Report on the Radio Testing

For

A-Safe UK Limited

on

Gateway

Report no. TRA-036958-47-00A

8 April 2020

Element Materials Technology Warwick Ltd.
Registered in England and Wales. Registered Office: 5 Fleet Place, London, EC4M 7RD
Company Reg No. 02536659

Report Number: TRA-036958-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
A-Safe UK Limited
Gateway
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15D

TEST DATE: 6th August 2019 - 13th January 2020

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Date:	8 April 2020	

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1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	8 April 2020	Original

2 Summary

TEST REPORT NUMBER:	TRA-036958-47-00A
WORKS ORDER NUMBER:	TRA-036958-01
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION(S):	FCC 47CFR 15D
EQUIPMENT UNDER TEST (EUT):	Gateway
FCC IDENTIFIER:	2AMYT-GATEWAY001
EUT SERIAL NUMBER: 02A04190515000012	002E9E0398, S-02-02-0006, 000027, 002E9E03A0,
MANUFACTURER/AGENT:	A-Safe UK Limited
ADDRESS:	Habergham Works Ainleys Industrial Estate Elland HX5 9JP United Kingdom
CLIENT CONTACT:	Dean Cowan ☎ 01422 261619 ✉ Dean.Cowan@asafe.com
TEST DATE:	6th August 2019 - 13th January 2020
TESTED BY:	D Winstanley, D Moncayola Element

3 Test Summary

TEST/EXAMINATION	Part 15	Result
Coordination with Fixed Microwave Service	15.307 (b)	No Note 1
Antenna Requirement	15.317 15.203	Pass
Modulation Techniques	15.319 (b)	Pass
Conducted AC Powerline	15.315 15.207	Pass
Emission Bandwidth	15.323 (a)	Pass
Peak Transmit Power	15.319 (c)	Pass
Power Spectral Density	15.319 (d)	Pass
Antenna Gain	15.319 (e)	Pass
Automatic Discontinuation of Transmission	15.319 (f)	Pass
Radio Frequency Radiation Exposure	15.319 (i)	Pass
Monitoring Thresholds	15.323 (c)(2) 15.323 (c)(9)	Pass
Monitoring of Intended Transmit Window and Maximum Reaction Time	15.323 (c)(1)	Pass
Monitoring Bandwidth	15.323 (c)(7)	Pass
Access Criteria Functional Test	15.323 (c)(6)	Pass
Duration of Transmission	15.323 (c)(3)	Pass
Connection Acknowledgement	15.323 (c)(4)	Pass
Lower threshold Selected Channel, Power Accuracy, Segment Occupancy	15.323 (c)(5)	Pass
Monitoring Antenna	15.323 (c)(8)	Pass
Duplex Connections	15.323 (c)(10)	Note 2
Alternative Monitoring Interval for Co-located Devices	15.323 (c)(11)	Note 3
Fair Access to Spectrum Related to (c)(10) & (c)(11)	15.323 (c)(12)	Note 3
Emission Inside and Outside the Sub-band	15.323 (d)	Pass
Frame Period	15.323 (e)	Pass
Frequency Stability	15.323 (f)	Pass
AC Powerline conducted Emissions	15.207	Pass

Note:
1. Requirement removed April 4th 2005 see public notice DX 05-1005.
2. The EUT is not the initiating device.
3. The EUT does not utilise the provisions of 15.323 (c)(11)

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

4 Contents

5 Introduction

This report TRA-036958-47-00A presents the results of the Radio testing on a A-Safe UK Limited, Gateway to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for A-Safe UK Limited by Element, at the address detailed below.

☐ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☒ Element Skelmersdale
Unit 1
Pendle Place
Skelmersdale
West Lancashire
WN8 9PN
UK

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

FCC Site Listing:
Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

ISED Registration Number(s):

Element Skelmersdale	3930B
Element Hull	3483A

The test site requirements of ANSI C63.4-2014 are met up to 1 GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

6 Test Specifications

6.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- ANSI C63.17-2013 - American National Standard Methods of Measurement of the Electromagnetic and Operational Compatibility of Unlicensed Personal Communications Services (UPCS) Devices

6.2 Deviations from Test Standards

There were no deviations from the test standard.

7 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada (now ISED)
ISED	Innovation, Science and Economic Development Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

8 Equipment Under Test

8.1 EUT Identification

- Name: Gateway
- Serial Number: 002E9E0398, S-02-02-0006, 000027, 002E9E03A0, 02A04190515000012
- Software Revision: 19.05.14.4
- Build Level / Revision Number: 04

8.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Type – Laptop
Model – Lenovo Thinkpad

8.3 EUT Mode of Operation

8.3.1 Transmission

The mode of operation for transmitter tests was as follows…

The EUT was set into transmit mode via a USB link between PC and EUT. Through this link a connection the device is established and allows access to pre loaded scripts to enable the unit to be set to transmit as required.

Slot Type – 1-Full
Antenna – 0
Slot number – 00
Carrier - 23- 27 (as required)
Pattern – 5
Power level – 1
Preamble – n
NEMO - Disabled

For limited testing the device was set to TBR6 test mode and connected to a CMD60 test set

8.4 EUT Radio Parameters

8.4.1 General

Band of operation:	1920 MHz – 1930 MHz
Frequency range of operation:	1921.536 MHz – 1928.448 MHz
Modulation type(s):	GFSK
Occupied channel bandwidth(s):	1.4 MHz
Channel spacing:	1.728 MHz
ITU emission designator(s):	1M4F1D
Declared output power(s):	<112 mW
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable
Nominal Supply Voltage:	3.0 Vdc
Location of notice for license exempt use:	User manual
Duty cycle:	4.1667 %

8.4.2 Antennas

Type:	SINBON A9704174
Frequency range:	1.88 GHz – 1.93 GHz
Impedance:	50 Ohms
Gain:	1.37 dBi
Polarisation:	Omni
Connector type:	SMA
Mounting:	Fixed

8.5 EUT Description

The A-Safe Gateway is used to connect a large number of DECT ULE nodes to the internet.
Our main original purpose is to use the Gateway with RackEye sensors, although may be used with other sensors in the future.
The Gateway uses a DECT ULE radio module to transmit and receive messages wirelessly with the Node Sensors. The Gateway uses an LTE 4G radio module with 3G and 2G back off to connect to the A-Safe cloud servers.

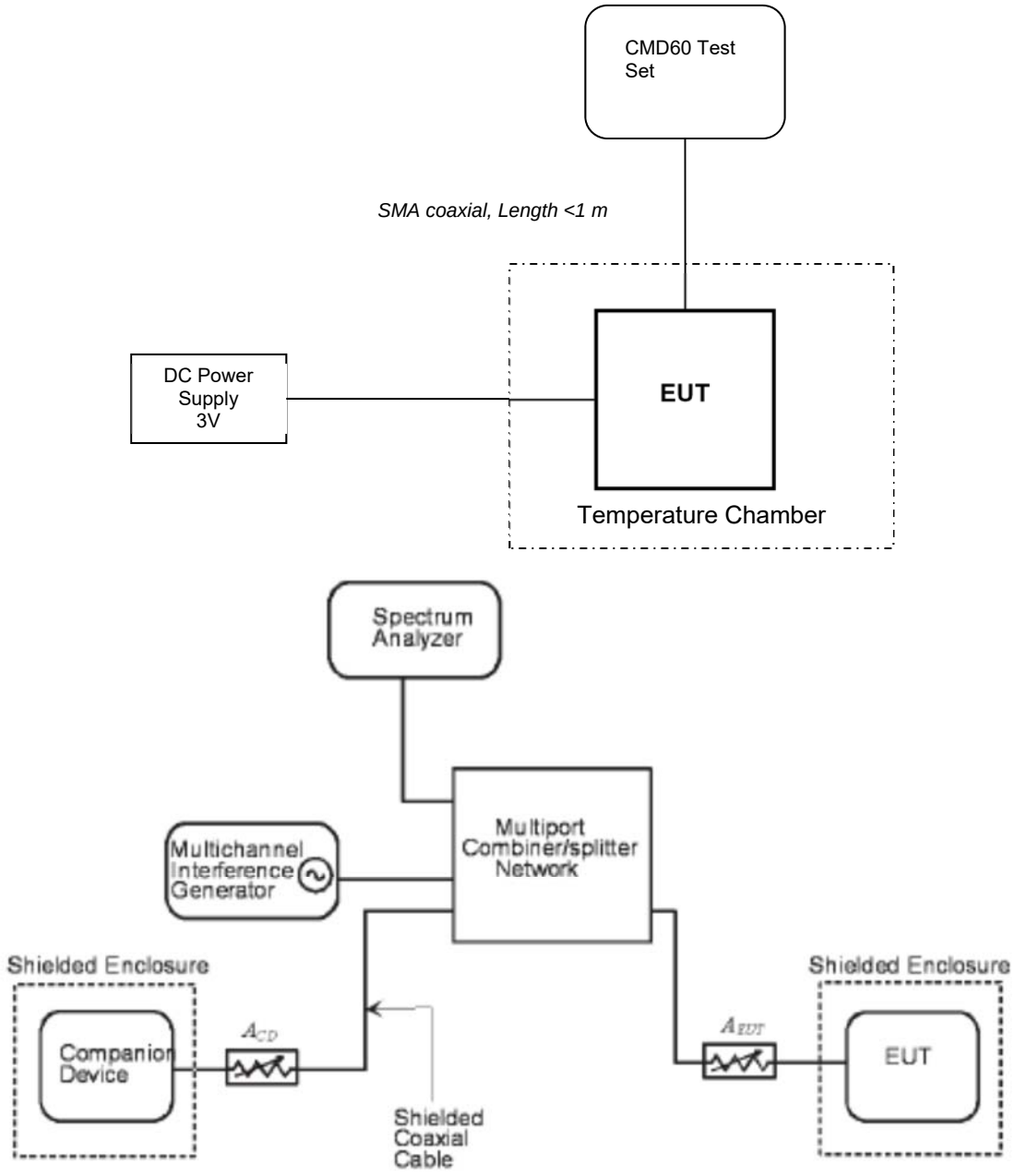
9 Modifications

No modifications were performed during this assessment.

