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ACCREDITED
Certificate Number 1953-01

Amendment to Test Report R062602-01

Company: PDM Industries
805Galvin Road South #100
Bellevue, NE 68005

Contact: Fred Davis

Product: BullzI RF Tag, BITGA-12, 25 and 50
FCC ID: QFFLLIBCRAMDERF

Test Report No: R062602-01A

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DATE: 31 July 2002
Total Pages: 20

NCEE is a FCC registered lab. Registration #100875

Table of Contents

1.0 Summary of test results

1.1 Test Results

The EUT was shown to comply with the guidelines for intentional radiators according to Parts 15.203, 15.209 and 15.231e. See Section 4 for more detailed information.

1.2 Test Methods

The equipment was tested to comply with CFR 47, Part 15, for intentional radiators. The EUT was tested in accordance to methods of ANSI/IEEE C63.4, 2001. The configuration of the EUT was varied to maximize emissions. All measurements were made at a distance of 3 meters; the antenna height was varied from 1 meter to 4 meters. Both antenna polarizations were examined. The orientation of the EUT was first examined to determine in which position the EUT produced the greatest emissions. New batteries were used.

1.3 Reason for amended report

Modifications from the original report have been made in order to better clarify the measurement results.

2.0 Description

2.1 Equipment under test

The BullzI RF tags are for use with the BullzI asset tracking system. There are three models of tags each with a different duration between transmissions, the shortest duration being 12 seconds.

2.1.1 Identification: BullzI RF Tag, BITGA-0 (test unit), 2, 12 and 25

2.1.2 EUT received date: 22 July 2002

2.1.3 EUT tested date: 22 July 2002

2.1.4 Manufacturer: PDM Industries, Bellevue, NE

2.1.5 Serial numbers: BITGA-12, SN: C100100; BITGA-25, SN: GO1CGS1; BITGA-0, SN: test1; BITGA-2, SN: 1C1C1C1

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility, which is a FCC registered lab. This site has been fully described in a report submitted to the FCC, and accepted in a letter dated May 4, 2001. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 56 ± 5%

Temperature of 24 ± 3° Celsius

2.3 Special equipment or setup

Two tags were modified to transmit more frequently than once per 10-second interval. One unit was set to transmit continuously. The second, SN: 1C1C1C1 was set to transmit at a 2 second interval.

3.0 Test equipment used

Serial #	*Manufacturer*	*Model*	*Description*	*Last cal.*
1654	EMCO	3142B	Biconilog antenna	3-May-02
6415	EMCO	3115	DRG Horn ant.	24-Oct-01
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	11-Jun-02
082001/003	Rohde & Schwarz	TS-PR18	Preamplifier	10-Aug-01
2575	Rohde & Schwarz	ES-K1	Software v1.60	N/A

4.0 Detailed Results

4.1 FCC Part 15.203

The antenna is incorporated into the printed circuit board and there are no connectors attached to it or leading into the case. The plastic case is sealed against moisture. Thus the EUT complies with part 15.203.

4.2 FCC Part 15.231e

The EUT, SN: test1, was used to first find the orientation of the EUT that provided the worst case. The emissions from the unit were then examined from 30MHz to 4GHz. The antenna was positioned 3m from the EUT and the antenna position was varied between 1 and 4 meters as the EUT was rotated on the turntable. Figures 1 through 3 show the test setup that provided a worst-case configuration. Figure 3 is the EUT in its plastic case as configured for final measurements. A table showing the final results is shown below. All measurements were taken using a quasi-peak detector set to 120kHz bandwidth for measurements under 1GHz, for measurements over 1GHz an average detector set to 1MHz bandwidth was used. An averaging factor was applied to the measurements. The BullzI tag ID Code is an 896 bit binary number. All tag ID Codes are unique and always have forty-nine (49) bits (of the 896 bits) in the “1” state. The tag only transmits these forty-nine (49) bits. The period of one bit is 122.04μs, therefore:

Maximum Transmission Duration = 896 bits X 122.04μs / bit = 109.3 mSec

In the worst case, some BullzI tag ID Codes will be transmitted in slightly less than 100mSec. Therefore:

$$Ave = Pk - [20\log((Pw*N)/100mS)]$$

Where:

Ave = Calculated average fundamental field strength in dBμv/m

Pk = Peak Corrected Field Strength Measurement in dBµv/m
Pw = Transmitted Pulse Width in milliseconds
N = Number of pulses in a 100 millisecond window, worst case

Assuming the transmitted pulse width equals the modulating pulse width then:

Pw = 122 µS, N = 49
Ave = Pk - [20log((.122 * 49) / 100)]
Ave = Pk – 24.47 dBµv/m

Allowing for further error a correction of –20dB was used in providing the results below.

Frequency MHz	Level dBµV/m	Level (AV Corrected) dBµV/m	Limit dBµV/m	Margin dB	Height cm	Angle deg	Pol.
303.84	79.44	59.44	66.9	7.46	100	154	HORIZONTAL
607.74	65.03	45.03	47	1.97	115	356	HORIZONTAL
911.58	62.83	42.83	47	4.17	100	200	HORIZONTAL
1215.5	56.25	36.25	53.9	17.65	99	107	HORIZONTAL
1519.5	72.85	52.85	53.9	1.05	107	331	HORIZONTAL
1823	59.95	39.95	53.9	13.95	106	61	VERTICAL
2127	60.29	40.29	53.9	13.61	119	3	HORIZONTAL
2431	66.14	46.14	53.9	7.76	106	71	VERTICAL
2735	66.27	46.27	53.9	7.63	106	27	HORIZONTAL
3342.5	51.52	31.52	53.9	22.38	141	35	VERTICAL
3646.5	59.86	39.86	53.9	14.04	201	255	HORIZONTAL
3950.5	55.04	35.04	53.9	18.86	178	254	HORIZONTAL

All measurement results are located in the corresponding interval with a probability of approximately 95% (coverage factor k=2). The interval for these measurements is U_x (expanded uncertainty):

Radiated Emissions, 30MHz – 1GHz, 3m distance: U_x = +/- 3.4 dB
Radiated Emissions, 1GHz – 4GHz, 3m distance: U_x = +/- 3.6 dB

Figures 8 and 9 show that the 20dB bandwidth of the signal is less than 150kHz. Figure 10 shows the time between pulses for the BITGA-12 transmitter, which is the shortest period between pulses. Figures 11 and 12 show the pulse trains for 2 different models.

