

TEST REPORT FROM RADIO FREQUENCY INVESTIGATION LTD.

Test Of: Wavetrend (Pty) Ltd.
L-TG800 Transmitter

To: FCC Part 15 Subpart C: 2001
(Intentional Radiators)
Section 15.231

Test Report Serial No:
RFI/MPTB1/RP42906JD05A

This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director: 	Checked By: 
Tested By: 	Release Version No: PDF01
Issue Date: 03 July 2002	Test Dates: 24 May 2002 to 30 May 2002

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Radio Frequency Investigation Ltd, Ewhurst Park, Ramsdell, Basingstoke, Hampshire, RG26 5RQ, ENGLAND. Tel: +44 (0) 1256 851193 Fax: +44 (0) 1256 851192	Registered in England, No. 211 7901. Registered Office: Ewhurst Park, Ramsdell, Basingstoke, Hampshire RG26 5RQ	 UKAS TESTING 0644
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RADIO FREQUENCY INVESTIGATION LTD.

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1. Client Information

Company Name:	Wavetrend (Pty) Ltd
Address:	Block 2B, Upper Level The Cloisters Office Park Cnr Rivonia & 9th Avenue Rivonia Johannesburg 2128 South Africa
Contact Name:	Mr D Rabe

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2. Equipment Under Test (EUT)

The client has supplied the following information (with the exception of the Date of Receipt):

2.1. Identification Of Equipment Under Test (EUT)

Brand Name:	Link-IT
Model Name or Number:	L-TG800
Serial Number:	4278612-10027043
Country of Manufacture:	South Africa
FCC ID Number:	Not applicable
Date of Receipt:	24 May 2002

2.2. Description Of EUT

The L-TG800 is an intentional transmitter used for asset tagging applications. The transmitted data includes customer site code (CSC), tag ID, tag age counter value, movement alarm and tamper alarm status. Each tag unit is encapsulated in a moulded plastic case, which is ultrasonically sealed for protection against adverse weather conditions.

2.3. Modifications Incorporated In EUT

None.

2.4. Additional Information Related To Testing

Type Of Unit:	Transmitter
Transmit Output Power Characteristics:	38µW
Operating Frequency:	433.92 MHz
Power Supply Requirement:	Internal battery supply of 3.1 V
Weight:	<25 g
Dimensions:	85 x 70 x 9 mm
Highest frequency generated or used in the EUT:	433.92 MHz

2.5. Support Equipment

There was no support equipment used to exercise the EUT during testing.

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3. Test Specification, Methods And Procedures

3.1. Test Specification

Reference:	FCC Part 15 Subpart C: 2001 (Intentional Radiators). Section 15.231(e) (Periodic Operation within the Band 40.66 to 40.70 MHz and above 70 MHz).
Title:	Code of Federal Regulations, Part 15 (47CFR15: 2001-01) Radio Frequency Devices: Digital Devices.
Comments:	A description of the test facility used for this test is on file with, and has been accepted by, the Federal Communications Commission as required by Section 2.948 of Federal Rules.
Purpose of Test:	To determine whether the equipment complied with the requirements of the specification for the purposes of certification.

3.2. Methods And Procedures

The methods and procedures used were as detailed in:

ANSI C63.2 (1996)

Title: American National Standard for Instrumentation - Electromagnetic noise and field strength.

ANSI C63.4 (2001)

Title: American National Standard Methods of Measurement of Electromagnetic Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.5 (1998)

Title: American National Standard for the Calibration of antennas used for Radiated Emission measurements in Electromagnetic Interference (EMI) control.

ANSI C63.7 (1988)

Title: American National Standard Guide for Construction of Open Area Test Sites for performing Radiated Emission Measurements.

CISPR 16-1 (1999)

Title: Specification for radio disturbance and immunity measuring apparatus and methods. Part 1. Radio disturbance and immunity measuring apparatus.

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3.3. Definition Of Measurement Equipment

The measurement equipment used complied with the requirements of the standards referenced in the Methods & Procedures section above. Appendix 1 contains a list of the test equipment used.

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4. Deviations From The Test Specification

None.

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5. Operation Of The EUT During Testing

5.1. Operating Conditions

The EUT was tested in a normal laboratory environment.

During testing, the EUT was powered by an internal battery supply of 3.1Volts.

5.2. Operating Modes

The EUT was tested in the following operating modes:

Normal Mode used for Time Domain measurements.

7 milliseconds continuous transmit in a 15-second cycle.

Forced Transmit Mode used for spurious emissions and carrier power measurements.

400 milliseconds continuous transmit in a 15-second cycle.

5.3. Configuration And Peripherals

The EUT was tested in the following configuration:

Standalone

NB. Appendix 3 contains a schematic diagram of the test configuration.

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6. Summary Of Test Results

6.1. Radiated Emissions

Type	Specification Reference	Compliancy Status
Transmitter Deactivation Time	C.F.R. 47 Part 15.231(e): 2001	Complied
Electric Radiated Field Strength 30 MHz to 5000 MHz	C.F.R. 47 Part 15.231(e): 2001	Complied
Occupied Bandwidth	C.F.R. 47 Part 15.231(c): 2001	Complied

6.2. Location Of Tests

All the measurements described in this report were performed at the premises of Radio Frequency Investigation Ltd, Ewhurst Park, Ramsdell, Basingstoke, Hampshire, RG26 5RQ, England.

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7. Measurements, Examinations And Derived Results

7.1. General Comments

7.1.1. This section contains test results only. Details of the test methods and procedures can be found in Appendix 2 of this report.

7.1.2. Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 8 for details of measurement uncertainties.

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7.2. Transmitter Activation/Deactivation Time

7.2.1. The test was performed with a standard unmodified EUT.

7.2.2. Tests were performed to the limits specified in section 15.231 (e)

7.2.3. Plots of the initial scans can be found in Appendix 4 as follows:

Plot GPH42906\001: Sweep Time: 100 mSeconds. Transmitter Activated.

Plot GPH42906\002: Sweep Time: 16.2 Seconds. Transmitter Activated.

7.2.4. In each instance, it is demonstrated that the transmitter is activated for no longer than one second and that the silent period between transmissions is at least 30 times the duration of the transmissions but in no case less than ten seconds.

