CETECOM ICT Services GmbH

Radio Satellite Communication
Untertürkheimer Straße 6-10 . D-66117 Saarbrücken Telefon: +49 (0)681 598-0 Telefax: -9075

TTI-P-G166/98

Accredited Bluetooth Test Facility (BQTF)

Test report no.: 4-0306-02-01/01
FCC Part15.247/CANADA RSS-210
Digital Wireless Communication System
MCW-D Base station

Table of Contents

1 General information

1.1 Notes

The test results of this test report relate exclusively to the test item specified in 1.5. The CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the CETECOM ICT Services GmbH.

1.2 Testing laboratory

CETECOM ICT Services GmbH
66117 Saarbrücken
Untertürkheimer Straße 6 - 10
Deutschland
Telefone : + 49 681 598 - 0
Telefax : + 49 681 598 - 9075
E-mail : Harro.Ames@ict.cetecom.de
Internet : www.cetecom.de

Accredited testing laboratory
DAR-registration number : TTI-P-G 166/98-20

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

1.3 Details of applicant

Name : beyerdynamic GmbH & Co.
Street : Theresienstraße 8
City : 74003 Heilbronn
Country : Germany
Telephone: +49 (0) 7131 61 71 55
Telefax : +49 (0) 7131 6 04 59
Contact : Mr. Ulrich Roth
Telephone: +49 (0) 7131 61 71 55

1.4 Application details

Date of receipt of application : 05.03.2001
Date of receipt of test item : 05.03.2001
Date of test : 05.03.2001 – 15.03.2001
Re issued : 03.05.2002

1.5 Test item

Type of equipment	:	**Digital Wireless Communication System**
Type designation	:	**MCW-D**
Manufacturer	:	applicant
Street	:	
City	:	
Country	:	
Serial number	:	
Additional informations:	**:**	
Frequency	:	2400 – 2483,5 MHz
Type of modulation	:	10M0P7D (DSSS) Ch.Sep. : 5 MHz
Number of channels	:	16
Antenna	:	3 external rod antennas (1 for TX, 2 for RX)
Power supply	:	115V AC
Output power cond.	:	21 dBm
Type of equipment	:	Class B
Temperature range	:	-10°C - +55°C

1.6 Test standards: FCC Part 15 §15.247 / CANADA RSS-210

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

2 Technical test

2.1 Summary of test results

The radiated measurements were performed vertical and horizontal over the whole frequency range.We start at 1 m high with vertical receiving antenna and rotate the dish continuously. During rotation we use the antenna lift system to vary the high from 1 to 4 m. So we find maximum radiation output. At this points we do manual remeasurements. After this we do the same measurements in horizontal position of the receiving antenna. This (horizontal and vertical) is made for all the three planes of the test sample. We use the maximum received results. The detector function and selection of bandwidth are according ANSI C63.2-1996 item 8.2.1 and ANSI C63.4-1992 Item 4.2.
Antennas are conform with ANSI C63.2-1996 item 15.
150 kHz - 30 MHz: Quasi Peak measurement, 9kHz Bandwidth, passive loop antenna.
30 MHz - 200 MHz: Quasi Peak measurement, 120KHz Bandwidth, biconical antenna
200MHz - 1GHz: Quasi Peak measurement, 120KHz Bandwidth, log periodic antenna
>1GHz: Average, RBW 1MHz, VBW 10 MHz, waveguide horns and standard gain horns.

All measurement settings are according to FCC 15.35, 15.205, 15.209, 15.247 and the „Measurement guidelines for DSSS systems“, especially regarding the radiated measurements.

It was not possible to do RX radiated measurements as according to this communication system the master channel is transmitting continuously.

The product fullfills also the requirements for CANADA RSS-210

No deviations from the technical specification(s) were ascertained in the course of the tests.

Final verdict : PASS

Technical responsibility for area of testing :

16.01.02	**RSC 8414**	**Ames H.**	
Date	**Section**	**Name**	**Signature**

Technical responsibility for area of testing :

16.01.02	**RSC8412**	**Hausknecht D.**	
Date	**Section**	**Name**	**Signature**

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

2.2 Testreport

TEST REPORT

Testreport no. : 4-0306-02-01/01

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

TEST REPORT REFERENCE

LIST OF MEASUREMENTS

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Antenna Gain **SUBCLAUSE § 15.204**

The antenna gain of the complete system is calculated by the difference of conducted power of the module and the radiated power in EIRP.

	low channel peak	mid channel peak	high channel peak
Conducted power	**21.29 dBm**	**21.07 dBm**	**20.71 dBm**
Radiated power	**19.8 dBm**	**19.91 dBm**	**19.90 dBm**
Gain	**-1.49 dB**	**-1.16 dB**	**-0.81 dB**

The calculated antenna gain is between –0.81 and -1.49 dB for the external rod antenna.

Equipment under test MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Spectrum Bandwith of a DSSS System

§15.247(a)

6 dB bandwidth

TEST CONDITIONS		6 dB BANDWIDTH (kHz)		
Frequency (MHz)		2408.5 MHz	2439.5 MHz	2474.0 MHz
T_{nom}(25)°C	V_{nom}(115)V	3607	3607	3607
Measurement uncertainty		±1kHz		

RBW / VBW as provided in the „Measurement Guidelines“ (DA 00-705, March 30, 2000)

LIMIT **SUBCLAUSE §15.247(a) (2)**

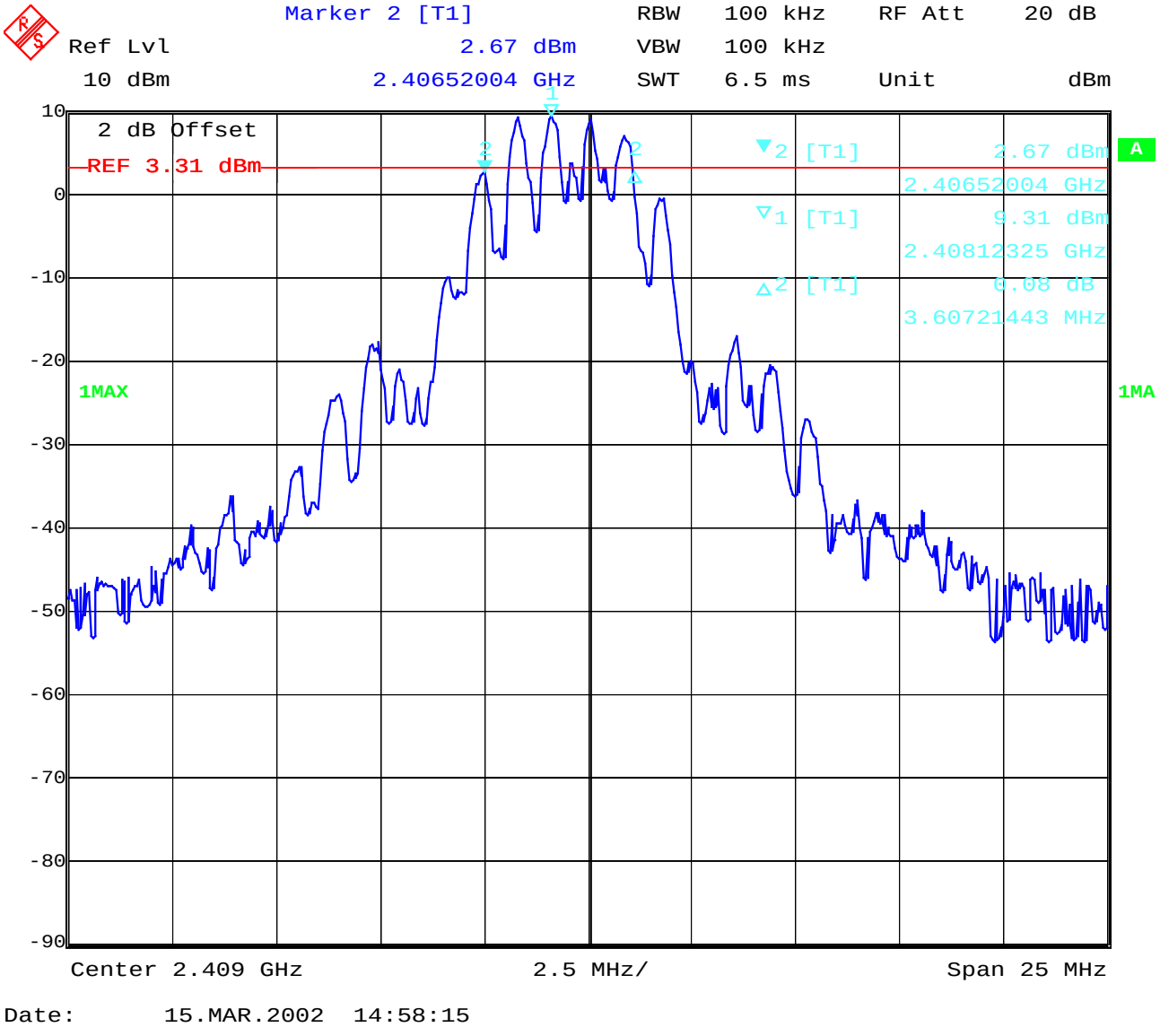
The minimum 6dB bandwith shall be at least 500 KHz

REFERENCE NUMBER(S) OF TEST EQUIPMENT USED
(for reference numbers see test equipment listing)
17 - 24

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Spectrum Bandwith of a DSSS System **§15.247(a)**
6 dB bandwidth

Channel 1



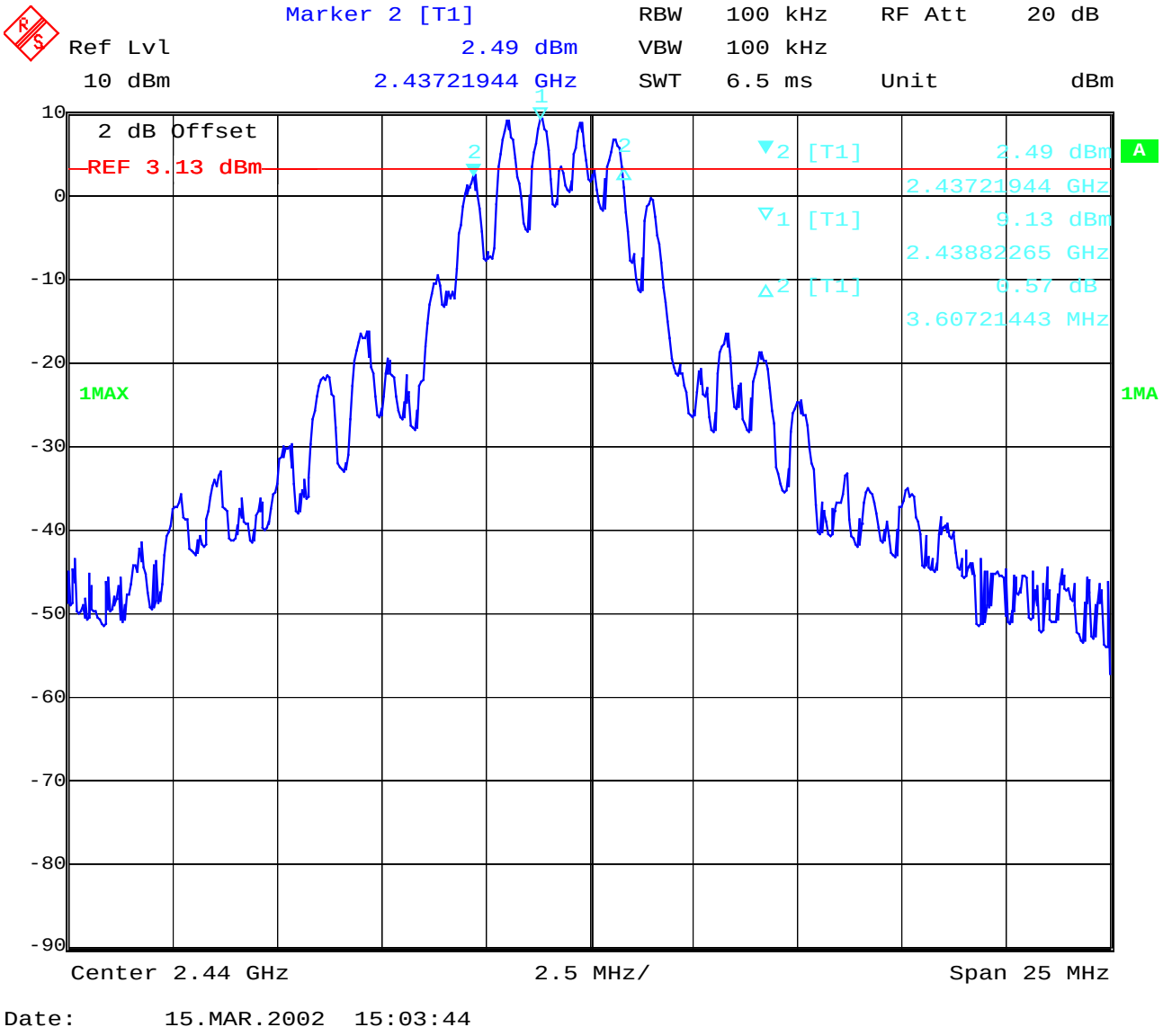
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Spectrum Bandwith of a DSSS System

§15.247(a)

6 dB bandwidth

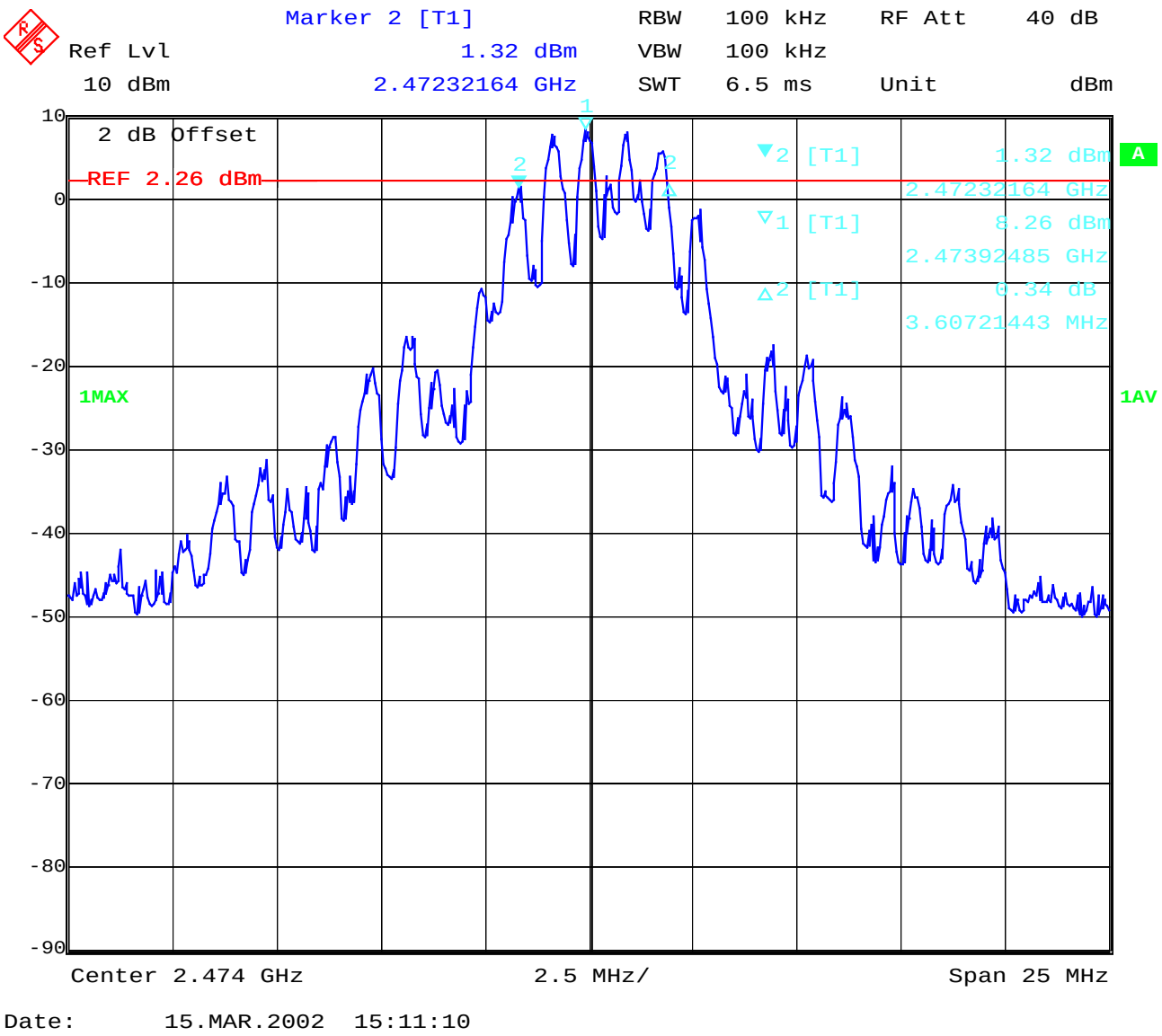
Channel 2



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Spectrum Bandwith of a DSSS System **§15.247(a)**
6 dB bandwidth

Channel 3:



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

MAXIMUM PEAK OUTPUT POWER (CONDUCTED) **SUBCLAUSE § 15.247 (b) (1)**

TEST CONDITIONS		MAXIMUM PEAK OUTPUT POWER (mW)		
Frequency (MHz)		2408.5 MHz	2439.5 MHz	2474.0 MHz
T_{nom}(25)°C	V_{nom}(115)V	Peak :21.29 dB AV : 14.69 dB	Peak :21.07 dB AV : 14.62 dB	Peak :20.71 dB AV : 14.40 dB
Maximum deviation from output power under extreme test conditions (dBc)		0.5	0.5	0.5
Measurement uncertainty		±3dB		

RBW/VBW : 10 MHz

LIMIT **SUBCLAUSE § 15.247 (b) (1)**

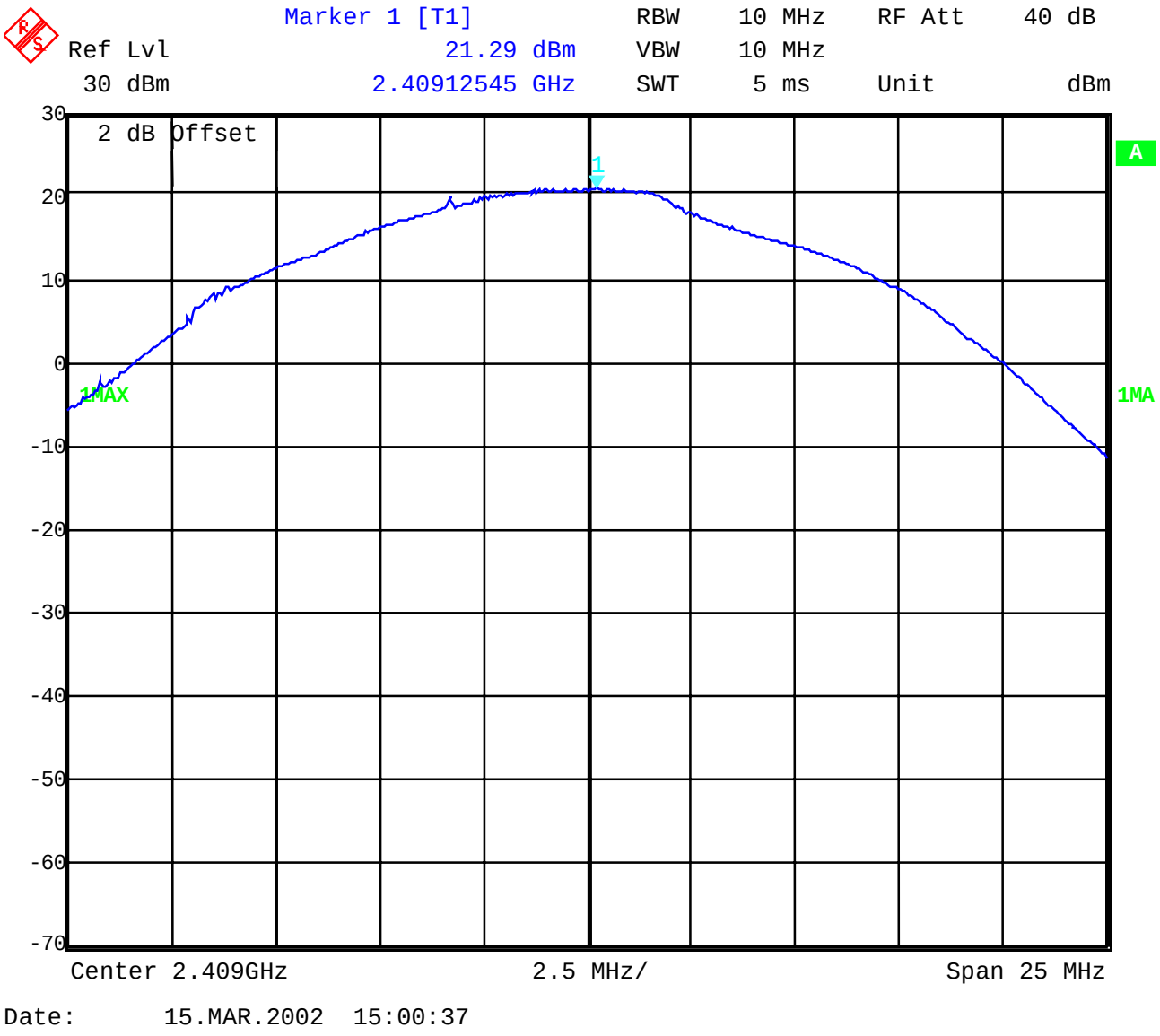
Frequency range	RF power output
2400-2483.5 MHz	1.0 Watt/ 30dBm

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

MAXIMUM PEAK OUTPUT POWER (CONDUCTED)

SUBCLAUSE § 15.247 (b) (1)

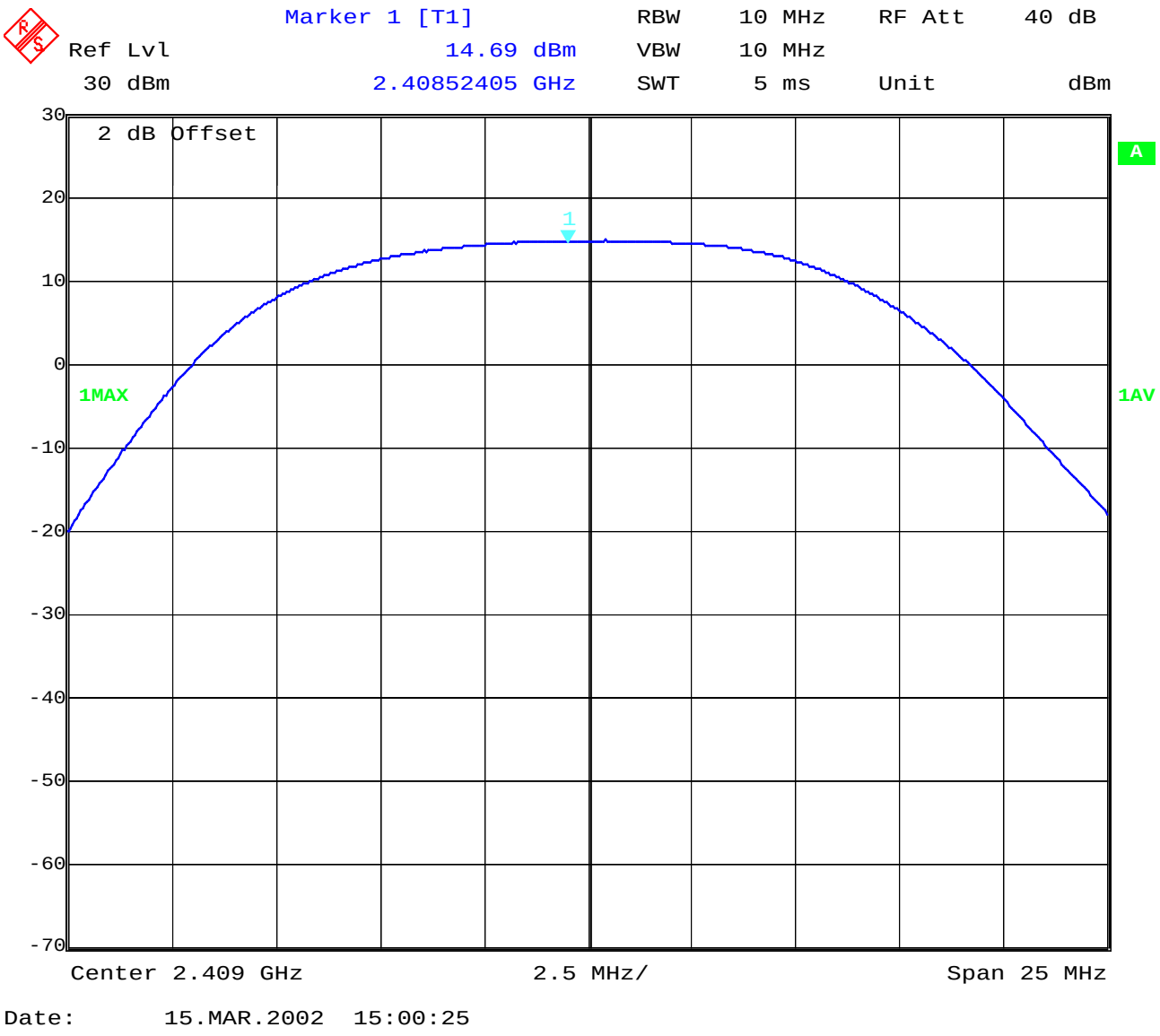
low channel peak



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

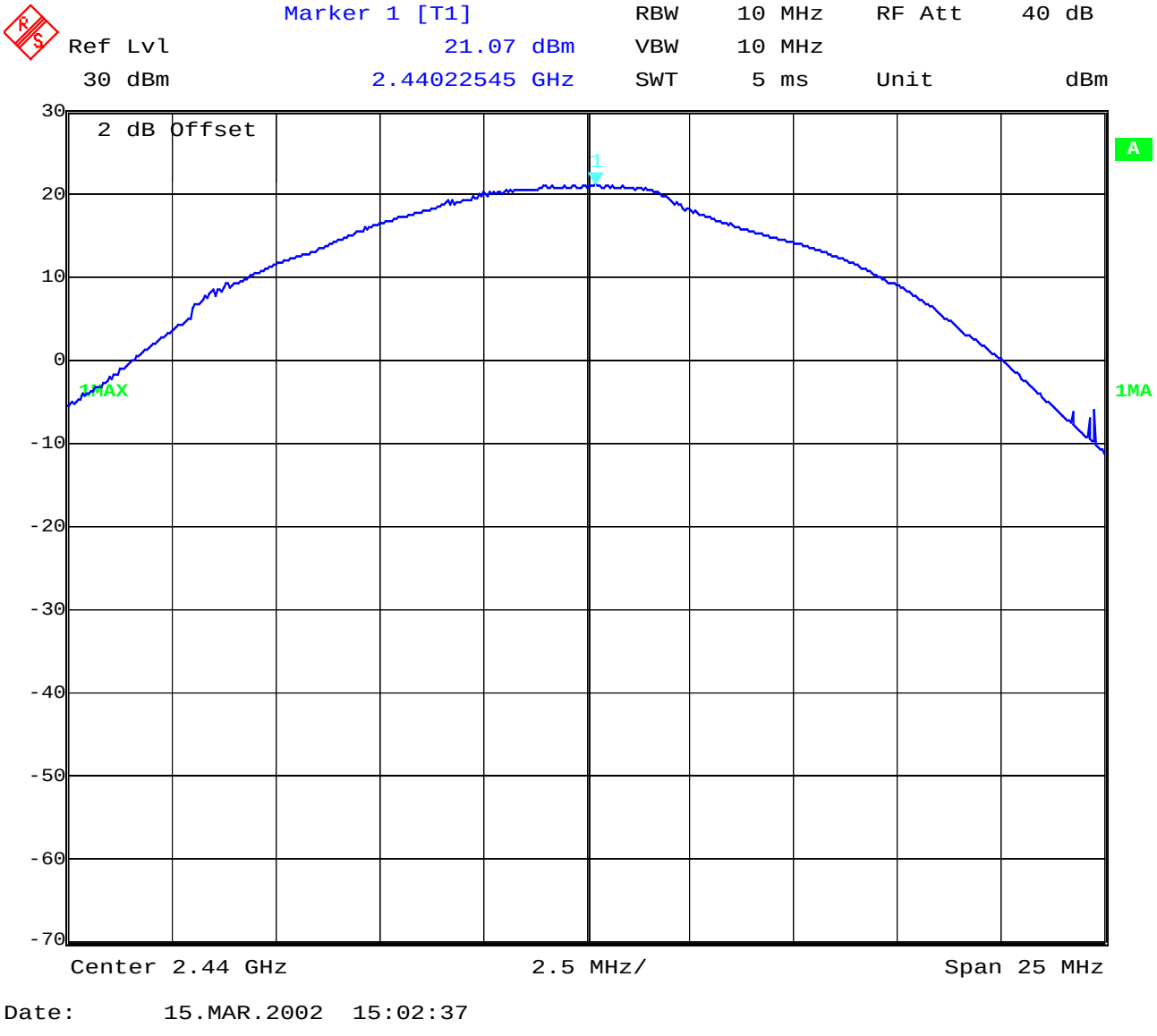
MAXIMUM PEAK OUTPUT POWER (CONDUCTED) SUBCLAUSE § 15.247 (b) (1)

low channel average



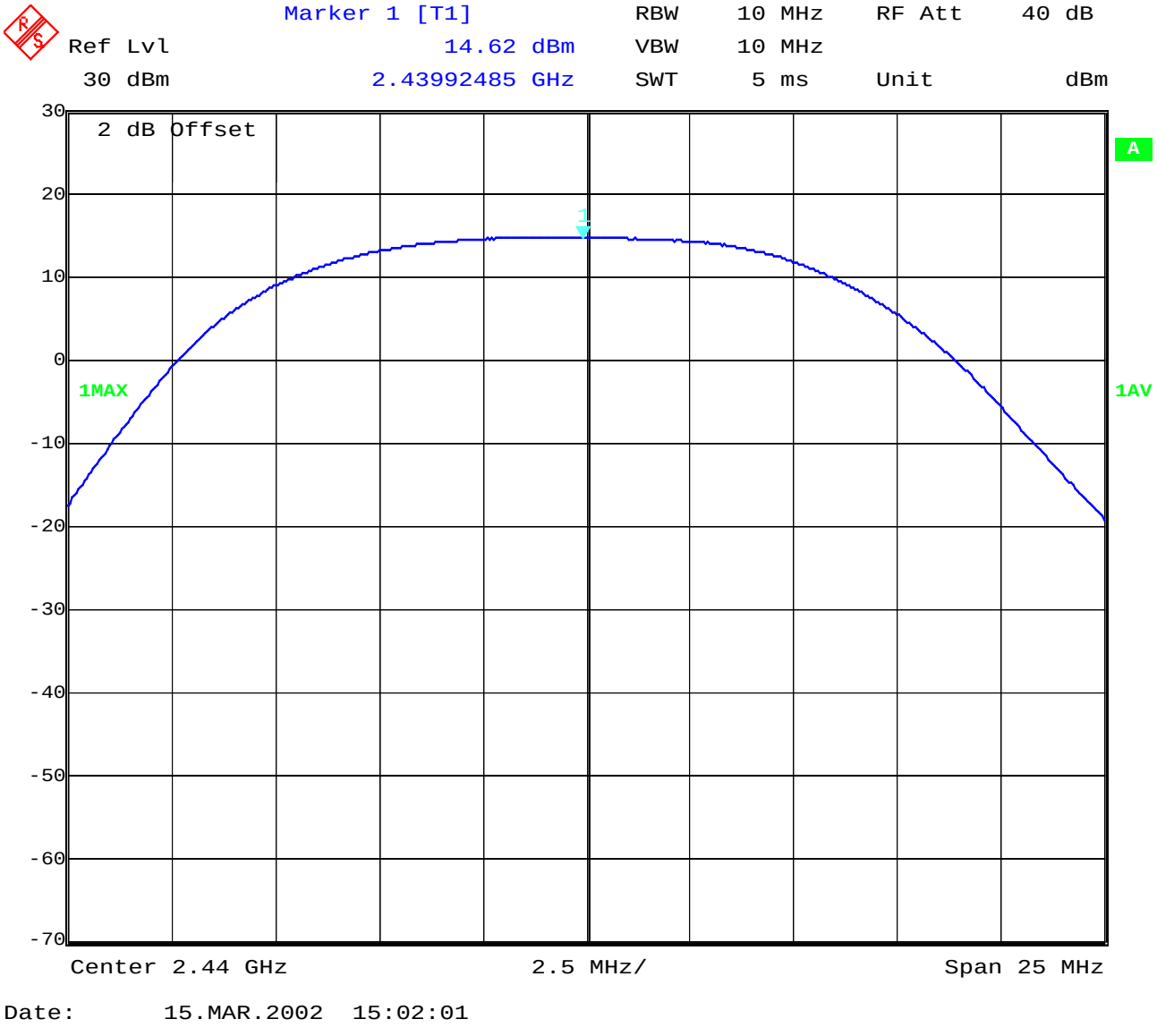
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
MAXIMUM PEAK OUTPUT POWER (CONDUCTED) **SUBCLAUSE § 15.247 (b) (1)**

