

LABORATORY TEST REPORT
RADIO PERFORMANCE MEASUREMENTS

for the

TBDB1G Base Station Transceiver

Tested in accordance with:

FCC 47 CFR Part 80

Report Revision: 1

Issue Date: 26 February 2021

PREPARED BY: I. D. Russell


Test Technician

CHECKED & APPROVED BY: M. C. James


Laboratory Technical Manager



FCC REGISTRATION: 838288

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

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REVISION

Date	Revision	Comments
26 February 2021	1	Initial test report

INTRODUCTION

Type approval testing of the TBDB1G, 50 Watt, Base Station transceiver in order to demonstrate compliance with FCC 47 Part 80. This radio supports 25 kHz wide band analogue modulation.

REPORT PREPARED FOR

Tait International Ltd
245 Wooldridge Road
Harewood
Christchurch 8051
New Zealand

DESCRIPTION OF SAMPLE

Manufacturer: Tait International Limited
Equipment: Base Station Transceiver
Type: TBDB1G
Product Code: TB7310-B1B0-0000-A000-10
Serial Number(s): 18331488
Frequency range: 136 → 174 MHz
Transmit Power: 50 W

Modulation	Channel Spacing	Speech Channels	Symbol Rate (symbols/sec)	Data Rate (bps)
Analogue FM	25 kHz	1	-	-

HARDWARE & SOFTWARE

Quantity: 1

Module	Product Code	Serial Number	Firmware Version	Hardware Version
Reciter	T01-01403-BAAA	18331256	p25-0.01.00-47875-g57afd504cf	2.01
Power Amplifier	T01-01405-BAAA	18337783	-	0.02

TEST CONDITIONS

All testing was performed between 24 → 26 February 2021, and under the following conditions:

Ambient temperature: 15°C → 30°C
Relative Humidity: 20% → 75%
Standard Test Voltage: 120 V_{AC}

TEST REQUIREMENTS AND RESULT SUMMARY

FCC Specification	Test Name	Test Methods	Result
FCC 47 CFR 2.1046	Transmitter Output Power (Conducted)	ANSI C63.26 5.2.4.2	P
FCC 47 CFR 2.1047 (a)	Transmitter Audio Frequency Response – Pre-emphasis	ANSI C63.26 5.3.3.2	P
FCC 47 CFR 2.1047 (b)	Transmitter Modulation Limiting	ANSI C63.26 5.3.2	P
FCC 47 CFR 2.1049 (c)	Transmitter Spectrum Masks	TIA-603-E 2.2.11	P
FCC 47 CFR 2.1051	Transmitter Spurious Emissions (Conducted)	ANSI C63.26 5.7	P
FCC 47 CFR 2.1053	Transmitter Spurious Emissions (Radiated)	ANSI C63.26 5.5	P
FCC 47 CFR 2.1055 (d) (1)	Transmitter Frequency Stability - Temperature	ANSI C63.26 5.6.4	P
FCC 47 CFR 2.1055 (d) (1)	Transmitter Frequency Stability - Voltage	ANSI C63.26 5.6.5	P

Test Case Result Definitions	
No test Performed	N
Test does not apply to the test object	N/A
Test object meets requirements	P (Pass)
Test object does not meet requirements	F (Fail)
Test object is not conclusive	I (Inconclusive)

Comments:

STATEMENT OF COMPLIANCE

We, TELTEST LABORATORIES of 558 Wairakei Road, Christchurch, New Zealand, declare under our sole responsibility that the product:

Equipment: Base Station Transceiver
Type: TBDB1G
Product Code: TB7310-B1B0-0000-A000-10
Serial Number(s): 18331488
Quantity: 1

to which this declaration relates, is in conformity with the following standards:

FCC 47 CFR Part 80

Signature: 

M. C. James
Laboratory Technical Manager

Date: 9 March 2021

The results obtained in this test report pertain only to the item(s) tested. Teltest does not make any claims of compliance for samples or variants that were not tested.

MODULATION TYPES, NECESSARY BANDWIDTH & EMISSION DESIGNATORS

MODULATION TYPES:

G3E Analogue Phase Modulation (PM)

CHANNEL SPACINGS: 25.0 kHz

EMISSION DESIGNATORS:

	25.0 kHz
Analog FM	16K0G3E

CALCULATIONS

Equation: $B_n = 2M + 2Dk$

(M is highest modulating frequency; D is peak allowable deviation; k is a constant of 1 for FM)

Analog Voice 25.0 kHz Bandwidth

Necessary bandwidth

M = 3.0 kHz

D = 5.0 kHz

$$B_n = (2 \times 3.0) + (2 \times 5.0) \times 1 \\ = 16.0 \text{ kHz}$$

Emission Designator

16K0G3E

G3E represents a PM voice transmission

TEST RESULTS

TRANSMITTER OUTPUT POWER (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1046

GUIDE: TIA/EIA-603D 2.2.1

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. The coaxial attenuator has an impedance of 50 Ohms.
3. The unmodulated output power was measured with an RF Power meter.

MEASUREMENT RESULTS:

Manufacturer's Rated Output Power: 50 W and 2 W

Nominal 50 W	154.0125 MHz	162.0125 MHz
Measured	51.9	54.8
Variation (%)	3.8	9.6
Nominal 2 W	154.0125 MHz	162.0125 MHz
Measured	2.1	2.1
Variation (%)	4.0	5.6
Measurement Uncertainty	± 0.6 dB	

Example calculation

$$\begin{aligned}
 \text{Power in dBm} &= \text{Measured power (dBm)} + \text{attenuator and cable loss (dB)} \\
 \text{Chan 1 power (dBm)} &= 16.97 \text{ dBm} + 30.18 \text{ dB} \\
 &= 47.15 \text{ dBm} \\
 \text{Power in Watts} &= (10^{(47.15 \text{ dBm})/10})/1000 \\
 &= 51.9 \text{ W}
 \end{aligned}$$

LIMIT CLAUSE:

FCC 47 CFR 80.215

The output power shall not exceed by more than 20%... the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC 47 CFR 2.1047 (a)

GUIDE: TIA/EIA-603D 2.2.6

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. An audio input tone of 1000 Hz was applied with the level set to obtain 20% of maximum deviation. This was used as the 0 dB reference point.
3. The AF was varied while the audio level was held constant.
4. The response in dB relative to 1000 Hz was measured.

