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TEST REPORT

Smartwater SW800-TNK Water Tank Transceiver

tested to

47 Code of Federal Regulations

Part 15 - Radio Frequency Devices

Subpart C – Intentional Radiators

including

Section 15.247 - Operation in the band 902 – 928 MHz

for

Smartwater Technology Ltd

This Test Report is issued with the authority of:

Andrew Cutler - General Manager

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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1. STATEMENT OF COMPLIANCE

The **Smartwater SW800-TNK Water Tank Transceiver** complies with FCC Part 15 Subpart C including Section 15.247 as an Intentional Radiator when the methods as described in ANSI C63.4 - 2003 and those defined in FCC KDB558074 D01 V03r04 are applied.

2. RESULTS SUMMARY

The results of testing carried out between 13th of January and the 11th February 2015 are detailed below:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required.
15.203	Antenna requirement	Complies. Reverse SMA antenna connector used.
15.204	External PA and antenna modifications	Noted.
15.205	Restricted bands of operation	Complies.
15.207	Conducted limits	Not applicable.
15.209	Radiated emission limits	Complies.
15.247		
(a)(2)	Minimum bandwidth	Complies
(b)(3)	Peak output power	Complies
(b)(4)	Antenna gain less than 6 dBi	Complies
(c)	Operation with directional antenna	Not applicable
(d)	Out of band emissions	Complies
(e)	Power spectral density	Complies
(f)	Hybrid systems	Not applicable
(g)	Use of all channels	Not applicable
(h)	Intelligent frequency hopping	Not applicable
(i)	Radio frequency hazards	Complies

3. INTRODUCTION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification with the following conditions:

The client selected the test sample.

The report relates only to the sample tested.

This report contains no corrections.

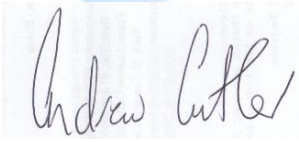
Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

To the best of my knowledge, these tests were performed using measurement procedures that are consistent with industry or Commission standards and demonstrate that the equipment complies with the appropriate standards.

I further certify that the necessary measurements were made by EMC Technologies NZ Ltd, 47 MacKelvie Street, Grey Lynn, Auckland, New Zealand.



Andrew Cutler
General Manager
EMC Technologies NZ Ltd

4. CLIENT INFORMATION

Company Name	Smartwater Technology Ltd
Address	4/41 Smales Road East Tamaki
City	Auckland 2013
Country	New Zealand.
Contact	Mr Ken Child

5. DESCRIPTION OF TEST SYSTEM

Brand Name	Smartwater
Model Number	SW800-TNK
Product	Water Tank Transceiver
Manufacturer	Smartwater Technology Ltd
Country of Origin	New Zealand / China
Serial Number	Not serialised
FCC ID	2ABG2SW800TNK

The device that was tested and reported in this test report is one of three transceivers that make up a system that is used to monitor and control the level of water in remote water tanks.

The system consists of three transceivers which are known as the Tank unit, Display unit and the Pump unit.

The device under test is the Tank unit, model number SW800-TNK, that is located at the water tank and it sends water level data on 922 MHz at approximately 30 minute intervals.

The Tank unit has an external antenna and a water pressure sensor attached and is powered using an internal lithium 3 Vdc battery that is recharged using a solar cell.

The system also comprises the following devices.

The Display unit, model number SW800-LCD, is a LCD display unit that displays the water tank level indication based upon the information transmitted to it from the water tank transmitter.

The Display unit has an external antenna and is powered by an internal battery and charged using a representative USB port via a USB charging adapter using the public AC mains at 120 Vac 60 Hz.

The Pump unit, model number SW800-PMP, is a water pump controller that allows water to be pumped from the water tank to various parts of the water supply system.

The Pump unit has an external antenna and is powered using the public AC mains at 120 Vac 60 Hz.

In normal operations the system communicates once every 30 minutes.