mid channel peak



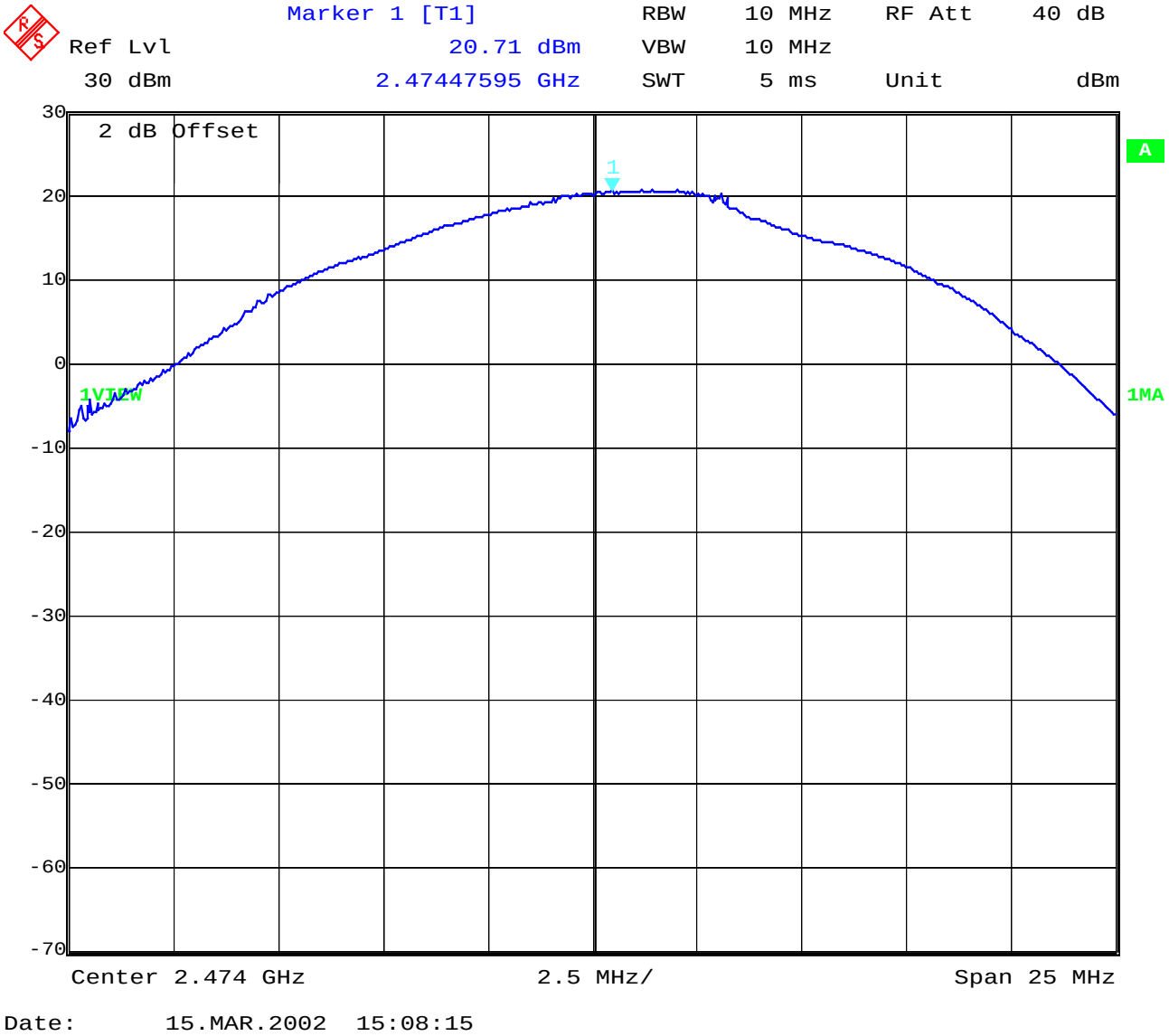
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
MAXIMUM PEAK OUTPUT POWER (CONDUCTED) **SUBCLAUSE § 15.247 (b) (1)**

mid channel average



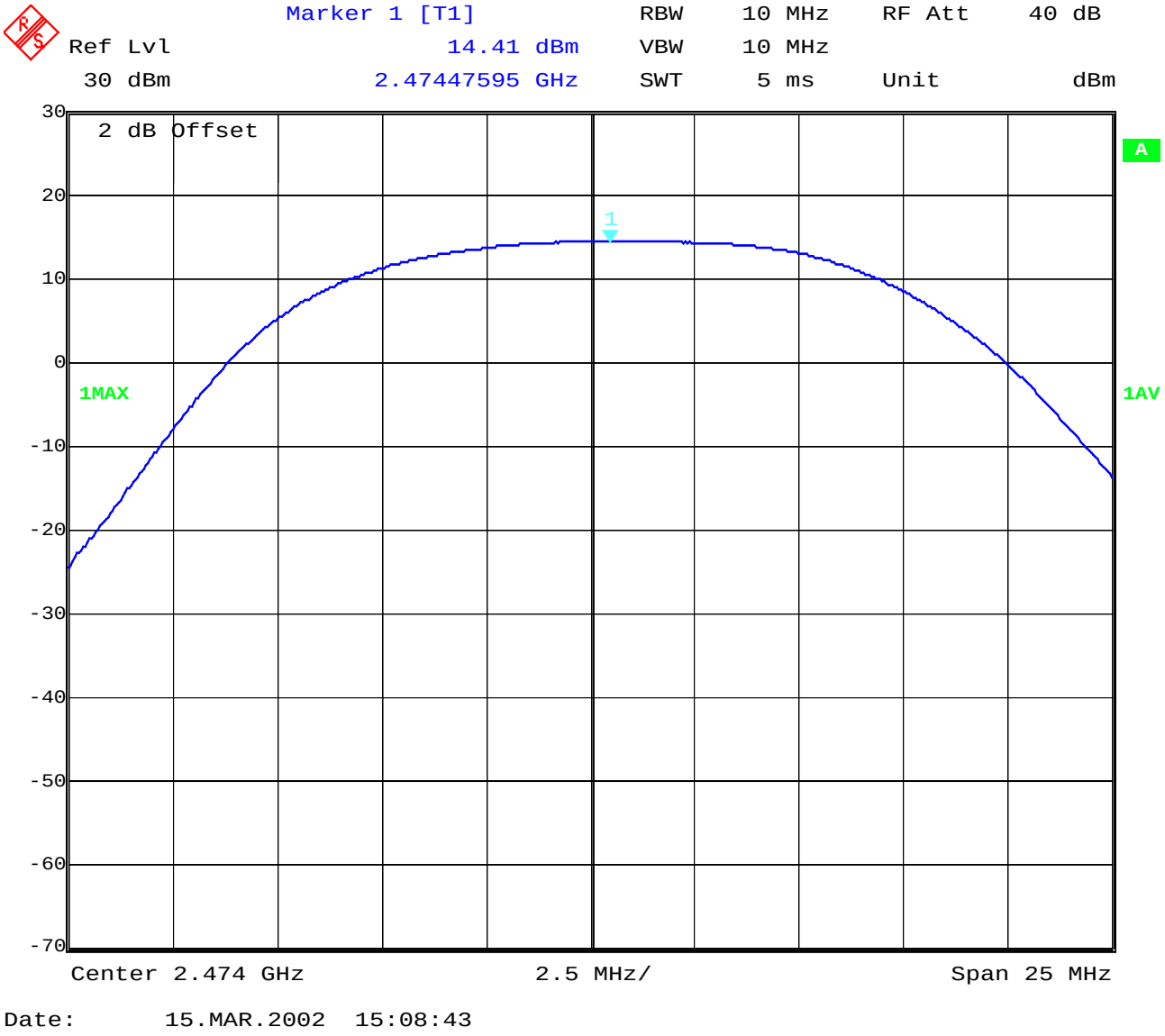
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
MAXIMUM PEAK OUTPUT POWER (CONDUCTED) **SUBCLAUSE § 15.247 (b) (1)**

high channel peak



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
MAXIMUM PEAK OUTPUT POWER (CONDUCTED) **SUBCLAUSE § 15.247 (b) (1)**

high channel average



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

MAXIMUM PEAK OUTPUT POWER (RADIATED) **SUBCLAUSE § 15.247 (b) (1)**

TEST CONDITIONS		MAXIMUM PEAK OUTPUT POWER (mW)		
Frequency (MHz)		2408.5 MHz	2439.5 MHz	2474.0 MHz
T_{nom}(25)°C	V_{nom}(115)V	19.80 dBm 95.5 mW	19.91 dBm 97.9 mW	19.90 dBm 97.7 mW
Maximum deviation from output power under extreme test conditions (dBc)		n.a.	n.a.	n.a.
Measurement uncertainty		±3dB		

RBW/VBW : 10 MHz

Measured at a distance of 3m

LIMIT **SUBCLAUSE § 15.247 (b) (1)**

Frequency range	RF power output
2400-2483.5 MHz	1.0 Watt

REFERENCE NUMBER(S) OF TEST EQUIPMENT USED
(for reference numbers see test equipment listing)
17 - 24

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Power spectral density **§15.247 (d)**

TEST CONDITIONS		RF POWER LEVEL IN 3 kHz BW		
Frequency (MHz)		2408.5	2439.5	2474.0
T_{nom}(25)°C	V_{nom}(115)V	-4.45 dBm	-4.36 dBm	-3.86 dBm
Maximum deviation from output power under extreme test conditions (dBc)				
Measurement uncertainty		±3dB		

The measurement was performed with the power density funktion of the analyzer. The readout is related to 1 Hz BW. For 3 kHz BW we have to add 34.8 dB.

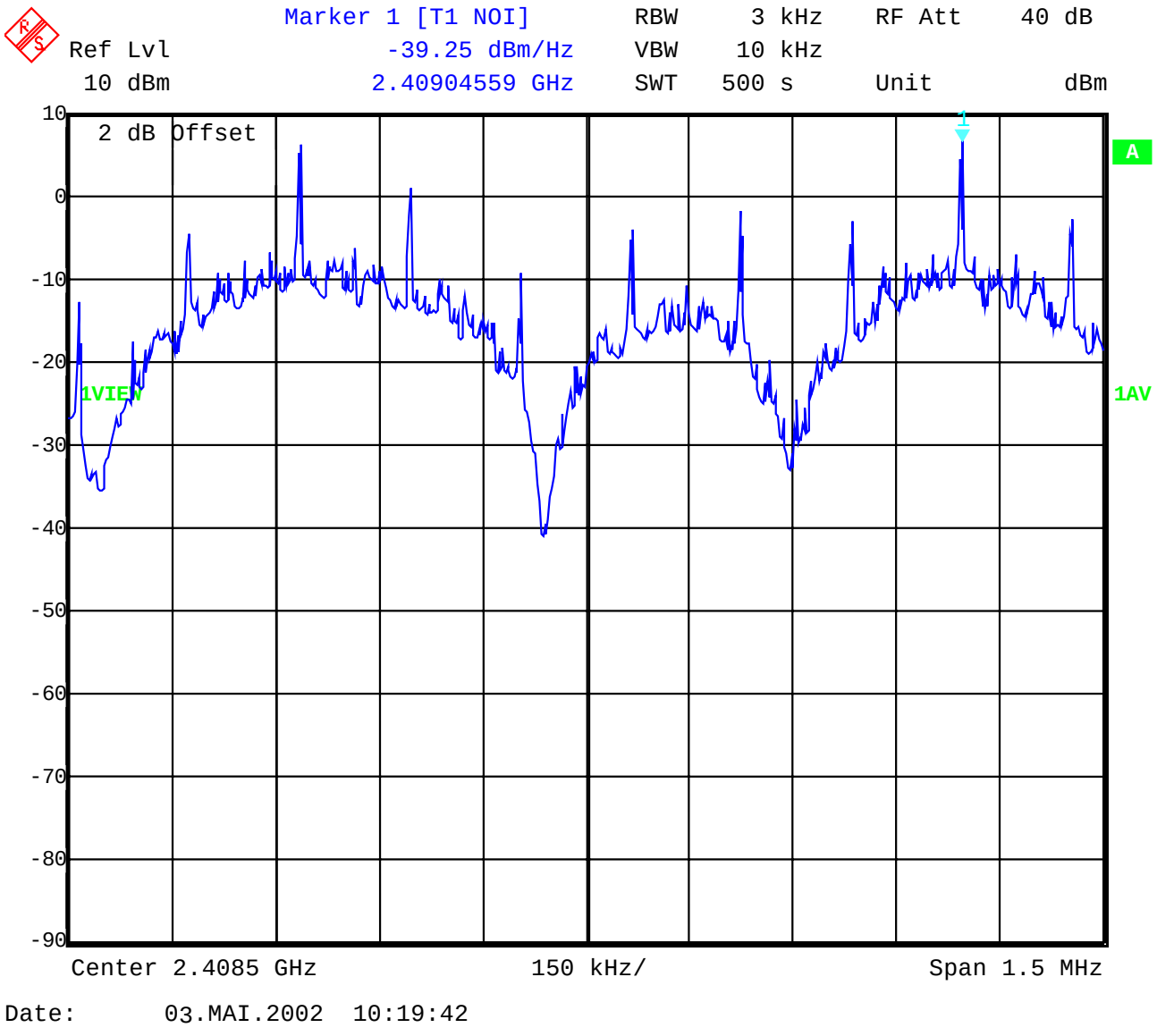
LIMIT **SUBCLAUSE §15.247(d)**

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band

REFERENCE NUMBER(S) OF TEST EQUIPMENT USED
(for reference numbers see test equipment listing)
17 - 24

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

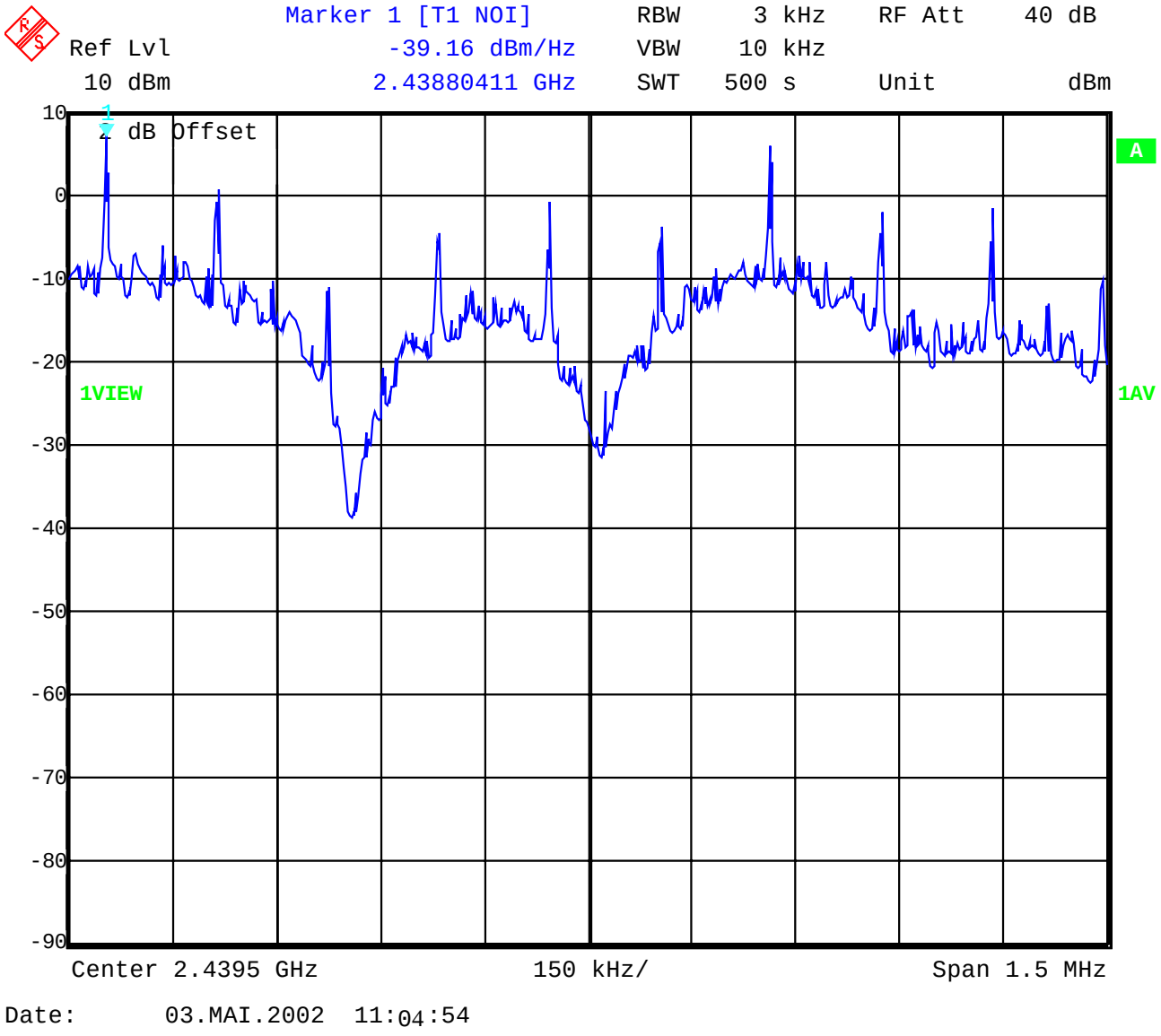
POWER SPECTRAL DENSITY **SUBCLAUSE § 15.247 (d)**
2408.5 MHz



LIMIT **SUBCLAUSE §15.247(d)**

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
POWER SPECTRAL DENSITY **SUBCLAUSE § 15.247 (d)**
2439.5 MHz

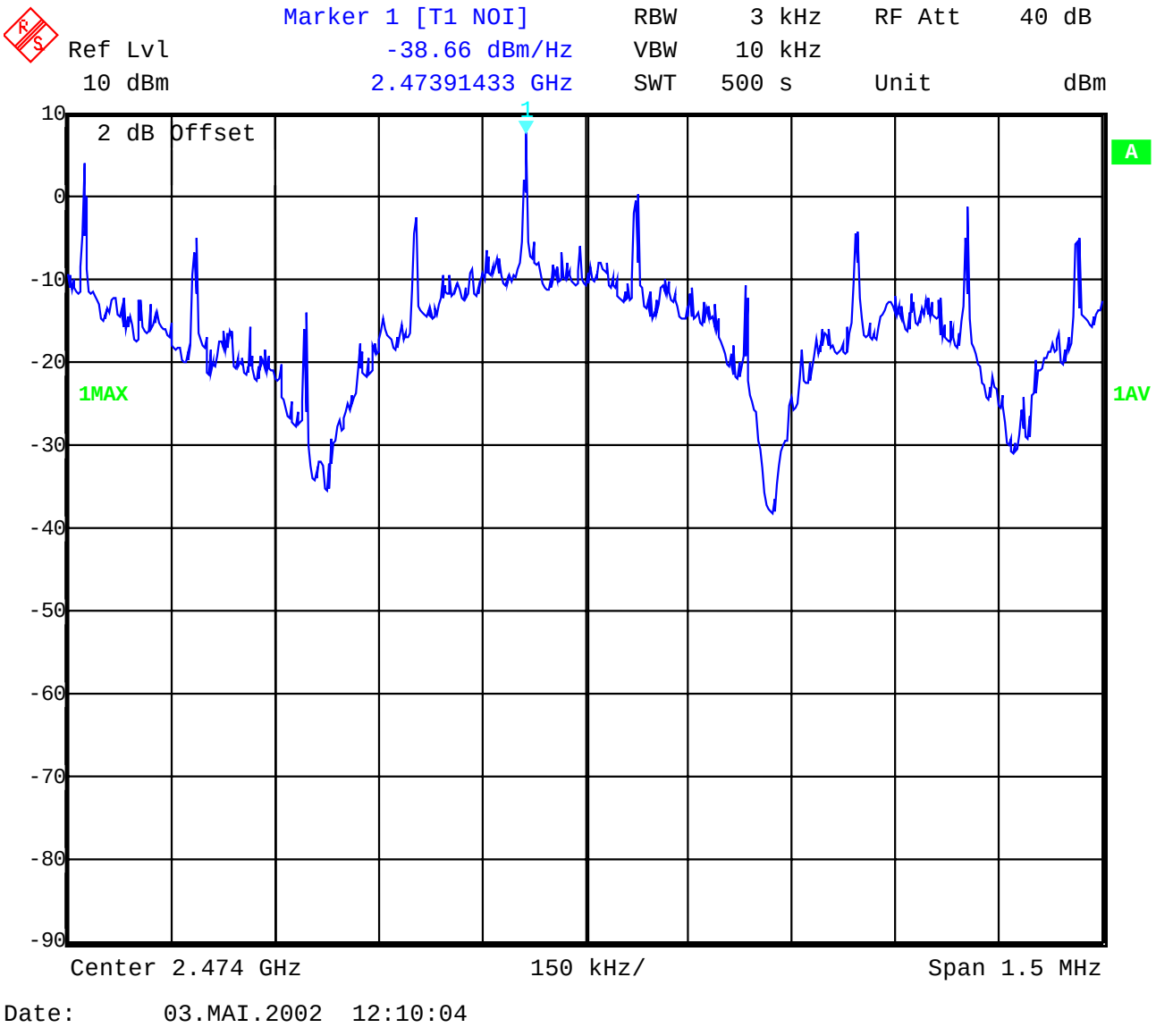


LIMIT **SUBCLAUSE §15.247(d)**

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

POWER SPECTRAL DENSITY **SUBCLAUSE § 15.247 (d)**
2474 MHz



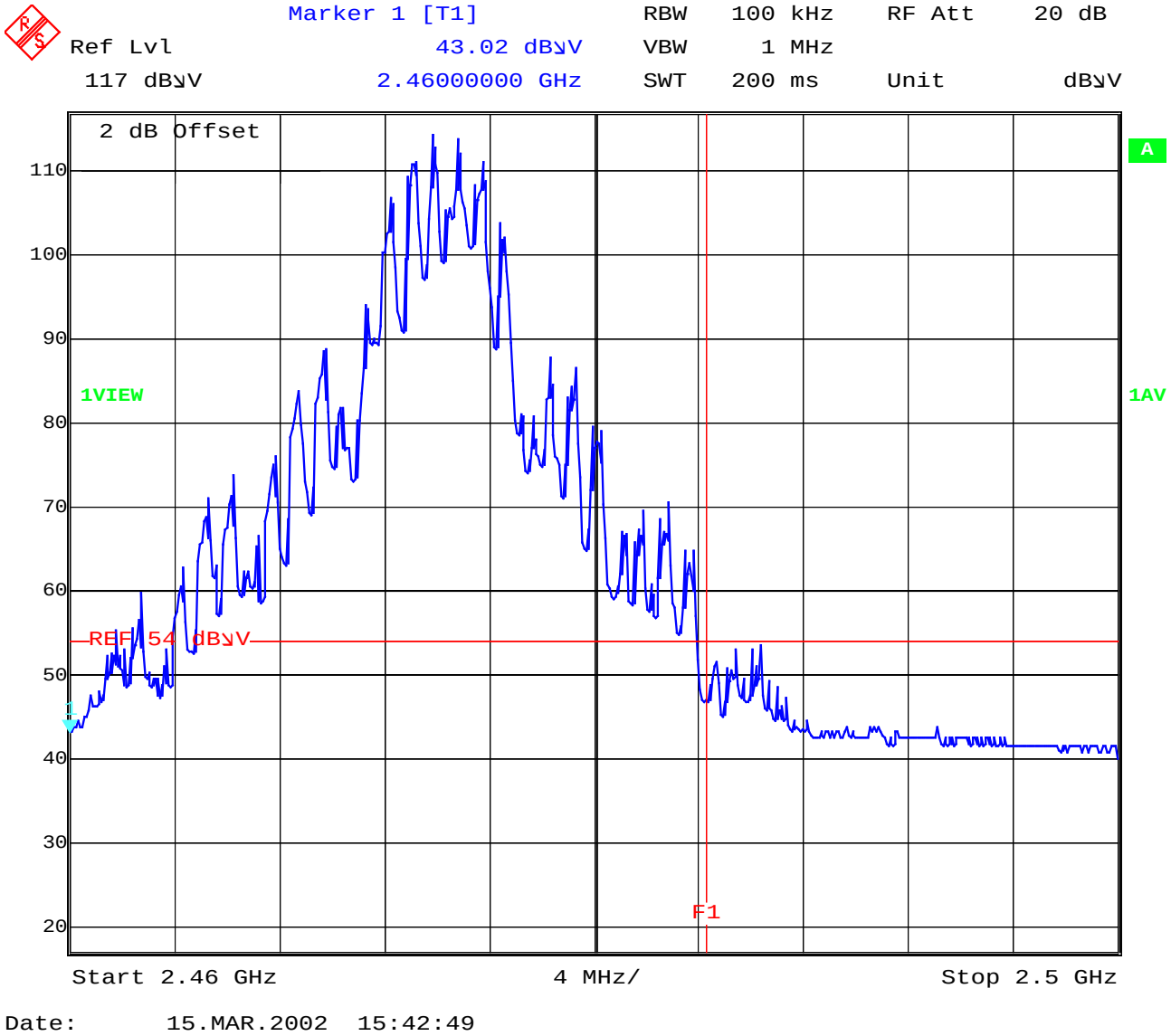
LIMIT **SUBCLAUSE §15.247(d)**

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Band-edge compliance of conducted emissions **§15.247 (c)**

high channel

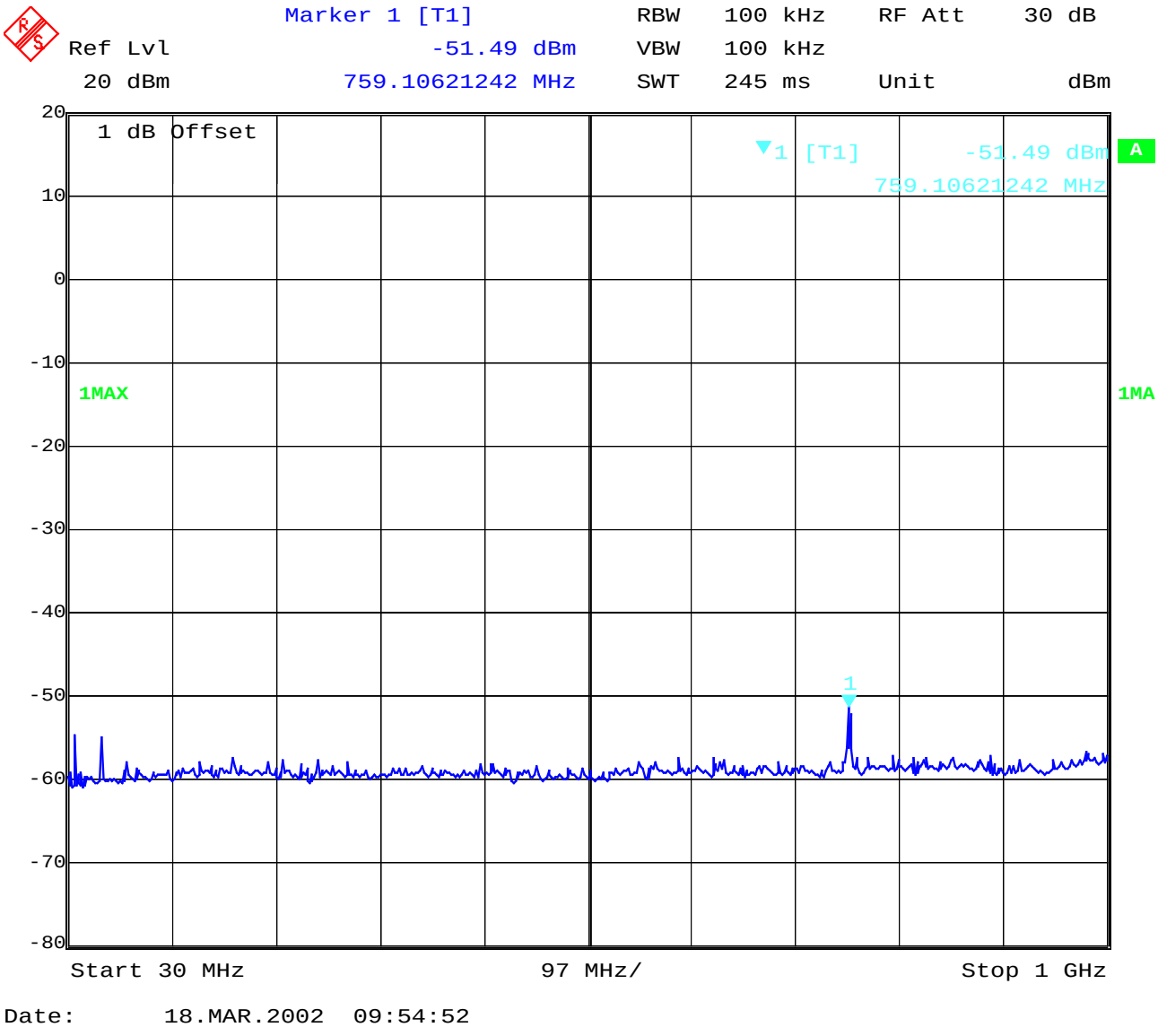


Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

SPURIOUS EMISSION LIMITATION **§ 15.247 (c) (1)**
CONDUCTED

All unwanted conducted emissions are << 20 dBc.

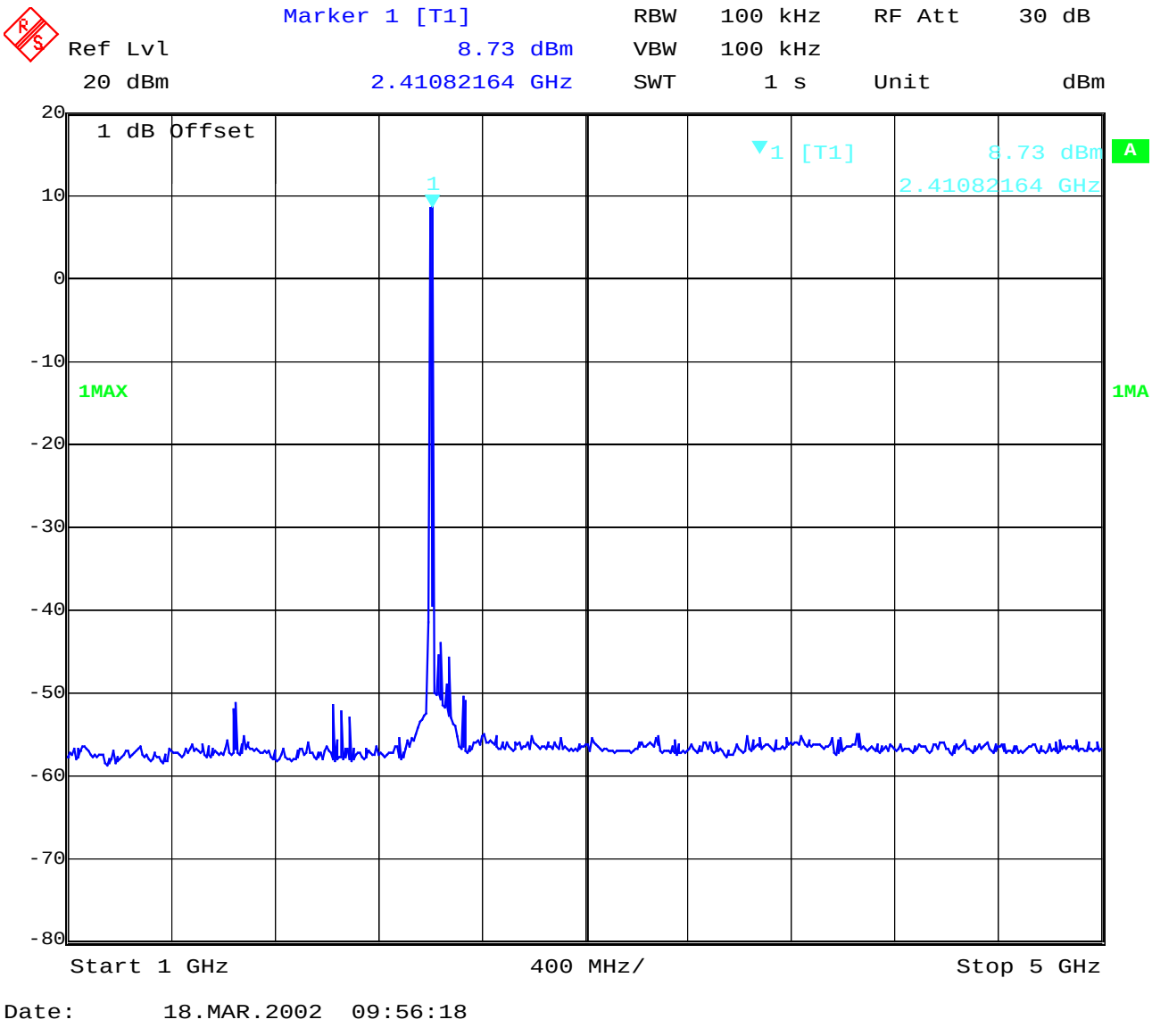
Low channel



The ref level is set to 20 dBm, that is the output of the card at nominal frequency.