10 EUT Test Setup

10.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



11 General Technical Parameters

11.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 5 V dc from the Supplied AC Mains adaptor.

11.2 Varying Test Conditions

Variation of temperature is required to ensure stability of the declared fundamental frequency. During frequency error testing the following variations were made:

	Category	***Variation***
☒	Standard	-20 to +50 C
☐	Extended	

Variation of supply voltage is required to ensure stability of the declared output power and frequency. During carrier power and frequency error testing the following variations were made:

	Category	***Nominal***	***Variation***
☒	Mains	110 V ac +/-2 %	85 % and 115 %
☐	Battery	New battery	Not Applicable

12 Antenna Requirements

12.1 Definition

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device

12.2 Test Limit

The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

12.3 Test Result

Antenna is permanently attached when the EUT is housing is complete.

13 Modulation Techniques

13.1 Definition

All transmissions must use only digital modulation techniques.

13.2 Test Limit

Attestation of compliance with the digital modulation requirement will be made in accordance with the disclosure statement required by the applicable equipment authorization procedures (see, e.g., 47CFR2).

13.3 Test Result (Attestation)

The A-Safe UK Limited Gateway is an isochronous device operating in the 1920 MHz – 1930 MHz frequency band.

The A-Safe UK Limited Gateway modulation technique is based on DECT technology as described in European standards EN 300 175-2 and EN 300 175-3.

The A-Safe UK Limited Gateway modulation techniques are MC/TDMA/TDD (Multi Carrier / Time Division Multiple Access / Time Division Duplex) using GFSK modulation.

14 Radio Frequency Radiation Exposure

14.1 KDB 447498 - General SAR test reduction and exclusion guidance

Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when SAR Exclusion Threshold requirement in KDB 447498 is satisfied, standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

In the frequency range below 100 MHz to 6 GHz and test separation distance of 50mm, the SAR Test Exclusion Threshold for operation in the 1920 MHz – 1930 MHz band will be determined as follows

SAR Exclusion Threshold (SARET)

SAR Exclusion Threshold = Step 1 + Step 2

Step 1

$$NT = [(MP/TSD^{A}) * \sqrt{f_{GHz}}]$$

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)
MP = Max Power of channel (mW) (inc tune up)
TSD^{A} = Min Test separation Distance or 50mm (whichever is lower) = 50

We can transpose this formula to allow us to find the maximum power of a channel allowed and compare this to the measured maximum power.

$$= [(NT \times TSD^{A}) / \sqrt{f_{GHz}}]$$

For Distances Greater than 50 mm Step 2 applies

Step 2

$$(TSD^{B} – 50mm) * 10\}$$

Where:
TSD^{B} = Min Test separation Distance (mm) = 50

Operating Frequency 1.921536 GHz

SARET = [(3.0 x 50) / √1.921536] + { (50 – 50) * 10 }
SARET = [150 / 1.38] + (0 * 10 }
SARET = 108.21mW

Operating Frequency 1.928448 GHz

SARET = [(3.0 x 50) / √1.928448] + { (50 – 50) * 10 }
SARET = [150 / 1.39] + (0 * 10 }
SARET = 108.02mW

Channel Frequency (MHz)	EIRP (mW)	Exclusion Threshold	Evaluation
1921.536	128.2	108.21	Required
1928.448	147.9	107.02	Required

Therefore evaluation for general population exposure conditions by measurement or numerical simulation is required.

14.2 MPE Calculation

47 CFR §§1.1310

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re - arranged} \quad R = \sqrt{\frac{EIRP}{S\,4\pi}}$$

where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Note:

The EIRP was calculated by addition on the maximum conducted carrier power dBm and the maximum antenna gain.

Result

Prediction Frequency (MHz)	Conducted Carrier power (dBm)	Antenna Gain (dBi)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm Required to be less than 1 mW/cm^2
1921.536	19.71	1.37	128.2	1	3.2
1924.992	20.01	1.37	137.4	1	3.4
1928.448	20.33	1.37	147.9	1	3.5

15 Transmitter Emission Bandwidth

15.1 Definition

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

15.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Measurement BW:	20 kHz
Spectrum Analyzer Video BW:	200 kHz
Measurement Span:	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 V dc	

15.3 Test Limit

Operation shall be contained within the 1920 MHz to 1930 MHz band. The emission bandwidth shall be less than 2.5 MHz but in no event shall the emission bandwidth be less than 50 kHz.

The emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier centre frequency and one above the carrier centre frequency, that are 26 dB own relative to the maximum level of the modulated carrier.

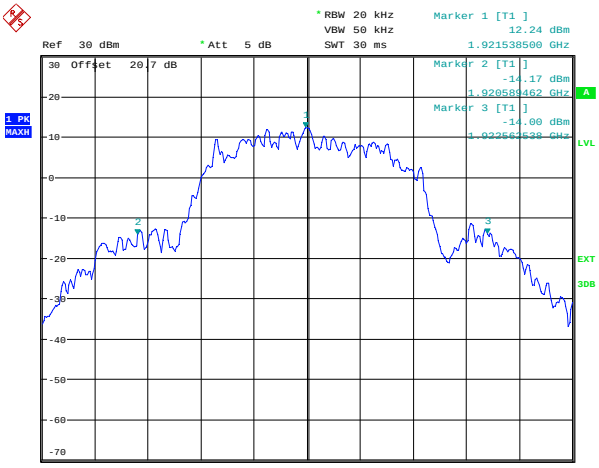
15.4 Test Results

Test Details: f_l = 1921.536 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1920.589462	1922.562538	1.973	50kHz< ∆f < 2.5MHz
-12	1920.947154	1922.204846	1.258	N/A
-6	1921.014462	1922.007731	0.993	N/A

Test Details: f_c = 1924.992 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1924.045462	1926.052192	2.007	50kHz< ∆f < 2.5MHz
-12	1924.393538	1925.660846	1.267	N/A
-6	1924.470462	1925.473346	1.003	N/A

Test Details: f_h = 1928.448 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1927.490692	1929.507038	2.016	50kHz< ∆f < 2.5MHz
-12	1927.853192	1929.115692	1.263	N/A
-6	1927.925308	1928.928192	1.003	N/A

26 dB Emission Bandwidth



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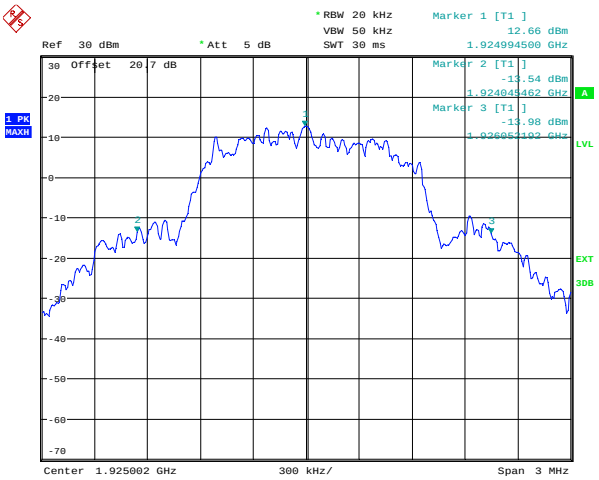

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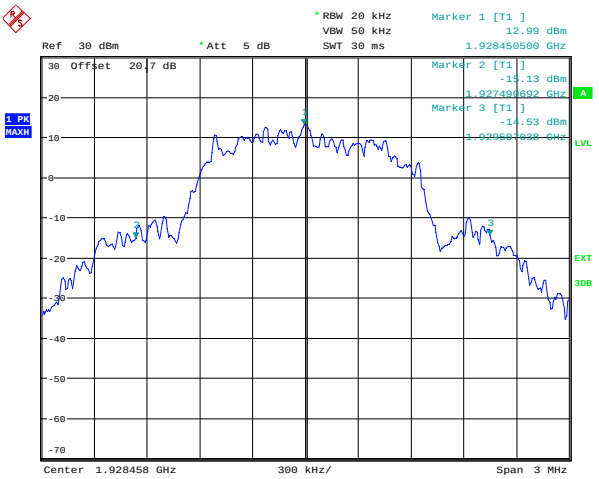

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16 Peak Transmit Power

16.1 Definition

The peak transmit power is the maximum of the RMS power during a transmit burst

16.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Occupied Bandwidths:	1.4 MHz
Measurement BW:	3 MHz
Measurement Span:	Zero Span
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

Peak transmit power shall not exceed 100 µW multiplied by the square root of the emission bandwidth in hertz

The limit for Peak Transmit Power (PTP) is calculated using the following formula:

$$PTP = 5 \text{ Log}_{10} \text{ EBW} - 10 \text{ dBm}$$

This limit must be corrected to take into account any gain of the antenna greater than 3dBi.
Where: EBW is the transmitter emission bandwidth in Hz as determined in the previous test.

$$EBW = 2.016\text{MHz}$$

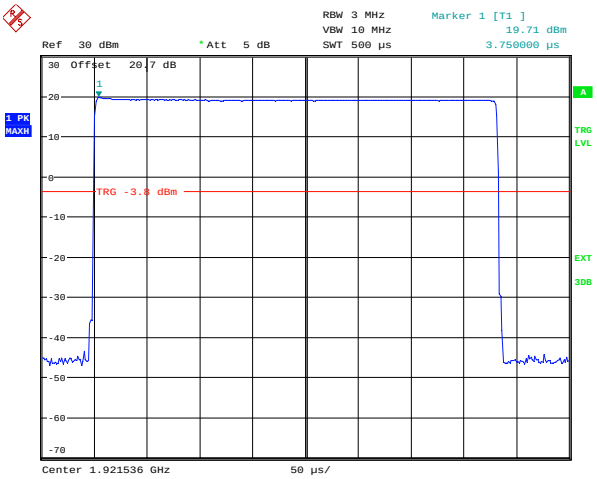
$$PTP = 5 \text{ Log}_{10} 2.016 - 10 \text{ dBm}$$

$$PTP = 21.52 \text{ dBm}$$

16.4 Test Results

Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)
1921.536	19.71	21.52
1924.992	20.03	21.52
1928.448	20.03	21.52

Note: 1. Permanent antenna was replaced with temporary antenna connector to enable conducted measurement.
2. Antenna gain < 3dBi and so correction of the limit is not required.