For testing purposes the transmitters were modified in order to transmit every 10 seconds or less.

The device has the following specifications:

FCC Band:	902 MHz – 928 MHz
Test Frequency:	922.000 MHz
Modulation Type:	Digital Modulation - Wide Band FSK
Antenna Type:	External whip antenna
Power Supply:	Internal battery that is charged using a solar cell.

6. RESULTS

Standard

The sample was tested in accordance with 47 CFR Part 15 Subpart C.

Methods and Procedures

The following measurement methods and procedures have been applied:

- ANSI C63.4 – 2003
- FCC KDB558074 D01 V03r04

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 is required for this device.

Section 15.203: Antenna requirement

An external whip antenna is used.

This antenna has a reverse SMA connector that is a unique antenna connector.

Result: Complies.

Section 15.204: External radio frequency power amplifiers and antenna modifications

An external power amplifier is **NOT** provided for use with this transmitter.

Suitable warning will be placed in the user manual regarding the modification of the device.

Result: Complies.

Section 15.205: Restricted bands of operation

The device tested transmits on a single frequency of 922 using digital modulation.

Section 15.247 allows this between 902 – 928 MHz

Result: Complies.

Section 15.107: Conducted limits

Conducted emission testing is not applicable.

This device operates using an internal battery power supply that is re-charged using a solar panel.

Result: Not applicable.

Section 15.209 – Radiated emissions

As this device contains digital devices that operate using frequencies below 30 MHz, low frequency measurements were attempted between 9 kHz – 30 MHz at the open area test site over a distance of 10 metres using a loop antenna the centre of which was 1 metre above the ground.

Details of the general test set up are provided in the photograph section of this report.

The general limits described in 15.209 have been applied with the 300 metre and 30 metre limits being extrapolated by a factor of 40 dB per decade as allowed for in section 15.31(d)(2).

Between 9 – 90 kHz and between 110 – 490 kHz an Average detector and a Peak detector were used.

Where a peak detector was used the limit was increased by +20 dB.

Between 90 kHz and 110 kHz band between 490 kHz and 30 MHz a Quasi Peak detector was used.

No emissions were detected on these frequencies of interest and no other emissions were detected from this device over the range of 9 kHz – 30 MHz

Result: Complies
Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (9 kHz – 30 MHz) ± 4.8 dB

Section 15.247(a)(2) - Minimum bandwidth

Digital devices operating in the 902 - 928 MHz band are required to have a minimum 6 dB bandwidth of 500 kHz.