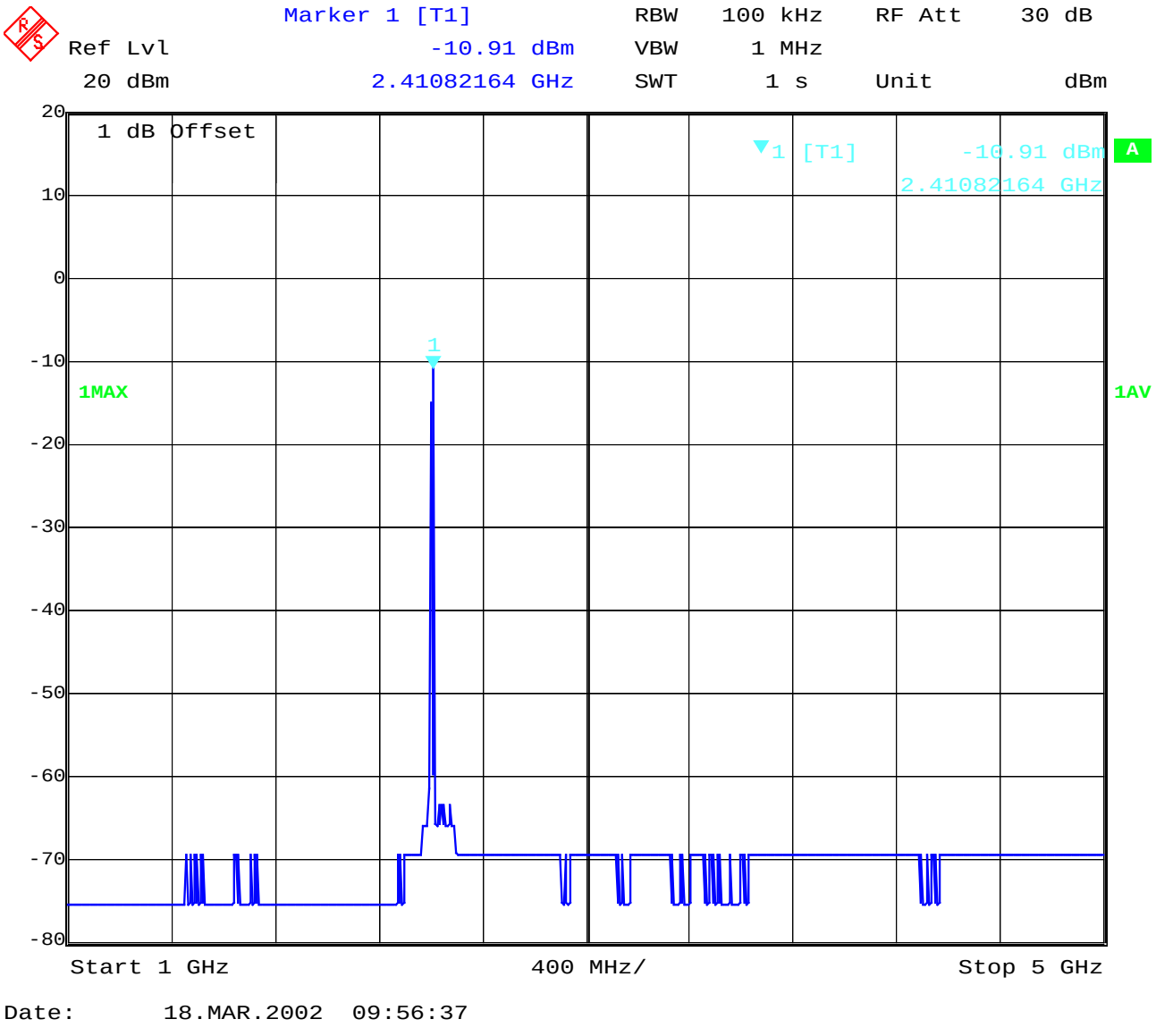
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

Low channel (peak)



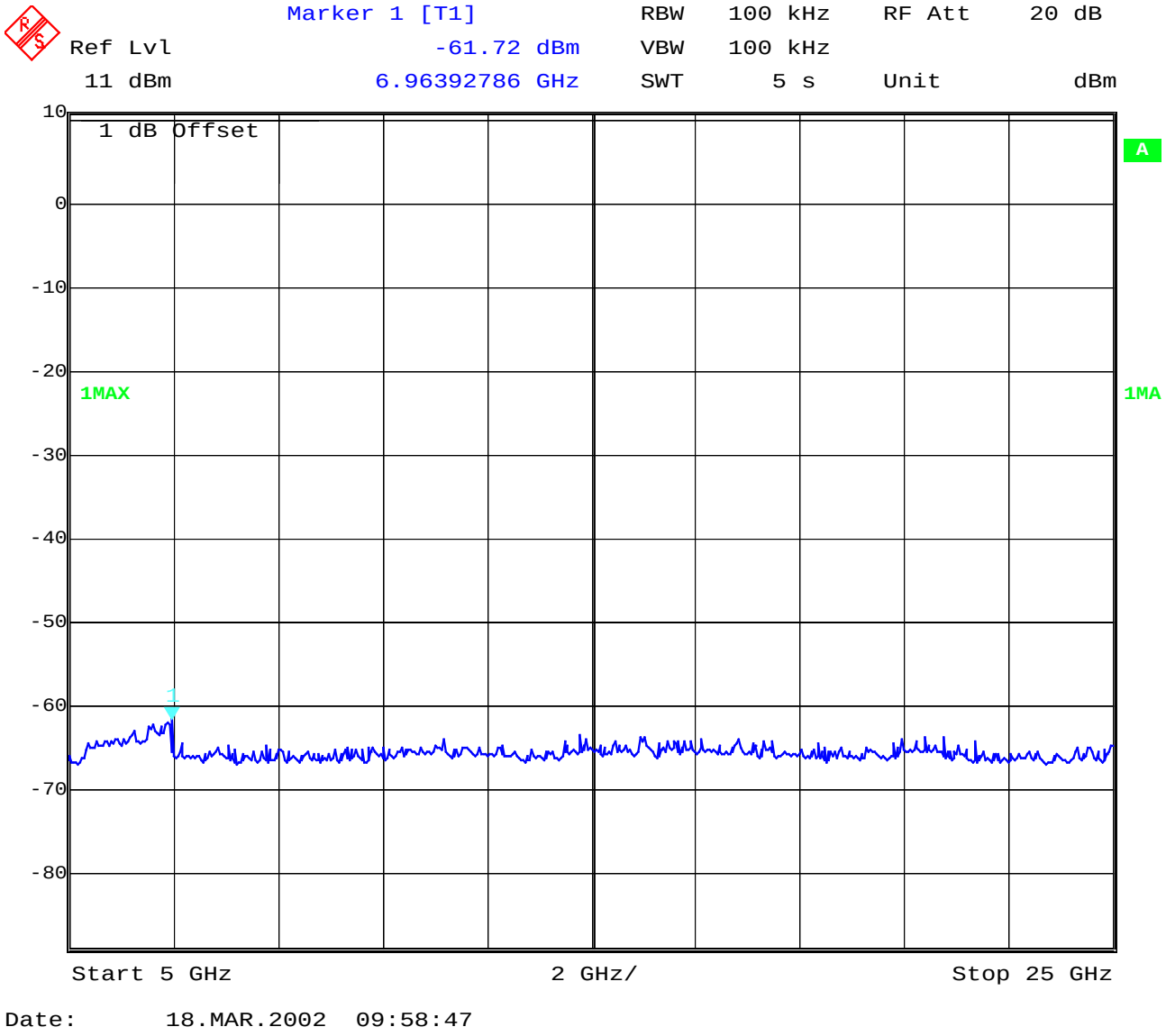
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

Low channel (average)



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

Low channel (peak)



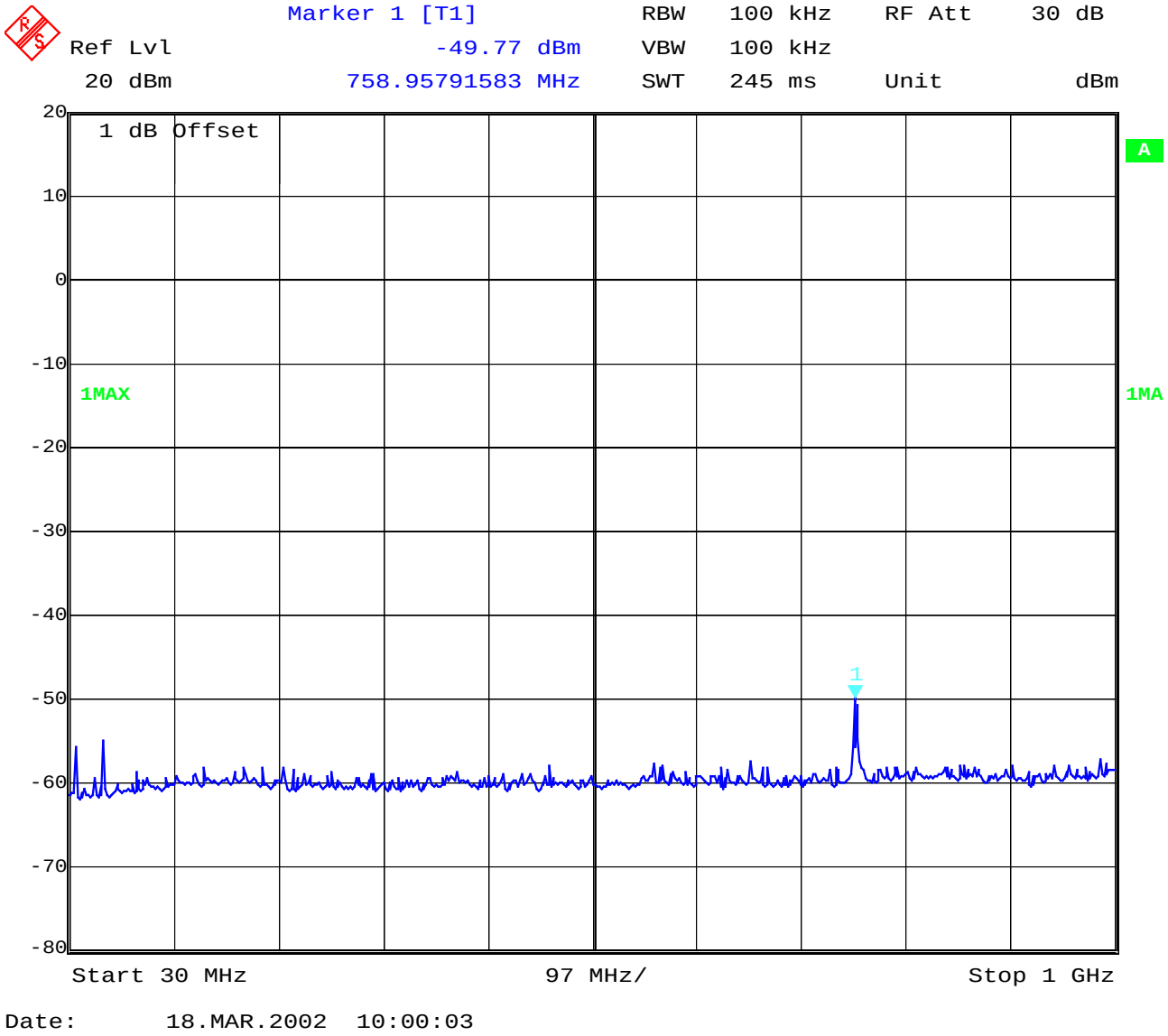
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

Low channel (average)

Date: 18.MAR.2002 09:57:50

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

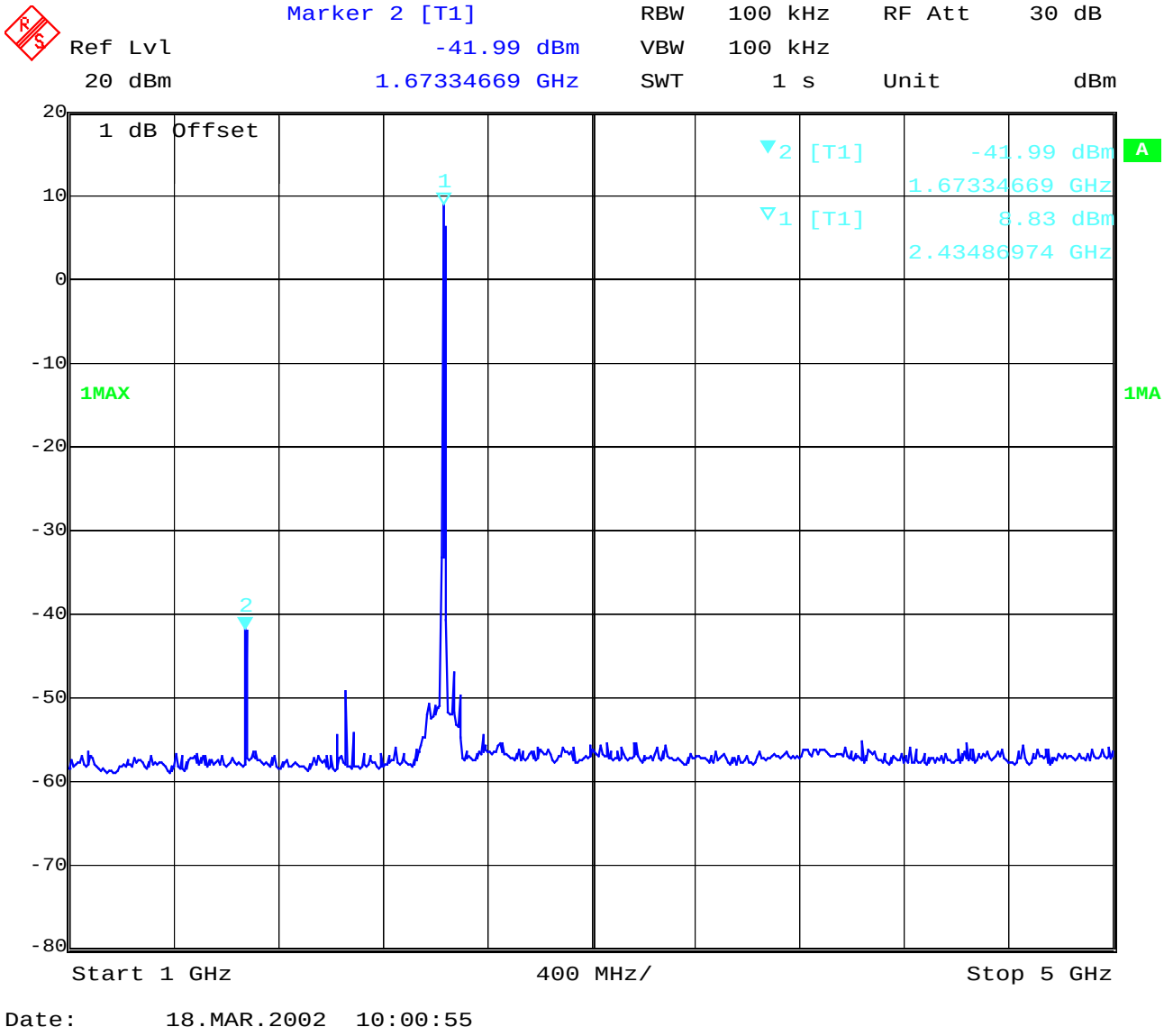
Mid channel



The ref level is set to 20 dBm, that is the output of the card at nominal frequency.

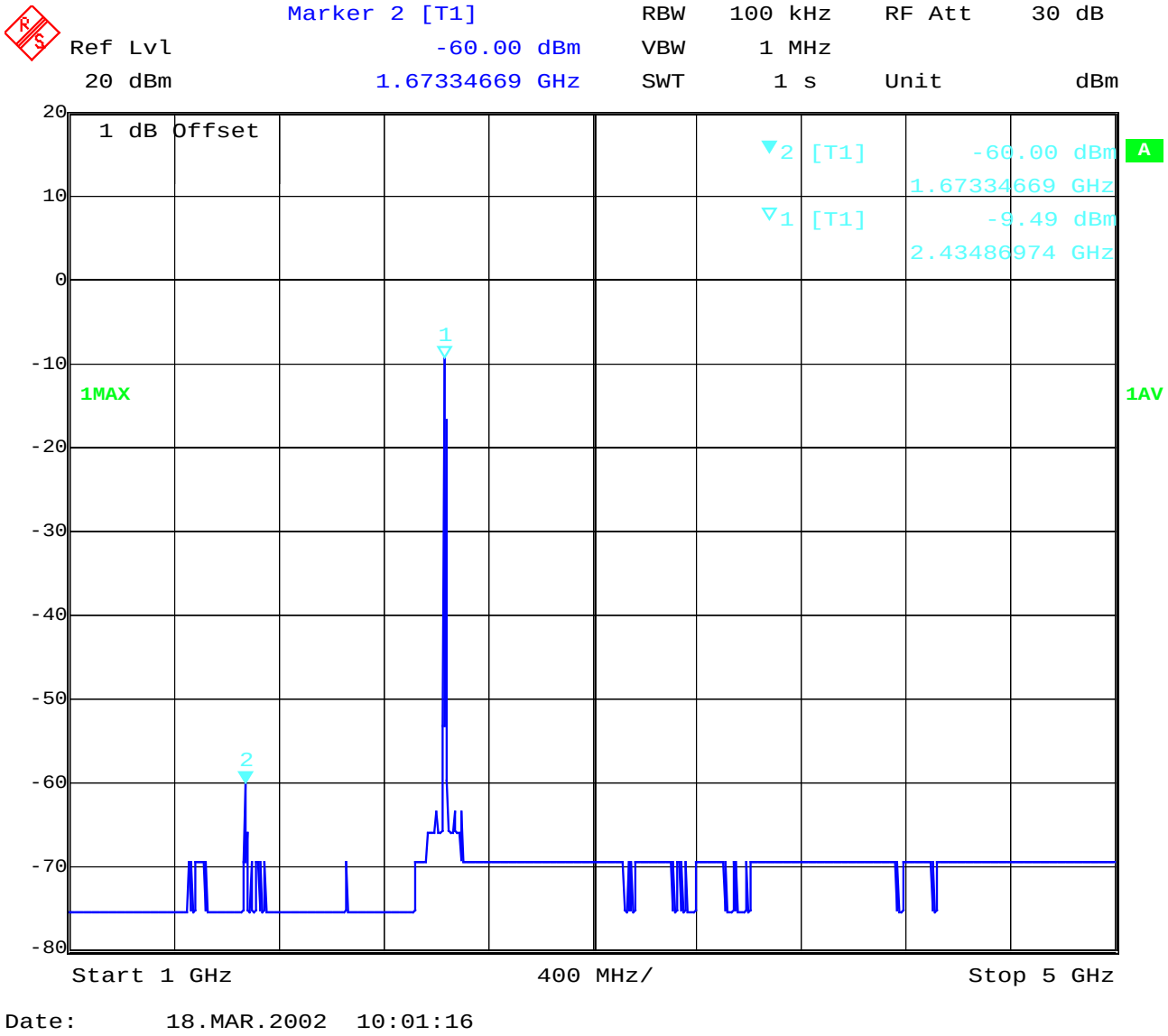
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

Mid channel (peak)



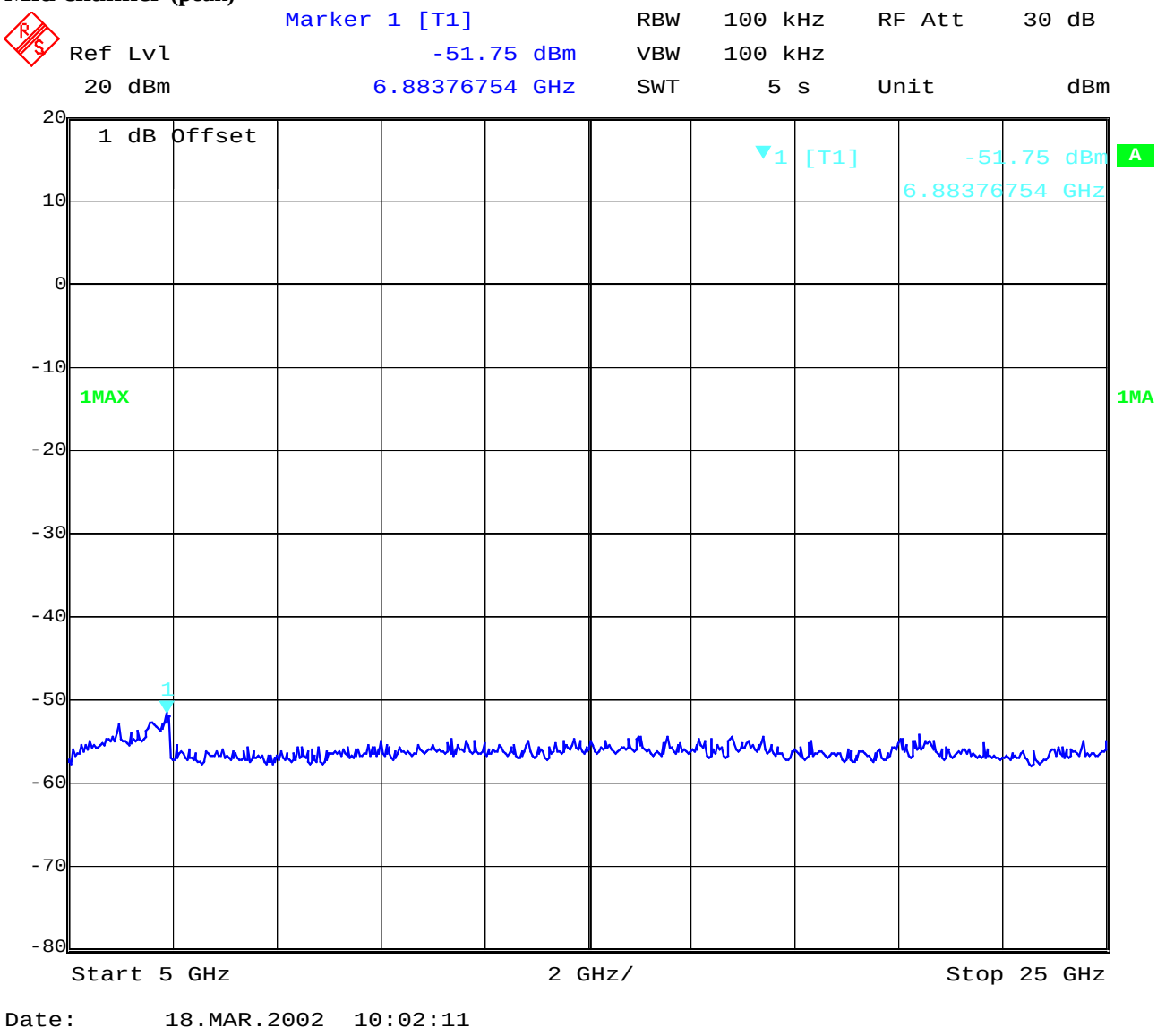
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

Mid channel (average)



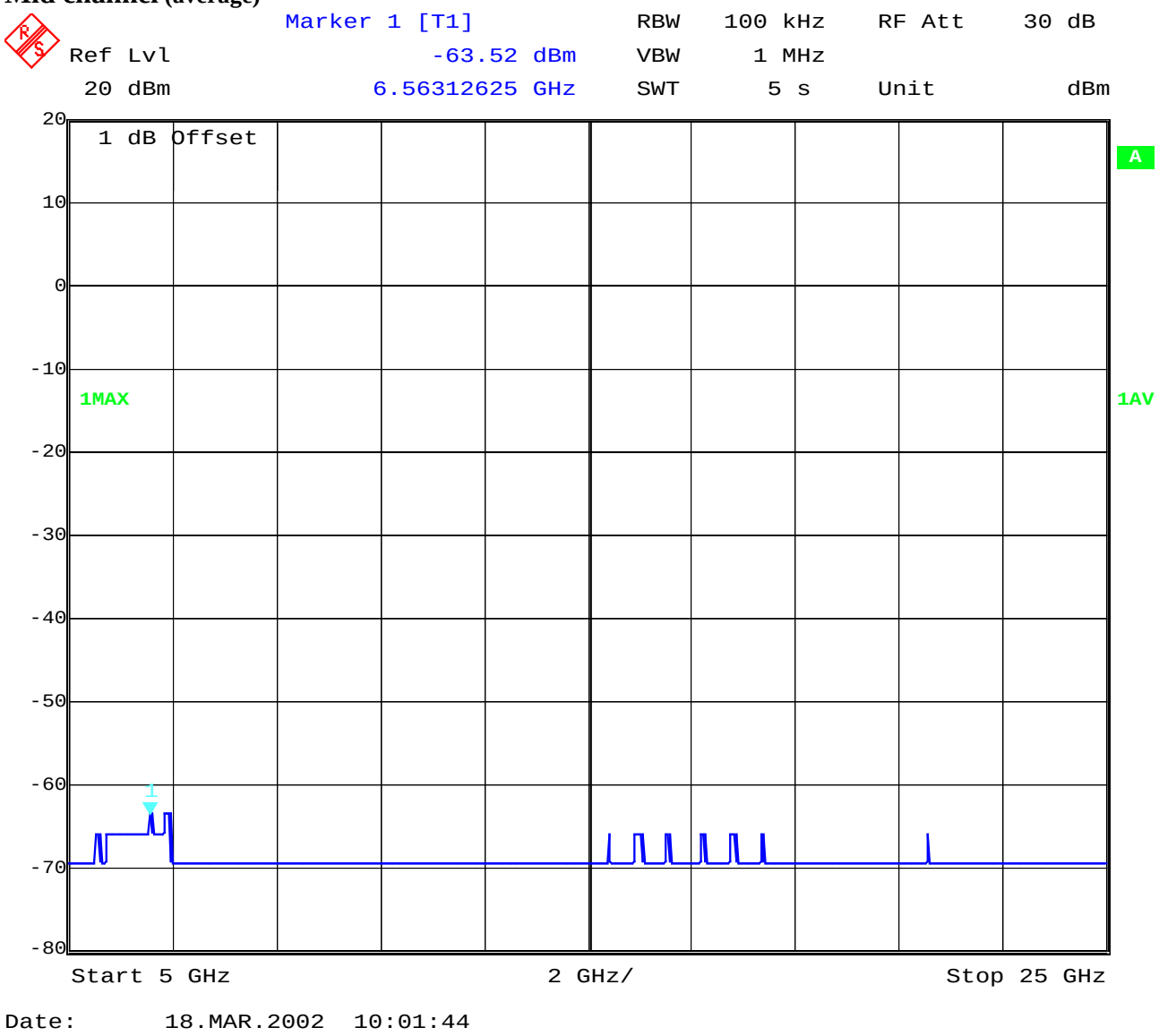
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

Mid channel (peak)



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

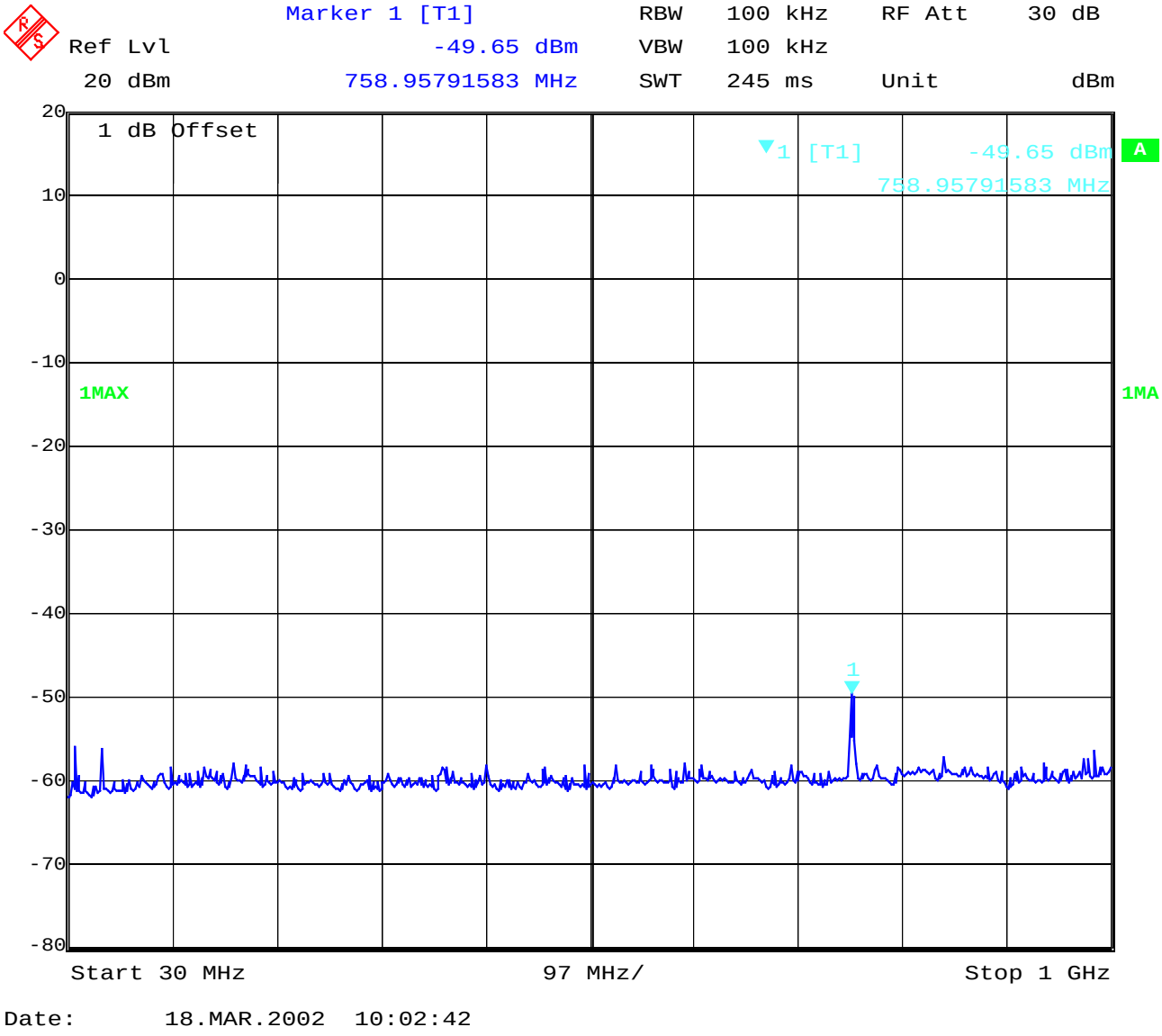
Mid channel (average)



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

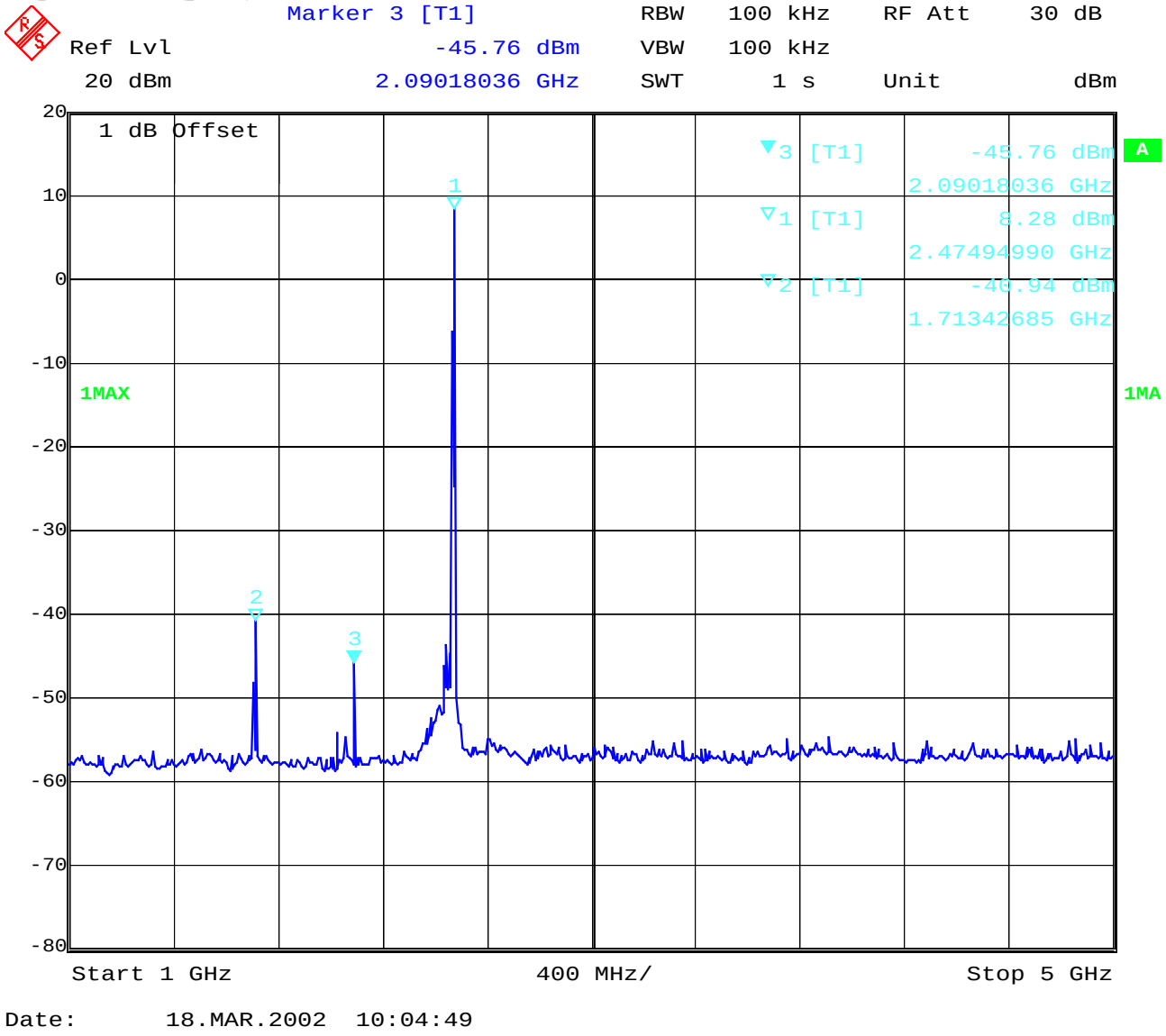
SPURIOUS EMISSION CONDUCTED **§ 15.247 (c) (1)**