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7.3. Occupied Bandwidth

7.3.1. The test was performed with a modified EUT set to transmit for 400 mS in a 15 second cycle with the correct modulation.

7.3.2. Tests were performed to the limits specified in section 15.231 (c).

7.3.3. Plots of the initial scans can be found in Appendix 4 as follows:

Plot GPH\42906\004: 20dB Bandwidth Measured with a 120 kHz Resolution Bandwidth.

Plot GPH\42906\005: 20dB Bandwidth Measured with a 120 kHz Resolution Bandwidth.

Plot GPH\42906\007: 20dB Bandwidth Measured with a 10 kHz Resolution Bandwidth

Plot GPH\42906\008: 20dB Bandwidth Measured with a 10 kHz Resolution Bandwidth

Results:

Frequency (MHz)	Instrument Resolution Bandwidth (kHz)	20dB Bandwidth (kHz)	0.25% Centre Frequency (kHz)	Margin (kHz)	Result
432.92	120	756.937	1082.3	325.363	Complied (Note 1)
432.92	120	439.159	1082.3	643.141	Complied (Note 2)
433.42	10	135.209	1083.55	948.341	Complied (Note 1)
433.42	10	132.075	1083.55	951.475	Complied (Note 2)

Note 1. Envelope of signal including transients.

Note 2. Envelope of signal excluding transients.

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7.4. Radiated Emissions

7.4.1. Electric Field Strength Measurements: Fundamental Emission

7.4.1.1. The client has stated that the transmitter frequency for the EUT was 433.895 MHz.

7.4.1.2. As stated in 15.231(b)(2) measurements were made using a Peak detector. A duty cycle correction factor of -22.06 dB has been applied to correct the peak levels to average levels (results incorporate antenna factors and cable losses):

Frequency (MHz)	Ant. Pol.	Measured Pk. Level (dB μ V/m)	Correction Factor (dB)	Av. Level (dB μ V/m)	Av. Limit (dB μ V/m)	Margin (dB)	Result
433.895	Horiz.	77.53	-22.06	55.47	72.87	17.40	Complied
433.895	Vert.	63.29	-22.06	41.23	72.87	31.64	Complied

7.4.1.3. The duty cycle correction factor in decibels was calculated as shown below:

$$cf = \left(\frac{a}{b} \right) \log 20$$

Inserting values for a and b we get :-

$$-22.06 = \left(\frac{7.889}{100} \right) \log 20$$

Where :-

a = Activation time in milliseconds.

b = 100 milliseconds or the period of one cycle whichever is the lesser.

cf = Correction Factor.

Therefore the Duty Cycle Correction Factor for the EUT is **-22.06dB**

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7.4.2. Electric Field Strength Measurements: 30 to 1000 MHz

7.4.2.1. The client has stated that the highest clock frequency for the EUT was 433.92 MHz. Therefore tests were performed up to 5000 MHz.

7.4.2.2. Radiated emission spurious limits stated in section 15.231 (e) shall not exceed a level of 20dB below the fundamental carrier limit, or the limit specified in section 15.209, whichever is the higher limit. If the frequency of the spurious emission is located in one of the Restricted Bands of operation stated in section 15.205, then the level of emissions shall not exceed the limit specified in section 15.209.

7.4.2.3. As stated in 15.231(b)(2) Measurements where made using a Peak detector. A Duty cycle correction factor of -22.06 dB has been applied to correct the peak levels to average levels. (results incorporate antenna factors and cable losses):

7.4.2.4. The duty cycle correction factor calculation can be found in section 7.4.1.3 of this report.

Frequency (MHz)	Ant. Pol.	Measured Pk. Level (dB μ V/m)	Correction Factor (dB)	Av. Level (dB μ V/m)	Av. Limit (dB μ V/m)	Margin (dB)	Result
867.787	Horiz.	51.86	-22.06	29.80	53.98	24.20	Complied
867.787	Vert.	44.65	-22.06	22.59	53.98	31.41	Complied

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7.4.3. Electric Field Strength Measurements (1000 to 5000 MHz)

7.4.3.1. The client has stated that the highest clock frequency for the EUT was 433.92 MHz. Therefore tests were performed up to 5000 MHz.

7.4.3.2. Radiated emission spurious limits stated in section 15.231 (e) shall not exceed a level of 20dB below the fundamental carrier limit, or the limit specified in section 15.209, whichever is the higher limit. If the frequency of the spurious emission is located in one of the Restricted Bands of operation stated in section 15.205, then the level of emissions shall not exceed the limit specified in section 15.209.

7.4.3.3. The following table lists frequencies at which emissions were measured using an Average and Peak detector function.

Average Levels

Frequency (GHz)	Antenna Polarity (H/V)	Average Level (dB μ V)	Antenna Factor (dB)	Cable Loss (dB)	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Average Margin (dB)	Result
1.302	Horiz.	18.86	21.5	0.6	40.96	53.98	13.02	Complied
1.736	Horiz.	21.29	22.0	0.7	43.99	53.98	9.99	Complied
2.169	Vert.	18.69	20.5	0.8	39.99	53.98	13.99	Complied
2.603	Horiz.	16.32	20.5	0.9	37.75	53.98	16.23	Complied
3.038	Horiz.	15.06	20.7	1.0	36.81	53.98	17.17	Complied

Peak Levels

Frequency (GHz)	Antenna Polarity (H/V)	Peak Level (dB μ V)	Antenna Factor (dB)	Cable Loss (dB)	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Peak Margin (dB)	Result
1.302	Horiz.	36.43	21.5	0.6	58.53	73.98	15.45	Complied
1.736	Horiz.	38.16	22.0	0.7	60.86	73.98	13.12	Complied
2.169	Vert.	32.17	20.5	0.8	53.47	73.98	20.51	Complied
2.603	Horiz.	29.72	20.5	0.9	51.12	73.98	22.86	Complied
3.038	Horiz.	27.43	20.7	1.0	49.18	73.98	24.80	Complied

