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Report of Measurements of Electromagnetic Compatibility Testing

Test Report File No.	:	**BP7169** Date of issue: August 15, 2001
Applicant	:	Applied Wireless Identifications Group Inc.
Model / Serial No.	:	LR-911
Product Type	:	Long Range Proximity Reader
Power Supply	:	5VDC to 12VDC
Manufacturer	:	Same as Applicant
License holder	:	Same as Applicant
Address	:	382 Route 59 Section 292
	:	Monsey, NY 10952
Test Type	:	☒**Compliance Investigation** ☐ **Manufacturer's Specification**
Test Project Number References(s)	:	01ME05266

Report Directory

1.0 G E N E R A L - Product Description

AWID's Sentinel-Prox LR-911 Reader is a long range (9 to 11 feet) reader that works with either thin, flexible passive windshield mounting tags or credit card size tags. This reader has a unique combination of long read range, small size and low power consumption. LR-911 has an internal power converter, allowing it to work over a wide range of supply voltages without affecting its performance. At 12 V DC, its current draw is less than 450 mA, making it convenient to be powered directly from an access control panel and eliminating the need for any additional external supply. Its data interface is simultaneous Wiegand and RS-232.
Primary applications are automated garage parking entry, hands free access control, asset tracking and asset management systems.

Frequency Hopping and Modulation

The LR-911 utilizes the frequency hopping technique to satisfy the FCC requirements for spread spectrum operation. With the modulation bandwidth less than 250 kHz, 50 frequency channels are selected in a pseudo random manner, with each dwell period at a nominal 300 milliseconds. These channels are separated by 0.5 MHz and extend from 903 to 927.5 MHz.
To guarantee that the modulation bandwidth will be at restricted by at least 20 dB between channels, the transmitter is switched off while hopping. The hopping frequencies are accurately controlled through the use of a fast PLL synthesizer, which can lock within 100 microseconds and utilizes a programmable hopping table, which provides the necessary pseudo-random control.

By making each dwell period identical and not allowing revisits until all channels are scanned, it is assured that each hopping channel is utilized equally on average.

Because the receiver utilizes homodyne demodulation, its carrier frequency is automatically identical to that of the transmitter and will hop in synchronous.

The receiver bandwidth is inherently designed to match the modulation bandwidth of the transponder and, since the LR-911 is multi-protocol, the receiver bandwidth is programmed to match the particular transponder used.

In order to avoid simultaneous occupancy of transmitting channels in a multi-transmitter environment, each frequency table is pseudo random and is in no way synchronous with any other (see Table 1).
And, although there is always a possibility that 2 or more transmitters can transmit simultaneously in any instant, the probability of any substantial energy buildup is, practically zero.

Table 1 Hopping Table for LR-911 Reader

Index	Freq.	Index	Freq.
0	903.538	25	910.462
1	915.007	26	924
2	907.538	27	919.538
3	924.462	28	908
4	911.538	29	903.077
5	927.077	30	926
6	912.923	31	913.538
7	918	32	923.077
8	914.462	33	910
9	916.462	34	920
10	919.077	35	924.462
11	904.462	36	927.538
12	912.462	37	911.077
13	908.923	38	906
14	921.538	39	912
15	914	40	906.462
16	904.923	41	923.538
17	922	42	904
18	908.462	43	917.538
19	920.462	44	920.923
20	907.077	45	915.538
21	905.538	46	925.538
22	916.923	47	922.462
23	909.538	48	918.462
24	916	49	926.462

figure 1. Functional Diagram of AWID LR-911

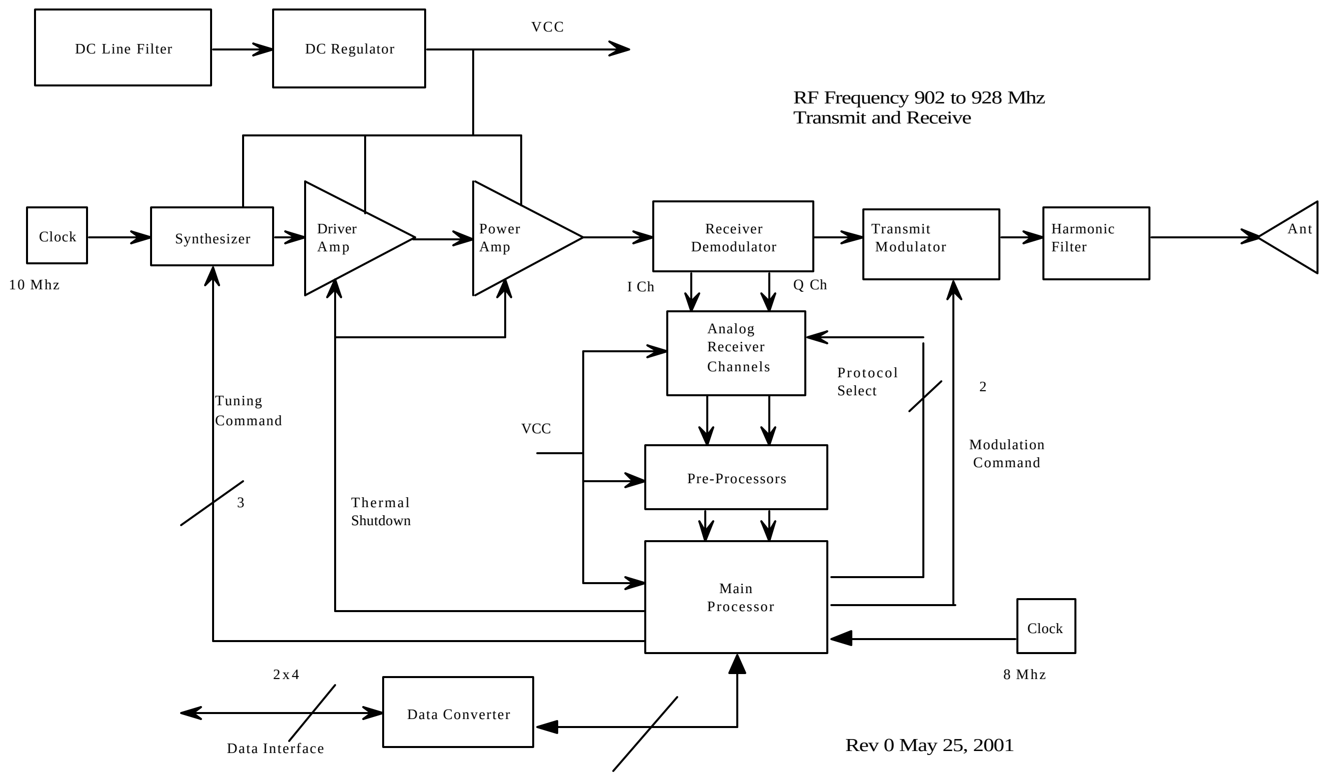


figure 2 Transmitter Modulation for Intellitag Protocol Activation

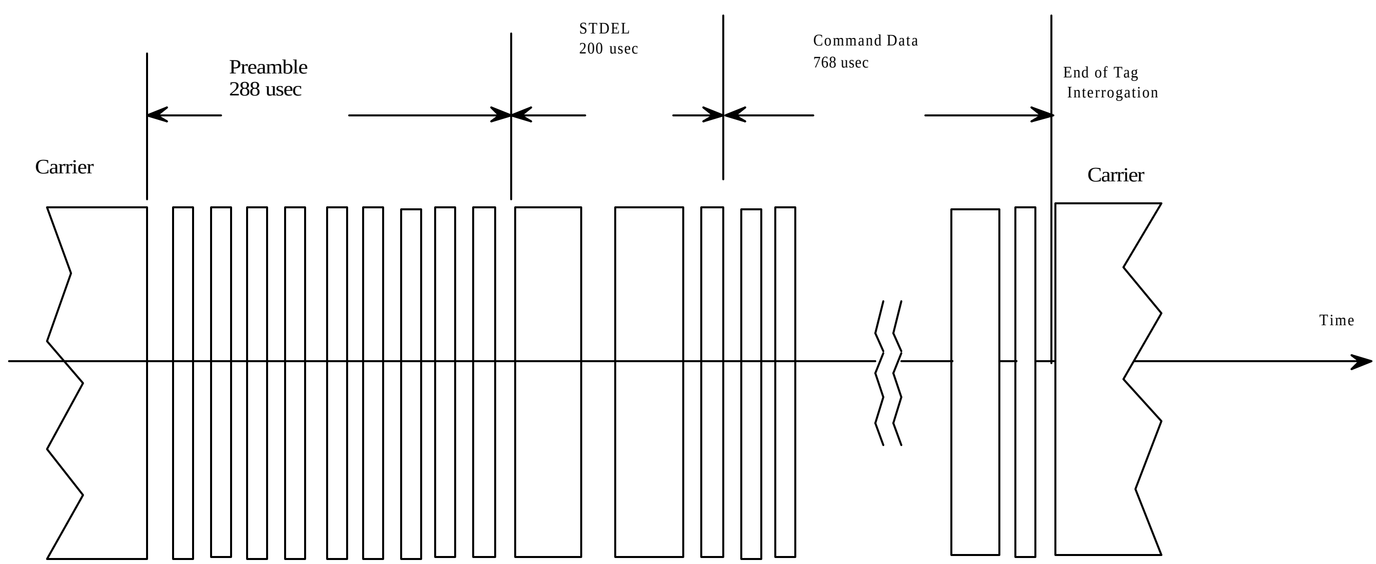
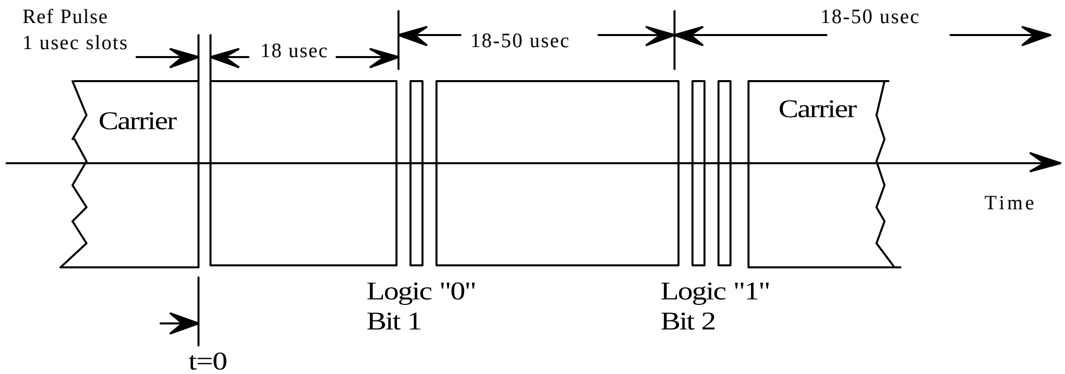


