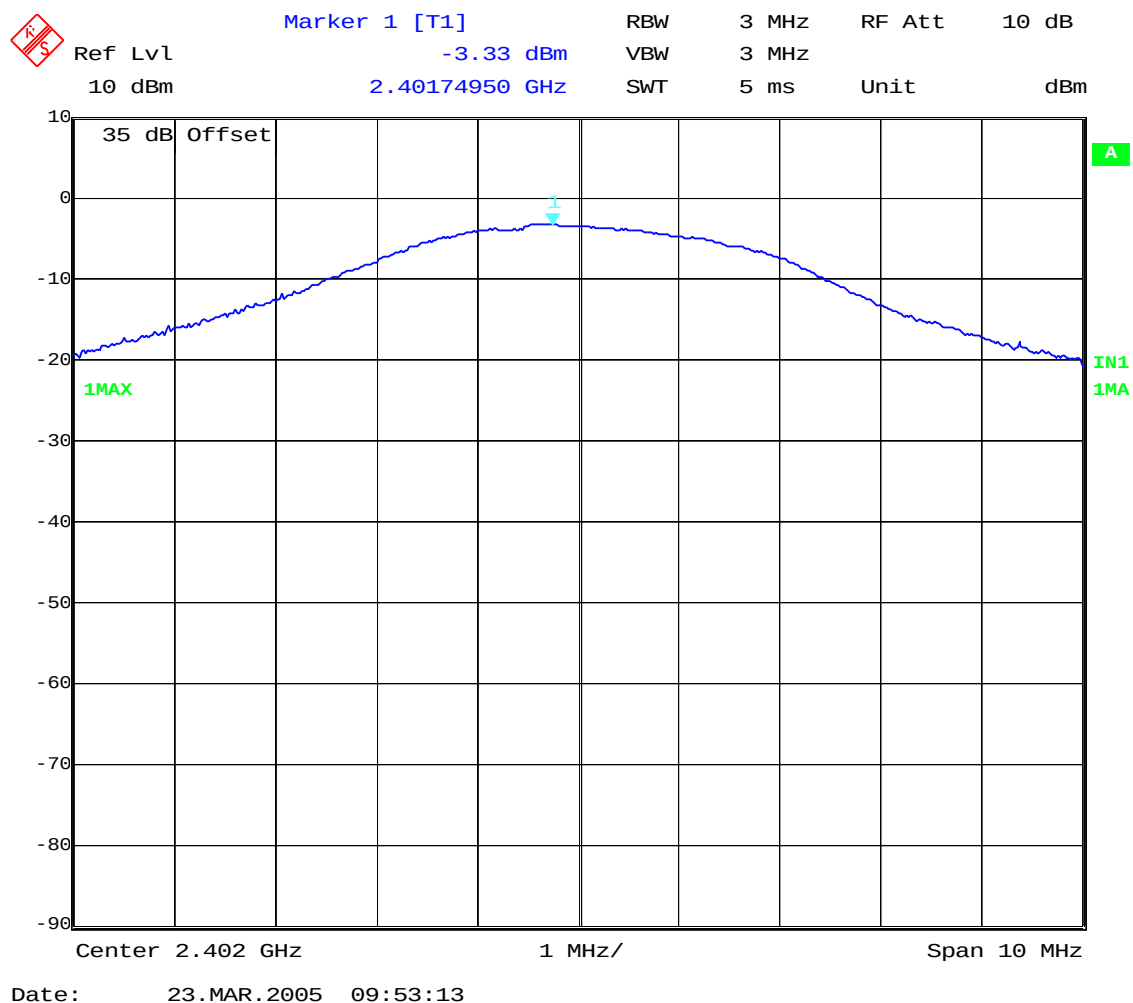
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PEAK OUTPUT POWER (RADIATED).

Lowest Channel: 2402 MHz.



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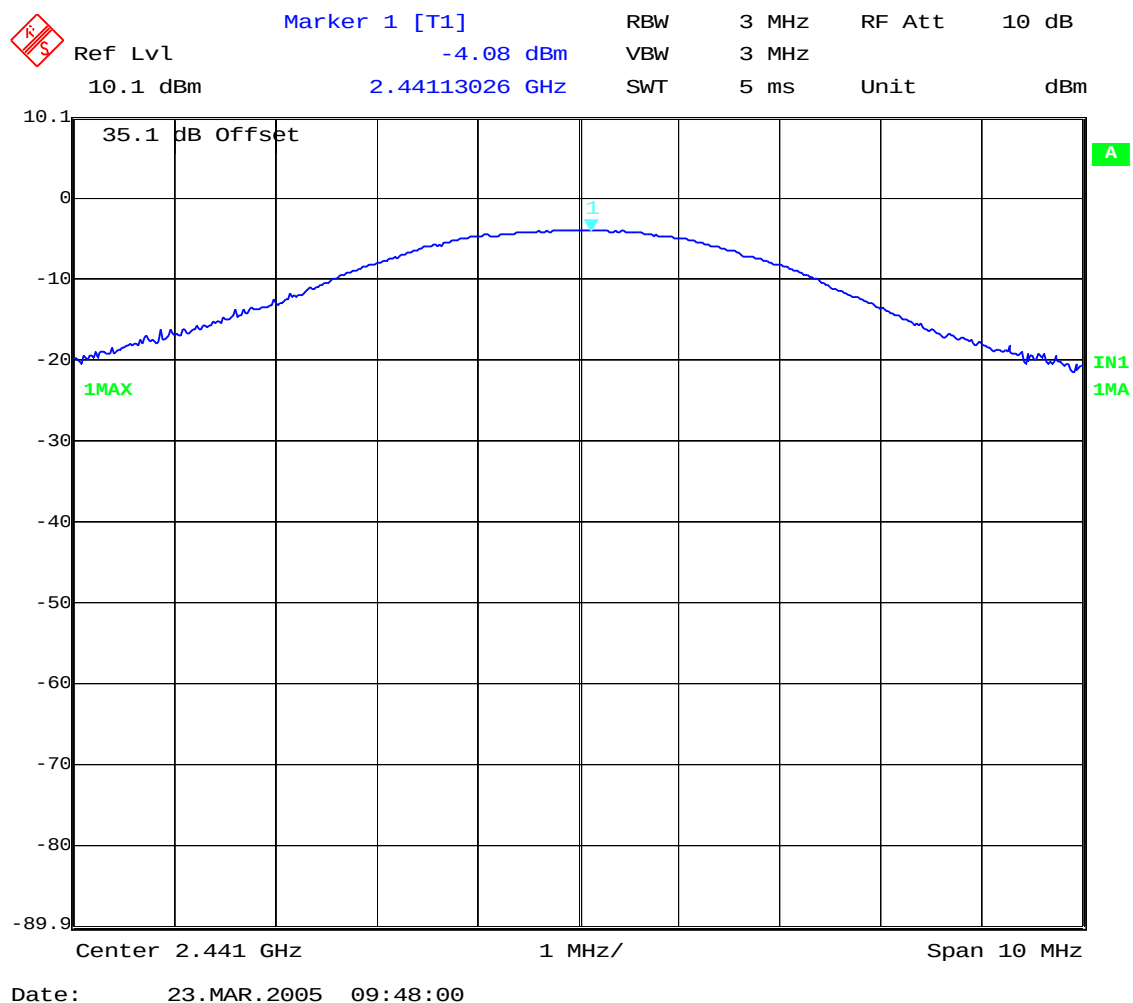
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PEAK OUTPUT POWER (RADIATED).

Middle Channel: 2441 MHz.