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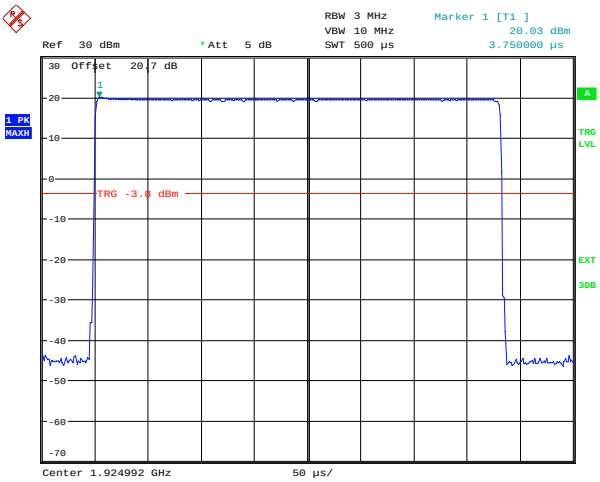

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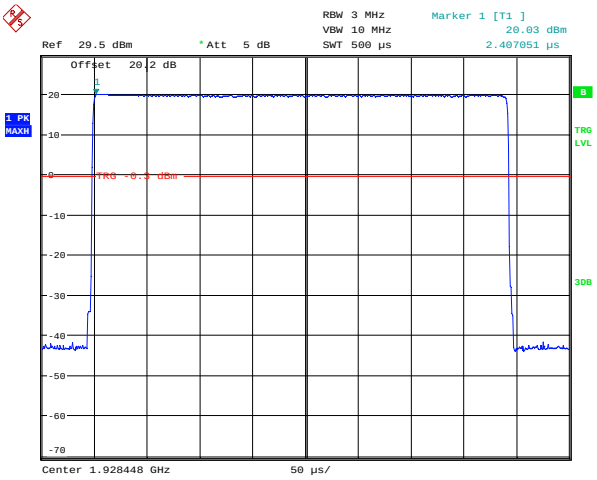

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17 Power Spectral Density

17.1 Definition

The power per unit bandwidth.

17.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.5
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Occupied Bandwidths:	1.4 MHz
Measurement BW:	3 kHz
Measurement Span:	Zero Span
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

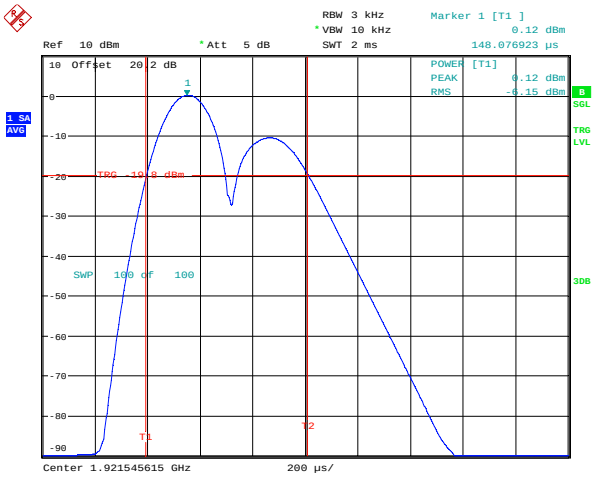
Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

17.3 Test Limit

The power spectral density shall not exceed 3mW in any 3 kHz bandwidth as measured with a spectrum analyser having a resolution bandwidth of 3 kHz.

Frequency (MHz)	Power Spectral Density (mW/3kHz)	Limit (mW/3kHz)
1921.536	1.03	3
1924.992	1.32	3
1928.448	0.70	3

Note: 1. Permanent antenna was replaced with temporary antenna connector to enable conducted measurement.
2. Antenna gain < 3dBi and so correction of the limit is not required.



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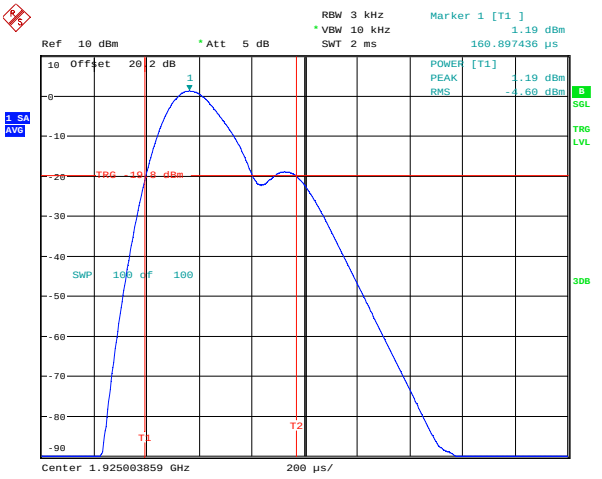

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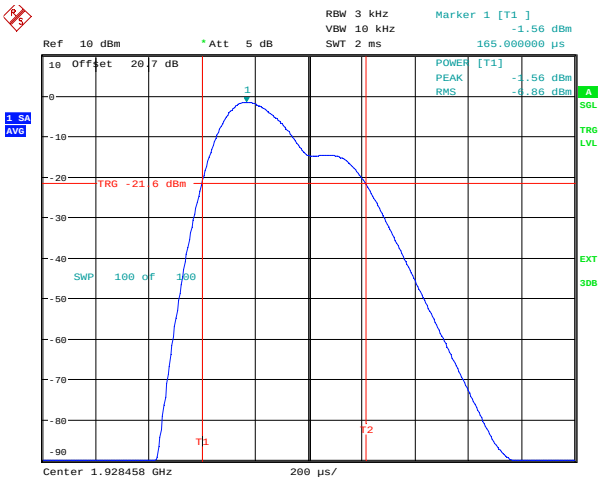

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18 Antenna Gain

18.1 Definition

Any directional gain of the antenna exceeding 3dBi has an effect on the limit applied to the measurements taken for the peak transmit power test. If the directional gain of the antenna is less than 3dBi it is not required to be taken into account.

18.2 Test Limit

The peak transmit power shall be reduced by the amount in decibels that the maximum directional gain of the antenna exceeds 3 dBi.

18.3 Test Result (Attestation)

Maximum Antenna Gain	Exceeds 3dBi by
1.37 dBi	N/A

Antenna Gain declared by Manufacturer

19 Automatic Discontinuation of Transmissions

19.1 Definition

Automatic discontinuation of transmission means break off of transmissions that are not control and signalling information.

19.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Mid

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

19.3 Test Limit

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude transmission of control and signalling information or use of repetitive codes used by certain digital technologies to complete frame or burst intervals.

19.4 Test Results

The RackEye is a Portable part and as such does not transmit control and signalling information the counterpart device is a fixed part device and does transmit control and signalling information.

Part	Transmits Control and Signalling Information	Equipment Under Test
Fixed Part	X	
Portable Part		X

The following tests were performed after a connection had been established with the counterpart device

Number	Test	Reaction of EUT	Pass / Fail
1	Batteries removed from Companion	B	Pass
2	Power removed from EUT	A	Pass

A – Connection breakdown, Cease of all transmissions.
B – Connection breakdown, EUT transmits control and signalling information.
C – Connection breakdown, Counterpart transmits control and signalling information.

20 Monitoring Thresholds

20.1 Definition

The spectrum sharing rules require that EUTs monitor their intended channel (time and spectrum window) prior to transmission to sense RF energy in the channel. If there is RF energy above the monitoring limit threshold the EUT must either defer transmission until the channel is clear or select another clear channel.

20.2 Test Parameters

Measurement standard - Calculation	ANSI C63.17 sub-clause 7.2.1
Calculations	As laid out in ANSI C63.17 sub-clause 4.3.3
Measurement standard	ANSI C63.17 sub-clause 7.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab

20.3 Calculations

Calculation of monitoring threshold limits for isochronous devices:

Lower threshold: $T_L = -174 + 10Log_{10}B + M_U + P_{MAX} - P_{EUT}$ (dBm)

Upper threshold: $T_U = -174 + 10Log_{10}B + M_U + P_{MAX} - P_{EUT}$ (dBm)

Where:
B = Emission bandwidth (Hz)
M_U = dBs the threshold may exceed thermal noise (30 for T_L & 50 for T_U)
P_{MAX} = Output Power Limit (dBm)
P_{EUT} = Transmitted power (dBm)

Monitor Threshold	B (Hz)	M_U (dB)	P_{MAX} (dBm)	P_{EUT} (dBm)	Threshold (dBm)
T_L	2016346.00	30.00	21.52	20.33	-79.8
T_U	2016346.00	50.00	21.52	20.33	-59.8

Note: 1. Threshold levels rounded up/down

The threshold level was determined following the procedure as laid out in ANSI C63.17 sub-clause 7.3.2 (a) Frequency administration was used to allow operation on the carrier closest to the centre of the band.

20.4 Test Limit

The EUT must not transmit until the interference level is less than or equal to:

Measured Threshold Level ≤ $T_U + U_M$

Where:
T_U = Calculated Upper threshold level
T_L = Calculated Lower threshold level
U_M = Margin of uncertainty in threshold measurements (6dB)

20.5 Results

Monitor threshold	Measured Threshold Level	Limit	Pass/Fail
Upper threshold (dBm)	-62.8 dBm	-53.76 dBm	Pass

21 Monitoring of Intended Transmit Window & Maximum Reaction Time

21.1 Definition

The reaction time is the minimum duration of the interference present during the monitoring interval that must be detected by the EUT so as to determine that the monitored time and spectrum window is occupied.