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8. Measurement Uncertainty

8.1. No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

8.2. The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

8.3. The uncertainty of the result may need to be taken into account when interpreting the measurement results.

8.4. The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
Transmitter Deactivation Time	433.92 MHz (Max 30 seconds)	95%	+/- 4.76%
Occupied Bandwidth	433.92 MHz	95%	+/- 5.14%
Radiated Emissions at 3.0 metres	30 MHz to 1000 MHz	95%	+/- 5.26 dB
Radiated Emissions at 3.0 metres	1 GHz to 5 GHz	95%	+/- 5.1 dB

8.5. The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

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Appendix 1. Test Equipment Used

RFI No.	Instrument	Maker	Type No.	Serial No.
A027	1 to 2 GHz Horn Antenna	Eaton	9188-2	301
A031	2 to 4 GHz Horn Antenna	Eaton	91889-2	557
A1037	Chase Bilog Antenna	Chase EMC Ltd	CBL6112B	2413
A197	Site 2 Controller SC144	Unknown	SC144	150720
A276	OATS Positioning Controller	Rohde & Schwarz	HCC	-
A428	4 to 6 GHz WG 12 horn	Flann	12240-20	134
A490	Bilog Antenna	Chase	CBL6111A	1590
C160	Cables	Rosenberger	UFA210A-1-1181-70x70	None
C228	Cable	Unknown	Not stated	Not stated
C341	Cable	Andrews	None	None
C362	Cable	Rosenberger	UFA210A-1-1181-70x70	1925
C563	C563-N-2	Rosenberger	UFA 210A-1-0787-70x70	96L0225
C565	C565-N-3	Rosenberger	UFA 210A-1-1181-70x70	96 L 0703
M069	ESMI Spectrum Analyser / Receiver	Rohde & Schwarz	ESMI	829 808/007 (DU) / 827 063/008 (RU)
M088	Receiver / Spectrum Analyser System	Rohde & Schwarz	ESBI	DU:835862/018 RU:835387/006
M173	Turntable Controller	R.H.Electrical Services	RH351	3510020
M191	Thermo-Hygro	RS Components	RS212-124	M191-212-124

NB In accordance with UKAS requirements, all the measurement equipment is on a calibration schedule.

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Appendix 2. Measurement Methods

A2.1. Radiated Emissions: FCC Part 15

A2.1.1. Radiated emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

A2.1.2. Initial measurements covering the entire measurement band in the form of swept scans in a shielded enclosure were performed in order to identify frequencies on which the EUT was generating interference. This determined the frequencies on which the EUT should be re-measured in full on the open area test site. In order to minimise the time taken for the swept measurements, a Peak detector was used in conjunction with the appropriate detector IF measuring bandwidth (see table below). Repetitive scans were performed to allow for emissions with low repetition rates, and for the duty cycle of the EUT. The test configuration was the same for the initial scans as for the final measurements.

A2.1.3. The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. Following the initial scans, graphs were produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. A tolerance line was set 6 dB below the specification limit and levels above the tolerance line were re-tested on the open area test site, at the appropriate distance, using a measuring receivers with a Quasi-Peak or Average detector (below 1000 MHz) where applicable, for measurements above 1000 MHz average and peak detectors were used.

A2.1.4. For the main (final) measurements the EUT was arranged on a non-conducting table on an open area test site, as detailed in the specification.

A2.1.5. All measurements on the open area test site were performed using broadband antennas.

A2.1.6. On the open area test site, at each frequency where a signal was found, the levels were maximised by initially rotating the turntable through 360°. For frequencies below 1000 MHz, the antenna was varied in height between 1 m and 4 m. For frequencies above 1000 MHz, the antenna was fixed at a height of 1.5m. At this point, any signals found to be between the limit and a level 6 dB below it were further maximised by changing the configuration of the EUT, e.g. re-routing cables to peripherals and moving peripherals with respect to the EUT.

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A2.1.7. The test equipment settings for radiated emissions measurements were as follows:

Receiver Function	Initial Scan Below 1000 MHz	Final Measurements Below 1000 MHz
Detector Type:	Peak	Quasi-Peak (CISPR) or Average
Mode:	Max Hold	Not applicable
Bandwidth:	100 kHz	120 kHz
Amplitude Range:	60 dB	20 dB
Measurement Time:	Not applicable	> 1 s
Observation Time:	Not applicable	> 15 s
Step Size:	Continuous sweep	Not applicable
Sweep Time:	Coupled	Not applicable

Receiver Function	Initial Scan Above 1000 MHz	Final Measurements Above 1000 MHz
Detector Type:	Peak	Peak/Average
Mode:	Max Hold	Not applicable
Bandwidth:	1 MHz	1 MHz
Amplitude Range:	60 dB	20 dB (typical)
Measurement Time:	Not applicable	> 1 s
Observation Time:	Not applicable	> 15 s
Step Size:	Continuous sweep	Not applicable
Sweep Time:	Coupled	Not applicable

Spurious radiated emissions were measured against the limits specified in Section 15.209 of C.F.R. 47 Part 15 Subpart C - Intentional Radiators OR those of Section 15.231(e) depending upon whichever permitted a higher field strength. Unless otherwise stated, the limits given in this report correspond to those specified in 15.209.