MEASUREMENT RESULTS:

See the plots on the following pages for 25.0 kHz channel spacing tested at 50 W transmit power.

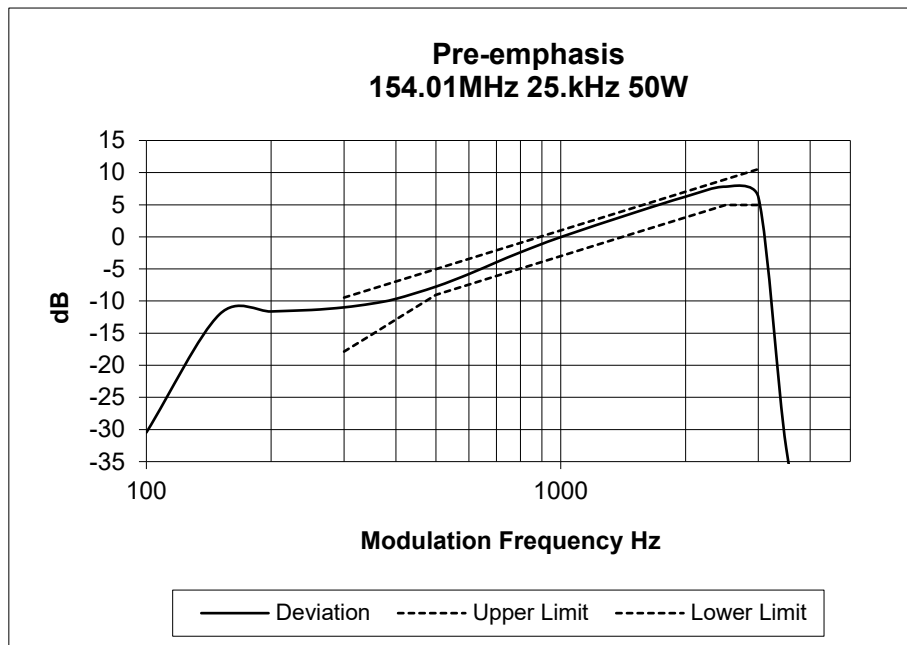
LIMIT CLAUSE: TIA/EIA-603D 3.2.6

MEASUREMENT UNCERTAINTY: $\pm 1.5\%$

SPECIFICATION: FCC 47 CFR 2.1047 (a)

Tx FREQUENCY: 154.0125 MHz

25 kHz Channel Spacing

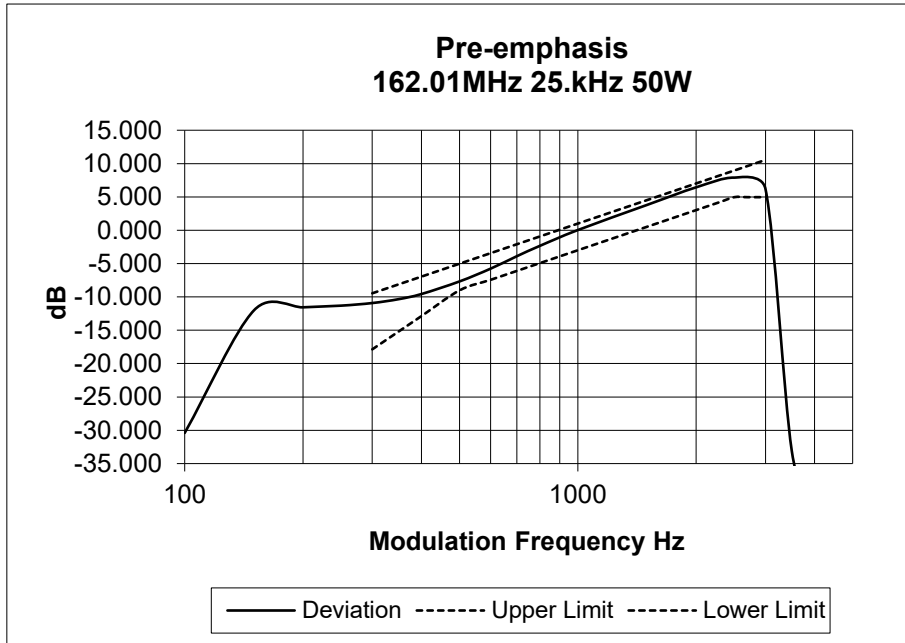


Transmitter Audio Frequency Response – Pre-emphasis

SPECIFICATION: FCC 47 CFR 2.1047 (a)

Tx FREQUENCY: 162.0125 MHz

25 kHz Channel Spacing



TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: TIA/EIA-603D 2.2.3

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. The modulation response was measured at three audio frequencies while varying the input level.
3. Measurements were made for both Positive and Negative Deviation.

MEASUREMENT RESULTS:

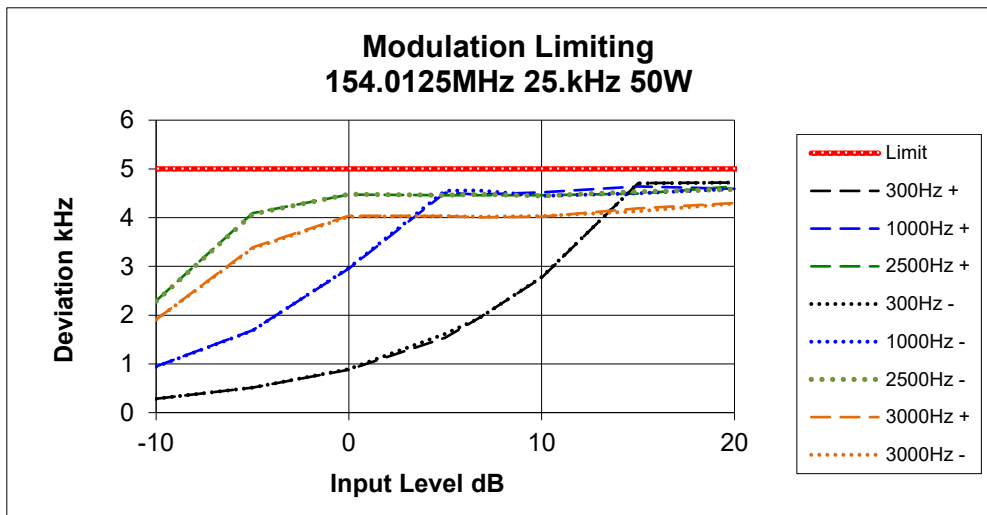
See the plots below for 25.0 kHz channel spacing.