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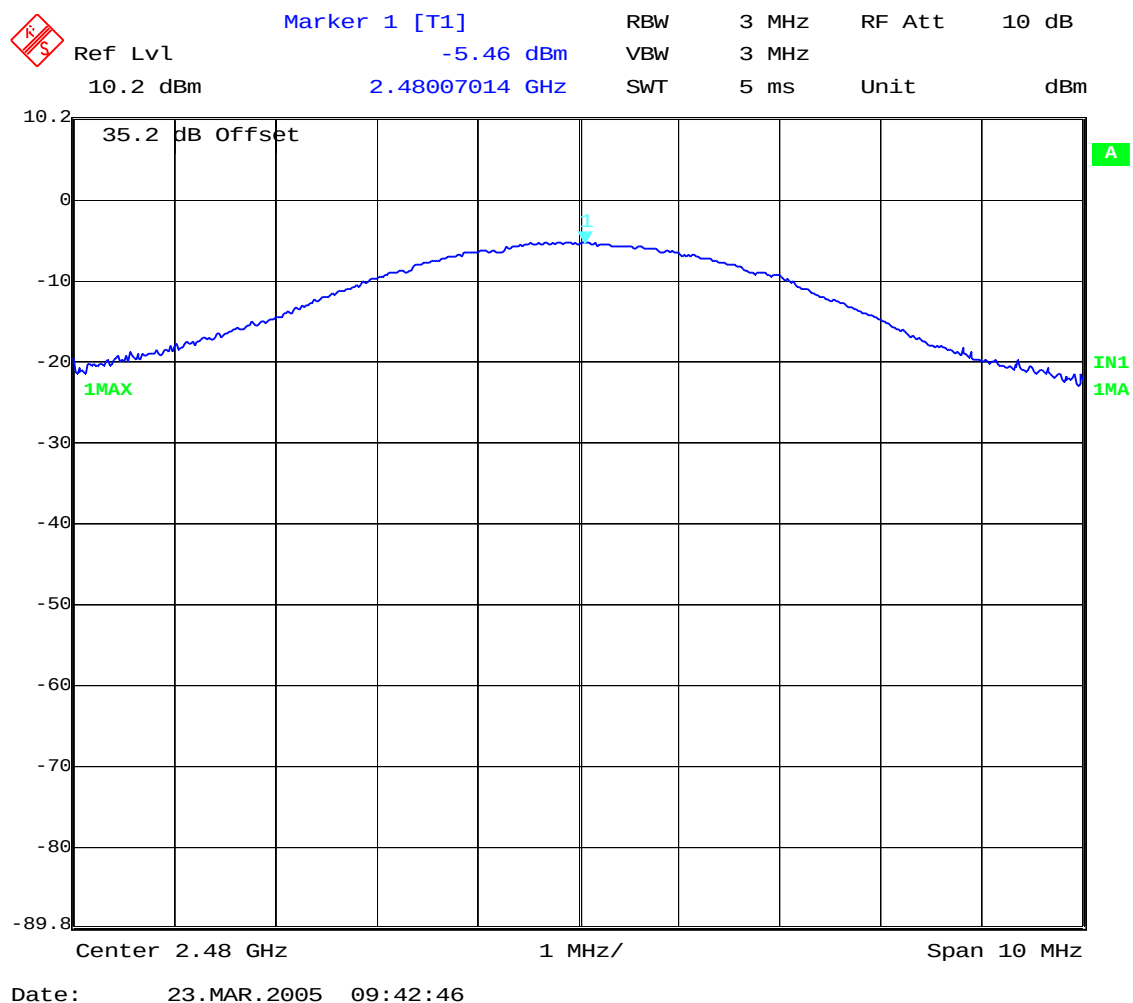
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PEAK OUTPUT POWER (RADIATED).

Highest Channel: 2480 MHz.



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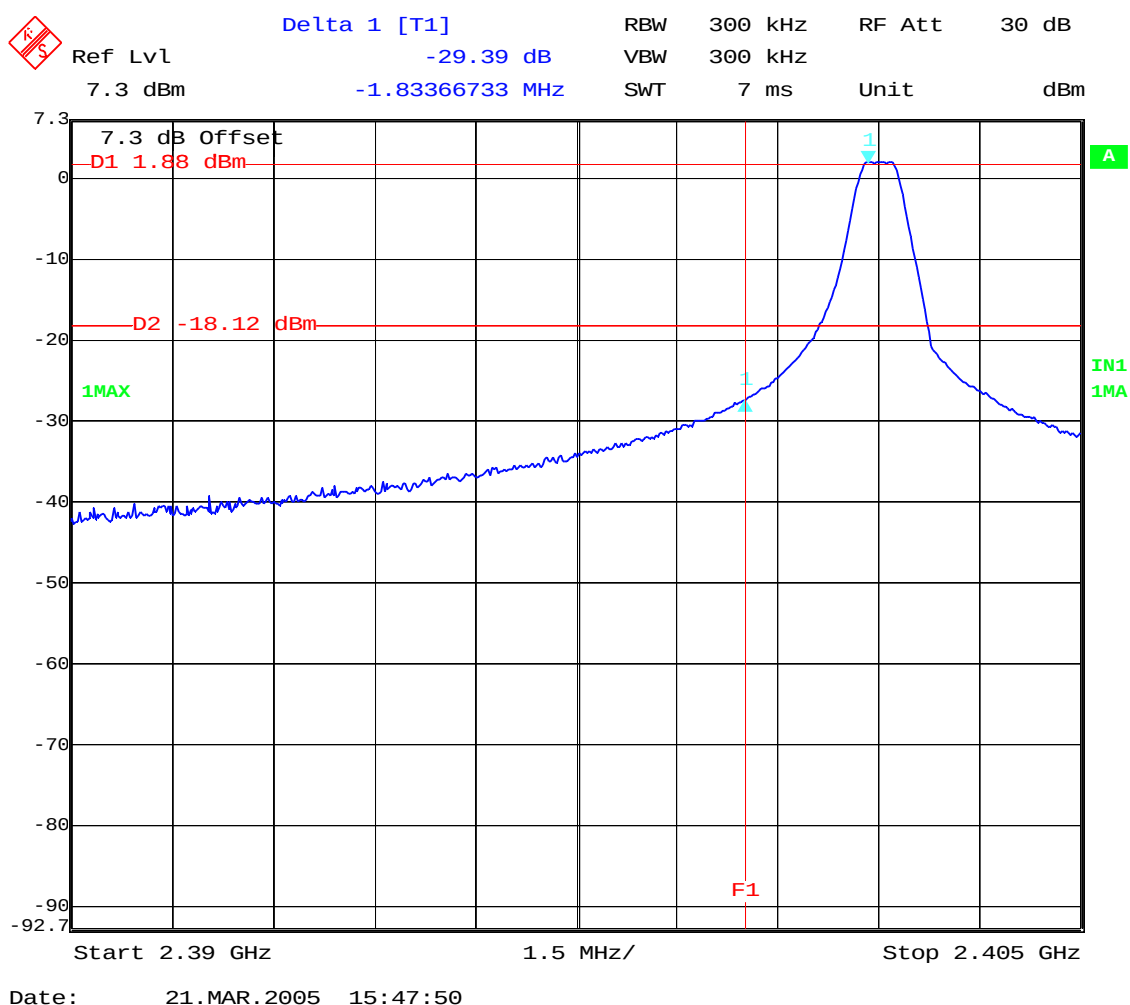
Section 15.247 Subclause (d). Band-edge of conducted emissions (Transmitter)

SPECIFICATION

Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below the highest level of the desired power.

