Sulis Consultants
CE Marking and Product Approvals

RF Test Report:

Zinwave ORU

Operation in the 869 - 894 MHz band

47CFR22H

&

Operation in the paging bands

47CFR22E

FCC ID: UPO302-1107

SC_TR_173_C

Sulis Consultants Limited
Mead House, Longwater Road, Eversley, Hampshire, RG27 0NW, UK
Registered in England & Wales, number 05466247
http://www.sulisconsultants.com

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1 Revision History

Revision	Originator	Date	Comment	Signature
A	C Blackham Director, Sulis Consultants Ltd	08 Dec 2015	Customer copy	
B	C Blackham Director, Sulis Consultants Ltd	09 Jan 2016	1st release	
C	C Blackham Director, Sulis Consultants Ltd	10 May 2016	Added part 22E results	

2 Purpose

This document details the test results of the Zinwave Optical Remote Unit, ORU, model number 302-1107**,** against FCC requirements whilst operating in the 869 - 894 MHz band.

3 Reference Documents

[1]	47CFR2	Title 47 Code of Federal Regulations Part 2: frequency allocations and radio treaty matters; general rules and regulations
[2]	47 CFR22	Title 47 Code of Federal Regulations Part 22: Public Mobile Services
[3]	TIA-603-D	Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards
[4]	KDB 935210 D05 V01	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement guidance for Industrial and Non-consumer signal booster, repeater and amplifier devices
[5]	KDB971168 DO1 v02r02	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement guidance for certification of licensed digital transmitters.

4 Test Information

4.1 Client and manufacturer

Zinwave Ltd

Harston Mill

Harston

Cambridge

CB22 7GG

UK

4.2 Test Locations

Testing was performed by Charlie Blackham of Sulis Consultants Ltd between 13th October and 6th January 2016, at Zinwave's offices in Harston.

4.3 Test sample

The results herein only refer to sample detailed in section 5.

5 Test Configuration

5.1 Test sample and Operating mode

The equipment under test (EUT) was:

Manufacturer	Name	Model Number	Serial Number
Zinwave	ORU	302-1107	310400000022

Table 1: Equipment under test

Modifications during test: None

Procedure:

- Set the system to maximum gain using the network management software
- Connect the signal generator to the RF service module of the Primary Hub
- Raise the signal level until the maximum output power is reached
- Perform the required test.

Test modulations:

- The system supports operation with a number of narrowband and wideband services, testing was performed with MSK and AWGN signal as per KDB 935210 D05.

5.2 Support equipment

The following equipment shall be used, configured as shown in Figure 1:

Name	Part Number	Label	Serial Number
Zinwave UNIhub (Primary Hub)			
Chassis		302-1001	00-17-68-00-09-B7
RF Service module		SM 1/6	030370002050
Optical module		OM 1/6	050750002036
Zinwave UNIhub (Secondary Hub)			
Chassis		302-1001	00-17-68-00-09-67
Input Optical module		OM 5/6	050750002039
Optical module		OM 3/6	050750002010

Table 2: Support Equipment

5.3 Equipment arrangement

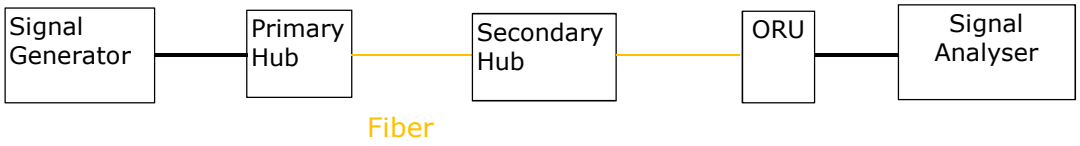


Figure 1: Test configuration – single channel

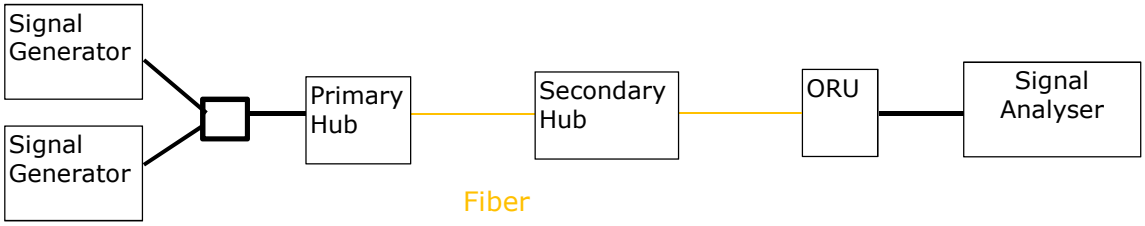


Figure 2: Test configuration – dual channel

Notes – additional connections not shown:

1. IQ output from Signal Generator #1 connected to IQ input of signal generator #2.
2. 10 MHz Ref Clock output of Signal Analyser connected to Ref Clock inputs of the two signal generators

5.4 Permitted Antennas

The system is designed for operation with antennas having a maximum gain of 8.0 dBi or 5.85 dBd.

This is the value used for determining EIRP or ERP where required.

6 Summary of Tests performed

This report contains results for the following tests:

6.1 Part 22H

Test	47 CFR Part	FCC limit	Section	Result
Determination of f_0	KDB 935210 D05 Section 3.3	None	7	N/A
Transmit Power	2.1046 22.913(a)	500 W ERP	8	Pass
Occupied Bandwidth	2.1049 KDB 935210 D05 Section 3.4	None	9	Pass
Conducted Spurious Emissions	2.1051 22.917	-13dBm / 100 kHz	10	Pass

Table 3: Summary of tests performed for part 22H

6.2 Part 22E: 929-930 and 931-932 MHz

Test	47 CFR Part	FCC limit	Section	Result
Determination of f_0	KDB 935210 D05 Section 3.3	None	7	N/A
Transmit Power	2.1046 22.535(f)	5 W ERP	8	Pass
Occupied Bandwidth	2.1049 KDB 935210 D05 Section 3.4	None	9	Pass
Conducted Spurious Emissions	2.1051 22.359(a)	-13dBm	10	Pass

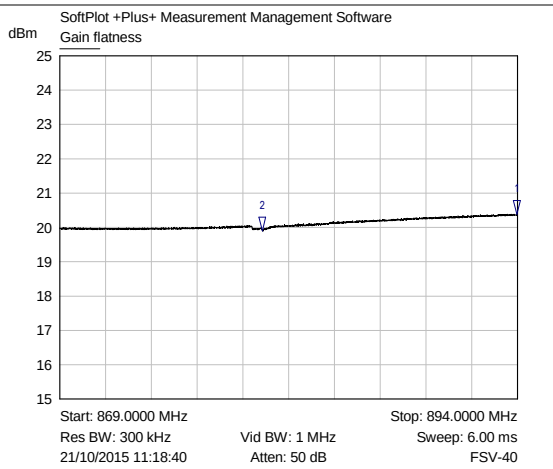
Table 4: Summary of tests performed for part 22E

6.3 Comments on requirements in KDB 935210 D05 V01:

Section	Comment
3.1 General	Two signal sources shall be used: • "narrowband" 200kHz MSK • "wideband" 4.2 MHz 16QAM
3.2 Measuring the EUT AGC threshold	**Not applicable to ORU and 3000 DAS** "Devices intended to be directly connected to an RF source only need to be evaluated for any over-the-air transmit paths." There are no such over-the-air paths
pre-TCB KDB FCC response	Increased input level test not required due to 3.2
3.7 EUT frequency stability measurements	Not required as DAS does not contain oscillator and therefore has no ability to change frequency.