LIMIT CLAUSE: TIA/EIA-603D 1.3.4.4

MEASUREMENT UNCERTAINTY: $\pm 1.5\%$

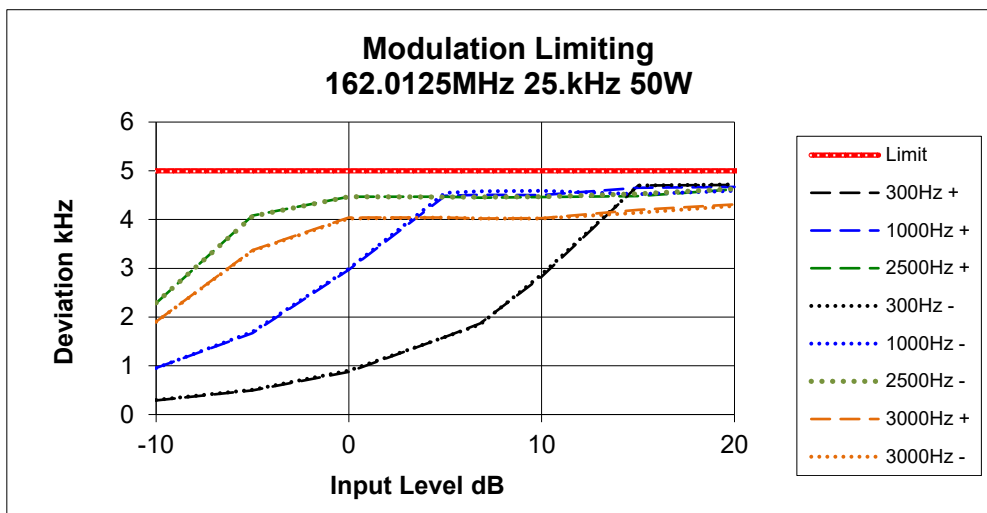
Tx FREQUENCY: 154.0125 MHz

25 kHz Channel Spacing



Tx FREQUENCY: 162.0125 MHz

25 kHz Channel Spacing



TRANSMITTER OCCUPIED BANDWIDTH AND SPECTRUM MASKS

SPECIFICATION: FCC 47 CFR 2.1049 (c)

GUIDE: TIA/EIA-603D 2.2.11 (Analog)

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment Set up.
2. For analog measurements: The EUT was modulated by a 2500 Hz tone at an input level 16 dB above a level that produced 50% deviation. The input level was established at the frequency of maximum response of the audio modulating circuit.
3. The Occupied Bandwidth was measured on the Spectrum Analyser, with bandwidth settings as follows.

Resolution bandwidth = 300 Hz, Video Bandwidth = 3 kHz

MEASUREMENT RESULTS:

See the plots on the following pages for 25.0 kHz channel spacing.

MEASUREMENT UNCERTAINTY 95% ± 0.65 dB

LIMIT CLAUSE: FCC 47 CFR 80.211 (f)

f) The mean power when using emissions other than those in paragraphs (a), (b), (c) and (d) of this section:

(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;

(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

Authorized bandwidth for G3E emissions is 20kHz (80.205)

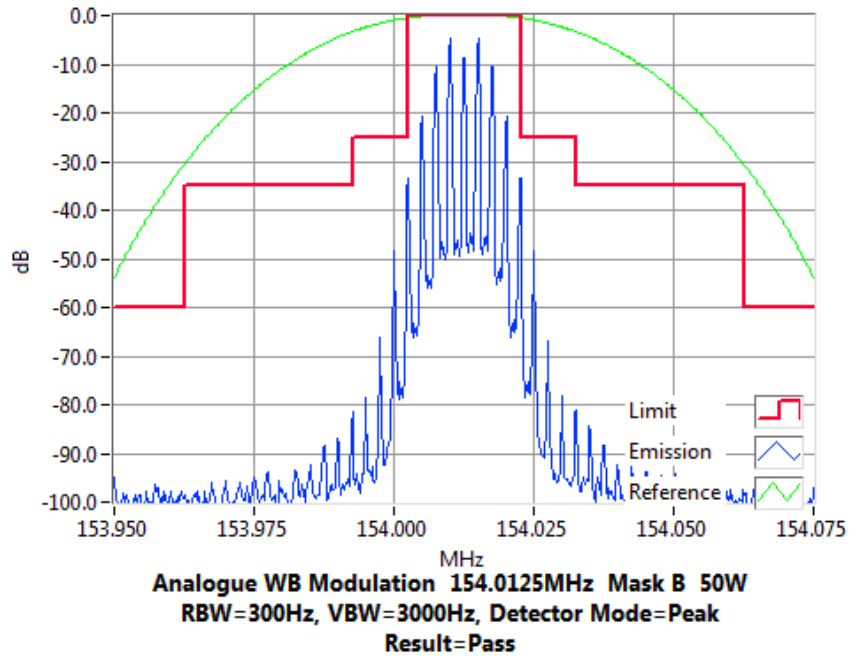
NB The captions of the plots on the following pages include "Mask B". This refers to "Emission Mask B" defined in 47 CFR 90.210 (b) which is identical to emission mask required by 80.211(f).

