



Radio Test Report
FCC 47CFR90.217
For
457MHz radio module
TEL2RADIO457

Reference Standard: FCC 47CFR90.271 Oct '11
Manufacturer: The IMC Group Ltd
For type of equipment and serial number, refer to section 3
Report Number: 04-559/4998/1/12
Report Produced by: -

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Certificate of Test 4998/1

The unit noted below has been tested by **R.N. Electronics Limited** and, where appropriate, conforms to the relevant subpart of FCC 47CFR90.217. This is a certificate of test only and should not be confused with an equipment authorization. Other standards may also apply.

Equipment:	457MHz radio module
Model Number:	TEL2RADIO457
Proposed FCC ID:	N20TEL2RADIO456
Unique Serial Number:	W1
Manufacturer:	The IMC Group Ltd Suite 6 24 Swan Street Kingsclere Newbury Berkshire RG20 5PJ UK
Customer Purchase Order Number:	406662
Full measurement results are detailed in Report Number:	04-559/4998/1/12
Test Standards:	FCC 47CFR90.217, Oct 2011 Licensed Non-Broadcast Transmitter; Class TNB

NOTE:

Certain tests were not performed based upon manufacturer's declarations. Certain other requirements are subject to manufacturer declaration only and have not been tested/verified. For details refer to section 3 of this report.

DEVIATIONS:

None.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

Date of Test: 19th - 20th April 2012

Test Engineer:

Peter Finley

Approved By:
Technical Director

Customer Representative:

File name IMC GROUP LTD.4998.1.DOCX

The contents of this report are beyond the scope of UKAS Testing Laboratory No. 2360 accreditation.

QMF21J - 3; FCC47CFR90.217; RNE ISSUE 01, JUL 2012

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2. Summary of test results

The 457MHz radio module TEL2RADIO457 was tested to the following standards: -

FCC 47CFR90.217 (Oct 2011); Licensed Non-Broadcast Transmitter TNB

Any compliance statements are made reliant on the modes of operation as instructed to us by the Manufacturer based on their specific knowledge of the application and functionality of the equipment tested. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard, particularly under different conditions to those during testing. This report relates to the equipment tested as identified by a unique serial number and at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed

Title	Reference	Results
1. RF power output	47CFR2, subpart J	Conducted PASSED
2. Modulation characteristics	47CFR2, subpart J	Not Applicable ^{1, 2}
3. Occupied bandwidth	47CFR2, subpart J	PASSED
4. Spurious emissions at antenna terminals	47CFR2, subpart J	PASSED
5. Field strength of spurious radiation	47CFR2, subpart J	PASSED
6. Frequency stability	47CFR2, subpart J	PASSED

¹ No limits apply.

² No applicable parameters/tests are specified.

This report was printed on: 22 November 2012

3. Equipment Under Test (EUT)

3.1 Equipment general specification

Applicant	The IMC Group Ltd Suite 6 24 Swan Street Kingsclere Newbury Berkshire RG20 5PJ UK
Manufacturer of EUT	The IMC Group Ltd
Brand name of EUT	The IMC Group Ltd
Model Number of EUT	TEL2RADIO457
Proposed FCC ID	N20TEL2RADIO456
Serial Number of EUT	W1
Date when equipment was received by RN Electronics	19-April-2012
Date of test:	19th - 20th April 2012
Customer order number:	406662
Visual description of EUT:	A small PCB module covered with a metal can on component side. A co-axial link attaches to an antenna.
Main function of the EUT:	Single channel transceiver. Transmitter/receiver selection set by solder link.
Height	5mm
Width	36mm
Depth	26mm
Weight	25g
Voltage	3.3V DC
Current required from above voltage source	not stated

3.2 Equipment RF parameters and configurations for testing

Frequency range	457.6 MHz single fixed frequency
Normal use position	As part of a wall mounted system
Normal test signals	random data
Declared modulation parameters	FSK
Declared power level	10mW at antenna port
Declared channel bandwidth	4.8kHz
Declared frequency stability	5ppm initial, plus 1ppm / year ageing
Antenna details	External antenna – maximum gain 2.1dBi
Highest frequency generated / used	457.6 MHz
Lowest frequency generated / used	32MHz (crystal oscillator)

3.3 Functional description of EUT

The TEL2RADIO457 is a RoHS compliant FCC approved embedded industrial Narrow band FM radio transceiver.