High channel



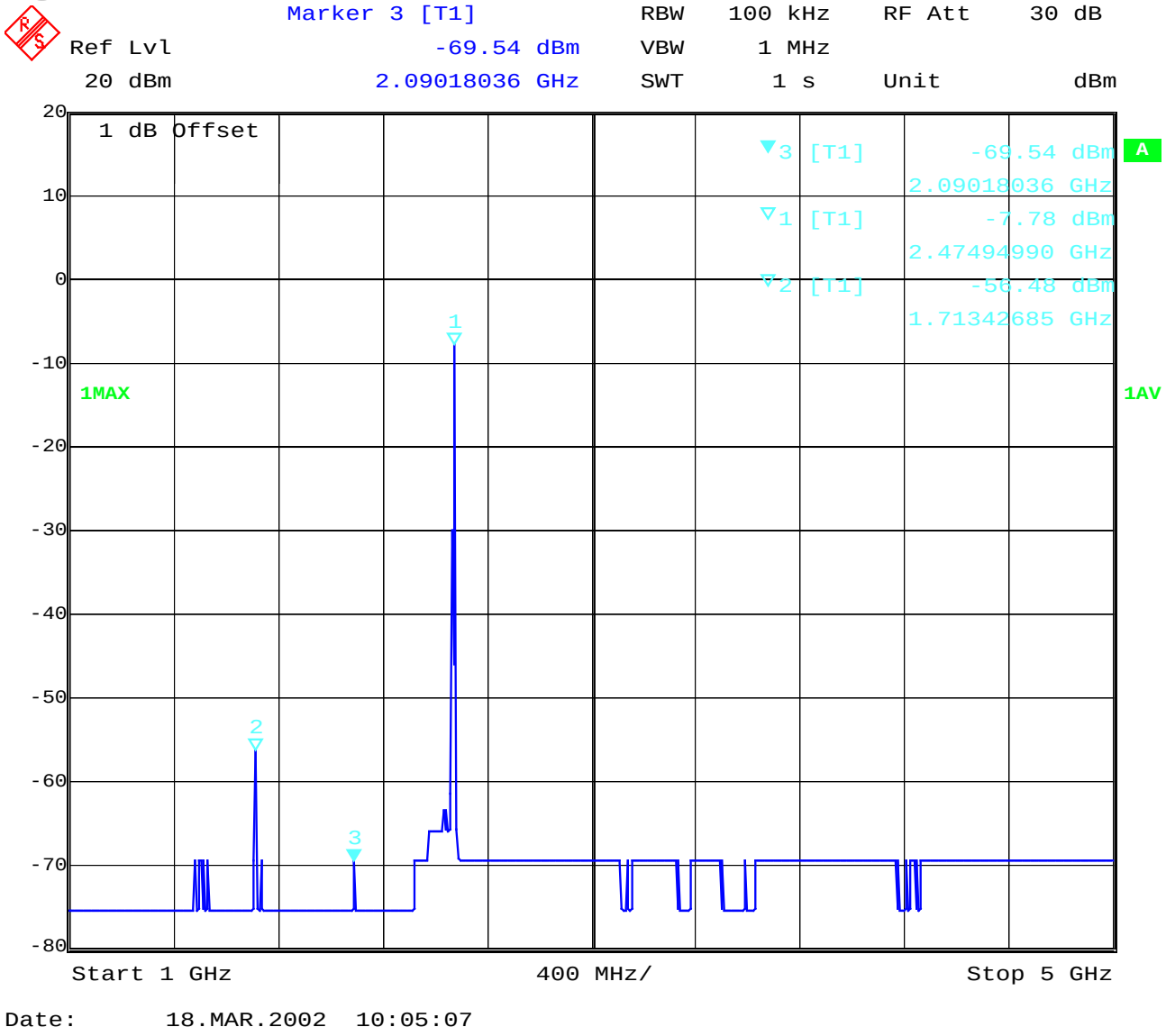
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

High channel (peak)



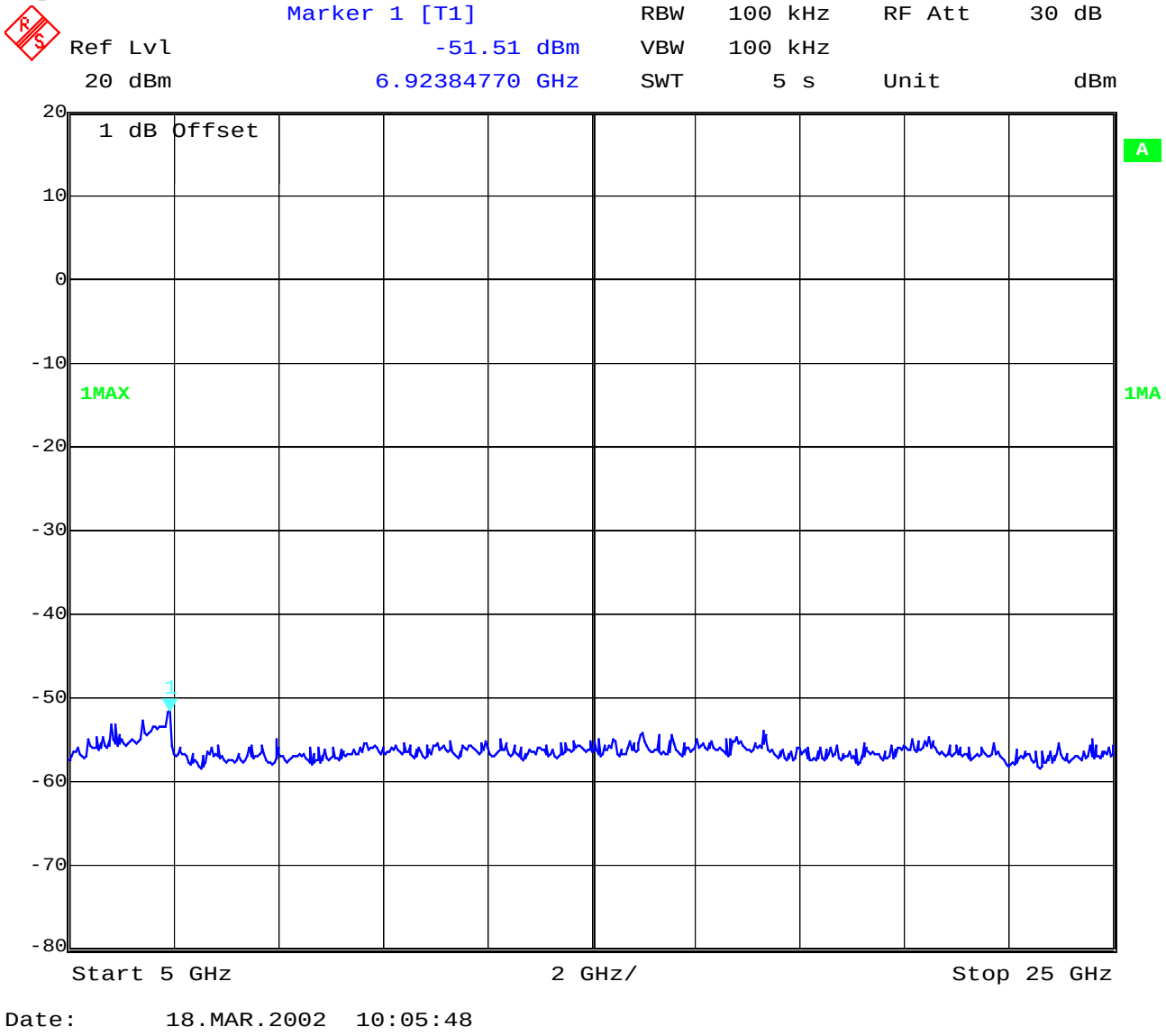
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

High channel (average)



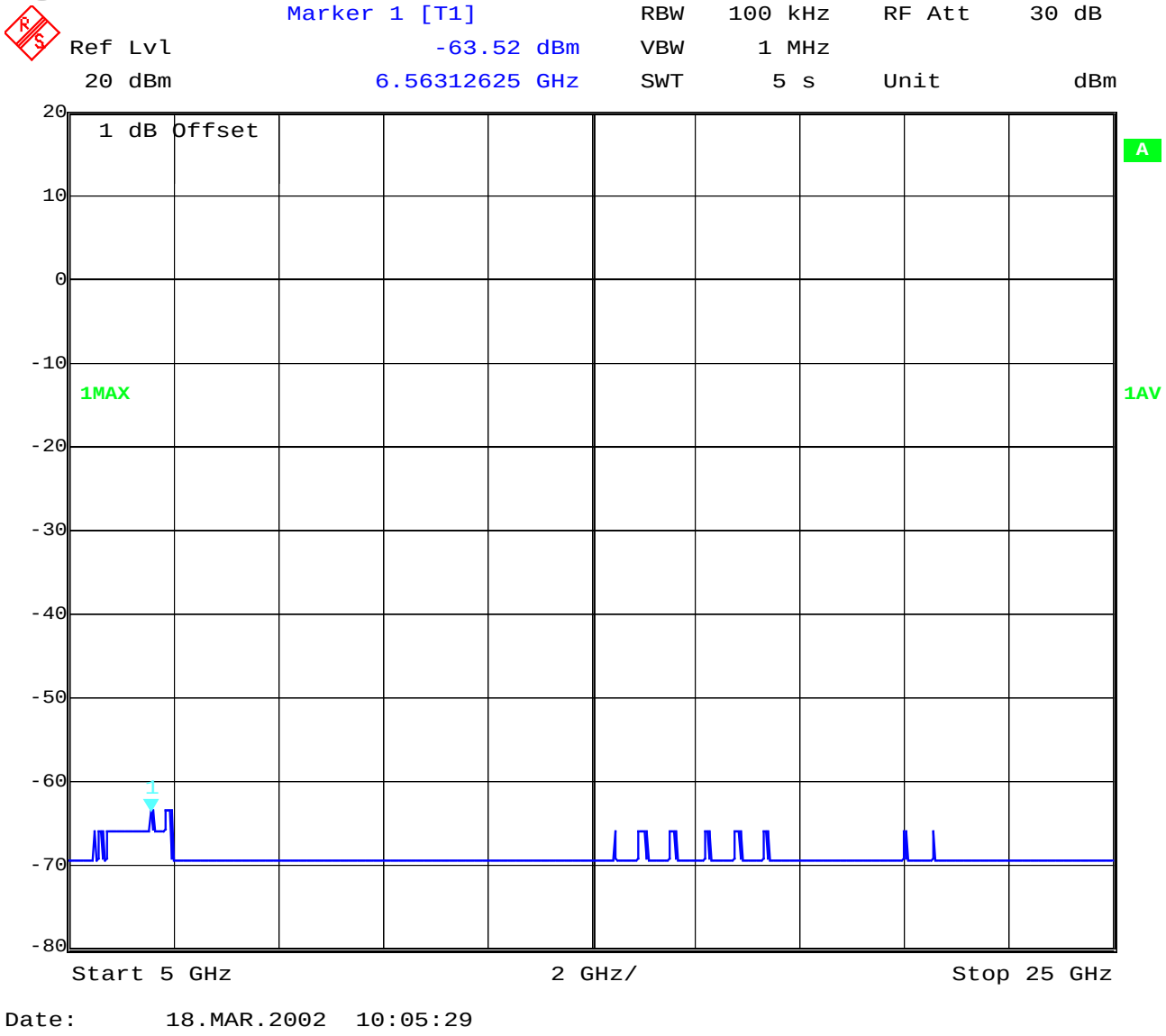
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

High channel (peak)



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION **§ 15.247 (c) (1)**
CONDUCTED

High channel (average)



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

SPURIOUS EMISSION (radiated) § 15.247 (c) (1)
up to 4 GHz (simultaneous transmission on low, middle and high channel)

EMISSION LIMITATIONS					
f (MHz)	polari-zation	amplitude of emission (dBµV/m) AVERAGE	amplitude of emission (dBµV/m) QUASI PEAK	limit max. allowed emmision power (dBµV/m)	results
low channel					
159.7	vertical		38.6	43.5	complies
184.3	vertical		37.1	43.5	complies
190.1	vertical		40.8	43.5	complies
760.6	horizontal		51.2	-20 dBc	no restr. band
1197.3	vertical	31.7		54.0	complies
1716.2	vertical	39.2		54.0	complies
1864.9	vertical	32.1		54.0	complies
mid channel					
159.7	vertical		38.6	43.5	complies
184.3	vertical			43.5	complies
190.1	vertical			43.5	complies
760.6	horizontal			46.0	complies
1197.3	vertical	31.7		54.0	complies
1716.2	vertical	39.2		54.0	complies
1864.9	vertical	32.1		54.0	complies
high channel					
159.7	vertical		38.6	43.5	complies
184.3	vertical			43.5	complies
190.1	vertical			43.5	complies
760.6	horizontal			46.0	complies
1197.3	vertical	31.7		54.0	complies
1716.2	vertical	39.2		54.0	complies
1864.9	vertical	32.1		54.0	complies
Measurement uncertainty		± 3dB			

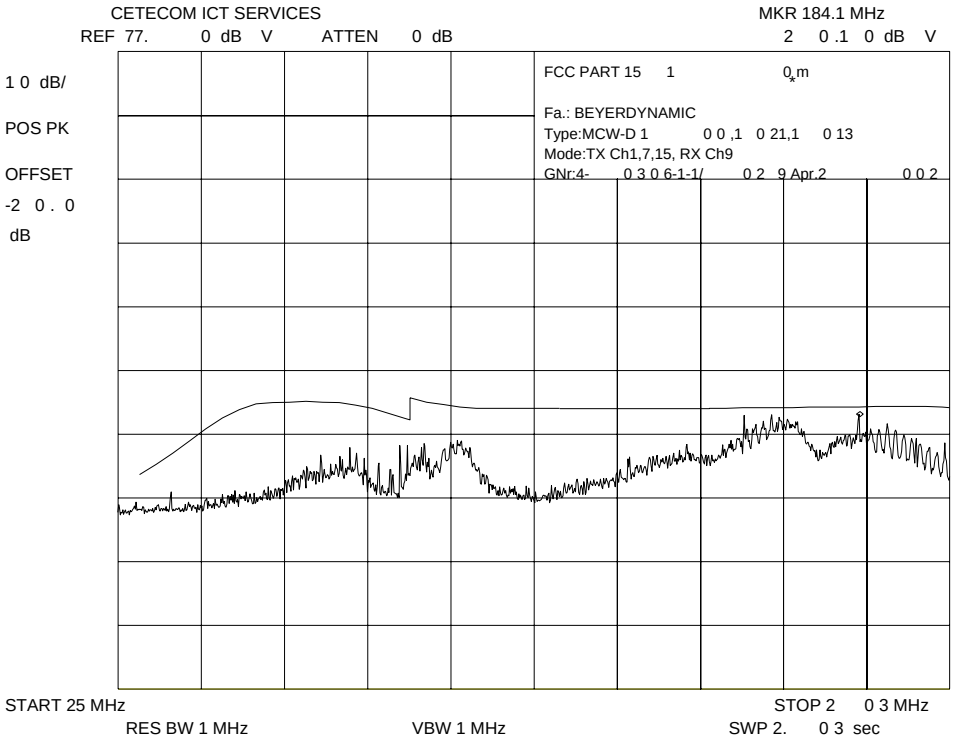
LIMITS SUBCLAUSE § 15.247 (c)

In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, 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)).

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

EMISSION LIMITATIONS- Radiated **§ 15.247 (c) (1)**

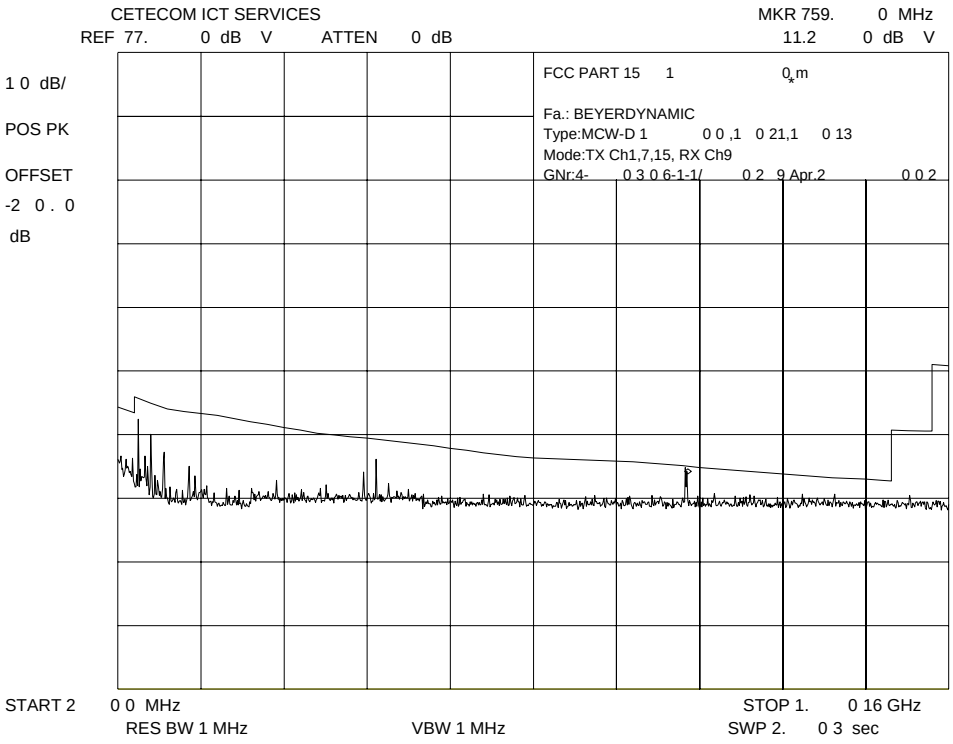
3 channels simultan up to 200 MHz.



REFERENCE NUMBER(S) OF TEST EQUIPMENT USED
(for reference numbers see test equipment listing)
17 - 24

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
EMISSION LIMITATIONS- Radiated **§ 15.247 (c) (1)**

3 channels simultan up to 1000 MHz.



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

EMISSION LIMITATIONS- Radiated § 15.247 (c) (1)

3 channels simultan up to 4 GHz, carrier suppressed by a stub tuner to avoid overstearing.

This is only a scan.
Measurements were performed by main with 100/120 kHz BW for CISPR Quasipeak below 1 GHz, above 1 GHz with 1MHz RBW/VBW at average and peak.

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
SPURIOUS EMISSION (radiated) § 15.247 (c) (1)
up to 12 GHz

EMISSION LIMITATIONS					
f (MHz)	polari-zation	amplitude of emission (dBµV/m) AVERAGE	amplitude of emission (dBµV/m) QUASI PEAK	limit max. allowed emmision power (dBµV/m)	results
valid for all 3 channels					
4815.8	vertical	47.2		54.0	complies
4879.8	vertical	40.7		54.0	complies
4950.9	vertical	40.9		54.0	complies
7218.9	vertical	27.3		54.0	complies
7314.8	vertical	27.6		54.0	complies
7420.2	vertical	29.9		54.0	complies
Measurement uncertainty		± 3dB			

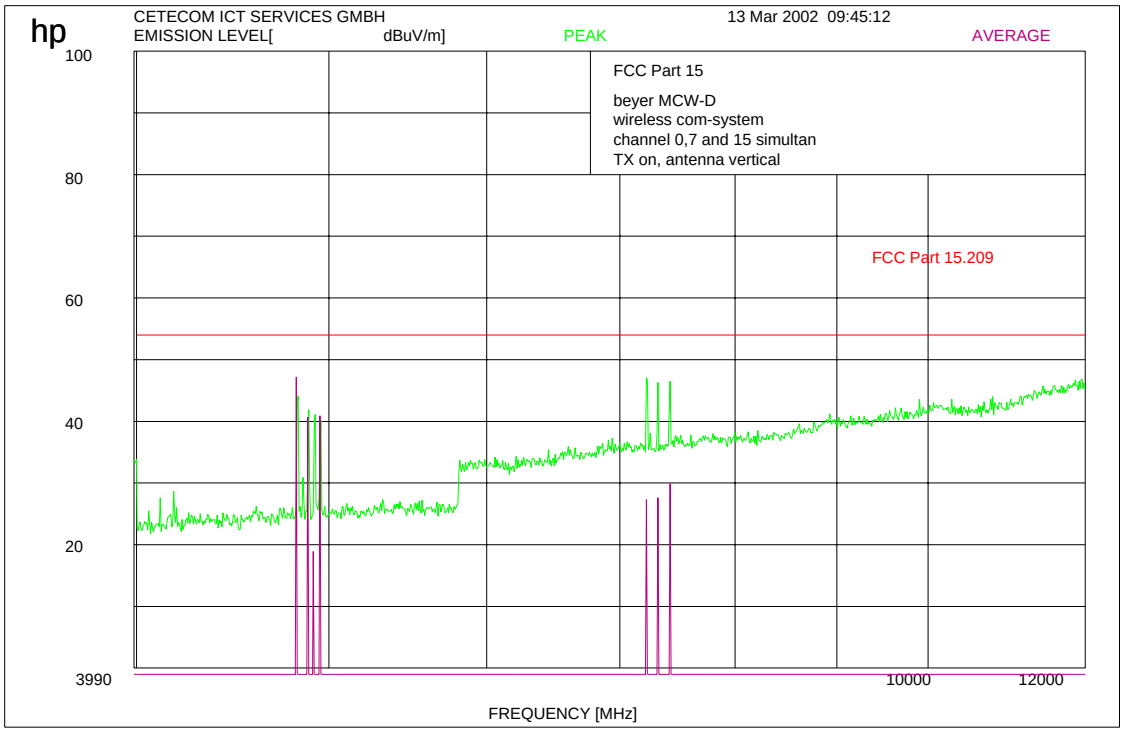
Horizontal measurements were more than 6 dB lower

LIMITS SUBCLAUSE § 15.247 (c)

In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, 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)).

EMISSION LIMITATIONS- Radiated **§ 15.247 (c) (1)**

3 channels simultan up to 12 GHz, carrier suppressed by a high pass filter to avoid overstearing.

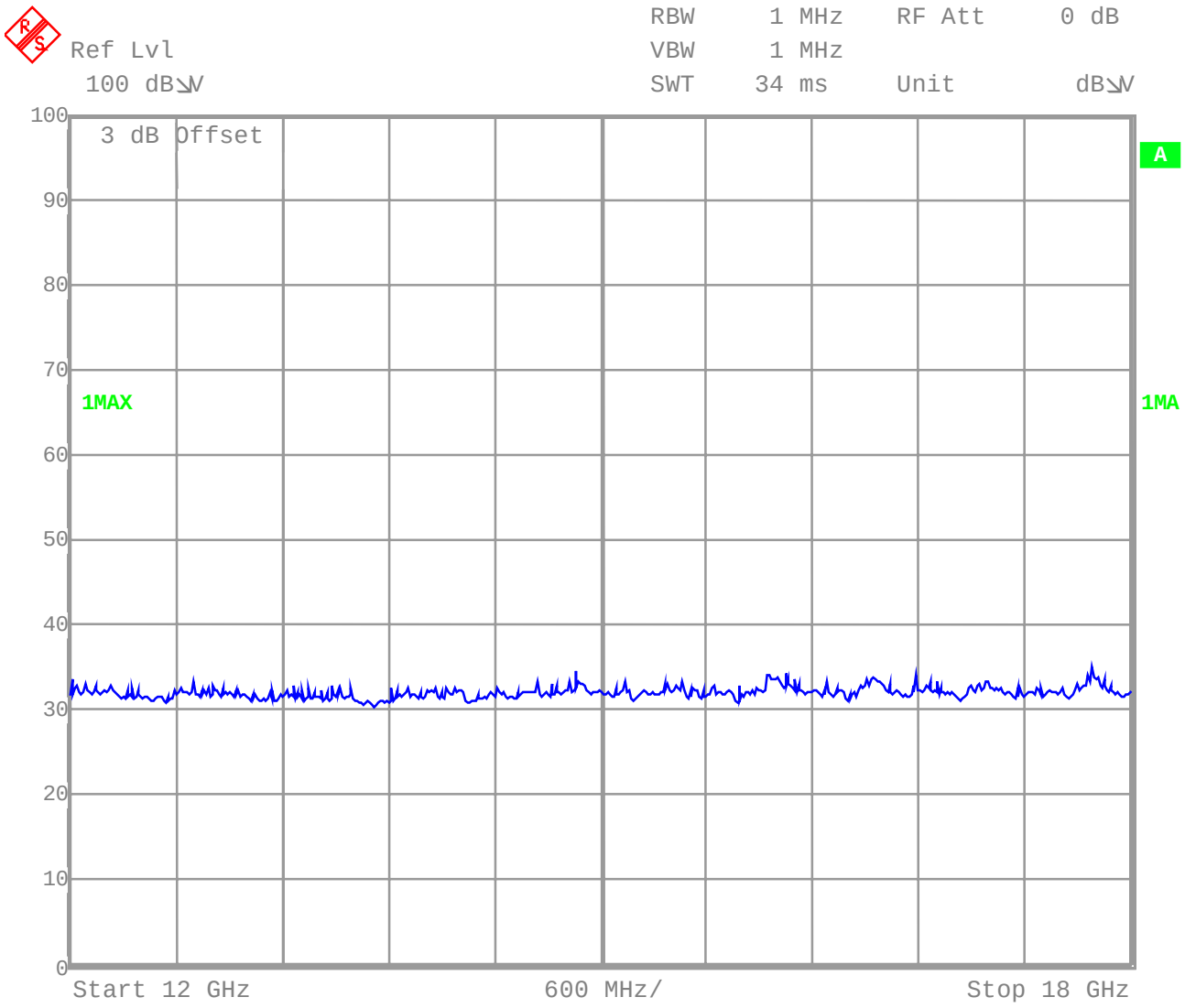


This is only a scan.
Measurements were performed by main with 100/120 kHz BW for CISPR Quasipeak below 1 GHz, with 1MHz RBW/VBW at average and peak over 1 GHz.

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

EMISSION LIMITATIONS (Transmitter) CLAUSE § 15.247 (c) (1)

Channel 1-3 (this is valid for all 3 channels)
Peak



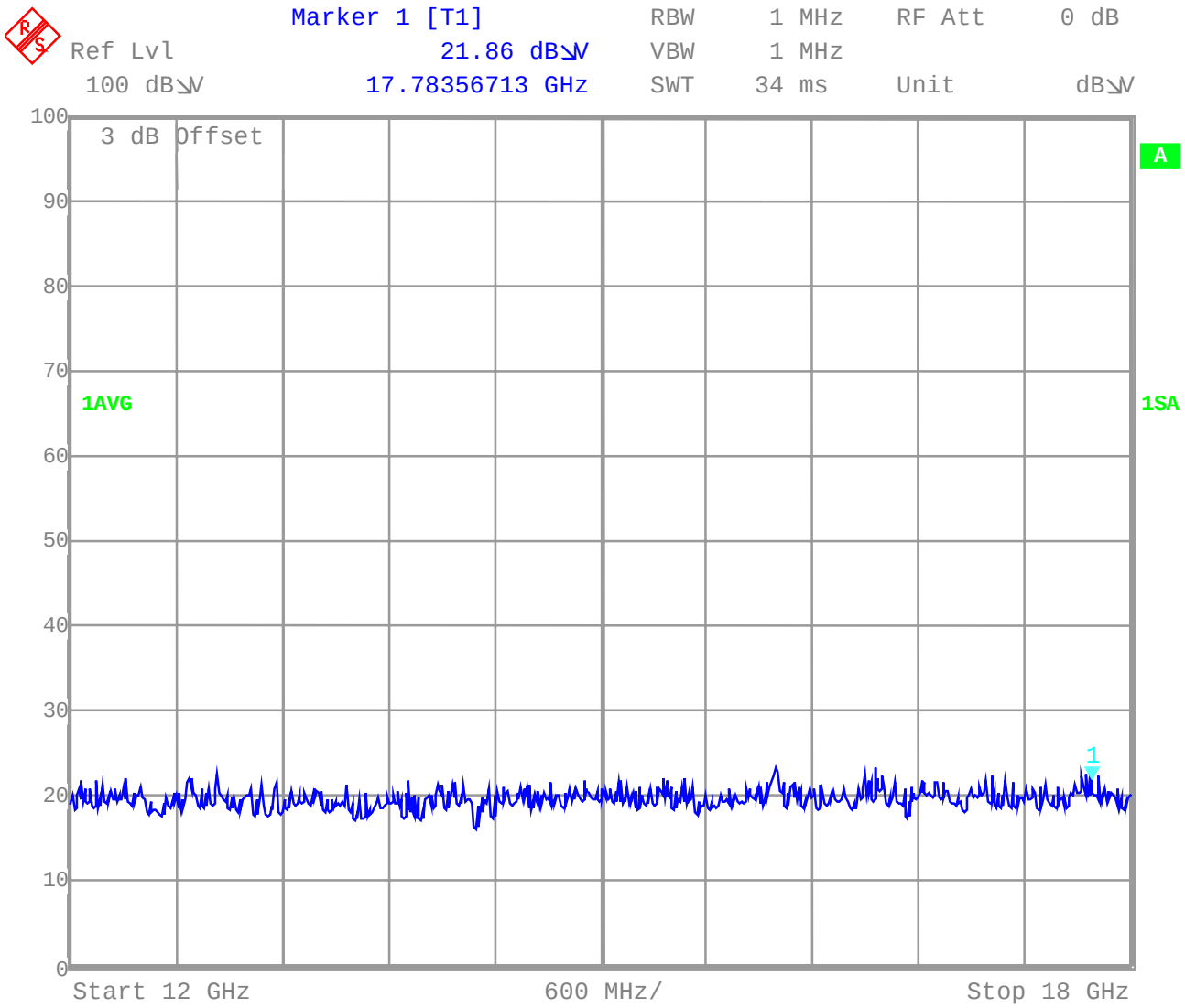
LIMITS **SUBCLAUSE § 15.247 (c)**

In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, 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)).

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

EMISSION LIMITATIONS (Transmitter) CLAUSE § 15.247 (c) (1)

Channel 1-3 (this is valid for all 3 channels)
Average

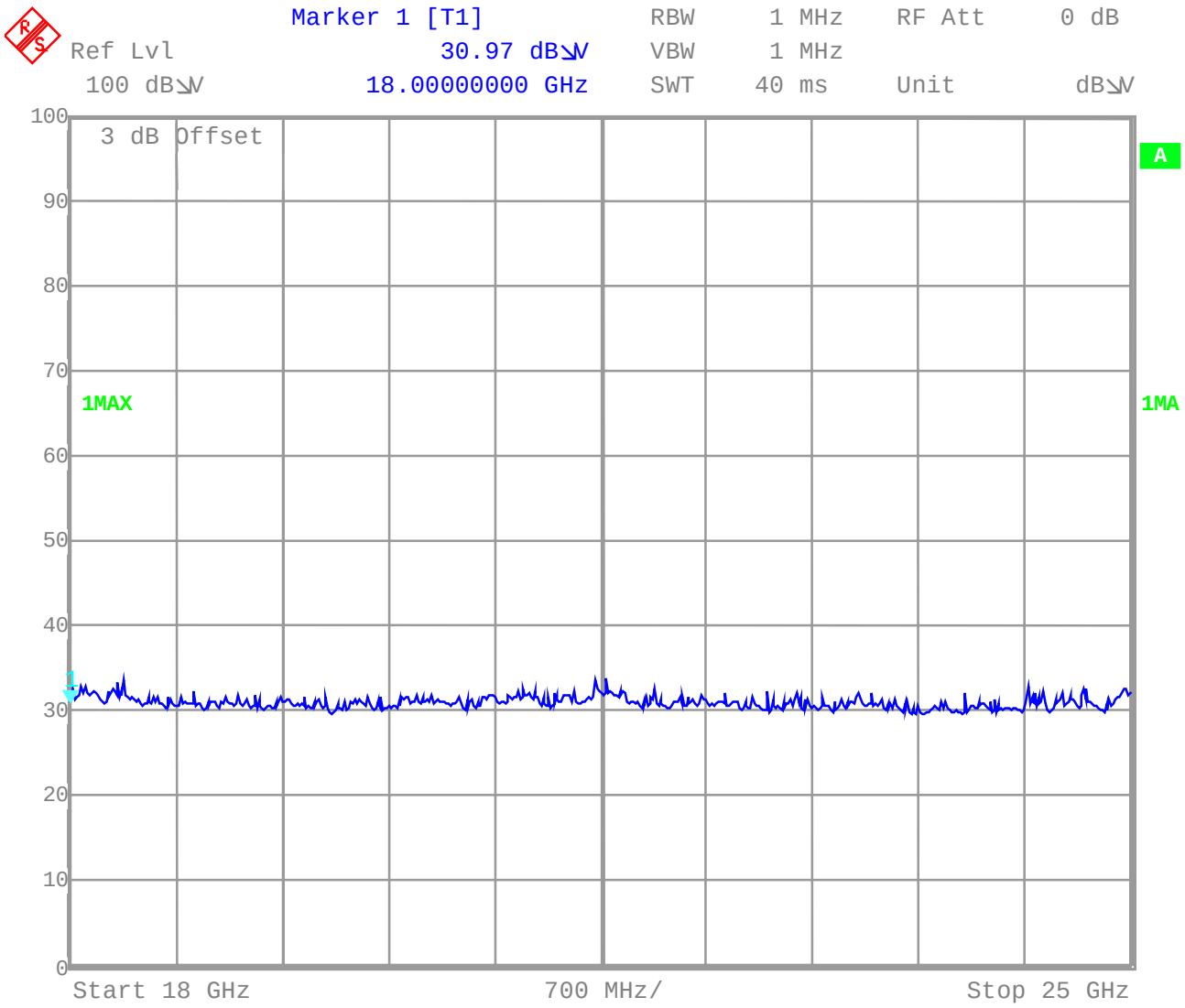


LIMITS **SUBCLAUSE § 15.247 (c)**

In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, 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)).