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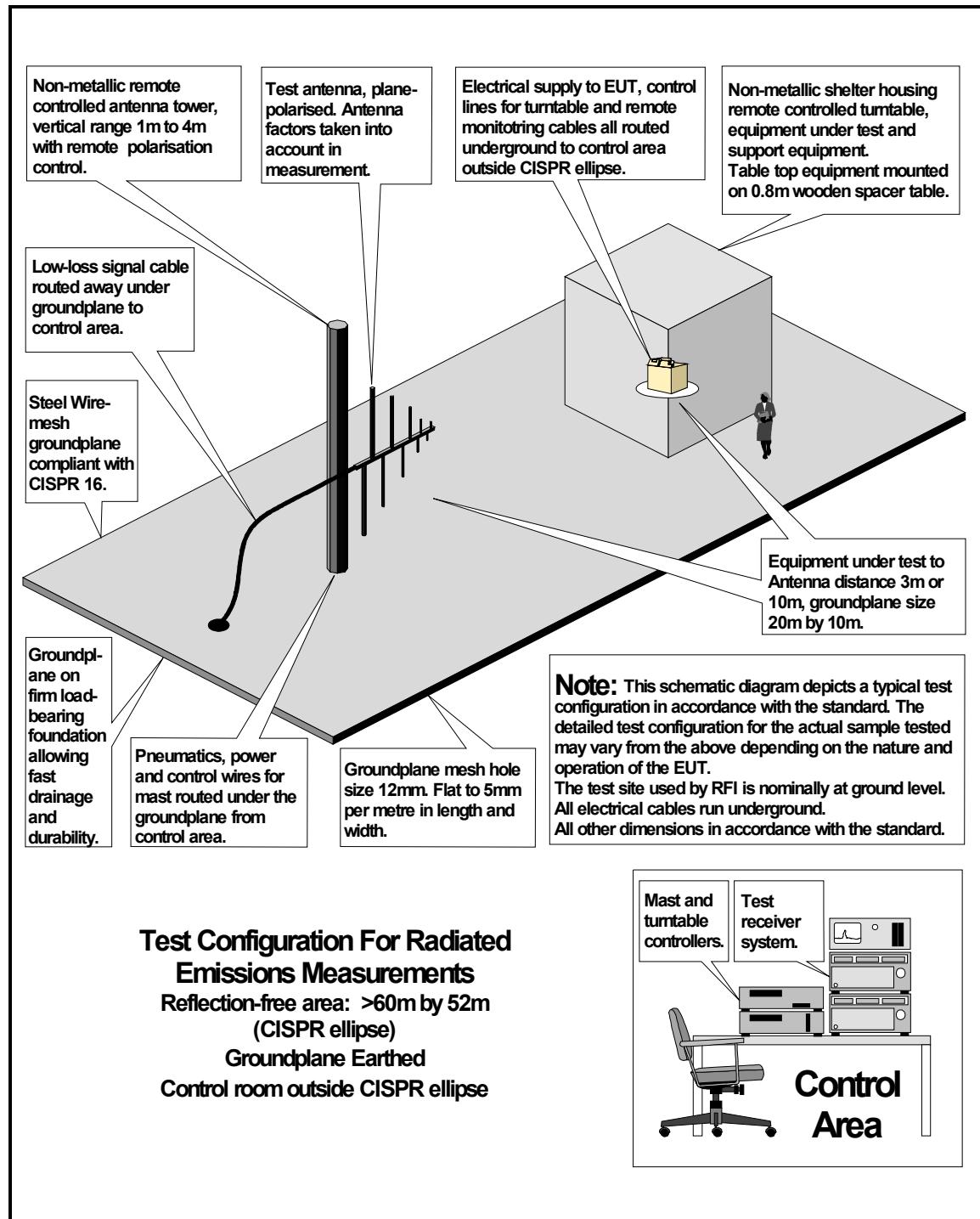
Appendix 3. Test Configuration Drawings

This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\42906JD05\EMIRAD	Test configuration for measurement of radiated emissions
DRG\42906JD05\001	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test

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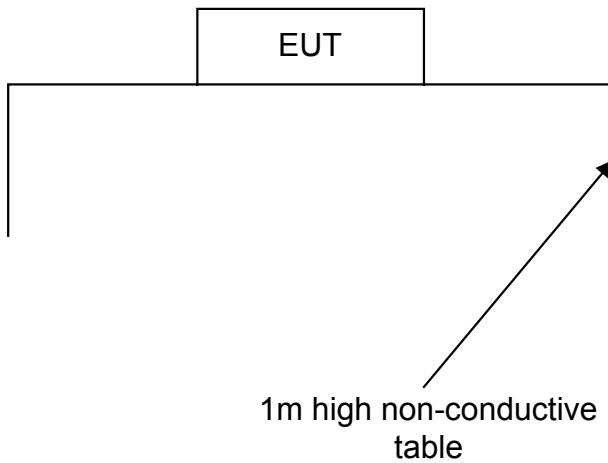
DRG\42906JD05\EMIRAD



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DRG\42906JD05\001

Configuration of EUT and Local Support Equipment



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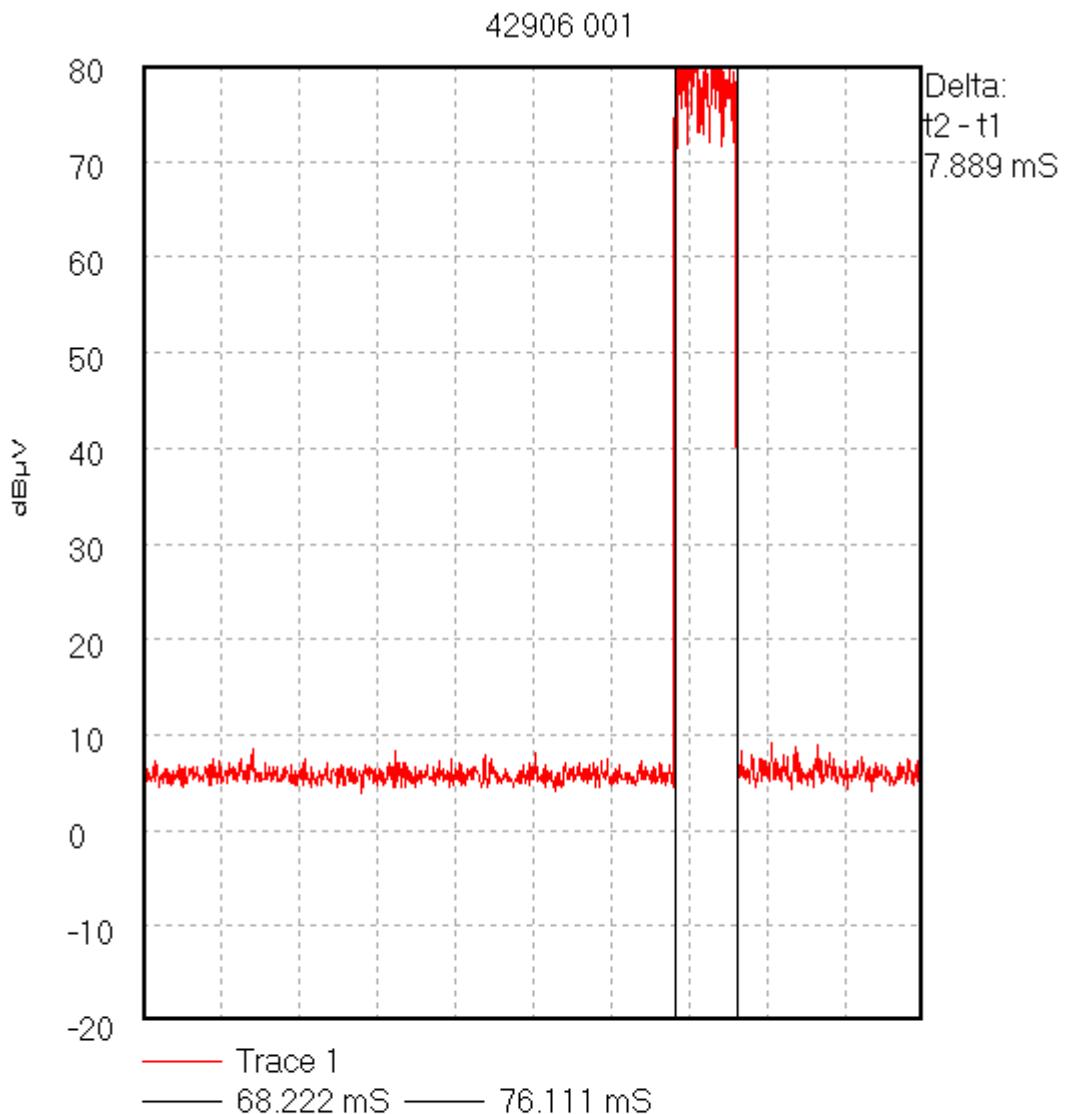
Appendix 4. Graphical Test Results

