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REPORT ON ELECTROMAGNETIC COMPATIBILITY TESTS

Performed at:
TWENTY PENCE TEST SITE

Twenty Pence Road,
Cottenham,
Cambridge
U.K.
CB24 8PS

on

Sepura PLC

SC2024

dated

26th January 2016

Document History

Issue	Date	Affected page(s)	Description of modifications	Revised by	Approved by
1	11/02/16		Initial release		

Based on report template:
v090319

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Equipment Under Test (EUT):	SC2024
Test Commissioned by:	Sepura PLC 9000 Cambridge Research Park Beach Drive Waterbeach Cambridge CB25 9TL
Representative:	Steve Wood
Test Started:	26th November 2016
Test Completed:	22nd January 2016
Test Engineer:	Dave Smith/Mihai Andries
Date of Report:	26th January 2016

Written by:	Dave Smith	Checked by:	Derek Barlow
Signature:	D. A. Smith	Signature:	D. Barlow
Date:	26th January 2016	Date:	11th February 2016

dB Technology can only report on the specific unit(s) tested at its site. The responsibility for extrapolating this data to a product line lies solely with the manufacturer.

Test Standards Applied

Part 90 of CFR47	*Private Land Mobile Radio Services*

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Emissions Test Results Summary

Part 90 **PASS**

Test	Port	Method	Limit	PASS/FAIL	*Notes*
Output Power Radiated		90.205	90.205(h)	No Limit	#1
Output Power Conducted	antenna	90.205 2.1046	90.205(h)	No Limit	#1
Types of Emissions	antenna	90.207 2.1047	Specified by manufacturer		
Bandwidth	antenna	90.209 2.1049	90.209(b)(5)	PASS	#2
Emissions Masks Radiated		90.210 2.1051	90.221(d)	PASS	#3
Emissions Masks Conducted	antenna	90.210 2.1051	90.221(d)	PASS	#3
Frequency Stability	antenna	90.213 2.1055	90.213	PASS	
Frequency Transient Behaviour	antenna	90.214	90.214	PASS	
Adjacent Channel Power		90.221	90.221(b)	PASS	

#1 There is no specific limit on output power.

#2 The additional note 6 was applied which allows a bandwidth of up to 22kHz providing the additional Adjacent Channel Power requirements are met.

#3 The additional note 5 was applied which only stipulates limits 75kHz from the carrier providing the additional Adjacent Channel Power requirements are met.

This Report shows that the EUT met all of the requirements for the tests performed - as shown above.

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1 EUT Details

1.1 General

The EUT was a TETRA Voice + Data Hand Portable. The transmitter can operate over the following frequency bands:

450MHz to 470MHz - in Trunked-Mode Operation (TMO) or Direct-Mode Operation (DMO).

Measurements were made at the top, near middle and bottom of the appropriate frequency ranges:

Bottom: 450 MHz
Middle: 460 MHz
Top: 470 MHz

The nominal output power is 35dBm (3.1W).

The product can be used on a standalone basis in which case it is powered from an internal battery. It can also be used when placed in a charging unit.

This report additionally includes radiated emissions measurements with a Remote Speaker Microphone (RSM) connected.

Unless otherwise stated, tests were performed with nominal power supply voltage.

The product is intended to comply with the FCC part 90 requirements - specifically the sections applicable to Tetra devices.

Radiated field strength tests were performed at the dB Technology Test Site Registered with the FCC: Registration number: 90528.

Output Stage Settings:

With reference to the requirements of **2.1046(a)** and **2.1033(c)(8),** the DC voltages and currents in the elements of the final radio are regulated within the product and not user variable.

Modulation Characteristics:

With reference to the requirements of **2.1047,** the device uses digital modulation which is not proportional in any way to the level or frequency of the audio signal. We consider that compliance with the relevant Mask of Part 90 using pseudo random digital data is sufficient to adequately demonstrate the Modulation Characteristics as per Section 2.1047.

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1.2 Modifications to EUT and Peripherals

Details of any modifications that were required to achieve compliance are listed below. The modification numbers are referred to in the results sections as appropriate.

Mod No:	Details	Implemented for
0	Original unmodified unit.	

1.3 EUT Operating Modes

The EUT was tested in the following operating mode or modes. Generally, operating modes are chosen that will exercise the functions of the EUT as fully as possible and in a manner likely to produce maximum emission levels or susceptibility. Individual test result sheets reference the operating mode of the EUT.

Operating Mode	Details
1	Transmit on selected channel.

1.4 Measurement Uncertainty

The following estimations of Measurement Uncertainty have been made:

Description	Estimated Uncertainty
Conducted Output Power Using Power meter	±1dB
Conducted Spurious Emissions	±3dB
Radiated Spurious Emissions	±4dB
Frequency Stability	±15Hz

These measurement uncertainties are based on an expanded uncertainty expressed as the 95% confidence level using a coverage factor of K = 2.

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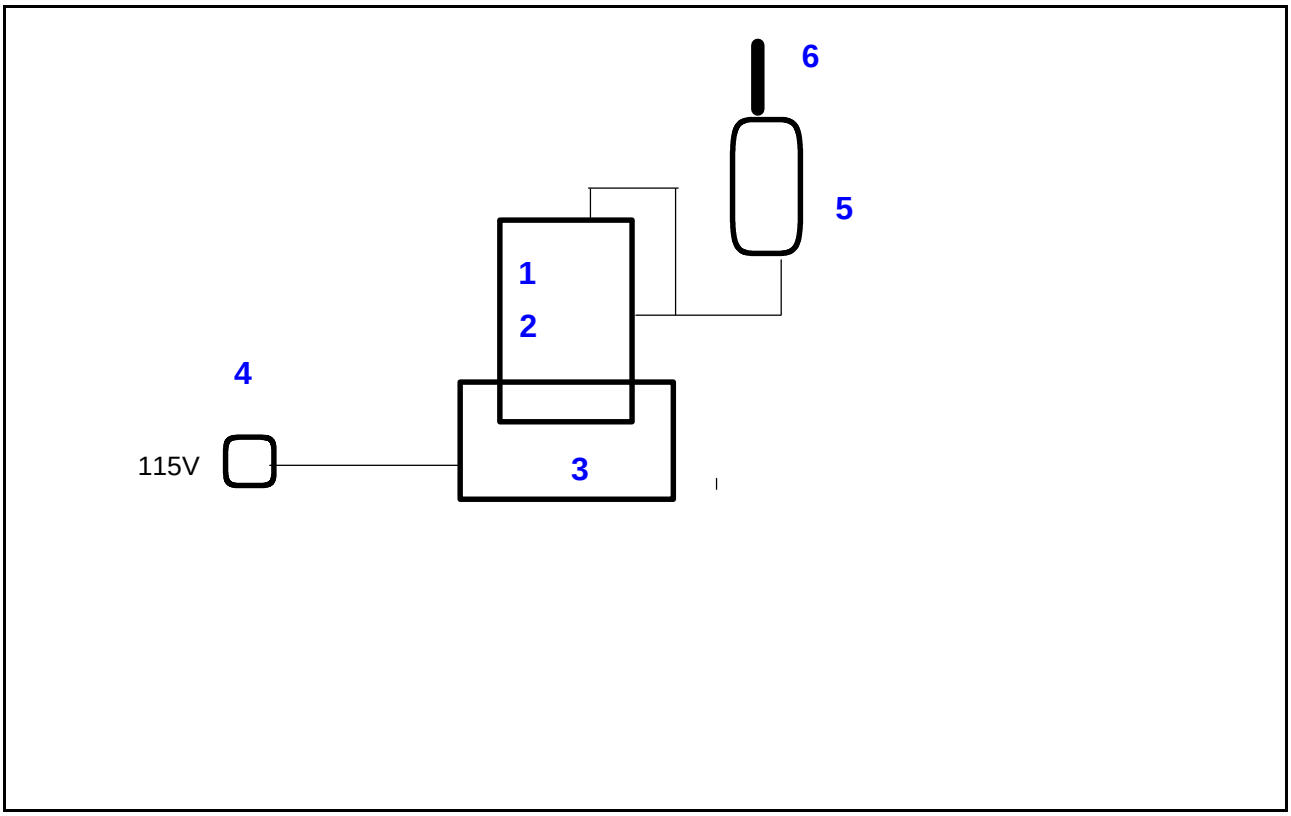
Figure 1 Charger and RSM Configuration



Item	Manufacturer	Model	Description	Serial No:	Notes
1	Sepura	SC2024	EUT	1PR001520GKL317	#1
2	Sepura	SC2024	EUT	1PR001546GKV6YU	#2
3	Sepura	300-01624	STP/SC20 Series 1 + 1 Charger		
4	CLICK	CPS024100240	PSU for Battery Charger		
5	Sepura	300-00388	Advance Remote Speaker Microphone		
6	Sepura	300-00663	450MHz to 470MHz Antenna		

#1 Used for radiated tests.
#2 Used for conducted antenna tests.

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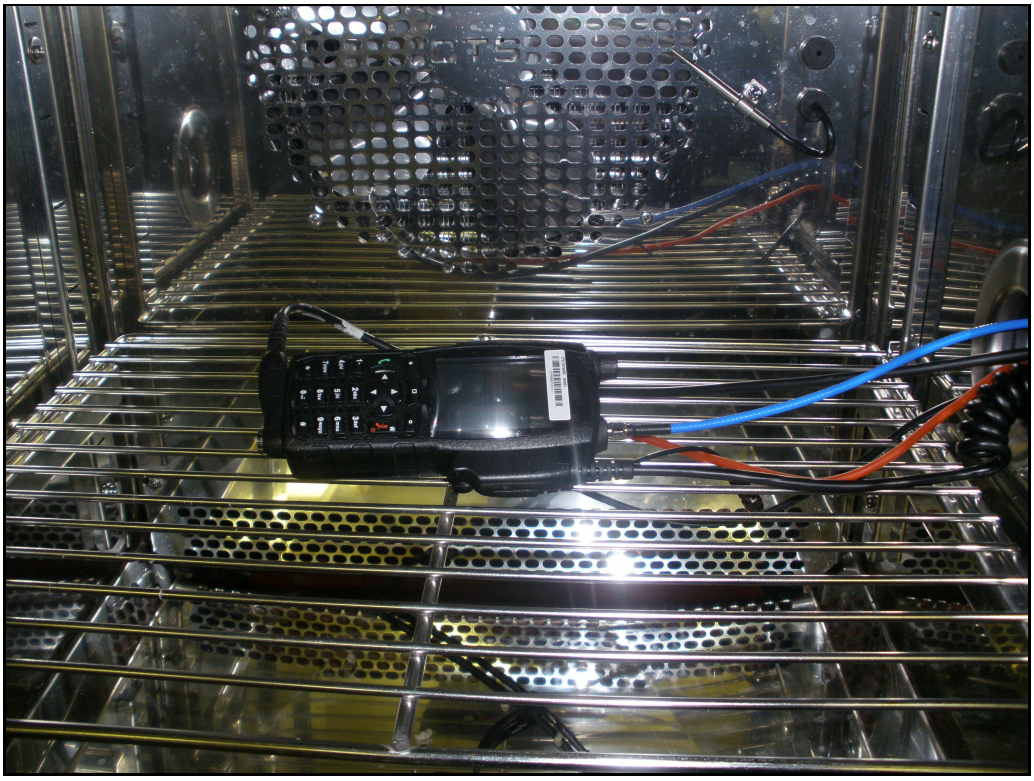
Photograph 1 Connected to Analyser



Photograph 2 In Environmental Chamber

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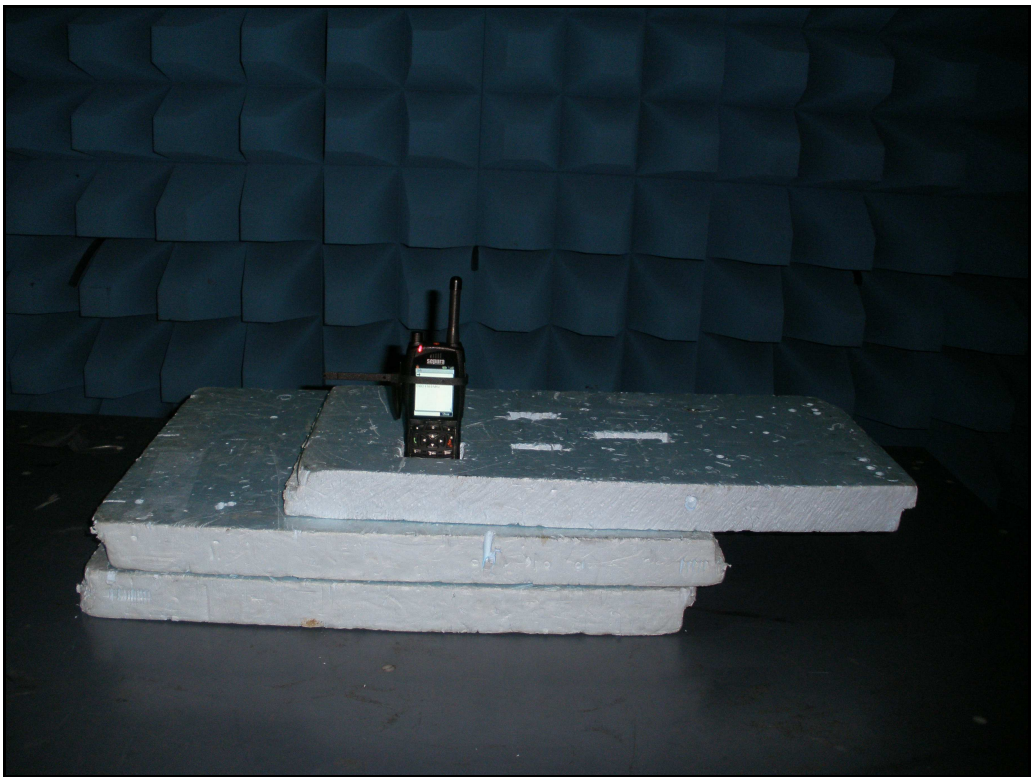