21.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.5
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	f1 - 1924.992 MHz ; f2 – 1923.264MHz

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

21.3 Test Method

The EUT was restricted to operation on two channels. The interference generator was fed pulses from the function generator to produce a pulsed carrier of the specified time length and the output of the interference generator was set to the required level. The pulse generator and companion device were synchronized so the position of the pulses corresponded to the time-slot pattern in the frame of the EUT.

For each of the required tests the pulse width and interference level are as below:

Test c)

With the interference generator output set at the relevant calculated threshold level plus measurement uncertainty (U_M) and the width of the pulse interference exceeds the largest of 50µs and $50\sqrt{1.25/B}$ µs verify that the EUT does not establish a connection.

Test d)

With the interference generator output set at 6dB above the relevant calculated threshold level plus measurement uncertainty (U_M) and the width of the pulse interference exceeds the largest of 35µs and $35\sqrt{1.25/B}$ µs verify that the EUT does not establish a connection.

Where B = Emission bandwidth of the EUT in MHz

21.4 Test Results

Test Equation (µs)	Pulse Width (µs)	f_1 Interferer Level (dBm)	f_2 Interferer Level (dBm)	EUT transmission Frequency	Pass/Fail
$50\sqrt{1.25/B}$	50µs	$T_L + U_m$	T_L	f_2	Pass
$35\sqrt{1.25/B}$	35µs	$T_L + U_m + 6$	T_L	f_2	Pass

Notes:
1. T_L is the calculated Lower threshold.
2. U_M is Margin of uncertainty in threshold measurements (6dB).

22 Monitoring Bandwidth & Antenna

22.1 Definition

The methods implemented for checking whether the spectrum is occupied or not.

22.2 Test Limit

ANSI C63.17 sub-clause 7.4 states that if the monitoring is made through the radio receiver used by the EUT for communication the intended bandwidth requirements for the monitoring system are met.

22.3 Test Results

The monitoring bandwidth test was carried out in accordance with ANSI C63.17 sub-clause 7.4.

22.3.1 Monitoring Bandwidth

As declared by the manufacturer the EUT uses the radio receiver used for communication for monitoring therefore the intended bandwidth requirements for the monitoring system are met of ANSI C63.17 sub-clause 7.4 are met.

22.3.2 Monitoring Antenna

The antenna of the EUT used for transmitting is the same antenna that is used for monitoring.

23 Power Accuracy

23.1 Definition

Checks that a power level can be determined within a set margin.

23.2 Test Limit

The power measurement resolution for the previous comparison must be accurate to within 6dB.

23.3 Test Results

The monitoring threshold test covered in Part 15.323 (c)(2) automatically proves that this requirement is met.

24 Segment Occupancy

24.1 Definition

To ensure that any group of devices does not utilise more than a maximum amount of time / spectrum

24.2 Test Limit

No device or group of co-operating devices located within 1 m of each other shall, during any frame period, occupy more than 6 MHz of aggregate bandwidth, or alternatively, more than one third of the time and spectrum windows defined by the system.

24.3 Test Results (Declaration)

See manufacture Declaration

25 Access Criteria Test Interval

25.1 Definition

This test is for an EUT transmitting control and signalling channels, and validates that the EUT tests the access conditions at least as often as once every 30 s when no acknowledgement is provided for control and signalling channel transmissions.

25.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.1.1
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz (f1)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

25.3 Test Limit

The EUT, if it transmits, must do so on *f*1, and if the EUT is a TDMA device, it must additionally do so on the unblocked timeslot.
The EUT must terminate or pause in its repetitive transmission of the control and signalling channel on the open channel to repeat the access criteria not less frequently than every 30 s

25.4 Test Method

These tests are only applied to a EUT capable of transmitting control and signalling information.

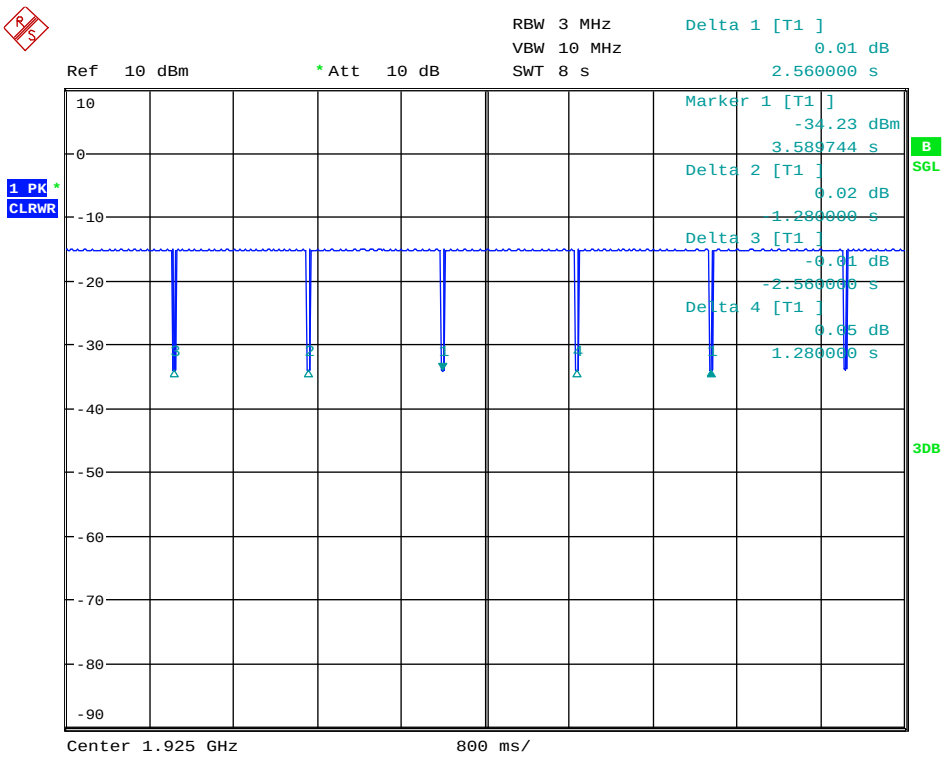
The EUT was restriced to only one operating frequency. The interference generator was fed pulses from the function generator to produce a pulsed carrier of the specified time length and the output of the interference generator was set to the required level. The pulse generator and EUT were synchronized so the position of the pulses corresponded to the time-slot pattern in the frame of the EUT. The tests were performed to find the following:

Test b)
The interference generator was setup to introduce interference on all but one time slot (single slot). The free slot was set to coincide with slot *2*. The transmissions if any should occur on the free time slot. Verify that the access criteria are checked not less frequently than every 30 seconds

25.5 Test Results

Test	Test Data Required	Test Result	Limit	Pass/Fail
Access Criteria Selection of Channel	Any transmissions and on which time slot	Transmission on f1 Time Slot 2	Pass	Pass
Repetition of Access Criteria (note 1)	Interval Between Access Criteria	1.28	<30 Seconds	Pass

Note:
1. The interval between access criteria test is checked 5 times.
2. See Annex G for plots of the access criteria test interval.



Repetition of Access Criteria

26 Access Criteria Functional Test

26.1 Definition

This test is to verify that transmission restarts on a different access channel if the access criteria are not met again on the old channel.

26.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.1.2 / 8.1.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1923.264 MHz (f1) / 1924.992 MHz (f2)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

26.3 Test Method

ANSI C63.17 sub-clause 8.1.2 (47CFR15.323(c)(6) option not implemented)

These tests are only applied to a EUT capable of transmitting control and signalling information. ANSI C63.17 sub-clause 8.1.3 is not applicable the random waiting interval option is not implemented.

The EUT was frequency administered to two operating frequencies. The interference generator was set to the required level. The tests were performed to find the following:

f1 = 1924.992 MHz
f2 = 1926.720 MHz

Test b)
With no interference on, the EUT must transmit on f1 or f2. The interference is then applied to the channel used by the EUT at the appropriate level. Verify that after the application of interference the EUT transmits on the open channel after the next pause.

ANSI C63.17 sub-clause 8.1.3 (47CFR15.323(c)(6) option implemented)

These tests are only applied to a EUT capable of transmitting control and signalling information. ANSI C63.17 sub-clause 8.1.2 is not applicable as the random waiting interval option is implemented.

The EUT was frequency administered to one operating frequency. The interference generator was set to the required level. The tests were performed to find the following:

f1 = 1924.992 MHz

Test b)
With no interference on, the EUT must transmit on f1. The interference is then applied to f1. The EUT must stop transmitting within 30 Seconds.

Test c)
Cancel the interference. Measure the time interval between the end of the interference transmission and the beginning of transmission by the EUT.

Test d)
Repeat the test steps b) and c) 100 times. If each of the time intervals measured is equal to or greater than 10 ms and less than or equal to 150 ms and the measured time intervals vary uniformly between 10 ms and 150 ms, the EUT passes the test.

26.4 Test Results

ANSI C63.17 sub-clause 8.1.2

Test	Before interference EUT transmits on	After interference on f1 EUT transmits on	Limit	Pass/Fail
8.1.2 Test b	f2	F1	Change channel after application of interference	Pass

Notes: 1. Random Waiting Interval option not implemented.

ANSI C63.17 sub-clause 8.1.3

Not applicable 47CFR15.323(c)(6) option not implemented

27 Duration Of Transmission

27.1 Definition

The amount of time a device uses a channel without repeating access criteria

27.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.2.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

27.3 Test Limit

The EUT shall not continue to use the same channel without executing the access criteria at least as often as every 8 h.