Appendix A

Test setup photos

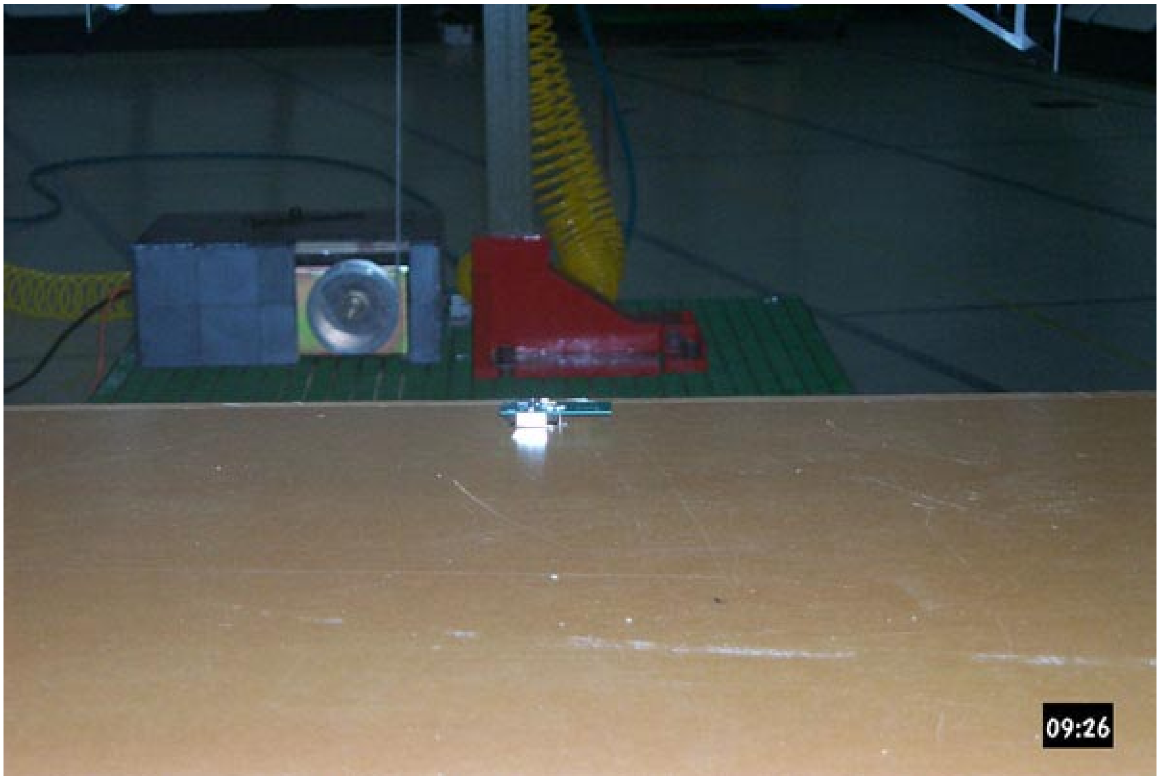

Figure 1 Configuration of EUT found to produce worst-case emissions

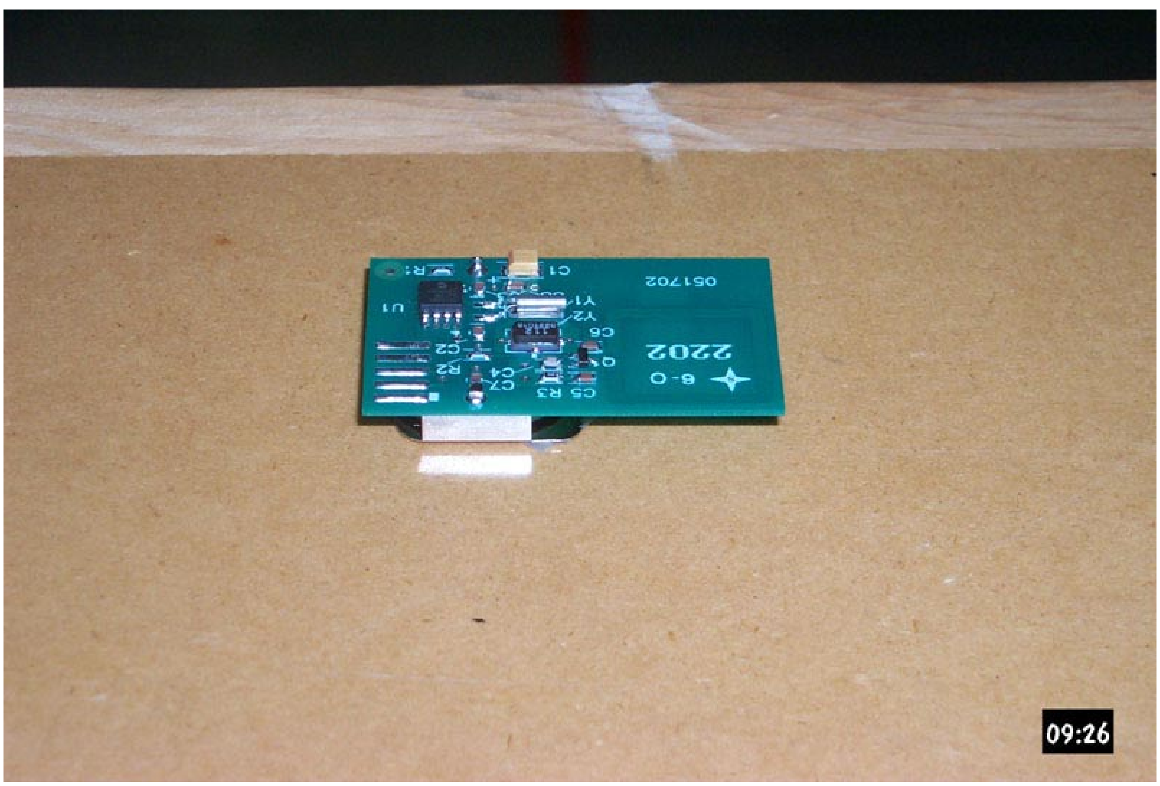

Figure 2 Close-up of EUT on table

Figure 3 Final configuration of EUT in plastic case, orientation matching worst-case