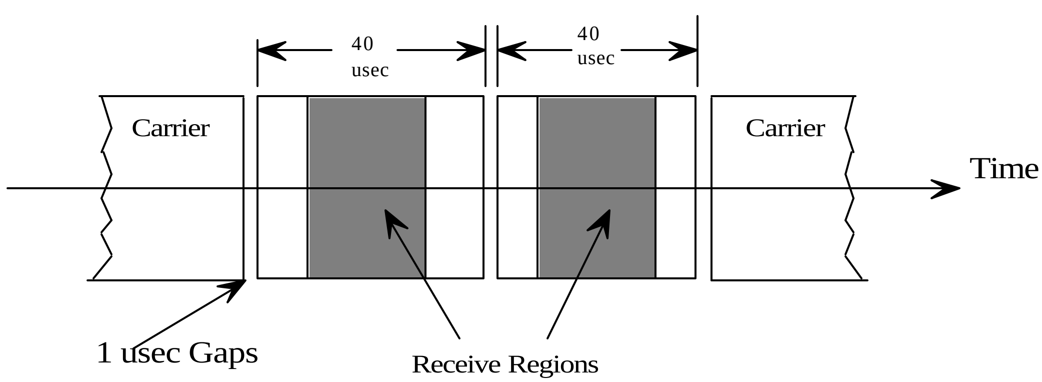
figure 3. Modulation Waveforms for Duralabel System Protocol

Transmit Modulation For Transponder Activation
Portion of Data Stream



Total Command word=17 Bits After Reference Pulse

The Receive Command



There are 34 Repetions of the above Receive Commands
For Each of the Sets of Transponder Data

FUNCTIONAL DESCRIPTION

Theory of Operation:
The LR-911 is an RFID (Radio Frequency Identification) long-range Transceiver, operating at UHF (902-928 MHz), in a Frequency Hopping mode.
The unit has a self-contained antenna and operates directly on DC power.
The dual data interface provides both Wiegand and RS-232 interfaces.

Modulation Protocols:
There are 2 prime tag protocols, requiring transmitter modulation for transponder activation.
These protocols, which can be individually selected for a particular site, are:

1. Intellitag
2. Duralabel

In addition the LR-911 is also operable with a number of other transponders requiring nothing more than CW illumination.

Applications:
The LR-911 can be utilized in a number of applications in both security access and asset management.
For example, the LR-911 may be used in Parking Garages and Gate locations for both entry and identification.

DC Regulator:
This is a high efficiency Switching regulator whose output is a fixed 5 Volts.
The regulator can function with input voltages as high as 16 volts but, to provide stable and reliable operation, the input operating voltage range is limited 5 to 12 volts at 5Watts maximum.

Synthesizer:
The synthesizer is a high speed, self-contained chip, which includes the Phase Lock Loop, VCO and interface controls. There are 50 frequencies, which are hopped as specified in
Table 1.

Driver Amplifier and Power Amplifier:
These devices amplify the weak synthesizer output to a level in excess of 1 watt.
The Power Amplifier will operate in a near saturated condition for optimum efficiency and minimal noise.

Receiver Demodulator:
As the Power Amplifier output progresses toward the antenna it passes through a Homodyne I/Q demodulator where it acts as a receiver local oscillator.
Because a Homodyne receiver is used, there is no spurious local oscillator radiation.

Transmit Modulator:

The Transmit Modulator is basically a high-speed non-reflective RF switch, which generates an appropriate modulation command for the purpose of activating the transponders.
As previously mentioned, there will be 2 modulation schemes.
The Intellitag modulation is described in Figure 2
The Duralabel System is described in Figure 3.

Harmonic Filter:
This filter is designed to bring the radiated harmonics to a level below 500 microvolts /meter at a 3 meter distance. The peak output power to the antenna is +30 dBm maximum

Antenna:
The antenna is a Circular Polarized patch antenna. And has a gain of 6.91 dBi.

Analog Receiver Channels:
The Analog Receiver's video bandwidth is designed to accommodate a number of known transponder types.
The lower frequency cut-off is programmable in order to provide adequate receiver recovery after a series of modulation pulses.

Pre-Processors:
Each of the Pre-Processors time-samples and decodes the I and Q signals from the Receiver Demodulator. It include a CRC check to insure the data is correct and re-transmits the correct data to the Main Processor, using TTL level RS-232 protocol.

The Main Processor:
The Main Processor generates the frequency hopping command to control the Synthesizer, generates the transmitter modulation command for tag activation and provides the interface which transmits the data from the Pre-Processors to the user. It also accepts commands from the user to perform inter-active functions.

1.1 Device Configuration During Test

The LR911 is configured for worst case condition during the transmit mode testing. This was with 15VDC and with modulation (duralabel mode).

During the receive mode testing all modulation and transmitting was turned off and the unit was tested at 15VDC worst case condition .

Support Equipment :

Texas Instruments Extensa 600CDT S/N 160597S08B4
FCC ID# EUNDESIGNOTE6

"The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report."

1.1.1 Deviations from ANSI C63.4 Standard Test Set-up

☒ None

☐ As described below:

1.2 Device Modifications Necessary for Compliance

☒ N/A

☐ As described below:

Environmental conditions in the lab:

	Range
Temperature:	20-25°C
Relative Humidity	30 - 60 %
Atmospheric pressure	680 - 1060 mbar

1.3 Field Strength Calculation

If a preamplifier was used during the Radiated Emissions testing it is required that the amplifier gain be subtracted from the Spectrum Analyzer (Meter) Reading. In addition, a correction factor for the antenna, cable used and a distance factor, if any, must be applied to the Meter Reading before a true field strength reading can be obtained. These considerations are automatically presented as a part of the print out. This modified specification limit is referred to as the “Actual Level” or simply the level, which is the actual field strength present at the antenna. The quantity can be derived in the following manner:

Level = Meter Reading + Gain/Loss + Transducer

Where

Meter Reading = Spectrum Analyzer Reading
Transducer = Antenna Factor
Gain/Loss = Cable Loss – Amplifier Gain (if any)

The Margin on the printout will be the actual margin level from the limit

For Example:

At 6835.407 MHz we had a meter reading of 28.7 dB/uV , a Gain/Loss of -23.7 dB and a transducer factor of 36.9 dB.

Level = 28.7+ (-23.7)+ 36.9

Level = 41.9 dBuv/m

This result is below the FCC Class B limit of 54 dBuV/m at 6835.407 MHz

1.4 MPE Estimate for LR-911 Transceiver

Table 1 of CFR 1.1310 states MPE for Uncontrolled Exposure is f/1500 mW/cm^2
In the 300-1500 MHz range.

F=902 MHz minimum

MPE=f/1500 mW/cm^2
= 902/1500 mW/cm^2
= .601 mW/cm^2
= 6.01 W/m^2

In order to calculate the range at which the power density is 0.601 mW/cm^2 . The following Equation is used:

$P_d = (P_t * G_t) / (4P_I * R^2)$ where:

P_t = transmitted power (743 mw)
G_t = gain of transmitting antenna (6.91dBi)
P_I = 3.14
R = distance from the antenna

Solving for R :

$R^2 = (Pt * G_t) / (4P_I * P_d)$
$R = [(P_t * G_t) / (4P_I * P_d)]^{\wedge} 0.5$
=[(.743*6.91)/(4*3.14*6.01)]^0.5
=[(5.13413)/ (75.4856)]^0.5
=[.0680147] ^0.5
= 0.261 meters
= 10.27 inches

The Range at which the power density of the LR911 transceiver is 0.6 mW/cm^2 is 10.27 inches(26.1cm). This information will be placed in LR-911 operation Manual

2.0 EMISSIONS TEST REGULATIONS:
FCC PART 15 ,Paragraphs 15.209 (b) ;15.247 (a)(i) ; (a) (1); (b) (2)
FCC PART 15 , Paragraphs 15.109 SUBPART B Class B
Test Methods:
Filing and Measurement Guidelines DA 00-705 Released March 30,2000

2.1 EUT OPERATION MODE - EMISSIONS TESTS:

- ☐ Standby
- ☐ Test program (H-Pattern)
- ☐ Test program (color bar)
- ☒ Test program (customer specific)
- ☐ Practice operation
- ☐ Normal operation Mode:
- ☒ As per manufacturer’s instructions
- ☐ other