27.4 Test Results

Duration of Transmission	Maximum Transmission Time (Seconds)	Maximum Transmission Time Limit	Pass/Fail
Period	9.33	<8 Hours	Pass

Note: The EUT is a ULE Fixed part device communicating with a Portable port
The longest transmissions occur during portable part power up sequence

28 Connection Acknowledgement

28.1 Definition

To verifies that the two devices communicating over a duplex connection comply with the access criteria.

28.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.2.1
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

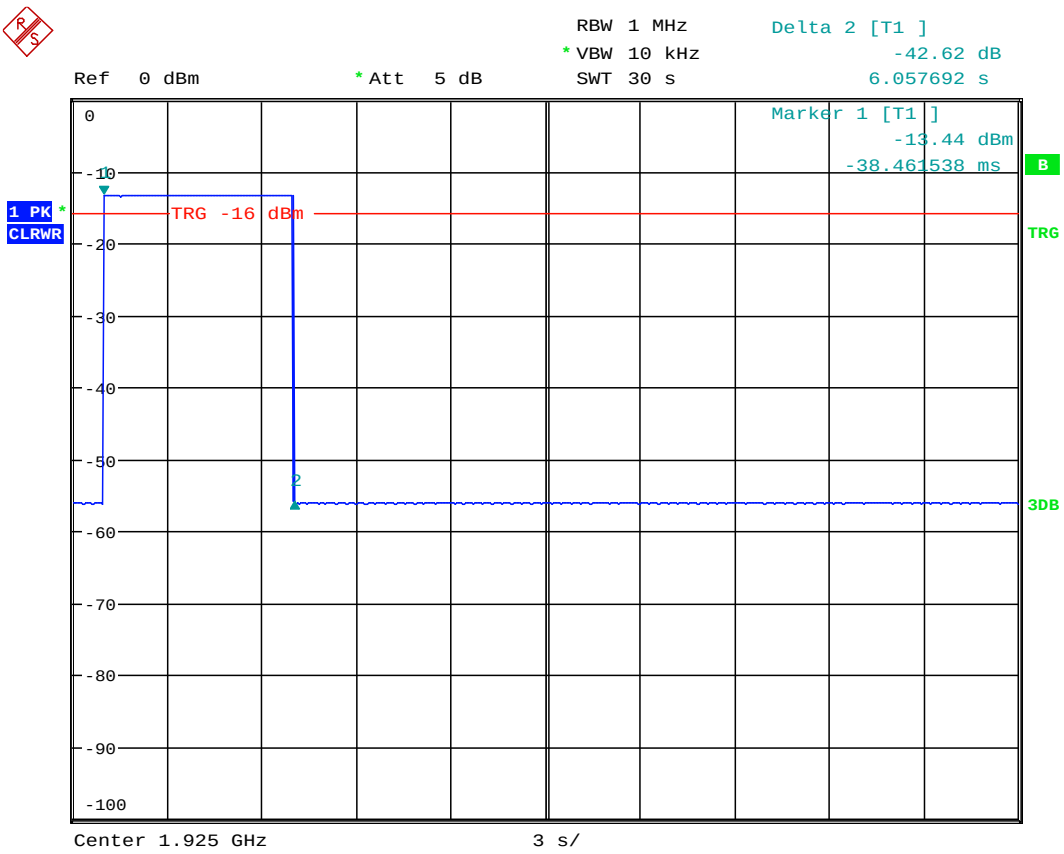
28.3 Test Method

The test was carried out in two parts. The first was to verify that with the companion device off (no initial acknowledgement received) the EUT does not transmit on the same time/spectrum window for more than the limit. The second was to verify that after a connection is broken the EUT terminates its transmission on the current communication channel within 30 seconds or less. As the device only transmits single packets this was tested by transmitting a single packet, blocking acknowledgements and trying to transmits single packet again.

28.4 Test Results

Test	Time Taken (seconds)	Limit (seconds)	Pass/Fail
Transmission on communications channel no acknowledgement received	N/A Note 1	1	Pass
Valid Packet , acknowledgement blocked , packet transmit	<10 seconds	30	Pass

Note:
1. EUT is not the initiating device
2. The EUT is a ULE Fixed part device communicating with a Portable port
3. The longest transmissions occur during portable part power up sequence



Valid packet - Acknowledgements Blocked – Packet transmit

29 Least Interfered Channel (LIC) Procedure

29.1 Definition

To determine that an EUT is operating in the LIC mode can properly select the channel with the lowest interference power, within a 6 dB resolution

29.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.3.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1923.264 MHz (f1) / 1926.720 MHz(f2)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

29.3 Test Method

The EUT utilizes more than 40 channels; therefore the least interfered channel testing is applicable.

The EUT was restricted to operating on two frequencies only, designated f1 and f2.

Test b)
Interference on f1 was set at $T_L + U_M + 7dB$ and at $T_L + U_M$ on f2. Initiate communication. The EUT should transmit on f2. Repeat 5 times. If the EUT transmits on f1 the test is failed.

Test c)
Interference on f1 was set at $T_L + U_M$ and at $T_L + U_M + 7dB$ on f2. Initiate communication. The EUT should transmit on f1. Repeat 5 times. If the EUT transmits on f2 the test is failed.

Test d)
Interference on f1 was set at $T_L + U_M + 1dB$ and at $T_L + U_M - 6dB$ on f2. Initiate communication. The EUT should transmit on f2. Repeat 5 times. If the EUT transmits on f1 the test is failed.

Test e)
Interference on f1 was set at $T_L + U_M - 6dB$ and at $T_L + U_M + 1dB$ on f2. Initiate communication. The EUT should transmit on f1. Repeat 5 times. If the EUT transmits on f2 the test is failed.

29.4 Test Results

Test	Transmit on f1	Transmit on f2	Wanted Transmit Channel	Pass/Fail
b	No	Yes	f2	Pass
c	Yes	No	f1	Pass
d	No	Yes	f2	Pass
e	Yes	No	f1	Pass

Note: 1. All tests were repeated 5 times.

30 Selected Channel Confirmation

30.1 Definition

To determine that an EUT monitors the selected channel immediately prior to transmission. The test described as follows is intended to verify that the EUT makes its channel selection decision on the basis of a recent power level reading

30.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.3.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1923.264 MHz (f1) / 1924.992 MHz (f2)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

30.3 Test Method

a) Allow EUT transmission on only two carrier frequencies, which will be designated f1 and f2. This limitation to carriers f1 and f2 is performed preferably by administration commands for the EUT, or alternatively by applying by a multicarrier interference generator uniform interference on all system carriers except f1 and f2, at a level of TL + UM + 20 dB in-band per carrier. Set the interference level to the EUT on f1 to a level of TL + UM + 20dB, and let there be no interference applied on f2.

b) Initiate transmission and verify that the EUT transmits on f2. If a connection was made, terminate it.

c) Apply interference on f2 at a level of TL + UM + 20 dB in-band, and immediately remove all interference from f1 and immediately (but not sooner than 20 ms after the interference on f2 is applied) cause the EUT to attempt transmission. The EUT should now transmit on f1, if it transmits.

d) If the EUT transmits on f2, it fails.

30.4 Test Results

Test	Transmit on f1	Transmit on f2	Wanted Transmit Channel	Pass/Fail
a	No	Yes	f2	Pass
b	Yes	No	f1	Pass

Note: 1. Results in the above table are applicable for both single and long slot configurations.

31 Emissions Inside and Outside the Sub-Band - Conducted

31.1 Definition

In-Band Emissions
Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the operating band that results from the modulation process but excluding spurious emissions.

Spurious emission.
Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude in-band and out-of-band emissions.

31.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.6
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1921.536 MHz / 1928.448 MHz

31.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions from the EUT were measured on a spectrum analyser.

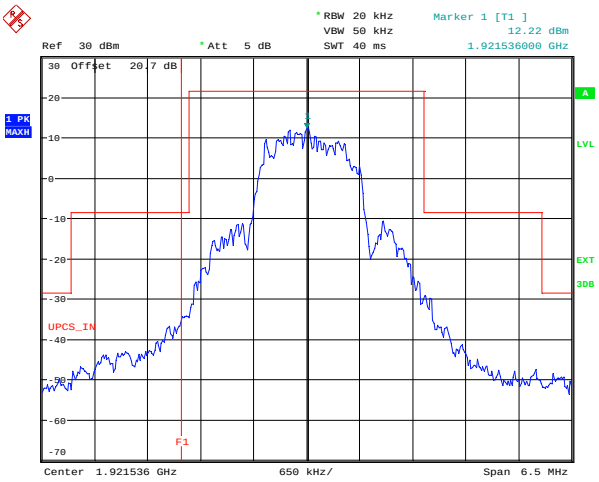
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

31.4 Test Results

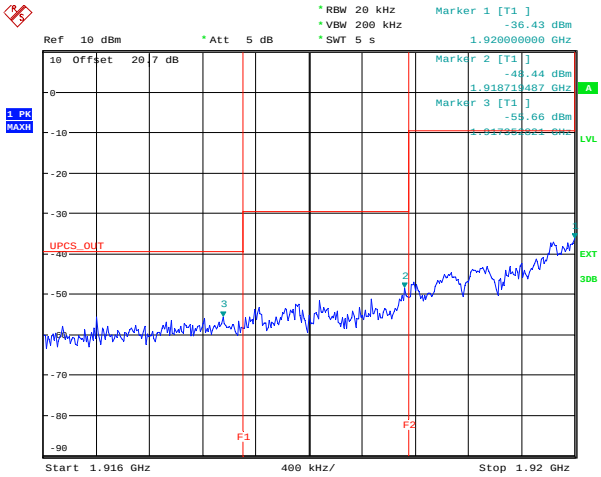
RF carrier set to the lowest carrier defined by the EUT					
Out-of-Band Emissions from UPCS bandedge	**FREQ. (MHz)**	**MEAS. Rx. (dBm)**	**CABLE & ATTEN. LOSS (dB)**	**EMISSION LEVEL (dBm)**	**LIMIT (dBm)**
> - 2.5MHz	Not Applicable – Radiated testing performed				
- 1.25 MHz – 2.5 MHz	1918.719	-69.14	20.7	-48.44	-29.5
- 1.25 MHz	1920.000	-57.13	20.7	-36.43	-9.5
In-band Emissions	See plot				
+ 1.25 MHz	1930.420	-82.27	20.7	-61.57	-9.5
+ 1.25 MHz – 2.5 MHz	1931.420	-84.39	20.7	-63.69	-29.5
> + 2.5MHz	Not Applicable – Radiated testing performed				

