

Report on the Radio Testing
For
Gas Control Equipment Limited
on
Zeno Lite with Clarity
Report no. TRA-038556-47-01A
2019/08/22

RF915 5.0

Report Number: TRA-038556-47-01A
Issue: A

REPORT ON THE RADIO TESTING OF A
GAS CONTROL EQUIPMENT LIMITED
ZENO LITE WITH CLARITY
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 2019/03/01

Written by:

Steven Garwell
Radio Test Engineer

Approved by:

Date: 2019/08/22

John Charters
Department Manager - Radio

Disclaimers:

[1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF915 5.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	2019/08/22	Original

2 Summary

TEST REPORT NUMBER: TRA-038556-47-01A

WORKS ORDER NUMBER: TRA-041253-03

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: 47CFR15.247

EQUIPMENT UNDER TEST (EUT): Zeno Lite With Clarity

FCC IDENTIFIER: QOQBGM12LMA

EUT SERIAL NUMBER: ZL101416

MANUFACTURER/AGENT: Gas Control Equipment Limited

ADDRESS: 100 Empress Parkway
Penny Lane
Haydock
Merseyside
WA11 9DB

CLIENT CONTACT: Will Turner
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ORDER NUMBER: 45-027-022

TEST DATE: 2019/03/01

TESTED BY: Steven Garwell
Element

2.1 Test Summary

Test Method and Description		Requirement Clause	Applicable to this equipment	Result / Note
		47CFR15		
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.205	<input checked="" type="checkbox"/>	PASS
AC power line conducted emissions		15.207	<input type="checkbox"/>	Note 1
Occupied bandwidth		15.247(a)(2)	<input type="checkbox"/>	Note 1
Conducted carrier power	Peak	15.247(b)(3)	<input checked="" type="checkbox"/>	PASS
	Max.		<input type="checkbox"/>	
Conducted / radiated RF power out-of-band		15.247(d)	<input type="checkbox"/>	Note 1
Power spectral density, conducted		15.247(e)	<input type="checkbox"/>	Note 1
Calculation of duty correction		15.35(c)	<input type="checkbox"/>	Note 1

Notes:

Note 1: Limited Testing to cover radiated spurious emissions and carrier power measurements to support Class II permissive change to confirm new host configuration for FCC compliance.

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).

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4 Introduction

This report TRA-038556-47-01A presents the results of the Radio testing on a Gas Control Equipment Limited, Zeno Lite With Clarity to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Gas Control Equipment Limited by Element, at the address detailed below.

<input type="checkbox"/> Element Hull	<input checked="" type="checkbox"/> Element Skelmersdale
Unit E	Unit 1
South Orbital Trading Park	Pendle Place
Hedon Road	Skelmersdale
Hull	West Lancashire
HU9 1NJ	WN8 9PN
UK	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.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

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

IC Registration Number(s):

Element Hull	3483A
Element North West	3930B

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

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

5 Test Specifications

5.1 *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.

5.2 *Deviations from Test Standards*

Limited Testing to cover radiated spurious emissions and carrier power measurements to support Class II permissive change to confirm new host configuration for FCC compliance.

6 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
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

7 Equipment Under Test

7.1 EUT Identification

- Name: Zeno Lite With Clarity
- Serial Number: ZL101416
- Model Number: RS-00600C
- Software Revision: V 1.360
- Build Level / Revision Number: Pre-production

7.2 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.

1: Laptop

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for transmit tests was as follows:-

The device was programmable by customer supplied scripts to allow continuous transmission on top, middle and bottom channels

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2400 – 2483.5
Modulation type:	GFSK
Occupied channel bandwidth:	1 MHz
Channel spacing:	2 MHz
ITU emission designator:	G1D
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable
Nominal Supply Voltage:	24 V dc
Method of prevention of use on non-US / non-Canadian frequencies:	Label / user manual / both

7.4.2 Antennas

Type:	Integral PCB
Frequency range:	2400 MHz – 2483.5 MHz
Impedance:	50 Ohm
Gain:	0
Polarisation:	Omni-Directional
Connector type:	Not Applicable

7.5 EUT Description

The EUT is a portable oxygen concentrator for patients requiring supplementary oxygen. The device has multiple wireless connections.

8 Modifications

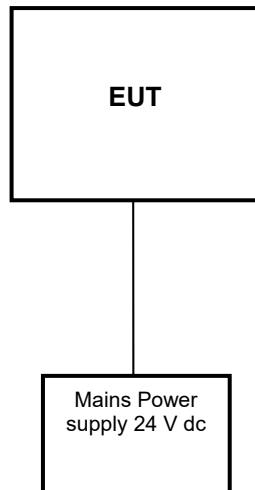
No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

The following diagram shows basic EUT interconnections:

The EUT is a standalone portable device powered by mains supply or internal battery cells.