Photograph 3 Standalone: Radiated Emissions - Upright

Photograph 4 Standalone: Radiated Emissions - Flat

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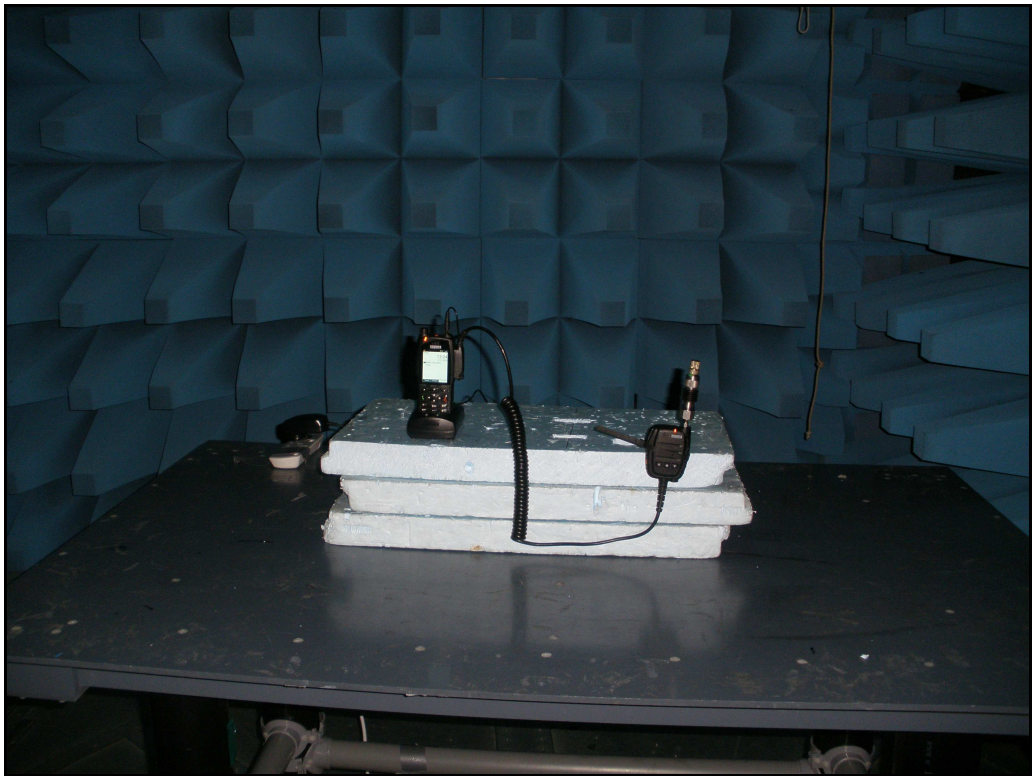
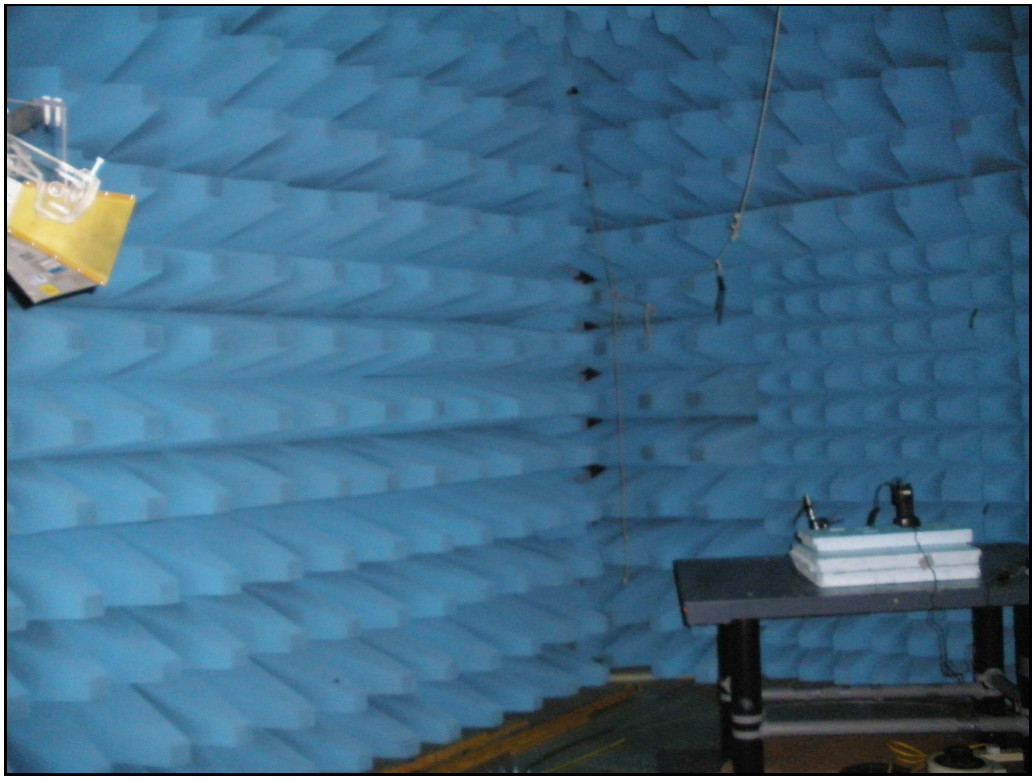


Photograph 5 With RSM and Charger - Radiated Emissions - Upright



Photograph 6 With RSM and Charger - Showing measuring antenna

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2 Test Equipment

The test equipment used during the tests was one or more of the items listed below. Individual test result sheets indicate which items were used.

The Tetra Test Set and FSU are owned by Sepura.

Ref No:	Details	Serial Number	Cal Date	Cal Interval
A23	EMCO 3115 DR Guide (1-18GHz)	9507-4525	30/01/2015	3 years
A24	Chase X-wing Bilog CBL6144 26MHz-3GHz	27590	28/10/2013	3 years
A30	Schwarzbeck MiniBicon (30MHz to 1GHz)	9115-180	21/01/2013	3 years
A38	Schwarzbeck VULP 9118A Log Periodic	580	21/07/2015	3 years
A8	EMCO 3115 DR Guide	6070	23/07/2015	3 years
PM6	Marconi 6960B RF Power Meter	236923/003	16/12/2014	1 year
PRE20	Mini-Circuits 2 x 20M-6G pre-amp	020	18/11/2015	1 year
PS3	Marconi 6920 RF Power Sensor (-70dBm / -20dBm) 10MHz to 20GHz	890	15/12/2014	1 year
PS9	Marconi 6912 RF Power Sensor (-30dBm / +20dBm) 30kHz to 4.2 GHz	973	16/12/2014	1 year
R13	Anritsu MS2830A	6201180830	21/01/2015	1 year
R8	Agilent E7405A Spectrum Analyser	MY44212494	21/04/2015	1 year
RFF11	High Pass RF Filter 890MHz to 22GHz	11	18/11/2015	1 year
SG13	HP 8648C 150kHz-3.2GHz Signal Generator	3426A01238	01/07/2014	2 years
TTS	IFR 2968 Tetra Test Set	296501/321	02/07/2015	1 year
FSU	R&S FSU Spectrum Analyser	200088	26/10/2447	1 year

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3 Test Methods

3.1 Antenna Conducted Carrier Power

The antenna output is connected to a spectrum analyser via a suitable PAD. The bandwidth on the spectrum analyser is set to greater than the EUT occupied bandwidth. A peak measurement is recorded. Additional measurements are made with antenna output connected to a power meter providing average measurements.

3.2 Antenna Conducted Transmitter Unwanted Emissions

Measurements are made with the antenna output connected to a spectrum analyser via a suitable PAD. Sweeps are made over the specified frequency ranges . The limit is set relative to the measured carrier power. A peak detector is used.

3.3 Antenna Conducted Occupied Bandwidth

Measurements are made with the antenna output connected to a spectrum analyser via a suitable PAD. Sweeps are made with a 300Hz Resolution Bandwidth and a 1kHz Video Bandwidth. A peak detector is used. Markers are used to determine the 99% power bandwidth.

3.4 Antenna Conducted Adjacent Channel Power

Measurements are made with the antenna output connected to a Tetra Test Set via a suitable PAD. The Analyser is set to make adjacent channel power measurements using the pre-configured settings for Tetra with 25 kHz channel spacing and 18kHz channel bandwidth.

3.5 Frequency Stability

The EUT is placed in an environmental chamber. The temperature inside the chamber is set to the required level and allowed to stabilise.

For DMO mode the antenna output is connected to a spectrum analyser via a suitable PAD. The EUT is set to transmit with constant carrier (at a frequency 2.25kHz above channel centre frequency). The frequency is measured using the frequency counter function of the spectrum analyser.

For TMO mode the antenna output is connected to a Tetra Test Set. The EUT is set to transmit using normal burst operation. the frequency error, as indicated by the Tetra Test Set, is recorded.

Measurements are made at the specified temperature and over the required voltage supply range of the EUT.

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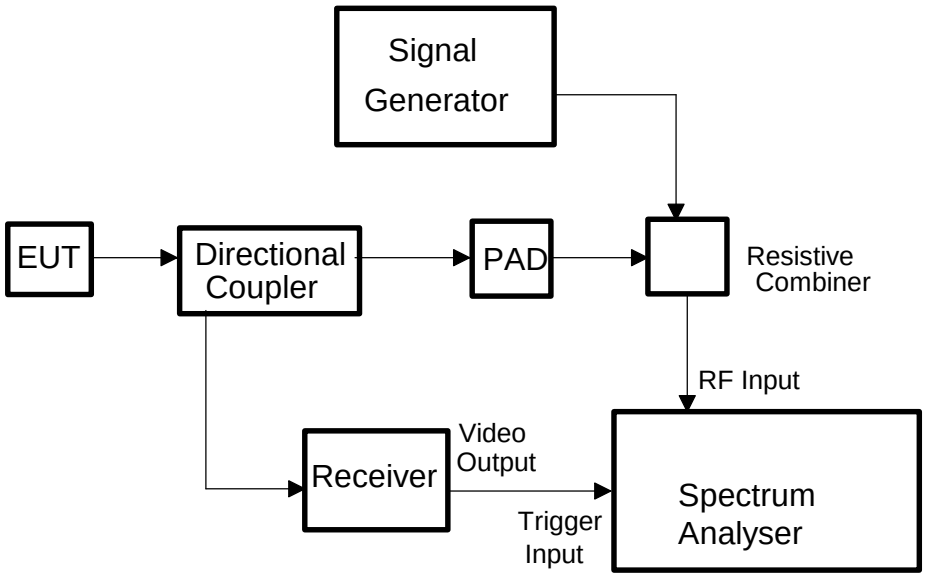
3.6 Transient Frequency Behaviour



The test equipment was set up as shown above.

The spectrum analyser was set to 0Hz span with its inbuilt FM demodulation function activated.

Initially only the EUT was set to transmit an unmodulated signal and the centre frequency of the analyser adjusted to give 0Hz FM deviation.

The EUT transmitter was then switched off and the signal generator set to provide a carrier only output. The frequency of the signal generator was adjusted to again give 0Hz FM deviation on the spectrum analyser.

The signal generator FM modulation was then switched on and adjusted to give 25kHz FM deviation on the spectrum analyser.

The spectrum analyser was then set to trigger only on video output from the receiver. The directional coupler was used to feed an attenuated portion of the EUT transmitter into the receiver. The receiver was tuned to the transmit frequency and so produced a change on its video output when the transmitter was switched on and off. This signal was used to trigger the spectrum analyser.

FM deviation data was recorded from the spectrum analyser for both carrier switch on and switch off and at all test frequencies.

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3.7 Radiated Transmitter Emissions (Substitution Method)

Initial scans are performed in a semi-anechoic screened room at a distance of 3m. Scans are performed over the frequency range specified in the test standard with the antenna both horizontally and vertically polarised. During these scans the EUT and peripherals are rotated through 360°. Bench top EUTs are placed on a non-conducting bench at a height of 0.8m above the ground plane. Floor standing EUTs are placed 0.1m above the ground plane. The EUT cables were manipulated in an attempt to produce maximum emissions. The results of the scans are shown in the plots included at the end of the report.

Significant emissions identified by the scans are measured using a substitution method. Maximised emission readings are obtained by rotating the EUT through 360° and adjusting the height of the antenna from 1m to 4m. Measurements are made with the antenna both horizontally and vertically polarised and the results tabulated.

The EUT is then replaced with a calibrated reference antenna fed from a signal generator. The level fed into the reference antenna is measured with a power meter. Measurements are made to determine the power output of the signal generator required to give the same emission levels as were observed from the EUT.

The radiated power from the EUT is calculated as:

Signal Level fed into Reference Antenna	+ Gain of Reference Antenna	+ Radiated Level From EUT	- Radiated Level From Reference Antenna

For example, assuming following measurements:

Signal Level fed into Reference Antenna	=	-14.3dBm
Gain of Reference Antenna	=	7.1 dBi
Radiated Level from EUT (i.e. Level at Measuring Receiver)	=	37 dBuV
Radiated Level from Reference Antenna (i.e. Level at Measuring Receiver)	=	61.5 dBuV

Then the Radiated Power from the EUT = -14.3 + 7.1 +37 - 61.5 dBm (isotropic)
= - 31.7 dBm (isotropic)

4 Test Results

The following sections contain tabulated test results. Plots of various scans are included at the back of this section.

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4.1 Conducted Antenna Output Power

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13

Conducted Antenna Output Power

Company:	Sepura PLC	*Product:*	SC2024
Date:	18/01/2016	*Test Eng:*	Mihai Andries
Ports:	antenna		
Test:	90.205 using limits of	90.205(h)	
Ports:			
Test:			

Notes	Comments and Observations

Spectrum anlayser results using a peak detector are shown in plots 1 to 3.

Average power was measured using the bandpower function.

Measurements were made with continuous modulation.

Taking into account the loss of the cable and attenuators the following measurements were made:

Channel	Peak dBm	Average dBm
450 MHz	37.2	34.8
460 MHz	37.1	34.8
470MHz	37.1	34.8

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4.2 Conducted Antenna Occupied Bandwidth

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13

Conducted Antenna Occupied Bandwidth

Company:	Sepura PLC	*Product:*	SC2024
Date:	18/01/2016	*Test Eng:*	Mihai Andries
Ports:	antenna		
Test:	90.209 using limits of	90.209(b)(5)	
Ports:			
Test:			

Notes	Comments and Observations

Measurements were made with continuous modulation applied.
Spectrum analyser results are shown in plots 4 to 6.

Using the 99% Bandpower function of the spectrum analyser, the following measurements were recorded:

450 MHz	21.37	kHz
460 MHz	21.42	kHz
470 MHz	21.42	kHz

Limit:

Using note 6 of Part 90.209, the limit is 22kHz
(providing Adjacent Channel Power requirements are met).

PASS

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4.3 Frequency Stability - DMO Mode - Absolute Frequency Measurements

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13

Frequency Stability (DMO)

Company: Sepura PLC		*Product:* SC2024	
Date: 19/01/2016		*Test Eng:* Mihai Andries	
Ports: antenna			
Test: 90.213	using limits of	90.213	
Ports:			
Test:	using limits of		

Notes	Comments and Observations

DMO Frequency (as recorded from Spectrum Analyser Frequency Counter)

		450MHz Channel	460MHz Channel	470MHz Channel
-30.0°C	6.4V	450.001824	460.001808	470.001797
	7.4V	450.001830	460.001803	470.001796
-20.0°C	6.4V	450.001844	460.001839	470.001828
	7.4V	450.001848	460.001838	470.001823
-10.0°C	6.4V	450.001790	460.001781	470.001773
	7.4V	450.001793	460.001778	470.001769
0.0°C	6.4V	450.001756	460.001754	470.001745
	7.4V	450.001752	460.001760	470.001743
10.0°C	6.4V	450.001699	460.001682	470.001666
	7.4V	450.001696	460.001678	470.001662
20.0°C	6.4V	450.001690	460.001684	470.001672
	7.4V	450.001692	460.001685	470.001663
30.0°C	6.4V	450.001620	460.001601	470.001579
	7.4V	450.001624	460.001599	470.001576
40.0°C	6.4V	450.001556	460.001521	470.001481
	7.4V	450.001549	460.001517	470.001468
50.0°C	6.4V	450.001669	460.001661	470.001653
	7.4V	450.001662	460.001664	470.001650

See next page for deviation from nominal voltage/temperature.