RESULTS:

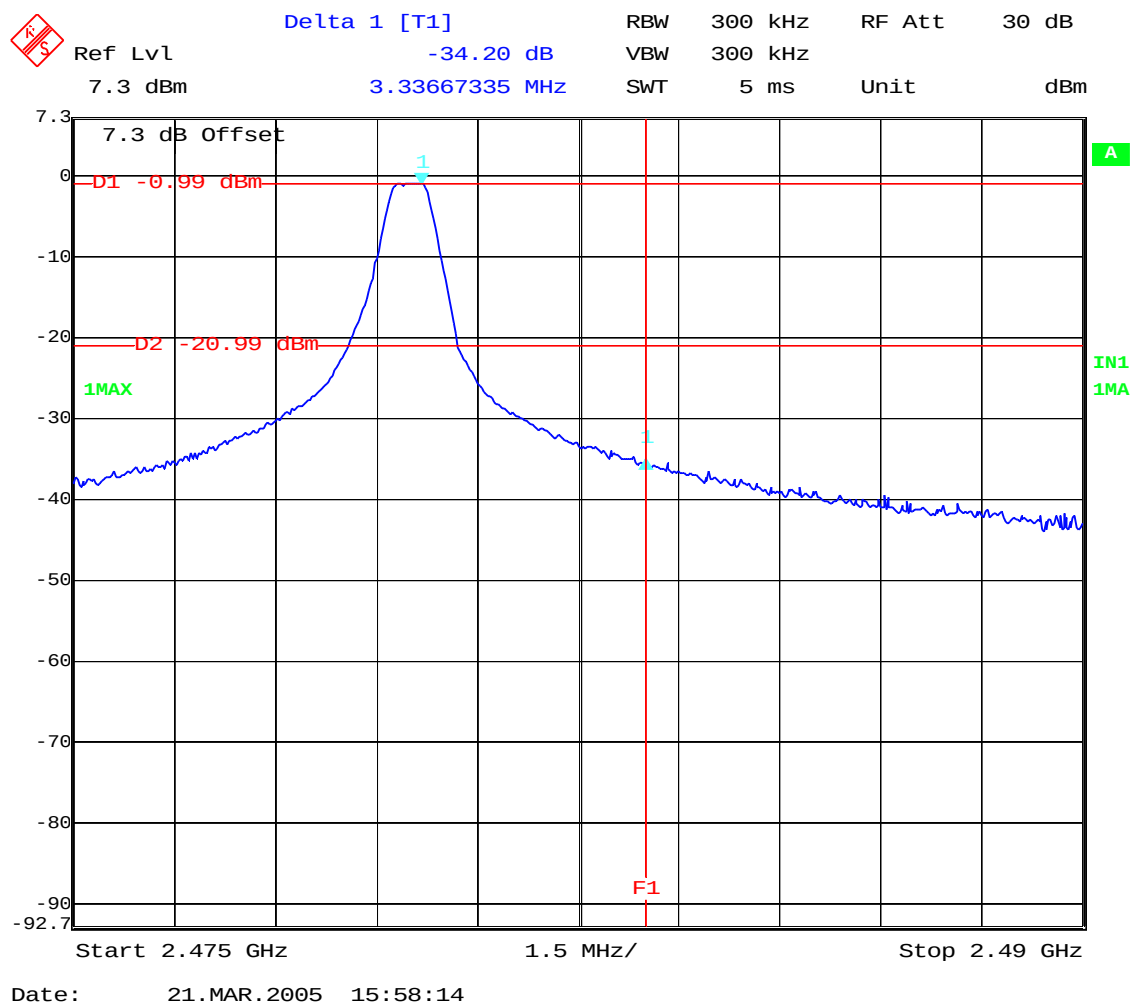
1. LOW FREQUENCY SECTION 2402 MHz (HOPPING OFF). See next plot.



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2. HIGH FREQUENCY SECTION 2480 MHz (HOPPING OFF). See next plot.



Verdict: PASS

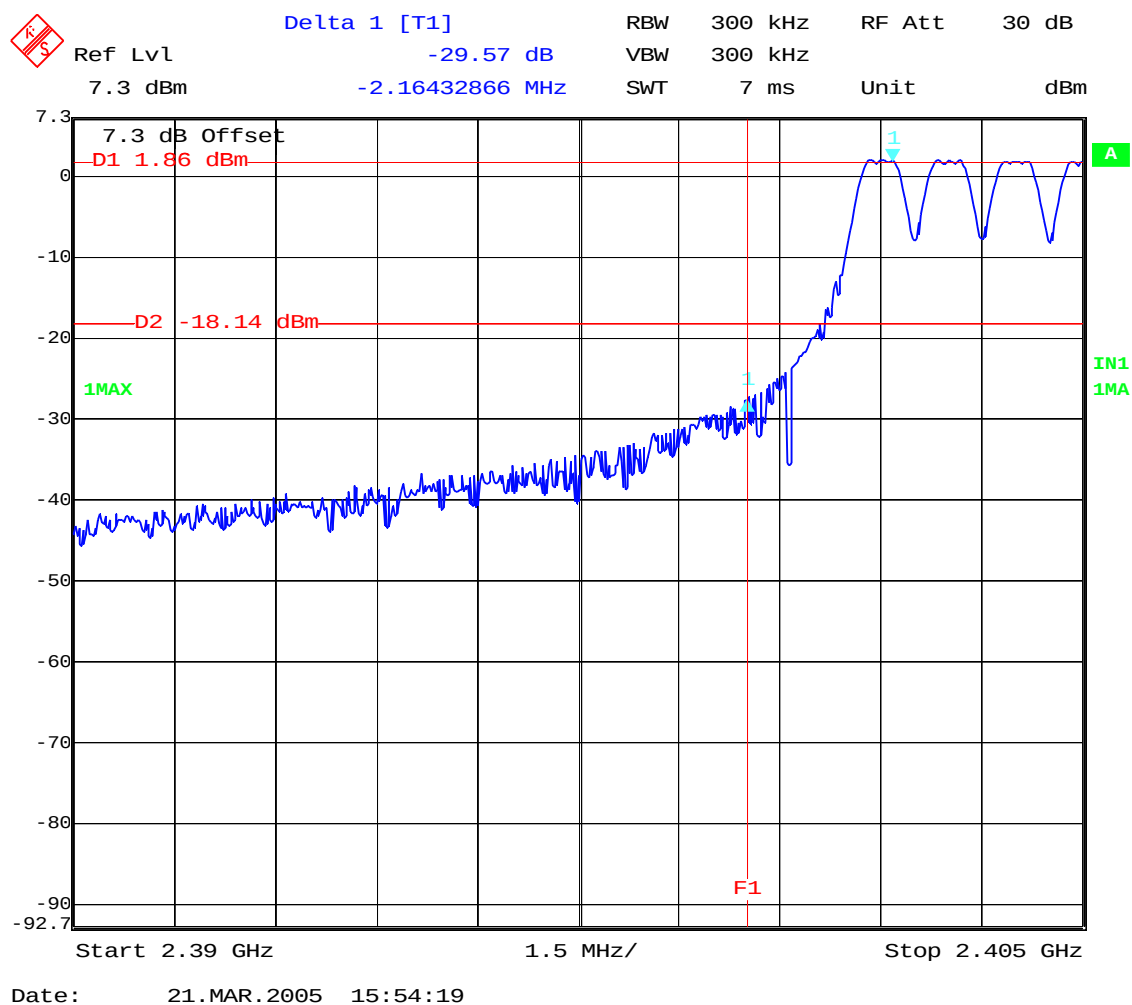
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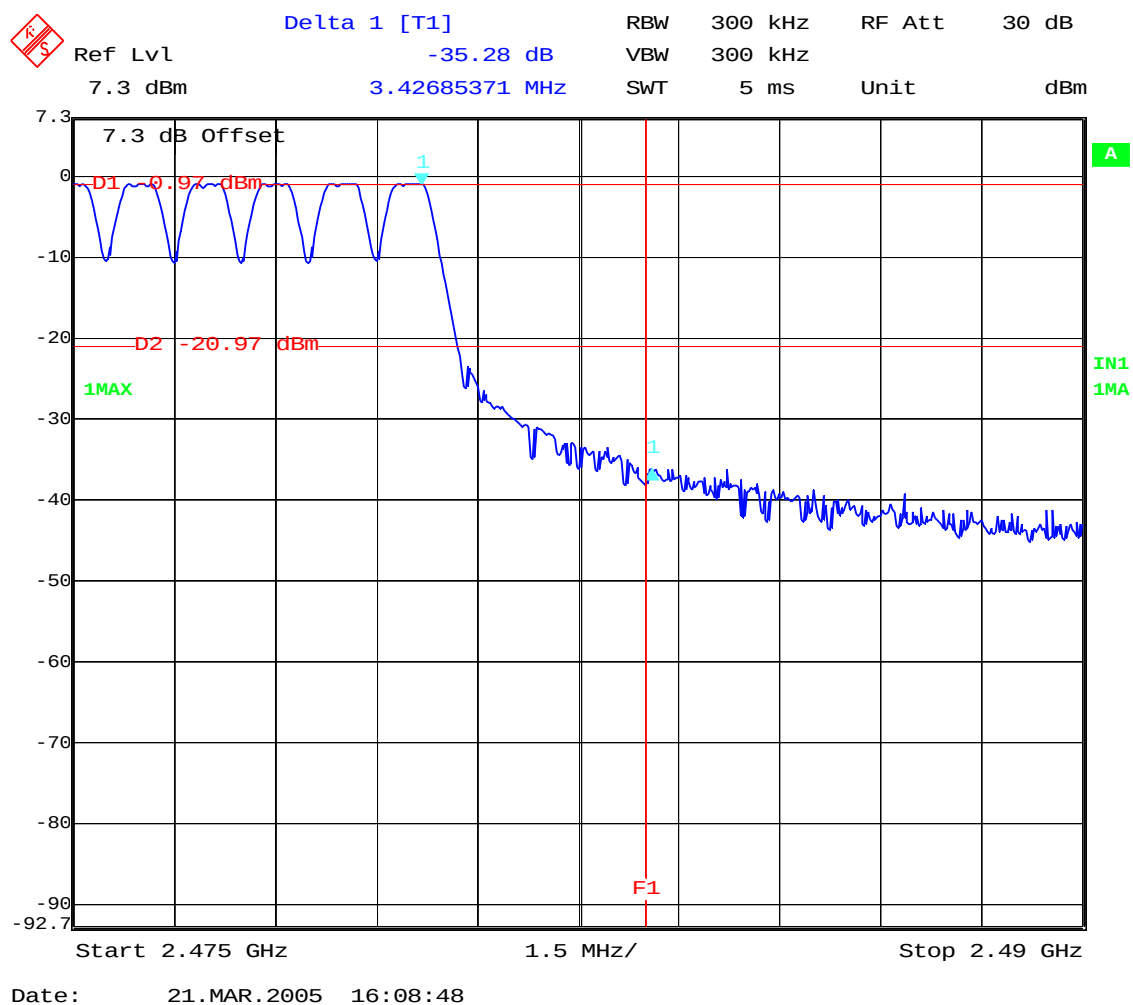
3. LOW FREQUENCY SECTION (HOPPING ON). See next plot.