Occupied Bandwidth and Spectrum Masks

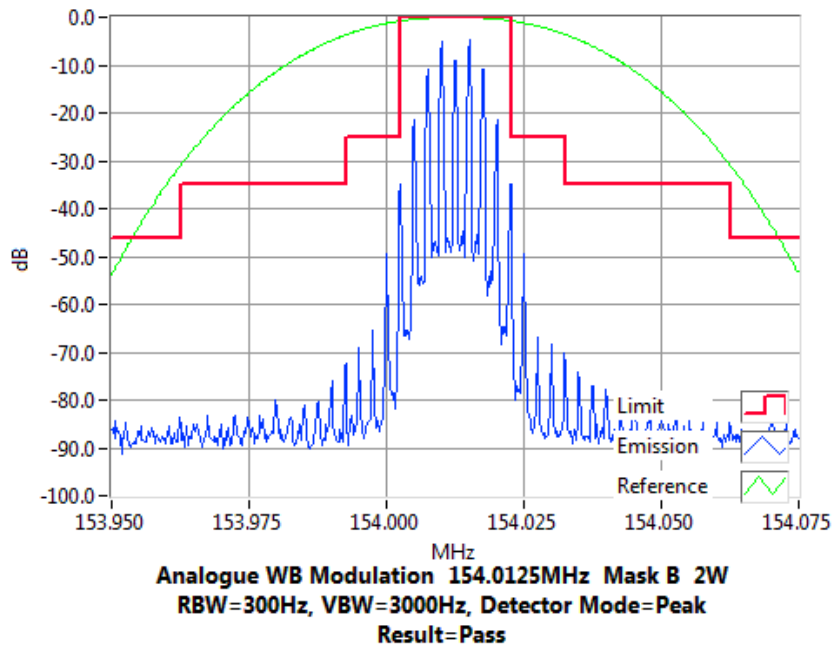
ANALOG VOICE

SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 154.0125 MHz 50 W 25 kHz Channel Spacing



Tx FREQUENCY: 154.0125 MHz 2 W 25 kHz Channel Spacing

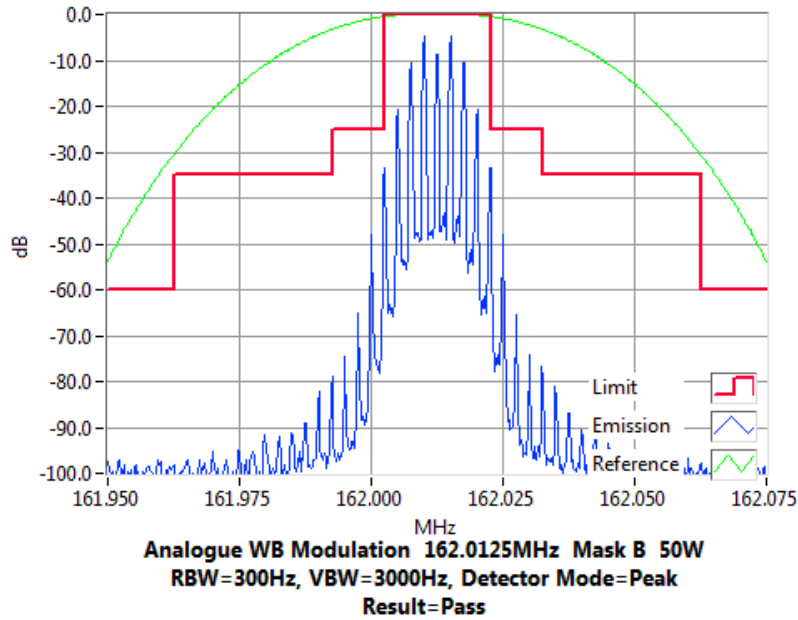


Occupied Bandwidth and Spectrum Masks

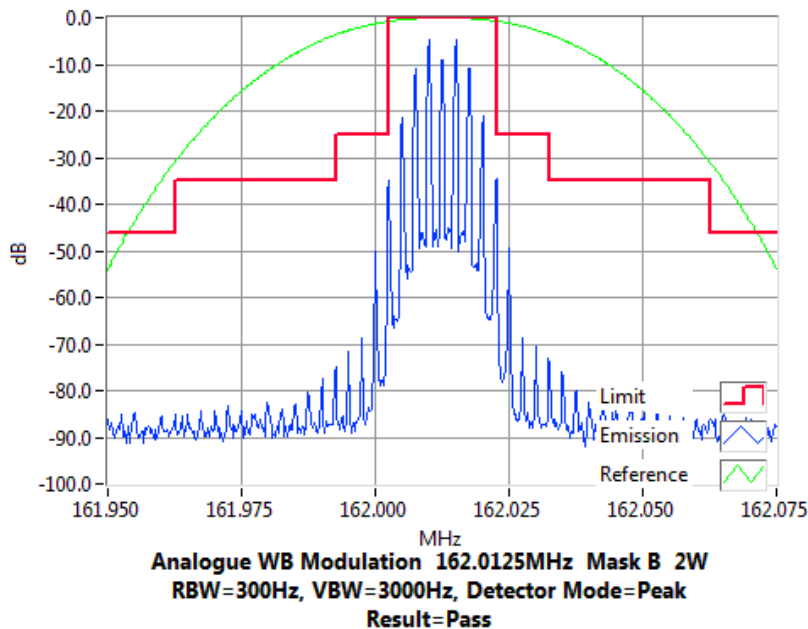
ANALOG VOICE

SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 162.0125 MHz 50 W 25 kHz Channel Spacing



Tx FREQUENCY: 162.0125 MHz 2 W 25 kHz Channel Spacing



TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATIONS: FCC 47 CFR 2.1051

GUIDE: TIA/EIA-603D 2.2.13

MEASUREMENT PROCEDURE:

1. Refer Annex A for equipment set up.
2. The frequency range examined was from the lowest frequency generated within the EUT, to a frequency higher than the 10th Harmonic: (9 kHz to 2GHz)
3. The EUT was set to transmit high or low power, modulated with WB Analogue. A scan is performed with a resolution bandwidth of 100 kHz and a video bandwidth of 300 kHz for frequencies up to 1 GHz, and a resolution bandwidth of 1 MHz and a video bandwidth of 3 MHz for frequencies above 1 GHz. A filter was used for frequencies just below the second harmonic to 1 GHz.
4. The spectrum analyser was loaded with the appropriate calibration figures to compensate for the cables, attenuator and filter losses.

Spurious emissions which were attenuated by more than 20 dB below the limit were not recorded.