Appendix B

Emissions results

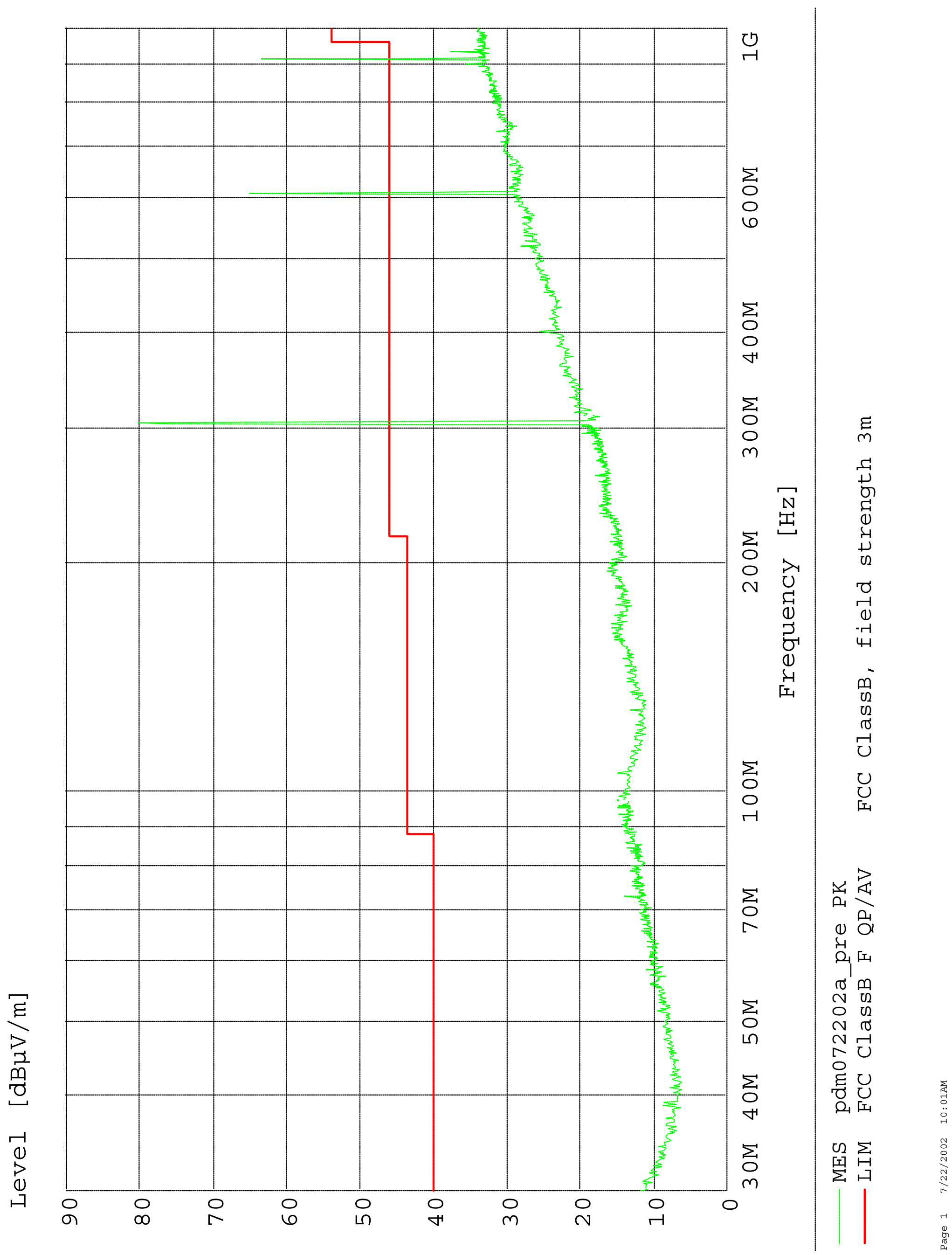

Figure 4 Radiated Emissions, no averaging correction

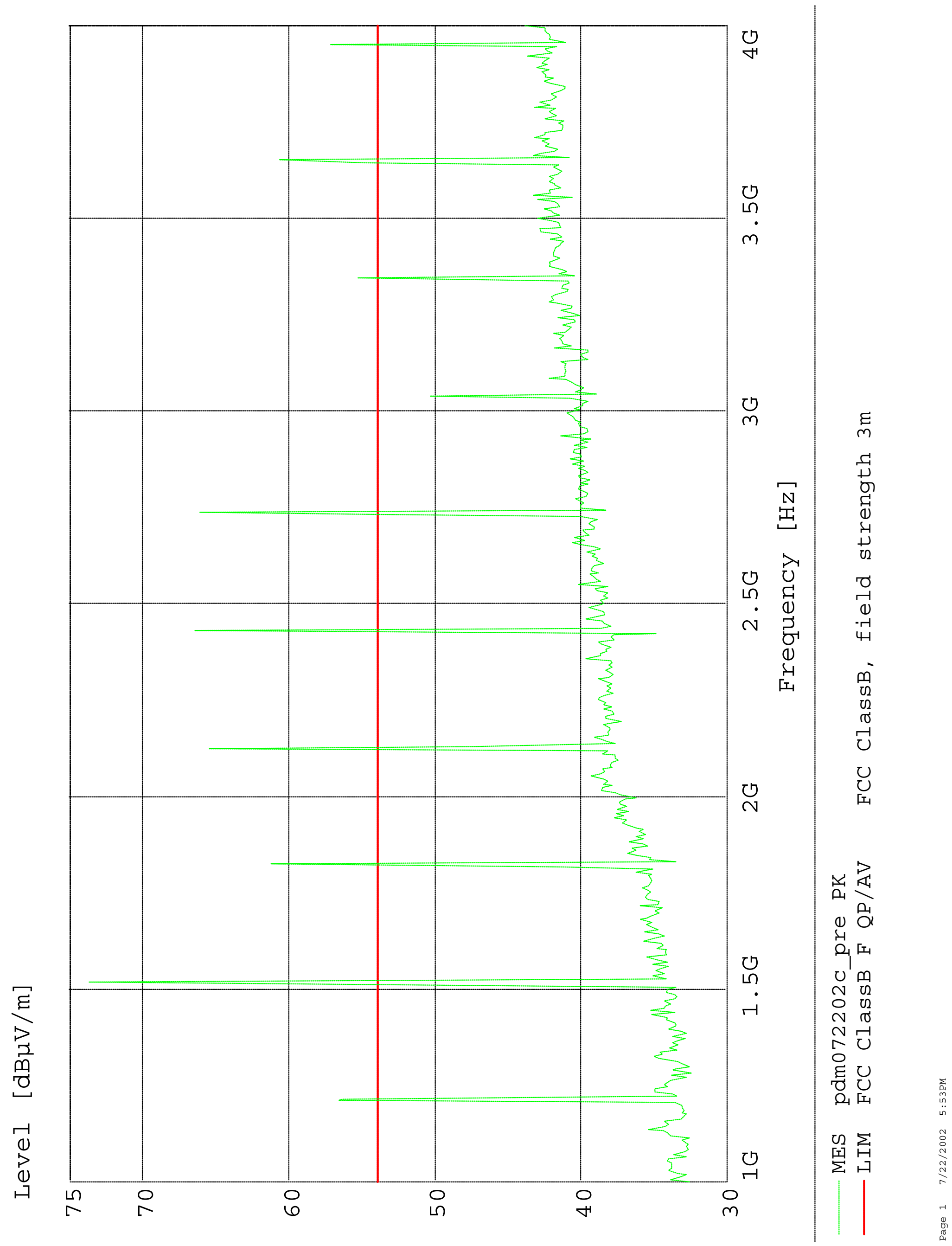

Figure 5 Radiated Emissions, no averaging correction