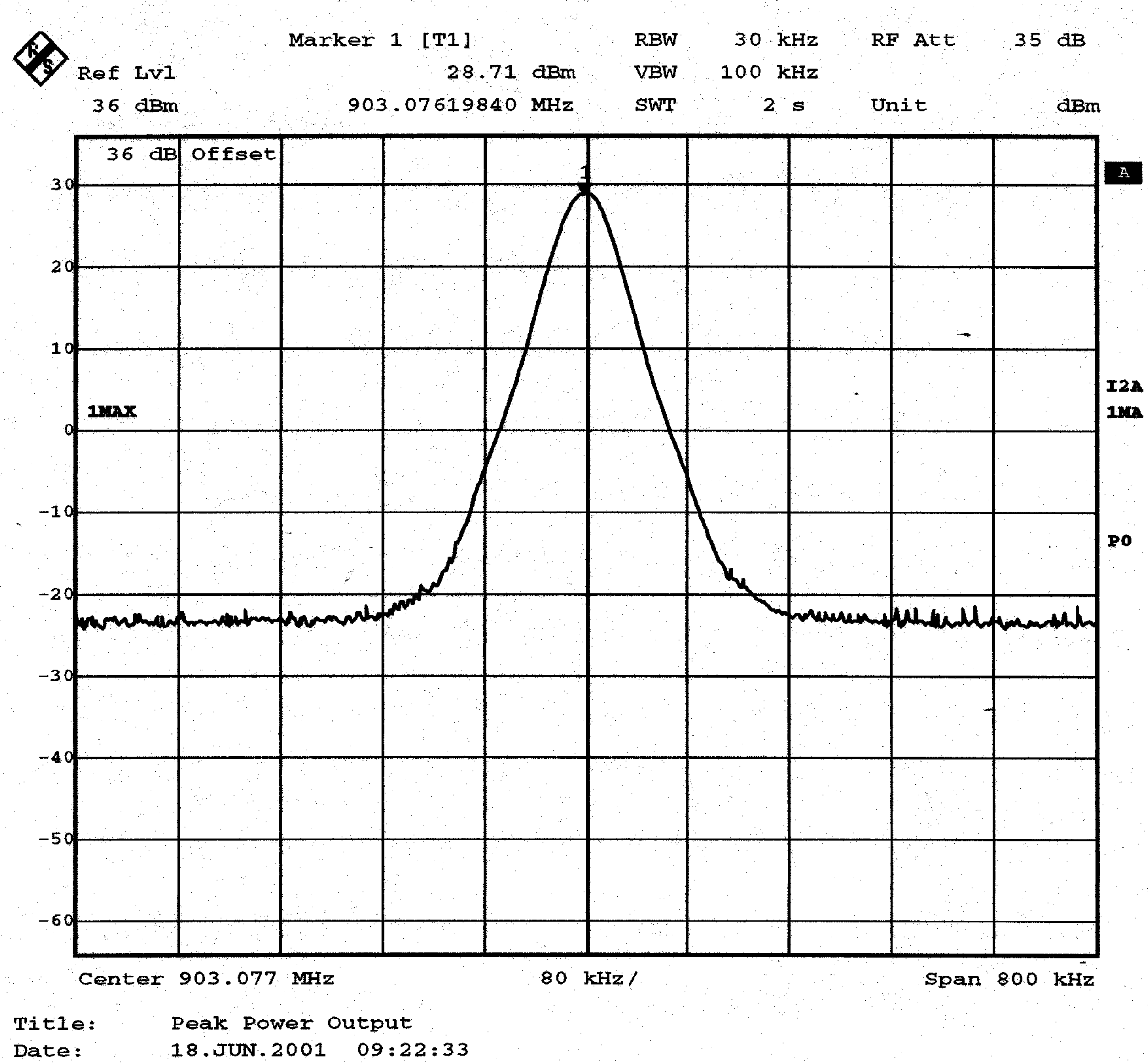
2.1.1 Conducted Measurements :

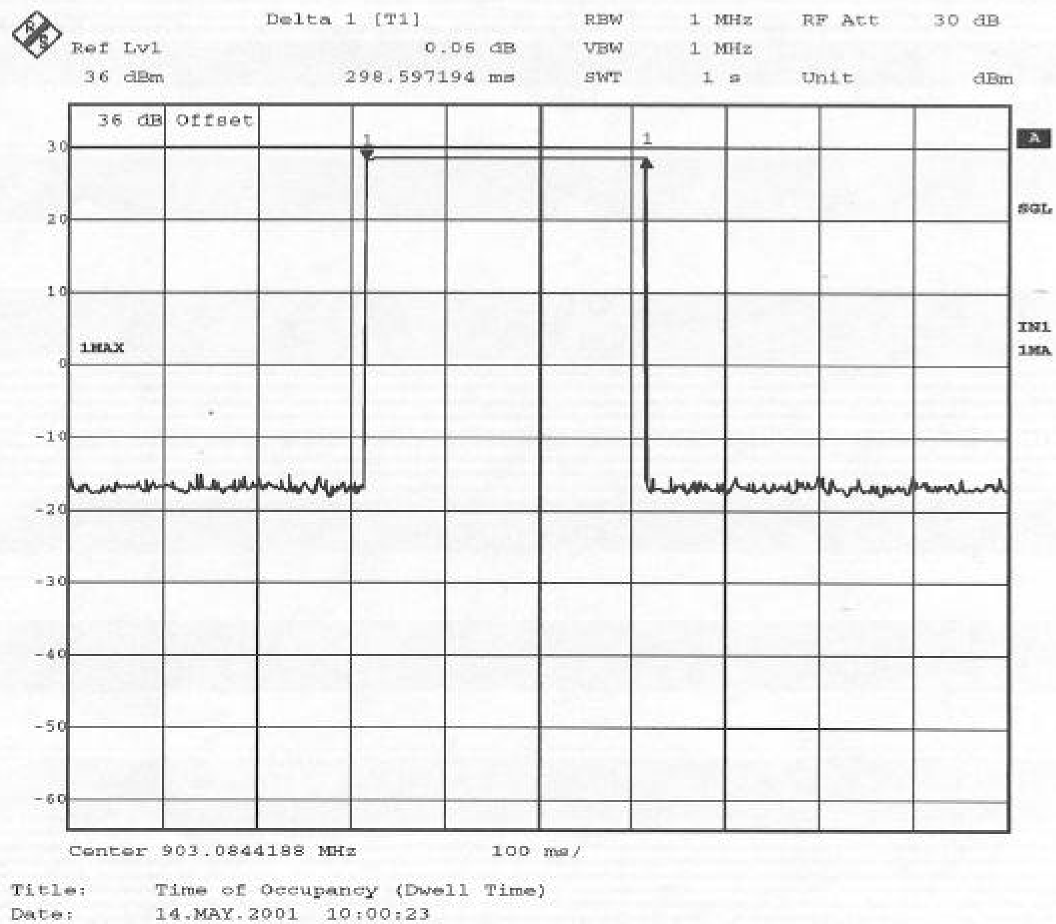
Measurements	Results
Peak Output Power	28.71 dBm
Time of Occupancy	298.6 ms
20 dB Bandwidth	34.068 kHz
Carrier Frequency Separation	464 kHz
Number of Hopping Frequencies	50
Band Edge Compliance	>20dB down
Spurious RF Conducted Emissions	>20dB down

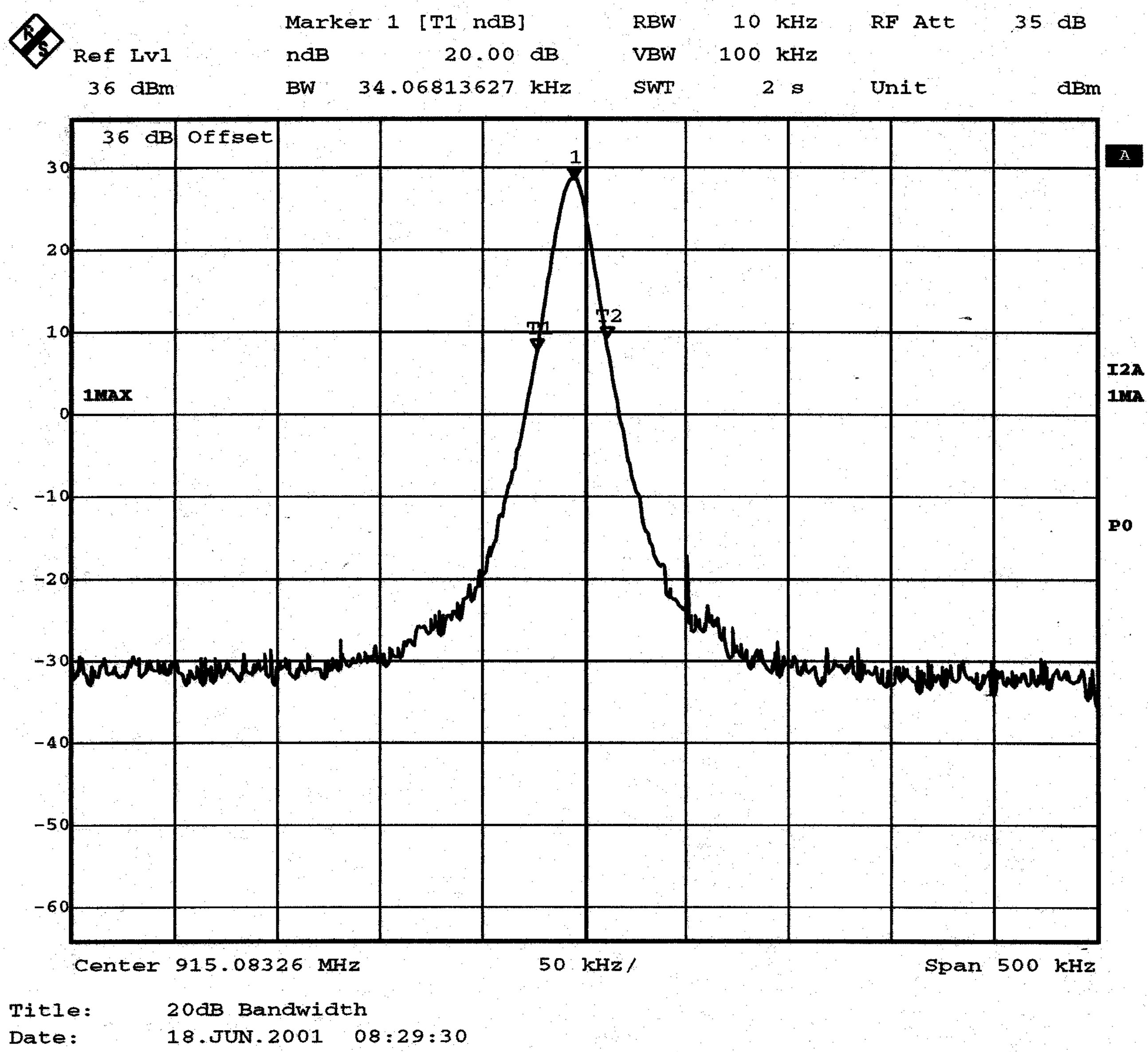
☒ **Test Applicable** ☐ **Test Not Applicable**