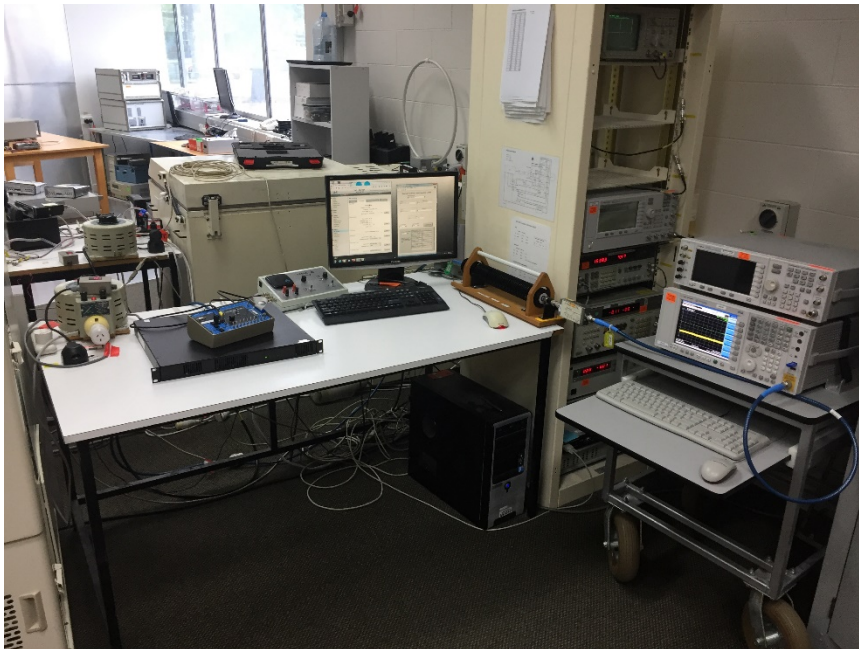
A photograph of the test set-up is included below.

MEASUREMENT RESULTS:

See the tables and plots on the following pages for 25.0 kHz channel spacing.

LIMIT CLAUSE: FCC 47 CFR 80.211

Photo: Conducted Emissions Test Setup



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

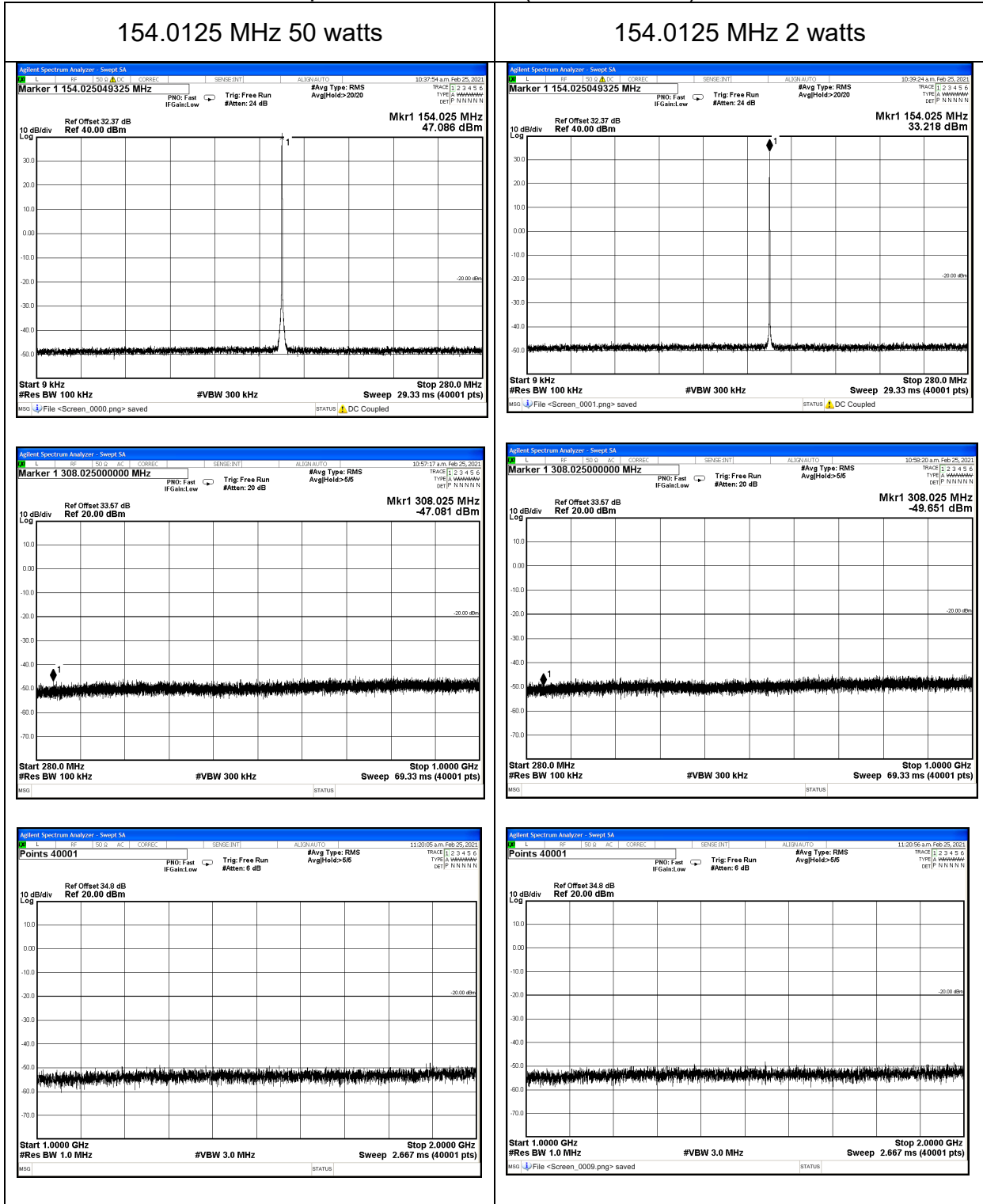
25 kHz Channel Spacing 154.0125 MHz @ 50 W Emission Mask B