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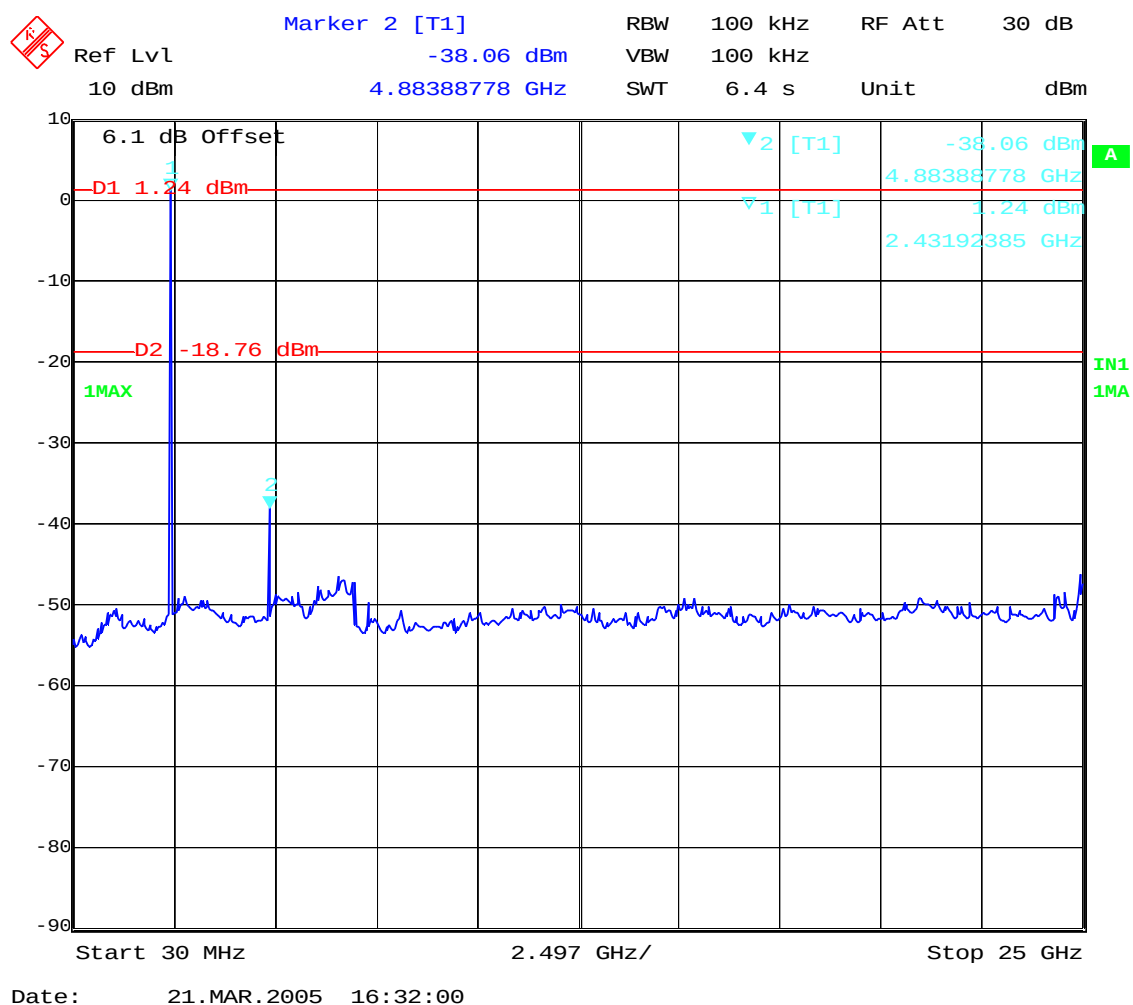
4. HIGH FREQUENCY SECTION (HOPPING ON). See next plot.



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2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).