This appendix contains the following graphs:

Graph Reference Number	Title
GPH\42906JD05\001	Transmissions Activation Time Tested For Wavetrend
GPH\42906JD05\002	Transmissions Activation Time Tested For Wavetrend
GPH\42906JD05\004	20dB Bandwidth @ 120kHz Res B/W Tested For Wavetrend.
GPH\42906JD05\005	20dB Bandwidth @ 120kHz Res B/W Tested For Wavetrend.
GPH\42906JD05\007	20dB Bandwidth @ 10kHz Res B/W Tested For Wavetrend
GPH\42906JD05\008	20dB Bandwidth @ 10kHz Res B/W Tested For Wavetrend.

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GPH\42906\001
Transmissions Activation Time Tested For Wavetrend.



Start 433.92 MHz; Stop 433.92 MHz

Ref 80 dB_μV; Ref Offset 0.0 dB; 10 dB/div

RBW 68.966 kHz; VBW 10.0 kHz; Att 0 dB; Swp 100.0 mS

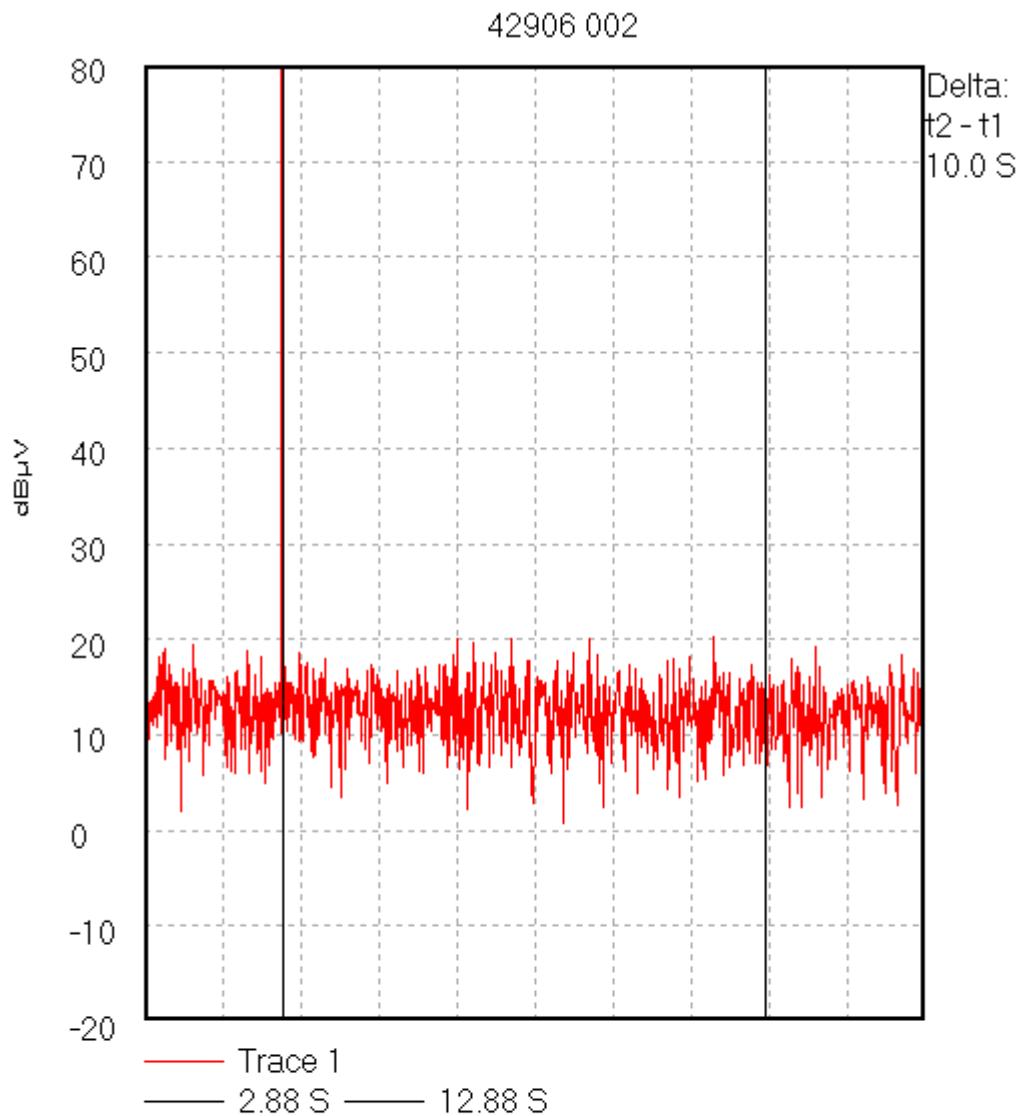
Peak 70.777 mS, 80.83 dB_μV

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GPH\42906\002

Transmissions Activation Time Tested For Wavetrend.