Test equipment used for conducted Measurements:

☒ **ES140** **Rohde &Schwarz** **EMI Receiver,** **Equipment No.: 837514/001**
Range:20Hz-40GHz Last Calibration Date:03/31/2001 Calibration Due Date: 03/31/2002


Marker 1 [T1]
RBW 30 kHz
RF Att 35 dB
Ref Lvl
28.71 dBm
VBW 100 kHz
36 dBm
903.07619840 MHz
SWT 2 s
Unit dBm
36 dB Offset
30
20
10
0
-10
-20
-30
-40
-50
-60
1MAX
A
I2A
1MA
PO
Center 903.077 MHz
80 kHz/
Span 800 kHz
Title: Peak Power Output
Date: 18.JUN.2001 09:22:33


Delta 1 [T1]
Ref Lvl
36 dBm
0.06 dB
298.597194 ms
RBW 1 MHz
VBW 1 MHz
SWT 1 s
RF Att 30 dB
Unit dBm
36 dB Offset
1MAX
SGL
IN1
1MA
Center 903.0844188 MHz
100 ms/
Title: Time of Occupancy (Dwell Time)
Date: 14.MAY.2001 10:00:23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RBW 10 kHz
RF Att 35 dB
Ref Lvl
ndB 20.00 dB
VBW 100 kHz
36 dBm
BW 34.06813627 kHz
SWT 2 s
Unit dBm
36 dB Offset
1
T1
T2
1MAX
A
I2A
1MA
PO
30
20
10
0
-10
-20
-30
-40
-50
-60
Center 915.08326 MHz
50 kHz/
Span 500 kHz
Title: 20dB Bandwidth
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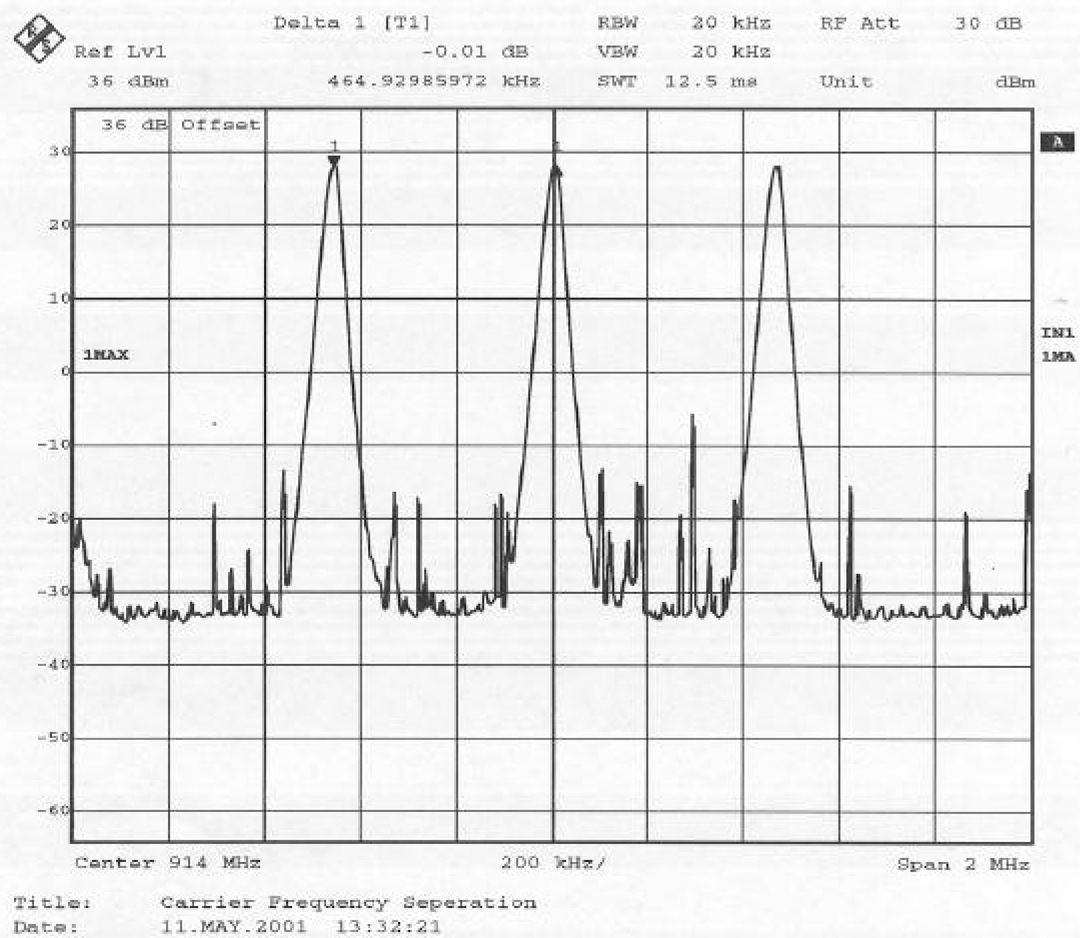
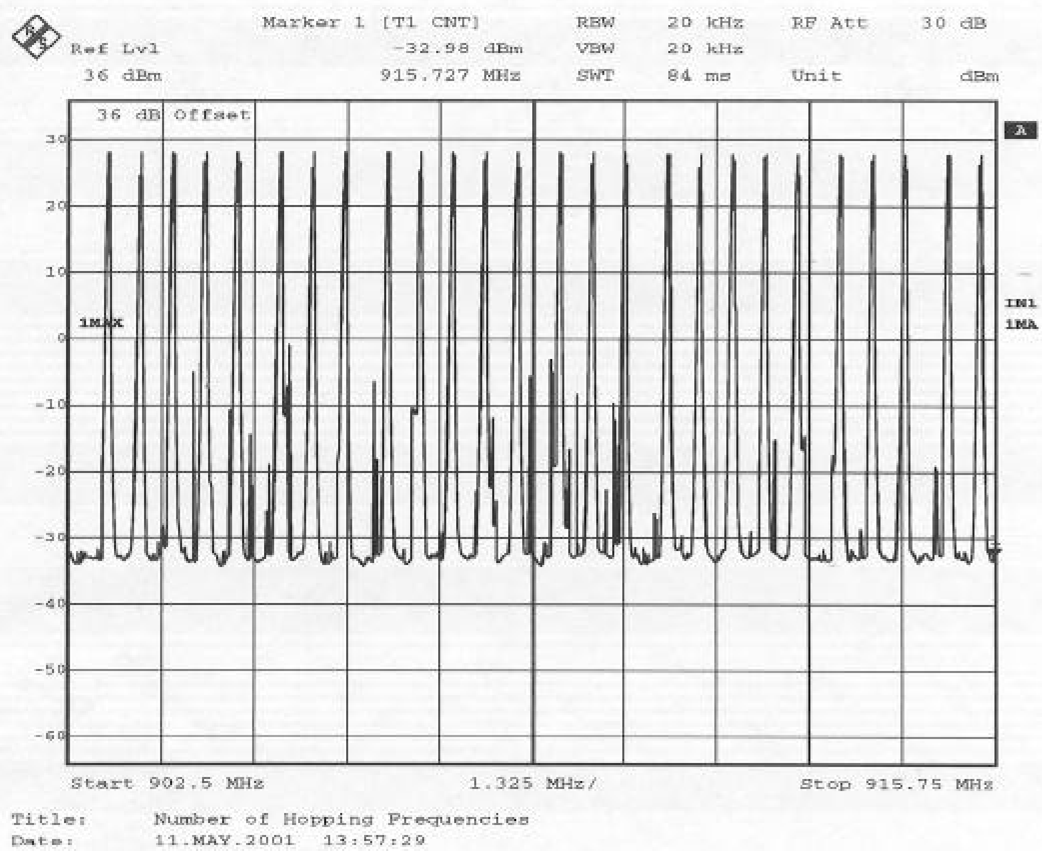
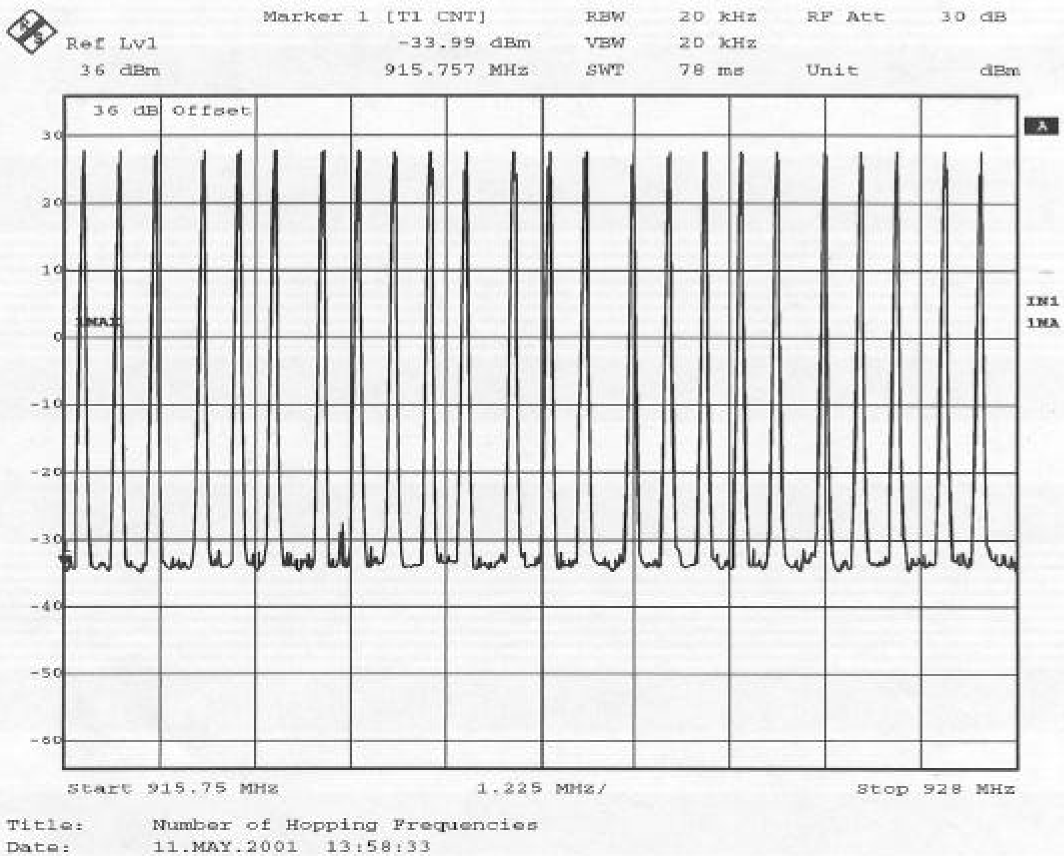
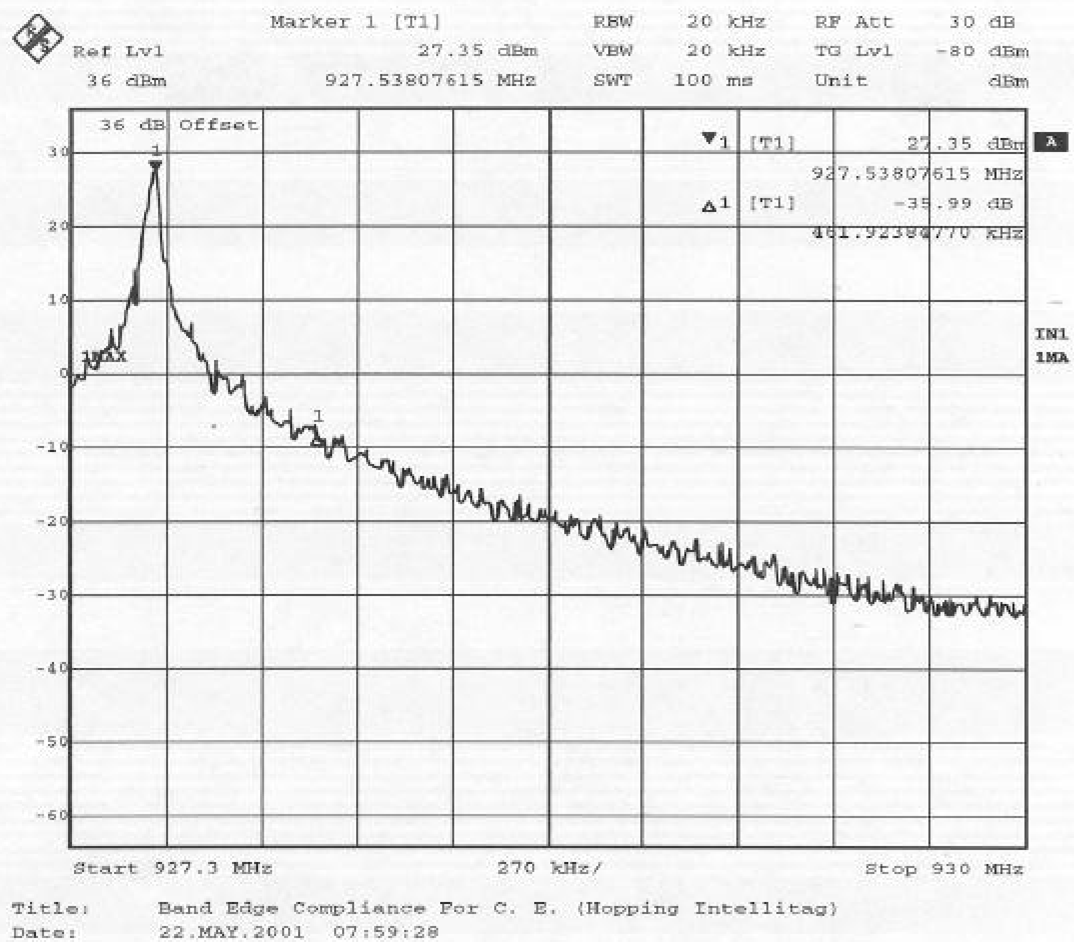