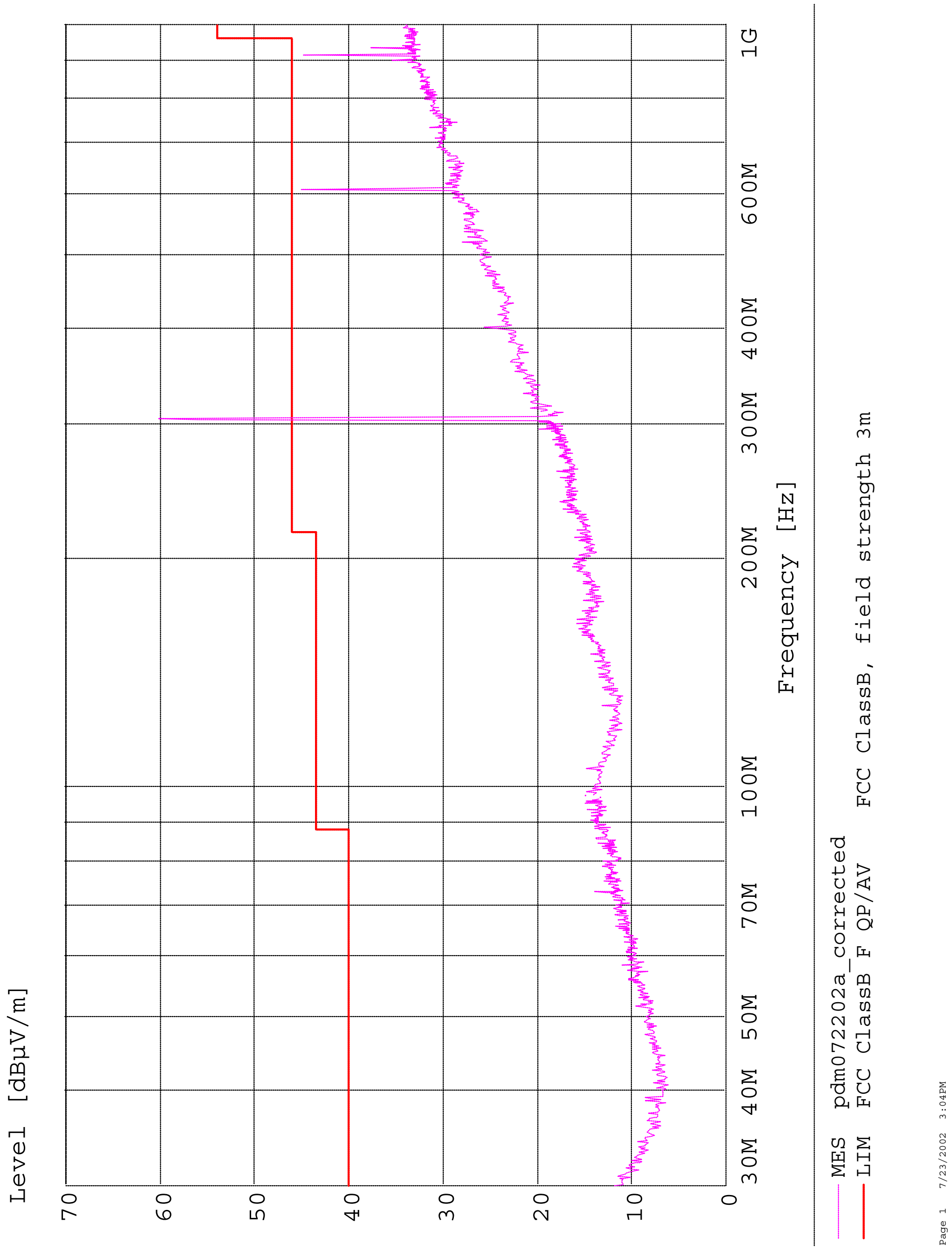

Figure 6 Radiated Emissions, with 20dB averaging correction

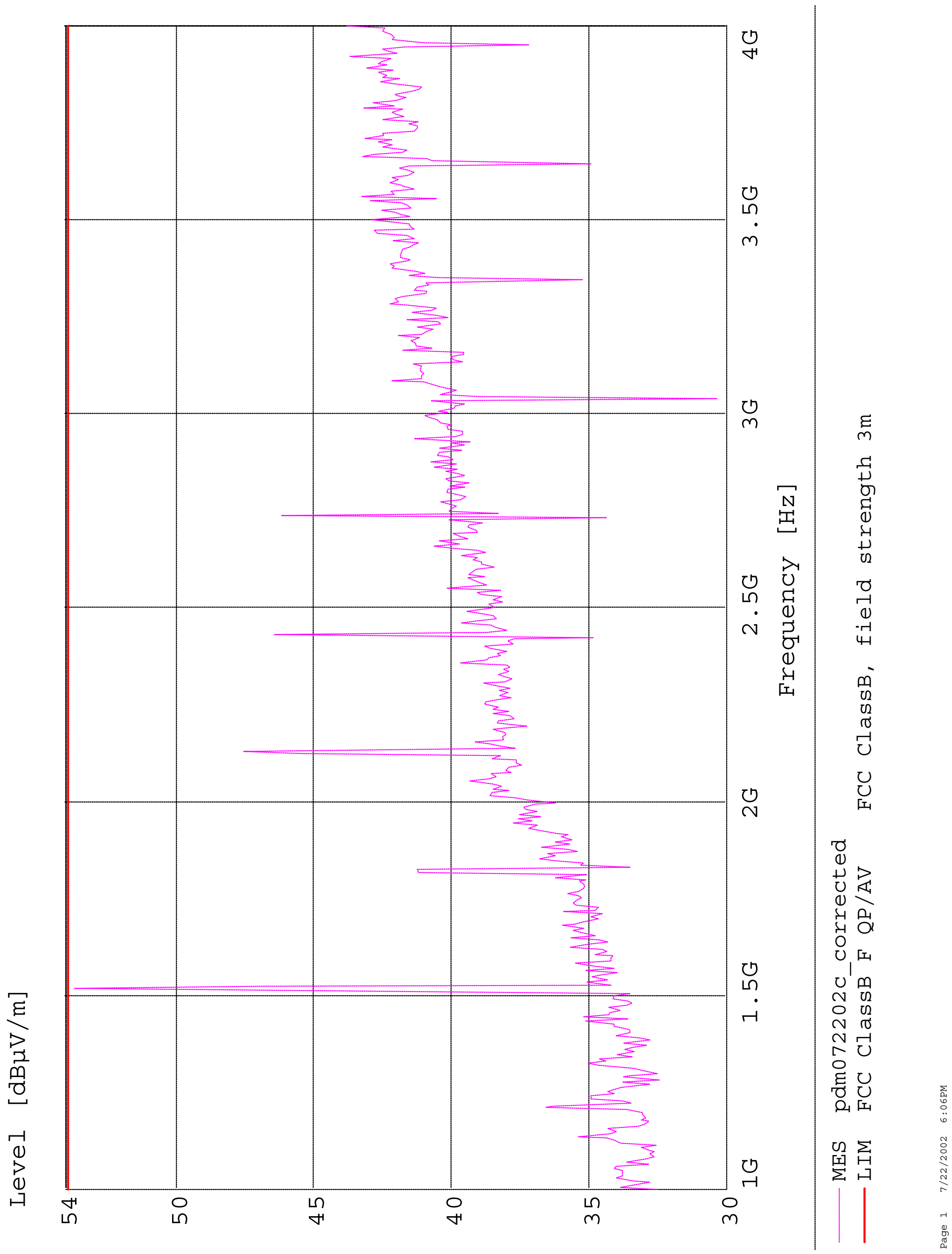