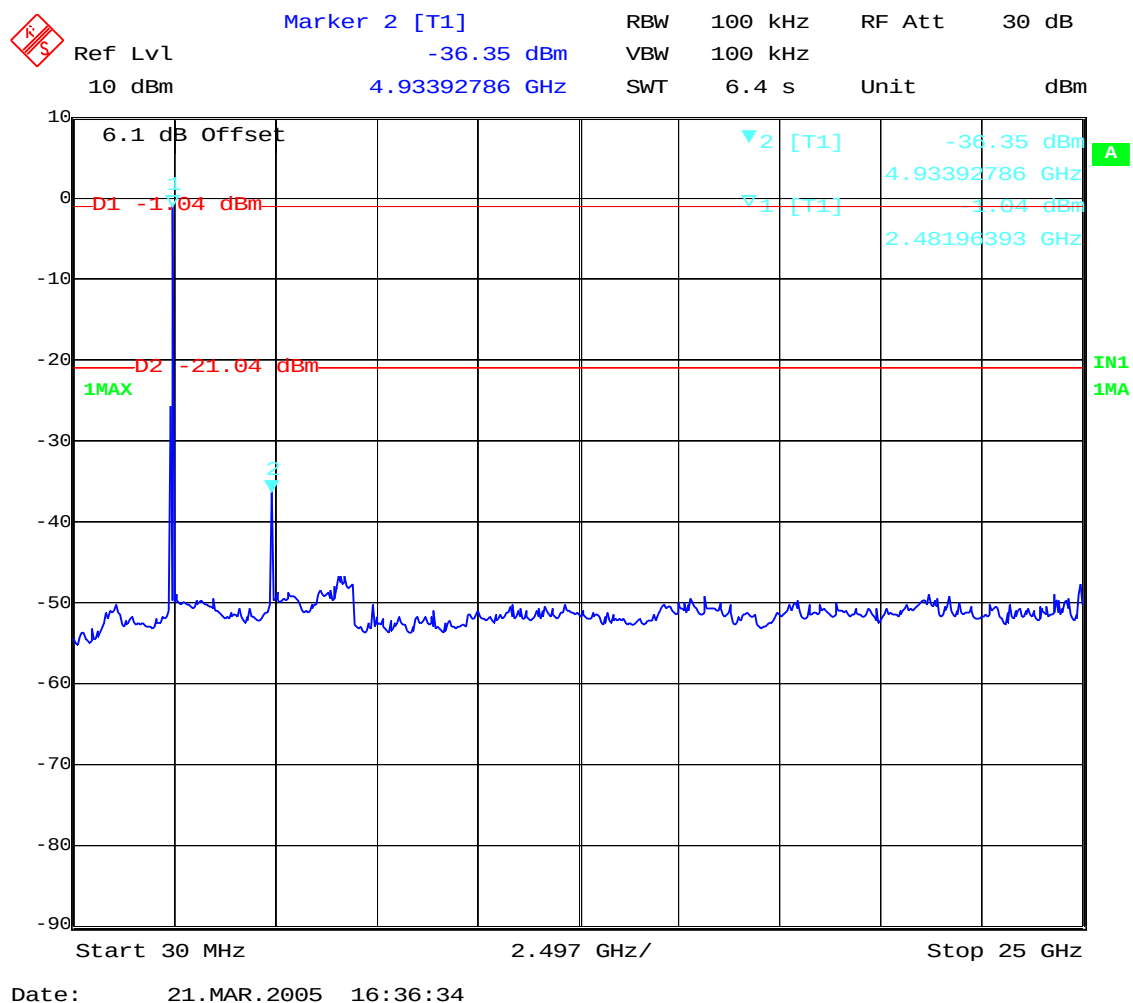


Note: The peak above the limit is the carrier frequency.

Verdict: PASS

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3. HIGH CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

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Section 15.247 Subclause (d). Emission limitations radiated (Transmitter)

SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyser. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

The equipment transmits continuously in the selected channel so it is not necessary a duty cycle correction factor.

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1. CHANNEL: LOWEST (2402 MHz).

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-25 GHz.

No spurious signals were found in all the range.

Additionally, no spurious signals were found inside the restricted bands 2310-2390 MHz and 2483.5-2500 MHz, and at the harmonic frequencies.

2. CHANNEL: MIDDLE (2441 MHz).

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-25 GHz.

No spurious signals were found in all the range.

Additionally, no spurious signals were found inside the restricted bands 2310-2390 MHz and 2483.5-2500 MHz, and at the harmonic frequencies.

3. CHANNEL: HIGHEST (2480 MHz).

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-25 GHz.

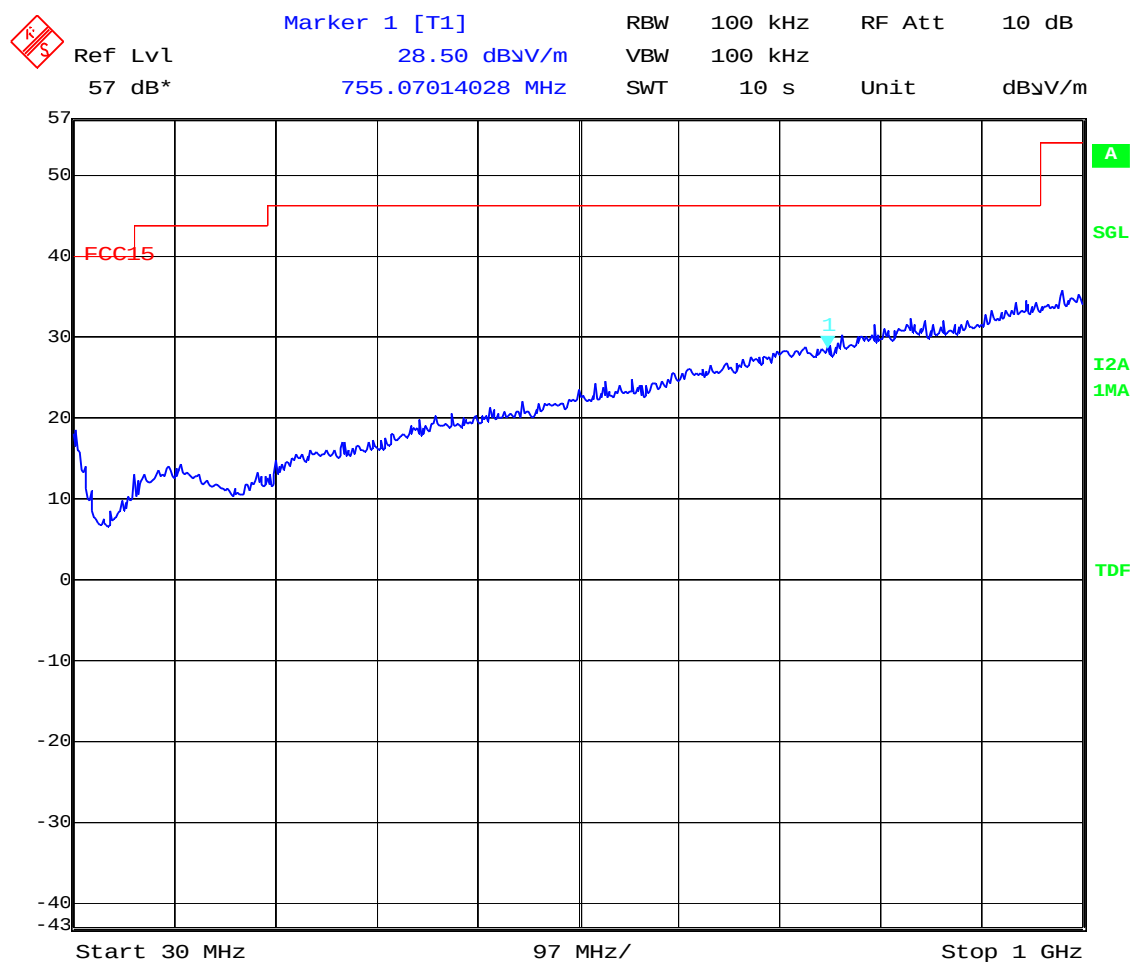
No spurious signals were found in all the range.