Delta 1 [T1]
RBW 20 kHz
RF Att 30 dB
Ref Lvl
-0.01 dB
VBW 20 kHz
36 dBm
464.92985972 kHz
SWT 12.5 ms
Unit dBm
36 dB Offset
1MAX
IN1
1MA
Center 914 MHz
200 kHz/
Span 2 MHz
Title: Carrier Frequency Seperation
Date: 11.MAY.2001 13:32:21



1-25 Frequencies



26-50 Frequencies


Marker 1 [T1]
Ref Lvl 27.35 dBm
36 dBm 927.53807615 MHz
RBW 20 kHz
VBW 20 kHz
SWT 100 ms
RF Att 30 dB
TG Lvl -80 dBm
Unit dBm
36 dB Offset
▼1 [T1] 27.35 dBm
927.53807615 MHz
Δ1 [T1] -35.99 dB
461.92384770 kHz
A
IN1
1MA
1MAX
30
20
10
0
-10
-20
-30
-40
-50
-60
Start 927.3 MHz
270 kHz/
Stop 930 MHz
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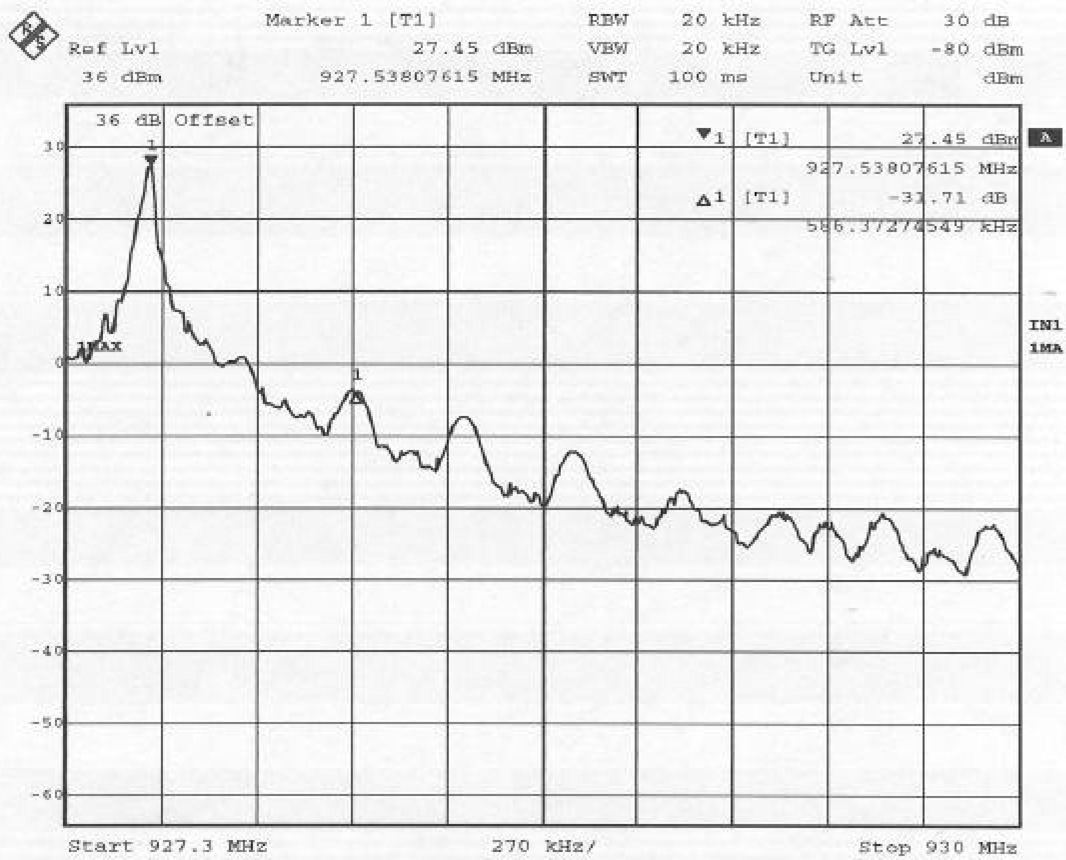
Date: 22.MAY.2001 07:59:28