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%
EMISSION LIMITATIONS (Transmitter) CLAUSE § 15.247 (c) (1)

Channel 1-3 (this is valid for all 3 channels)
Peak



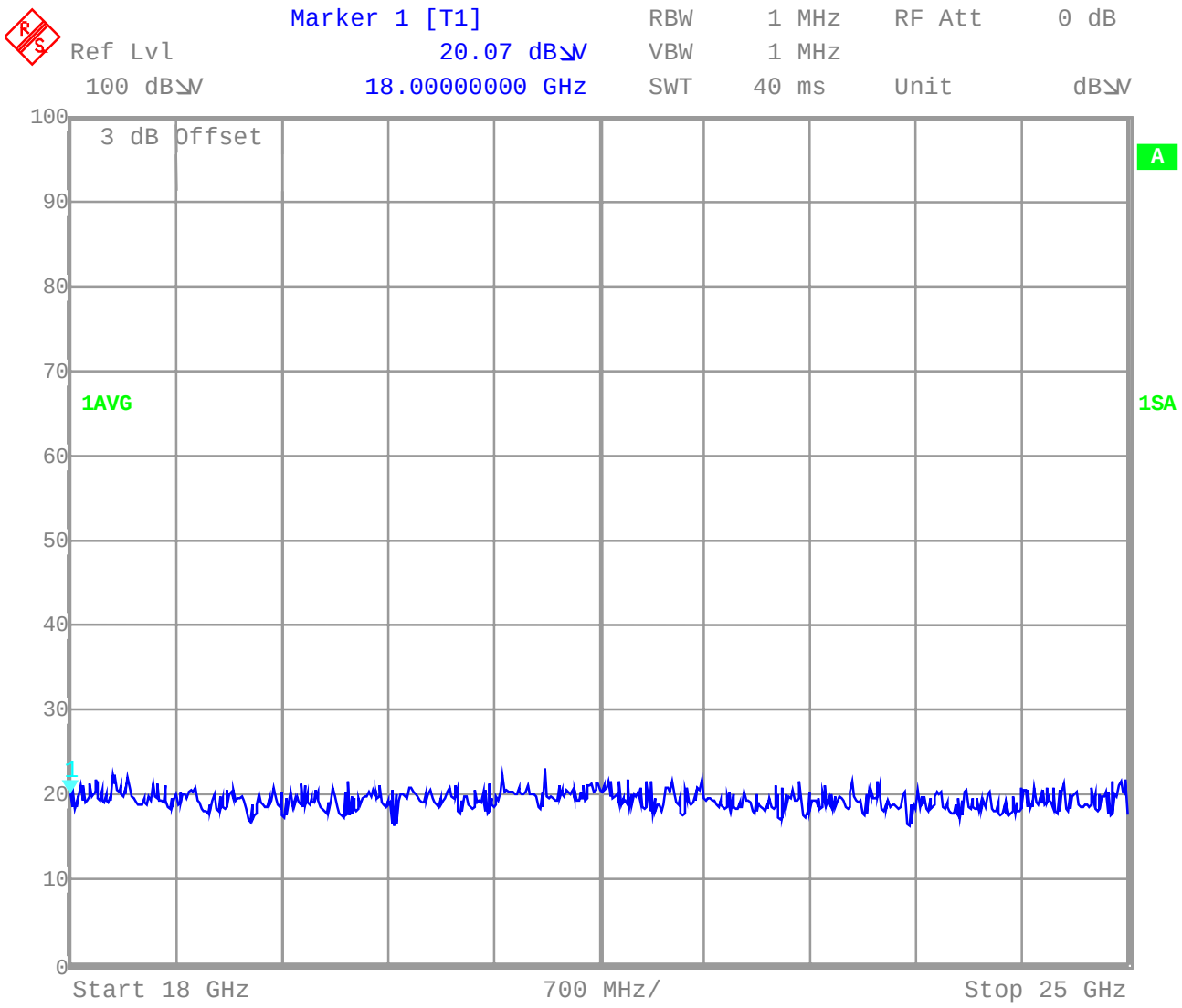
LIMITS **SUBCLAUSE § 15.247 (c)**

In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, 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)).

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

EMISSION LIMITATIONS (Transmitter) CLAUSE § 15.247 (c) (1)

Channel 1-3 (this is valid for all 3 channels)
Average



LIMITS **SUBCLAUSE § 15.247 (c)**

In any 100 kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, 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)).

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

PROCESSING GAIN OF DSSS SYSTEMS SUBCLAUSE §15.247 (e)

The processing gain of this product was measured by ADCON

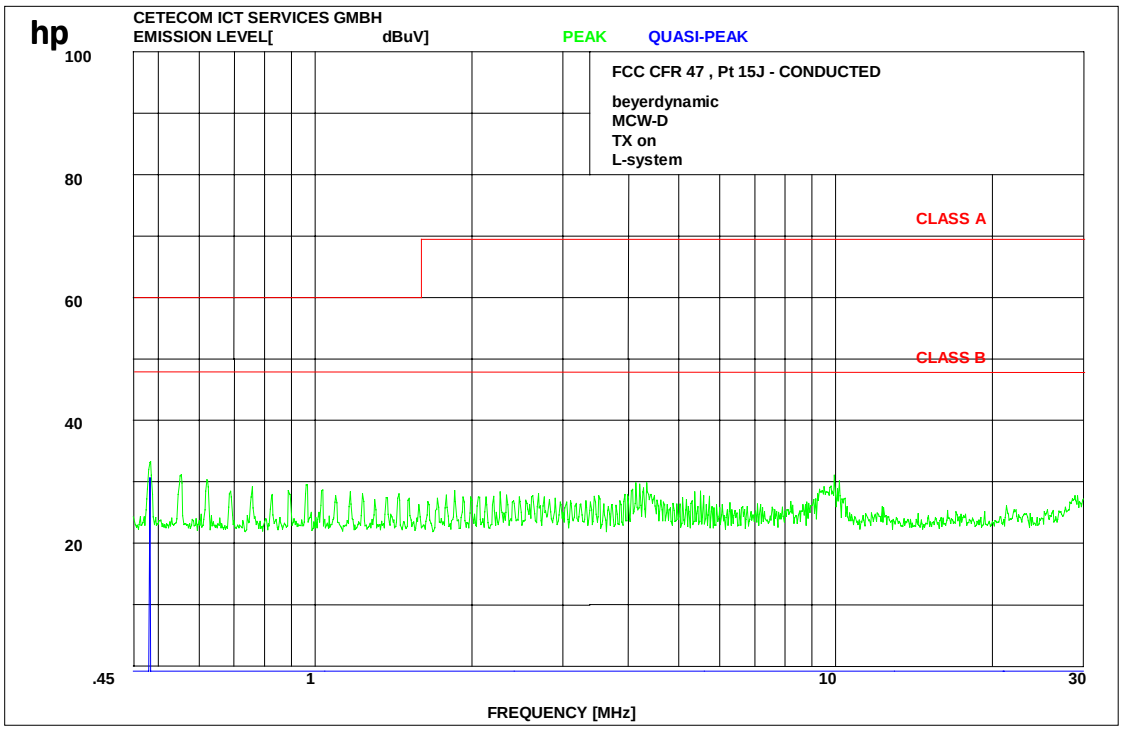
It will be provided in an external paper.

It is in all cases over 10 dB.

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Low frequency conducted emissions : **§ 15.107/207**
Measured with AC/DC power adapter

L1-system



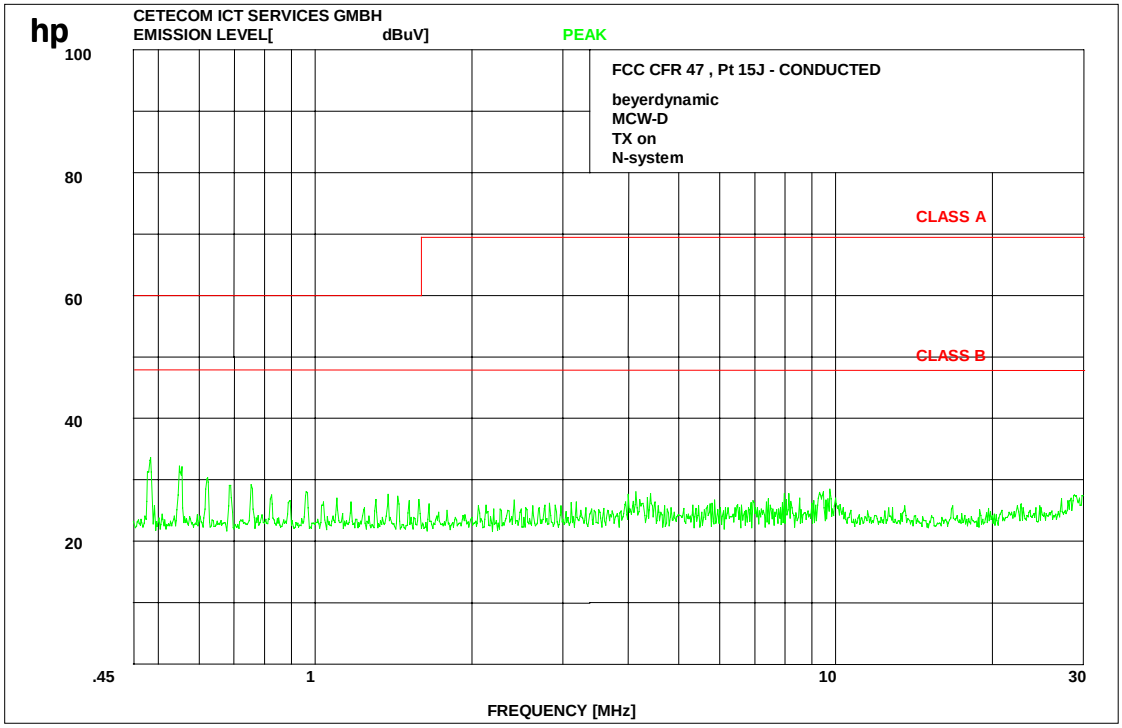
Technical specification : 15.207 (Revised as of October 1, 1991)
Limit

0.45 to 30 MHz	250 µV / 47.96 dBµV

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Conducted emissions **§ 15.107/207**
Measured with LISN

N-system



Technical specification : 15.207 (Revised as of October 1, 1991)
Limit

0.45 to 30 MHz	250 µV / 47.96 dBµV

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

To simplify the identification on each page of the test equipment used, on each page of the test report, each item of test equipment and ancillaries such as cables are identified (numbered) by the Test Laboratory, below.

No	Instrument/Ancillary	Type	Manufacturer	Serial No.
01	Spectrum Analyzer	8566 A	Hewlett-Packard	1925A00257
02	Analyzer Display	8566 A	Hewlett-Packard	1925A00860
03	Oscilloscope	7633	Tektronix	230054
04	Radio Analyzer	CMTA 54	Rohde & Schwarz	894 043/010
05	System Power Supply	6038 A	Hewlett-Packard	2848A07027
06	Signal Generator	8111 A	Hewlett-Packard	2215G00867
07	Signal Generator	8662 A	Hewlett-Packard	2224A01012
08	Funktionsgenerator	AFGU	Rohde & Schwarz	862 480/032
09	Regeltrenntrafo	MPL	Erfi	91350
10	Netznachbildung	NNLA 8120	Schwarzbeck	8120331
11	Relais-Matrix	PSU	Rohde & Schwarz	893 285/020
12	Power-Meter	436 A	Hewlett-Packard	2101A12378
13	Power-Sensor	8484 A	Hewlett-Packard	2237A10156
14	Power-Sensor	8482 A	Hewlett-Packard	2237A00616
15	Modulationsmeter	9008	Racal-Dana	2647
16	Frequenzzähler	5340 A	Hewlett-Packard	1532A03899
17	Absorber Schirmkabine	---	MWB	87400/002
18	Spectrum Analyzer	85660 B	Hewlett-Packard	2747A05306
19	Analyzer Display	85662 A	Hewlett-Packard	2816A16541
20	Quasi Peak Adapter	85650 A	Hewlett-Packard	2811A01131
21	RF-Preselector	85685 A	Hewlett-Packard	2833A00768
22	Biconical Antenne	3104	Emco	3758
23	Log. Per. Antenne	3146	Emco	2130
24	Double Ridge Horn	3115	Emco	3088
25	EMI-Testreceiver	ESAI	Rohde & Schwarz	863 180/013
26	EMI-Analyzer-Display	ESAI-D	Rohde & Schwarz	862 771/008
27	Biconical Antenne	HK 116	Rohde & Schwarz	888 945/013
28	Log. Per. Antenne	HL 223	Rohde & Schwarz	825 584/002
29	Relais-Switch-Unit	RSU	Rohde & Schwarz	375 339/002
30	Highpass	HM985955	FSY Microwave	001
31	Amplifier	P42-GA29	Tron-Tech	B 23602
32	Absorber Schirmkabine		Frankonia	
33	Steuerrechner	PSM 7	Rohde & Schwarz	834 621/004
34	EMI Test Reciever	ESMI	Rohde & Schwarz	827 063/010
35	EMI Test Receiver	Display	Rohde & Schwarz	829 808/010

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

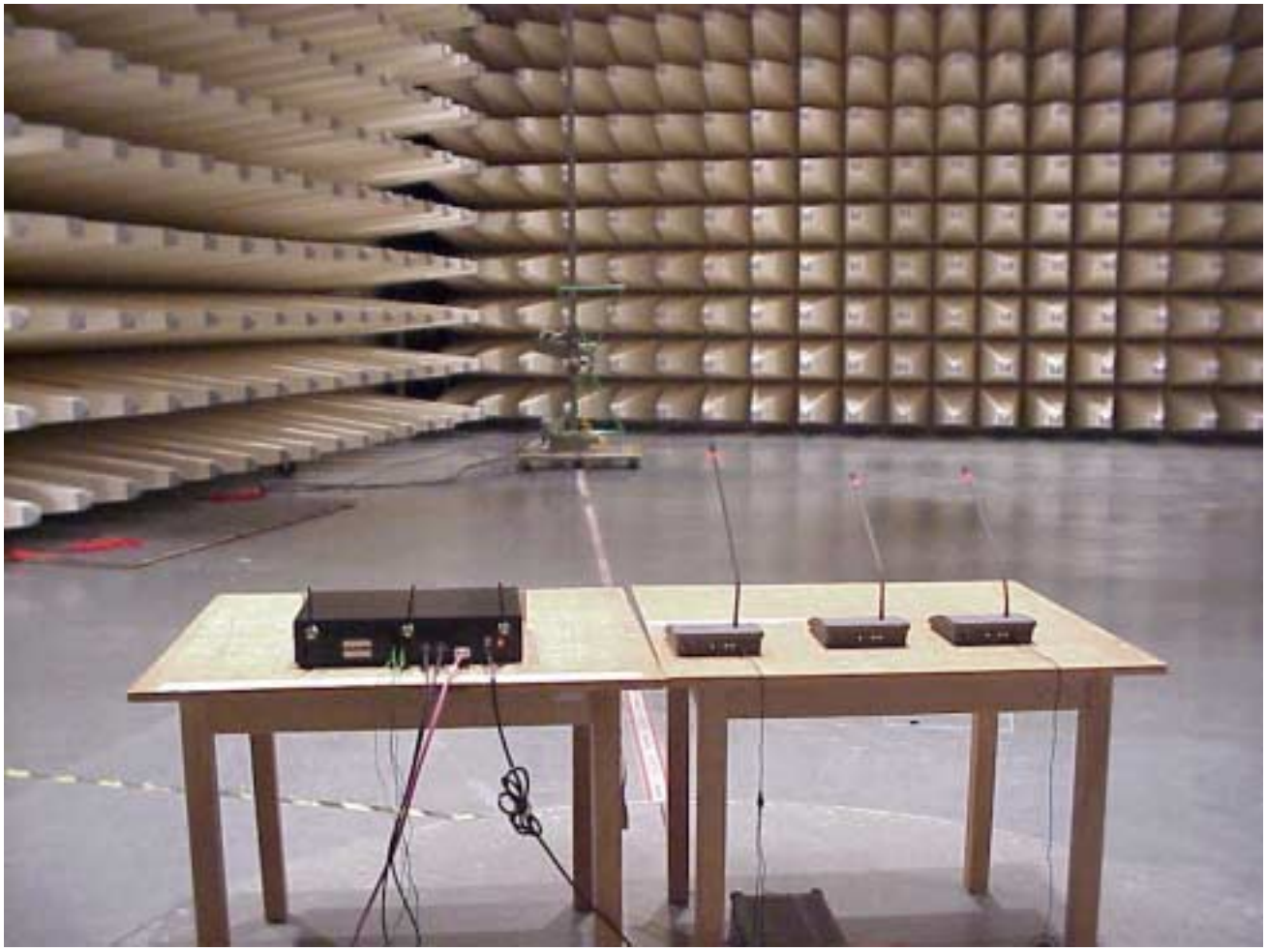
To simplify the identification on each page of the test equipment used, on each page of the test report, each item of test equipment and ancillaries such as cables are identified (numbered) by the Test Laboratory, below.

No	Instrument/Ancillary	Type	Manufacturer	Serial No.
36	Controler	HD 100	Deisel	100/322/93
37	Relais Matrix	PSN	Rohde & Schwarz	829 065/003
38	Control Unit	GB 016 A2	Rohde & Schwarz	344 122/008
39	Relais Switch Unit	RSU	Rohde & Schwarz	316 790/001
40	Power Supply	6032A	Hewlett Packard	2846A04063
41	Spektrum Monitor	EZM	Rohde & Schwarz	883 720/006
42	Meßempfänger	ESH 3	Rohde & Schwarz	890 174/002
43	Meßempfänger	ESVP	Rohde & Schwarz	891 752/005
44	Biconi Ant. 20-300MHz	HK 116	Rohde & Schwarz	833 162/011
45	Logper Ant. 0.3-1 GHz	HL 223	Rohde & Schwarz	832 914/010
46	Amplifier 0.1-4 GHz	AFS4	Miteq Inc.	206461
47	Logper Ant. 1-18 GHz	HL 024 A2	Rohde & Schwarz	342 662/002
48	Polarisationsnetzwerk	HL 024 Z1	Rohde & Schwarz	341 570/002
49	Double Ridge G Horn Antenne 1-26.5 GHz	3115	EMCO	9107-3696
50	Microw. Sys. Amplifier 0.5- 26.5 GHz	8317A	Hewlett Packard	3123A00105
51	Spectrum Analyzer	8562A	Hewlett Packard	2809AO2682
52				
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				
66				
67				

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Test Site

Central unit with table units



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

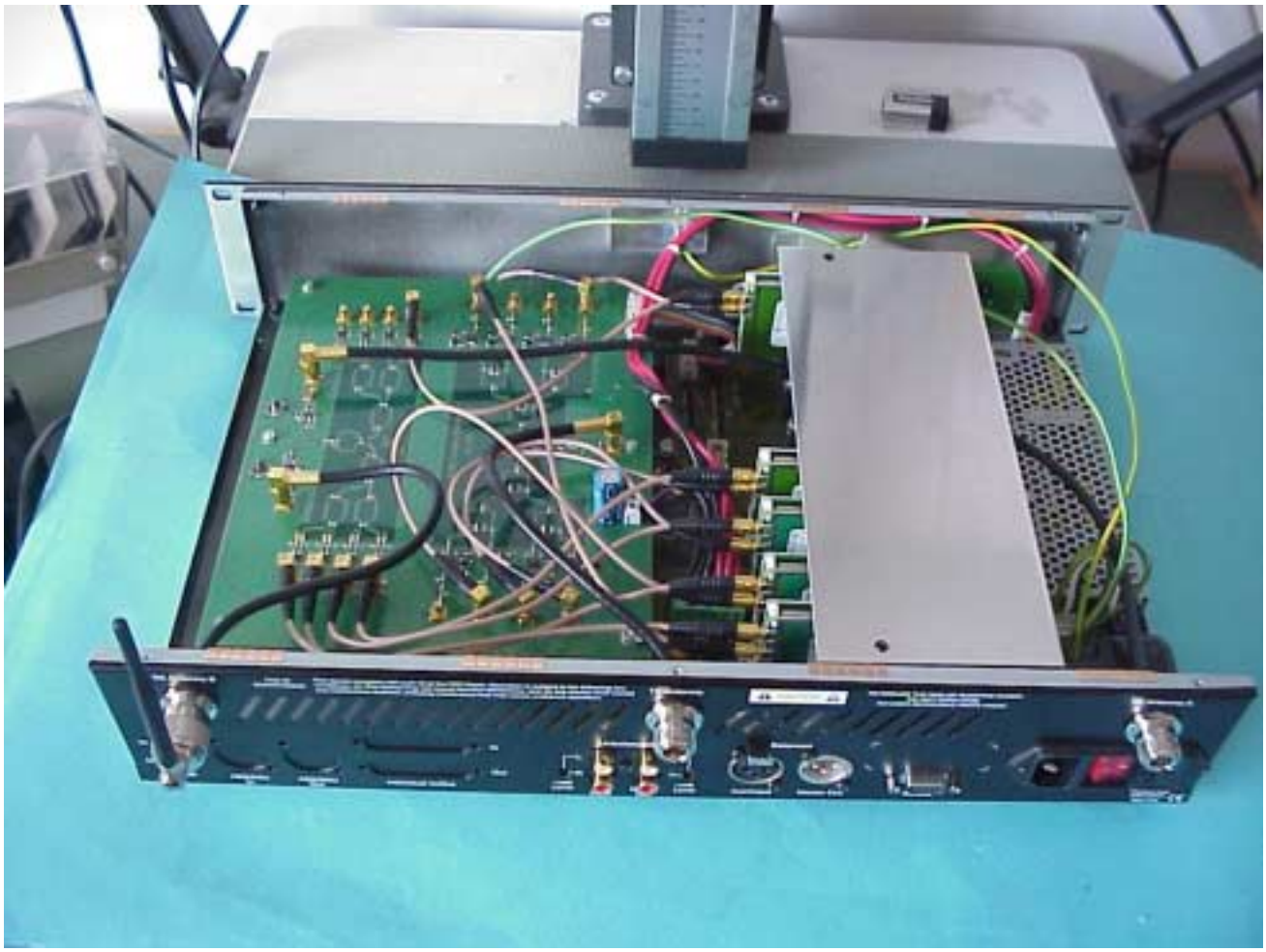
Photographs of the equipment

Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Photographs of the equipment

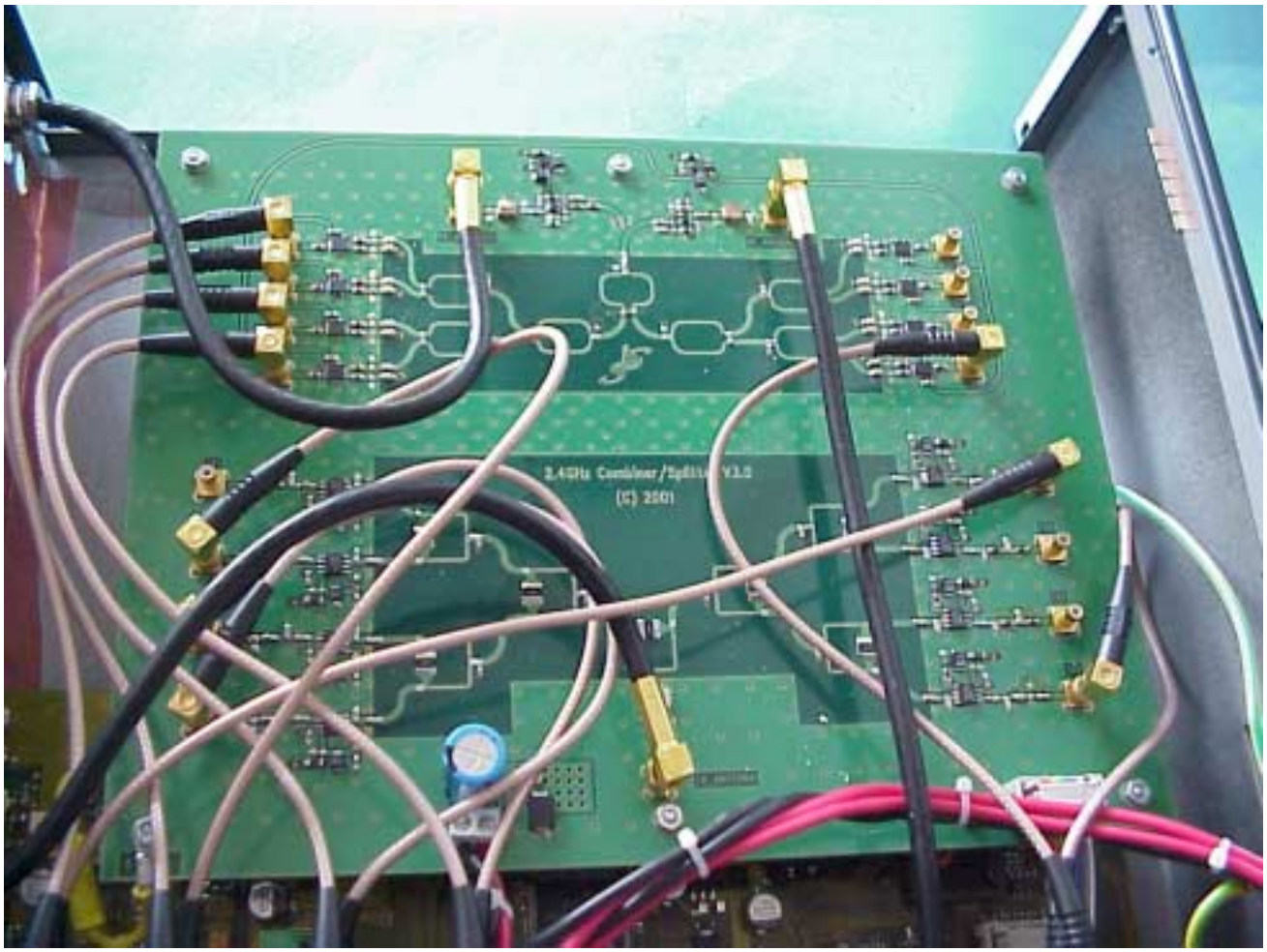
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Photographs of the equipment



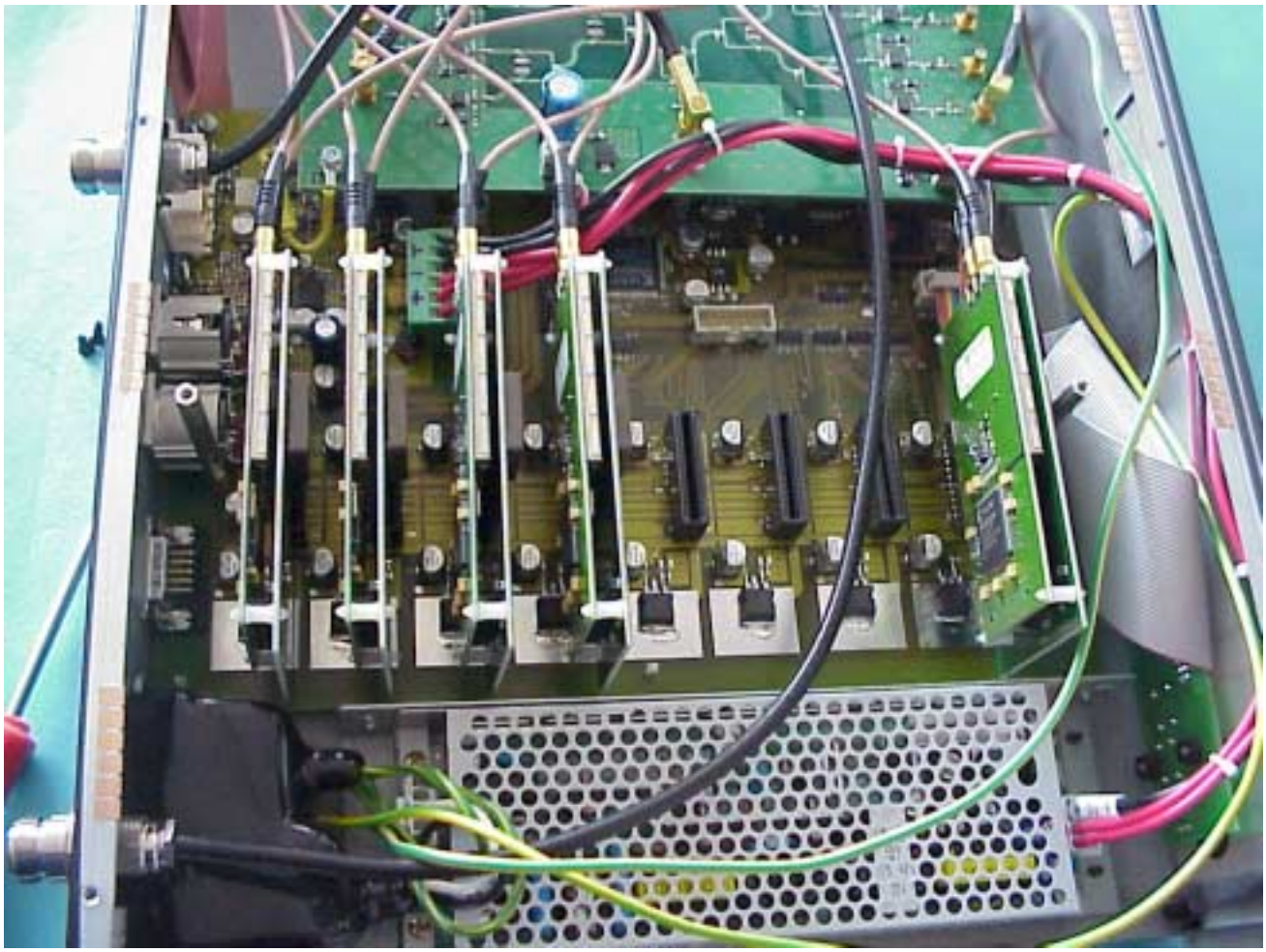
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Photographs of the equipment



Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Photographs of the equipment

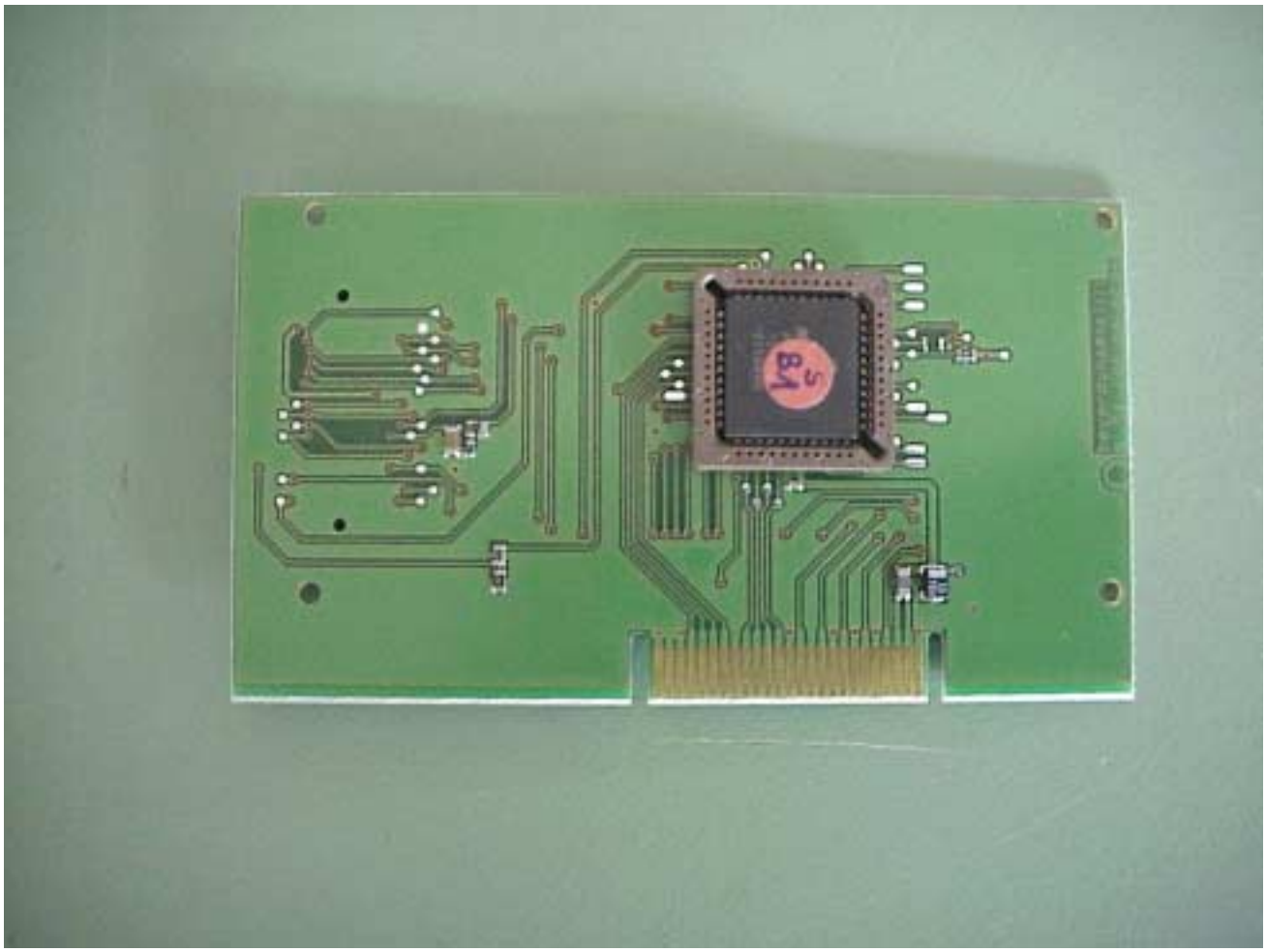


Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Photographs of the equipment