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4.4 Frequency Stability - DMO Mode - Deviations from Nominal Volt/Temp - ppm

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13

Frequency Stability (DMO)

Company: Sepura PLC		*Product:* SC2024	
Date: 19/01/2016		*Test Eng:* Mihai Andries	
Ports: antenna			
Test: 90.213	using limits of	90.213	
Ports:			
Test:	using limits of		

Notes	Comments and Observations

DMO Frequency deviation from nominal voltage/temperature - ppm

		450MHz Channel	460MHz Channel	470MHz Channel
-30.0°C	6.4V	0.293	0.267	0.285
	7.4V	0.307	0.257	0.283
-20.0°C	6.4V	0.338	0.335	0.351
	7.4V	0.347	0.333	0.340
-10.0°C	6.4V	0.218	0.209	0.234
	7.4V	0.224	0.202	0.226
0.0°C	6.4V	0.142	0.150	0.174
	7.4V	0.133	0.163	0.170
10.0°C	6.4V	0.016	-0.007	0.006
	7.4V	0.009	-0.015	-0.002
20.0°C	6.4V	-0.004	-0.002	0.019
	7.4V	0.000	0.000	0.000
30.0°C	6.4V	-0.160	-0.183	-0.179
	7.4V	-0.151	-0.187	-0.185
40.0°C	6.4V	-0.302	-0.357	-0.387
	7.4V	-0.318	-0.365	-0.415
50.0°C	6.4V	-0.051	-0.052	-0.021
	7.4V	-0.067	-0.046	-0.028

The part 90 Limit for the 421MHz to 512MHz band mobiles is 5ppm **PASS**

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4.5 Frequency Stability - TMO Mode - Frequency Error Hz

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: TTS

Frequency Stability (TMO)

Company: Sepura PLC		*Product:* SC2024	
Date: 20/01/2016		*Test Eng:* Mihai Andries	
Ports: antenna			
Test: 90.213	using limits of	90.213	
Ports:			
Test:	using limits of		

Notes	Comments and Observations

TMO Frequency Error (as recorded from Tetra Test Set) (Hz)

		450MHz Channel	460MHz Channel	470MHz Channel
-30.0°C	6.4V	10.2	11.3	10.8
	7.4V	11.4	9.4	12.3
-20.0°C	6.4V	10.2	8.7	9.6
	7.4V	7.8	8.9	10.7
-10.0°C	6.4V	8.5	10.4	9.9
	7.4V	9.8	8.1	11.1
0.0°C	6.4V	14.0	12.4	12.7
	7.4V	10.1	12.8	13.3
10.0°C	6.4V	11.9	8.4	9.4
	7.4V	7.2	8.6	8.5
20.0°C	6.4V	12.1	11.1	13.7
	7.4V	13.7	9.3	11.7
30.0°C	6.4V	12.0	15.3	12.5
	7.4V	14.5	15.5	14.8
40.0°C	6.4V	13.2	15.9	14.4
	7.4V	14.9	11.7	15.6
50.0°C	6.4V	14.0	14.8	13.1
	7.4V	13.7	15.2	14.8

See next page for deviation in ppm.

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4.6 Frequency Stability - TMO Mode - Deviation from nominal volt/temp - ppm

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: TTS

Frequency Stability (TMO)

Company: Sepura PLC		*Product:* SC2024	
Date: 20/01/2016		*Test Eng:* Mihai Andries	
Ports: antenna			
Test: 90.213	using limits of	90.213	
Ports:			
Test:	using limits of		

Notes	Comments and Observations

TMO Frequency deviation - ppm

		450MHz Channel	460MHz Channel	470MHz Channel
-30.0°C	6.4V	-0.008	0.004	-0.002
	7.4V	-0.005	0.000	0.001
-20.0°C	6.4V	-0.008	-0.001	-0.004
	7.4V	-0.013	-0.001	-0.002
-10.0°C	6.4V	-0.012	0.002	-0.004
	7.4V	-0.009	-0.003	-0.001
0.0°C	6.4V	0.001	0.007	0.002
	7.4V	-0.008	0.008	0.003
10.0°C	6.4V	-0.004	-0.002	-0.005
	7.4V	-0.014	-0.002	-0.007
20.0°C	6.4V	-0.004	0.004	0.004
	7.4V	0.000	0.000	0.000
30.0°C	6.4V	-0.004	0.013	0.002
	7.4V	0.002	0.013	0.007
40.0°C	6.4V	-0.001	0.014	0.006
	7.4V	0.003	0.005	0.008
50.0°C	6.4V	0.001	0.012	0.003
	7.4V	0.000	0.013	0.007

The part 90 Limit for the 421MHz to 512MHz band mobiles is 5ppm **PASS**

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4.7 Conducted Emission Antenna Adjacent Channel Power

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: FSU

Conducted Antenna - Mask Y close to carrier

Company: Sepura PLC		*Product:* SC2024	
Date: 19/01/2016		*Test Eng:* Dave Smith	
Ports:			
Test: 90.221	using limits of	90.221(b)	
Ports:			
Test:	using limits of		

Notes	Comments and Observations

Using a spectrum analyser with the appropriate Tetra adjacent channel power settings. Captured results are shown in plots 7 to 9.

Readings in dBc

Channel

	-75kHz	-50kHz	-25kHz	+25kHz	+50kHz	+75kHz
450 MHz	-77.60	-72.61	-63.56	-64.24	-72.76	-77.83
460 MHz	-77.96	-72.11	-63.08	-63.98	-72.72	-78.02
470 MHz	-77.37	-72.520	-62.3	-62.75	-72.52	-77.69
Limit (dBc)	-65	-65	-55	-55	-65	-65
	PASS	PASS	PASS	PASS	PASS	PASS

Limit shown is the maximum allowed level (dBc) for a product with output power more than 1 W and operating in the 450MHz to 470MHz bands (Part 90.221(b)

PASS

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4.8 Conducted Emission Antenna - Frequency transient

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R8

Conducted Antenna - Mask Y close to carrier

Company: Sepura PLC		*Product:* SC2024	
Date: 19/01/2016		*Test Eng:* Dave Smith	
Ports: antenna			
Test: 90.214	using limits of	90.214	
Ports:			
Test:	using limits of		

Notes	Comments and Observations

The output of the antenna port of the EUT was fed through a Directional Coupler and then combined with the output of a signal generator.

The spectrum analyser has an FM demodulation function.

The EUT was initially set to produce a constant carrier output and the tuning of the spectrum analyser adjusted to give 0Hz FM deviation.

The output of the EUT was turned off and a carrier only signal output from the signal generator set at approximately the same frequency as the EUT. This frequency was adjusted to again give 0Hz FM deviation on the spectrum analyser.

The signal generator was then set to give 25kHz FM deviation (with 1kHz signal).

The forward power output of the directional coupler was fed into a receiver tuned to the carrier frequency. The video output of this receiver was used to trigger the spectrum analyser when the EUT RF is turned on or off.

The results of sweeps captured from the spectrum analyser are shown in plots 10 to 15.

All of the plots show the EUT comfortably meets the Transient Frequency Behaviour limits for a 25kHz channel spacing transmitter as shown below:

	Frequency	Duration
t1	± 25 kHz	10 msec
t2	± 12.5 kHz	25 msec
t3	± 25 kHz	10 msec

PASS

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4.9 Conducted Emission Antenna Spurious Emissions

Factor Set 1: - - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13

Conducted Antenna Spurious

Company: Sepura PLC		*Product:* SC2024	
Date: 14/01/2016		*Test Eng:* Dave Smith	
Ports: antenna			
Test: 90.210	using limits of	90.221(d)	
Ports:			
Test:	using limits of		

Notes	Comments and Observations
	Results of scans shown in plots 16 to 19. The limit line shown on the plots is at -13dBm. All spurious emissions were below this limit. The limit of -13dBm was derived as follows: **The applicable Mask is taken from part 90.221(d) which specifies an attenuation of:** 43 + 10 log (P) If the output is P Watts, the absolute limit is given by: 10 log (P) - (43 + 10 log (P)) = -43dBW converting to dBm: -43dBW = -13 dBm This absolute limit is therefore the same (-13dBm) regardless of the actual measured output power P. **PASS**

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4.10 Radiated Emissions - Transmit Carrier ERP - Standalone

Factor Set 1: A30_dBi_14A - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13 A38 A30 SG13 PM6 PS9

Substitution Emissions

Company: Sepura PLC *Product:* SC2024
Date: 27/11/2015 *Test Eng:* Dave Smith
Ports:
Test: 90.205 using limits of 90.205(h)
Ports:
Test: using limits of

Op Mode	Mod State	CF Set	Freq. MHz	Cable Loss Sig Gen Level Cable dBuV	Cable Loss Rec'vr Level Cable dBuV	Ant Pol	Rec'vr Level EUT dBm	Sig Gen Level Sub'n Ant dBm	Rec'vr Level Sub'n Ant dBm	Sub'n Ant Gain dBi	**ERP dBm**	Limit dBm	Margin dB	Note
1	0	1	450.000	115.0	115.0	V	-0.3	-3.6	-40.4	-0.0	**36.5**			
1	0	1	450.000	115.0	115.0	H	1.1	-3.6	-39.4	-0.0	**36.9**			
1	0	1	460.000	115.0	115.0	V	0.4	-3.6	-39.3	-0.1	**36.1**			
1	0	1	460.000	115.0	115.0	H	1.4	-3.6	-39.6	-0.1	**37.3**			
1	0	1	470.000	115.0	115.0	V	0.4	-3.7	-39.9	0.1	**36.8**			
1	0	1	470.000	115.0	115.0	H	-0.1	-3.7	-39.7	0.1	**36.0**			
Results				Minimum Margin PASS/FAIL					**N/A**					

Notes

Standalone
The results above are radiated measurements using the substitution method.
There are no specific limits in the standard for this test.

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4.11 Radiated Emissions - Transmit Carrier ERP - RSM

Factor Set 1: A30_dBi_14A - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13 A38 A30 SG13 PM6 PS9

Substitution Emissions

Company: Sepura PLC *Product:* SC2024
Date: 27/11/2015 *Test Eng:* Dave Smith
Ports:
Test: 90.205 using limits of 90.205(h)
Ports:
Test: using limits of

Op Mode	Mod State	CF Set	Freq. MHz	Cable Loss Sig Gen Level Cable dBuV	Cable Loss Rec'vr Level Cable dBuV	Ant Pol	Rec'vr Level EUT dBm	Sig Gen Level Sub'n Ant dBm	Rec'vr Level Sub'n Ant dBm	Sub'n Ant Gain dBi	**ERP dBm**	Limit dBm	Margin dB	Note
1	0	1	450.000	115.0	115.0	V	-8.6	-3.6	-40.4	-0.0	**28.2**			
1	0	1	450.000	115.0	115.0	H	-14.2	-3.6	-39.4	-0.0	**21.6**			
1	0	1	460.000	115.0	115.0	V	-11.0	-3.6	-39.3	-0.1	**24.6**			
1	0	1	460.000	115.0	115.0	H	-12.4	-3.6	-39.6	-0.1	**23.5**			
1	0	1	470.000	115.0	115.0	V	-9.9	-3.7	-39.9	0.1	**26.4**			
1	0	1	470.000	115.0	115.0	H	-12.7	-3.7	-39.7	0.1	**23.4**			
Results				Minimum Margin PASS/FAIL					**N/A**					

Notes

Charger + RSM.
The results above are radiated measurements using the substitution method.
There are no specific limits in the standard for this test.

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4.12 Radiated Emissions - Transmit Spurious - Standalone - Below 1GHz

Factor Set 1: A30_dBi_14A - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13 A38 A30 SG13 RFF11 PM6 PS9

Substitution Emissions

Company: Sepura PLC *Product:* SC2024
Date: 27/11/2015 *Test Eng:* Dave Smith
Ports:
Test: 90.210 using limits of 90.221(d)
Ports:
Test: using limits of

Op Mode	Mod State	CF Set	Freq. MHz	Cable Loss Sig Gen Level Cable dBuV	Cable Loss Rec'vr Level Cable dBuV	Ant Pol	Rec'vr Level EUT dBm	Sig Gen Level Sub'n Ant dBm	Rec'vr Level Sub'n Ant dBm	Sub'n Ant Gain dBi	**ERP dBm**	Limit dBm	Margin dB	Note
1	0	1	900.000	100.0	100.0	V	-90.4	-21.4	-71.3	-6.6	**-47.2**	-13.0	34.2	
1	0	1	900.000	100.0	100.0	H	-92.2	-21.4	-69.3	-6.6	**-51.0**	-13.0	38.0	
1	0	1	920.000	100.0	100.0	V	-86.2	-21.5	-72.0	-6.4	**-42.1**	-13.0	29.1	
1	0	1	920.000	100.0	100.0	H	-89.6	-21.5	-68.8	-6.4	**-48.7**	-13.0	35.7	
1	0	1	940.000	100.0	100.0	V	-84.6	-21.6	-71.6	-6.2	**-40.8**	-13.0	27.8	
1	0	1	940.000	100.0	100.0	H	-84.4	-21.6	-69.8	-6.2	**-42.4**	-13.0	29.4	

Results	Minimum Margin PASS/FAIL	**27.8** dB **PASS**

Notes

Standalone. Dummy antenna.