FEATURES:

FCC Part 90 (transmitter) and Part 15 compliant (receiver)
10mW output power
Single channel 457.6MHz
High sensitivity receiver
FM narrow band modulation

APPLICATIONS:

Telemetry systems

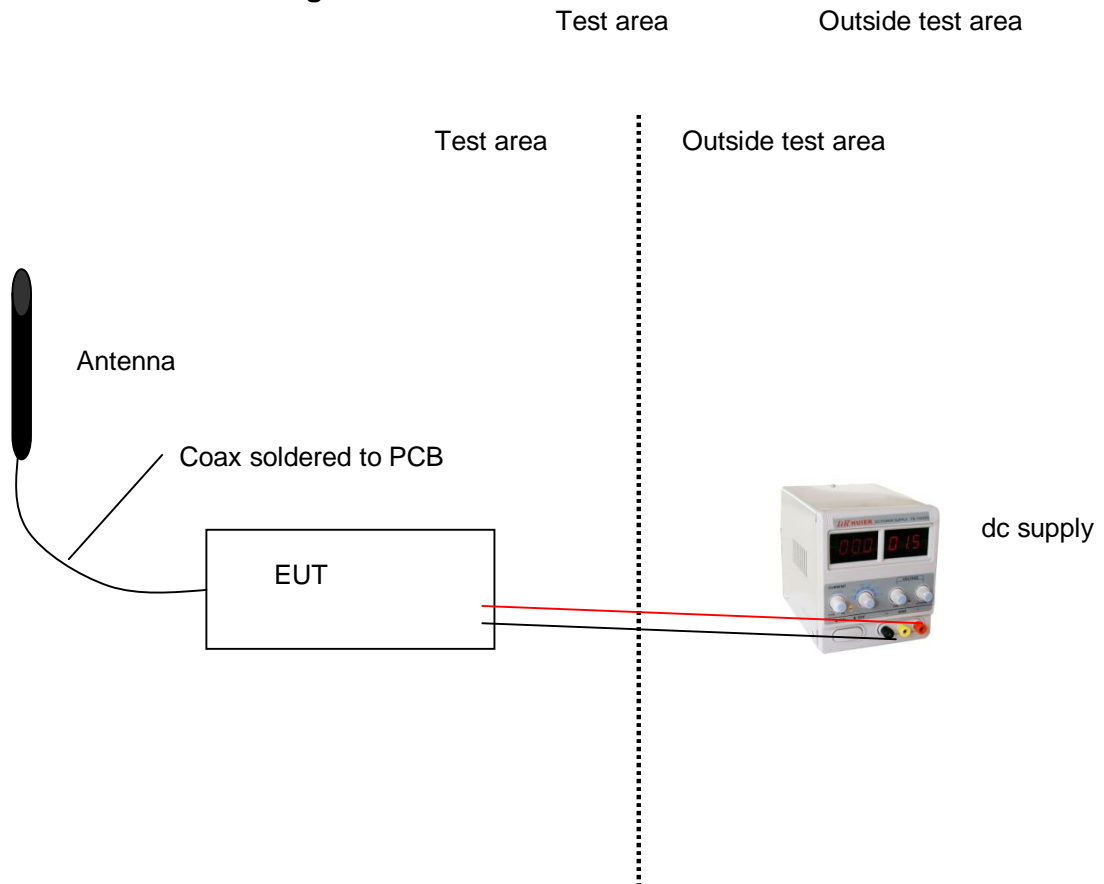
3.3 EUT modes

Mode	Description	Used for test
Transmitter Test	Transmitter on continuously 100% duty cycle, modulated by internal data.	YES
Transmitter Normal	Transmitter transmits periodically once every 5 minutes for maximum of 200ms.	NO
Receive	Receive only (transmission disabled by solder link).	NO

Description of ancillary equipment connected to the equipment under test, for the purpose of tests, can be found in Section 10.