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



10 General Technical Parameters

10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 24 V dc from a mains power adaptor.

10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band and the manufacturer has declared sufficient frequency stability (refer to section 7.4).

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

	<i>Category</i>	<i>Nominal</i>	<i>Variation</i>
<input type="checkbox"/>	Mains	110 V ac +/- 2 %	85 % and 115 %
<input checked="" type="checkbox"/>	Power Supply	24 V dc	N/A

11 Radiated emissions

11.1 Definitions

Spurious emissions

Emissions on a frequency or frequencies, which 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 out-of-band emissions.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Frequencies Measured:	2402 MHz, 2442 MHz, 2480 MHz
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: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 39 % RH	20 % RH to 75 % RH (as declared)
Supply: 24 V dc	

11.3 Test Limit

Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

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

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, 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 dB μ V/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 dB μ V;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

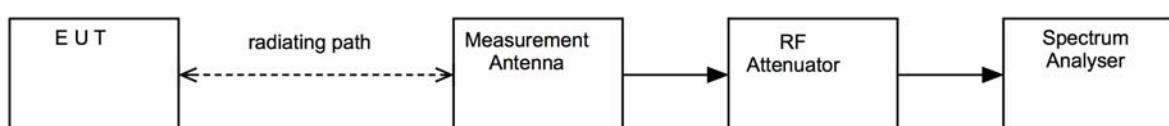
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

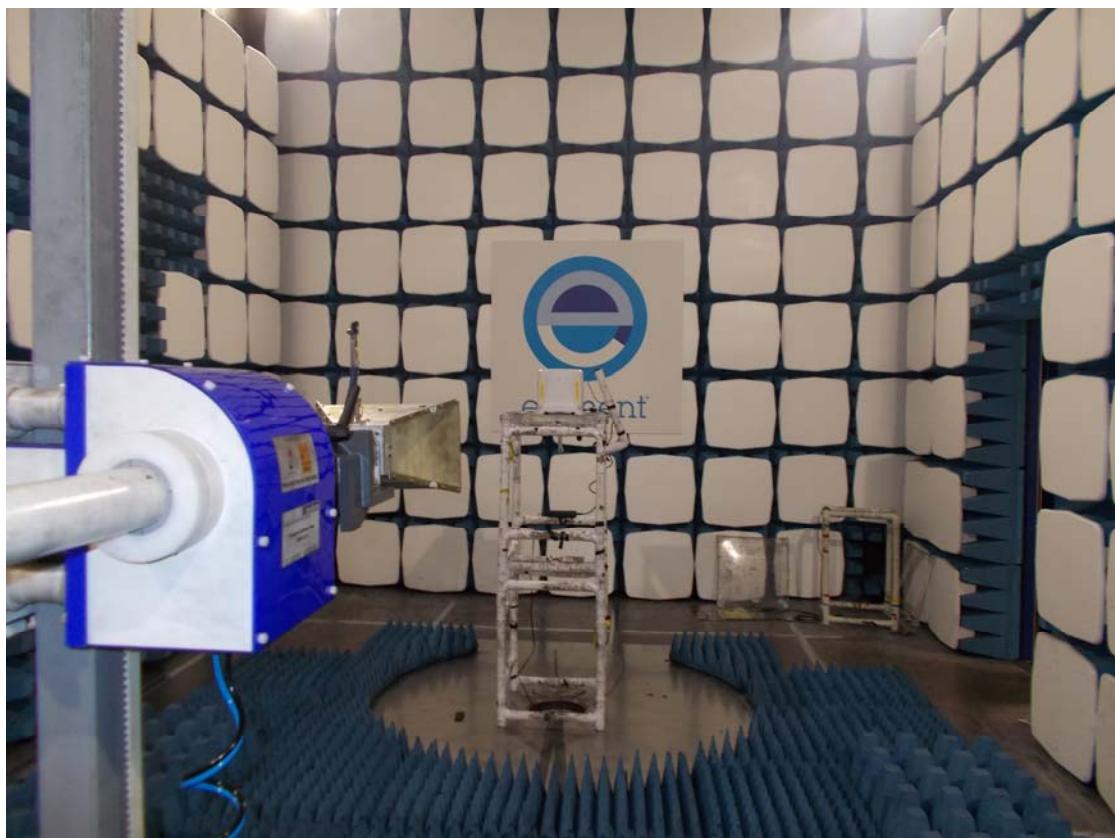
CF is the distance factor in dB (where measurement distance different to limit distance);