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4.13 Radiated Emissions - Transmit Spurious - RSM + Charger - Below 1GHz

Factor Set 1: A30_dBi_14A - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13 A38 A30 SG13 RFF11 PM6 PS9

Substitution Emissions

Company: Sepura PLC *Product:* SC2024
Date: 27/11/2015 *Test Eng:* Dave Smith
Ports:
Test: 90.210 using limits of 90.221(d)
Ports:
Test: using limits of

Op Mode	Mod State	CF Set	Freq. MHz	Cable Loss Sig Gen Level Cable dBuV	Cable Loss Rec'vr Level Cable dBuV	Ant Pol	Rec'vr Level EUT dBm	Sig Gen Level Sub'n Ant dBm	Rec'vr Level Sub'n Ant dBm	Sub'n Ant Gain dBi	**ERP dBm**	Limit dBm	Margin dB	Note
1	0	1	900.000	100.0	100.0	V	-91.9	-21.4	-71.3	-6.6	**-48.7**	-13.0	35.7	
1	0	1	900.000	100.0	100.0	H	-89.3	-21.4	-69.3	-6.6	**-48.2**	-13.0	35.2	
1	0	1	920.000	100.0	100.0	V	-91.9	-21.5	-72.0	-6.4	**-47.8**	-13.0	34.8	
1	0	1	920.000	100.0	100.0	H	-90.0	-21.5	-68.8	-6.4	**-49.0**	-13.0	36.0	
1	0	1	940.000	100.0	100.0	V	-92.8	-21.6	-71.6	-6.2	**-49.0**	-13.0	36.0	
1	0	1	940.000	100.0	100.0	H	-91.8	-21.6	-69.8	-6.2	**-49.8**	-13.0	36.8	

Results	Minimum Margin PASS/FAIL	**34.8** dB **PASS**

Notes

Charger + RSM. Dummy antenna.

See plot 20

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4.14 Radiated Emissions - Transmit Spurious - Standalone - Above 1GHz

Factor Set 1: A23_dBi_15A - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13 A8 A23 SG13 RFF11 PM6 PS3

Substitution Emissions

Company: Sepura PLC *Product:* SC2024
Date: 30/11/2015 *Test Eng:* Dave Smith
Ports:
Test: 90.210 using limits of 90.221(d)
Ports:
Test: using limits of

Op Mode	Mod State	CF Set	Freq. MHz	Cable Loss Sig Gen Level Cable dBuV	Cable Loss Rec'vr Level Cable dBuV	Ant Pol	Rec'vr Level EUT dBm	Sig Gen Level Sub'n Ant dBm	Rec'vr Level Sub'n Ant dBm	Sub'n Ant Gain dBi	**ERP dBm**	Limit dBm	Margin dB	Note
1	0	1	1800.000	100.0	100.0	V	-54.4	-23.1	-27.9	8.7	**-40.9**	-13.0	27.9	
1	0	1	1800.000	100.0	100.0	H	-50.8	-23.1	-26.7	8.7	**-38.5**	-13.0	25.5	
1	0	1	1840.000	100.0	100.0	V	-53.3	-23.4	-28.2	8.7	**-39.8**	-13.0	26.8	
1	0	1	1840.000	100.0	100.0	H	-47.8	-23.4	-26.8	8.7	**-35.7**	-13.0	22.7	
1	0	1	1880.000	100.0	100.0	V	-56.2	-23.4	-28.3	8.7	**-42.6**	-13.0	29.6	
1	0	1	1880.000	100.0	100.0	H	-51.1	-23.4	-27.9	8.7	**-37.9**	-13.0	24.9	

Results	Minimum Margin PASS/FAIL	**22.7** dB **PASS**

Notes

Standalone. Dummy antenna.

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4.15 Radiated Emissions - Transmit Spurious - RSM + Charger - Above 1GHz

Factor Set 1: A23_dBi_15A - - -
Factor Set 2: - - - -
Factor Set 3: - - - -
Test Equipment: R13 A8 A23 SG13 RFF11 PM6 PS9

Substitution Emissions

Company: Sepura PLC *Product:* SC2024
Date: 30/11/2015 *Test Eng:* Dave Smith
Ports:
Test: 90.210 using limits of 90.221(d)
Ports:
Test: using limits of

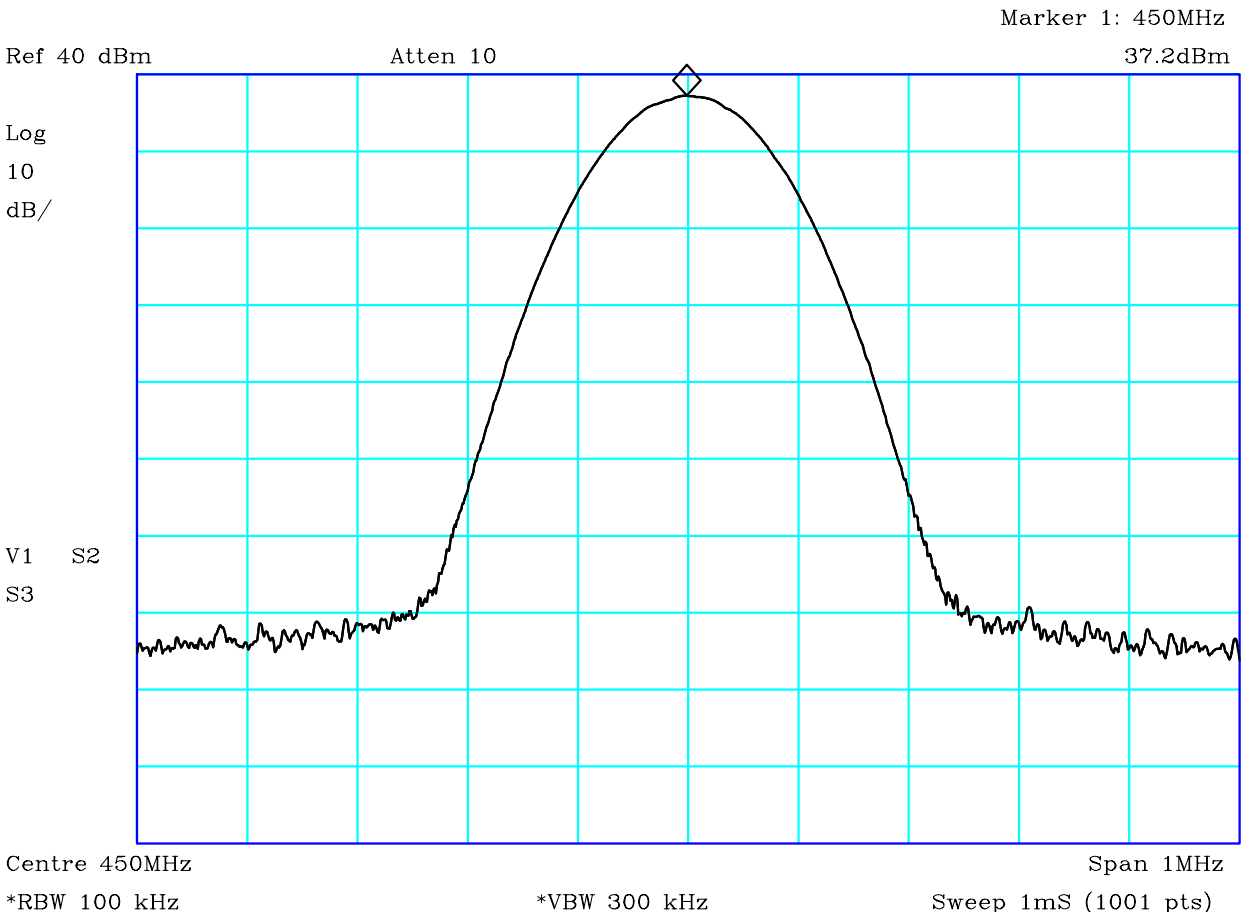
Op Mode	Mod State	CF Set	Freq. MHz	Cable Loss Sig Gen Level Cable dBuV	Cable Loss Rec'vr Level Cable dBuV	Ant Pol	Rec'vr Level EUT dBm	Sig Gen Level Sub'n Ant dBm	Rec'vr Level Sub'n Ant dBm	Sub'n Ant Gain dBi	**ERP dBm**	Limit dBm	Margin dB	Note
1	0	1	1800.000	100.0	100.0	V	-54.7	-23.1	-27.9	8.7	**-41.2**	-13.0	28.2	
1	0	1	1800.000	100.0	100.0	H	-58.0	-23.1	-26.7	8.7	**-45.7**	-13.0	32.7	
1	0	1	1840.000	100.0	100.0	V	-53.0	-23.4	-28.2	8.7	**-39.5**	-13.0	26.5	
1	0	1	1840.000	100.0	100.0	H	-56.0	-23.4	-26.8	8.7	**-43.9**	-13.0	30.9	
1	0	1	1880.000	100.0	100.0	V	-56.3	-23.4	-28.3	8.7	**-42.6**	-13.0	29.6	
1	0	1	1880.000	100.0	100.0	H	-60.1	-23.4	-27.9	8.7	**-46.9**	-13.0	33.9	

Results	Minimum Margin PASS/FAIL	**26.5** dB **PASS**

Notes

Charger + RSM. Dummy antenna.

See plot 21



CF1:30dB Pad

PLOT 1 Conducted Antenna Power - 450MHz

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part 90	Method:	
Limit1:		Limit2:	
Limit3:		Limit4:	

Peak Search result=37.2dBm
The average power using the signal analyser was found to be 34.82dBm

Facility:		Mode:	Tx
		Modification State:	0
File:	H601858E.txt	Analyser:	R13

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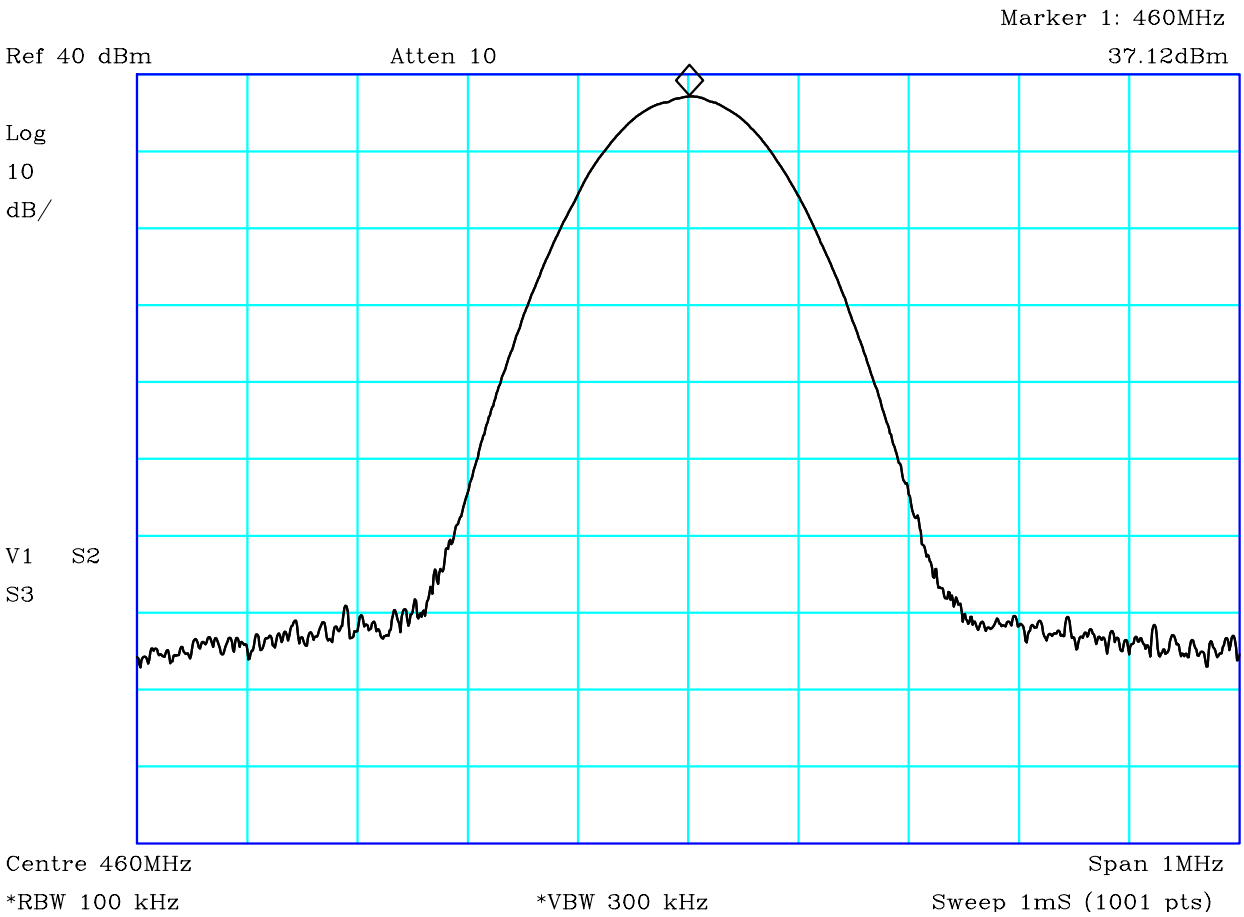

CF1:30dB Pad

PLOT 2 Conducted Antenna Power - 460MHz

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part 90	Method:	
Limit1:		Limit2:	
Limit3:		Limit4:	

Peak Search result=37.12dBm
The average power using the signal analyser was found to be 34.8dBm

Facility:		Mode:	Tx
		Modification State:	0
File:	H6018597.txt	Analyser:	R13

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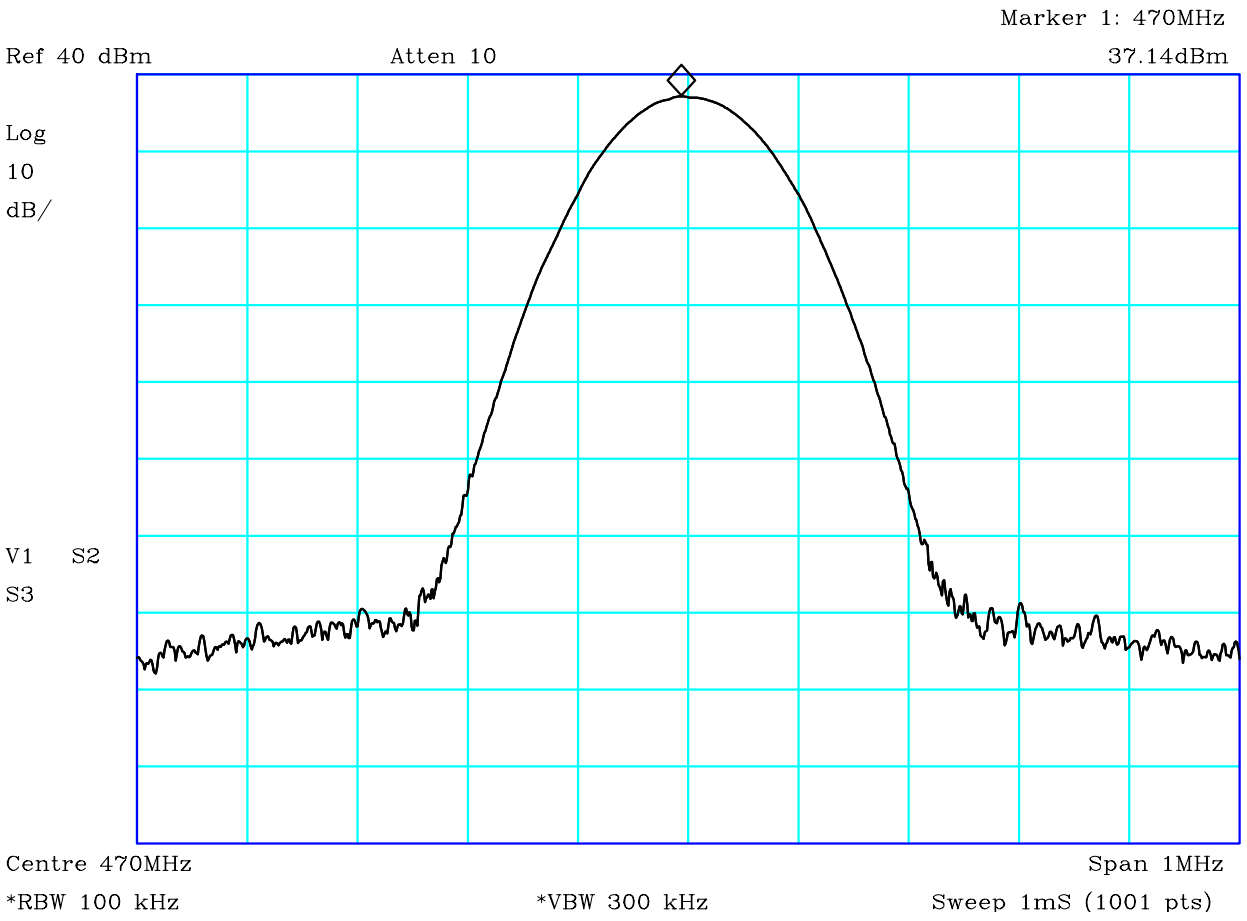