Additionally, no spurious signals were found inside the restricted bands 2310-2390 MHz and 2483.5-2500 MHz, and at the harmonic frequencies.

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FREQUENCY RANGE 30 MHz-1000 MHz.



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(This plot is valid for all three channels).

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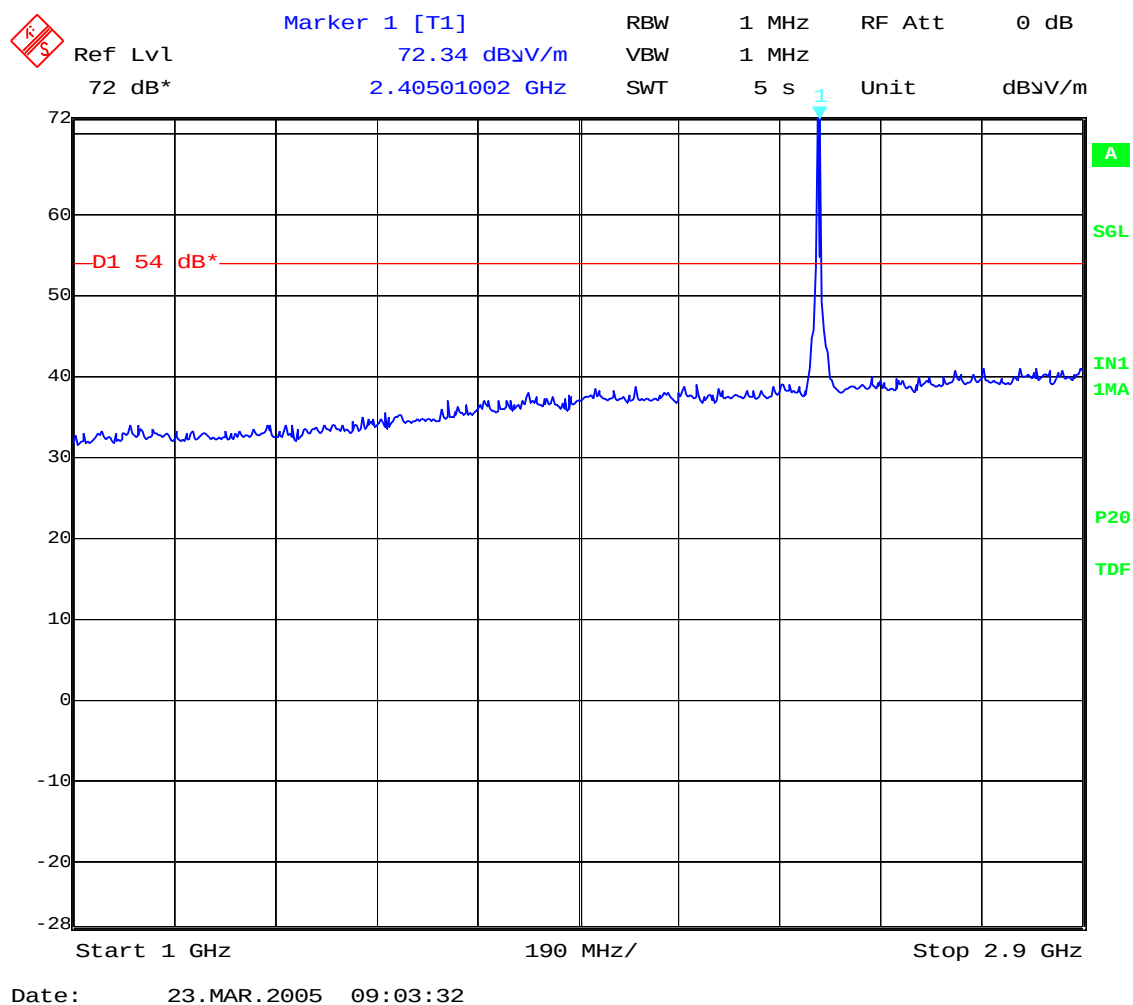
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FREQUENCY RANGE 1 GHz to 2.9 GHz.

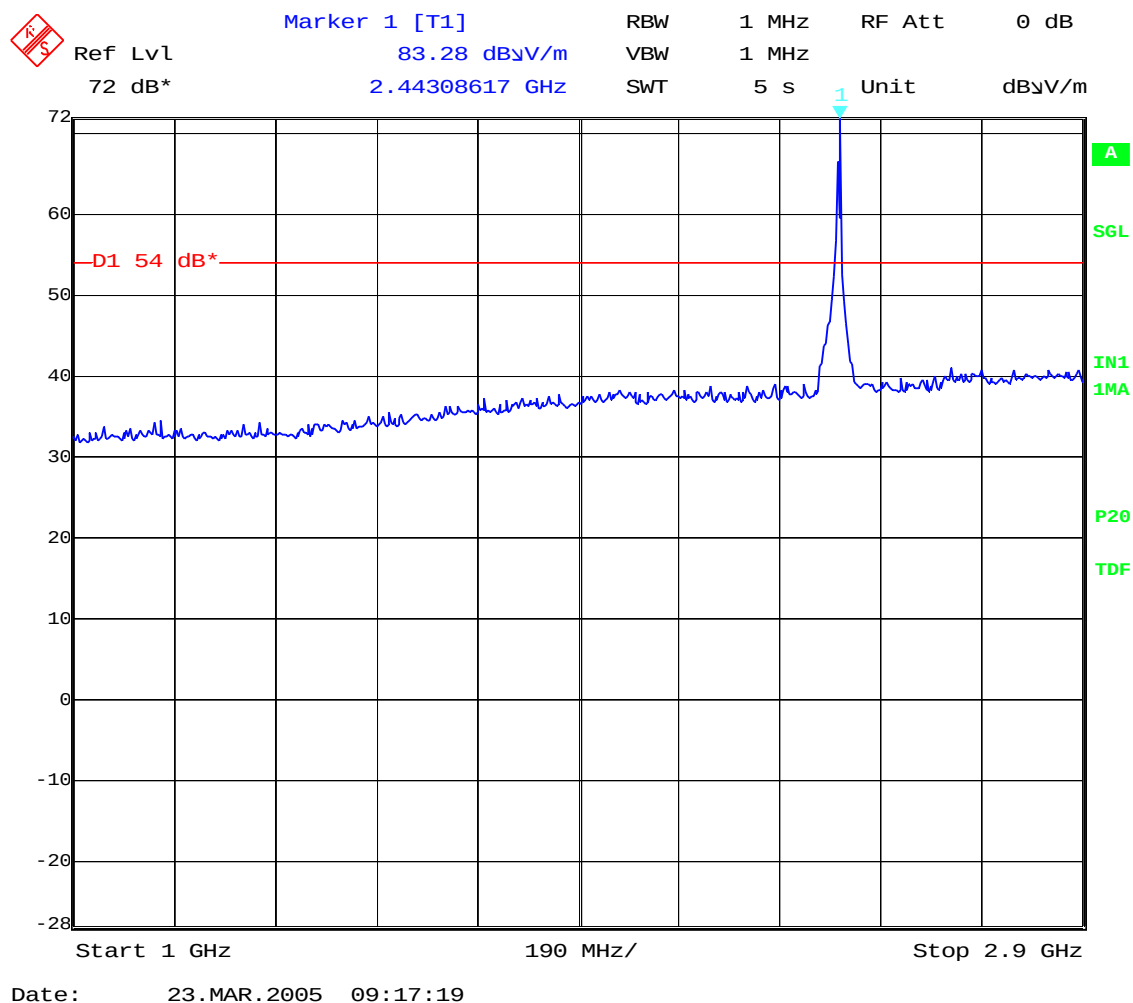
CHANNEL: Lowest (2402 MHz).