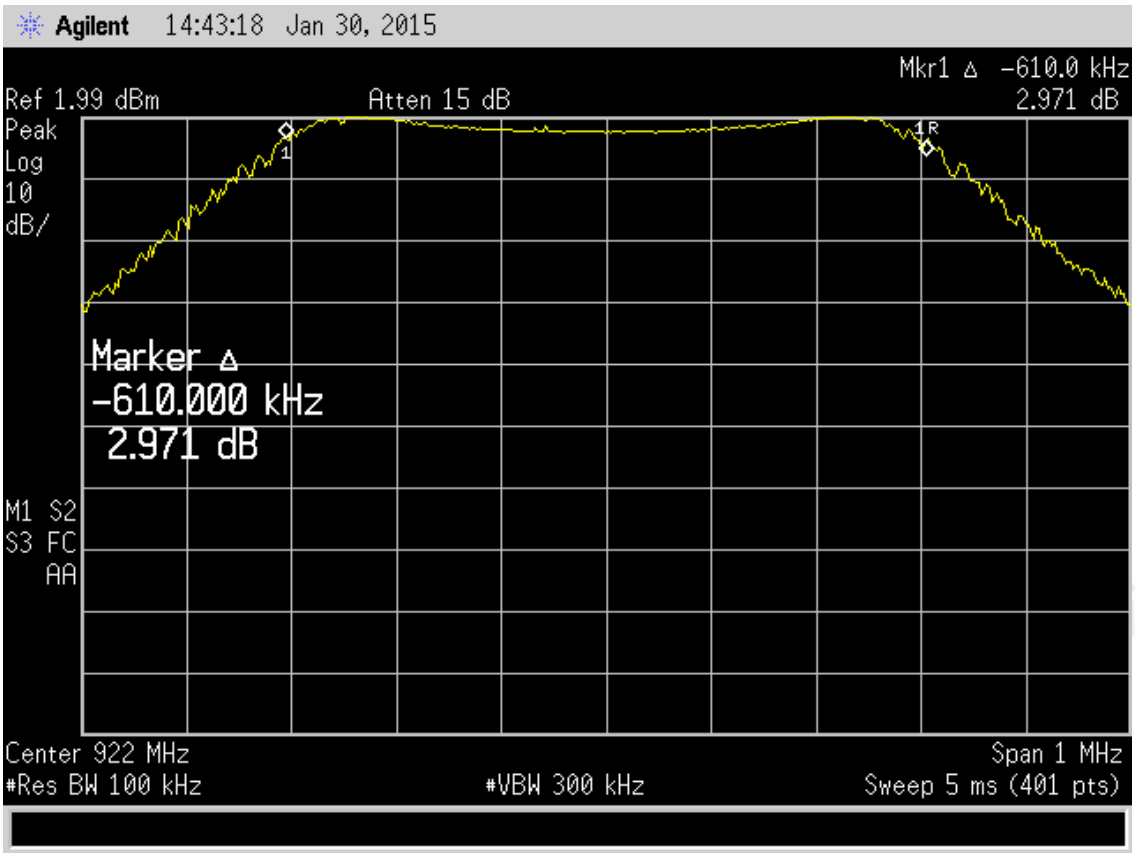
Testing was carried out using Spectrum Analyser using a 1 MHz span with a resolution bandwidth of 1% and a video bandwidth of approximately 3 x the resolution bandwidth

The results are summarised as follows:

Frequency (MHz)	Bandwidth (kHz)
922.000	610.000

Result: Complies

Frequency: 922.000 MHz



Section 15.247(b)(3)– Peak output power

As the device has an antenna port conducted power measurements were made at this port.

Frequency (MHz)	Level (dBm)	Limit (dBm)
922.000	+2.0	30.0

A limit of 1 watt (+30.0 dBm) has been applied.

Additionally radiated power measurements were made at the test site to ensure that the antenna gain does not exceed 6 dBi.

The device being placed in the centre of the test table at a height of 80 cm above the ground plane with the transmit antenna vertical.

Testing was carried out on 922 MHz using both vertical and horizontal polarisations.

Frequency (MHz)	Field Strength (dBµV/m)	Radiated Power (dBm)	Conducted Power (dBm)	Antenna Gain (dB)	Antenna Polarisation
922.000	100.6	5.4	2.0	3.4	Vertical

Measurements were made using a peak detector with a 1 MHz bandwidth.

The radiated power level in dBm was determined by formula from the field strength using the formula Field strength (V/m) = (square root of (30 x transmitter power (watts))) / distance (metres)

The antenna gain has been shown to not exceed +6 dBi.

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Orere Point, Auckland.