Limits	**Out-of-Band Emissions From UPCS bandedge**	**Attenuation (dB) required below Reference power of 112mW**
	± 1.25MHz	30
	±1.25 MHz – 2.5 MHz	50
	> ±2.5MHz	60
	In band Emissions from centre of emission bandwidth	**Attenuation (dB) required below permitted peak power for the EUT**
	1B – 2B	30
	2B – 3B	50
	3B – UPCS band edge	60

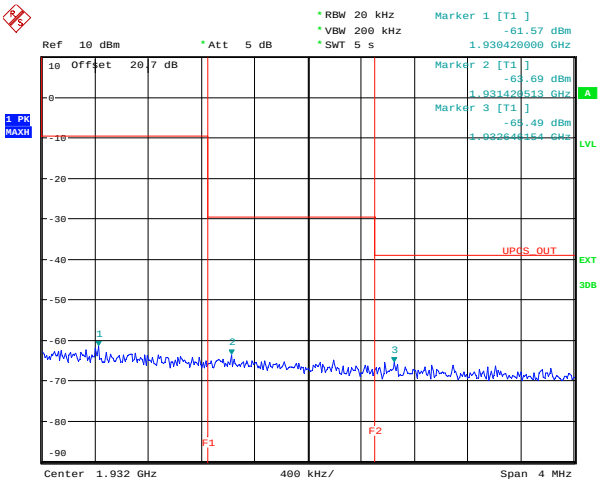
Emissions inside the Sub-Band RF carrier set to the lowest carrier defined by the EUT



Conducted Emissions outside the Sub-Band RF carrier set to the lowest carrier defined by the EUT



Lower Bandedge - > 2.5MHz

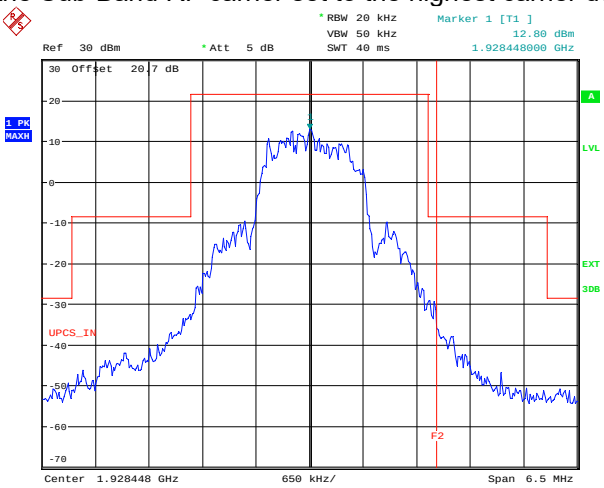


Upper Bandedge - > 2.5MHz

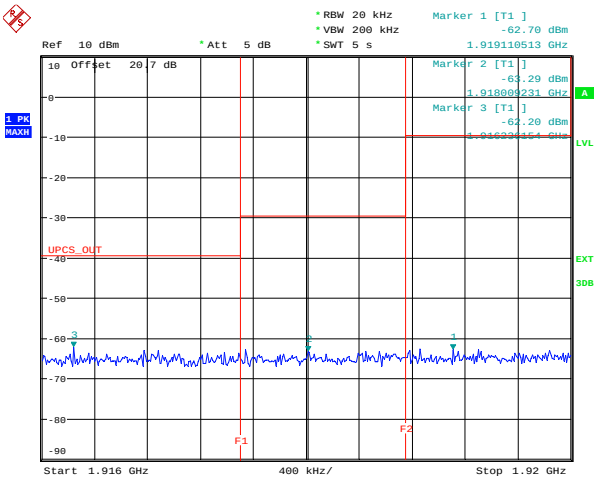
RF carrier set to the highest carrier defined by the EUT					
Out-of-Band Emissions from UPCS bandedge	**FREQ. (MHz)**	**MEAS. Rx. (dBm)**	**CABLE & ATTEN. LOSS (dB)**	**EMISSION LEVEL (dBm)**	**LIMIT (dBm)**
> - 2.5MHz	Not Applicable – Radiated testing performed				
- 1.25 MHz – 2.5 MHz	1918.009	-83.99	20.7	-63.29	-29.5
- 1.25 MHz	1919.110	-83.40	20.7	-62.70	-9.5
In-band Emissions	See plot				
+ 1.25 MHz	1930.000	-57.08	20.7	-36.38	-9.5
+ 1.25 MHz – 2.5 MHz	1931.503	-72.35	20.7	-51.65	-29.5
> + 2.5MHz	Not Applicable – Radiated testing performed				

Limits	**Out-of-Band Emissions From UPCS bandedge**	**Attenuation (dB) required below Reference power of 112mW**
	± 1.25MHz	30
	±1.25 MHz – 2.5 MHz	50
	> ±2.5MHz	60
	In band Emissions from centre of emission bandwidth	**Attenuation (dB) required below permitted peak power for the EUT**
	1B – 2B	30
	2B – 3B	50
	3B – UPCS band edge	60

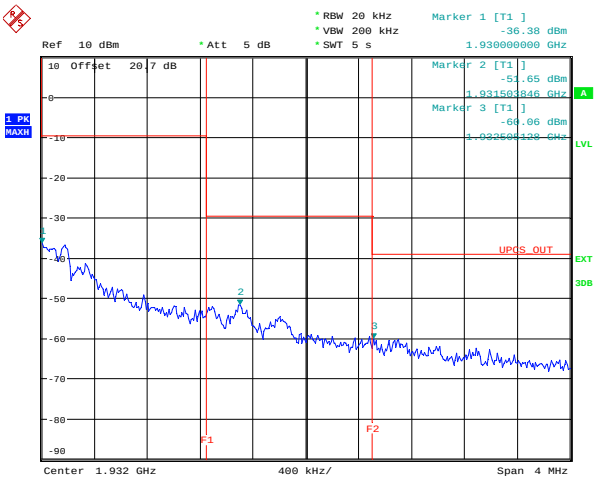
Emissions inside the Sub-Band RF carrier set to the highest carrier defined by the EUT



Conducted Emissions outside the Sub-Band RF carrier set to the highest carrier defined by the EUT



Lower Bandedge - > 2.5MHz



Upper Bandedge - > 2.5MHz

32 Emissions Inside and Outside the Sub-Band - Radiated

32.1 Definition

In-Band Emissions
Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the operating band that results from the modulation process but excluding spurious emissions.

Spurious emission.
Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude in-band and out-of-band emissions.

32.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.1.6. ANSI C63.10-2013, Clause 6.5 and 6.6
Test Location:	Element Skelmersdale / Hull
Test Chamber:	Radio Chamber
EUT Channels / Frequencies Measured:	Low / High
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

32.3 Test Limit

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

Frequency (MHz)	*Field Strength (µV/m at 3 m)*
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

32.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure ii, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dBµV/m at the regulatory distance, using:

$$FS = PR + CL + AF – PA + DC – CF$$

Where,

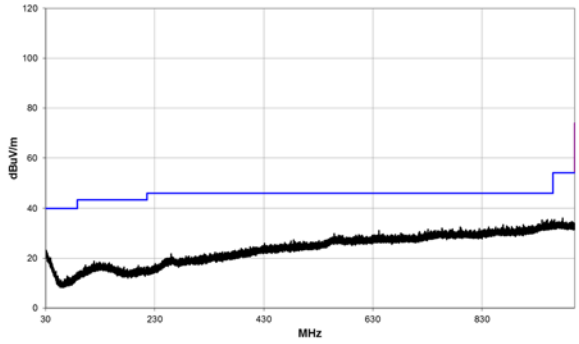
PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);
CF is the distance factor in dB (where measurement distance is different to limit distance);

This field strength value is then compared with the regulatory limit.

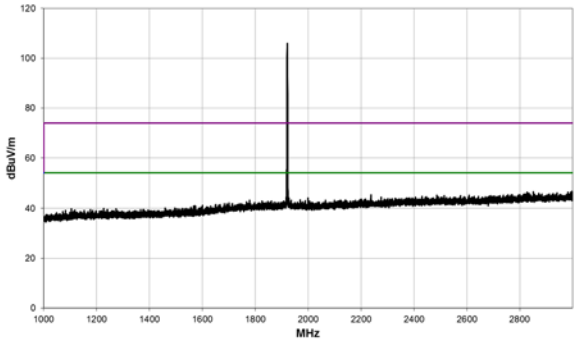
Figure ii Test Setup

32.5 Test Results

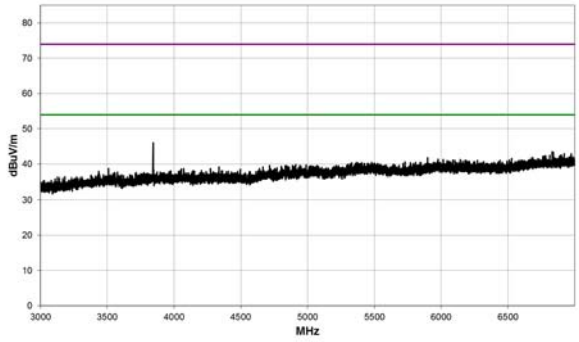
RF carrier set to the lowest carrier defined by the EUT										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Pre-amp Gain (dB)***	***Antenna Factor (dB/m)***	***Cable Loss (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	3843.942	54.3	35.80	32.70	5.30	-	-	56.5	668.34	5000
Av	3842.533	35.7	35.80	32.70	5.30	-	-	37.9	78.52	500