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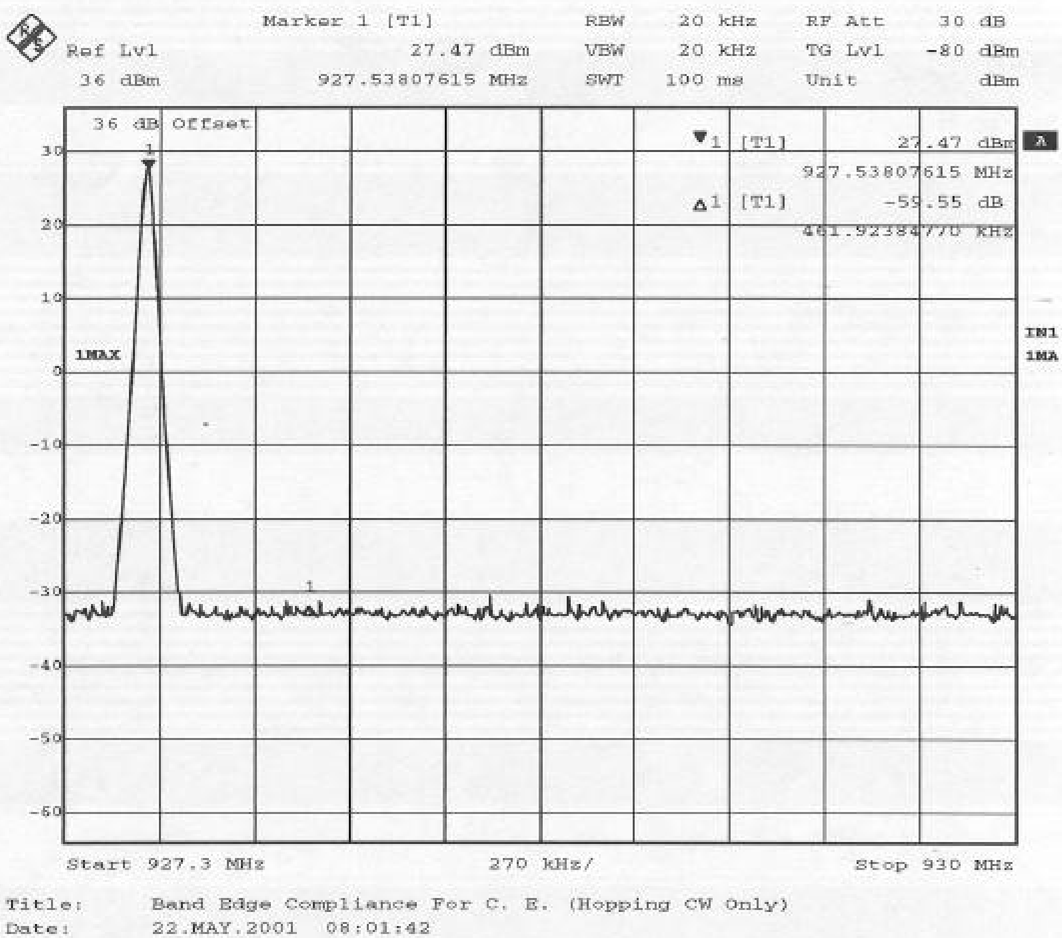
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Ref Lvl
36 dBm
27.47 dBm
927.53807615 MHz
RBW 20 kHz
VBW 20 kHz
SWT 100 ms
RF Att 30 dB
TG Lvl -80 dBm
Unit dBm
36 dB Offset
▼1 [T1] 27.47 dBm
927.53807615 MHz
Δ1 [T1] -59.55 dB
461.92384770 kHz
A
IN1
1MA
1MAX
30
20
10
0
-10
-20
-30
-40
-50
-60
Start 927.3 MHz
270 kHz/
Stop 930 MHz
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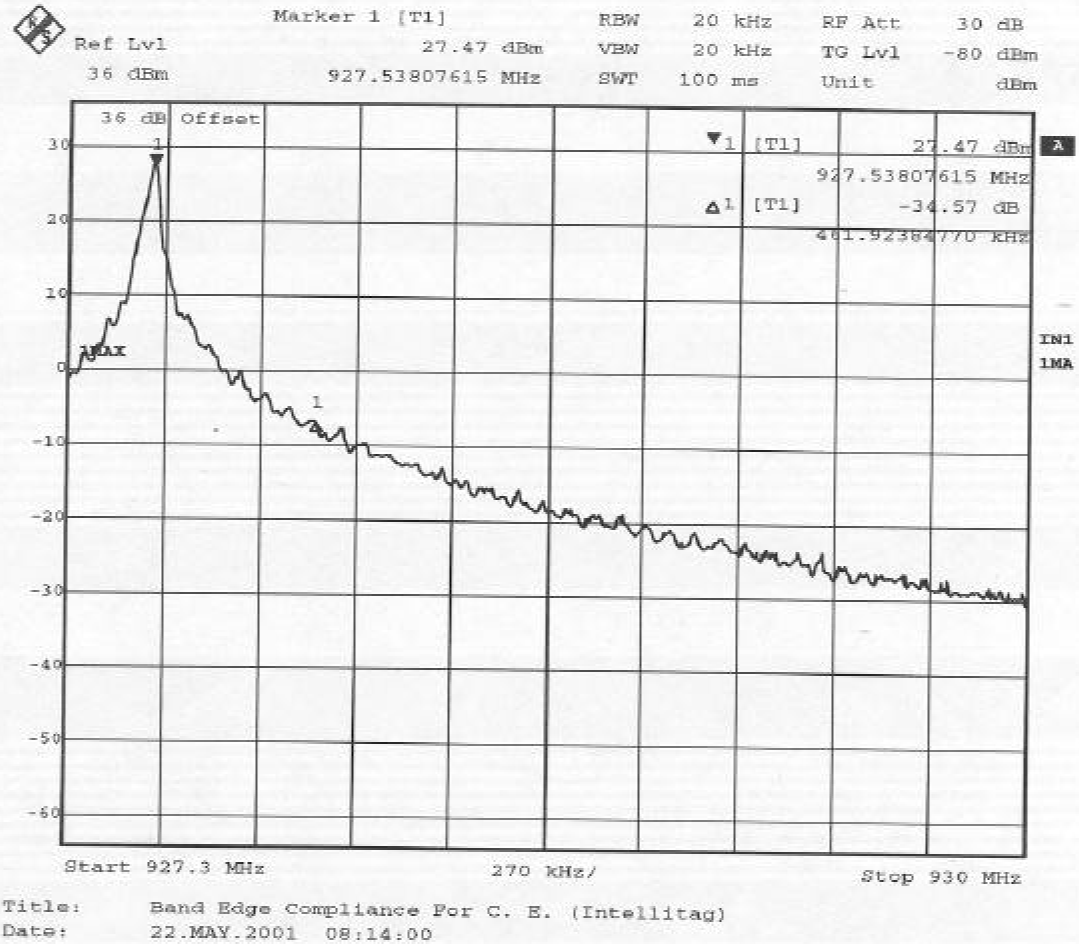
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27.47 dBm
927.53807615 MHz
Ref Lvl
36 dBm
RBW 20 kHz
VBW 20 kHz
SWT 100 ms
RF Att 30 dB
TG Lvl -80 dBm
Unit dBm
36 dB Offset
▼1 [T1] 27.47 dBm
927.53807615 MHz
Δ1 [T1] -34.57 dB
461.92384770 kHz
1MAX
IN1
1MA
Start 927.3 MHz
270 kHz/
Stop 930 MHz
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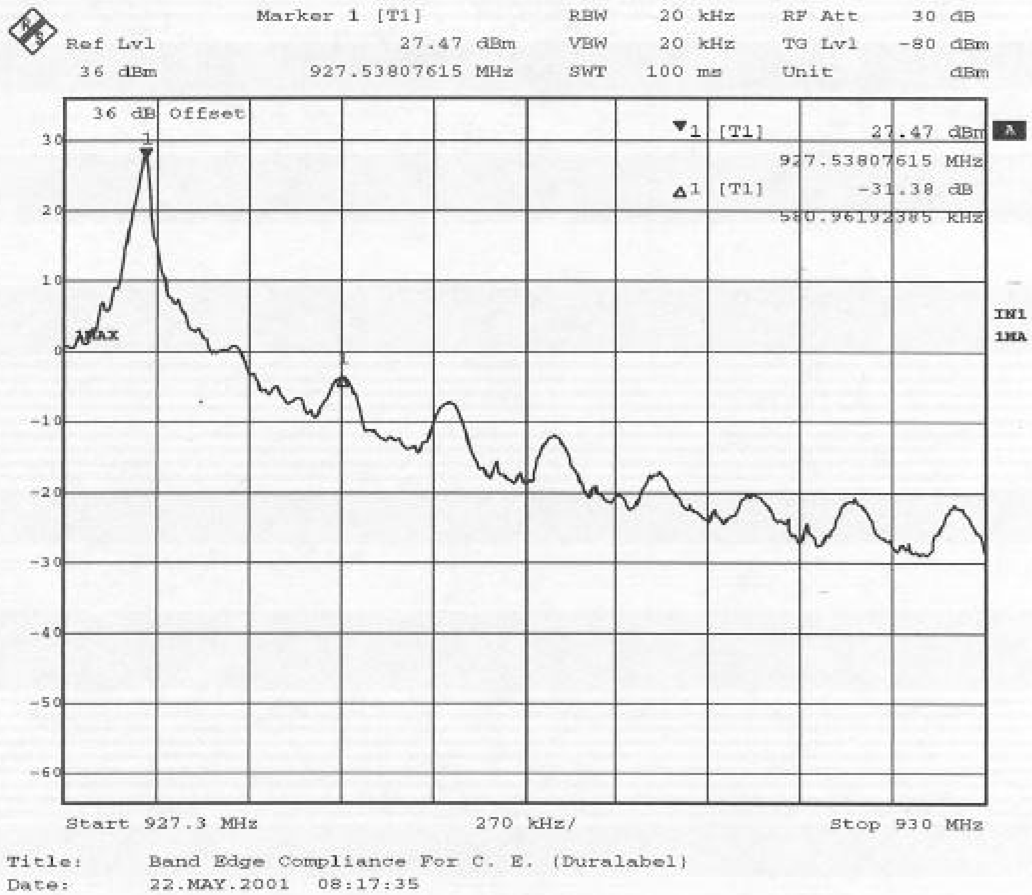
Date: 22.MAY.2001 08:14:00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Ref Lvl
36 dBm
27.47 dBm
927.53807615 MHz
RBW 20 kHz
VBW 20 kHz
SWT 100 ms
RF Att 30 dB
TG Lvl -80 dBm
Unit dBm
36 dB Offset
▼1 [T1] 27.47 dBm
927.53807615 MHz