Any modifications made to the EUT, whilst under test, can be found in Section 11.

3.4 Emissions configuration



The equipment under test was supplied by 3.3V DC power via a DC supply.

4. Specifications

The tests were performed by RN Electronics Engineer Peter Finley who set up the tests, the test equipment, and operated it in accordance with the **R.N. Electronics Ltd** procedures manual and the relevant standards listed below.

4.1 Relevant standards

Reference	Standard Number	Version	Description
4.1.1	47CFR Part 90, Subpart I	2011	Part 90 – Private Land Mobile Radio Services Subpart I – General Technical Standards
4.1.2	47CFR Part 2, Subpart J	2011	Part 2 – Frequency allocations and radio treaty matters; General rules and regulations. Subpart J – Equipment authorization procedures.
4.1.3	ITU Rec. SM.329	10 (02/03)	Unwanted emissions in the spurious domain.
4.1.4	TIA-603-C	2004	Land mobile FM or PM communications equipment measurement and performance standards.

4.2 Deviations

None.

4.3 Test site

R.N. Electronics Ltd. sites M and OATS are listed with the FCC. Registration Number 293246

4.4 Tests at Extremes of Temperature & Voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T amb	15°C - 20°C	V nom	3.3V dc
T min	-30 °C	V min	3.0V dc
T max	+50 °C	V max	3.6V dc

Extremes of voltage are based on manufacturer's declared specification.

Extremes of temperature are based upon 47CFR2.1055(a)(1) use.

The ambient test conditions of humidity and pressure in the laboratory were as follows:
38-48% RH; 9800-9900 mbar.

- ☐ A permanent internal RF port was used for testing.
- ☐ A test fixture was used for testing.
- ☒ A temporary RF port was created for testing (solder connection at antenna port).
- ☐ The equipment external RF port was used for testing.

4.5 Measurement Uncertainties

Parameter	Uncertainty	
Transmitter Tests		
Conducted RF power	<± 0.8 dB	9kHz – 18GHz
Occupied bandwidth	± 1.9 %	
Radiated spurious emissions	± 3.5 dB	
Conducted spurious emissions	± 2.6 dB	9kHz – 22GHz
Frequency error	<± 0.1 ppm	

5. Tests, Methods and Results

5.1 RF power output

5.1.1 Test methods

Test Requirements

47CFR Part 2, Subpart J

Test Method:

TIA-603-C

5.1.1.1 Configuration of EUT

The EUT was placed in a temperature controlled chamber and thermal balance was achieved before testing commenced. The EUT was operated in **Transmitter Test** mode. Measurements were made via the calibrated test fixture.

5.1.1.2 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section. The power stated is the maximum power observed from an average power detector.

5.1.2 Test results

Ambient conditions.

Temperature: 20 °C

Relative humidity: 38 %

Pressure: 9800 mbar

RADIO PARAMETERS.

Rated Power	10 mW
Channel Spacing	12.5 kHz
Modulation	FSK

TABLE OF CARRIER POWER

Test Conditions		Carrier Power (dBm)		
		Low	Mid	High
T amb	V nom	-	9.40	-
T amb	V min	-	9.05	-
T amb	V max	-	9.74	-
Max Tx Power observed (mW)			9.42	
Variation in Tx power observed (dB)			-0.95 to -0.26	

LIMITS:

90.217; 120mW (20.8 dBm).

These results show that the EUT has **PASSED** this test.

5.1.2.1 Test Equipment used

E290, E397.

See Section 10 for more details

5.2. Spurious emissions at antenna terminals

5.2.1 Test Methods

Test Requirements 47CFR Part 2, Subpart J

Test Method: TIA-603-C
ITU-R Rec. SM.329

5.2.1.1 Configuration of EUT

The EUT was tested on the bench and ambient conditions were monitored. The EUT was operated in **Transmitter Test** mode.

5.2.1.2 Test Procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site A. A complete scan of emissions from 25MHz to 5 GHz was made to identify any signals within 20dB of the limits. Any identified spurious signals were measured and plots were taken in the required bandwidths.

5.2.2 Test Results

Ambient conditions.