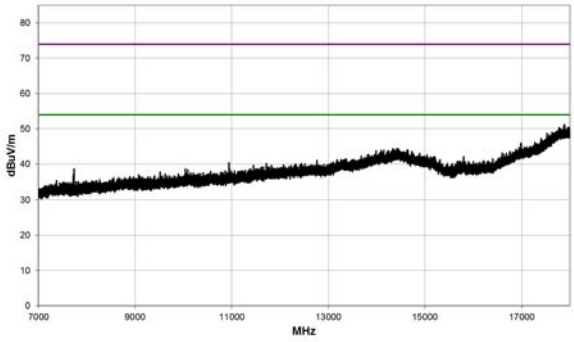
30 MHz – 1 GHz



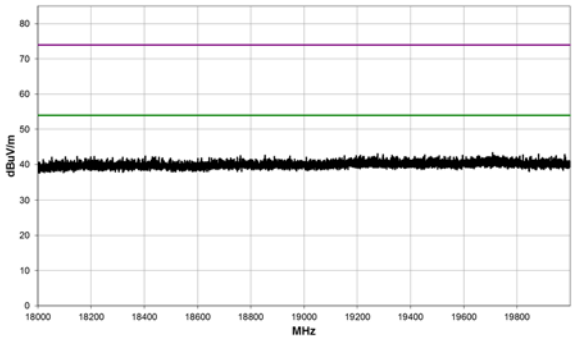
1 GHz – 3 GHz



3 GHz – 7 GHz

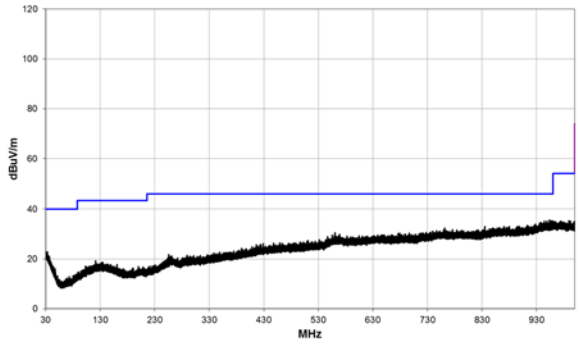


7 GHz – 18 GHz

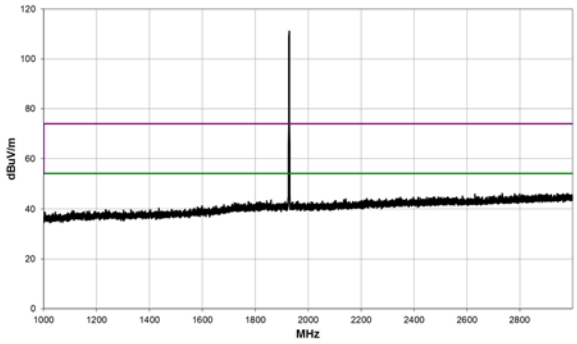


18 GHz – 20 GHz

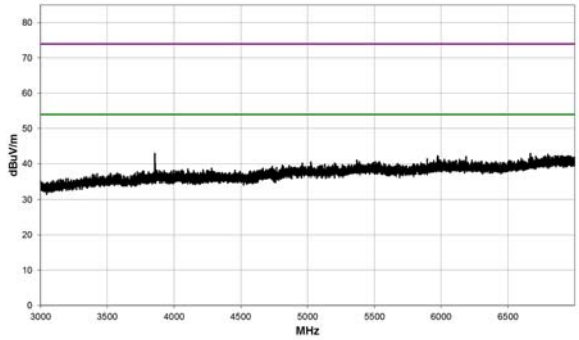
RF carrier set to the Highest carrier defined by the EUT										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Pre-amp Gain (dB)***	***Antenna Factor (dB/m)***	***Cable Loss (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	3856.117	55.5	35.80	32.80	5.30	-	-	57.8	776.25	5000
Av	3856.133	36.2	35.80	32.80	5.30	-	-	38.5	84.14	500



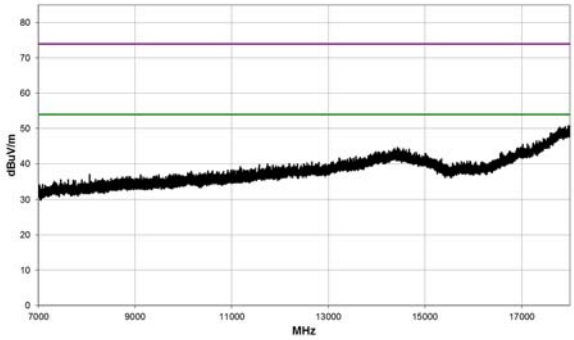
30 MHz – 1 GHz



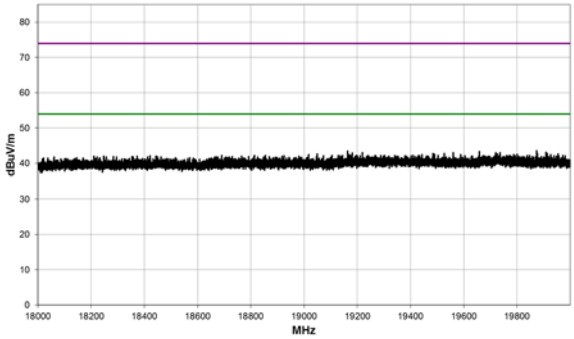
1 GHz – 3 GHz



3 GHz – 7 GHz



7 GHz – 18 GHz



18 GHz – 20 GHz

33 Frame Repetition Stability

33.1 Definition

This is the mean value of the frame repetition rate recorded over 1000 samples.

33.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

33.3 Test Limit

Each device that implements time division for the purpose of maintaining a duplex connection on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 50 parts per million (ppm).

Each device that further divides access in time in order to support multiple communication links on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 10 ppm.

33.4 Test Result

Frame Repetition Stability (ppm)	Limit (ppm)	Pass/Fail
-4.74	±10ppm	PASS

34 Frame Period and Jitter

34.1 Definition

Jitter is the difference in time between the rising edges of consecutive pulses occurring due to time-related, abrupt, spurious variations in the duration of the frame interval

34.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

34.3 Test Limit

The jitter introduced at the 2 ends of a communication link shall not exceed 25 µs for any 2 consecutive transmissions.

34.4 Test Result

Maximum Jitter (µs)	3xSD Jitter (µs)	3xSD Jitter (µs)	Frame period (ms)	Limit (µs)		Pass/ Fail
				Frame Period (ms)	Jitter (µs)	
-0.01	0.05	0.15	10.00015	20 or 10/X	25	Pass

35 Frequency Stability

35.1 Definition

The accuracy of the transmitted signal, This testing is carried out with the following conditions over 1000 samples.

35.2 Test Paramters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.1
Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
EUT Channels / Frequencies Measured:	1924.992 MHz

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

35.3 Test Limit

The carrier frequency stability shall be maintained within ±10 ppm (±0.001%).

35.4 Test Results

Temperature (ºC)	Voltage (Vdc)	Fc (MHz)	offset (kHz)	offset (ppm)	Limit (ppm)
+20	110 Vac	1924.992	14	7.27	±10ppm
+20	85% Vnom	1924.992	13	6.75	±10ppm
+20	115% Vnom	1924.992	13	6.75	±10ppm
-20	Vnom	1924.992	14	7.27	±10ppm
+50	Vnom	1924.992	-5	-2.60	±10ppm

Note: Frequency variation relative to EUT operating Frequency.

36 AC power-line conducted emissions

36.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

36.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	U404
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	Mid
EUT Channel Bandwidths:	2 MHz
EUT Modulation:	GFSK
Deviations From Standard:	None
Measurement BW:	
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 16 °C	+15 ºC to +35 ºC (as declared)
Humidity: 31 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	To Mains adapto

36.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	***Conducted limit (dBµV)***	
	Quasi-Peak	***Average****
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.
**A linear average detector is required.

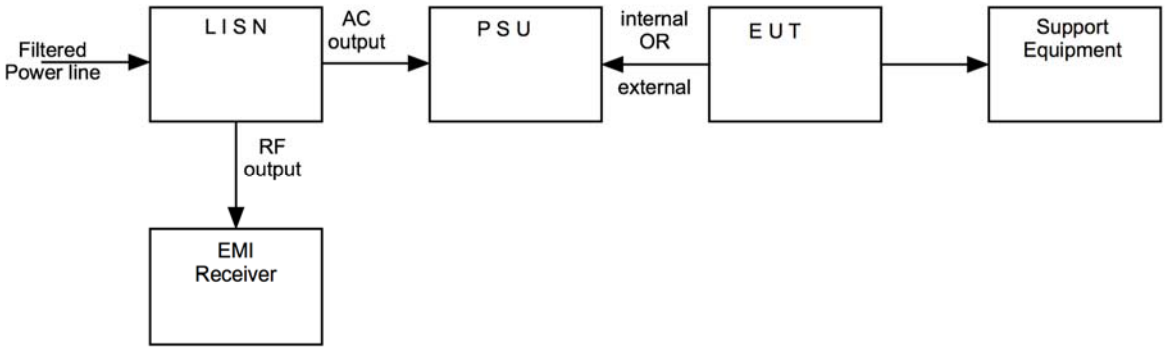
36.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