Result: Complies.
Measurement Uncertainty: ± 4.1 dB

Section 15.247 (d) – Out of band emissions

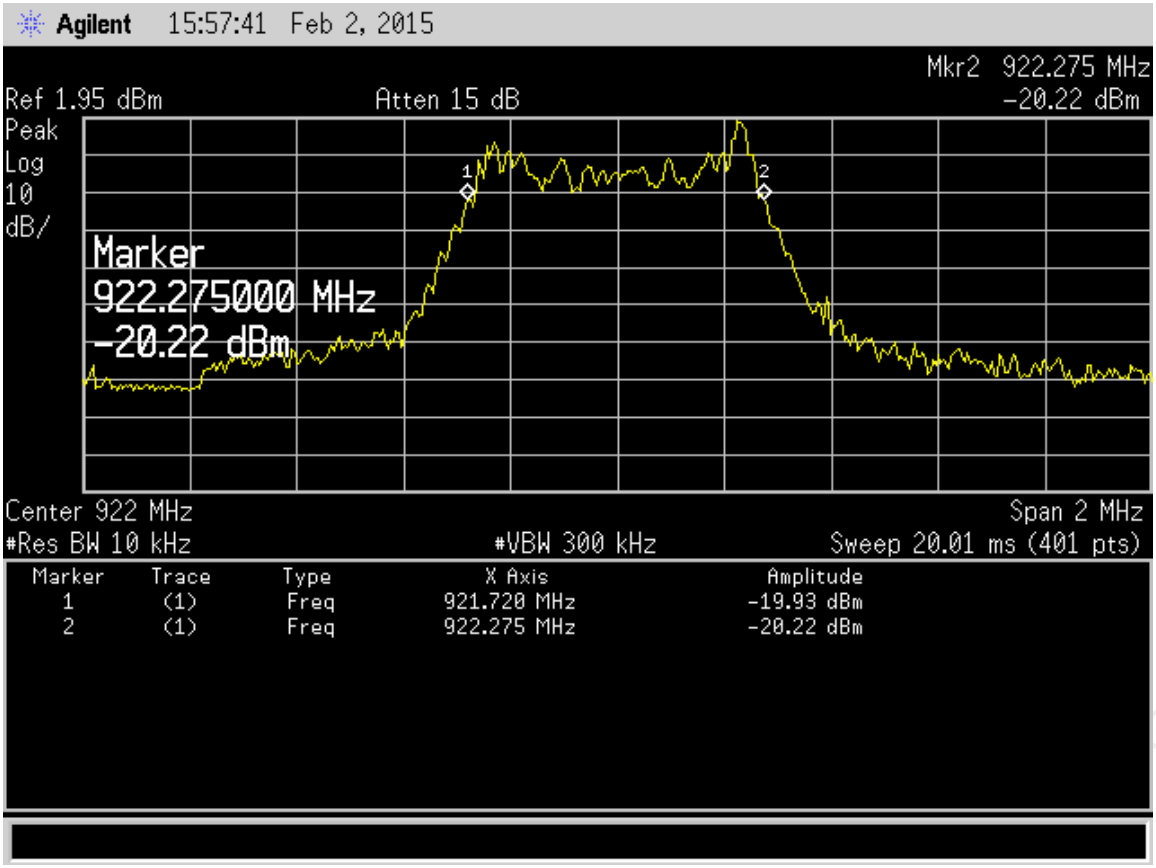
Band edge measurements:

Relative measurements were carried out to determine the -20 dB band-edge points.

Below is a plot of the -20 dB band edge points (actually -26 dB) when the device was transmitting on 922.000 MHz.

The band edge points were determined to be 921.720 MHz and 922.275 MHz.

Frequency: 922.000 MHz



The device is required to remain within the band of 902 - 928 MHz.

Result: Complies.
Measurement Uncertainty: ± 1.1 dB

Conducted spurious emissions

As the device has an antenna port spurious emission measurements were made at the antenna port using a spectrum analyser with a 100 kHz resolution bandwidth.

A limit of -20 dBc has been applied to these measurements which were made up to 10Fc

Frequency (MHz)	Level (dBm)	Limit (dBm)
922.000	+2.0	-
1844.0000	-37.2	-18.0
2766.0000	-30.1	-18.0
3688.0000	-44.2	-18.0
4610.0000	-40.0	-18.0
5532.0000	-40.5	-18.0
6454.0000	-42.6	-18.0
7376.0000	-54.2	-18.0
8298.0000	-54.2	-18.0
9220.0000	-54.0	-18.0

No other spurious emissions were observed at the antenna port

Result: Complies.
Measurement uncertainty: ± 1.1 dB

Spurious emissions and restricted band radiated emission measurements

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland.