Δ1 [T1] -31.38 dB
580.96192385 kHz
1MAX
IN1
1MA
30
20
10
0
-10
-20
-30
-40
-50
-60
Start 927.3 MHz
270 kHz/
Stop 930 MHz
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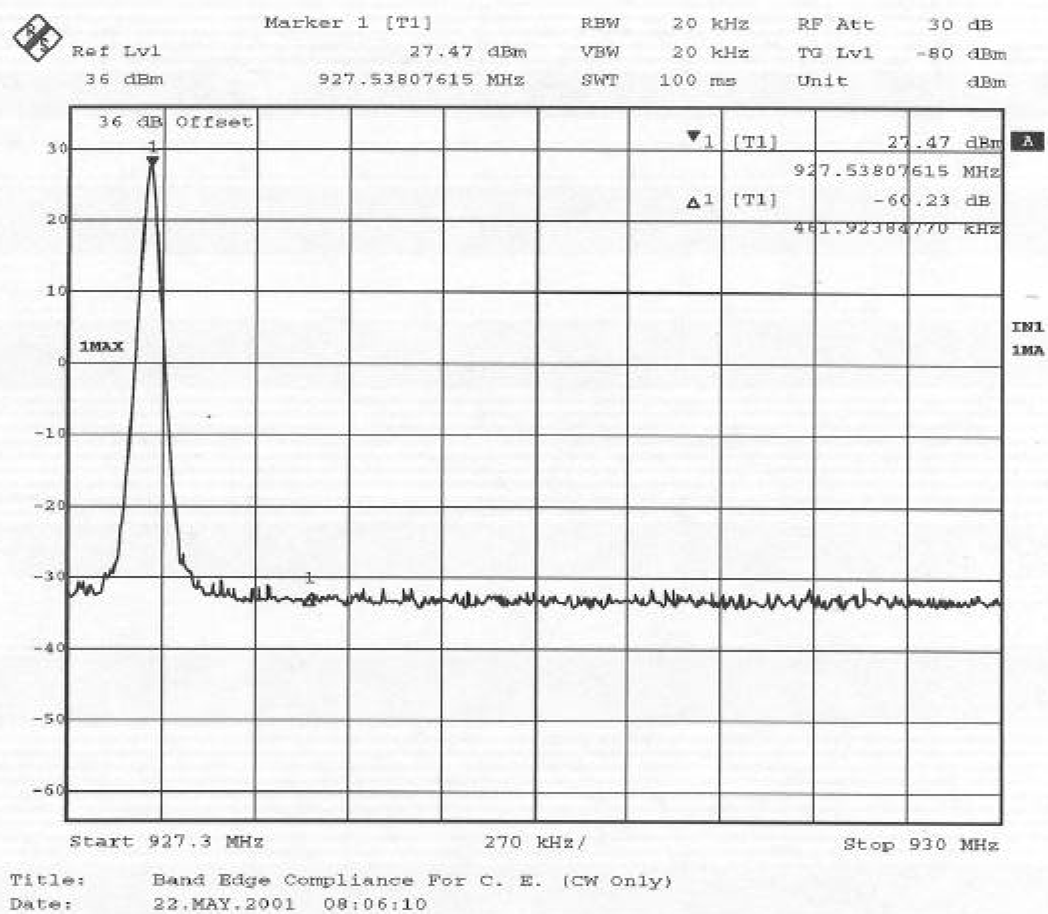
Date: 22.MAY.2001 08:17:35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36 dBm 927.53807615 MHz
RBW 20 kHz
VBW 20 kHz
SWT 100 ms
RF Att 30 dB
TG Lvl -80 dBm
Unit dBm
36 dB Offset
▼1 [T1] 27.47 dBm
927.53807615 MHz
Δ1 [T1] -60.23 dB
461.92384770 kHz
1MAX
IN1
1MA
Start 927.3 MHz
270 kHz/
Stop 930 MHz
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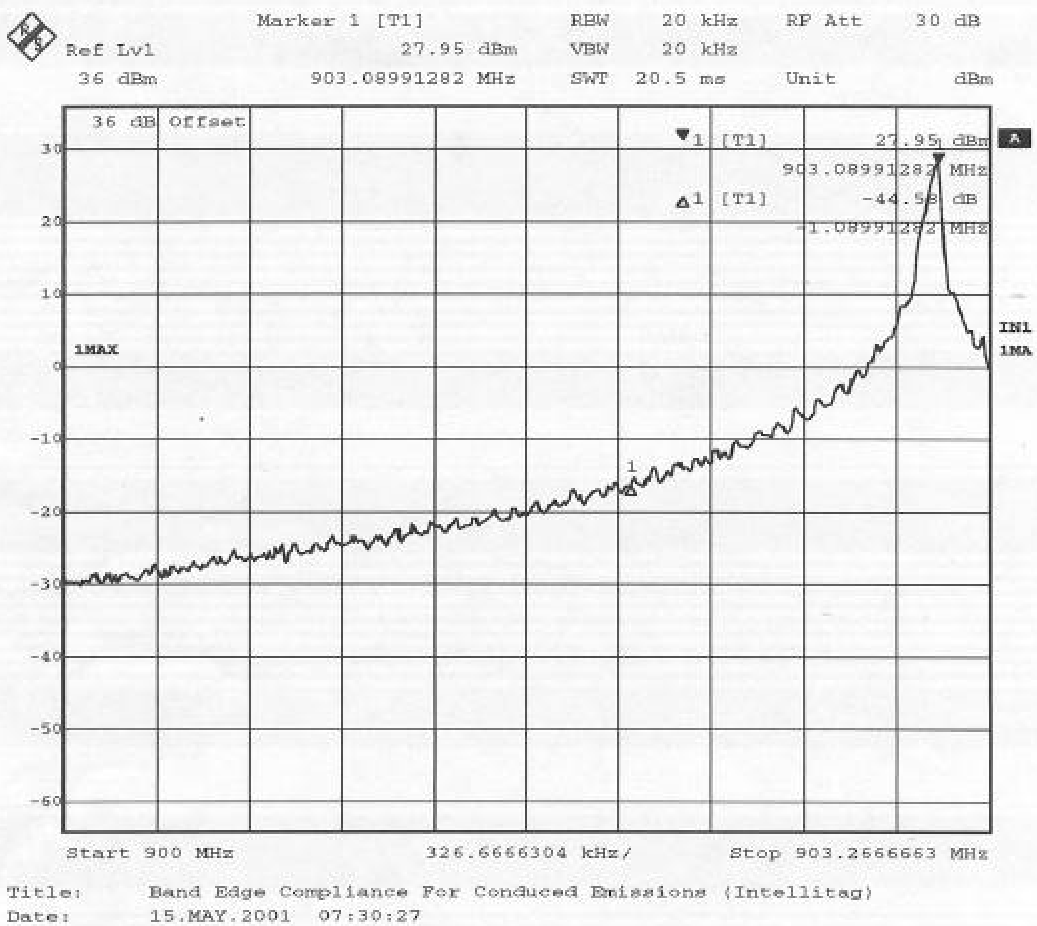
Date: 22.MAY.2001 08:06:10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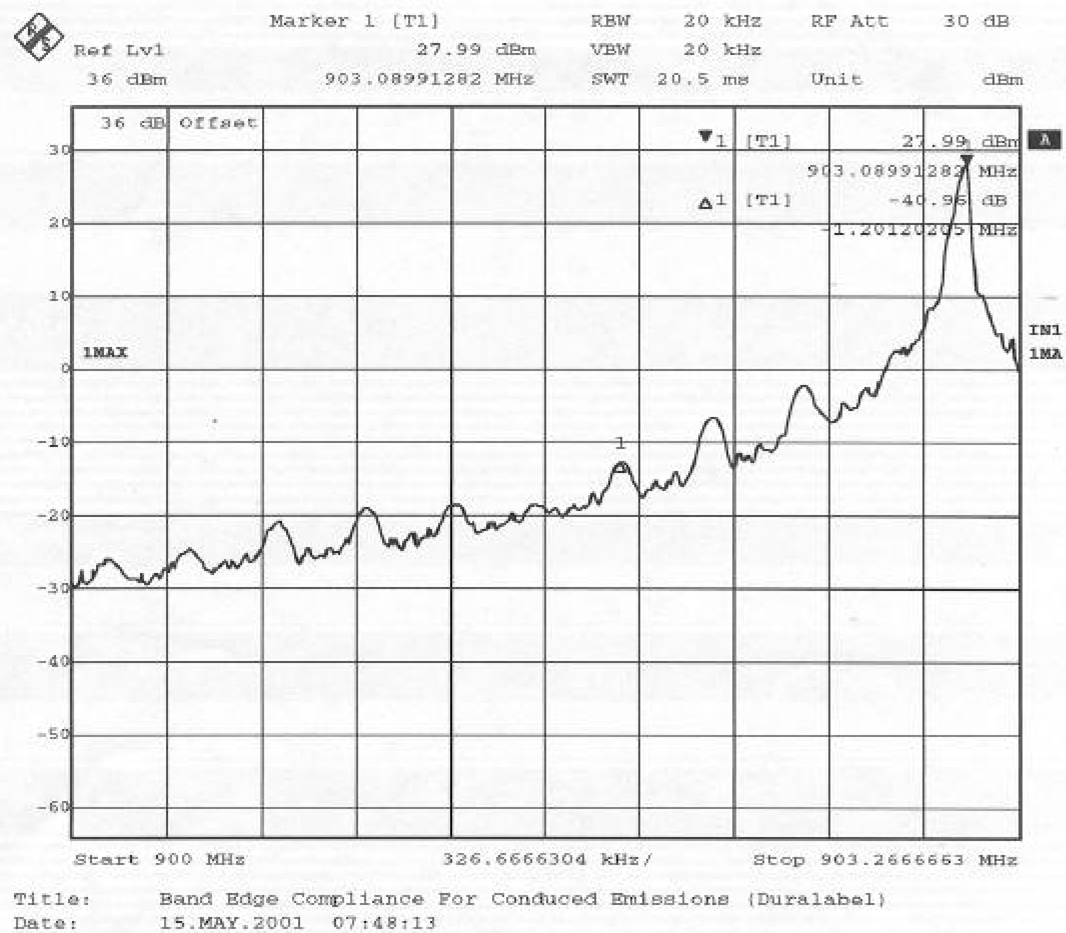
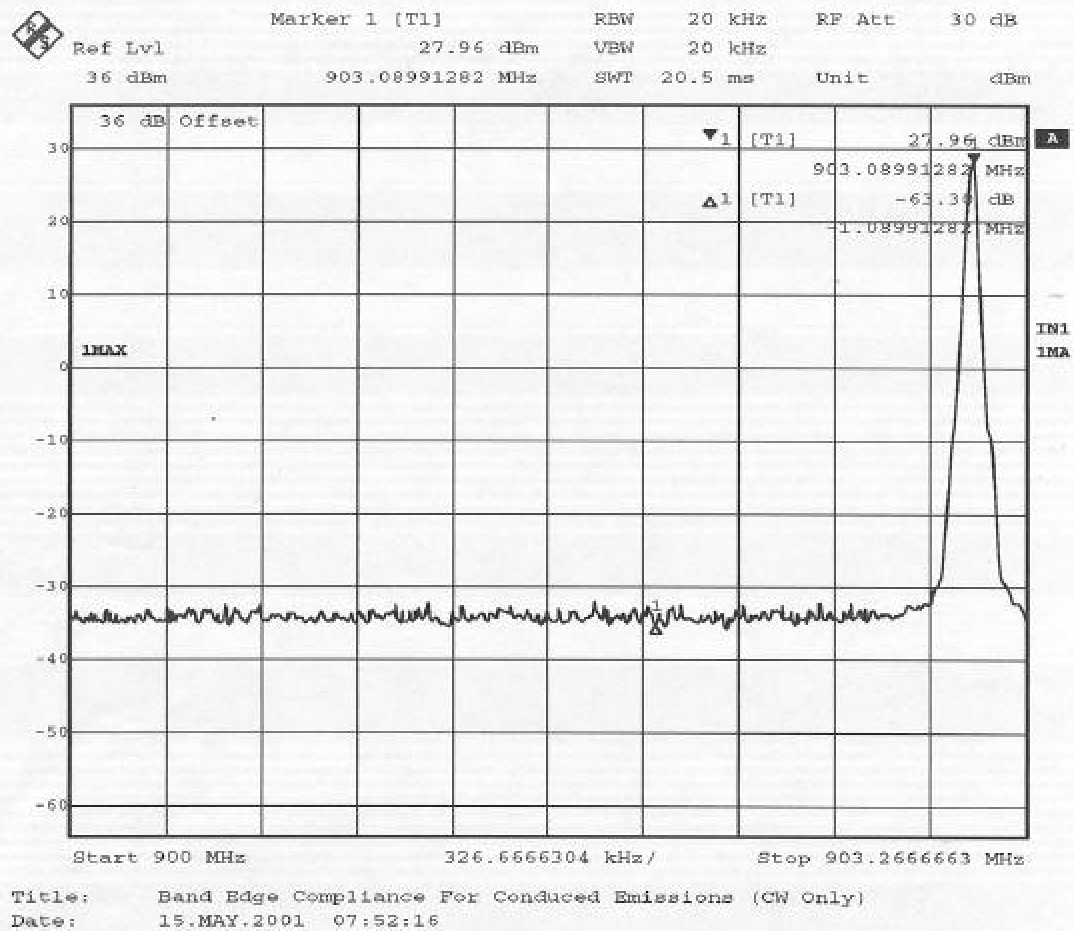
RBW 20 kHz
RF Att 30 dB
Ref Lvl
27.95 dBm
VBW 20 kHz
36 dBm
903.08991282 MHz
SWT 20.5 ms
Unit dBm
36 dB Offset
1 [T1] 27.95 dBm
903.08991282 MHz
1 [T1] -44.58 dB
-1.08991282 MHz
1MAX
IN1
1MA
30
20
10
0
-10
-20
-30
-40
-50
-60
Start 900 MHz
326.6666304 kHz/
Stop 903.2666663 MHz
Title: Band Edge Compliance For Conduced Emissions (Intellitag)
Date: 15.MAY.2001 07:30:27