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~

25 kHz Channel Spacing 154.0125 MHz @ 2 W Emission Mask B

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤12.75 GHz ± 3.0 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

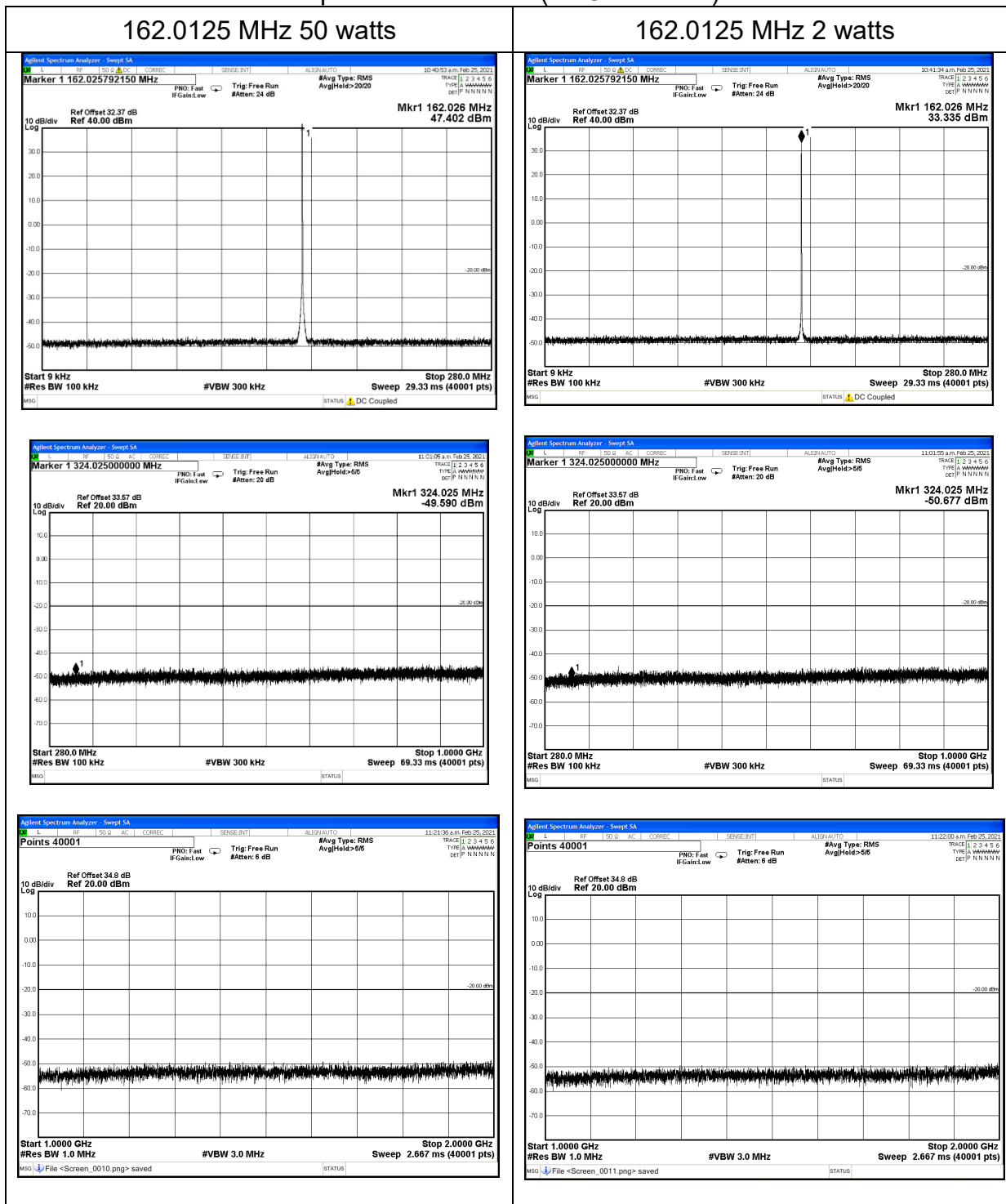
25 kHz Channel Spacing 162.0125 MHz @ 50 W Emission Mask B

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~

25 kHz Channel Spacing 162.0125 MHz @ 2 W Emission Mask B

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤12.75 GHz ± 3.0 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)



LIMIT CLAUSE: FCC 47 CFR 2.1053

Carrier Output Power	Emission Mask B 25 kHz Channel Spacing 50 + 10 Log ₁₀ (P _{Watts})	
50 W	-20 dBm	-67 dBc
2 W	-20 dBm	-53 dBc

TRANSMITTER SPURIOUS EMISSIONS (RADIATED)

SPECIFICATION: FCC 47 CFR 2.1053

GUIDE: TIA/EIA-603D 2.2.12

MEASUREMENT PROCEDURE:

Initial Scan:

1. The EUT is placed in the S-Line TEM cell and emissions are measured from 30 MHz to 800 MHz. Any emission within 20 dB of the limit is then re-tested on the OATS.
2. The EUT is placed in the reverberation chamber and emissions are measured from 800 MHz to the upper frequency required. Any emission within 20 dB of the limit is then re-tested on the OATS.
3. The harmonics emissions up to the 6th harmonic of the fundamental frequency are measured on the OATS (refer to Teltest report 4140 for results)

OATS Measurement:

1. The EUT is placed on a wooden turntable at a distance of three metres from the test antenna. The output terminal is connected to an RF dummy load.
2. The test antenna is raised from 1 m to 4 m to obtain a maximum reading; the turntable is then rotated through 360° to obtain the maximum response of each spurious emission. Valid emissions are determined by switching the EUT on and off.
3. The EUT is then replaced by a signal generator and substitution antenna to make measurements by the substitution method.