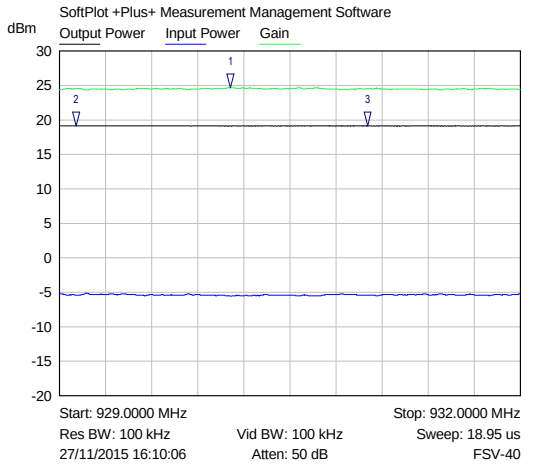
7 Determination of f_0

As per kDB 935210 D05 section 3.3, but measurement was performed over the service band frequency range only.



Mkr	Trace	X-Axis	Value	Notes
1	Gain flatness	893.9583 MHz	20.38 dBm	Max gain
2	Gain flatness	880.0768 MHz	19.91 dBm	Min gain

869 - 894 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Gain	930.1140 MHz	24.68 dBm	Max gain
2	Output Power	929.1073 MHz	19.19 dBm	Max output power
3	Output Power	931.0080 MHz	19.15 dBm	Max output power

929 – 930 and 931 - 932 MHz

Figure 3: Determination of f_0

8 Transmit Power

8.1 Test method

Part 22E

As per 935210 D05 the Maximum transmit power is determined from the maximum output power determined using a CW signal in section 7.

§22.535 Effective radiated power limits.

(f) *Signal boosters.* The effective radiated power of signal boosters must not exceed 5 watts ERP under any normal operating condition

Part 22H

The equipment was configured as per figure 1 and the measurements were made in accordance with KDB 971168 D01 using an RMS detector and the Peak to Average ratio was measured using the CCDF function of the analyser.

The signal generator was set to provide -5dBm to the input of the hub and the frequency set to an appropriate channel to include f_0 as determined in section 7.

§22.913 Effective radiated power limits.

The effective radiated power (ERP) of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.

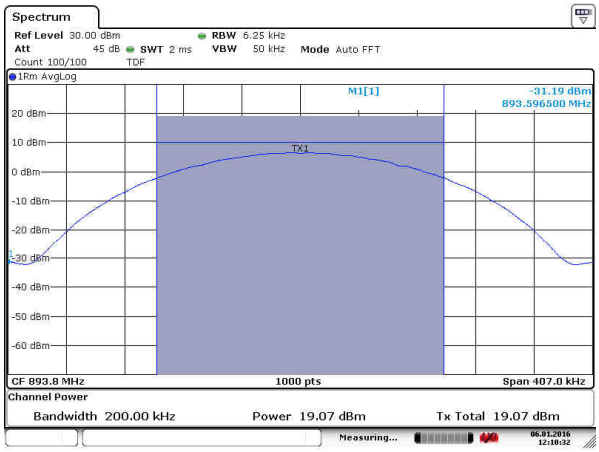
(a) *Maximum ERP.* In general, the effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts

8.2 Test results

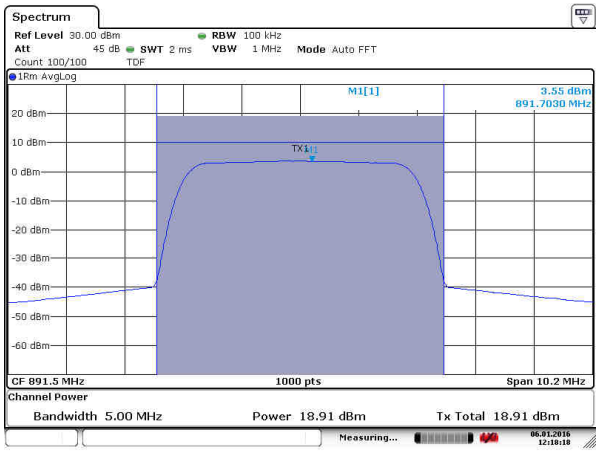
Rule	Mode	Freq. (MHz)	TX power (dBm)	TX power ERP (dBm)	TX power ERP (W)	Limit ERP (W)	Result
22H	Narrowband	893.8	19.07	24.92	0.31	500.0	Pass
22H	Wideband	891.5	18.91	24.76	0.30	500.0	Pass
22E	N/A	929.107	19.19	25.04	0.32	5.0	Pass
22E	N/A	931.008	19.15	25.00	0.32	5.0	Pass

Table 5: Transmit power

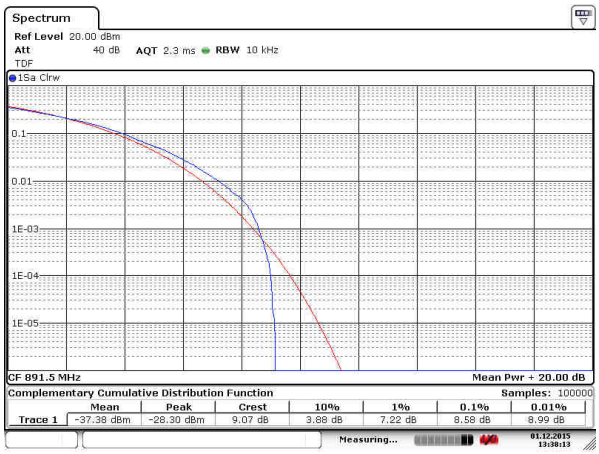
Plots for 22H shown below, value for 22E taken from Figure 3.