Radiated emission measurements were carried out with the limits as per section 15.209 applied when these emissions fell within the restricted bands.

All other emissions are required to meet a limit of -20 dBc with relation to the highest in band emission.

The highest emission observed was on 922.00 MHz using vertical polarisation with a level of 100.6 dBµV/m recorded being recorded when a 100 kHz bandwidth peak detector was used

The transmitter was placed on the test table top which was a total of 0.8 m above the test site ground plane.

Measurements of the radiated field were attempted at 3 metres from the device with no emission being detected.

Measurements below 1000 MHz were made using a Quasi Peak Detector with a bandwidth of 120 kHz.

Measurements above 1000 MHz were made using an average detector with a bandwidth of 1.0 MHz and also a peak detector with a bandwidth of 1.0 MHz.

When an emission is located, it is positively identified and its maximum level is found by rotating the automated turntable, and by varying the antenna height with an automated antenna tower.

All emissions were measured in both vertical and horizontal antenna polarisations.

The emission level is determined in field strength by taking the following into consideration:

Level (dBµV/m) = Receiver Reading (dBµV) + Antenna Factor (dB/m) + Coax Loss (dB) – Amplifier Gain (dB)

Result: Complies
Measurement uncertainty: ± 4.1 dB

Transmitting continuously on 922.000 MHz

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Antenna	Margin (dB)	Result	Detector
1844.0000	56.5	52.2	80.6	Vertical	24.1	Pass	Peak
2766.0000	64.1	60.9	74.0	Vertical	9.9	Pass	Peak
2766.0000	47.9	43.5	54.0	Vertical	6.1	Pass	Average
3688.0000	60.5	63.5	74.0	Horizontal	13.5	Pass	Peak
3688.0000	41.5	42.1	54.0	Horizontal	12.5	Pass	Average
4610.0000	72.8	68.3	74.0	Vertical	5.7	Pass	Peak
4610.0000	47.5	43.1	54.0	Vertical	10.9	Pass	Average
5532.0000	71.1	66.7	80.6	Vertical	9.5	Pass	Average
6454.0000	63.1	61.5	80.6	Vertical	17.5	Pass	Peak
7376.0000	55.0	57.5	74.0	Horizontal	16.5	Pass	Peak
7376.0000	42.0	41.8	54.0	Vertical	12.0	Pass	Average
8298.0000	62.1	59.5	74.0	Vertical	11.9	Pass	Peak
8298.0000	43.4	43.4	54.0	Vertical	10.6	Pass	Average
9220.0000	59.1	58.5	80.6	Vertical	21.5	Pass	Peak

Other emissions observed

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Antenna	Margin (dB)	Result	Detector
57.595		28.5	40.0	Horizontal	11.5	Pass	QPeak
74.910		30.0	40.0	Horizontal	10.0	Pass	QPeak
111.162		36.7	43.5	Horizontal	6.8	Pass	QPeak
149.579		35.4	43.5	Horizontal	8.1	Pass	QPeak
181.503		32.7	43.5	Horizontal	10.8	Pass	QPeak
200.440		35.3	43.5	Horizontal	8.3	Pass	QPeak
251.843		37.7	46.0	Horizontal	8.3	Pass	QPeak
297.835		35.7	46.0	Horizontal	10.3	Pass	QPeak
302.806		37.9	46.0	Horizontal	8.1	Pass	QPeak
322.444	41.7		46.0	Vertical	4.3	Pass	QPeak
322.444		37.0	46.0	Horizontal	9.0	Pass	QPeak
326.653	41.1		46.0	Vertical	4.9	Pass	QPeak
340.681		38.3	46.0	Horizontal	7.7	Pass	QPeak
346.293	40.8		46.0	Vertical	5.2	Pass	QPeak
374.349		39.0	46.0	Horizontal	7.0	Pass	QPeak
586.172	40.6		46.0	Vertical	5.4	Pass	QPeak
591.783	39.3		46.0	Vertical	6.7	Pass	QPeak
600.200	39.9		46.0	Vertical	6.1	Pass	QPeak

All other emissions observed had a margin to the limit that exceeded at least 15 dB.