MEASUREMENT RESULTS:

See the tables on the following pages

LIMIT CLAUSE: FCC 47 CFR 80.211

Spurious Emissions (Tx Radiated)

SPECIFICATION: FCC 47 CFR 2.1053

25 kHz Channel Spacing 154.0125 MHz @ 50 W Emission Mask B

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~

25 kHz Channel Spacing 154.0125 MHz @ 2W Emission Mask B

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

25 kHz Channel Spacing 162.0125 MHz @ 50 W Emission Mask B

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~

25 kHz Channel Spacing 162.0125 MHz @ 2 W Emission Mask B

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

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LIMIT CLAUSE: FCC 47 CFR 2.1053

Carrier Output Power	Emission Mask B 25 kHz Channel Spacing 50 + 10 Log ₁₀ (P _{Watts})	
50 W	-20 dBm	-67 dBc
2 W	-20 dBm	-53 dBc

TRANSMITTER FREQUENCY STABILITY - TEMPERATURE

SPECIFICATION: FCC 47 CFR 2.1055 (a) (1)

GUIDE: TIA/EIA-603D 2.2.2

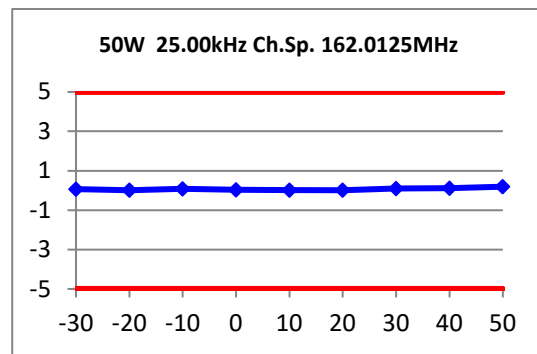
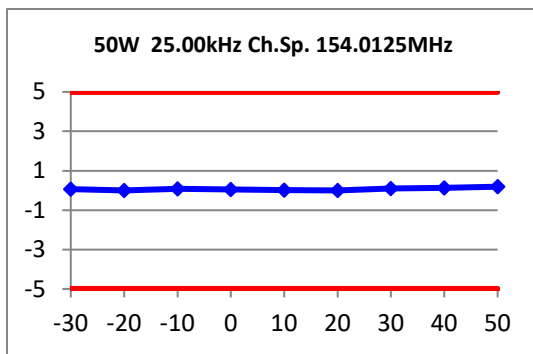
MEASUREMENT PROCEDURE:

1. Refer Annex A for equipment set up.
2. The EUT was tested for frequency error from -30° C to +50° C in 10° C increments
3. The frequency error was recorded in parts per million (ppm).

MEASUREMENT RESULTS:

See the plots below for 25 kHz channel spacing.

Temperature (°C)	Error (ppm)	
	154.0125 MHz	162.0125 MHz
-30	0.06	0.07
-20	0	0.01
-10	0.08	0.08
0	0.05	0.04
10	0.01	0.02
20	0	0.01
30	0.1	0.1
40	0.13	0.12
50	0.19	0.19
Measurement Uncertainty	$\pm 7 \times 10^{-8}$	



LIMIT CLAUSE: FCC 47 CFR 80.209

Frequency range	Frequency Error (ppm)
150-174	5

TRANSMITTER FREQUENCY STABILITY - VOLTAGE

SPECIFICATION: FCC 47 CFR 2.1055 (d) (1)

GUIDE: TIA/EIA-603D 2.2.2

MEASUREMENT PROCEDURE:

1. Refer Annex A for equipment set up.
2. The EUT was tested for frequency error at an input voltage to the radio of 85% to 115%.
3. The frequency error was recorded in parts per million (ppm).

MEASUREMENT RESULTS:

	FREQUENCY ERROR (ppm) for 25 kHz BW		
	120 V _{AC}	102 V _{AC}	138 V _{AC}
154.0125 MHz	0.02	0.01	0.01
162.0125 MHz	0.01	0.02	0.02
	Measurement Uncertainty		$\pm 7 \times 10^{-8}$