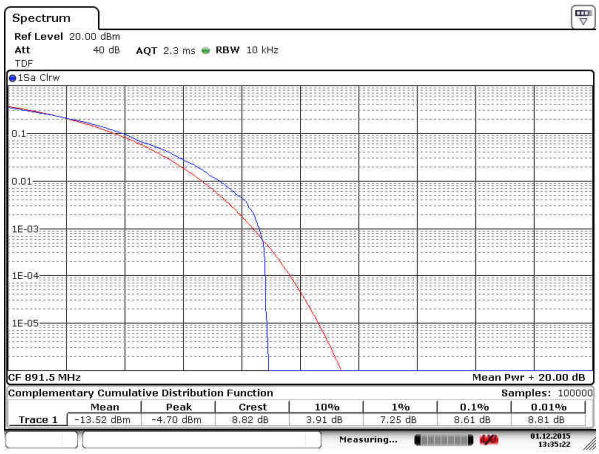
Narrowband



Wideband



Input: 0.1% CCDF 8.58 dB



Output: 0.1% CCDF 8.61 dB

Figure 4: Peak to Average ratio (PAR) plots

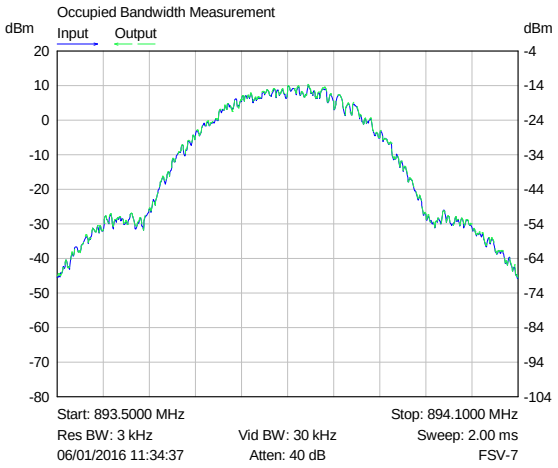
9 Occupied bandwidth: Input vs output signal

9.1 Test method

KDB 935210 D05 section 3.4

The occupied bandwidths of the input and output signal were measured using the in-built 99% Occupied Bandwidth function of the FSV and measurements captured using Softplot software

9.2 Test results

<table>
<tr>
<td>


Output

Measurement Parameter	Value
Occupied Power Bandwidth	246.00 kHz

Input

Measurement Parameter	Value
Occupied Power Bandwidth	245.40 kHz

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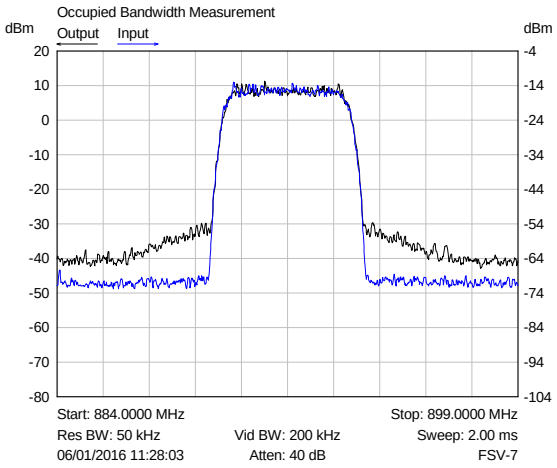


Output

Measurement Parameter	Value
Occupied Power Bandwidth	4.11000 MHz

Input

Measurement Parameter	Value
Occupied Power Bandwidth	4.11000 MHz

</td>
</tr>
<tr><td>22H: 200k GMSK</td><td>22H: 4M2 AWGN</td></tr>
<tr><td></td><td></td></tr>
<tr><td>929 – 930 MHz (20kHz FSK)</td><td>931 - 932 MHz (20kHz FSK)</td></tr>
</table>

Figure 5: input vs output plots

10 Conducted Spurious Emissions inc. Band Edge

10.1 Requirement and test method: 22H

§22.917 Emission limitations for cellular equipment.

The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

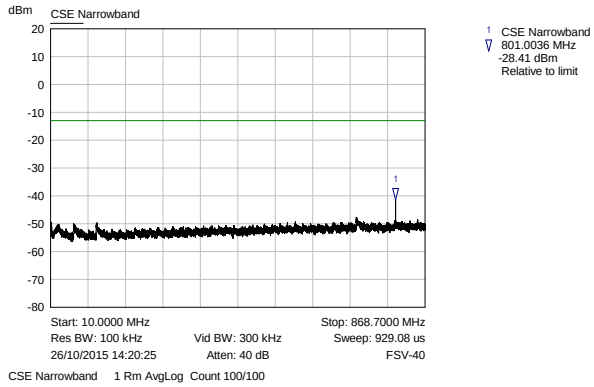
(a) *Out of band emissions.* The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

(b) *Measurement procedure.* Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (*i.e.* 100 kHz or 1 percent of emission bandwidth, as specified).

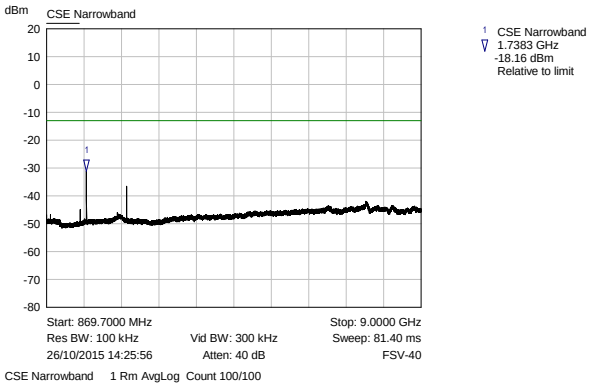
Equipment was configured to give maximum rated output of 20 dBm.