Section 15.247(e) – Power Spectral Density

As the device has an antenna port the Power Spectral Density was determined using conducted emission measurements.

Measurements were initially made using a frequency span of 1 MHz and a measurement bandwidth of 10 kHz to determine the emission peaks.

Final measurements were made using a resolution bandwidth of 3 kHz.

A radiated measurement was made.

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result	BW (kHz)
921.7700	94.0	-1.2	8.0	Vertical	9.2	Pass	3.0

A limit of +8 dBm applies

Result: Complies.
Measurement Uncertainty: ± 1.1 dB

Section 15.247(i) – Radio Frequency Hazard Information

As per Section 15.247 (i) spread spectrum transmitters operating in the 902 – 928 MHz band are required to be operated in a manner that ensures that the public is not exposed to RF energy levels in accordance with CFR 47, Section 1.1307(b)(1).

The device when in operation is fixed and a safe distance could be maintained when events are undertaken.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of 0.615 mW/cm^2 (f/1500 = 922/1500) has been applied.

Power density, $mW/cm^2 = E^2/3770$
E for MPE: $0.615 = E^2/3770$

$E = \sqrt{0.615*3770}$

E = 48.1 V/m

The maximum distance from the antenna at which the MPE is met or exceeded is calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain and separation distance in metres.

The highest radiated power has been measured to be +5.4 dBm or 0.0035 watts EIRP.

Therefore:

$E = \sqrt{(30 * P * G) / d}$

$d = \sqrt{(30 * P * G) / E}$

$d = \sqrt{(30 * 0.0035) / 48.1}$

d = 0.007 m or 0.7 cm

Result: Complies if a minimum safe distance of 20 cm is specified in the set up instructions for this system.

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal Due	Interval
Aerial Controller	EMCO	1090	9112-1062	3710	N/a	N/a
Aerial Mast	EMCO	1070-1	9203-1661	3708	N/a	N/a
Biconical Antenna	Schwarzbeck	BBA 9106	-	3789	05/02/2017	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	04/06/2017	3 years
Log Periodic Antenna	Schwarzbeck	VUSLP 91111	9111-228	3785	01/12/2017	3 years
Receiver	Rohde & Schwarz	ESIB-40	100171	4003	29/04/2015	1 year
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	3776	15/04/2015	1 year
Turntable	EMCO	1080-1-2.1	9109-1578	3709	N/a	N/a
VHF Balun	Schwarzbeck	VHA9103	-	3789	05/02/2017	3 years

At the time of testing all test equipment was within calibration

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies Ltd registration with the Federal Communications Commission as a listed facility, registration number: 90838, which was last updated in June 2014.

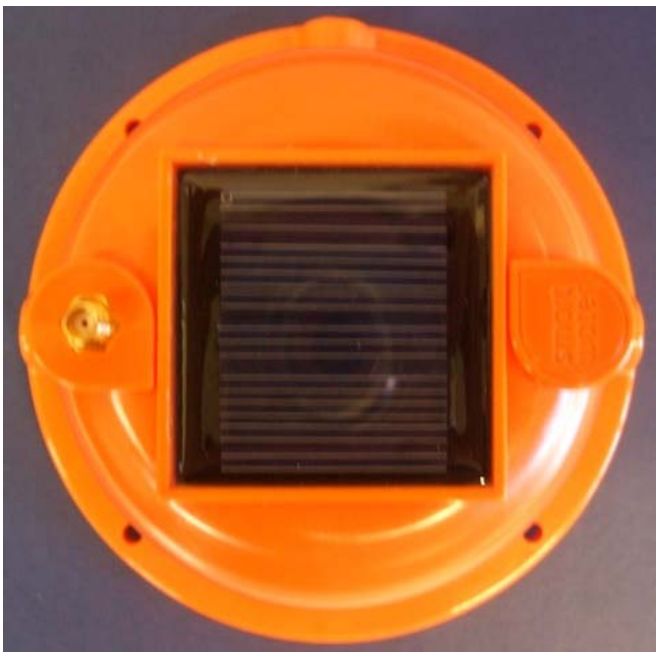
All testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