Note: The peak above the limit is the carrier frequency.

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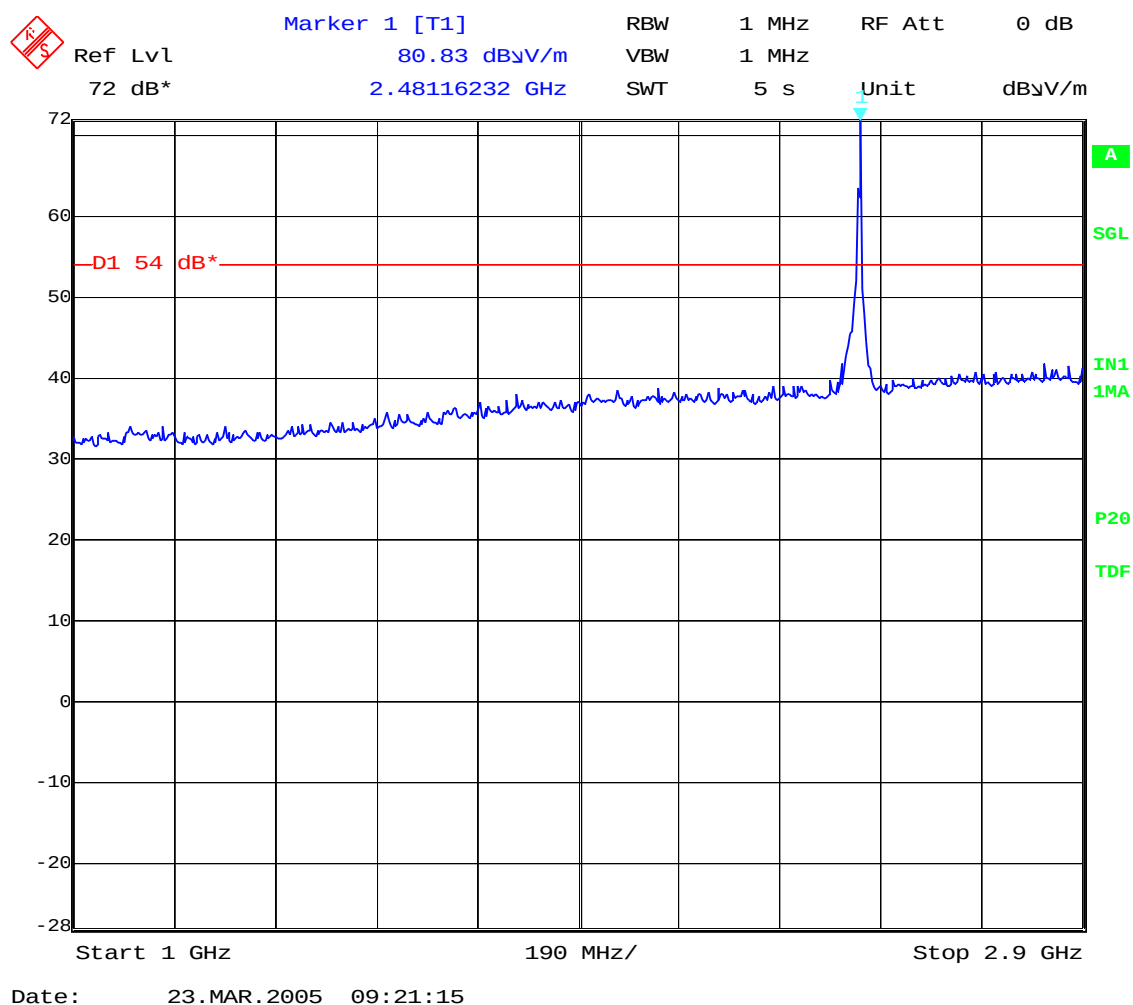
CHANNEL: Middle (2441 MHz).



Note: The peak above the limit is the carrier frequency.

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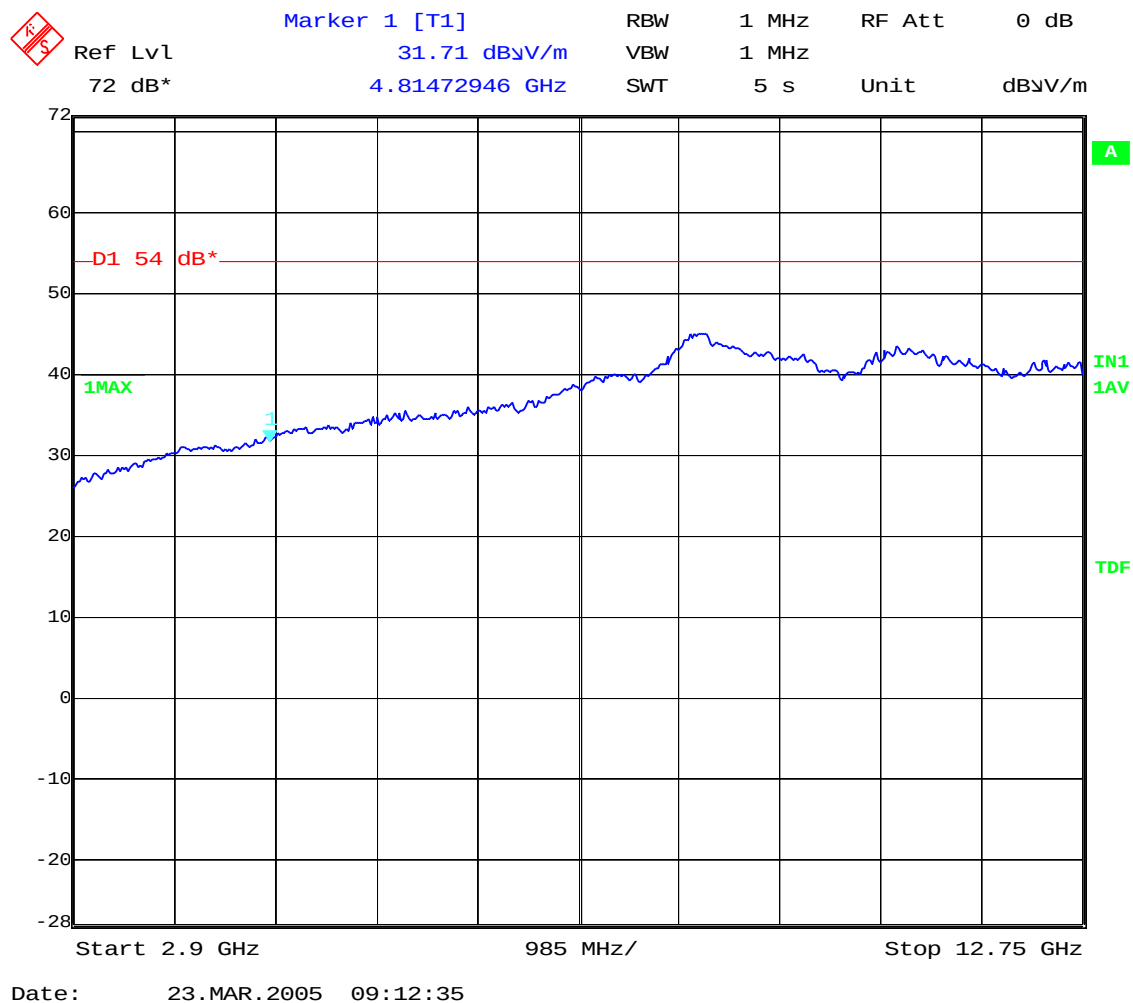
CHANNEL: Highest (2480 MHz).



Note: The peak above the limit is the carrier frequency.