CF1:30dB Pad

PLOT 3 Conducted Antenna Power - 470MHz

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part 90	Method:	
Limit1:		Limit2:	
Limit3:		Limit4:	

Peak Search result=37.14dBm
The average power using the signal analyser was found to be 34.8dBm

Facility:		Mode:	Tx
		Modification State:	0
File:	H601859D.txt	Analyser:	R13

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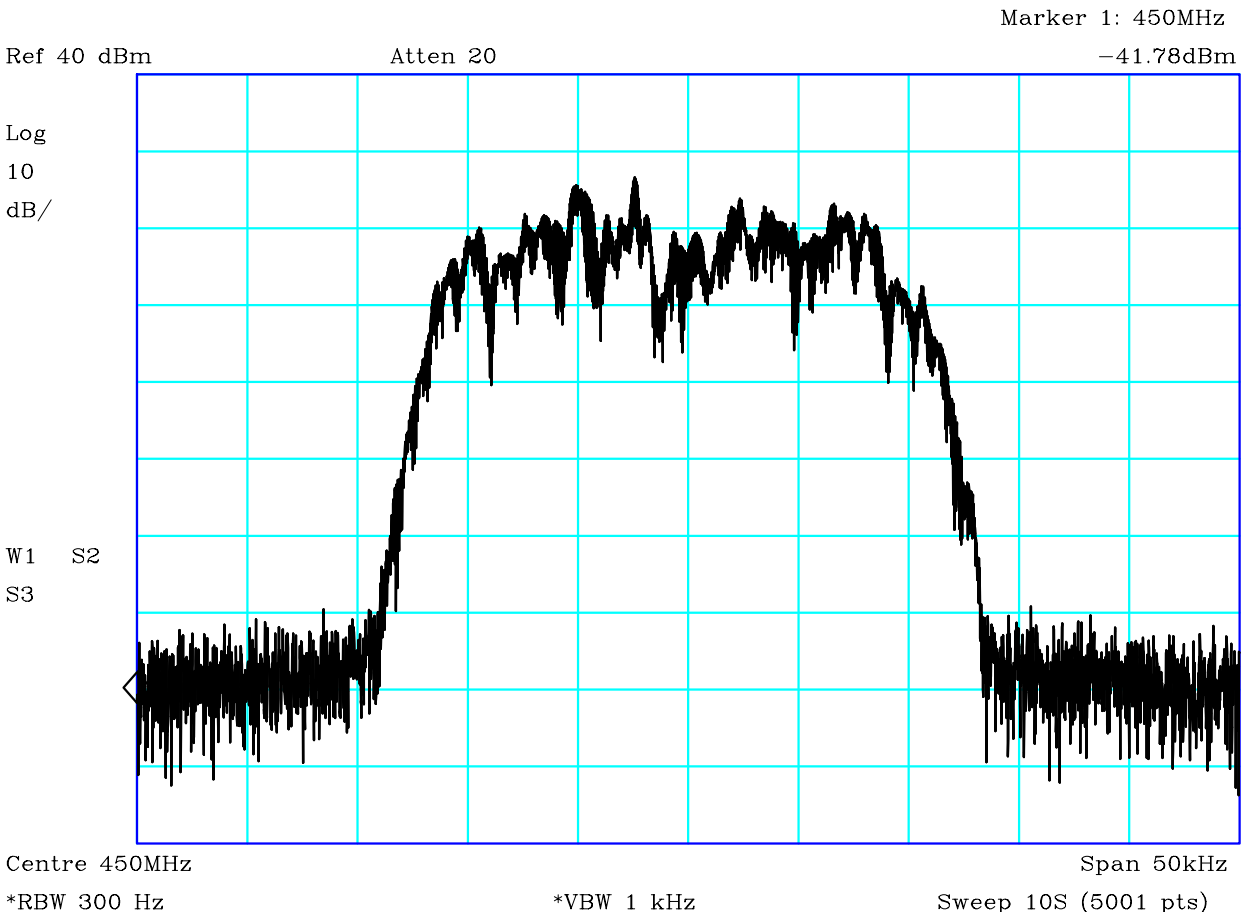

CF1:30dB Pad

PLOT 4 Occupied Bandwidth - 450MHz

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part 90	Method:	
Limit1:		Limit2:	
Limit3:		Limit4:	

99% Occupied Bandwidth=21.370kHz

Facility:		Mode:	Tx
		Modification State:	0
File:	H60185B9.txt	Analyser:	R13

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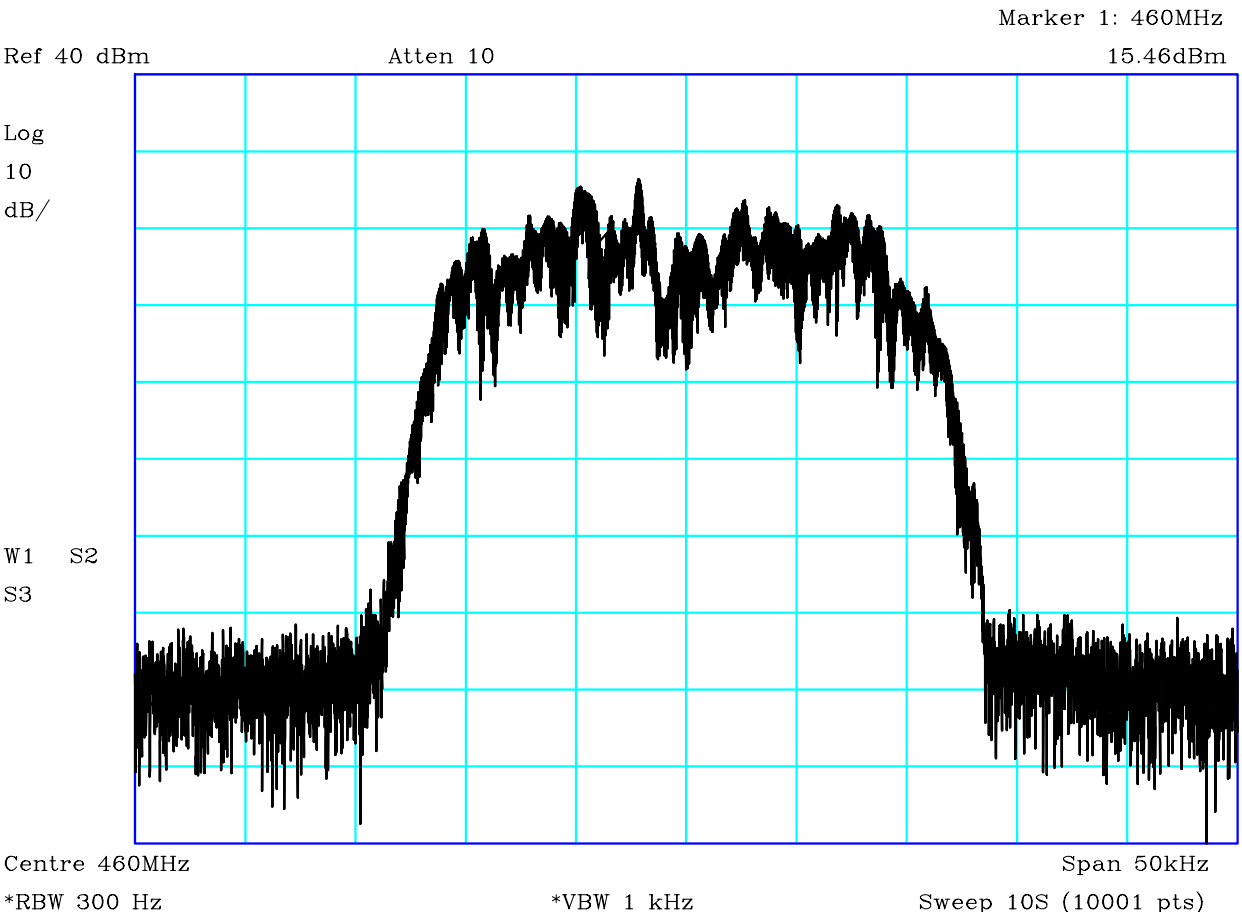

CF1:30dB Pad

PLOT 5 Occupied Bandwidth - 460MHz

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part 90	Method:	
Limit1:		Limit2:	
Limit3:		Limit4:	

99% Occupied Bandwidth=21.42kHz

		Mode:	Tx
		Modification State:	0
File:	H60276A0.txt	Analyser:	R13

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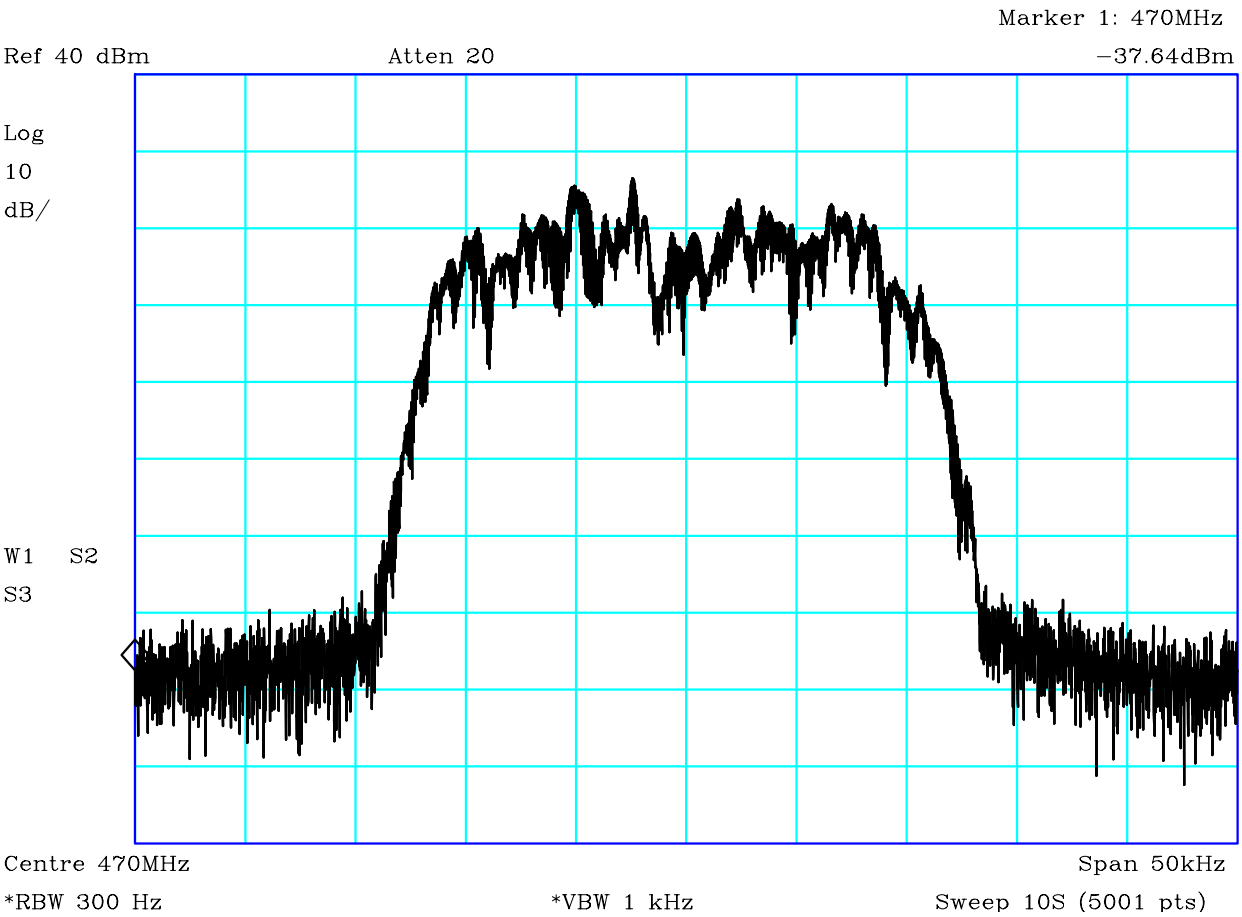

CF1:30dB Pad

PLOT 6 Occupied Bandwidth - 470MHz

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part 90	Method:	
Limit1:		Limit2:	
Limit3:		Limit4:	