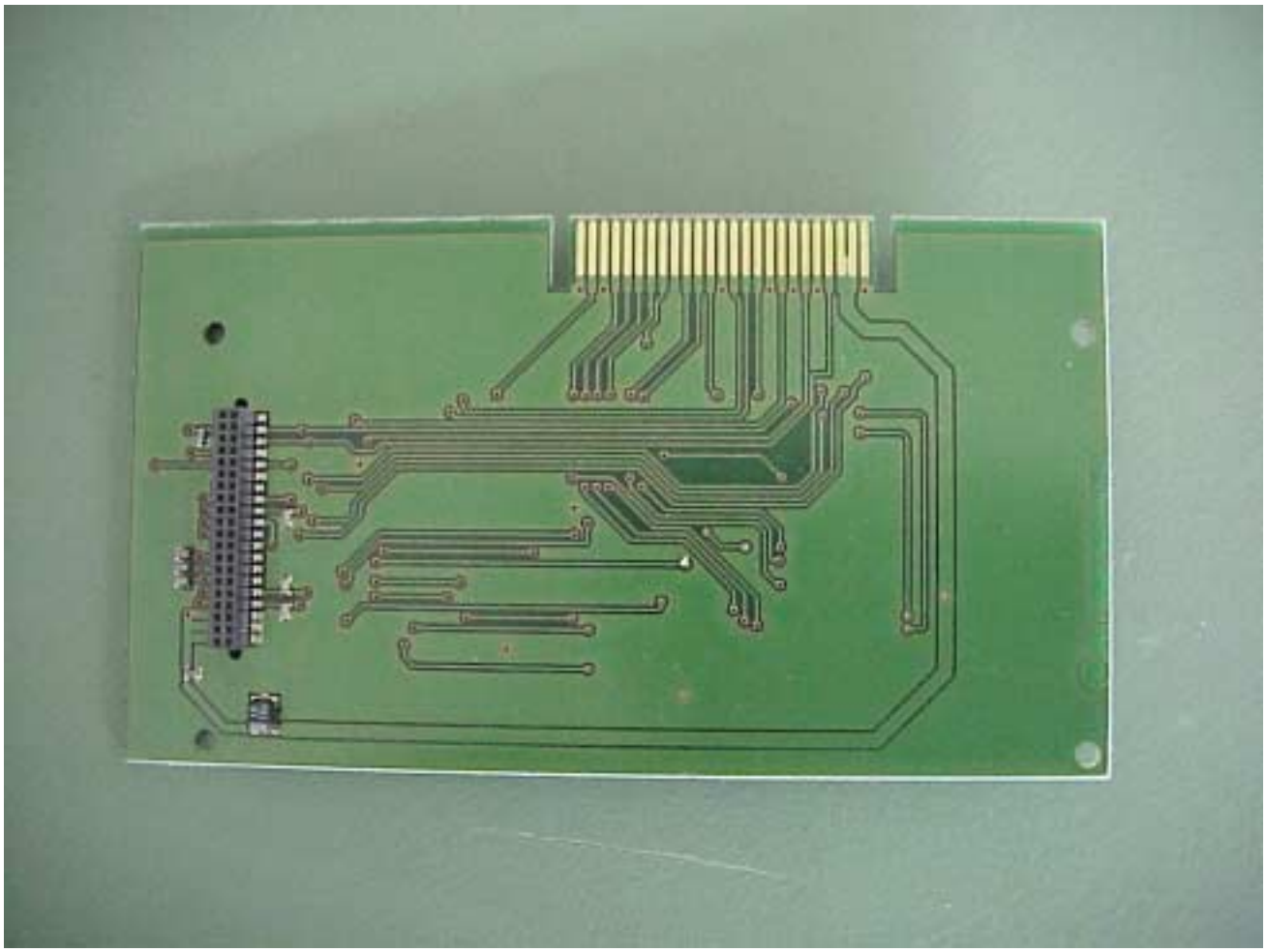
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Photographs of the equipment



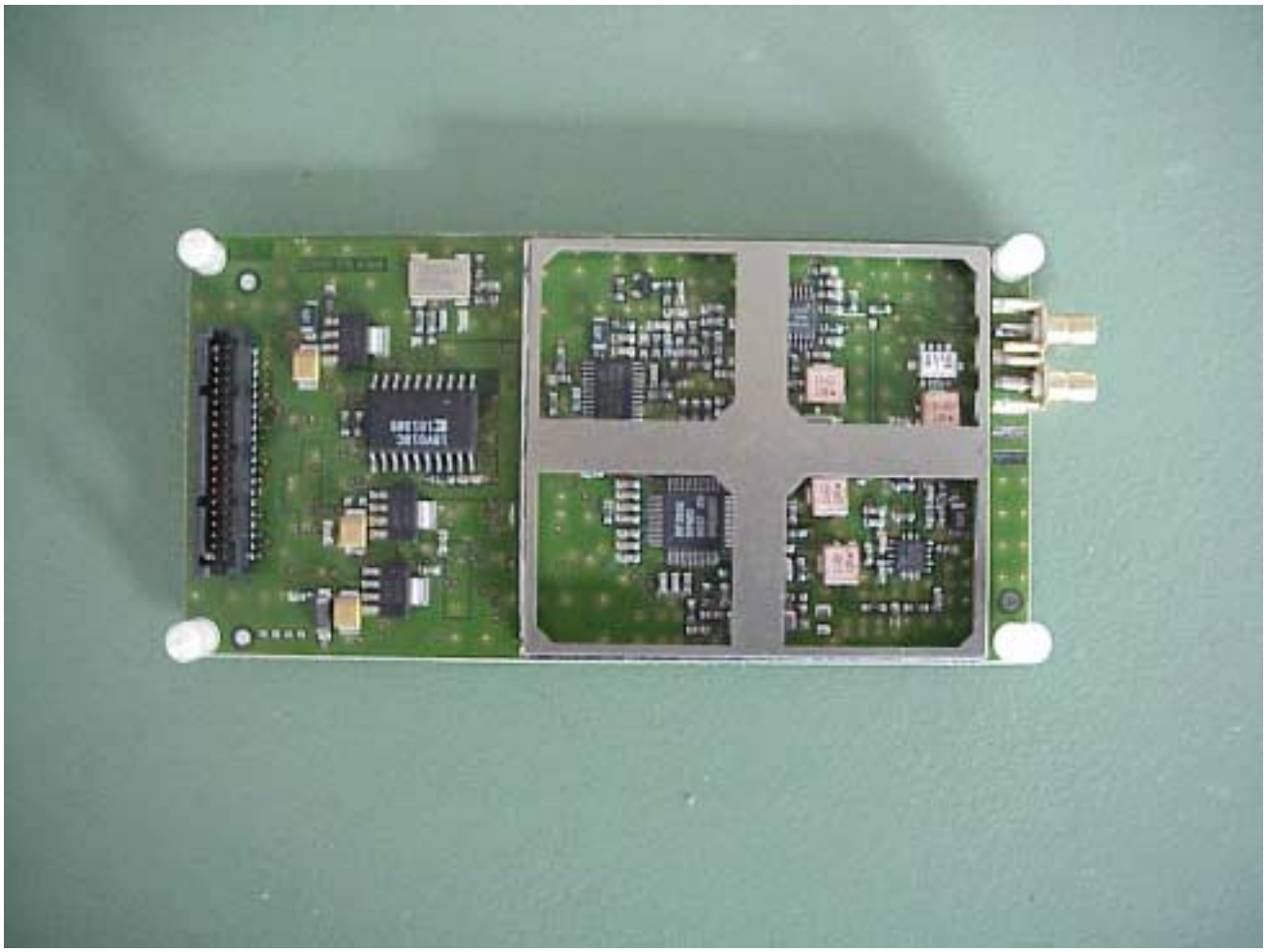
Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Photographs of the equipment

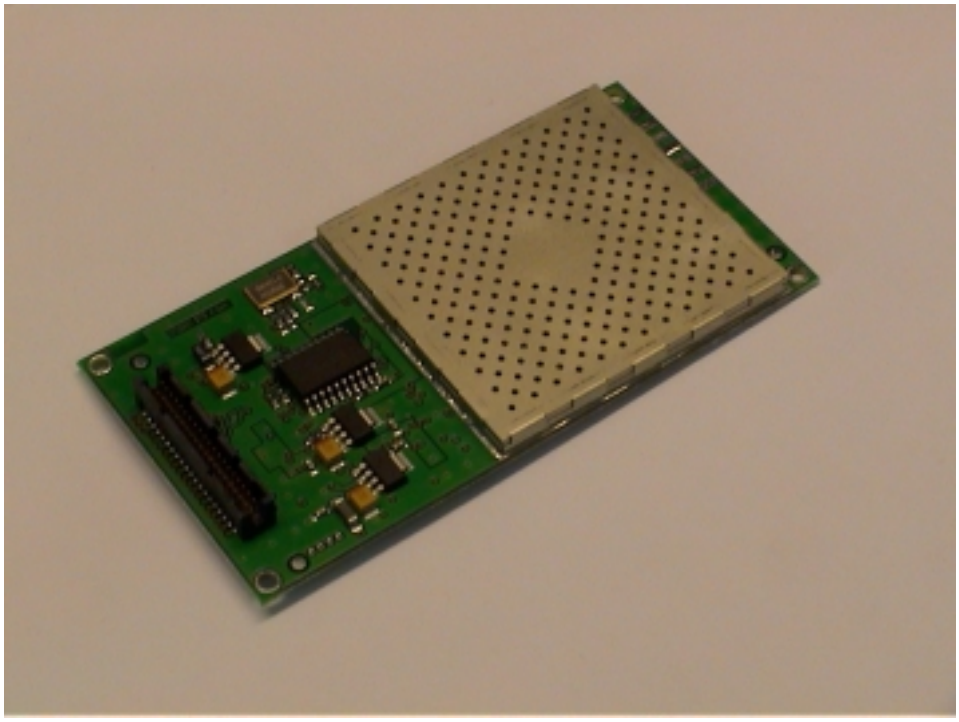


Equipment under test : MCW-D
Ambient temperature : 25°C
Relative humidity : 47%

Photographs of the equipment



MAX RF Module



Technical Construction File

V0.7

ADCON RF Technology B.V.

Table of Contents

1 Introduction

The MAX module is a plug-in module for real-time data transception at 2.4GHz.
It comprises 16 RF channels. The air aggregate data rate is 611 kpbs. It utilises a dBPSK DSSS modulation scheme. Air framing, CRC checking and configuration of the RF components is handled by the module itself which leaves the communication to the board to which it interfaces limited to transception of messages.
This interface physically consists of a 40 pin connector to which the supply voltage is also connected. The module is without housing, because it is intended for integration in a customer defined final product. The PCB size is 100 x 50 mm. There is no antenna connector. There is a land pattern on the PCB instead to which a coaxial cable can be soldered to connect an external antenna.

This document describes the technical details of the MAX module. The following information is included:
- Technical specifications of the MAX module
- Description of hardware, including schematics and layout
- Short description of the software embedded in the MAX module

In the following text “customer” references to the manufacturer of the final product who incorporates the MAX modules into a final product.

This document is intended for radio approval authorities and laboratories.

2 Hardware

2.1 Specifications of MAX module

Parameter	Min.	Typ.	Max.	Unit	Condition
Overall					
Operating Frequency Range		2400 to 2483		MHz	
Channel Bandwidth			7	MHz	
RF channels		8			
Transmit mode		TDD/FDMA			Time domain duplex/Frequency domain multiple access
Modulation Method		QPSK			
Spread Spectrum Technique		DS			
Spreading		11bit barker			
Process gain		10.4		dB	
Aggregate data rate		611		kbps	
Operating Ambient Temp.		+10 to +50		°C	
RF Connection Type		Pigtail solder pads			
RF Impedance		50		Ω	
Interface Connector		40 pin, 1.27mm			40 pin BERG 87409-120 (male)
PCB Material		FR4			
PCB Size		100x50		mm	
Transmitter					
Tx Output Power	7.2	11.5	15.9	dBm	
Tx Spurious Outputs		ETSI compliant			
Carrier suppression		- 20		dBc	
Carrier Frequency Accuracy		+/- 25		ppm	Overall
Receiver					
RF Frequency Range		2400 to 2483		MHz	
IF Frequency		380		MHz	
Receive Sensitivity		-93		dBm	
Power Supply					
Supply Voltage Range	3.5	3.6	4	V	
Average power consumption		310	330	mA	Full operation
Average power consumption		140	170	mA	Receive only
Startup power consumption			800	mA	During max. 300ms
Air format					
Transmit/receive cycle		12,45833		ms	
Or cycles per second		80,26755853		s^{-1}	
Address range		16		Bits	
Datagram size		16		Bytes	
Error detection		16bit CRC			
Audio samples per subframe		25			
Error detection per subframe		16bit CRC			
Audio subframes per frame		12			

Audio quality					
Input signal					
Quantisation		16		bits	
Sample rate		24.000		ksps	
Interface		Serial			Conform PCM3500 specs, time slotted, master mode. Clock is provided by radio module
Compression		1:2			STS proprietary compression algorithm
Error suppression					Windowed repeat of last correct frame or mute
Sample rate bridging					Elegant sample skipping/inserting algorithm
Control interface					
Interface type		Async serial			
Baudrate		113.8		kbps	Can be used with 111.86kbps
Supporting signals		MIF BSY SRES			Message in FIFO Busy Serial Reset
Digital levels					
Vih	2.0			V	
Vil			0.8	V	
Voh	2.4			V	@Ioh=-24 mA
Vol			0.4	V	@Iol=24 mA

Settable channels:

0 2408.4MHz
1 2412.8MHz
2 2417.2MHz
3 2421.6MHz
4 2426.0MHz
5 2430.3MHz
6 2434.7MHz
7 2439.1MHz
10 2452.3MHz
11 2456.7MHz
12 2461.1MHz
13 2465.4MHz
14 2469.8MHz
15 2474.2MHz

Though the module permits the setting of 16 individual RF channels it is advisable to only select either the even or uneven channels to minimize the risk of modules interfering with each other. This reduces the number of useable RF channels to 8. The choice between the use of either the even or uneven channels should depend on the frequency location of possible interfering signals.

2.2 Technical Description of the Hardware

The following description refers to the schematics of the RF-PCB (see Appendix xxx) and to the included block diagram (see figure 1).

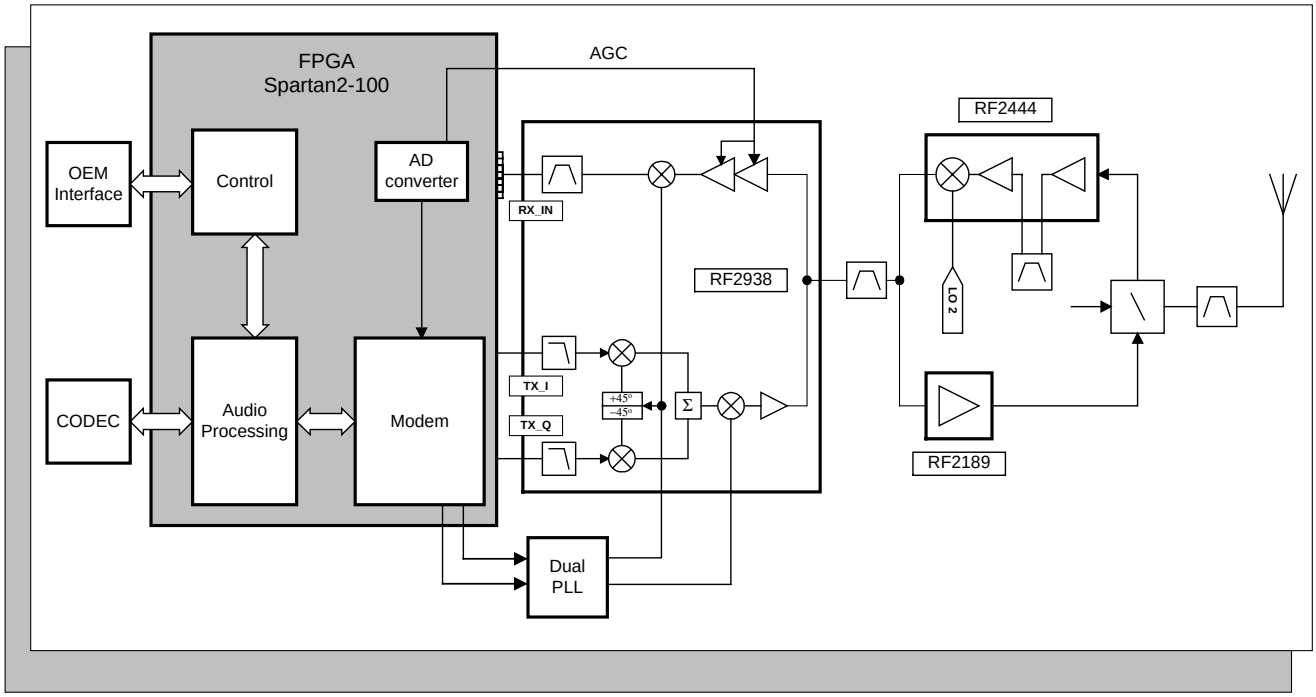


Figure 1. Block diagram of MAX module

Baseband Spread Spectrum

All baseband functionality is integrated in the Spartan2-100 FPGA. This device also provides the necessary signals to configure the RF chip set as well as the interface to the externally connected device (i.e. the device utilizing the MAX module as it's wireless interface).

Radio

The RF2938 (U1) is a 2.4GHz transceiver IC. It includes the modulator, demodulator, programmable low pass filters, the variable gain amplifier for reception and a driver stage for the PA, the RF2189. The IF frequency for receiving and transmitting is 380MHz. The SAW-filter SAW855771 from Sawtek (U4) is used to limit the bandwidth and to increase channel selectivity.
Low pass filter LFK30-05E2442LO84 (U13) and Bandpass filter DFC_22_LIGHT (U21) are used to reduce the bandwidth during transmission and receiving. An extra filter for receiving is band pass filter DFC_22_LIGHT (U22). During transmission the following two extra filters are used: DFC_22_LIGHT (U11,12). The AS169_73 (U3) is an RF-switch that is controlled by the FPGA to switch the RF signal path between reception and transmission.

Synthesizers
The Si4136 (U7) is a dual PLL that includes two VCOs for generation of the 2GHz RF LO-signal and the 2xIF = 760MHz IF LO-signal. The buffer amplifier around the BFR520 (Q2) provides isolation and some gain to get a proper power level at the RF2938 input. The reference signal for the PLL is supplied by the Rakon SXO110A TCXO (U6) operating at a frequency of 12.228MHz. The PLL is configured by the FPGA.

2.3 PCB information in appendices

The following PCB information can be found into the appendices:

Appendix A: Photographs of the MAX module
Appendix B: The schematic of the MAX module
Appendix C: Layout of the MAX module with the following information included:

- Layer 1
- Layer 2
- Layer 3
- Layer 4
- Drill

Appendix D: Silkscreen data of the MAX module
Appendix E: Bill Of Materials of the MAX module

2.4 Changing the antenna port configuration

To facilitate mounting of the MAX module in Base Station units, it is possible to change the antenna port configuration from a shared TX/RX port to separate TX and RX ports. To accomplish this, one resistor and one capacitor have to be rotated. See figure 2 for details.

Resistor R60 has to be rotated 90° so that it becomes resistor R69. Capacitor C67 has to be removed and on the position of R68 a 22pF 0603 capacitor must be placed.

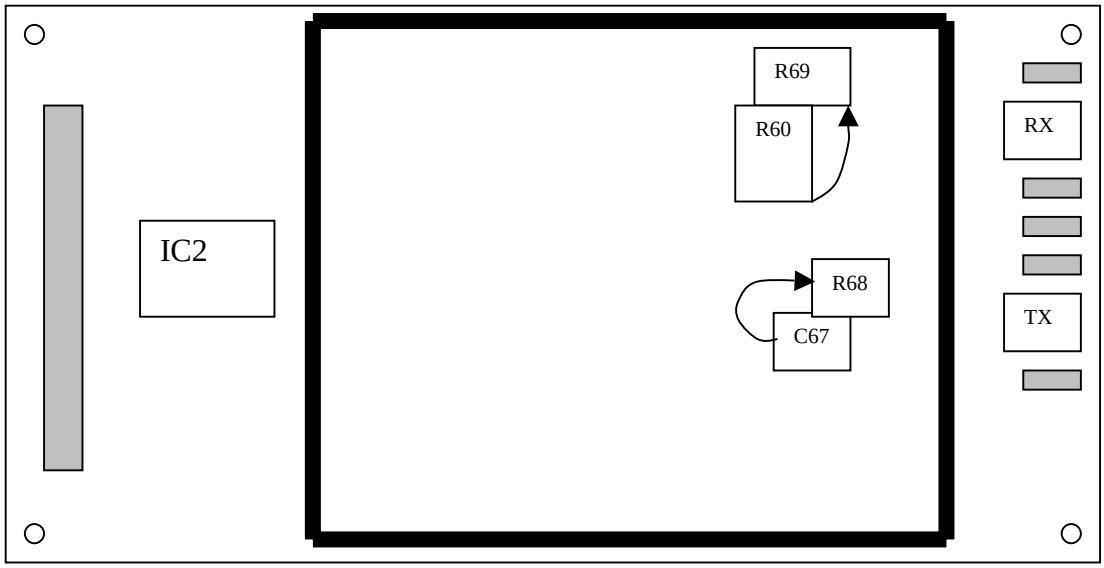


Figure 2. Changing antenna port configuration

3 Software

3.1 Short software description

The MAX module is intended to be used for real time audio transception (full duplex audio and data communication). Therefore it is able to interface to a Burr-Brown PCM3500 Codec. The audio sample rate is 24kHz. The system clock is therefore 12.288MHz (512 x 24kHz).

The radio modules support time domain duplex communication, meaning that there is a possibility for simultaneous flow of communication in both directions for audio and data at the same time.

3.1.1 Voice transmission

The audio that is transmitted is of "conference quality" (16 bit 24kHz sampling). This means that it is of a better quality than a voice connection as in telecommunications (300..3300 Hz) but typically less suited for hi-fi audio.
The audio signal is compressed by a factor of two to reduce the radio bandwidth.
Great care has been taken to ensure that no disturbances are put out at the receiver side when the signal is perturbed by interference. The likelihood of such a disturbance under normal operating conditions is assumed to be less than once in the lifetime of a unit.
On event of a perturbed audio sub frame, an effort is made to mask this or in case of longer interruptions, to mute the audio output.
Mismatch in clock frequencies of the base station and the table units is eliminated by an elegant remove/insert sample algorithm.

All of these algorithms have been demonstrated to and approved by the customer. For this purpose two CD's have been compiled with sound samples with the actual algorithms applied.

3.1.2 Control communication

Next to the audio transmission a control link is established. This control data is sent in the same frame as the audio data. The control link is addressable and broadcasts can be applied. Each airframe can convey 16 bytes of payload. The capacity of this link is approximately 10kbps. The address space is 16 bits, so a total of 65000 table units can be addressed.

3.2 Interface Description

In addition to real time audio transception, the MAX module offers addressable data communication facilities. All processing, audio compression and error detection, masking and muting is performed in the module.

The 40 pin BERG 87409-120, 1.27 mm pitch, connector supplies all other signals. A mating connector could be the BERG 87023-620 for a surface mount solution.

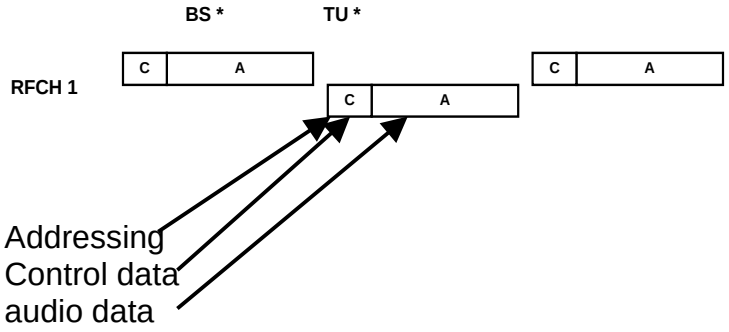
Pin	Name	Function	Remark
1.	VDD_RF	Power supply	Should be a clean and stable 3.6 v signal and should be able to deliver 800mA at startup.
2.	VDD_RF		
3.	VDD_RF		
4.	MCU_IN	Control output[1]	
5.	MCU_OUT	Control input[2]	
6.	BSY	Busy input	Holds of new messages on control output
7.	MIF	Message in FIFO	Signifies that a message is in the FIFO. This line gets asserted after the entire message is written into the module.
8.	SRES	Serial Reset	Resets the serial interface to a defined state
9.	FLASH_TDO	No user pin	Leave not connected
10.	DI	CODEC data out	
11.	DO	CODEC data in	
12.	FS	CODEC frame sync	CODEC output
13.	BCK	CODEC bit clock	CODEC output
14.	PD_CDC	CODEC power down	
15.	SCKIO	CODEC serial clock	CODEC input
16.	OSC_IN	TCXO input	12.288MHz +/-25ppm overall accuracy
17.	SOF(IN/OUT)	Frame synchronization	Base station only, input for slave, output for master.
18.	TXMUTE	Audio transmit disable	Only valid in table unit mode
19.	GPD	Global power down	Puts radio module in low power state
20.	FPGA_TMS	No user pin	Leave not connected
21.	FPGA_TCK	No user pin	Leave not connected
22.	FSO	CODEC frame sync	CODEC output
23.	HST_OUT	High speed output	Not implemented
24.	GND	Ground	
25.	HST_IN	High speed input	Not implemented
26.	GND	Ground	
27.	NC	Not connected	
28.	PD_REG_DIG	FPGA supply power down	Tie high normally. Ground pin to put module in zero power mode.
29.	/RESET	Reset FPGA	
30.	PD_FPGA	FPGA power down pin	Not supported yet. Tie high.
31.	FPGA_TDO	No user pin	Leave not connected
32.	FPGA_TDI	No user pin	Leave not connected
33.	FLASH_TCK	No user pin	Leave not connected
34.	FLASH_TMS	No user pin	Leave not connected

[1] To user micro controller
[2] From user micro controller

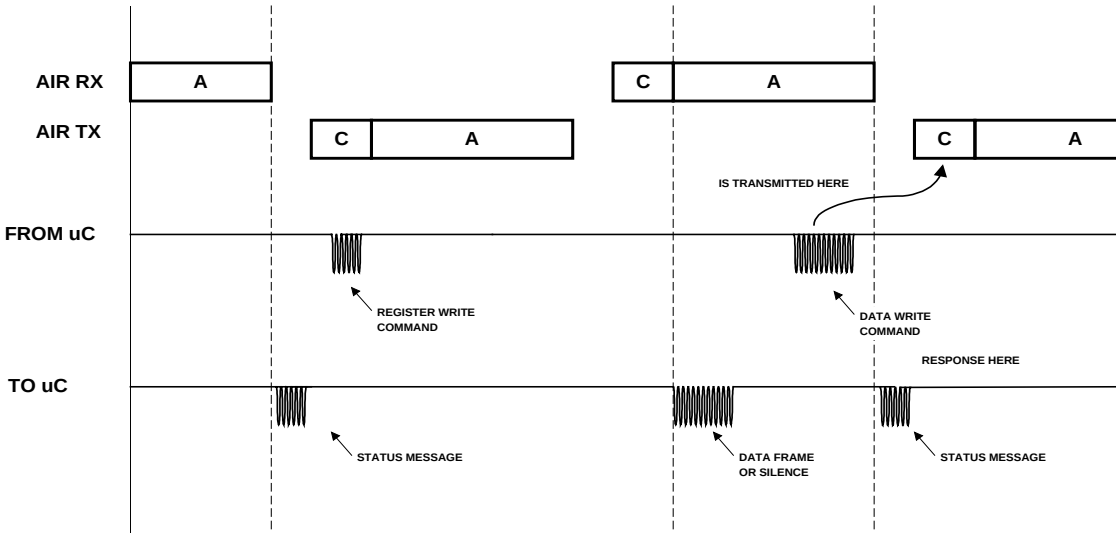
35.	FLASH_TDI	No user pin	Leave not connected
36.	GAIN_LNA	LNA gain select	Enables reduction of sensitivity
37.	HI_LOW_POWER	PA power select	Enables reduction of transmit power
38.	GND	Ground	A good clean ground signal should be supplied
39.	GND		
40.	GND		

3.3 Air timing

The radio modules use a Time Domain Duplex system to attain bi-directional communication. This processing is transparent to the user and it is of limited value to have knowledge about this. In some cases however to get the maximum performance of the system it is good to have some idea of system operation.



The airframes contain Addressing Control data and Audio data. These data packets are transmitted alternately by the base station and the table units. This is done in an interval of a little more than 12ms. In these 12ms a number of things happen on the control interface. This activity is depicted in the image below:



This section will discuss the different kinds of activity on the control interface in- and outputs. A detailed description of the messages will be given in the programming model chapter.

At the reception of each frame a message is sent to the user micro controller informing the latter about the quality of reception. In the base station this can be used as a criterion to switch to a different reception antenna. Besides the quality indicator room has been left to implement register reads. Right now there is no information inside the FPGA that can or is worth to be read.

A second message that is put out by the radio module is the Control Data message. This message is put out if the message validates for reception at that module. Validation will be done on whether a message received correctly, if the message is filled, if the address is correct or if a broadcast message is received.

At any time the user can take the initiative to send a control message to the radio module. This can be either a control data message or a command. Though the control data message can be fed to the radio module at any time, it is only transmitted at the airframe starting after message completion. This means that though a user can take a second to feed the message into the module, it will only be sent after it has been completed. A message can be cancelled by asserting the SRES line on the radio module.

To respond to a message received from the radio module the user has limited time to make sure that the reply is transmitted at the next message slot. A spreadsheet has been provided to calculate this available processing time with regard to the baud rate.

3.4 User interface

The MAX module interfaces to a customer specific control unit. The interface to the user is through the customer's hardware. Therefore every reference to the user interface is left to the manufacturer that incorporates the MAX module into a final product.