Temperature: 20 °C

Relative humidity: 38 %

Pressure: 9800 mbar

RADIO PARAMETERS

Channel Name	Mid
Channel Spacing	12.5 kHz
Modulation Type	FSK
Power Level	10mW

Spurious Frequency (MHz)	Measured Spurious Level (dBm)
-	-
Frequency Range	Plot Number
25MHz-300MHz	101
300MHz-457.5 MHz	102
457.7 MHz-1000MHz	103
1000MHz-3000MHz	104
3000MHz-5000MHz	105

Analyser plots for the spurious emissions can be found in Section 6.2 of this report.

Limits:

90.217 (b) 30dBc

These results show that the EUT has **PASSED** this test.

5.2.2.1 Test Equipment used

E342

See Section 10 for more details.

5.3 Field strength of spurious radiations

5.3.1 Test Methods

Test Requirements 47CFR Part 2, Subpart J

Test Method: TIA-603-C
ITU-R Rec. SM.329

5.3.1.1 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. The EUT was operated in **Transmitter Test** mode.

5.3.1.2 Test Procedure

Tests were made in accordance with the Test Methods noted above using the Test Equipment noted below.

25MHz - 1GHz, measurements were made in an ALSE with groundplane. The equipment was rotated 360° and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions.

Above 1GHz, measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. The EUT was raised and antenna was placed 1.5m above the ground in line with the EUT, which was rotated through 360° to record the worst case emissions.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

5.3.2 Test results

Test Environment:

Temperature: 15-17°C

Humidity: 48%

None within 20dB of limit.

LIMITS:

90.217 (b) 30dBc

These results show that the EUT has **PASSED** this test.

5.3.2.1 Test Equipment used

E001, E268, E327, E342, E428, E429, TMS82

See Section 10 for more details

5.4 Modulation characteristics

Not applicable:

No limits apply.

No applicable parameters/tests are specified.

5.5 Occupied bandwidth

5.5.1 Test Methods

Test Requirements

47CFR Part 2, Subpart J

Test Method:

TIA-603-C

5.5.1.1 Configuration of EUT

The EUT was placed on a bench and ambient conditions were monitored. The EUT was operated in **Transmitter Test** mode.

5.5.1.2 Test Procedure

Tests were made in accordance with the Test Method above using the Test Equipment noted below. A 1kHz RBW (1% span), 3x VBW, auto sweep time, normal detector and max hold settings were used for the bandwidth.

5.5.2 Test results

Tests were performed using Test Site **A**.

Temperature of test Environment: 20°C

Analyser plots for the occupied bandwidth can be found in Section 6.1 of this report.

Channel	F_c	F_l -30dB point	$F_c - F_l$ (kHz)	Frequency stability (kHz)	Total (kHz)
Bottom					
Middle	457.600127	457.594127	6.0	4.3	10.3
Top					

Channel	F_c	F_h -30dB point	$F_h - F_c$ (kHz)	Frequency stability (kHz)	Total (kHz)
Bottom					
Middle	457.600127	457.606127	6.0	4.3	10.3
Top					

LIMITS:

90.217 (b) Total offset of -30dB point including frequency stability \leq 25kHz

These results show that the EUT has **PASSED** this test.

5.5.2.1 Test Equipment used

E342, E434, L264, TMS38

See Section 10 for more details.

5.6 Frequency stability

5.6.1 Test Methods

Test Requirements

47CFR Part 2, Subpart J

Test Method:

TIA-603-C

5.6.1.1 Configuration of EUT

The EUT was placed in a temperature controlled chamber and thermal balance was achieved before testing commenced. Measurements were made via the calibrated test fixture. The EUT was operated in **Transmitter Test** mode.

5.6.1.2 Test Procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site A. An unmodulated carrier was unavailable, therefore, the mean of two frequency measurements taken at the same level one on each of the upper & lower sides of the modulation envelope was calculated. The error was noted as the difference between the nominal and the actual frequency.

5.6.4 Test results

Ambient conditions.

Temperature: 20 °C

Relative humidity: 40 %

Pressure: 9900 mbar

RADIO PARAMETERS.