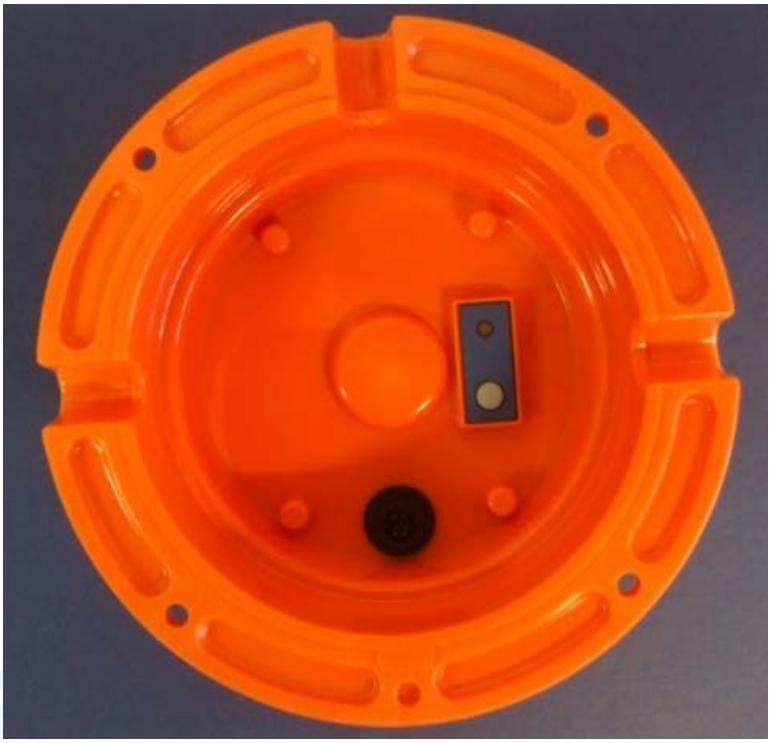
All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

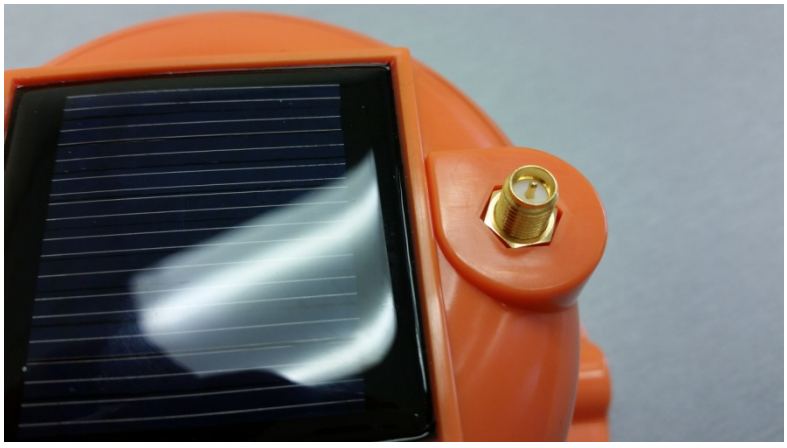
9. PHOTOGRAPHS

External Photos





Antenna details



Internal Photo

Test set up