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

Figure i Test Setup



11.5 Test Set-up Photograph

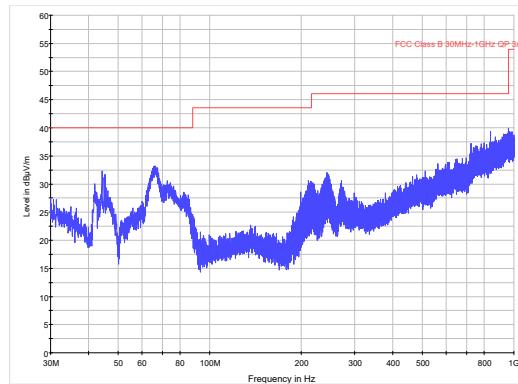


11.6 Test Equipment

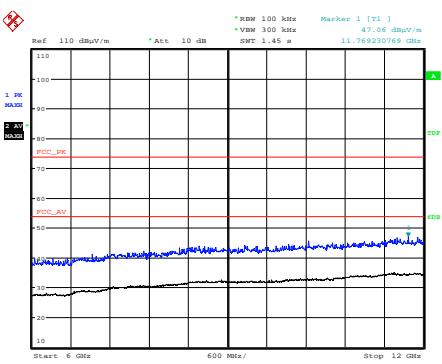
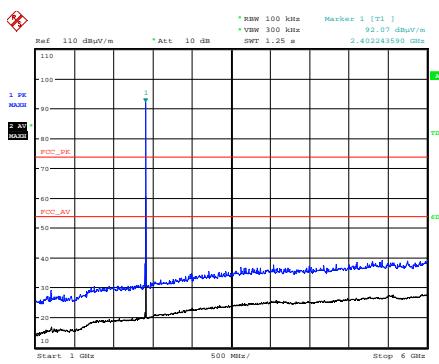
Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Receiver	R&S	ESVS10	L317	2019-03-22
Spectrum Analyser	R&S	FSU26	REF909	2019-06-15
Pre Amp	Agilent	8449B	L572	2019-10-12
Bilog	Chase	CBL611/A	U573	2019-08-02
1-18GHz Horn	EMCO	3115	L139	2019-09-25

11.7 Test Results

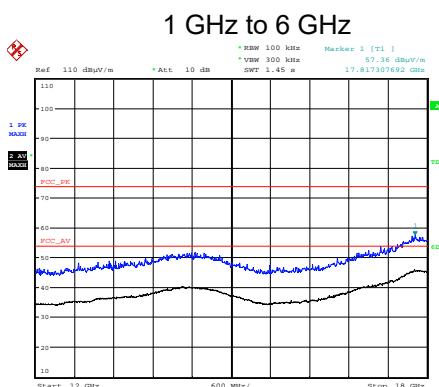
Frequency 2402 MHz:



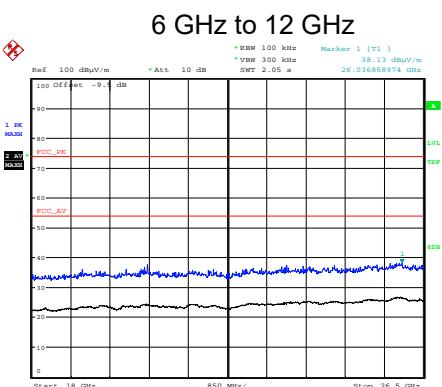
30 MHz to 1 GHz



Date: 1.MAR.2019 07:57:41



Date: 1.MAR.2019 08:00:15



Date: 1.MAR.2019 08:01:11

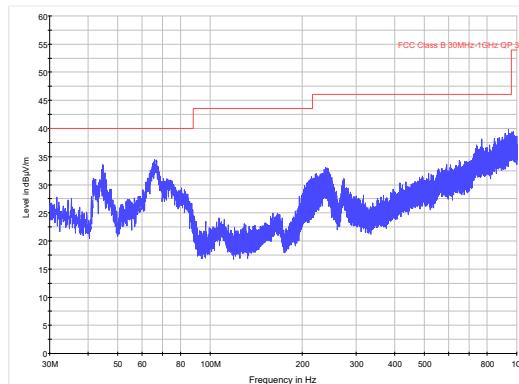
12 GHz to 18 GHz

Date: 1.MAR.2019 09:15:44

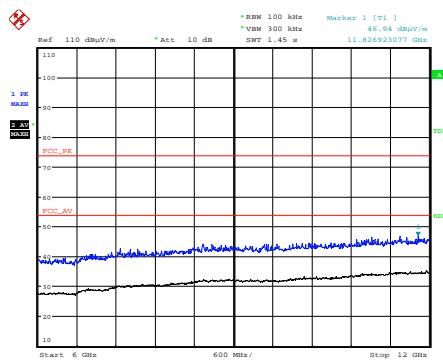
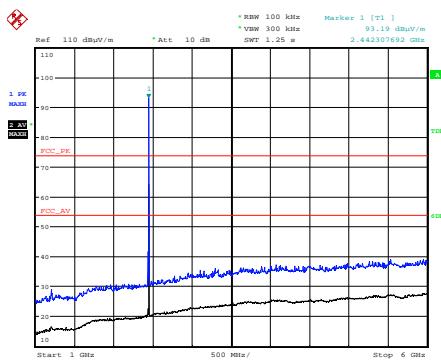
18 GHz to 26.5 GHz

Frequency 2402 MHz:										
Detector	Freq. (MHz)	Meas'd Emission (dB μ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrapol'n Factor (dB)	Field Strength (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
No Emissions Within 20 dB Of The Limit										PASS

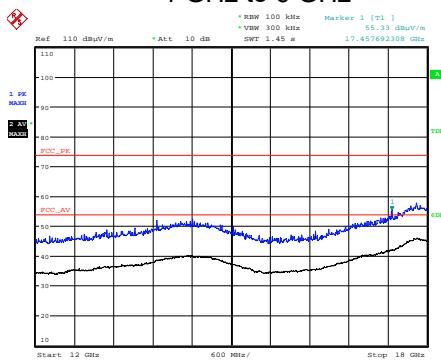
Frequency 2442 MHz:



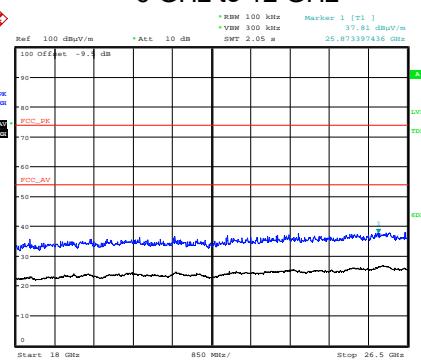
30 MHz to 1 GHz



Date: 1.MAR.2019 08:23:14



Date: 1.MAR.2019 08:25:40



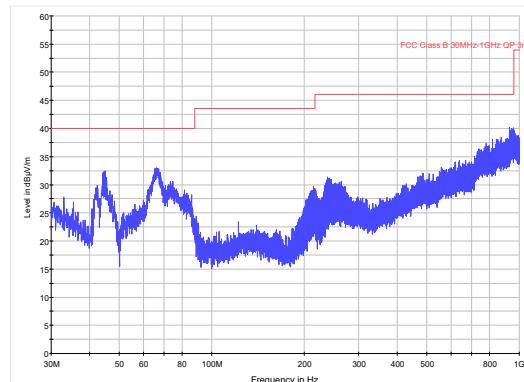
Date: 1.MAR.2019 08:26:37

12 GHz to 18 GHz

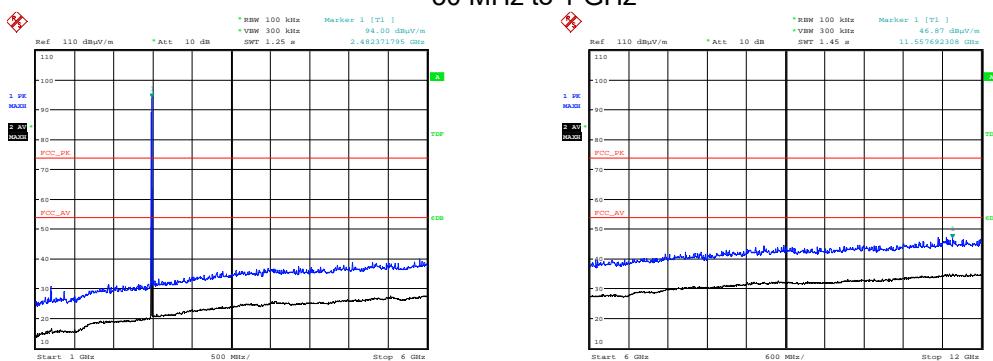
Date: 1.MAR.2019 09:12:29

18 GHz to 26.5 GHz

Frequency 2480 MHz:



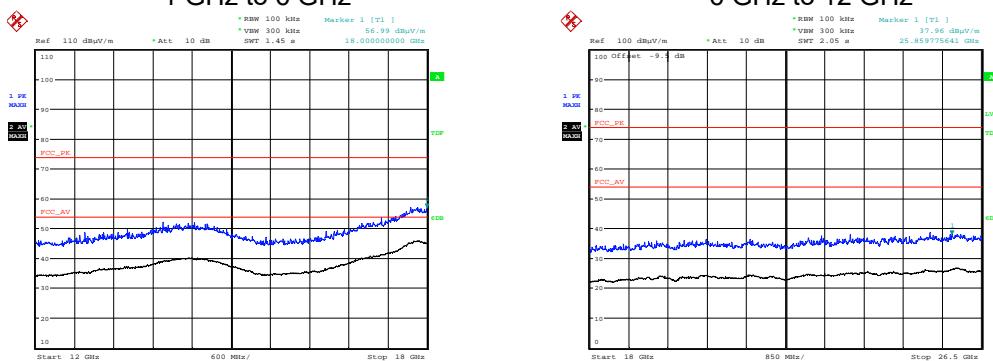
30 MHz to 1 GHz



Date: 1.MAR.2019 08:40:20

Date: 1.MAR.2019 08:43:01

1 GHz to 6 GHz



Date: 1.MAR.2019 08:43:53

Date: 1.MAR.2019 09:07:57

12 GHz to 18 GHz

18 GHz to 26.5 GHz

Frequency 2480 MHz:										
Detector	Freq. (MHz)	Meas'd Emission (dB μ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
No Emissions Within 20 dB Of The Limit									PASS	

12 Maximum peak conducted output power

12.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Frequencies Measured:	2402 MHz, 2442 MHz, 2480 MHz
Deviations From Standard:	None
Measurement BW:	3 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	10 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 39 % RH	20 % RH to 75 % RH (as declared)
Supply: 24 V dc	

12.3 Test Limit

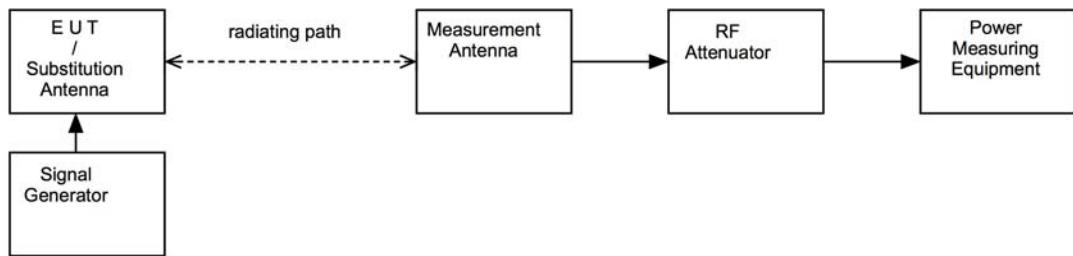
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

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.

Figure iv Test Setup



12.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Spectrum Analyser	R&S	FSU26	REF909	2019-06-15
Pre Amp	Agilent	8449B	L572	2019-10-12
1-18GHz Horn	EMCO	3115	L139	2019-09-25

12.6 Test Results

Detector	Freq. (MHz)	Meas'd Emission (dB μ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB μ V/m)	EIRP (mW)
Pk	2402.00	98.56	3.50	28.30	36.52	0.00	0.00	93.84	0.73
Av	2402.00	87.32	3.50	28.30	36.52	0.00	0.00	82.60	0.06

Detector	Freq. (MHz)	Meas'd Emission (dB μ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB μ V/m)	EIRP (mW)
Pk	2442.00	100.64	3.60	28.50	36.52	0.00	0.00	96.22	1.26
Av	2442.00	89.74	3.60	28.50	36.52	0.00	0.00	85.32	0.10

Detector	Freq. (MHz)	Meas'd Emission (dB μ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB μ V/m)	EIRP (mW)
Pk	2480.00	101.75	3.60	28.60	36.52	0.00	0.00	97.43	1.66
Av	2480.00	90.76	3.60	28.60	36.52	0.00	0.00	86.44	0.13

Note: carrier power measurements were taken radiated as no conducted sample was available at the time of the test.

13 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] Radiated spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**
Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[2] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[3] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[4] Conducted carrier power

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

[5] Conducted / radiated RF power out-of-band

Uncertainty in test result – up to 8.1 GHz = **3.31 dB**
Uncertainty in test result – 8.1 GHz to 15.3 GHz = **4.43 dB**
Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**
Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[6] Power spectral density

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