Rated Power	10 mW
Channel Spacing	12.5 kHz
Modulation	FSK

TABLE OF FREQUENCY ERROR

Test Conditions		Frequency Reading (MHz)		
		Low	Mid	High
T amb	V nom		457.599960	
T amb	V min		457.599877	
T amb	V max		457.599877	
-30C	V nom		457.595710	
-20C	V nom		457.598833	
-10C	V nom		457.600417	
0C	V nom		457.601000	
10C	V nom		457.600667	
30C	V nom		457.598917	
40C	V nom		457.598083	
50C	V nom		457.597833	

Max Frequency Error observed (Hz)	+667 / - 4290
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LIMITS:

The limits are combined with the occupied bandwidth, refer to occupied bandwidth test on previous pages.

These results show that the EUT has **PASSED** this test.

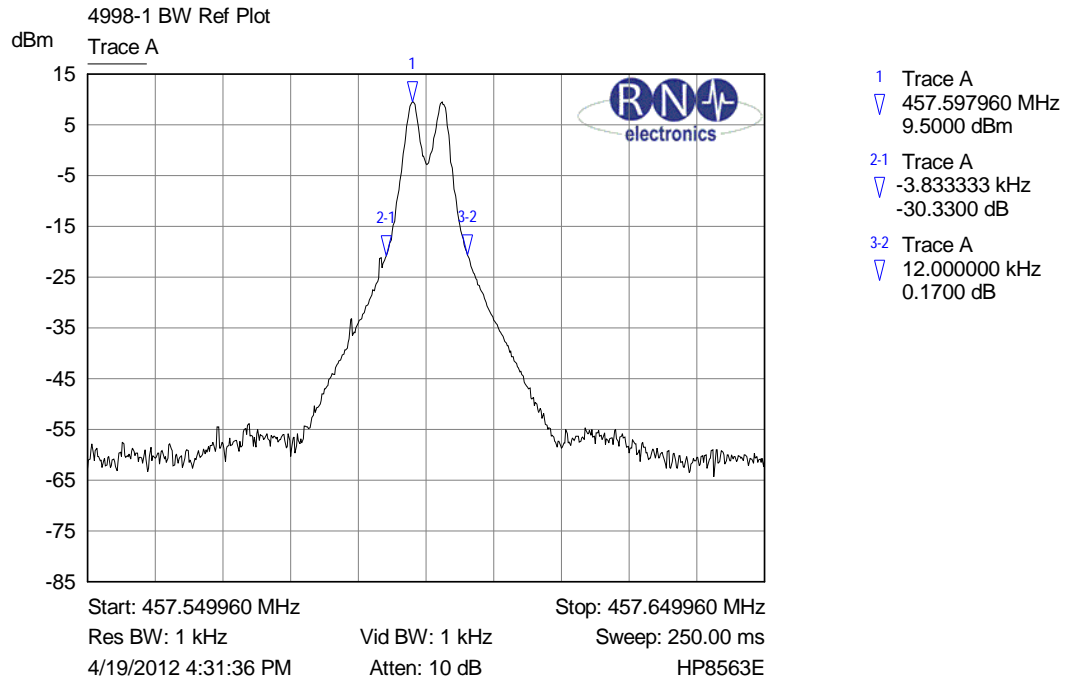
5.6.2.1 Test Equipment used

E227, E342, E434, L264, TMS38

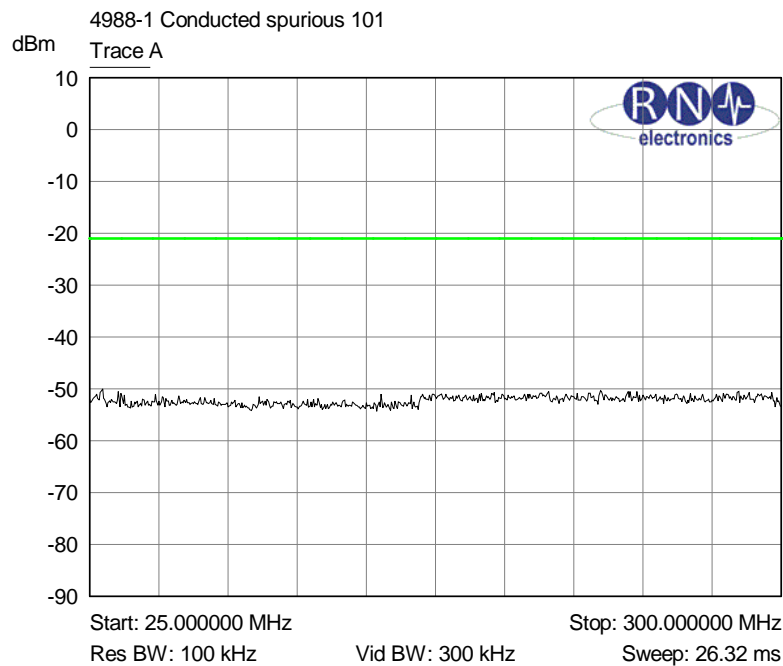
See Section 10 for more details

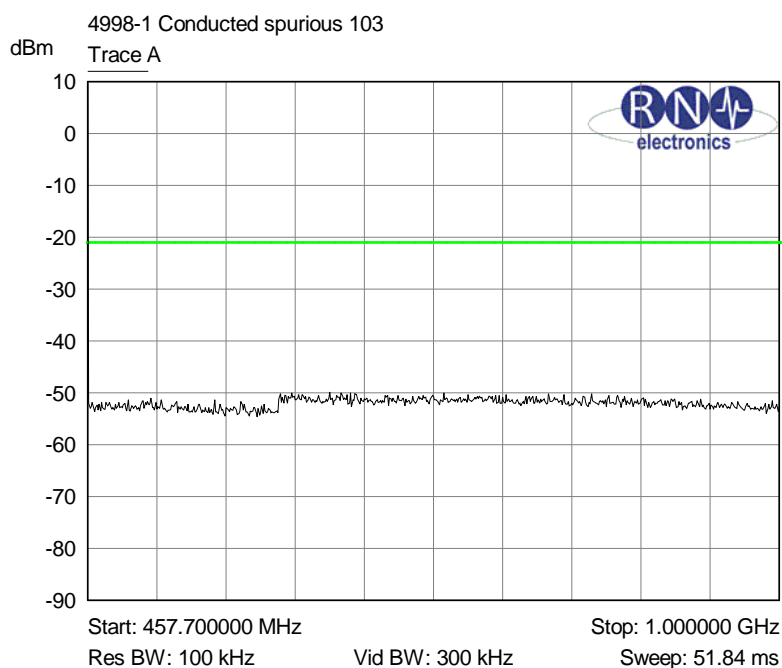
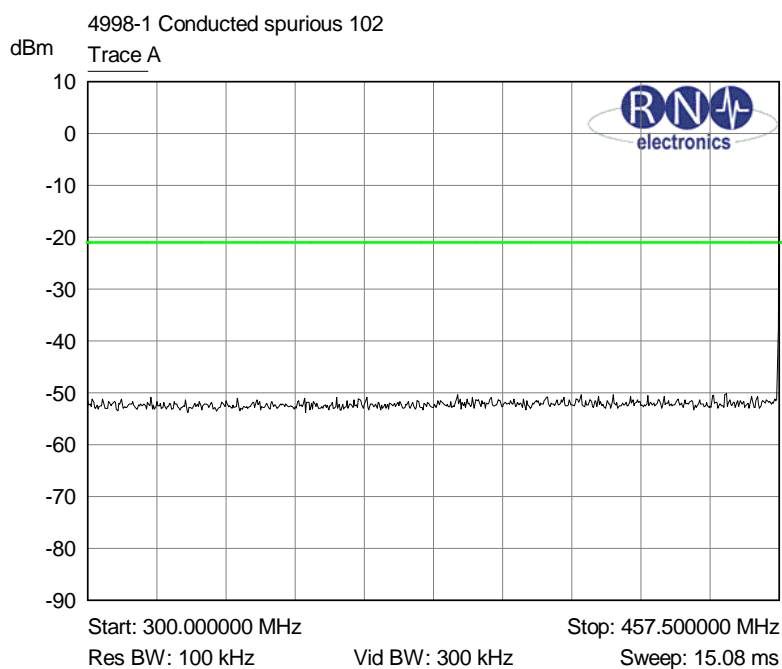
6. Plots and Results