Appendix A: Photographs of MAX module

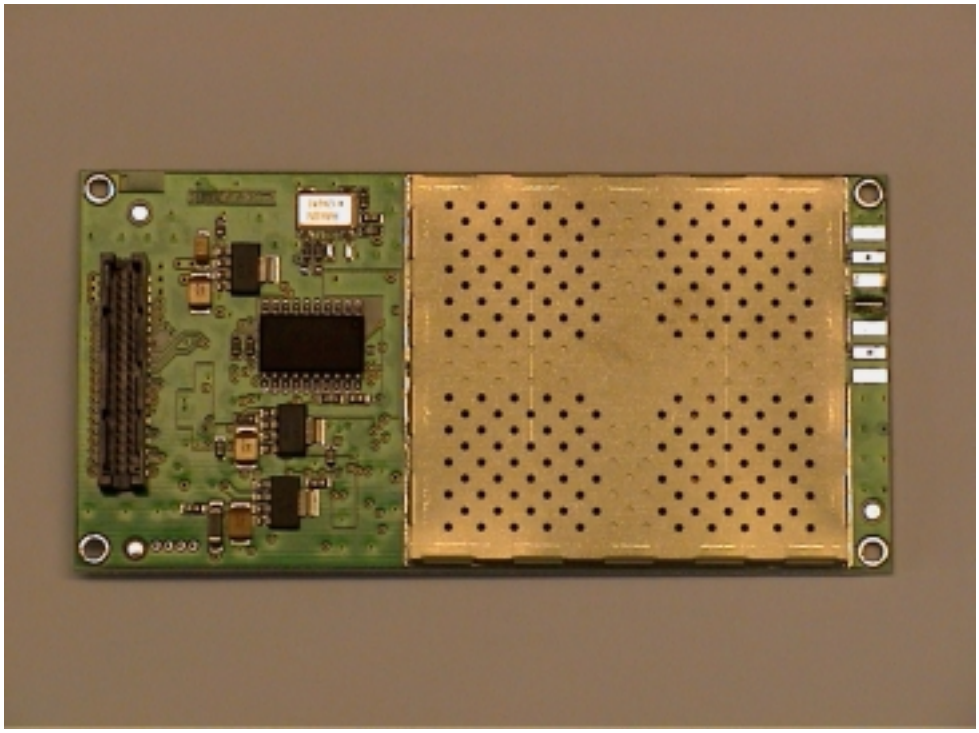


Figure 3. MAX module as supplied

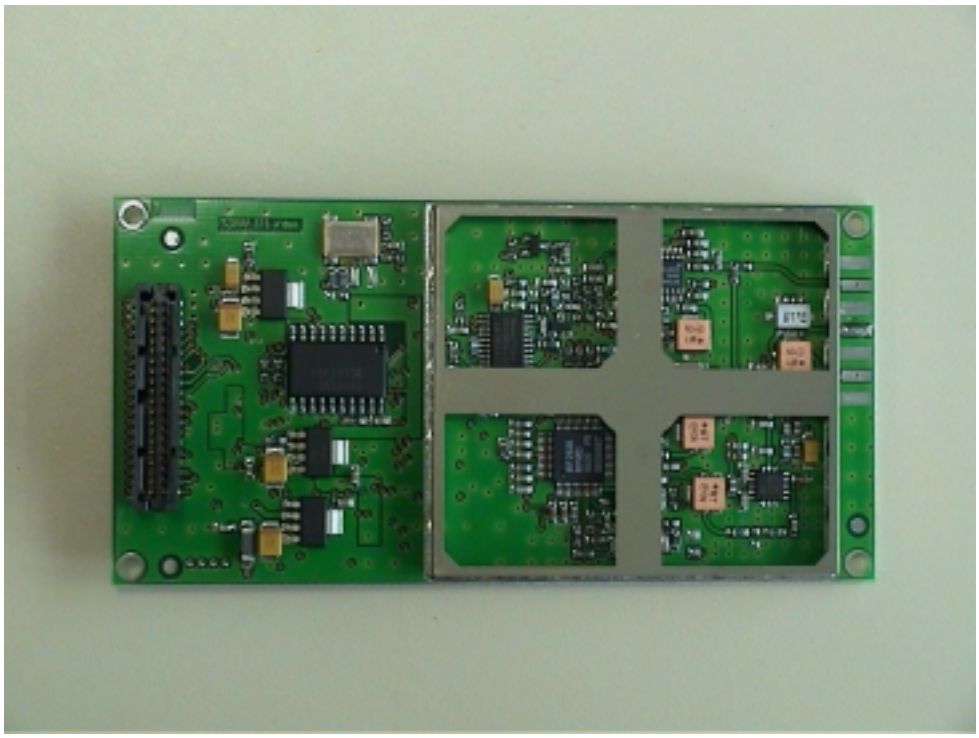


Figure 4. MAX module with lid removed

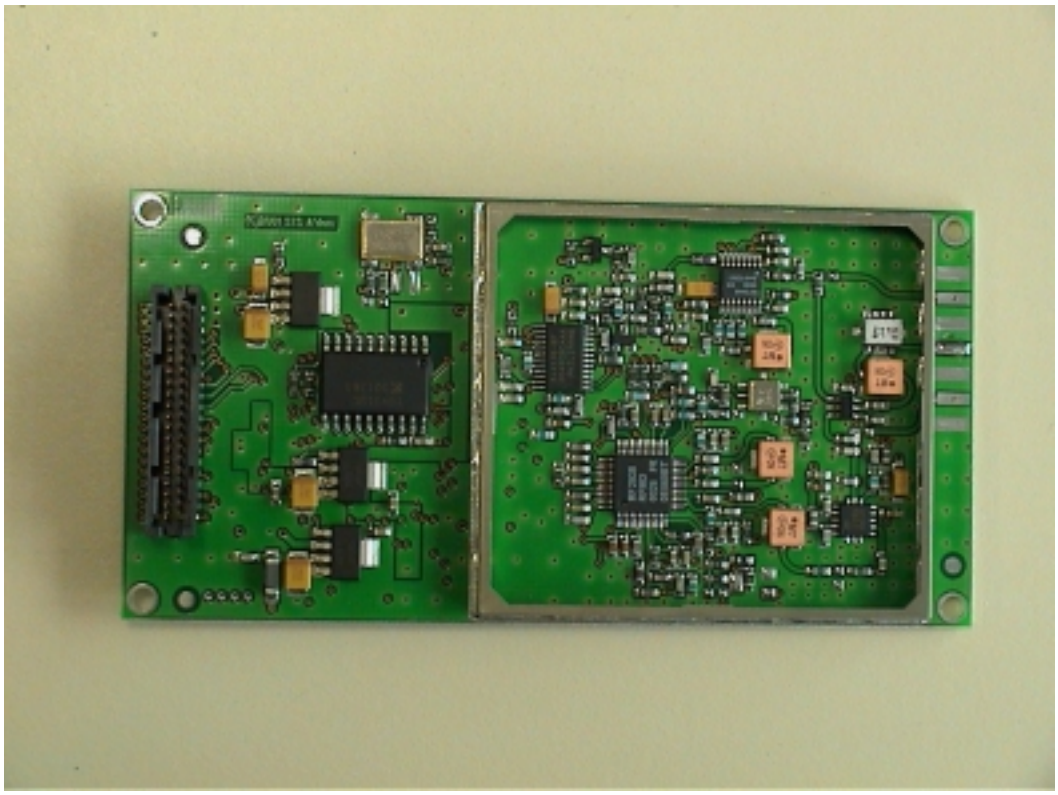


Figure 5. MAX module with cross removed

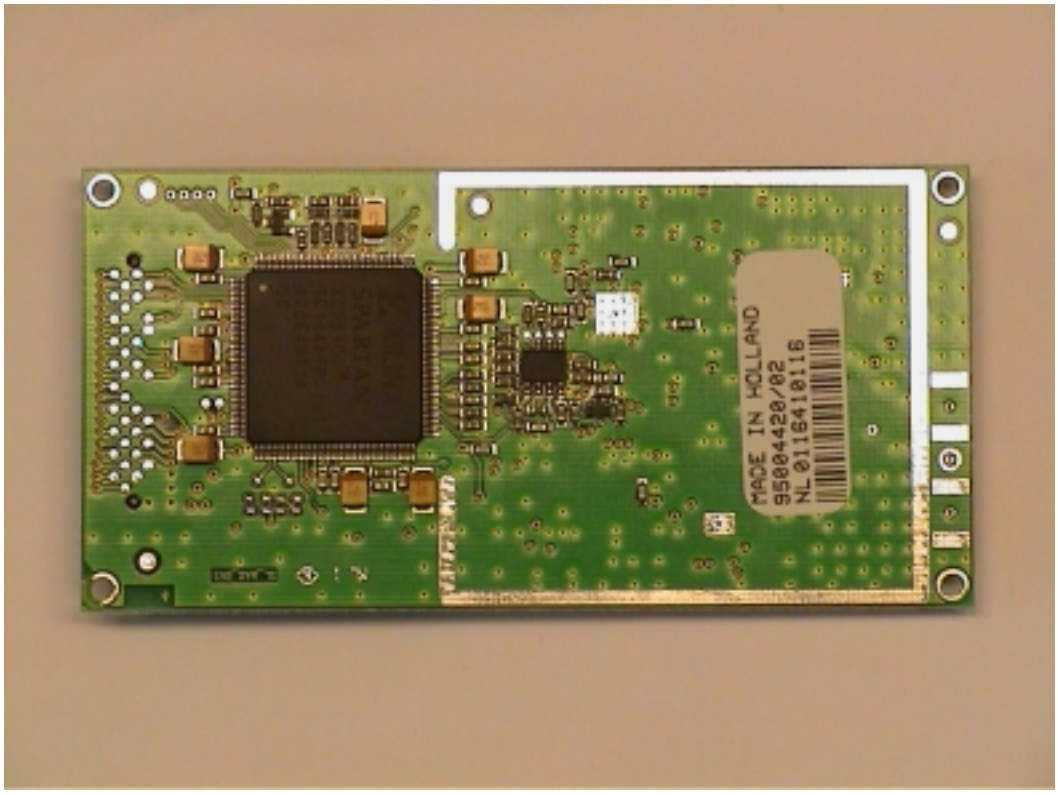
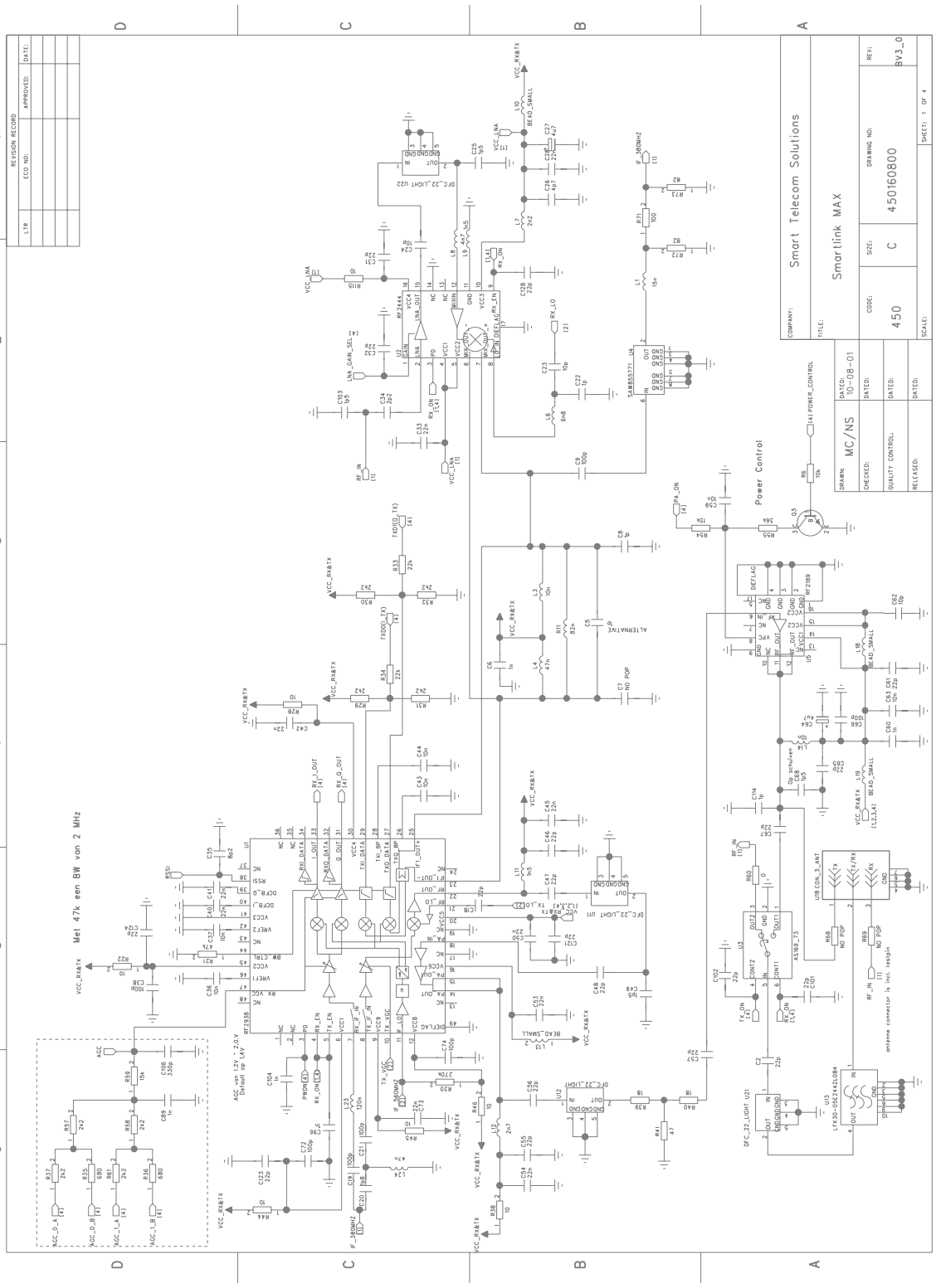
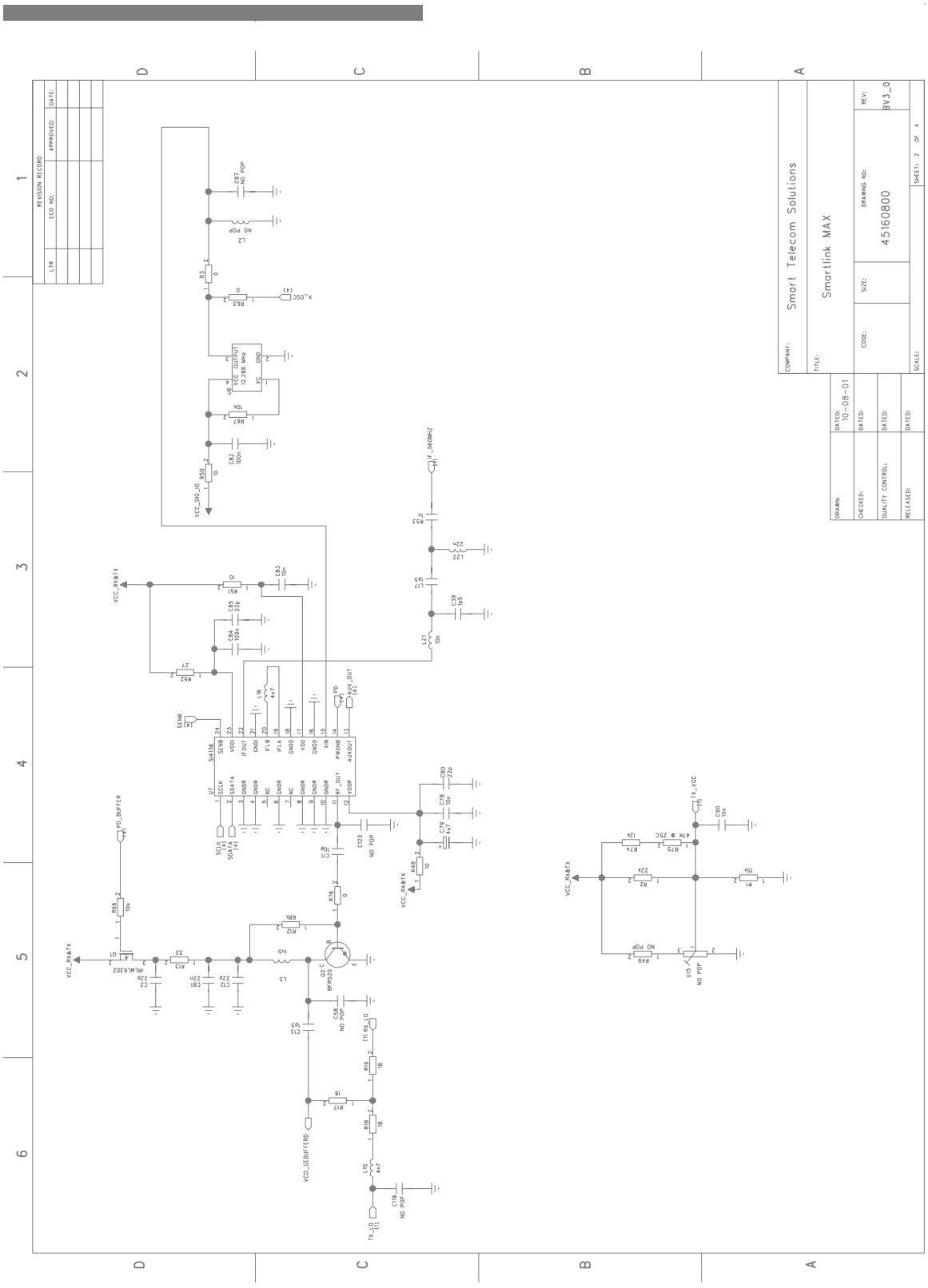
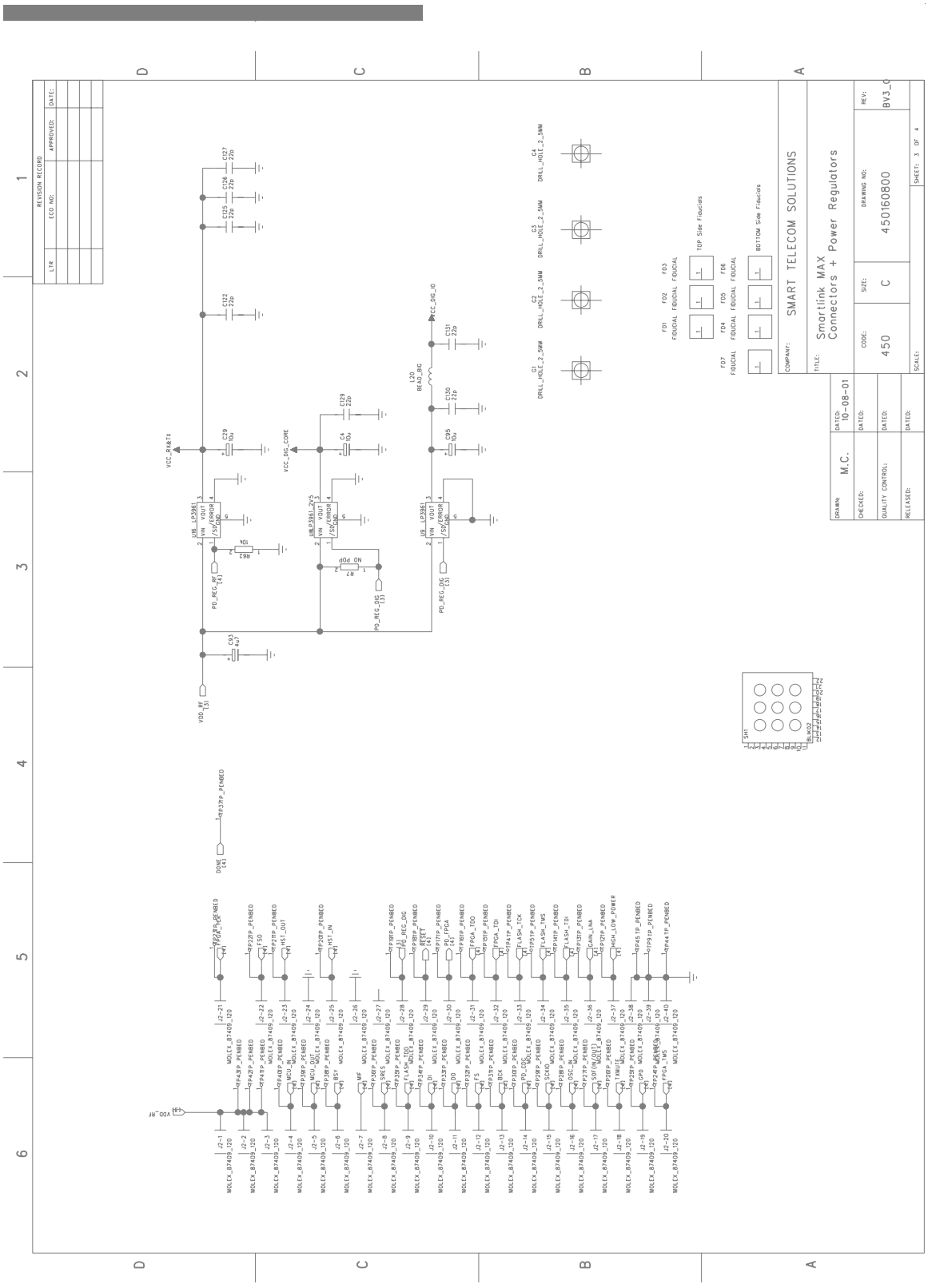


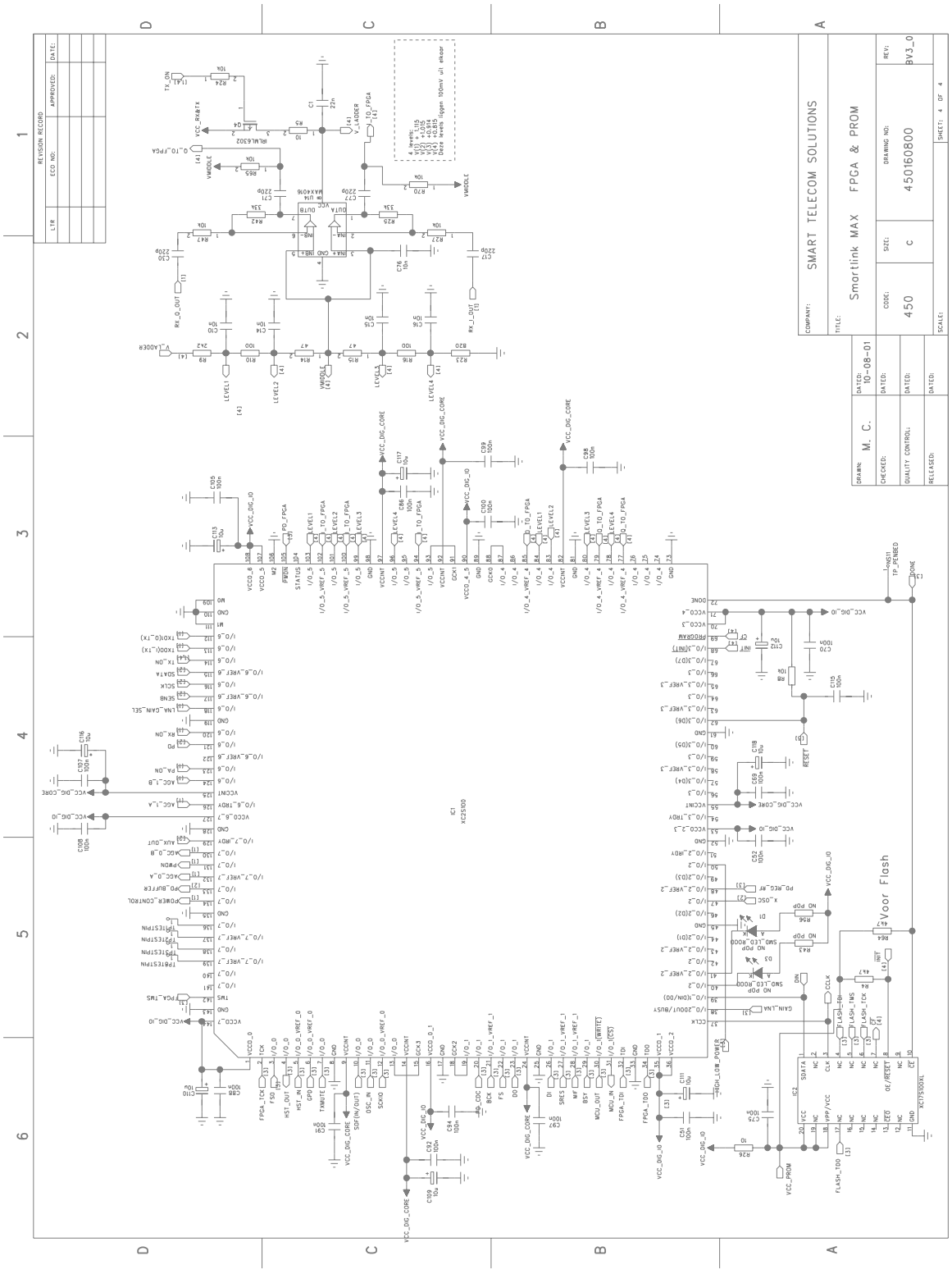
Figure 6. MAX module bottom side

Appendix B: Schematics of MAX module

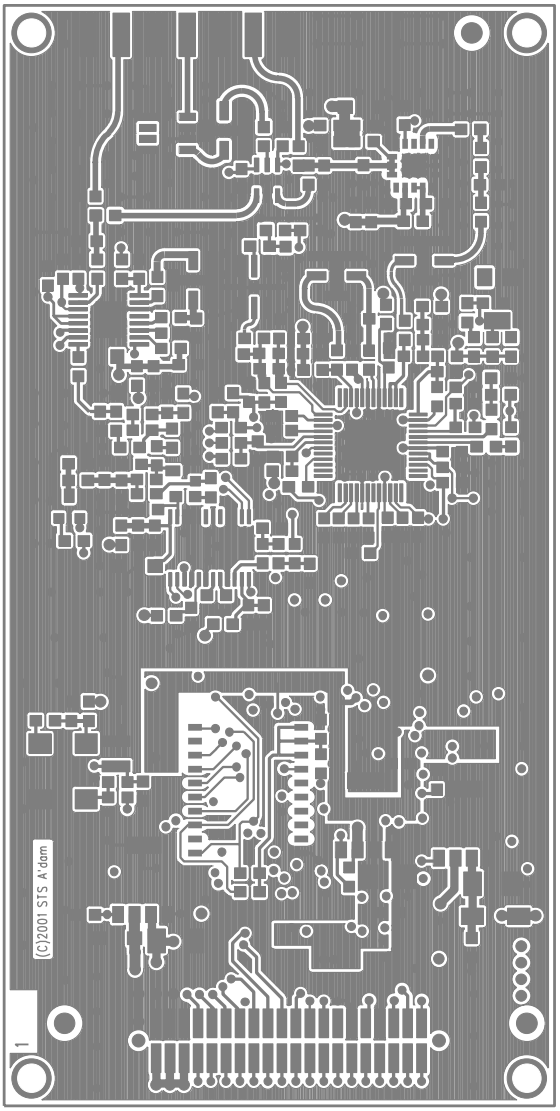



REVISION RECORD
ECO NO:
APPROVED:
DATE:
COMPANY: Smart Telecom Solutions
TITLE: Smartlink MAX
DRAWING NO: 45160800
REV: BV3_0
SIZE:
SHEET: 2 OF 4
SCALE:
DRAWN: DATED: 10-08-01
CHECKED: DATED:
QUALITY CONTROL: DATED:
RELEASED: DATED:
VCC_RX&TX
VCC_DIG_IO
VCO_SCBUFFERD
PD_BUFFER
TX_VCC
TX_IO
RX_IO
NO POP


SMART TELECOM SOLUTIONS
Smartlink MAX
Connectors + Power Regulators
450160800
VCC_RX&TX
VCC_DIG_CORE
VDD_RF
TOP Side Fiducials
BOTTOM Side Fiducials

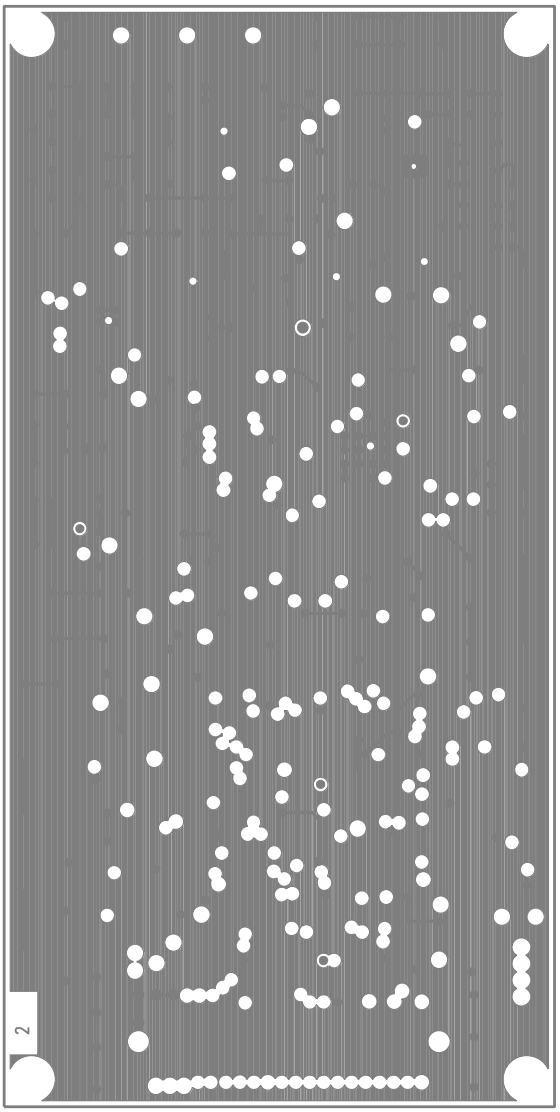

SMART TELECOM SOLUTIONS
Smartlink MAX FPGA & PROM
450160800
BV3_0
M. C.
10-08-01
Voor Flash

Appendix C: Gerber files of MAX module



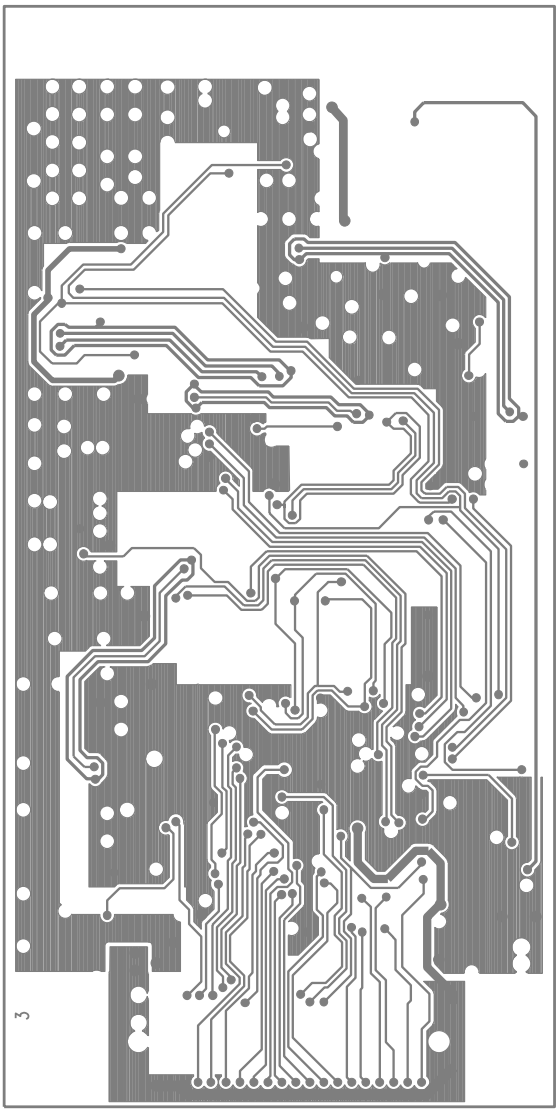
SL_MAX_BV2_16.pcb – Fri Sep 21 14:56:14 2001

Figure 7. Top layer



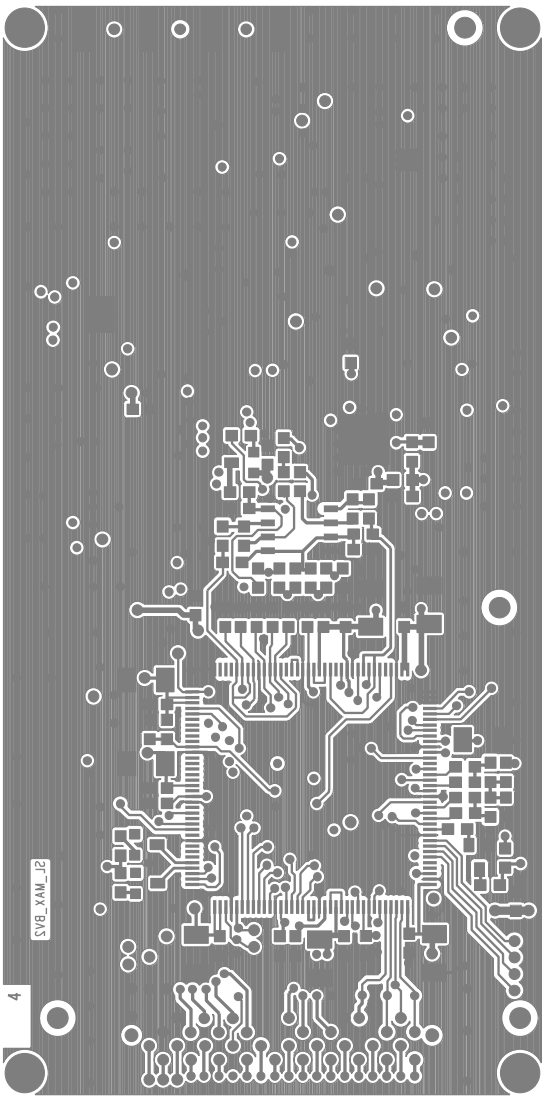
SL_MAX_BV2_16.pcb – Fri Sep 21 14:54:42 2001