Start 433.92 MHz; Stop 433.92 MHz

Ref 80 dB μ V; Ref Offset 0.0 dB; 10 dB/div

RBW 689.655 kHz; VBW 1.0 MHz; Att 0 dB; Swp 16.2 S

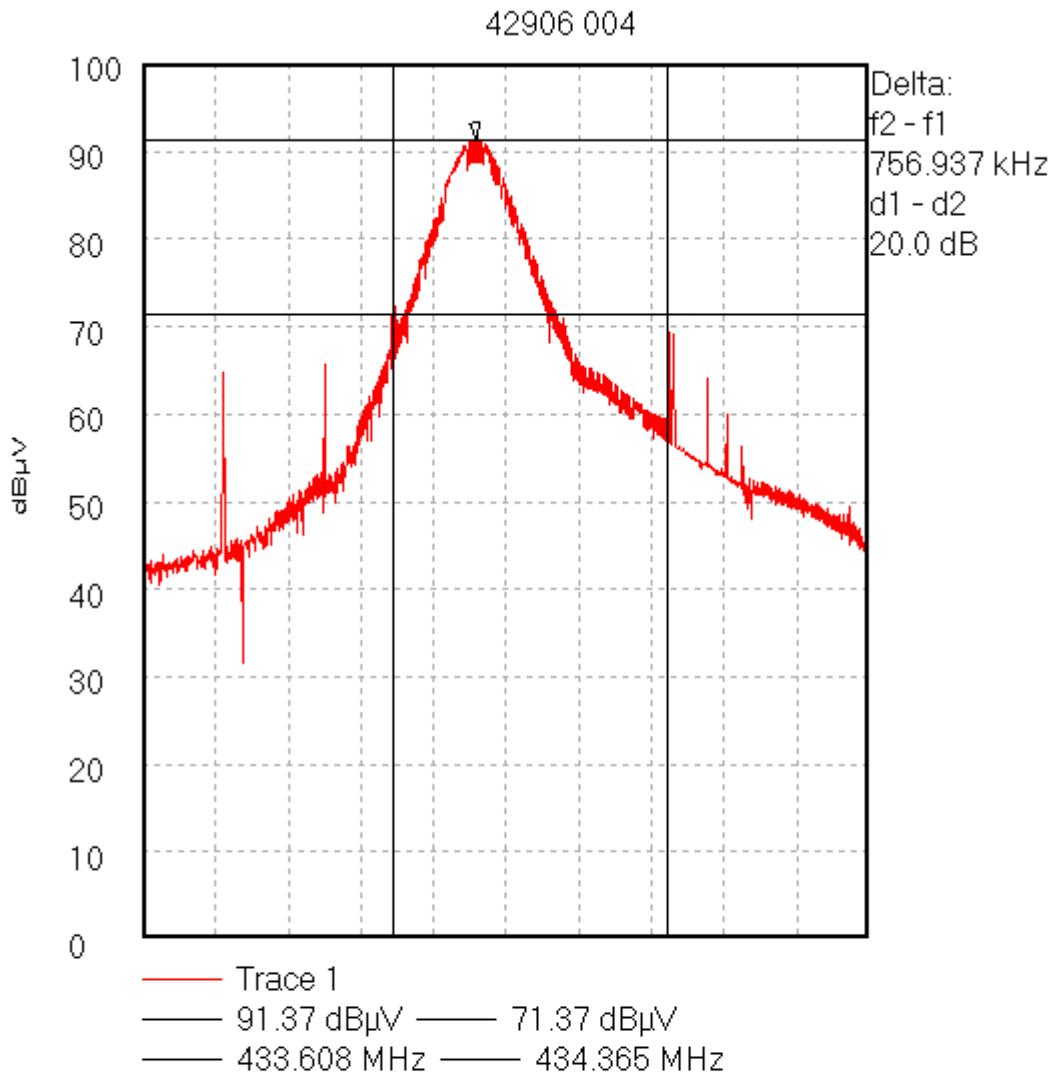
Peak 2.844 S, 83.98 dB μ V

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GPH\42906\004

20dB Bandwidth @ 120kHz Res B/W Tested For Wavetrend.