10.2 Band edge results

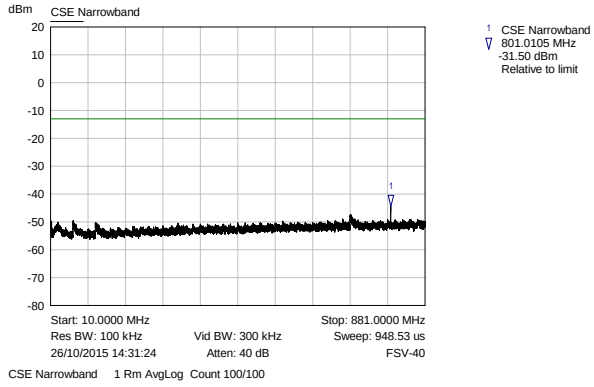
10.2.1 Narrowband single frequency: 22H



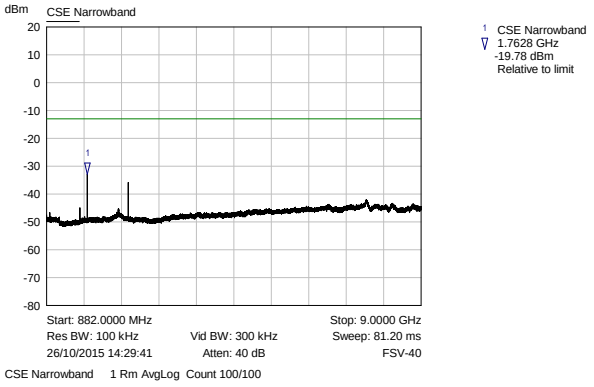
869.2 below band edge



869.2 above band edge



881.5



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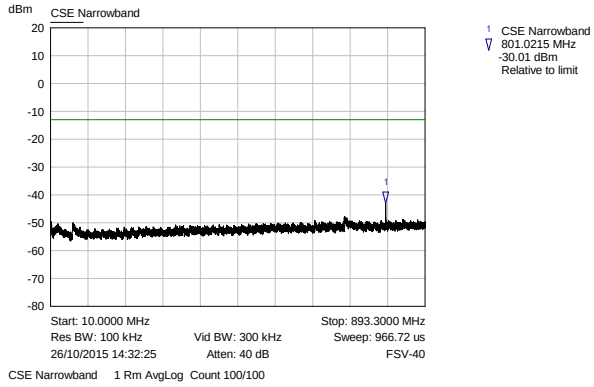
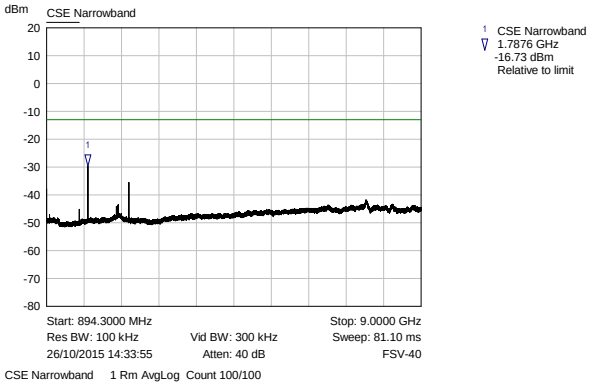
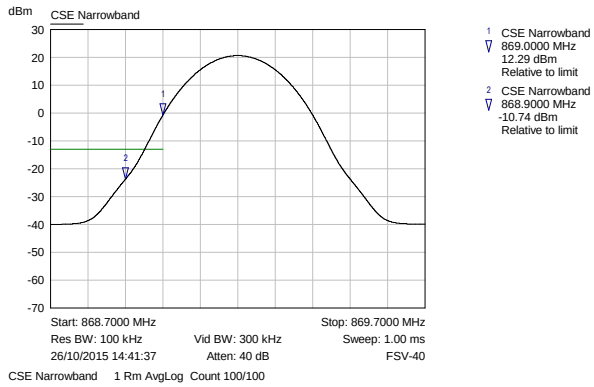


893.8 below band edge

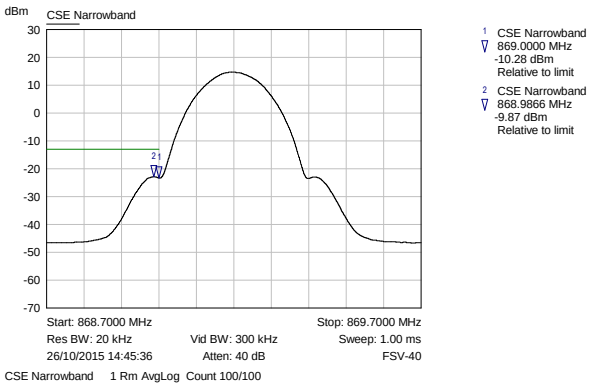


893.8 above band edge

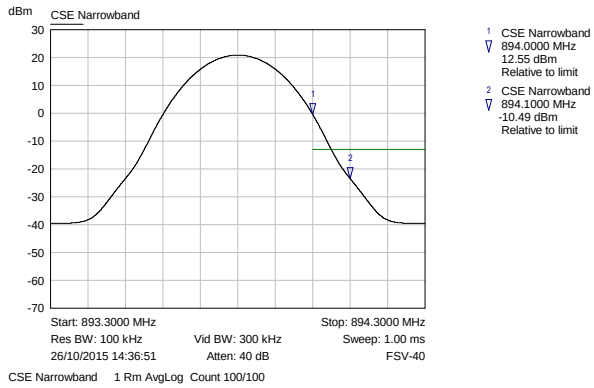
Figure 6: Narrow band CSE except band edge