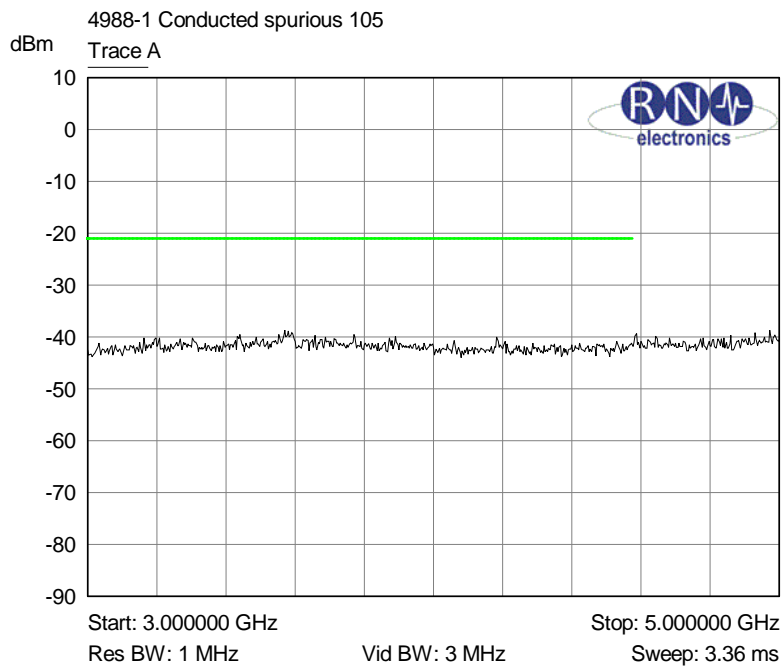
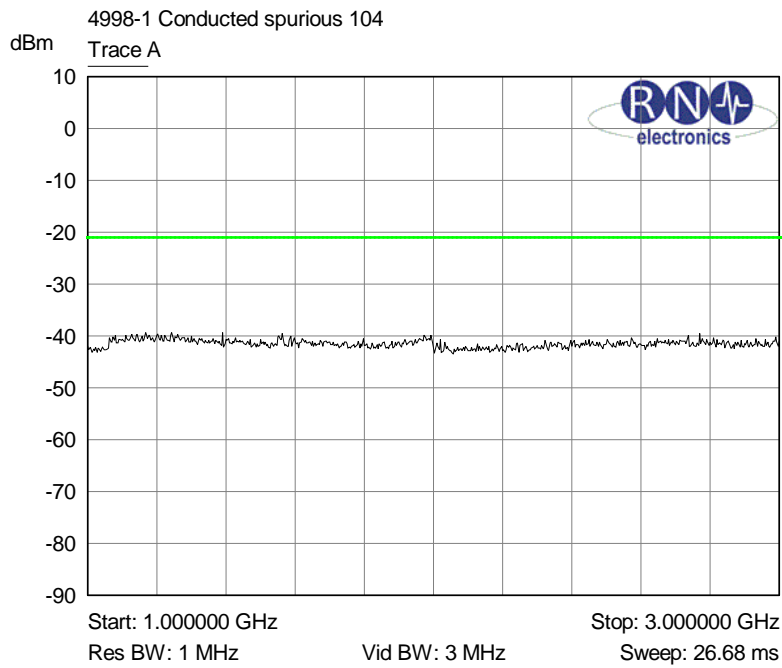
6.1 Spectrum (occupied bandwidth and attenuation) plots



6.2 Antenna port spurious emission plots







7 Explanatory Notes

None.

8. Photographs

Identifying Photographs of the EUT:





**Internal Photograph of the EUT (alternative
supplied without can)**



9. Signal Leads

Port Name	Cable Type
Antenna	coax to sma bulkhead
Input	3 pin header for dc power / data

10. Test Equipment Calibration list

The following table lists the test equipment used, last calibration date and calibration interval. All test equipment used has been maintained within the calibration requirements of **R.N. Electronics Ltd.** test facility quality system. Calibration intervals are regularly reviewed dependent on equipment manufacturer's recommendations and actual usage of the equipment.