99% Occupied Bandwidth=21.420kHz

Facility:		Mode:	Tx
		Modification State:	0
File:	H60185BC.txt	Analyser:	R13

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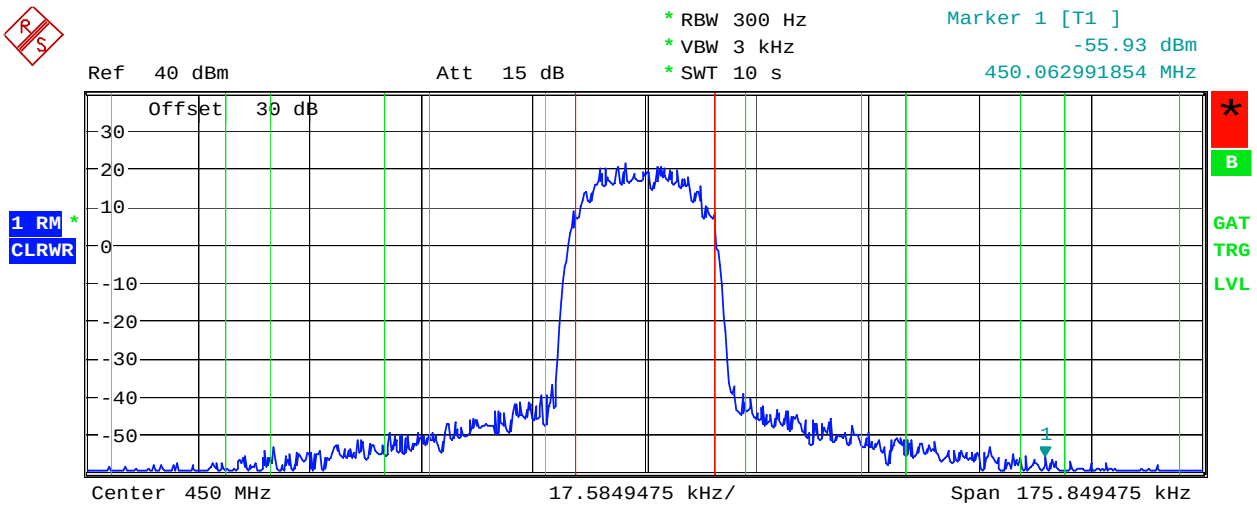

Tx Channel		**TETRA**	
Bandwidth	22 kHz	Power	34.83 dBm
Adjacent Channel			
Bandwidth	18 kHz	Lower	-63.56 dB
Spacing	25 kHz	Upper	-64.24 dB
Alternate Channel			
Bandwidth	18 kHz	Lower	-72.61 dB
Spacing	50 kHz	Upper	-72.76 dB
2nd Alternate Channel			
Bandwidth	18 kHz	Lower	-77.76 dB
Spacing	75 kHz	Upper	-77.83 dB

Date: 18.JAN.2016 16:24:40

PLOT 7 Adjacent Channel Power 450MHz - as an alternative to Masks of 90.210

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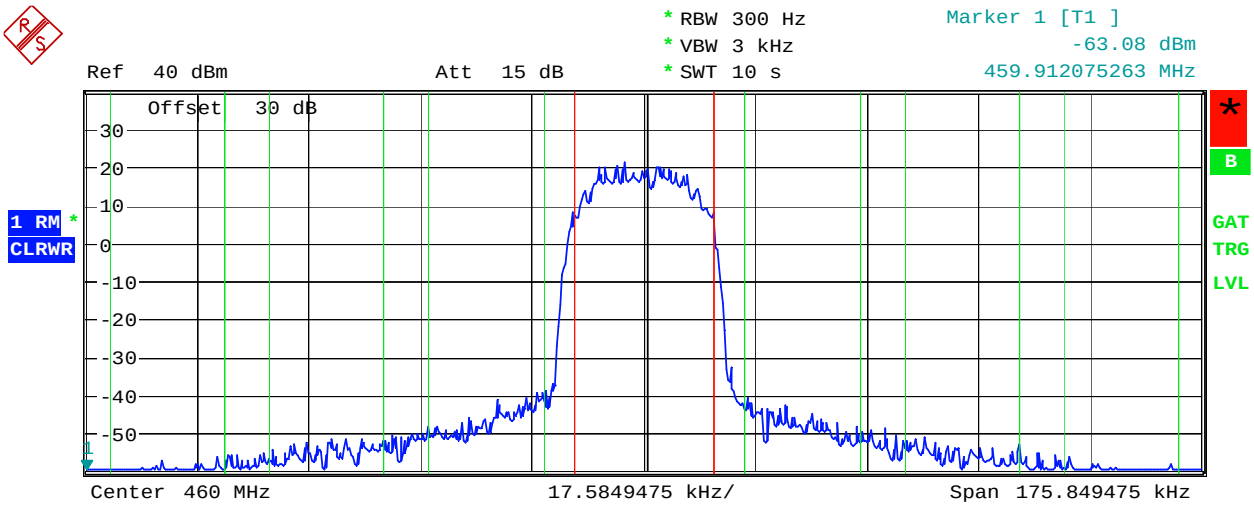

		TETRA	
Tx Channel			
Bandwidth	22 kHz	Power	34.79 dBm
Adjacent Channel			
Bandwidth	18 kHz	Lower	-63.08 dB
Spacing	25 kHz	Upper	-63.98 dB
Alternate Channel			
Bandwidth	18 kHz	Lower	-72.11 dB
Spacing	50 kHz	Upper	-72.72 dB
2nd Alternate Channel			
Bandwidth	18 kHz	Lower	-77.96 dB
Spacing	75 kHz	Upper	-78.02 dB

Date: 18.JAN.2016 16:27:24

PLOT 8 Adjacent Channel Power 460MHz - as an alternative to Masks of 90.210

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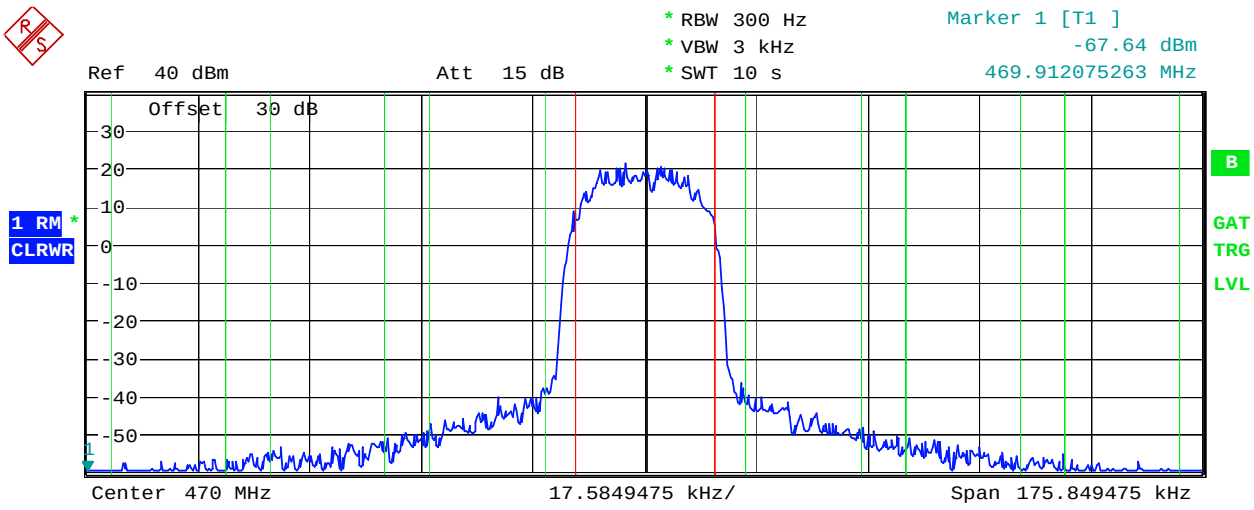

Tx Channel		**TETRA**	
Bandwidth	22 kHz	Power	34.83 dBm
Adjacent Channel			
Bandwidth	18 kHz	Lower	-62.30 dB
Spacing	25 kHz	Upper	-62.75 dB
Alternate Channel			
Bandwidth	18 kHz	Lower	-72.81 dB
Spacing	50 kHz	Upper	-72.52 dB
2nd Alternate Channel			
Bandwidth	18 kHz	Lower	-77.37 dB
Spacing	75 kHz	Upper	-77.69 dB

Date: 18.JAN.2016 16:29:34

PLOT 9 Adjacent Channel Power 470MHz - as an alternative to Masks of 90.210

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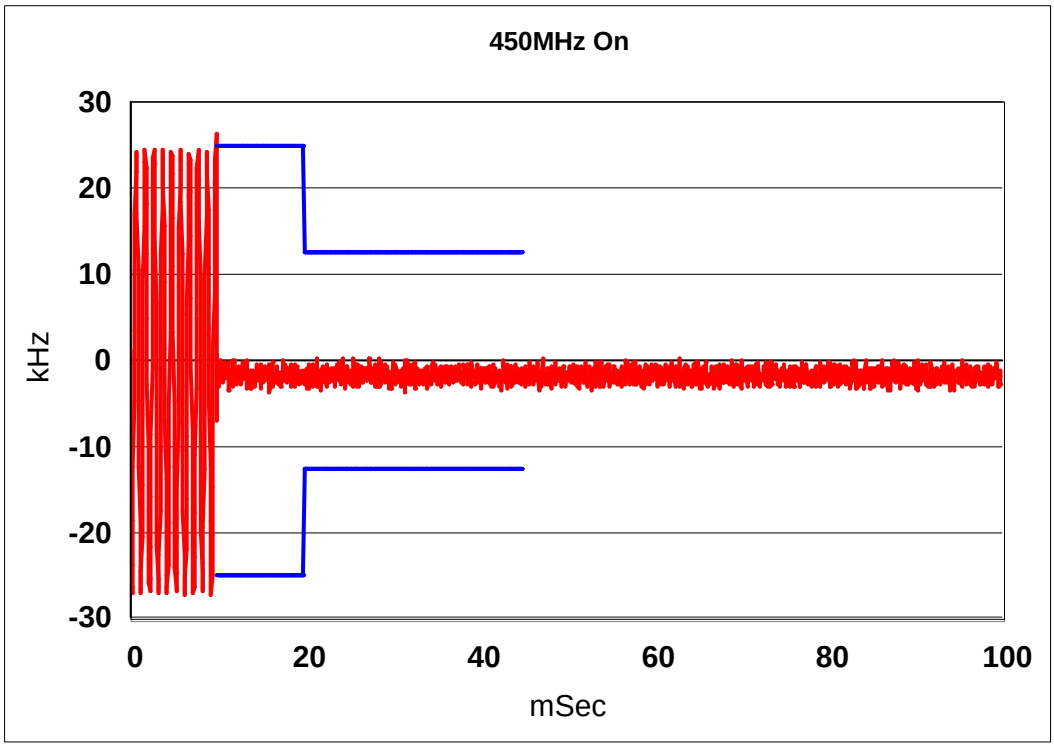
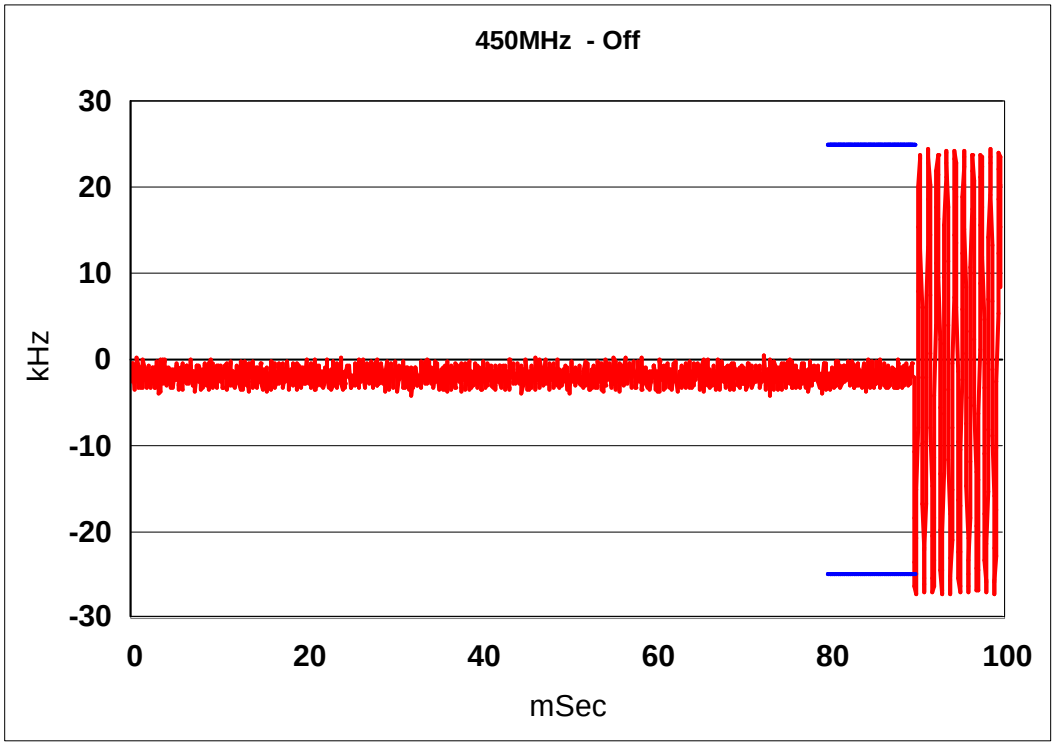