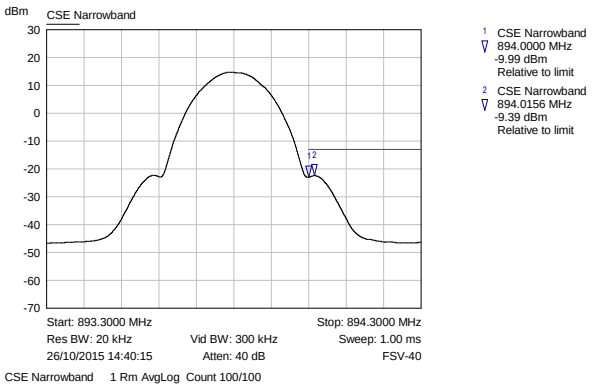
869.2 MHz



869.2 MHz band edge narrow RBW



893.8 MHz

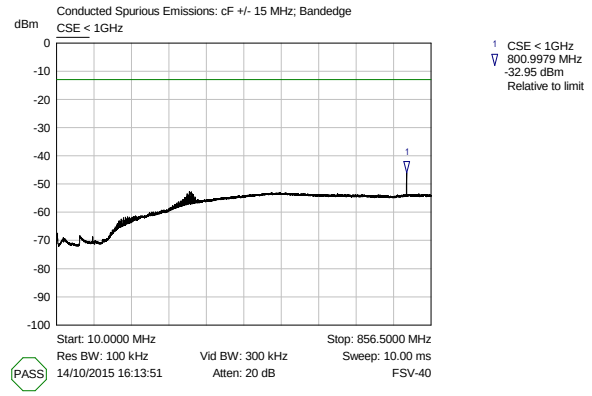


893.8 MHz band edge narrow RBW

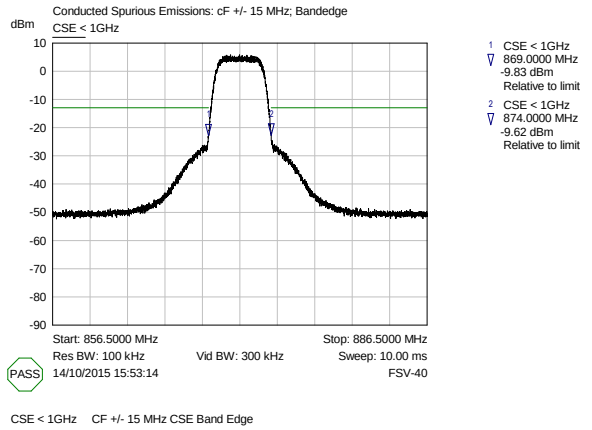
Figure 7: Narrowband CSE band edge

10.2.2 Wideband: 22H

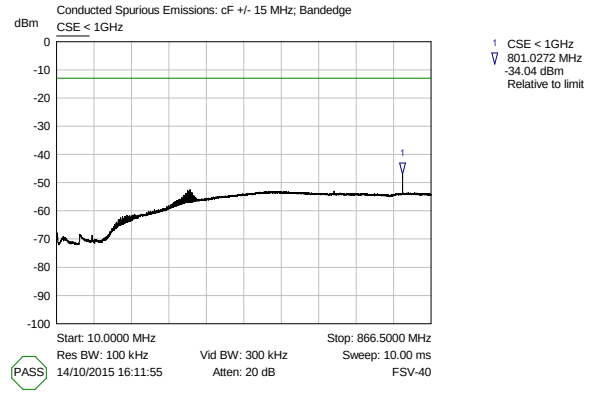
Results for band edge show compliance with emissions limits for frequencies within a 3 MHz band below and above the 5 MHz block containing the transmit frequency.



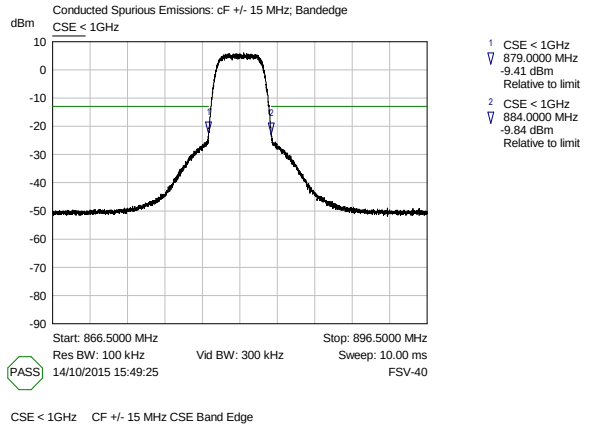
871.5 MHz



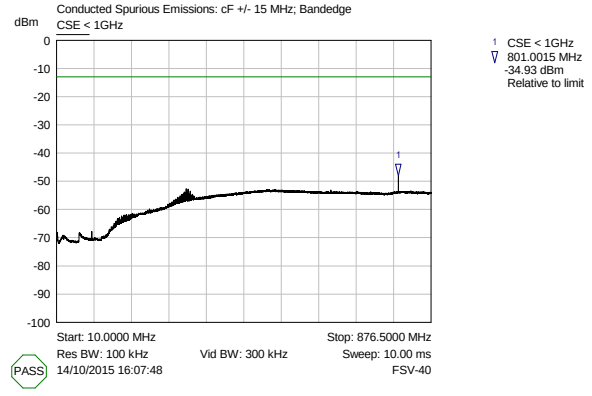
871.5 MHz band edge



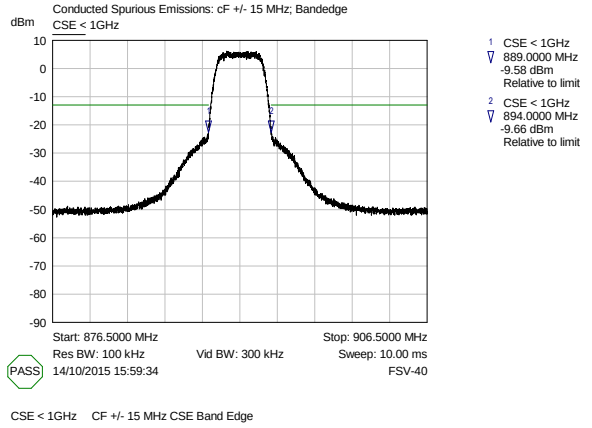
881.5 MHz



881.5 MHz band edge



891.5 MHz



891.5 MHz band edge

Figure 8: Wideband CSE inc. band edge

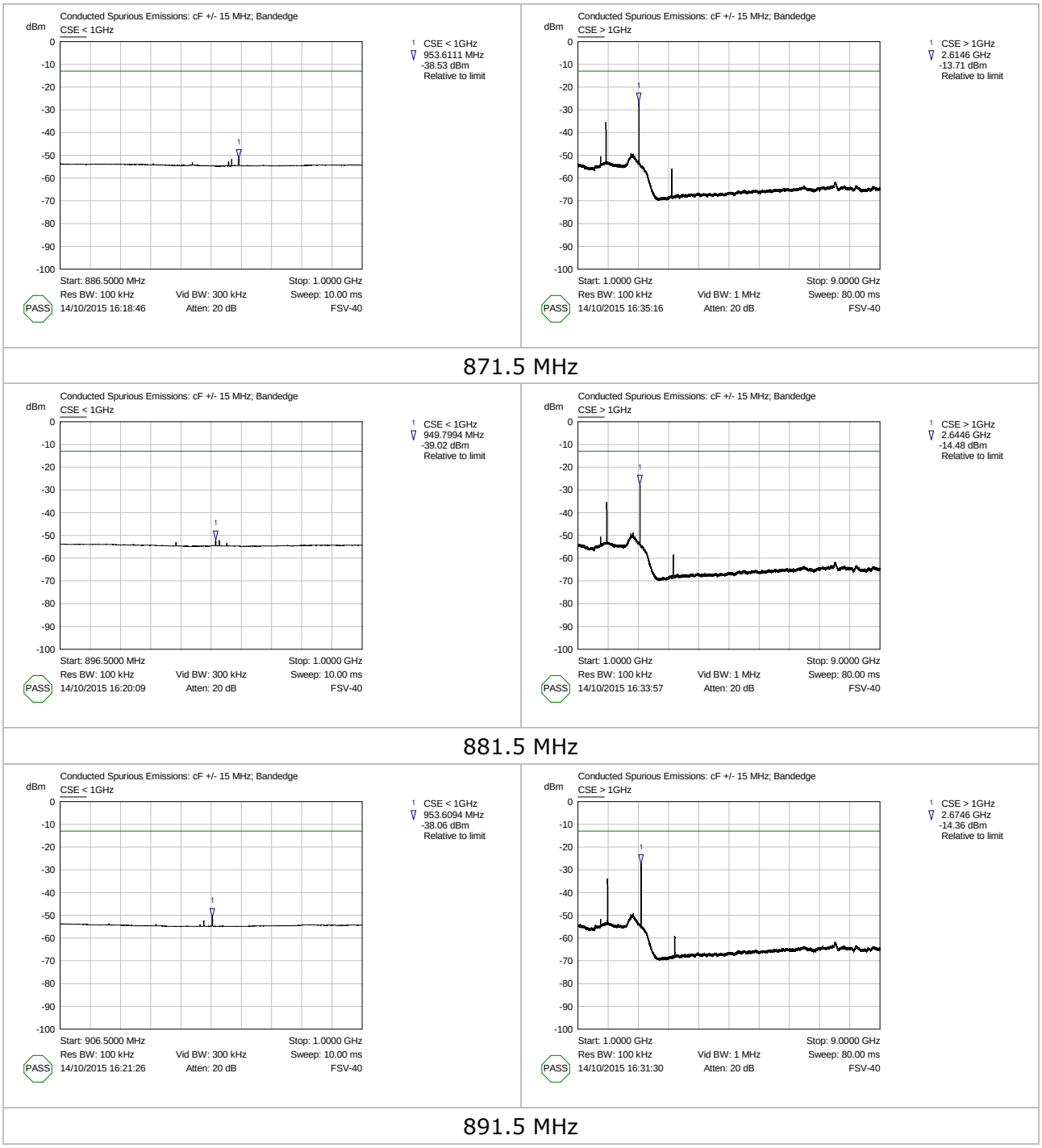
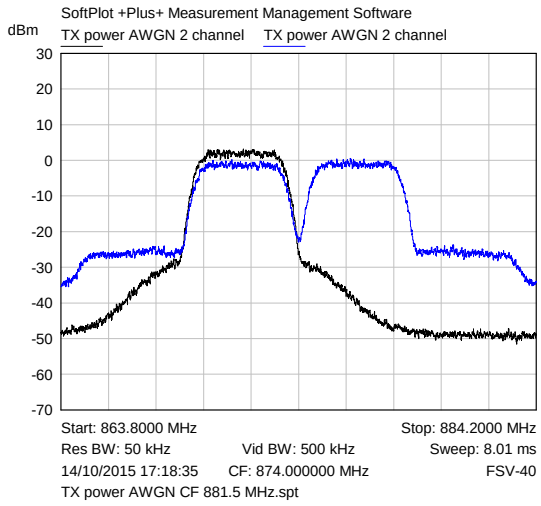