LIMIT CLAUSE: FCC 47 CFR 80.209

Frequency range	Frequency Error (ppm)
150-174	5

TEST EQUIPMENT LIST

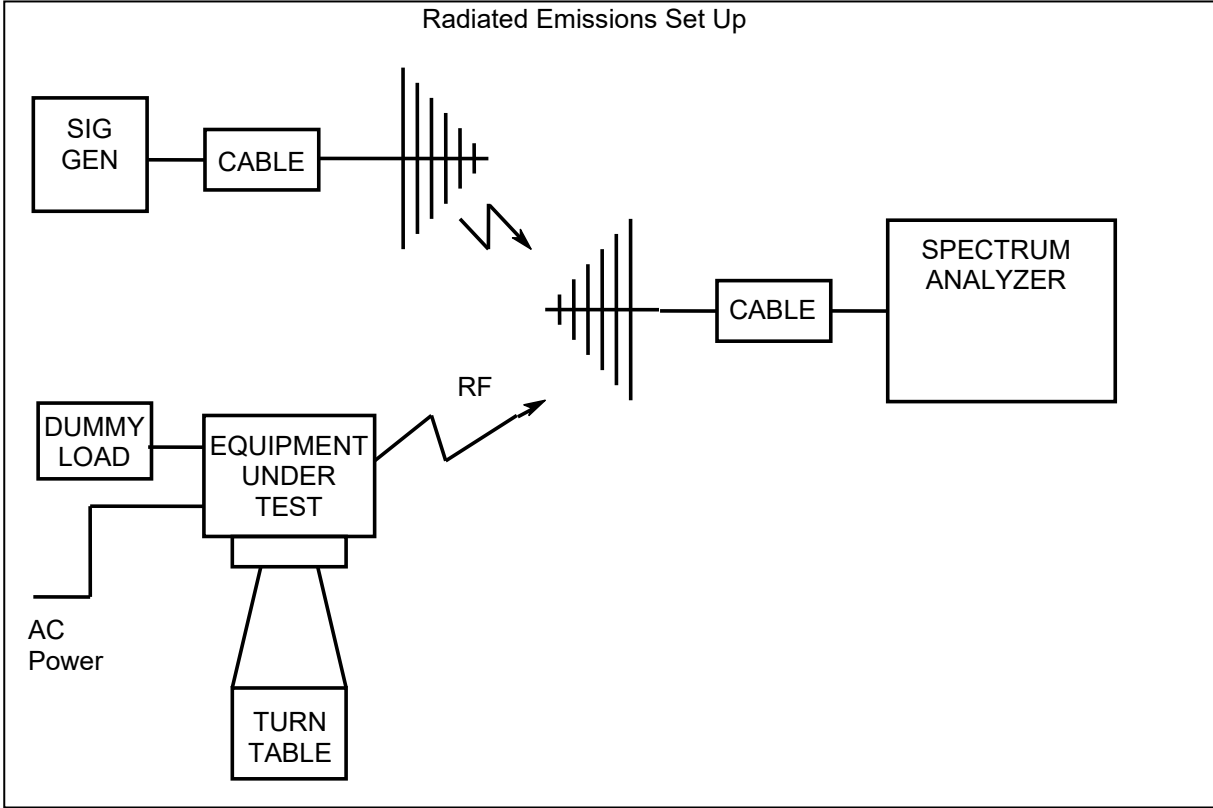
Equipment Type	Information	Manufacturer	Model No	Serial No#	Tait ID	Cal Due
Antenna	Reverb - 1-18GHz DRG	Schwarzbeck	BBHA 9120 D	9120D-885	E4857	
Antenna	Reverb - 1-18GHz DRG	Schwarzbeck	BBHA 9120 D	9120D-884	E4858	
Audio Analyser	TREVA1	Hewlett Packard	HP8903A	2437A04625	E4986	25-Sep-21
Coax Cable	Reverb - 4.5m Multiflex 141	TeltestBlue6	MF 141	TeltestBlue6	E4843	30-Oct-21
Coax Cable	Reverb - 2m Multiflex 141	TeltestBlue5	MF 141	TeltestBlue5	E4844	30-Oct-21
Coax Cable	Reverb - 2m Multiflex 141	TeltestBlue4	MF 141	TeltestBlue4	E4845	30-Oct-21
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue3	MF 141	TeltestBlue3	E4846	30-Oct-21
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue2	MF 141	TeltestBlue2	E4847	30-Oct-21
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue1	MF 141	TeltestBlue1	E4848	30-Oct-21
Coax Cable	2m Black	Suhner	RG214HF/Nm/Nm/2000	TeltestBlack5	E4850	30-Oct-21
Coax Cable	2.5m Blue	Suhner	Sucoflex 104A	33449/4PEA	E4997	27-Jan-21
Coax Cable	2m Black	Suhner	RG214HF/Nm/Nm/2000	TeltestBlack2	E4623	30-Oct-21
Coax Cable	2m Black	Suhner	RG214HF/Nm/Nm/2000	TeltestBlack3	E4624	30-Oct-21
Coax Cable	2m Black	Suhner	RG214HF/Nm/Nm/2000	TeltestBlack7	E5004	30-Oct-21
Environ. Chamber	Upright	Contherm	5400 RHLT.M	1416	E4051	7-Aug-23
Environ. Chamber	Upright	Contherm	5400 RHLT.M	1416	E4051	10-Jul-21
Filter High Pass/ Notch	135 to 175MHz	Tait		N/A	E3382	8-Jun-21
Modulation Analyser	TREVA1	Hewlett Packard	HP8901B (Opt 002)	2441A00393	E3073	28-Sep-21
Coax Cable	3m Blue	Suhner	Sucoflex 126EA	503429/126EA	E5015	30-Oct-21
Coax Cable	1.5m Blue	Suhner	Sucoflex 126EA	502868/126EA	E5028	3-Feb-22
RF Attenuator	3dB 0.5W	Weinschel	Model 1	CH6863	E5013	2-Nov-21
Power Meter	TREVA1 Power Head for HP8901	Hewlett Packard	HP11722A	3111A05573	E7054	28-Sep-21
RF Amplifier	+21.7 dB 1GHz	Tait	ZFL-1000LN	E3660	E3360	31-Jul-21
RF Amplifier	Pre-amplifier	Agilent	87405C	MY47010688	E4941	8-Oct-21
RF Attenuator	30+3dB 350W	Weinschel	67-30-33 & BW-N3W5+	CK9178	E5023	30-Oct-21
RF Attenuator	10dB 50W	Weinschel	24-10-34	BC3293	E4364	30-Oct-21
RF Attenuator	TREVA1 3dB	Weinschel	Model 1	BL9958	E4081	30-Oct-21
RF Chamber	S-LINE TEM CELL	Rohde & Schwarz	1089.9296.02	338232/003	E3636	28-Oct-22
RF Chamber	Reverb - Stirrer controller for reverb chamber	Teseq	Stirrer Controller	29765.1	E4854	
RF Chamber	Reverb - 0.5 - 18GHz Reverberation Chamber	Teseq	RVC XS	29765	E4855	
RF Combiner	TREVA1	Minicircuits	ZFSC-4-1	-	E4083	
RF Load	150W	Bird	8166	524	E3625	30-Oct-21
Signal Generator	Digital 4GHz	Agilent	E4437B	US39260389	E4764	9-Oct-21
Spectrum Analyser	26.5GHz	Agilent	PXA N9030A	MY49432161	E4907	3-Oct-22

TELTEST Laboratories
Tait International Ltd
Report Number 4152

Equipment Type	Information	Manufacturer	Model No	Serial No#	Tait ID	Cal Due
Spectrum Analyser	13.2GHz	Agilent	PSA E4445A	MY42510072	E4139	7-Oct-22
Temp & Humidity datalogger		Hobo	U21-011	10134276	E4981	7-Jul-21
TREVA 1		Teltest	-	1	-	2-Jun-21
Testware	Frequency Vs Temperature		April 2018	-	-	
Testware	Reverb Emissions		May 2019	-	-	
Testware	Sideband Spectrum		February 2017	-	-	
Testware	S-Line Radiated Emissions		April 2018	-	-	
Testware	TREVA		29/01/2020	-	-	
Testware	Spec An Correction Loader		June 2019	-	-	

NOTE: Items without calibration dates are calibrated immediately before use, or set using calibrated instruments.

ANNEX A – TEST SETUP DETAILS



All other testing is performed using the Teltest Radio **EVA**luation system (TREVA), which is configured as shown below. The Spectrum Analyser is connected to the EUT via the attenuator network for Conducted Emissions testing, and Occupied Bandwidth.