RN No	Model	Manufacturer	Description	Period	Last
E001	HP8542E	Hewlett Packard	EMI Receiver & RF Filter	12	09/11/2011
E131	ESG-3000A	Hewlett Packard	Signal Generator	24	09/11/2010
E227	6632A	Hewlett Packard	System DC Power Supply	12	26/01/2012
E268	BHA 9118	Schaffner	1-18 GHz Horn Antenna	24	14/04/2011
E290	6914	Marconi Instruments	Power Sensor	24	23/08/2011
E327	CBL6141A	Schaffner	Bi-log Antenna	24	01/05/2010
E342	8563E	HP	Spectrum Analyser 26.5 GHz	24	29/03/2011
E397	6960B	Marconi Instruments	RF Power Meter	24	16/07/2011
E428	HF906	Rhode & Schwarz	1-18 GHz Horn Antenna	24	25/11/2011
E429	-	RN Electronics	5 Switch Filter Box 0.91 GHz - 16.3 GHz	12	10/11/2011
E434	G3RUH	James Miller	10 MHz GPS Oscillator	-	-
L264	DT75	Instrotech Ltd	Digital Thermometer	24	13/07/2010
TMS38	VMT04/140	Heraeus Votsch	Environmental Oven	-	-
TMS82	8449B	Agilent	Pre Amplifier 1 - 26 GHz	12	14/11/2011

11. Auxiliary equipment

11.1 Auxiliary equipment supplied by The IMC Group Ltd.

Auxiliary equipment used for the purpose of test supplied by the above has been listed below

Model No.	Description	Manufacturer	Serial No
-	Whip antenna	-	-

11.2 Auxiliary equipment supplied by RN Electronics Limited

Auxiliary equipment used for the purpose of test supplied by the above has been listed below

RN No.	Model No.	Description	Manufacturer	Serial No
C015	L30-2	Stabilised Power Supply	Farnell	4436

12. Modifications

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

12.1 Modifications before test

There were no modifications made by R.N. Electronics Ltd before testing commenced.

12.2 Modifications during test

There were no modifications made by R.N. Electronics Ltd during testing.

13 Description of Test Sites

Site A	Radio / Calibration Laboratory and anechoic chamber
Site B	Semi-anechoic chamber
Site B1	Control Room for Site B
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions) VCCI Registration No. C-2823
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 293246
Site Q	Fully-anechoic chamber
Site OATS	3m and 10m Open Area Test Site FCC Registration No. 293246 IC Registration No. 5612A-1 VCCI Registration No. R-2580
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

14 Abbreviations and Units

%	Percent	Hz	Hertz
µV	microVolts	IF	Intermediate Frequency
µW	microWatts	kHz	kiloHertz
AC	Alternating Current	LO	Local Oscillator
ALSE	Absorber Lined Screened Enclosure	mA	milliAmps
AM	Amplitude Modulation	max	maximum
Amb	Ambient	mbar	milliBars
ANSI	American National Standards Institute	MHz	MegaHertz
°C	Degrees Celsius	min	minimum
CFR	Code of Federal Regulations	mm	milliMetres
CS	Channel Spacing	ms	milliSeconds
CW	Continuous Wave	mW	milliWatts
dB	decibels	NA	Not Applicable
dBµV	decibels relative to 1µV	nom	Nominal
dBc	decibels relative to Carrier	nW	nanoWatt
dBm	decibels relative to 1mW	OATS	Open Area Test Site
DC	Direct Current	OFDM	Orthogonal Frequency Division Multiplexing
EIRP	Equivalent Isotropic Radiated Power	ppm	Parts per million
ERP	Effective Radiated Power	QAM	Quadrature Amplitude Modulation
EUT	Equipment Under Test	QPSK	Quadrature Phase Shift Keying
FCC	Federal Communications Commission	Ref	Reference
FM	Frequency Modulation	RF	Radio Frequency
FSK	Frequency Shift Keying	RTP	Room Temperature and Pressure
g	Grams	s	Seconds
GHz	GigaHertz	Tx	Transmitter
		V	Volts