Marker 1 [T1]
RBW 20 kHz
RF Att 30 dB
Ref Lvl
27.99 dBm
VBW 20 kHz
36 dBm
903.08991282 MHz
SWT 20.5 ms
Unit dBm
36 dB Offset
1 [T1] 27.99 dBm
903.08991282 MHz
1 [T1] -40.96 dB
-1.20120205 MHz
1MAX
IN1
1MA
Start 900 MHz
326.6666304 kHz/
Stop 903.2666663 MHz
Title: Band Edge Compliance For Conduced Emissions (Duralabel)
Date: 15.MAY.2001 07:48:13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Ref Lvl 27.96 dBm
36 dBm 903.08991282 MHz
RBW 20 kHz
VBW 20 kHz
SWT 20.5 ms
RF Att 30 dB
Unit dBm
36 dB Offset
1 [T1] 27.96 dBm
903.08991282 MHz
1 [T1] -63.38 dB
-1.08991282 MHz
1MAX
IN1
1MA
A
30
20
10
0
-10
-20
-30
-40
-50
-60
Start 900 MHz
326.6666304 kHz/
Stop 903.2666663 MHz
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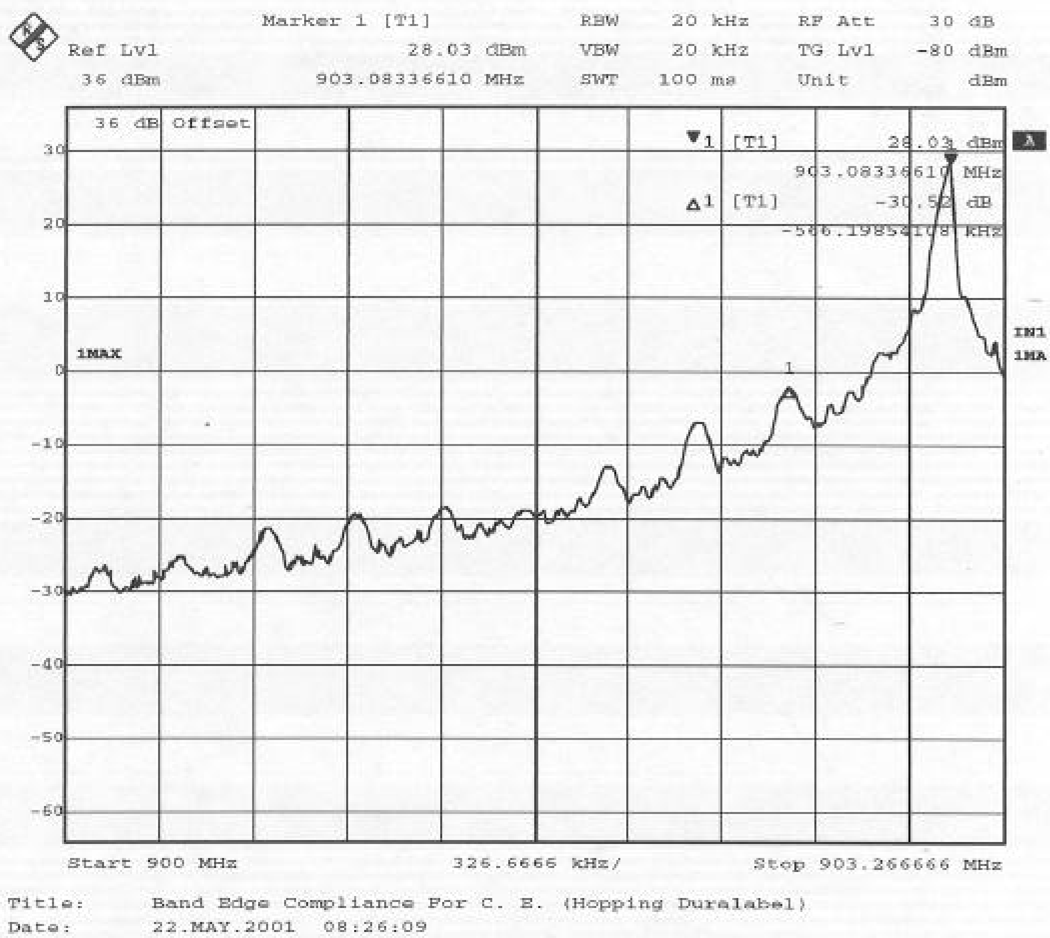
Date: 15.MAY.2001 07:52:16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RBW 20 kHz
RF Att 30 dB
Ref Lvl
28.03 dBm
VBW 20 kHz
TG Lvl -80 dBm
36 dBm
903.08336610 MHz
SWT 100 ms
Unit dBm
36 dB Offset
▼1 [T1] 28.03 dBm
903.08336610 MHz
Δ1 [T1] -30.52 dB
-566.19854108 kHz
1MAX
IN1
1MA
Start 900 MHz
326.6666 kHz/
Stop 903.266666 MHz
Title: Band Edge Compliance For C. E. (Hopping Duralabel)
Date: 22.MAY.2001 08:26:09