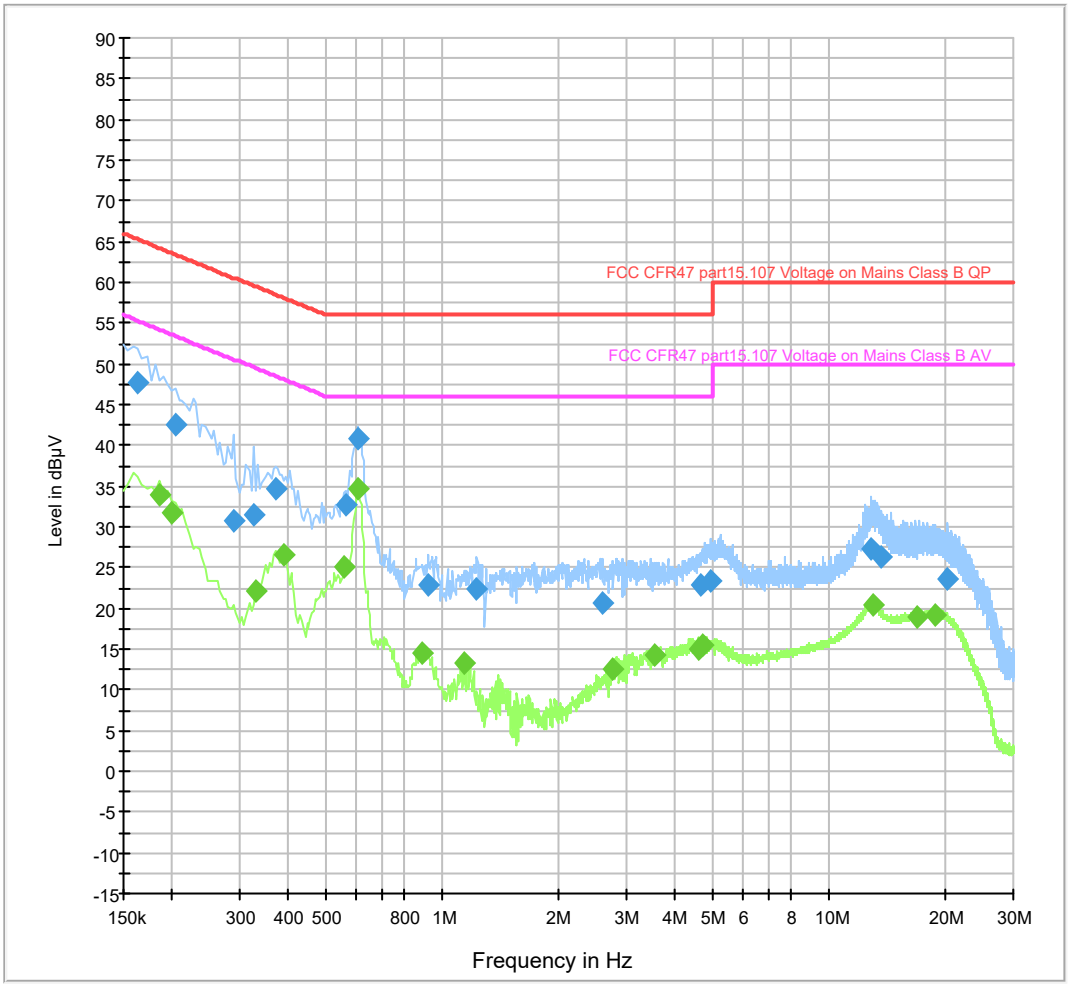
Figure ii Test Setup



Test Set-up Photograph

36.5 Test Results

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH195+UH443PL



Results measured using the quasi-peak detector								
Frequency (MHz)	**QuasiPeak (dBµV)**	**Meas. Time (ms)**	**Bandwidth (kHz)**	**PE**	**Line**	**Corr. (dB)**	**Margin (dB)**	**Limit (dBµV)**
0.163500	**47.7**	**2000.0**	**10.000**	**GND**	**N**	**9.9**	**17.6**	**65.3**
0.204000	**42.4**	**2000.0**	**10.000**	**GND**	**L1**	**9.9**	**21.0**	**63.4**
0.289500	**30.9**	**2000.0**	**10.000**	**GND**	**L1**	**10.0**	**29.7**	**60.5**
0.325500	**31.5**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**28.0**	**59.6**
0.370500	**34.6**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**23.9**	**58.5**
0.564000	**32.7**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**23.3**	**56.0**
0.609000	**40.9**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**15.1**	**56.0**
0.919500	**23.0**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**33.0**	**56.0**
1.230000	**22.3**	**2000.0**	**10.000**	**GND**	**L1**	**10.0**	**33.7**	**56.0**
2.602500	**20.6**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**35.4**	**56.0**
4.650000	**22.9**	**2000.0**	**10.000**	**GND**	**N**	**10.1**	**33.1**	**56.0**
4.960500	**23.4**	**2000.0**	**10.000**	**GND**	**N**	**10.1**	**32.6**	**56.0**
12.930000	**27.2**	**2000.0**	**10.000**	**GND**	**N**	**10.6**	**32.8**	**60.0**
13.605000	**26.3**	**2000.0**	**10.000**	**GND**	**L1**	**10.7**	**33.7**	**60.0**
20.355000	**23.5**	**2000.0**	**10.000**	**GND**	**N**	**11.0**	**36.5**	**60.0**

Results measured using the average detector								
Frequency (MHz)	**Average (dBµV)**	**Meas. Time (ms)**	**Bandwidth (kHz)**	**PE**	**Line**	**Corr. (dB)**	**Margin (dB)**	**Limit (dBµV)**
0.186000	**33.9**	**2000.0**	**10.000**	**GND**	**N**	**9.9**	**20.3**	**54.2**
0.199500	**31.8**	**2000.0**	**10.000**	**GND**	**N**	**9.9**	**21.8**	**53.6**
0.330000	**22.2**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**27.3**	**49.5**
0.388500	**26.6**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**21.5**	**48.1**
0.559500	**25.0**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**21.0**	**46.0**
0.604500	**34.7**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**11.3**	**46.0**
0.888000	**14.6**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**31.4**	**46.0**
1.140000	**13.3**	**2000.0**	**10.000**	**GND**	**N**	**10.0**	**32.7**	**46.0**
2.755500	**12.6**	**2000.0**	**10.000**	**GND**	**L1**	**10.1**	**33.4**	**46.0**
3.543000	**14.2**	**2000.0**	**10.000**	**GND**	**L1**	**10.1**	**31.8**	**46.0**
4.582500	**15.1**	**2000.0**	**10.000**	**GND**	**L1**	**10.2**	**30.9**	**46.0**
4.735500	**15.5**	**2000.0**	**10.000**	**GND**	**N**	**10.1**	**30.5**	**46.0**
13.051500	**20.3**	**2000.0**	**10.000**	**GND**	**N**	**10.6**	**29.7**	**50.0**
16.984500	**19.0**	**2000.0**	**10.000**	**GND**	**L1**	**10.9**	**31.0**	**50.0**
18.946500	**19.3**	**2000.0**	**10.000**	**GND**	**N**	**11.0**	**30.7**	**50.0**

37 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Spectrum Analyser	R&S	FSU46	REF910	2019-10-17	12	2020-10-17
Signal Generator	R&S	SMBV100A	U674	2019-05-07	12	2020-05-07
Digital Signal Generator	Agilent	ESG D3000A	RFG441	2019-02-14	12	2020-02-14
Temperature Indicator	Fluke	52 Series II	L426	2019-06-28	12	2020-06-28
Temperature Chamber	Votsch	VT 4002	U521	Use L426		
Radiocommunication Tester	R&S	CMD 60	RFG433	2019-07-30	12	2020-07-30
1-18GHz Horn	EMCO	3115	L139	2019-07-16	24	2021-07-16
Pre Amp	Agilent	8449B	L572	2019-10-15	12	2020-10-15
Bilog	Chase	CBL611/A	U573	2019-09-19	24	2021-09-19
Horn 18-26GHz (&U330)	Flann	20240-20	L300	2018-04-24	24	2020-04-24
Ferrite Lined Chamber	Rainford	ATS	REF886	2018-07-29	24	2020-07-29
Spectrum Analyser	R&S	FSU26	U405	2019-10-21	12	2020-10-21
Short SMA RF Cable	AtlanTec		REF2165	Calibrate in use		
Multimeter	Agilent	34405a	REF976	2019-11-21	12	2020-11-21
Lisn	R&S	ESH3-Z5.831.5	U195	2019-10-04	12	2020-10-04
Receiver	R&S	ESHS10	U187	2018-11-29	12	2019-11-29
Pulse Limiter	R&S	ESH3-Z2	U443	2019-10-17	12	2020-10-17
Variable Transformer	RS	8A	U034	Use REF976		
Combiners	-	-	-	Calibrate in use		

38 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result (Power Meter) = **1.08dB**
Uncertainty in test result (Spectrum Analyser) = **2.48dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.71dB**

[4] Spurious Emissions

Uncertainty in test result = **4.75dB**

[5] Maximum frequency error

Uncertainty in test result (Frequency Counter) = **0.113ppm**
Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,
Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[7] Frequency deviation

Uncertainty in test result = **3.2%**

[8] Magnetic Field Emissions

Uncertainty in test result = **2.3dB**

[9] Conducted Spurious

Uncertainty in test result – Up to 8.1GHz = **3.31dB**
Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**
Uncertainty in test result – Up to 26GHz = **3.14dB**

[10] Channel Bandwidth

Uncertainty in test result = **15.5%**

[11] Amplitude and Time Measurement – Oscilloscope

Uncertainty in overall test level = **2.1dB**,
Uncertainty in time measurement = **0.59%,**
Uncertainty in Amplitude measurement = **0.82%**

[12] Power Line Conduction

Uncertainty in test result = **3.4dB**

[13] Spectrum Mask Measurements

Uncertainty in test result = **2.59% (frequency)**
Uncertainty in test result = **1.32dB (amplitude)**

[14] Adjacent Sub Band Selectivity

Uncertainty in test result = **1.24dB**

[15] Receiver Blocking – Listen Mode, Radiated

Uncertainty in test result = **3.42dB**

[16] Receiver Blocking – Talk Mode, Radiated

Uncertainty in test result = **3.36dB**

[17] Receiver Blocking – Talk Mode, Conducted

Uncertainty in test result = **1.24dB**

[18] Receiver Threshold

Uncertainty in test result = **3.23dB**

[19] Transmission Time Measurement

Uncertainty in test result = **7.98**