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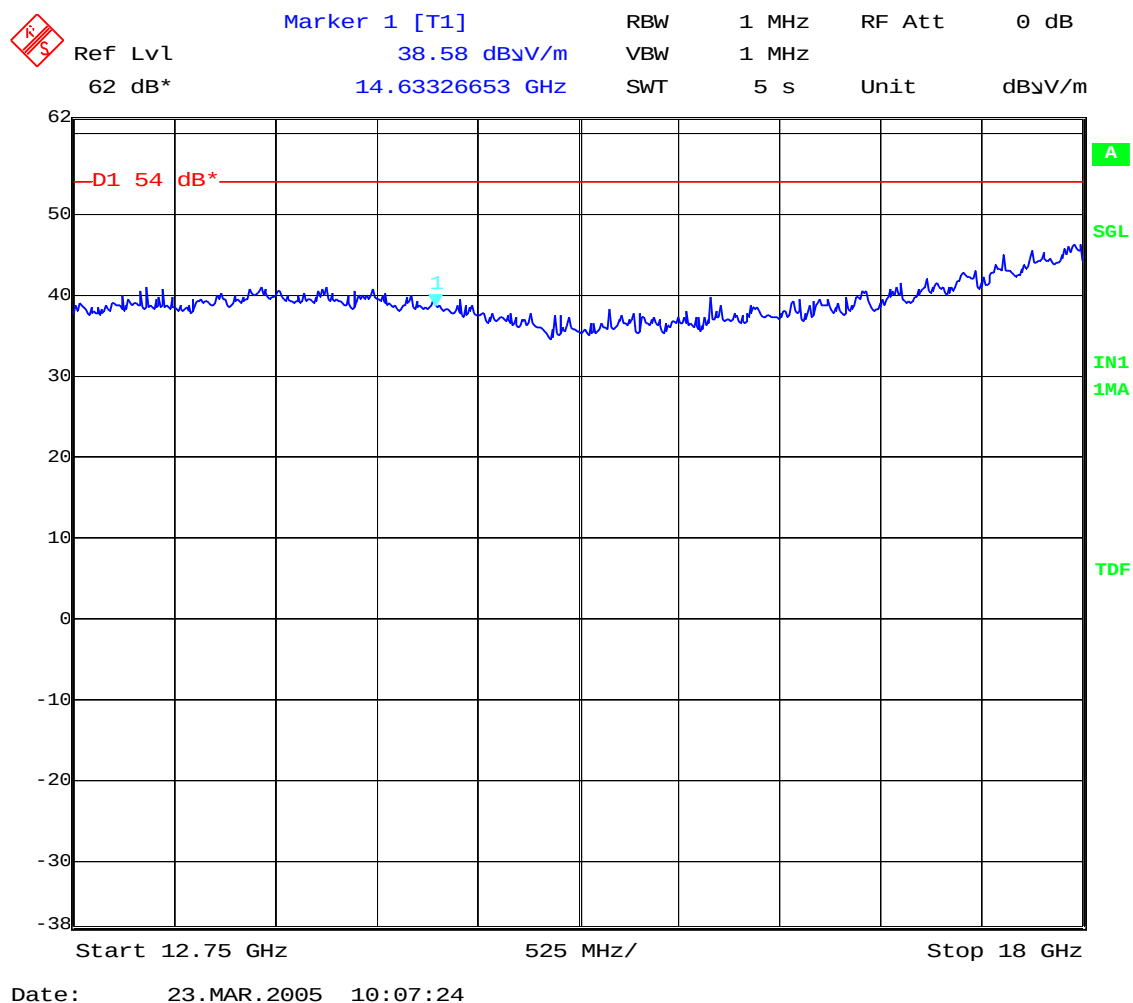
FREQUENCY RANGE 2.9 GHz to 12.75 GHz.



(This plot is valid for all three channels).

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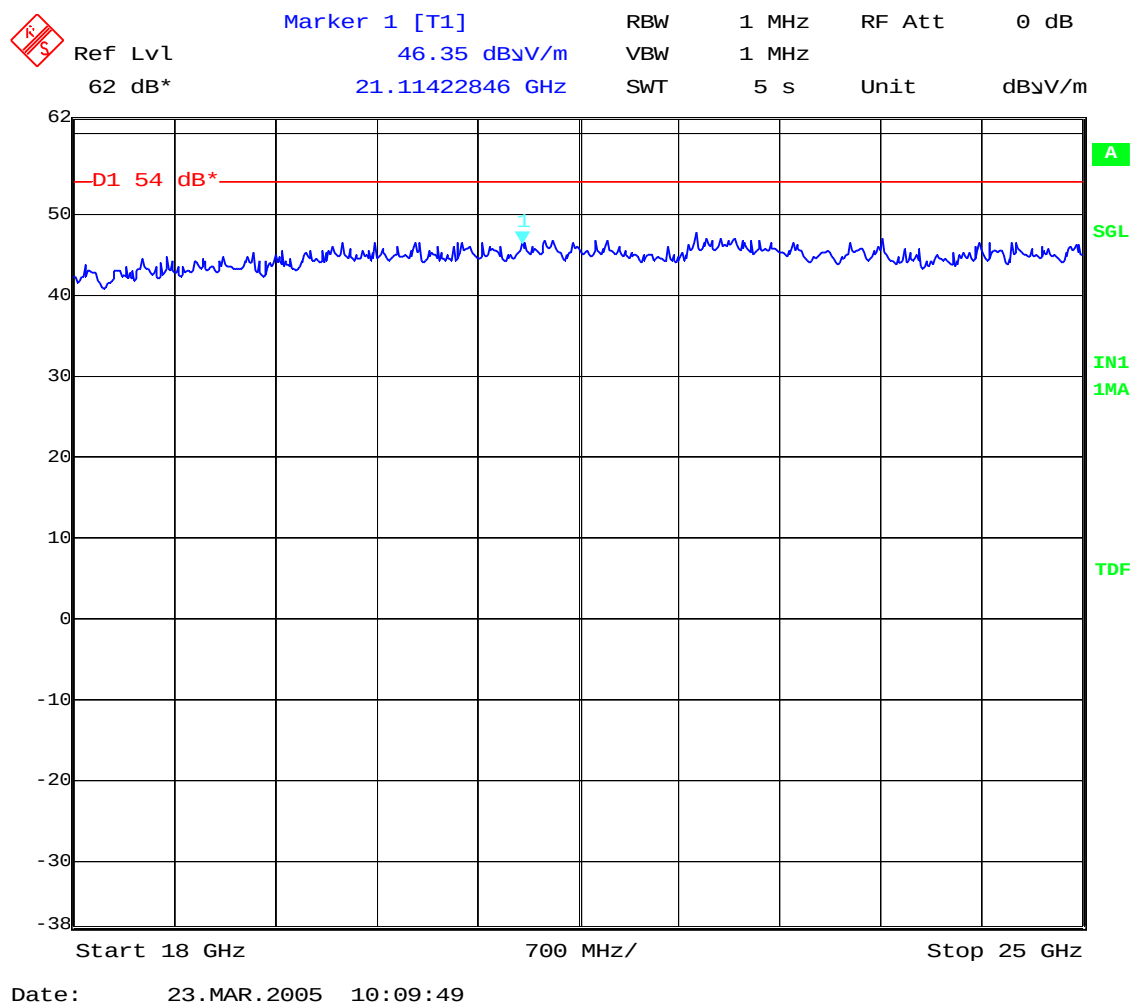
FREQUENCY RANGE 12.75 GHz to 18 GHz.



(This plot is valid for all three channels).

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FREQUENCY RANGE 18 GHz to 25 GHz.



(This plot is valid for all three channels).

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