Figure 8. Layer 2



SL_MAX_BV2_16.pcb – Fri Sep 21 14:55:27 2001

Figure 9. Layer 3



SL_MAX_BV2_16.pcb – Fri Sep 21 14:47:54 2001

Figure 10. Bottom layer

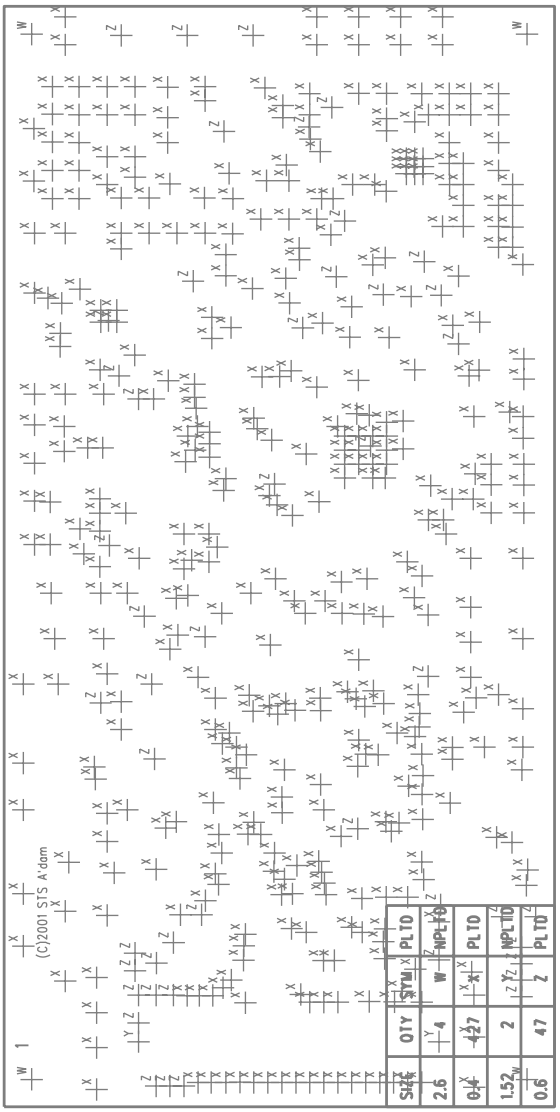


Figure 11. Drill data

Appendix D: Silk screen data of MAX module

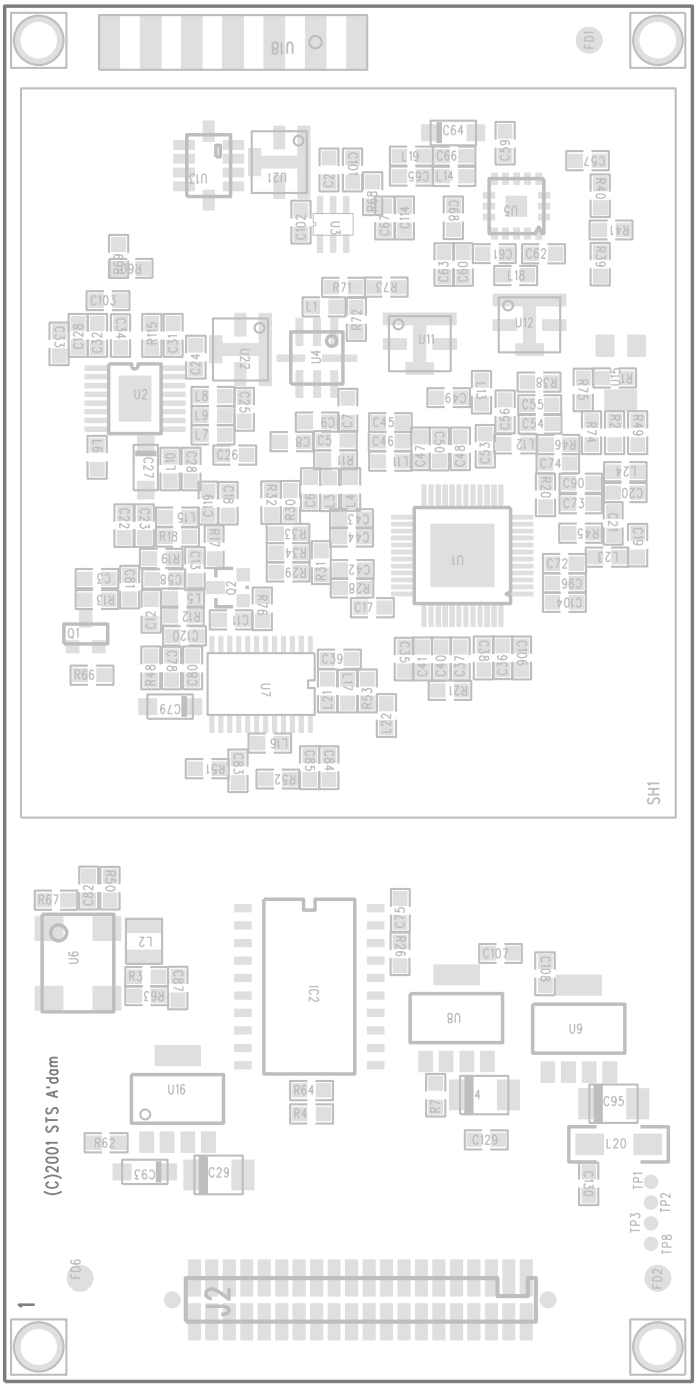


Figure 12. Silk screen top layer

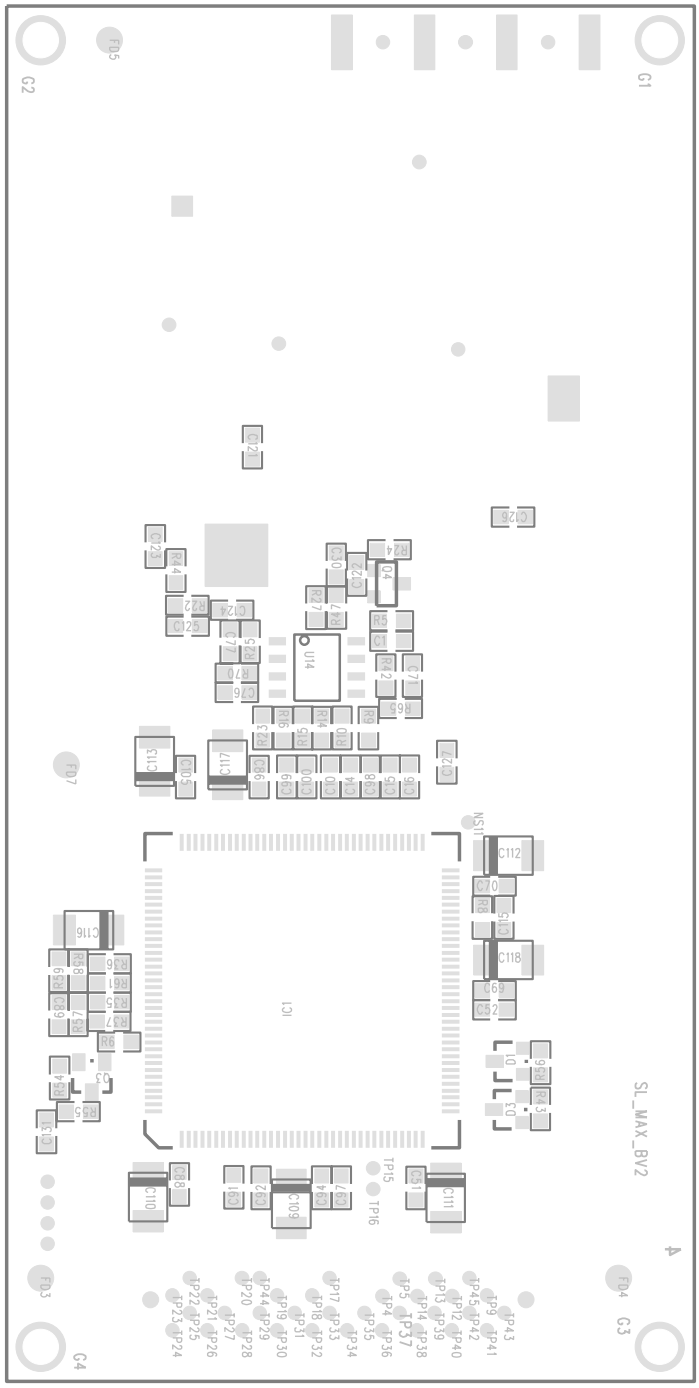


Figure 13. Silk screen bottom layer

Appendix E: Bill Of Materials of MAX module

										DOLLAR	
4	C51	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
5	C52	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
6	C69	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
7	C70	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
8	C75	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
9	C82	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
10	C84	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
11	C86	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
12	C88	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
13	C91	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
14	C92	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
15	C94	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
16	C97	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
17	C98	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
18	C99	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
19	C100	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
20	C105	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
21	C107	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
22	C108	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
23	C115	CND 100nF 16V 0603 X7R	6C100N	ALTERNATIVE	AVX KYOCERA	0603 Y C 104 K A T 2 A	100n	10% 16V dc	81340013	499-675	NEDERLAND BV
24	C9	CND 100pF 25V 0603 NP0	6C100P	ALTERNATIVE	AVX KYOCERA	0603 3 A 101 K A T 2 A	100p	10% 25V dc	81340037	722-110	NEDERLAND BV
25	C19	CND 100pF 25V 0603 NP0	6C100P	ALTERNATIVE	AVX KYOCERA	0603 3 A 101 K A T 2 A	100p	10% 25V dc	81340037	722-110	NEDERLAND BV
26	C21	CND 100pF 25V 0603 NP0	6C100P	ALTERNATIVE	AVX KYOCERA	0603 3 A 101 K A T 2 A	100p	10% 25V dc	81340037	722-110	NEDERLAND BV
27	C38	CND 100pF 25V 0603 NP0	6C100P	ALTERNATIVE	AVX KYOCERA	0603 3 A 101 K A T 2 A	100p	10% 25V dc	81340037	722-110	NEDERLAND BV
28	C66	CND 100pF 25V 0603 NP0	6C100P	ALTERNATIVE	AVX KYOCERA	0603 3 A 101 K A T 2 A	100p	10% 25V dc	81340037	722-110	NEDERLAND BV
29	C72	CND 100pF 25V 0603 NP0	6C100P	ALTERNATIVE	AVX KYOCERA	0603 3 A 101 K A T 2 A	100p	10% 25V dc	81340037	722-110	NEDERLAND BV
30	C74	CND 100pF 25V 0603 NP0	6C100P	ALTERNATIVE	AVX KYOCERA	0603 3 A 101 K A T 2 A	100p	10% 25V dc	81340037	722-110	NEDERLAND BV
31	C10	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
32	C14	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
33	C15	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
34	C16	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
35	C36	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
36	C37	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
37	C43	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
38	C44	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
39	C59	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
40	C63	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
41	C76	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
42	C78	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
43	C83	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
44	C90	CND 10nF 16V 0603 X7R	6C10N	ALTERNATIVE	AVX KYOCERA	0603 Y C 103 K A T 2 A	10n	10% 16V dc	81340001	722-236	NEDERLAND BV
45	C11	CND 10pF 25V 0603 NP0	6C10P	ALTERNATIVE	AVX KYOCERA	0603 3 A 100 K A T 2 A	10p	10% 25V dc	81340008	721-967	NEDERLAND BV
46	C23	CND 10pF 25V 0603 NP0	6C10P	ALTERNATIVE	AVX KYOCERA	0603 3 A 100 K A T 2 A	10p	10% 25V dc	81340008	721-967	NEDERLAND BV
47	C24	CND 10pF 25V 0603 NP0	6C10P	ALTERNATIVE	AVX KYOCERA	0603 3 A 100 K A T 2 A	10p	10% 25V dc	81340008	721-967	NEDERLAND BV
48	C62	CND 10pF 25V 0603 NP0	6C10P	ALTERNATIVE	AVX KYOCERA	0603 3 A 100 K A T 2 A	10p	10% 25V dc	81340008	721-967	NEDERLAND BV
49	C6	CND 1nF 25V 0603 NP0	6C1N	ALTERNATIVE	AVX KYOCERA	0603 3 A 102 K A T 2 A	1n	10% 25V dc	81340015	722-170	NEDERLAND BV
50	C60	CND 1nF 25V 0603 NP0	6C1N	ALTERNATIVE	AVX KYOCERA	0603 3 A 102 K A T 2 A	1n	10% 25V dc	81340015	722-170	NEDERLAND BV
51	C89	CND 1nF 25V 0603 NP0	6C1N	ALTERNATIVE	AVX KYOCERA	0603 3 A 102 K A T 2 A	1n	10% 25V dc	81340015	722-170	NEDERLAND BV
52	C96	CND 1nF 25V 0603 NP0	6C1N	ALTERNATIVE	AVX KYOCERA	0603 3 A 102 K A T 2 A	1n	10% 25V dc	81340015	722-170	NEDERLAND BV
53	C104	CND 1nF 25V 0603 NP0	6C1N	ALTERNATIVE	AVX KYOCERA	0603 3 A 102 K A T 2 A	1n	10% 25V dc	81340015	722-170	NEDERLAND BV
54	R53	CND 1nF 25V 0603 NP0	6C1N	ALTERNATIVE	AVX KYOCERA	0603 3 A 102 K A T 2 A	1n	10% 25V dc	81340015	722-170	NEDERLAND BV
56	C8	CND 1pF 25V 0603 NP0	6C1P	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R0 K A T 2 A	1p	10% 25V dc	81340049	721-840	NEDERLAND BV
57	C22	CND 1pF 25V 0603 NP0	6C1P	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R0 K A T 2 A	1p	10% 25V dc	81340049	721-840	NEDERLAND BV
58	C114	CND 1pF 25V 0603 NP0	6C1P	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R0 K A T 2 A	1p	10% 25V dc	81340049	721-840	NEDERLAND BV
59	C13	CND 1.5pF 25V 0603 NP0	6C1P5	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R5 K A T 2 A	1p5	10% 25V dc	81340060	721-864	NEDERLAND BV
60	C25	CND 1.5pF 25V 0603 NP0	6C1P5	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R5 K A T 2 A	1p5	10% 25V dc	81340060	721-864	NEDERLAND BV
61	C39	CND 1.5pF 25V 0603 NP0	6C1P5	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R5 K A T 2 A	1p5	10% 25V dc	81340060	721-864	NEDERLAND BV

62	C49	CND 1.5pF 25V 0603 NP0	6C1P5	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R5 K A T 2 A	1p5	10% 25V dc	81340060	721-864	NEDERLAND BV
63	C68	CND 1.5pF 25V 0603 NP0	6C1P5	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R5 K A T 2 A	1p5	10% 25V dc	81340060	721-864	NEDERLAND BV
64	C103	CND 1.5pF 25V 0603 NP0	6C1P5	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R5 K A T 2 A	1p5	10% 25V dc	81340060	721-864	NEDERLAND BV
66	L17	CND 1.5pF 25V 0603 NP0	6C1P5	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R5 K A T 2 A	1p5	10% 25V dc	81340060	721-864	NEDERLAND BV
67	C20	CND 1.8pF 25V 0603 NP0	6C1P8	ALTERNATIVE	AVX KYOCERA	0603 3 A 1R8 K A T 2 A	1p8	10% 25V dc	81340099	721-876	NEDERLAND BV
68	C17	CND 220pF 25V 0603 NP0	6C220P	ALTERNATIVE	AVX KYOCERA	0603 3 A 221 K A T 2 A	220p	10% 25V dc	81340016	722-133	NEDERLAND BV
69	C30	CND 220pF 25V 0603 NP0	6C220P	ALTERNATIVE	AVX KYOCERA	0603 3 A 221 K A T 2 A	220p	10% 25V dc	81340016	722-133	NEDERLAND BV
70	C71	CND 220pF 25V 0603 NP0	6C220P	ALTERNATIVE	AVX KYOCERA	0603 3 A 221 K A T 2 A	220p	10% 25V dc	81340016	722-133	NEDERLAND BV
71	C77	CND 220pF 25V 0603 NP0	6C220P	ALTERNATIVE	AVX KYOCERA	0603 3 A 221 K A T 2 A	220p	10% 25V dc	81340016	722-133	NEDERLAND BV
73	C1	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
74	C28	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
75	C33	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
76	C40	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
77	C41	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
78	C42	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
79	C45	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
80	C50	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
81	C53	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
82	C54	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
83	C73	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
84	C81	CND 22nF 16V 0603 X7R	6C22N	ALTERNATIVE	AVX KYOCERA	0603 Y C 223 K A T 2 A	22n	10% 16V dc	81340012	578-174	NEDERLAND BV
85	C2	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
86	C3	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
87	C12	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
88	C18	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
89	C31	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
90	C32	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
91	C46	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
92	C47	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
93	C48	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
94	C55	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
95	C56	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
96	C57	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
97	C61	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
98	C65	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
99	C67	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
100	C80	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
101	C85	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
102	C101	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
103	C102	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
104	C121	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
105	C122	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
106	C123	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
107	C124	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
108	C125	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
109	C126	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
110	C127	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
111	C128	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
112	C129	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
113	C130	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
114	C131	CND 22pF 25V 0603 NP0	6C22P	ALTERNATIVE	AVX KYOCERA	0603 3 A 220 K A T 2 A	22p	10% 25V dc	81340036	722-005	NEDERLAND BV
115	C34	CND 2.2pF 25V 0603 NP0	6C2P2	ALTERNATIVE	AVX KYOCERA	0603 3 A 2R2 K A T 2 A	2p2	10% 25V dc	81340040	721-888	NEDERLAND BV
116	C106	CND 330pF 25V 0603 NP0	6C330P	ALTERNATIVE	AVX KYOCERA	0603 3 A 331 K A T 2 A	330p	10% 25V dc	81340046	722-145	NEDERLAND BV
118	C26	CND 4.7pF 25V 0603 NP0	6C4P7	ALTERNATIVE	AVX KYOCERA	0603 3 A 4R7 K A T 2 A	4p7	10% 25V dc	81340052	721-920	NEDERLAND BV
119	C35	CND 8.2pF 25V 0603 NP0	6C8P2	ALTERNATIVE	AVX KYOCERA	0603 3 A 8R2 K A T 2 A	8p2	10% 25V dc	81340004	721-955	NEDERLAND BV
120	L3	SLF 10nH 0603 5%	6LT10N	ALTERNATIVE	TOKO	LL1608-FH10NJ	10n	5%	85670260	NOT	TRIE COMPONENTEN
121	L14	SLF 10nH 0603 5%	6LT10N	ALTERNATIVE	TOKO	LL1608-FH10NJ	10n	5%	85670260	NOT	TRIE COMPONENTEN
122	L21	SLF 10nH 0603 5%	6LT10N	ALTERNATIVE	TOKO	LL1608-FH10NJ	10n	5%	85670260	NOT	TRIE COMPONENTEN
123	L23	SLF 120nH 0603 5%	6LT120N	ALTERNATIVE	TOKO	LL1608-FSR12J	120n	5%	85670236	NOT	TRIE COMPONENTEN
124	L1	SLF 15nH 0603 5%	6LT15N	ALTERNATIVE	TOKO	LL1608-FH15NJ	15n	5%	85670269	NOT	TRIE COMPONENTEN
125	L5	SLF 1.5nH 0603 +/-0.3nH	6LT1N5	ALTERNATIVE	TOKO	LL1608-FH1N5S	1n5	+/-0.3nH	85670261	NOT	TRIE COMPONENTEN
126	L9	SLF 1.5nH 0603 +/-0.3nH	6LT1N5	ALTERNATIVE	TOKO	LL1608-FH1N5S	1n5	+/-0.3nH	85670261	NOT	TRIE COMPONENTEN
127	L11	SLF 1.5nH 0603 +/-0.3nH	6LT1N5	ALTERNATIVE	TOKO	LL1608-FH1N5S	1n5	+/-0.3nH	85670261	NOT	TRIE COMPONENTEN
128	L22	SLF 22nH 0603 5%	6LT22N	ALTERNATIVE	TOKO	LL1608-FH22NJ	22n	5%	85670270	NOT	TRIE COMPONENTEN

129	L7	SLF 2.2nH 0603 +/-0.3nH		6LT2N2	ALTERNATIVE	TOKO	LL1608-FH2N2S	2n2		+/-0.3nH	85670262	NOT	TRIE COMPONENTEN
130	L12	SLF 2.7nH 0603 +/-0.3nH		6LT2N7	ALTERNATIVE	TOKO	LL1608-FH2N7S	2n7		+/-0.3nH	85670263	NOT	TRIE COMPONENTEN
131	L4	SLF 47nH 0603 5%		6LT47N	ALTERNATIVE	TOKO	LL1608-FH47NJ	47n		5%	85670278	NOT	TRIE COMPONENTEN
132	L24	SLF 47nH 0603 5%		6LT47N	ALTERNATIVE	TOKO	LL1608-FH47NJ	47n		5%	85670278	NOT	TRIE COMPONENTEN
133	L8	SLF 4.7nH 0603 +/-0.3nH		6LT4N7	ALTERNATIVE	TOKO	LL1608-FH4N7S	4n7		+/-0.3nH	85670265	NOT	TRIE COMPONENTEN
134	L15	SLF 4.7nH 0603 +/-0.3nH		6LT4N7	ALTERNATIVE	TOKO	LL1608-FH4N7S	4n7		+/-0.3nH	85670265	NOT	TRIE COMPONENTEN
135	L16	SLF 4.7nH 0603 +/-0.3nH		6LT4N7	ALTERNATIVE	TOKO	LL1608-FH4N7S	4n7		+/-0.3nH	85670265	NOT	TRIE COMPONENTEN
136	L6	SLF 6.8nH 0603 5%		6LT6N8	ALTERNATIVE	TOKO	LL1608-FH6N8J	6n8		5%	85670266	NOT	TRIE COMPONENTEN
137	R11	SLF 82nH 0603 5%		6LT82N	ALTERNATIVE	TOKO	LL1608-FH82NJ	82n		5%	85670279	NOT	TRIE COMPONENTEN
138	R75	RES NTC 47K 0603		6NTC47K	PREFERRED	MURATA	NTH5G16P40B473F07TH	47K @ 25 C		TEMP: 4050 3%, RES: 1%	80300020	732-163	ijkN/Dc:at$i
139	R3	RES 0 0603 1%		6R0	ALTERNATIVE	ROHM	MCR03 EZH F 000	0		1%	80260019	772-227 N	ELECTRONICS B/
140	R60	RES 0 0603 1%		6R0	ALTERNATIVE	ROHM	MCR03 EZH F 000	0		1%	80260019	772-227 N	ELECTRONICS B/
141	R63	RES 0 0603 1%		6R0	ALTERNATIVE	ROHM	MCR03 EZH F 000	0		1%	80260019	772-227 N	ELECTRONICS B/
142	R76	RES 0 0603 1%		6R0	ALTERNATIVE	ROHM	MCR03 EZH F 000	0		1%	80260019	772-227 N	ELECTRONICS B/
143	R5	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
144	R22	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
145	R26	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
146	R28	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
147	R38	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
148	R44	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
149	R45	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
150	R46	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
151	R48	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
152	R50	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
153	R51	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
154	R115	RES 10 0603 1%		6R10	ALTERNATIVE	ROHM	MCR03 EZH F 100	10		1%	80261009	910-995 N	ELECTRONICS B/
155	R17	RES 18 0603 1%		6R18	ALTERNATIVE	ROHM	MCR03 EZH F 180	18		1%	80261809	911-021 N	ELECTRONICS B/
156	R18	RES 18 0603 1%		6R18	ALTERNATIVE	ROHM	MCR03 EZH F 180	18		1%	80261809	911-021 N	ELECTRONICS B/
157	R19	RES 18 0603 1%		6R18	ALTERNATIVE	ROHM	MCR03 EZH F 180	18		1%	80261809	911-021 N	ELECTRONICS B/
158	R39	RES 18 0603 1%		6R18	ALTERNATIVE	ROHM	MCR03 EZH F 180	18		1%	80261809	911-021 N	ELECTRONICS B/
159	R40	RES 18 0603 1%		6R18	ALTERNATIVE	ROHM	MCR03 EZH F 180	18		1%	80261809	911-021 N	ELECTRONICS B/
160	R52	RES 27 0603 1%		6R27	ALTERNATIVE	ROHM	MCR03 EZH F 270	27		1%	80262709	911-045 N	ELECTRONICS B/
161	R13	RES 33 0603 1%		6R33	ALTERNATIVE	ROHM	MCR03 EZH F 330	33		1%	80263309	911-057 N	ELECTRONICS B/
162	R14	RES 47 0603 1%		6R47	ALTERNATIVE	ROHM	MCR03 EZH F 470	47		1%	80264709	911-070 N	ELECTRONICS B/
163	R15	RES 47 0603 1%		6R47	ALTERNATIVE	ROHM	MCR03 EZH F 470	47		1%	80264709	911-070 N	ELECTRONICS B/
164	R41	RES 47 0603 1%		6R47	ALTERNATIVE	ROHM	MCR03 EZH F 470	47		1%	80264709	911-070 N	ELECTRONICS B/
165	R72	RES 82 0603 1%		6R82	ALTERNATIVE	ROHM	MCR03 EZH F 820	82		1%	80268209	911-100 N	ELECTRONICS B/
166	R73	RES 82 0603 1%		6R82	ALTERNATIVE	ROHM	MCR03 EZH F 820	82		1%	80268209	911-100 N	ELECTRONICS B/
167	R10	RES 100 0603 1%		6R100	ALTERNATIVE	ROHM	MCR03 EZH F 101	100		1%	80261001	911-112 N	ELECTRONICS B/
168	R16	RES 100 0603 1%		6R100	ALTERNATIVE	ROHM	MCR03 EZH F 101	100		1%	80261001	911-112 N	ELECTRONICS B/
169	R71	RES 100 0603 1%		6R100	ALTERNATIVE	ROHM	MCR03 EZH F 101	100		1%	80261001	911-112 N	ELECTRONICS B/
170	R35	RES 680 0603 1%		6R680	ALTERNATIVE	ROHM	MCR03 EZH F 681	680		1%	80266801	911-215 N	ELECTRONICS B/
171	R36	RES 680 0603 1%		6R680	ALTERNATIVE	ROHM	MCR03 EZH F 681	680		1%	80266801	911-215 N	ELECTRONICS B/
172	R23	RES 820 0603 1%		6R820	ALTERNATIVE	ROHM	MCR03 EZH F 821	820		1%	80268201	911-227 N	ELECTRONICS B/
173	R6	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
174	R8	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
175	R24	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
176	R27	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
177	R47	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
178	R62	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
179	R65	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
180	R66	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
181	R67	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
182	R70	RES 10K 0603 1%		6R10K	ALTERNATIVE	ROHM	MCR03 EZH F 103	10k		1%	80261003	911-355 N	ELECTRONICS B/
183	R74	RES 12K 0603 1%		6R12K	ALTERNATIVE	ROHM	MCR03 EZH F 123	12k		1%	80261203	911-367 N	ELECTRONICS B/
184	R1	RES 15K 0603 1%		6R15K	ALTERNATIVE	ROHM	MCR03 EZH F 153	15k		1%	80261503	911-379 N	ELECTRONICS B/
185	R54	RES 15K 0603 1%		6R15K	ALTERNATIVE	ROHM	MCR03 EZH F 153	15k		1%	80261503	911-379 N	ELECTRONICS B/
186	R59	RES 15K 0603 1%		6R15K	ALTERNATIVE	ROHM	MCR03 EZH F 153	15k		1%	80261503	911-379 N	ELECTRONICS B/
187	R2	RES 22K 0603 1%		6R22K	ALTERNATIVE	ROHM	MCR03 EZH F 223	22k		1%	80262203	911-392 N	ELECTRONICS B/
188	R33	RES 22K 0603 1%		6R22K	ALTERNATIVE	ROHM	MCR03 EZH F 223	22k		1%	80262203	911-392 N	ELECTRONICS B/
189	R34	RES 22K 0603 1%		6R22K	ALTERNATIVE	ROHM	MCR03 EZH F 223	22k		1%	80262203	911-392 N	ELECTRONICS B/
190	R20	RES 270K 0603 1%		6R270K	ALTERNATIVE	ROHM	MCR03 EZH F 274	270k		1%	80262704	911-525 N	ELECTRONICS B/
191	R9	RES 2.2K 0603 1%		6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2		1%	80262202	911-276 N	ELECTRONICS B/
192	R29	RES 2.2K 0603 1%		6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2		1%	80262202	911-276 N	ELECTRONICS B/

199	R30	RES 2.2k 0603 1%	6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2	1%	80262202	911-276 M	ELECTRONICS B/		
200	R31	RES 2.2k 0603 1%	6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2	1%	80262202	911-276 M	ELECTRONICS B/		
201	R32	RES 2.2k 0603 1%	6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2	1%	80262202	911-276 M	ELECTRONICS B/		
202	R37	RES 2.2k 0603 1%	6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2	1%	80262202	911-276 M	ELECTRONICS B/		
203	R57	RES 2.2k 0603 1%	6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2	1%	80262202	911-276 M	ELECTRONICS B/		
204	R58	RES 2.2k 0603 1%	6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2	1%	80262202	911-276 M	ELECTRONICS B/		
205	R61	RES 2.2k 0603 1%	6R2K2	ALTERNATIVE	ROHM	MCR03 EZH F 222	2k2	1%	80262202	911-276 M	ELECTRONICS B/		
206	R25	RES 33k 0603 1%	6R33K	ALTERNATIVE	ROHM	MCR03 EZH F 333	33k	1%	80263303	911-410 M	ELECTRONICS B/		
207	R42	RES 33k 0603 1%	6R33K	ALTERNATIVE	ROHM	MCR03 EZH F 333	33k	1%	80263303	911-410 M	ELECTRONICS B/		
208	R21	RES 47k 0603 1%	6R47K	ALTERNATIVE	ROHM	MCR03 EZH F 473	47k	1%	80264703	911-434 M	ELECTRONICS B/		
209	R4	RES 4.7k 0603 1%	6R4K7	ALTERNATIVE	ROHM	MCR03 EZH F 472	4k7	1%	80264702	911-318 M	ELECTRONICS B/		
210	R64	RES 4.7K 0603 1%	6R4K7	ALTERNATIVE	ROHM	MCR03 EZH F 472	4k7	1%	80264702	911-318 M	ELECTRONICS B/		
211	R55	RES 56k 0603 1%	6R56K	ALTERNATIVE	ROHM	MCR03 EZH F 563	56k	1%	80265603	911-446 M	ELECTRONICS B/		
212	R12	RES 68k 0603 1%	6R68K	ALTERNATIVE	ROHM	MCR03 EZH F 683	68k	1%	80266803	911-458 M	ELECTRONICS B/		
213	U3	SWI SPDT 2.4GHz	ASI69_73	PREFERRED	ALPHA	ASI69-73	ASI69-73	-	83740148	SEMI DICE	INTERNATIONAL		
214	Q3	TRA BC847A NPN	BC847	ALTERNATIVE	PHILIPS	BC847A	BC847A	-	82330002	932-980	Malchus		
215	L20	SLF BLM41P800S EMIFIL 1806	BEAD_BIG	ALTERNATIVE	MURATA	BLM41P800SPT	00 MHz 80 Ohm	-	85670258		DECATEL		
216	L10	SLF NCB0603R600 0603	BEAD_SMALL	ALTERNATIVE	NIC	NCB0603R600	100 MHz 60 Ohm	25% DC R$s	istanc$ 0.2 Ohm	85670273		Futur$	
217	L13	SLF NCB0603R600 0603	BEAD_SMALL	ALTERNATIVE	NIC	NCB0603R600	100 MHz 60 Ohm	25% DC R$s	istanc$ 0.2 Ohm	85670273		Futur$	
218	L18	SLF NCB0603R600 0603	BEAD_SMALL	ALTERNATIVE	NIC	NCB0603R600	100 MHz 60 Ohm	25% DC R$s	istanc$ 0.2 Ohm	85670273		Futur$	
219	L19	SLF NCB0603R600 0603	BEAD_SMALL	ALTERNATIVE	NIC	NCB0603R600	100 MHz 60 Ohm	25% DC R$s	istanc$ 0.2 Ohm	85670273		Futur$	
220	Q2	TRA BFR520 NPN	BFR520	PREFERRED	PHILIPS	BFR520	BFR520	-	82330092	741-747	TPC		
221	SH1	REEN SMARTTELECOM 02 & LID SMARTTELE	BLIK02	PREFERRED	MICROMETALLIC	RTTELECOM 02 & SMARTTELE.CO	-	84690316 & 9468	-	CROMETALLIC			
223	C4	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
224	C29	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
225	C95	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
226	C109	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
227	C110	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
228	C111	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
229	C112	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
230	C113	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
231	C116	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
232	C117	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
233	C118	CND 10uF 16V Tant.B	CT10U	ALTERNATIVE	AVX KYOCERA	TAJB106K016X	10u	+/- 10% 16V dc	81840051	498-737	NEDERLAND BV		
234	C27	CND 4.7uF 16V Tant.A	CT4U7	ALTERNATIVE	AVX KYOCERA	TAJA475K016X	4u7	+/- 10% 16V dc	81840052	197-269	NEDERLAND BV		
235	C64	CND 4.7uF 16V Tant.A	CT4U7	ALTERNATIVE	AVX KYOCERA	TAJA475K016X	4u7	+/- 10% 16V dc	81840052	197-269	NEDERLAND BV		
236	C79	CND 4.7uF 16V Tant.A	CT4U7	ALTERNATIVE	AVX KYOCERA	TAJA475K016X	4u7	+/- 10% 16V dc	81840052	197-269	NEDERLAND BV		
237	C93	CND 4.7uF 16V Tant.A	CT4U7	ALTERNATIVE	AVX KYOCERA	TAJA475K016X	4u7	+/- 10% 16V dc	81840052	197-269	NEDERLAND BV		
238	U11	FLT DFC22R44P084LHA BPF	DFC_22_LIGHT	PREFERRED	MURATA	DFC22R44P084LHA	Fc=2.4GHz	-	85670259	-	k$rk El$ktronika		
239	U12	FLT DFC22R44P084LHA BPF	DFC_22_LIGHT	PREFERRED	MURATA	DFC22R44P084LHA	Fc=2.4GHz	-	85670259	-	k$rk El$ktronika		
240	U21	FLT DFC22R44P084LHA BPF	DFC_22_LIGHT	PREFERRED	MURATA	DFC22R44P084LHA	Fc=2.4GHz	-	85670259	-	k$rk El$ktronika		
241	U22	FLT DFC22R44P084LHA BPF	DFC_22_LIGHT	PREFERRED	MURATA	DFC22R44P084LHA	Fc=2.4GHz	-	85670259	-	k$rk El$ktronika		
253	Q1	TRA IRLML6302 FET PMOS	IRLML6302	ALTERNATIVE	Int$rnational R$ctifi$r	IRLML6302	IRLML6302		82330093		?		
254	Q4	TRA IRLML6302 FET PMOS	IRLML6302	ALTERNATIVE	Int$rnational R$ctifi$r	IRLML6302	IRLML6302		82330093		?		
255	U13	FLT LFK30-05E2442L084 LPF	LFK30-05E2442L084	PREFERRED	Murata	LFK30-05E2442L084	Fc=2.4GHz		85670271		NIJKERK/DECATEL		
256	U9	CIN LP3961EMP-3.3	LP3961	PREFERRED	National S$miconductor	LP3961EMP-3.3	3V 800mA SOT223-5		83520086	-	EBV		
257	U16	CIN LP3961EMP-3.3	LP3961	PREFERRED	National S$miconductor	LP3961EMP-3.3	3V 800mA SOT223-5		83520086	-	EBV		
258	U8	CIN LP3961EMP-2.5	LP3961_2V5	PREFERRED	National S$miconductor	LP3961EMP-2.5	5V 800mA SOT223-5		83520085	-	EBV		
259	U14	CIN MAX4016ESA	MAX4016	PREFERRED	MAXIM	MAX4016ESA	DUAL OPAMP SO		83500075	-	NG EN HARTMAN		
260	J2	CON BERG 40pts 87409-120TR	MOLEX_87409_120	PREFERRED	BERG	7409-120TR Tap$ & r$$l w/pick-up de	DETOR_50 MIL	-	84350244		AVNET		
261	U6	QTZ 12.288MHz 25ppm	RAKON_SXO110A_12_288	PREFERRED	RAKON	SXO110A 12.288MHz	12.288 MHz	25 ppm	83480118	-	RAKON		
262	U5	CIN RF2189	RF2189	PREFERRED	RFMD	RF2189	PA 2.4GHz 3V	-	89000084		RFMD		
263	U2	CIN RF2444	RF2444	PREFERRED	RFMD	RF2444	IDOWNCONVERT	-	89000085		RFMD		
264	U1	CIN RF2938	RF2938	PREFERRED	RFMD	RF2938	d Sp$ctrum Trans	-	89000086		RFMD		
265	U4	FLT 855954 (old nam$: 855771)	SAW855771	PREFERRED	SAWTEK	855954 (old nam$: 855771)	Fc=380MHz BW=	-	83740150		SAWTEK		
266	U7	CIN Si4136-BT	Si4136	PREFERRED	Silicon Labs	Si4136-BT	YNTHESIZER WIT	-	89000087		SILICON LABS		
312	IC2	CIN XC17S100A-SO20C	XC17S100XL	PREFERRED	XILINX	XC17S100A-SO20C	OTP CONFIG RR		83270070		AVNET		
313	IC1	CIN XC2S100-5TQ144C	XC2S100	PREFERRED	XILINX	XC2S100-5TQ144C	SPARTAN-II FPG		83740149		AVNET		