PLOT 10 Frequency Transient - 450MHz - On



PLOT 11 Frequency Transient - 450MHz - Off

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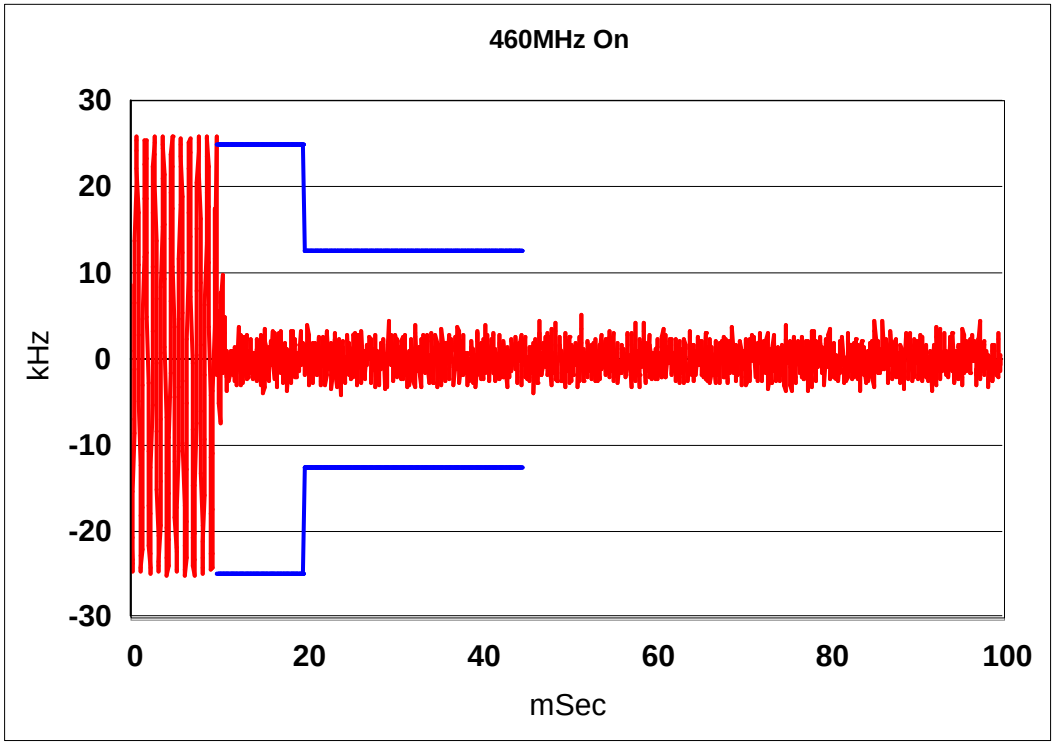
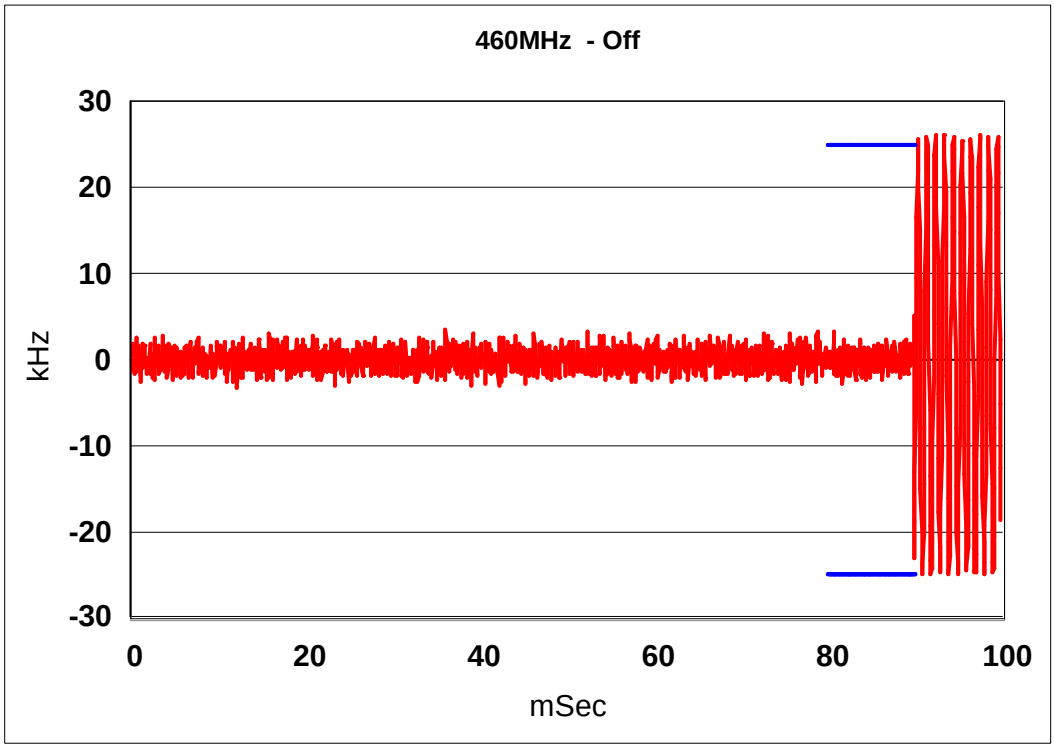


PLOT 12 Frequency Transient - 460MHz - On



PLOT 13 Frequency Transient - 460MHz - Off

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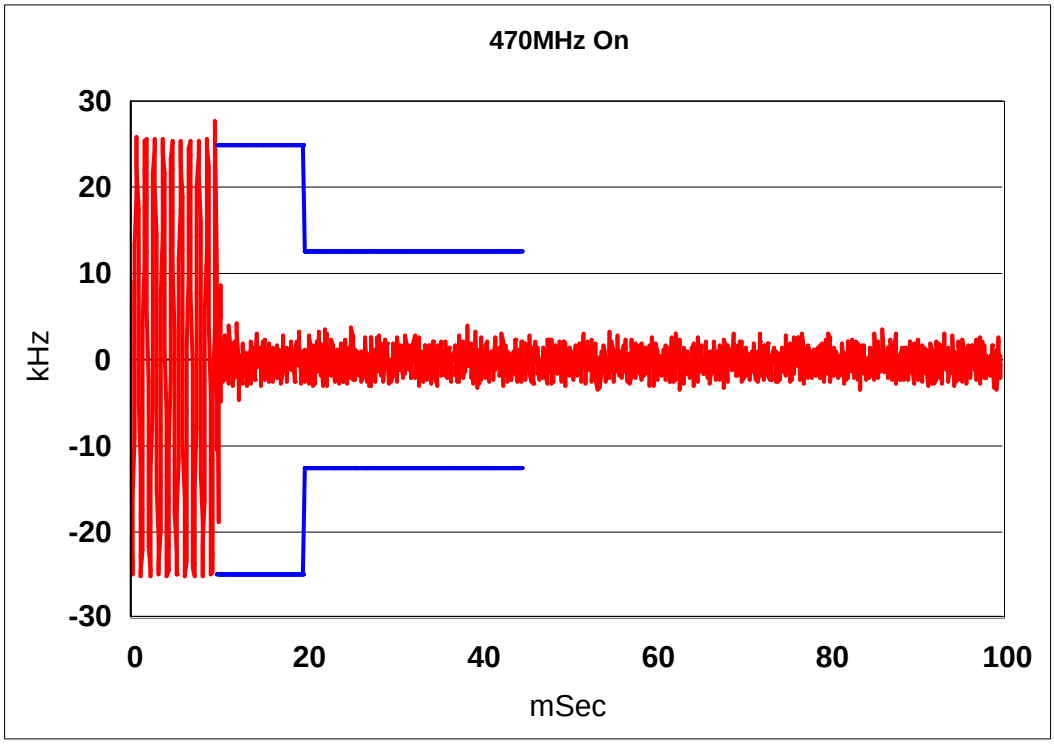
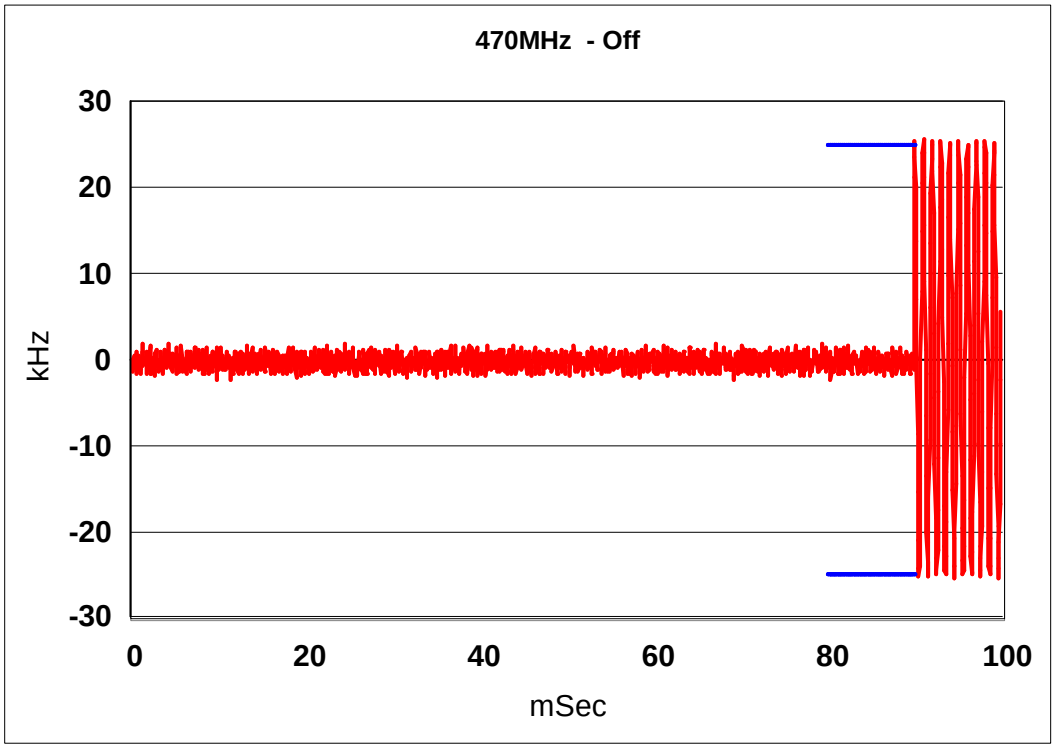


PLOT 14 Frequency Transient - 470MHz - On



PLOT 15 Frequency Transient - 470MHz - Off

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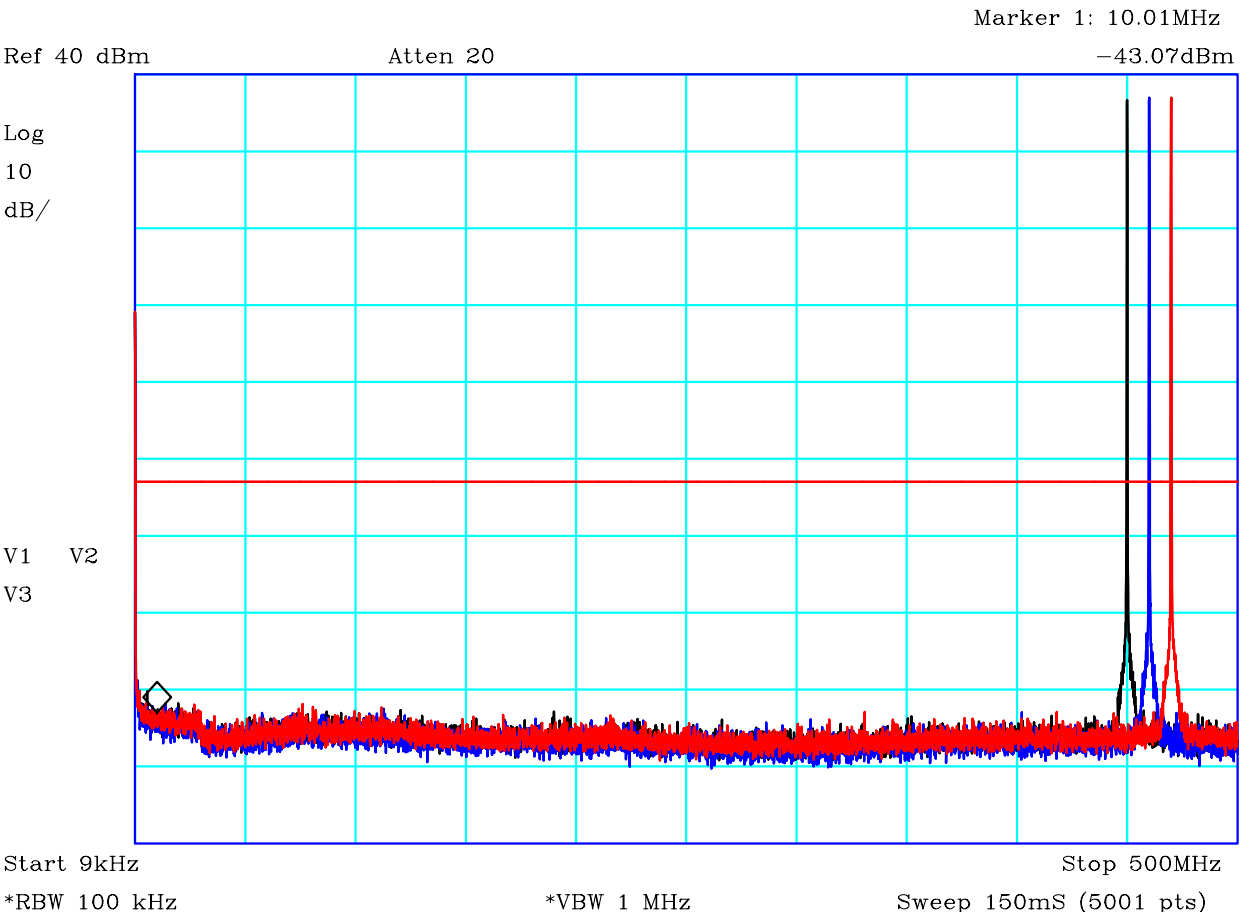

CF1:30dB Pad

PLOT 16 Antenna Cond Spurious Emissions: 9kHz-500MHz - Mask of 90.221(d)

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part90	Method:	
Limit1:(RED)	-13dBm	Limit2:	
Limit3:		Limit4:	

Black: Tx 450MHz
Blue: Tx 460MHz
Red: Tx 470MHz
Limit = -13dBmCalculation of limit shown in section 4.8. Mask of 90.221(d) used as an alternative to 90.210 as permitted in note 5.

		Mode:	Tx
		Modification State:	0
File:	H60195B4.txt	Analyser:	R13

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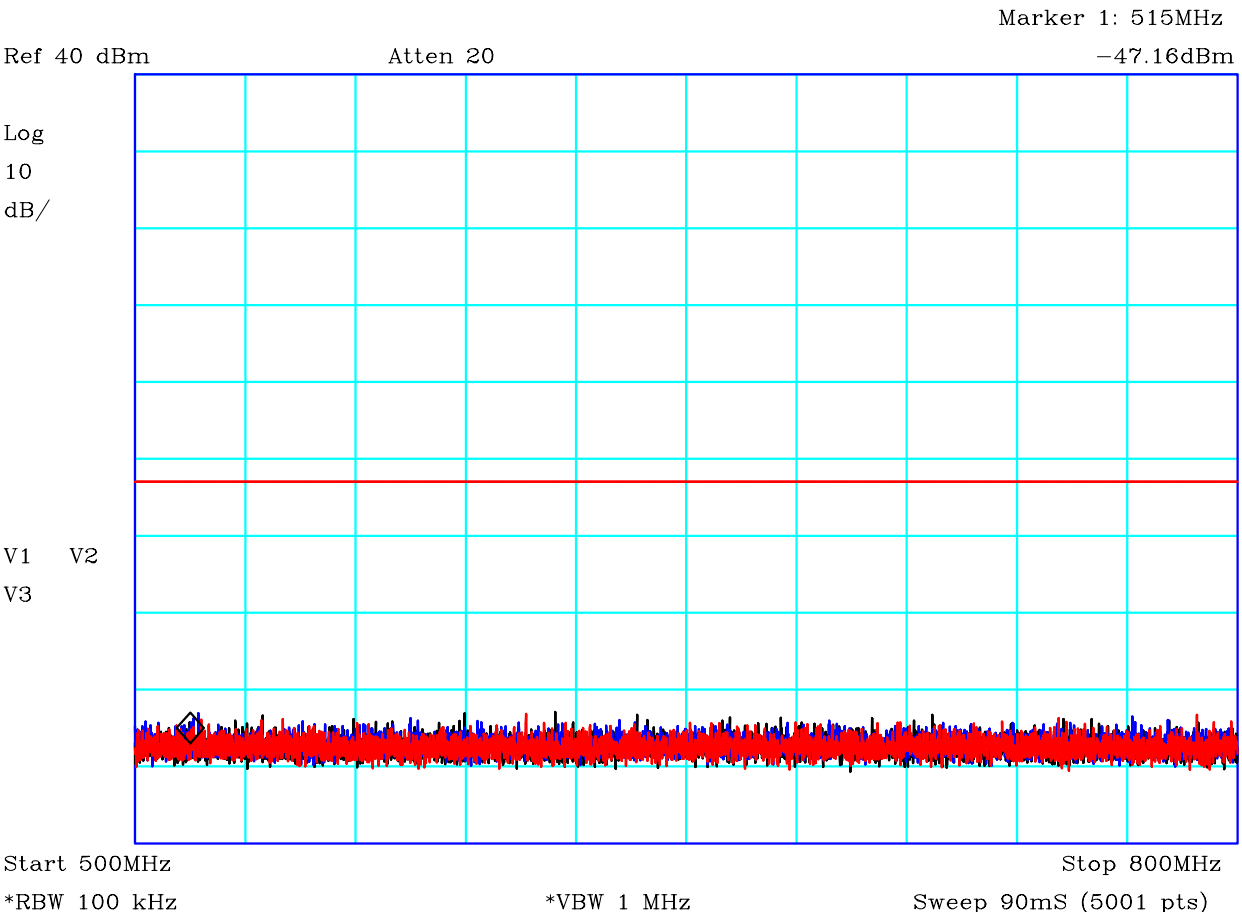

CF1:30dB Pad

PLOT 17 Antenna Cond Spurious Emissions: 500M-800MHz - Mask of 90.221(d)

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part90	Method:	
Limit1:(RED)	-13dBm	Limit2:	
Limit3:		Limit4:	

Black: Tx 450MHz
Blue: Tx 460MHz
Red: Tx 470MHz
Limit = -13dBmCalculation of limit shown in section 4.8. Mask of 90.221(d) used as an alternative to 90.210 as permitted in note 5.