Figure 9: Wideband CSE above band edge

10.2.3 Dual Channel band edge – AWGN: 22H

Check set-up



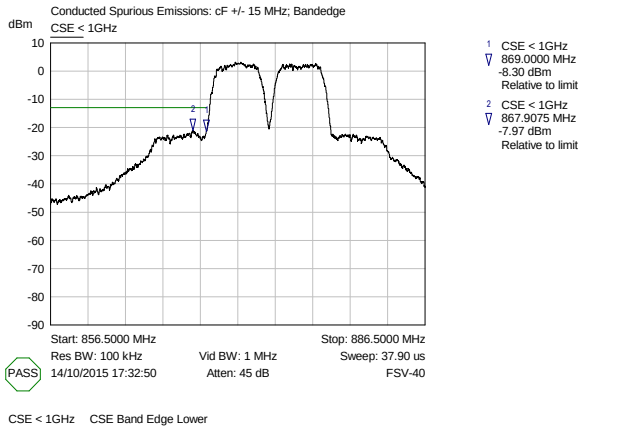
TX power AWGN 2 channel Single frequency

Measurement Parameter	Value
Channel power	20.05 dBm
Channel Bandwidth	10 MHz

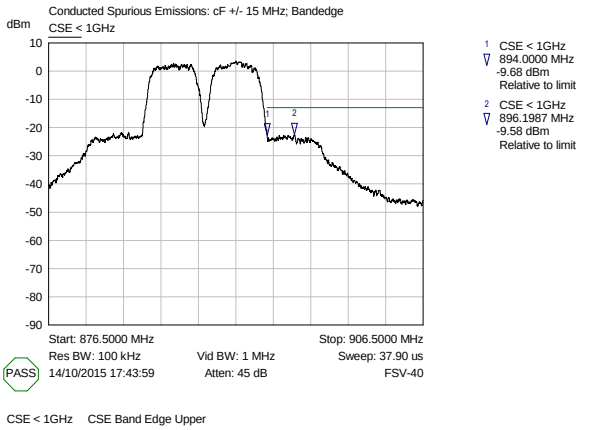
TX power AWGN 2 channel 2-channels

Measurement Parameter	Value
Channel power	20.06 dBm
Channel Bandwidth	10 MHz

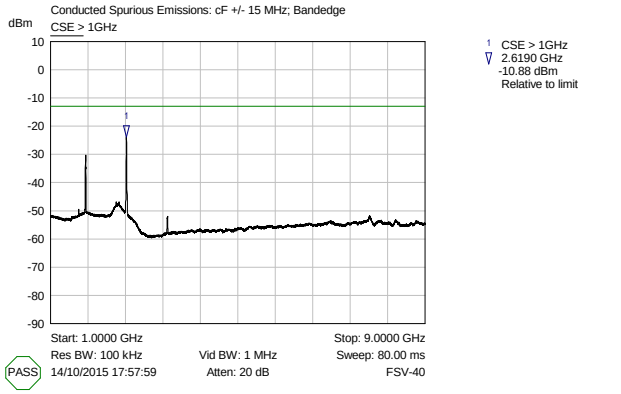
Dual channel total power



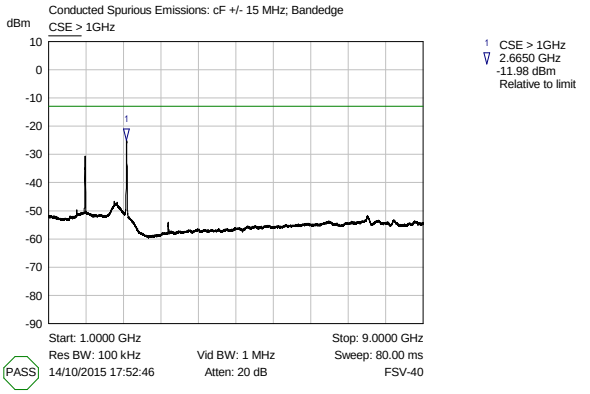
Band edge 871.5 and 876.5



Band edge 886.5 and 891.5

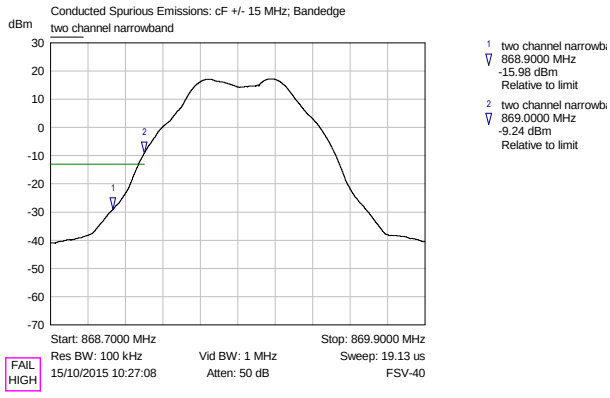


Band edge 871.5 and 876.5

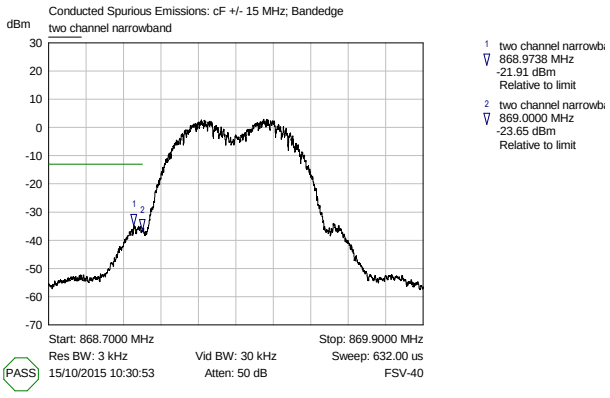


Harmonics: 886.5 and 891.5

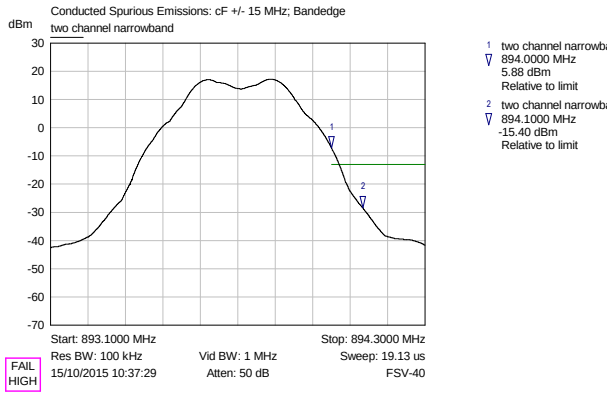