Figure 7 Radiated Emissions, with 20dB averaging correction

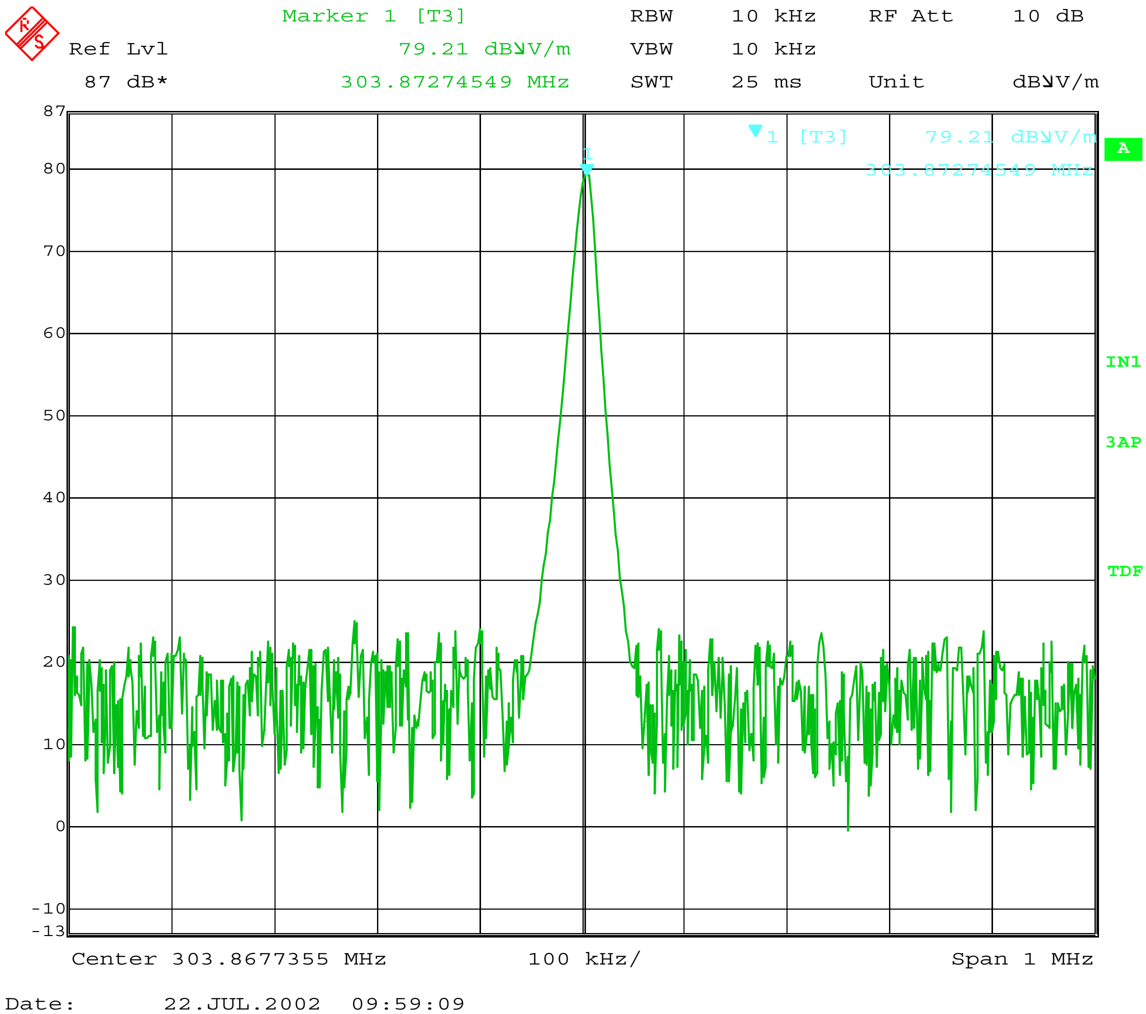

Figure 8 Bandwidth of test unit, BITGA-0

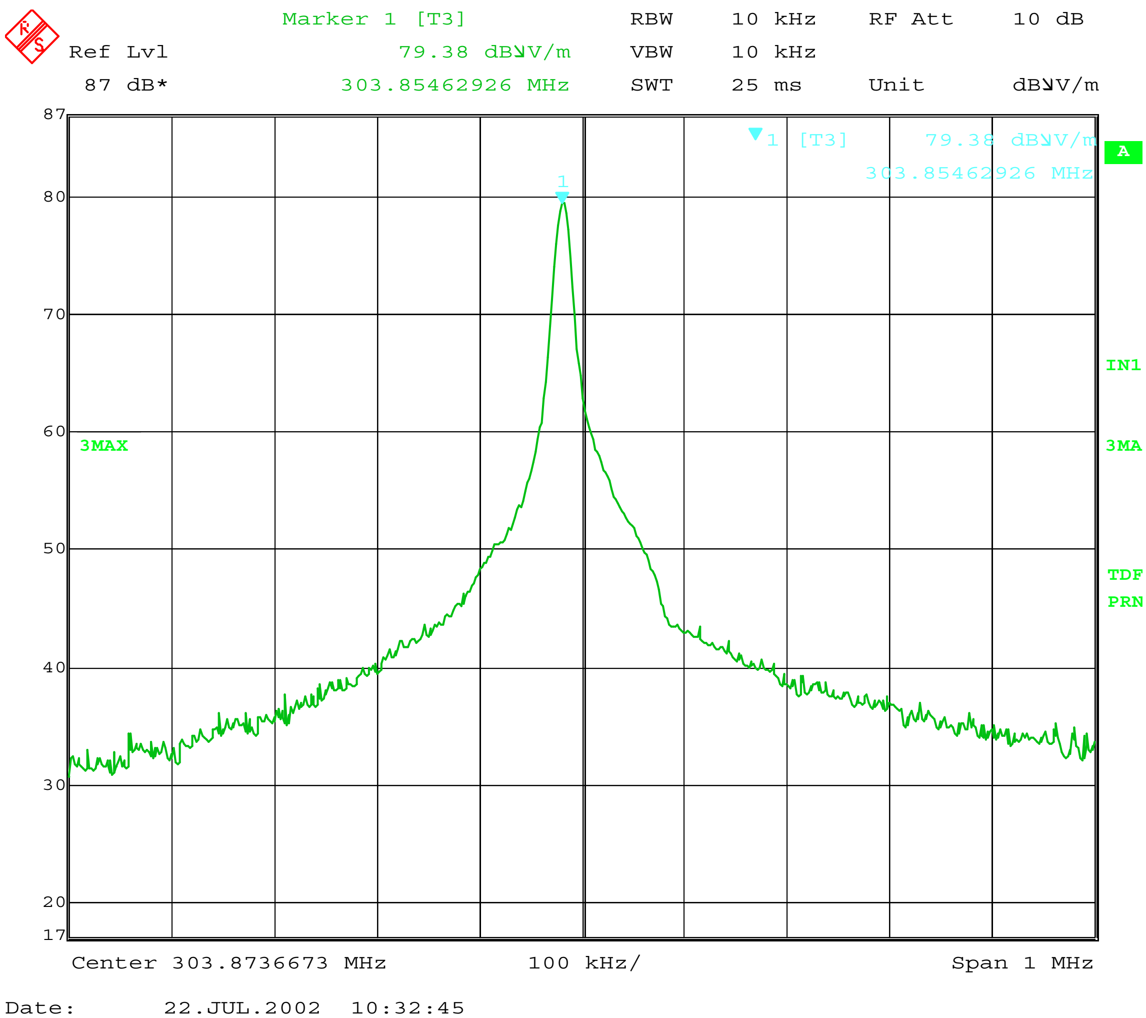

Figure 9 Bandwidth of sample unit, BITGA-2