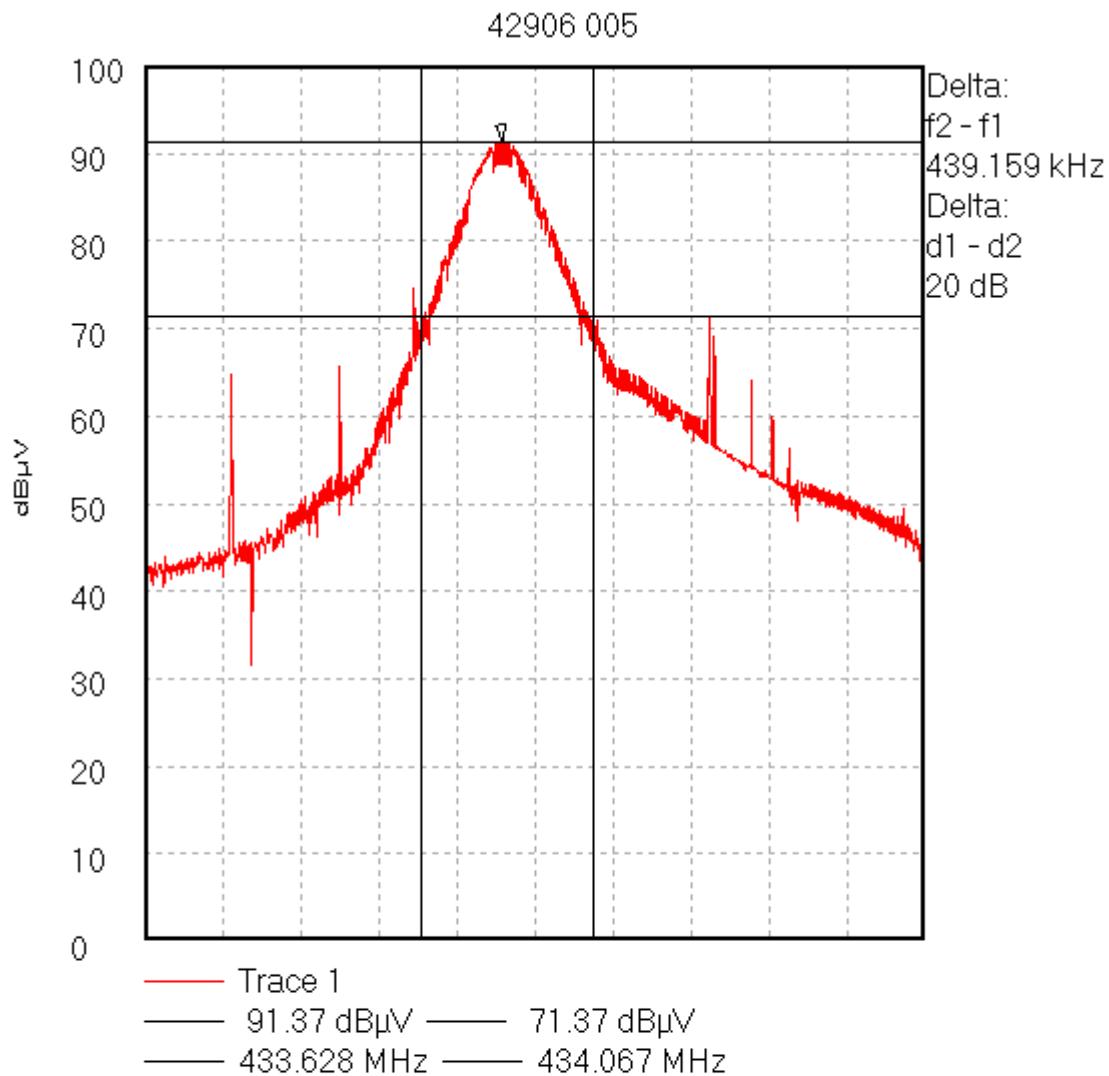


Start 432.92 MHz; Stop 434.92 MHz
Ref 100 dB μ V; Ref Offset 0.0 dB; 10 dB/div
RBW 120.0 kHz; VBW 100.0 kHz; Att 10 dB; Swp 20.0 mS
Peak 433.836 MHz, 91.37 dB μ V
Display Line: 91.37 dB μ V; 71.37 dB μ V; ; Limit Test Failed
24/05/2002 2:29:58 PM

Title: Test Of: Wavetrend (Pty) Ltd.
L-TG800 Transmitter
To: FCC Part 15 Subpart C: 2001
(Intentional Radiators) Section 15.231

GPH\42906\005

20dB Bandwidth @ 120kHz Res B/W Tested For Wavetrend.



Start 432.92 MHz; Stop 434.92 MHz

Ref 100 dB μ V; Ref Offset 0.0 dB; 10 dB/div

RBW 120.0 kHz; VBW 100.0 kHz; Att 10 dB; Swp 20.0 mS

Peak 433.836 MHz, 91.37 dB μ V

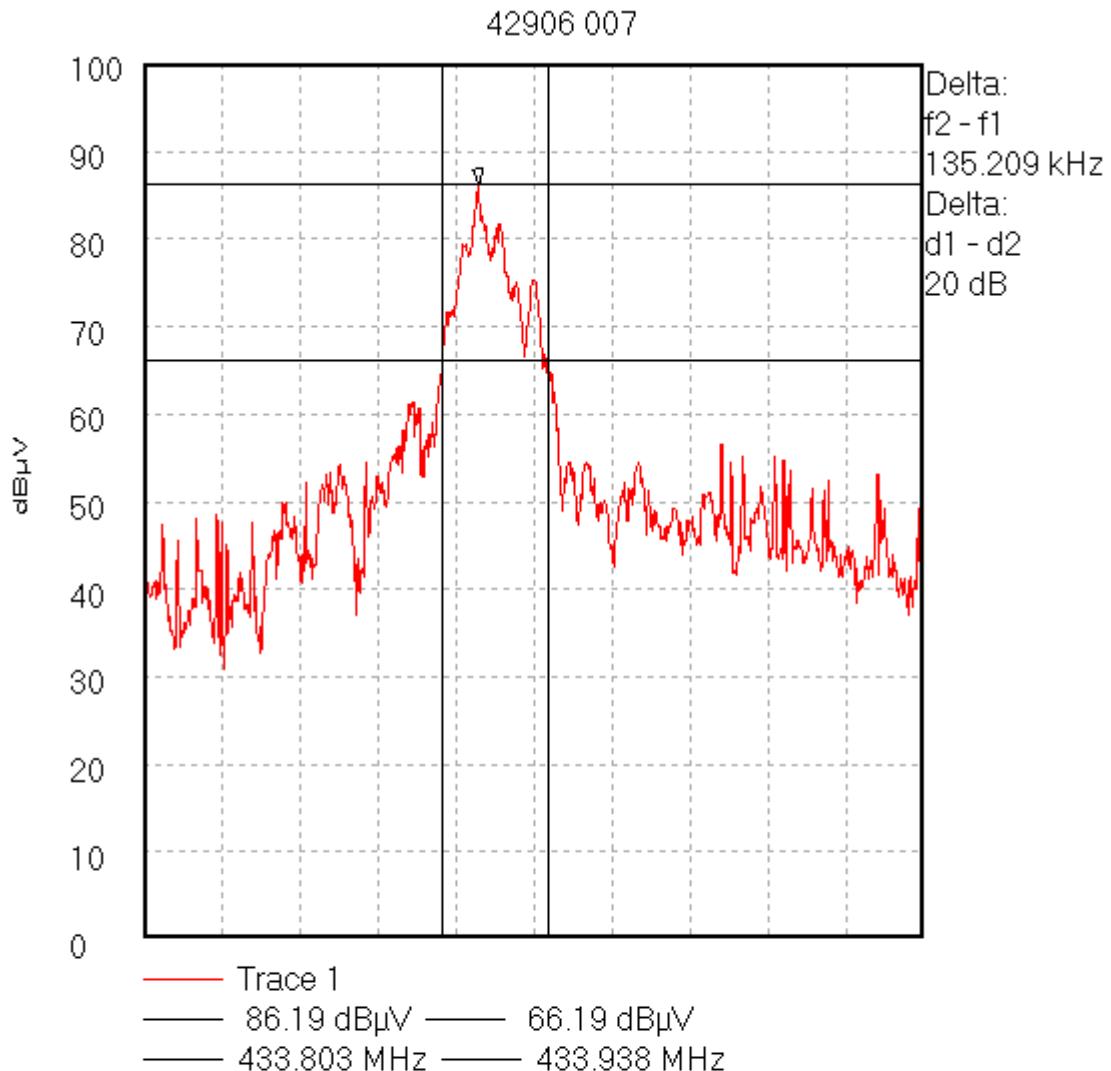
Display Line: 91.37 dB μ V; 71.37 dB μ V; ; Limit Test Failed