10.2.4 Dual Channel band edge – Narrowband: 22H



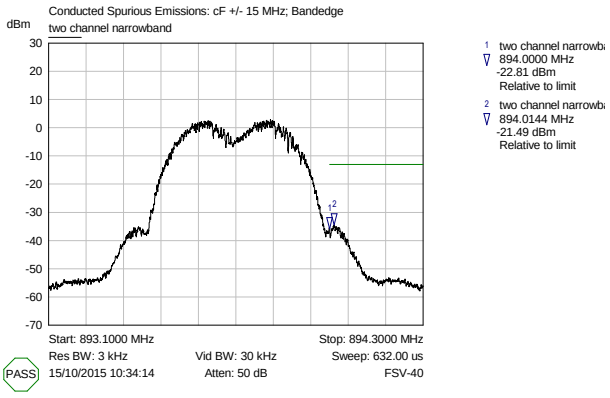
Band edge lower



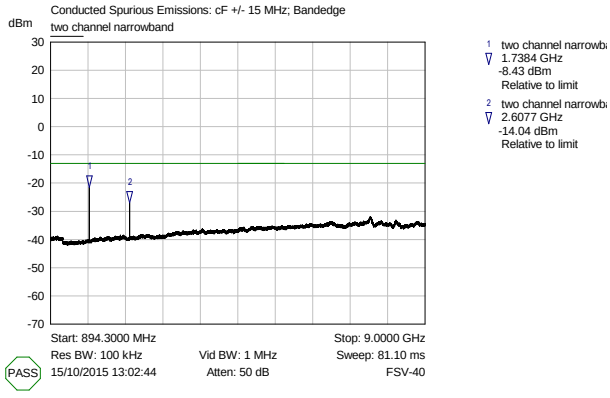
Band edge lower: 100 kHz band remeasured with 3kHz RBW



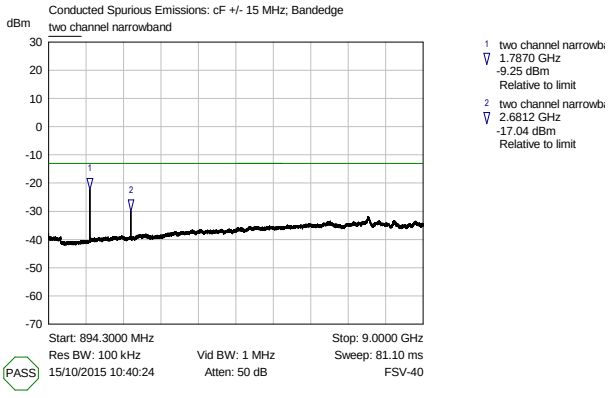
Band edge upper



Band edge upper: 100 kHz band remeasured with 3kHz RBW



CSE: 869.2 and 869.4 MHz TX



CSE: 893.6 and 893.8 MHz TX

10.3 Part 22E

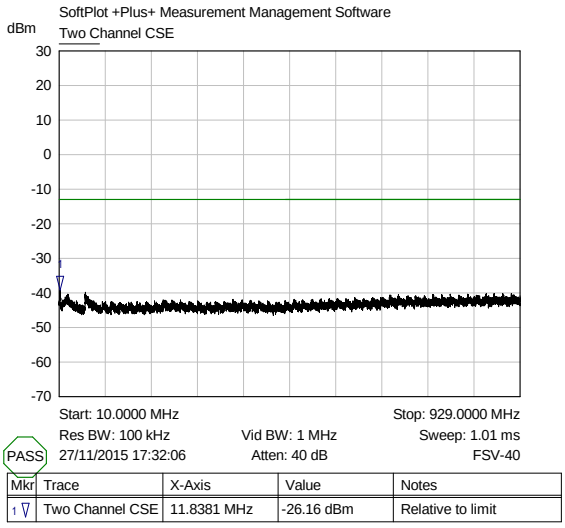
10.3.1 Single Channel

The level of Harmonic emissions from transmit frequencies in each band were investigated.

The plots below show worst case emissions levels for each band.

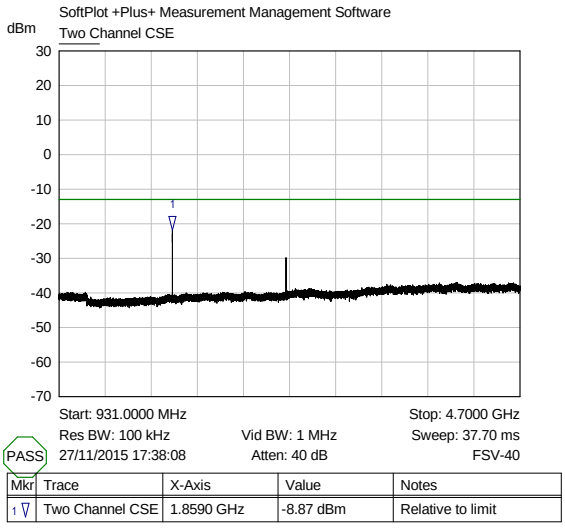
Measurement performed using RMS detector and sweep averaging method as for Transmit Power.