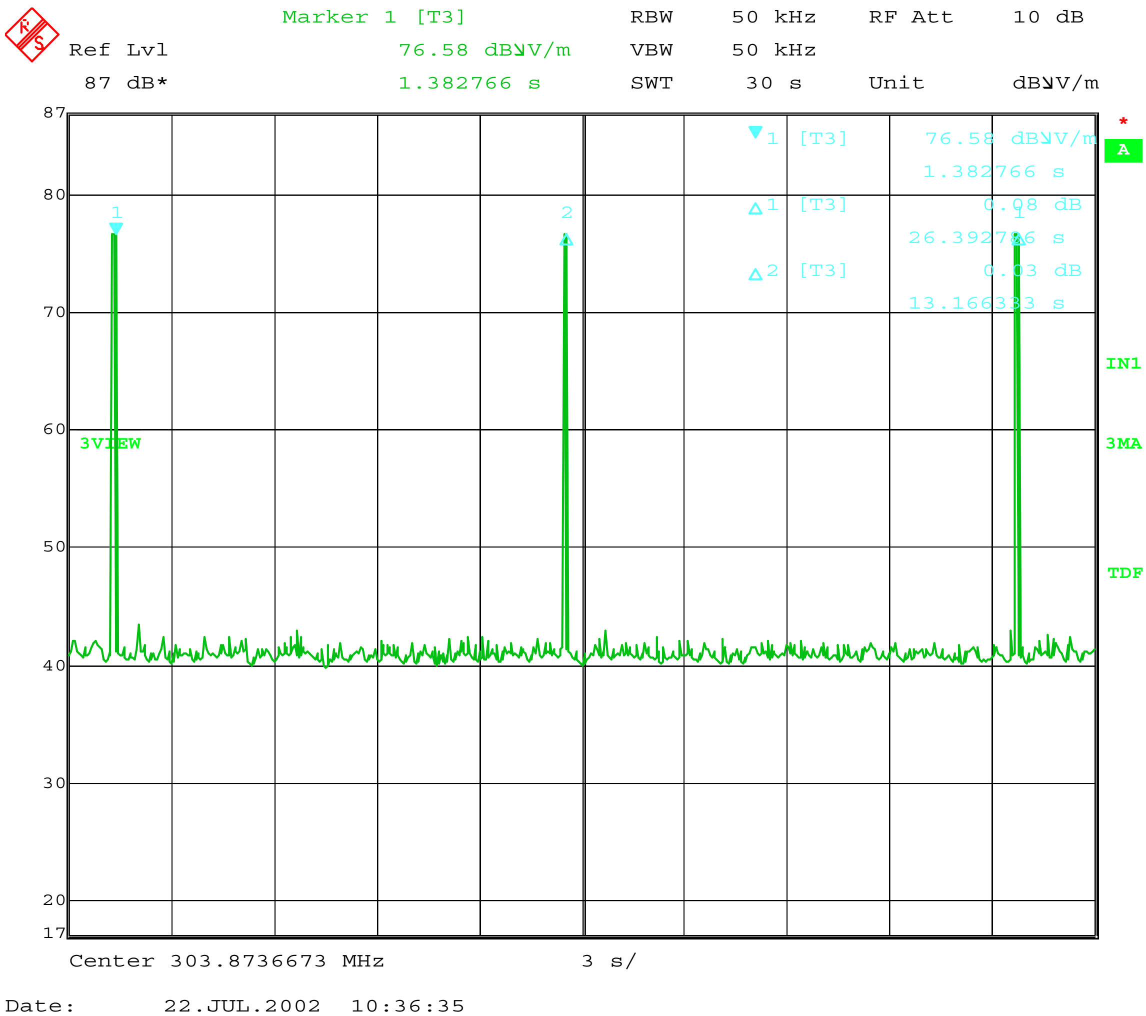

Figure 10 Time between pulses of BITGA-12

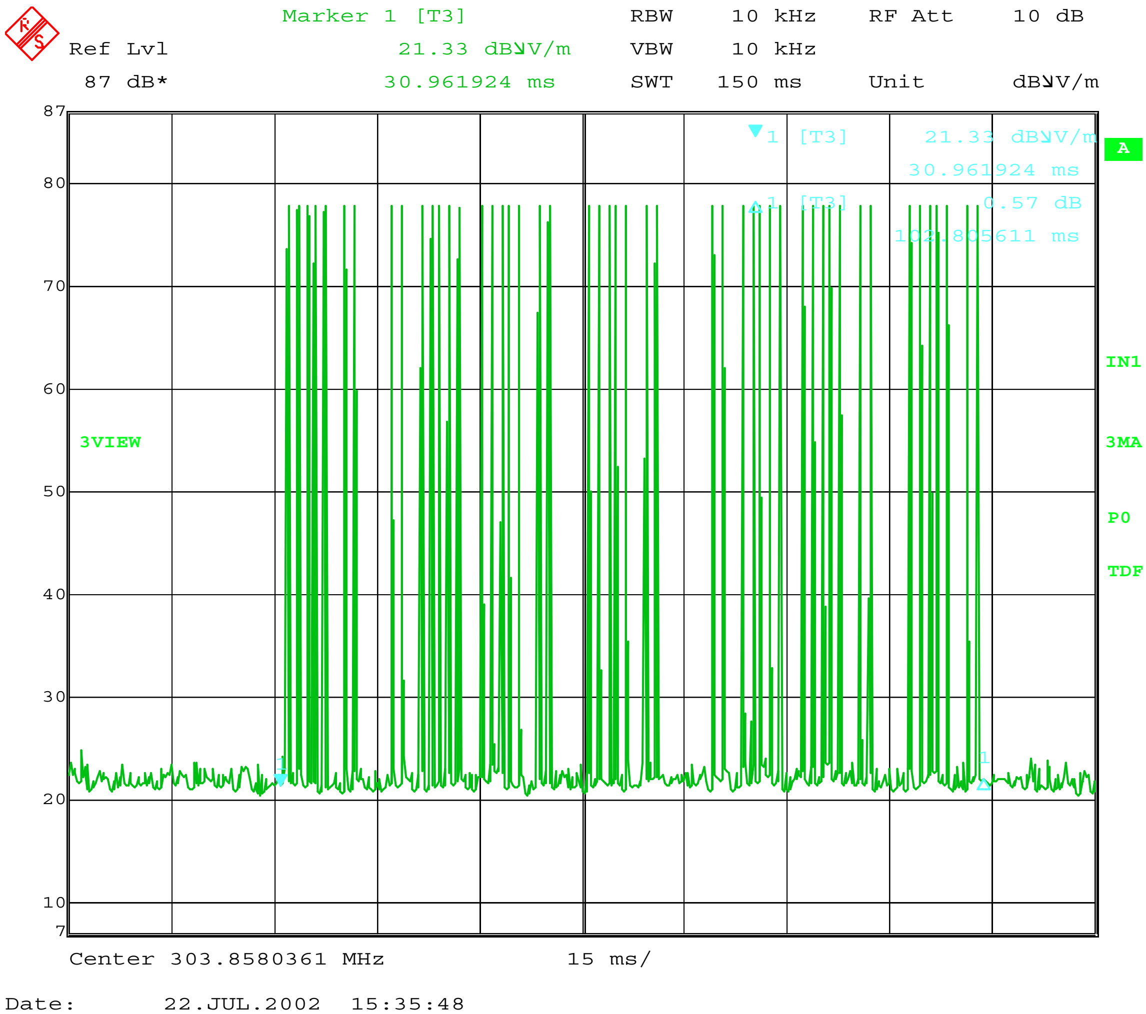

Figure 11 Pulse train of BITGA-12

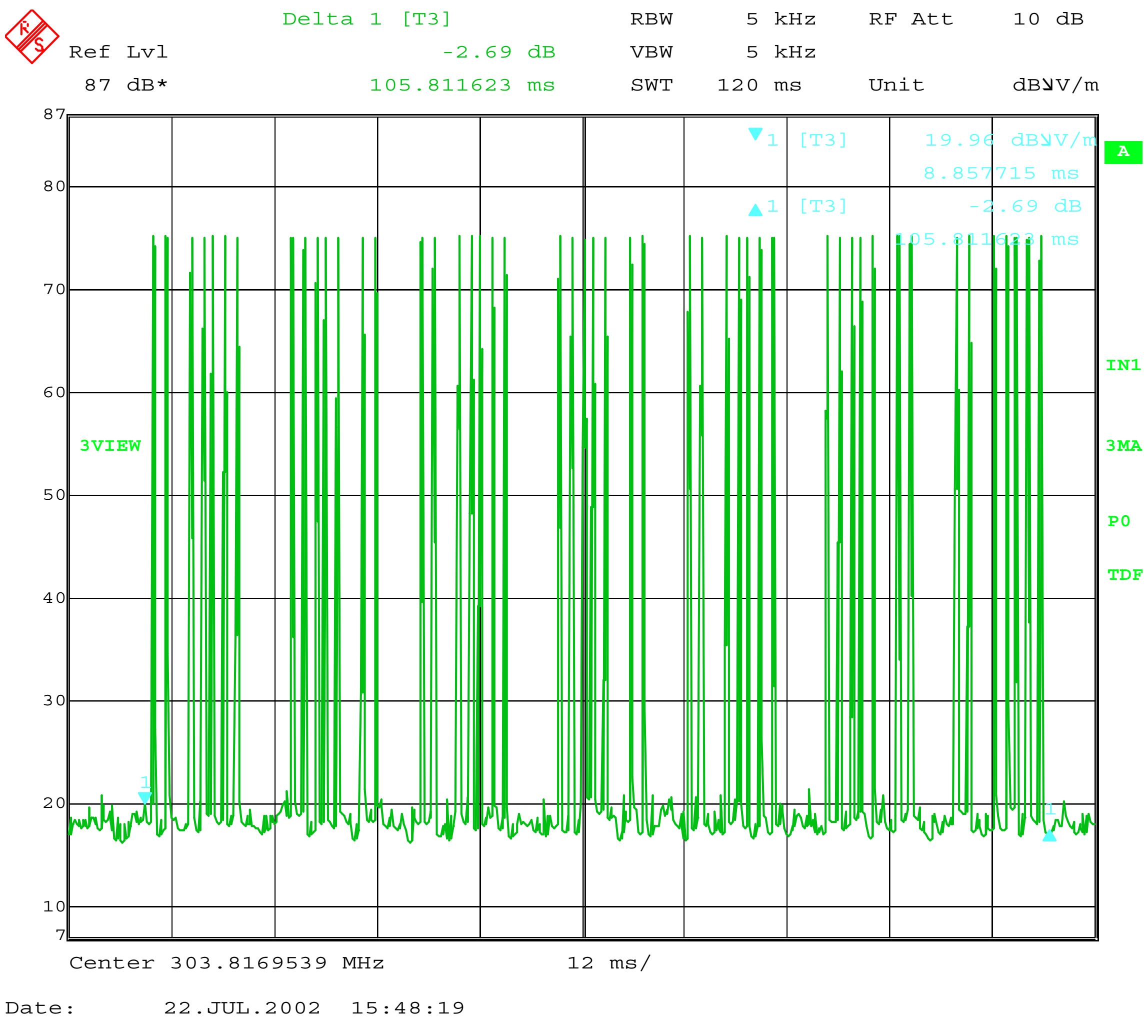

Figure 12 Pulse train of BITGA-25

Appendix C

Sample calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

Assume a receiver reading of 55 dBµV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBµV/m.

FS = 55 + 12 + 1.1 - 20 = 48.1 dBµV/m

The 48.1 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

Level in µV/m = Common Antilogarithm [(48.1 dBµV/m)/20]= 254.1 µV/m