24/05/2002 2:31:24 PM

Title: **Test Of: Wavetrend (Pty) Ltd.**
L-TG800 Transmitter
To: FCC Part 15 Subpart C: 2001
(Intentional Radiators) Section 15.231

GPH\42906\007

20dB Bandwidth @ 10kHz Res B/W Tested For Wavetrend.



Start 433.42 MHz; Stop 434.42 MHz

Ref 100 dB μ V; Ref Offset 0.0 dB; 10 dB/div

RBW 10.0 kHz; VBW 10.0 kHz; Att 10 dB; Swp 40.0 mS

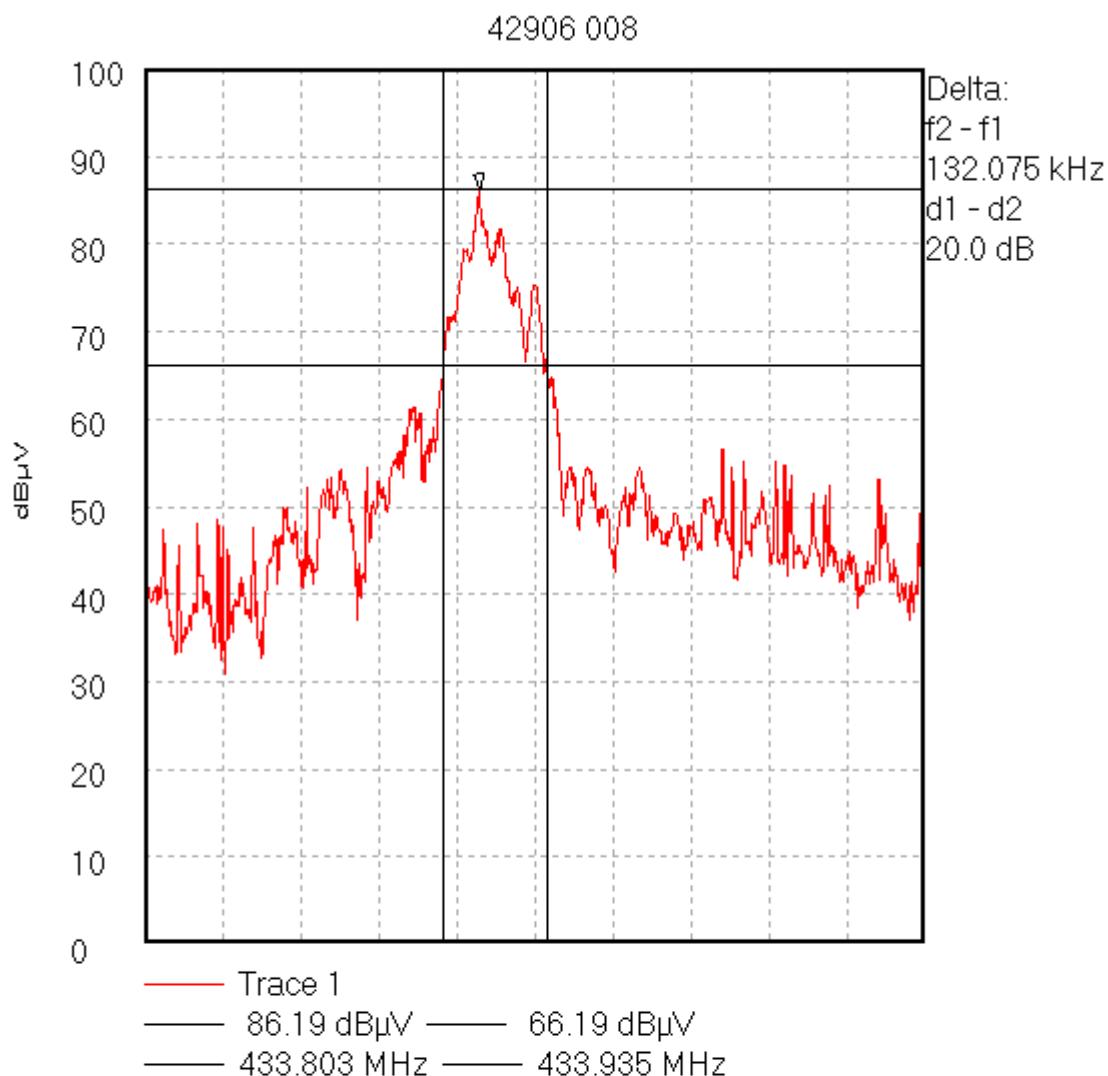
Peak 433.849 MHz, 86.19 dB μ V

Display Line: 86.19 dB μ V; 66.19 dB μ V; ; Limit Test Failed

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Title: Test Of: Wavetrend (Pty) Ltd.
L-TG800 Transmitter
To: FCC Part 15 Subpart C: 2001
(Intentional Radiators) Section 15.231

GPH\42906\008
20dB Bandwidth @ 10kHz Res B/W Tested For Wavetrend.



Start 433.42 MHz; Stop 434.42 MHz

Ref 100 dB μ V; Ref Offset 0.0 dB; 10 dB/div

RBW 10.0 kHz; VBW 10.0 kHz; Att 10 dB; Swp 40.0 mS

Peak 433.849 MHz, 86.19 dB μ V

Display Line: 86.19 dB μ V; 66.19 dB μ V; ; Limit Test Failed

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