There were no emissions within 8 dB of the limit and no emissions above the noise floor above 3 GHz.



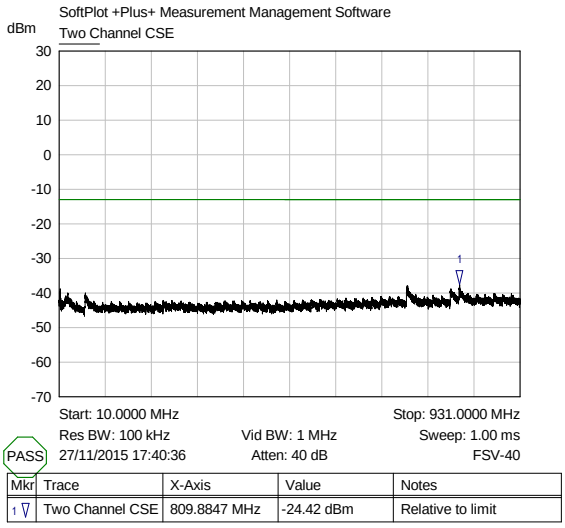
Mkr	Trace	X-Axis	Value	Notes
1	Two Channel CSE	11.8381 MHz	-26.16 dBm	Relative to limit

929 – 930MHz



Mkr	Trace	X-Axis	Value	Notes
1	Two Channel CSE	1.8590 GHz	-8.87 dBm	Relative to limit

929 – 930MHz pt 2

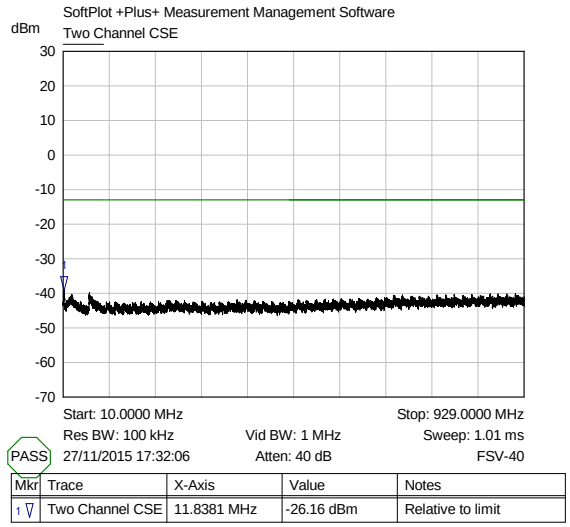


Mkr	Trace	X-Axis	Value	Notes
1	Two Channel CSE	809.8847 MHz	-24.42 dBm	Relative to limit

931 – 932MHz

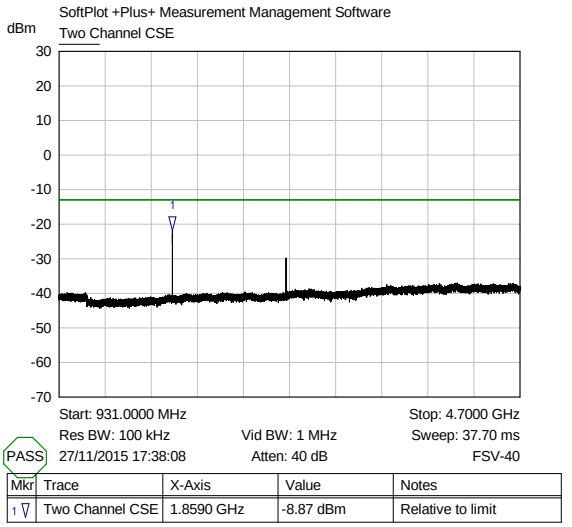
931 – 932MHz pt 2

10.3.2 Dual Channel



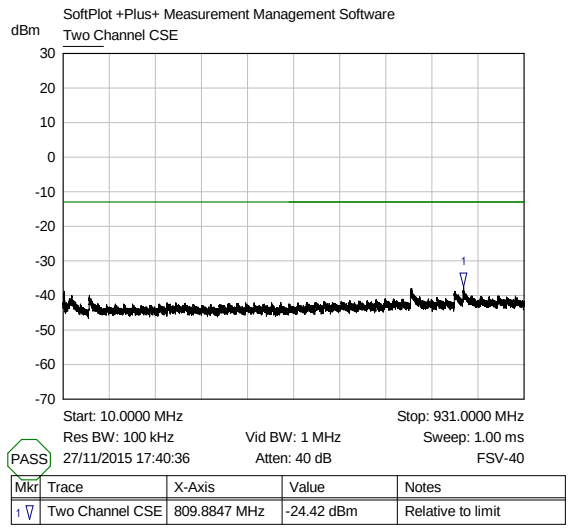
Mkr	Trace	X-Axis	Value	Notes
1	Two Channel CSE	11.8381 MHz	-26.16 dBm	Relative to limit

929 – 930MHz



Mkr	Trace	X-Axis	Value	Notes
1	Two Channel CSE	1.8590 GHz	-8.87 dBm	Relative to limit

929 – 930MHz pt 2



Mkr	Trace	X-Axis	Value	Notes
1	Two Channel CSE	809.8847 MHz	-24.42 dBm	Relative to limit

931 – 932MHz

931 – 932MHz pt 2

11 Test equipment

Description	Manufacturer	Model	Serial Number	Calibration
Signal Analyser	Rohde & Schwarz	FSV 40	Livingston Hire asset X479651	Code: 161467 Due 19 May 16
Signal Analyser	Rohde & Schwarz	FSV 7	Zinwave asset 000073	R&S 20-516458 Due 14 Nov 16
Signal Generator	Rohde & Schwarz	SMBV100A	Microlease asset 45440	Ref: 45440 Due 19 Nov 15
Signal Generator	Rohde & Schwarz	SMJ100A	100156	T493937A Due: 24 Dec 16
Cable	Utiflex	BUA01G	FA210A0009M30309	ABEX UK. Ref: green bua01g Due 08 Oct 17
Signal Generator	Agilent	E4437B	US39260377	Verified as part of system test
Attenuator	Mini-circuits	VAT 10	3 0433	
Cable (input)	Mini-circuits	CBL-1M-SMNM+	120274	
Cable (input)	Mini-circuits	CBL-1M-SMNM+	120295	
2-way splitter (input)	Mini-circuits	ZN2PD2-63-S+	UU21401232	
Low pass filter DC-1000 MHz	Mini-circuits	15542	UU14401231	

Table 6: Test Equipment

Measurement uncertainty for test equipment

Signal Analyser ±0.5 dB