		Mode:	Tx
		Modification State:	0
File:	H60195E4.txt	Analyser:	R13

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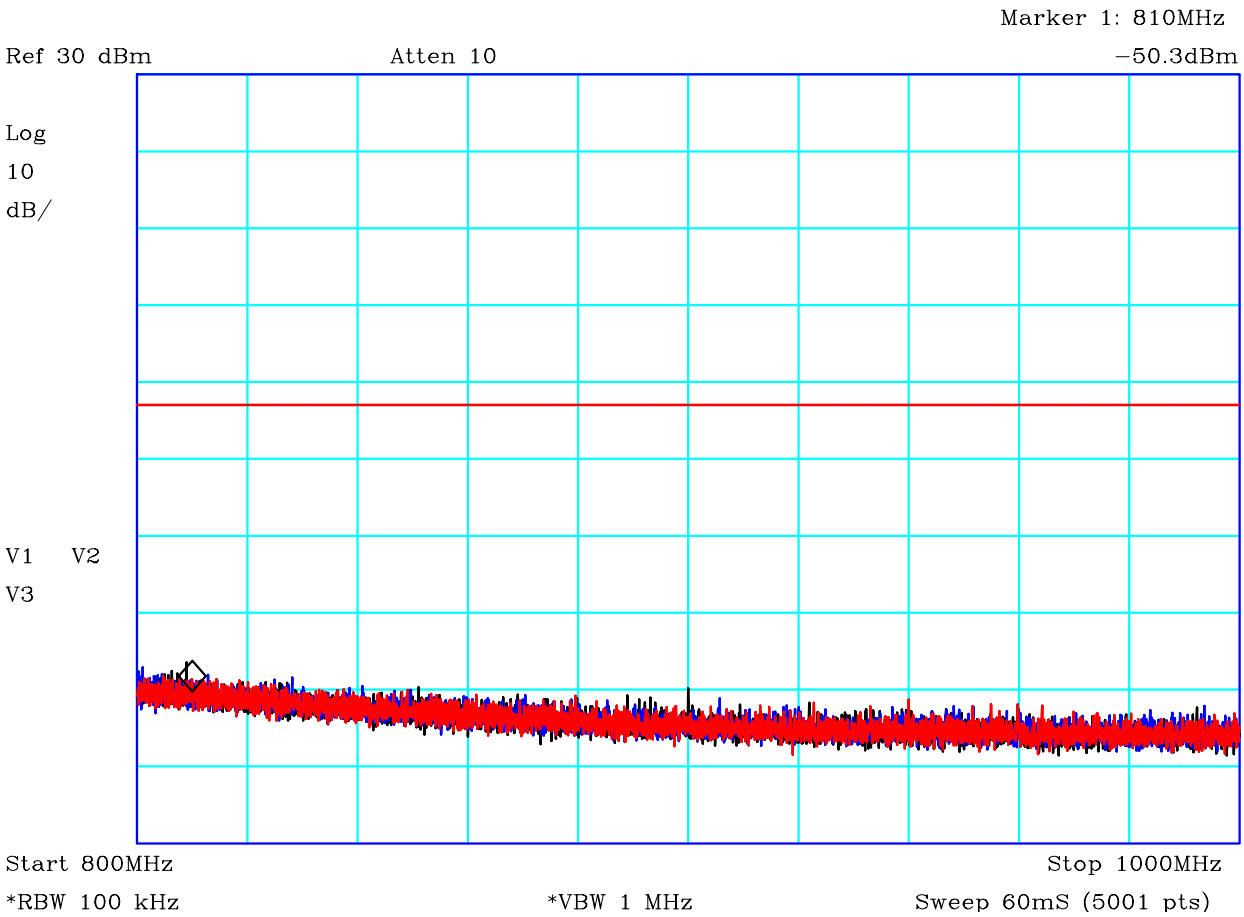

CF1:30dB Pad CF2:RFF11_140814

PLOT 18 Antenna Cond Spurious Emissions: 800MHz-1GHz - Mask of 90.221(d)

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part90	Method:	
Limit1:(RED)	-13dBm	Limit2:	
Limit3:		Limit4:	

Black: Tx 450MHz
Blue: Tx 460MHz
Red: Tx 470MHz
Limit = -13dBmCalculation of limit shown in section 4.8. Mask of 90.221(d) used as an alternative to 90.210 as permitted in note 5.

		Mode:	Tx
		Modification State:	0
File:	H60195EA.txt	Analyser:	R13

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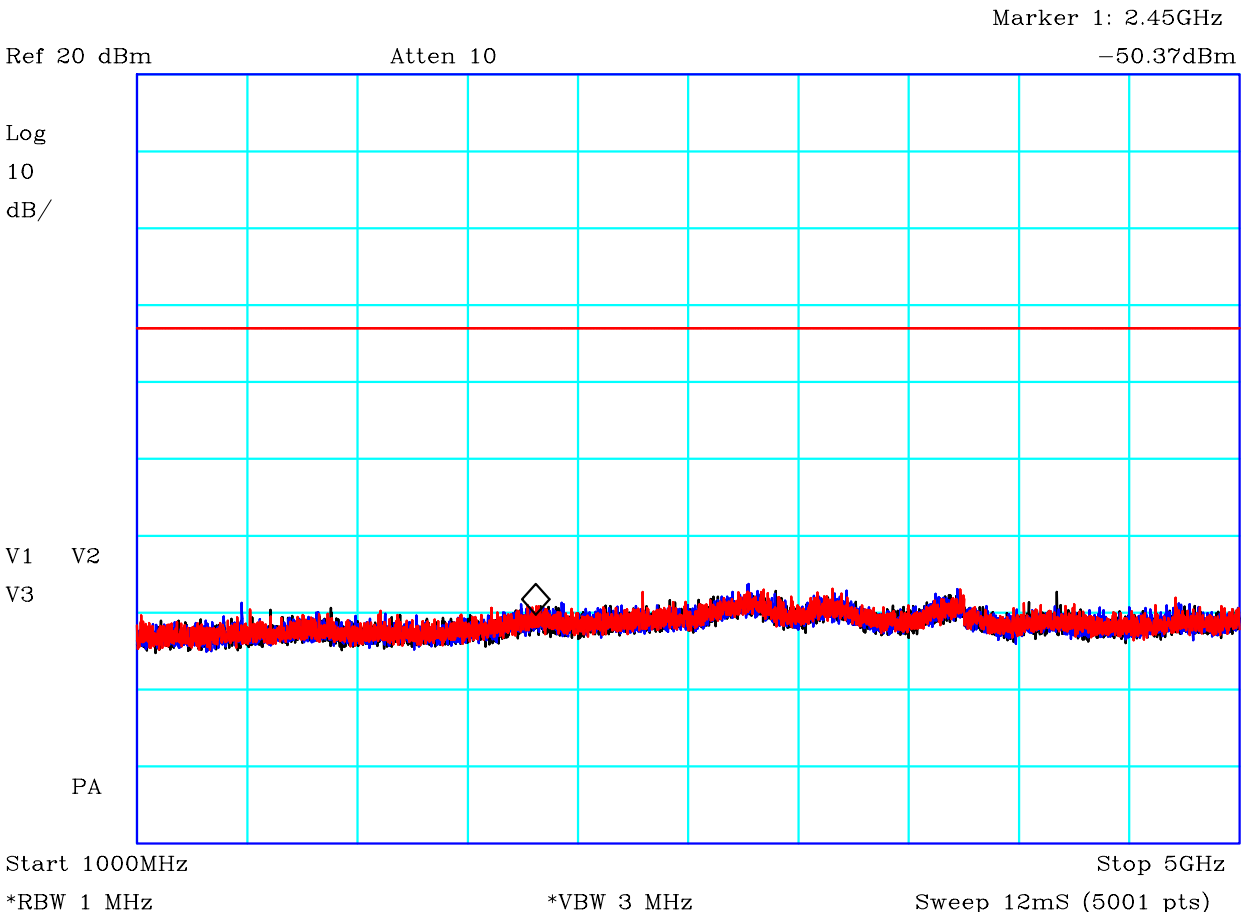

CF1:30dB Pad CF2:RFF11_140814

PLOT 19 Antenna Cond Spurious Emissions: 1GHz-5GHz - Mask of 90.221(d)

Company:	Sepura	Product:	SM2024
Date:	18/01/2016	Test Eng:	Mihai Andries
Method:	FCC Part90	Method:	
Limit1:(RED)	-13dBm	Limit2:	
Limit3:		Limit4:	

Black: Tx 450MHz
Blue: Tx 460MHz
Red: Tx 470MHz
Limit = -13dBmCalculation of limit shown in section 4.8. Mask of 90.221(d) used as an alternative to 90.210 as permitted in note 5.

		Mode:	Tx
		Modification State:	0
File:	H60195EB.txt	Analyser:	R13

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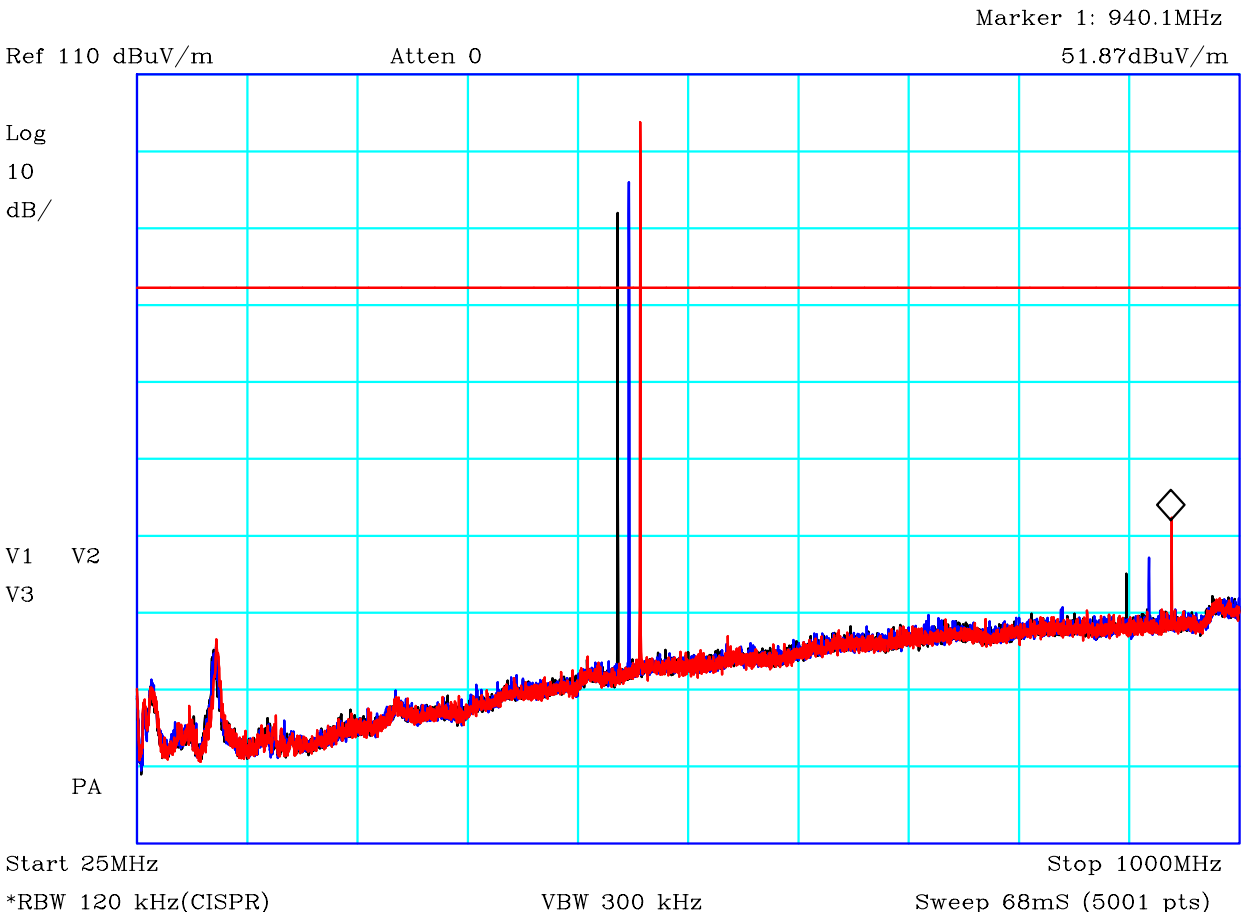

CF1:A24_140528 CF2:CBL059_CBL018_CBL065_CBL060_140528 CF3:10db_PAD_140528

PLOT 20 Radiated Emissions - Tx Mode - 25MHz to 1GHz

Company:	Sepura	Product:	SC2024
Date:	26/11/2015	Test Eng:	Dave Smith
Method:	FCC Part 90	Method:	
Limit1:(RED)	-13dBm	Limit2:	
Limit3:		Limit4:	

Black: Tx at 450MHz
Blue: Tx at 460MHz
Red: Tx at 470MHz
Maximisation of vertical + horizontal polarisation. Placed in charger. RSM connected. Dummy load on antenna. Normal pulse Tetra modulation.

Facility:	Anech_2	Height	1m,1.5m,2m	Mode:	Tx
Distance	3m	Polarisation	V+H	Modification State:	0
Angle	0-360	File:	H5A265B3.txt	Analyser:	R13

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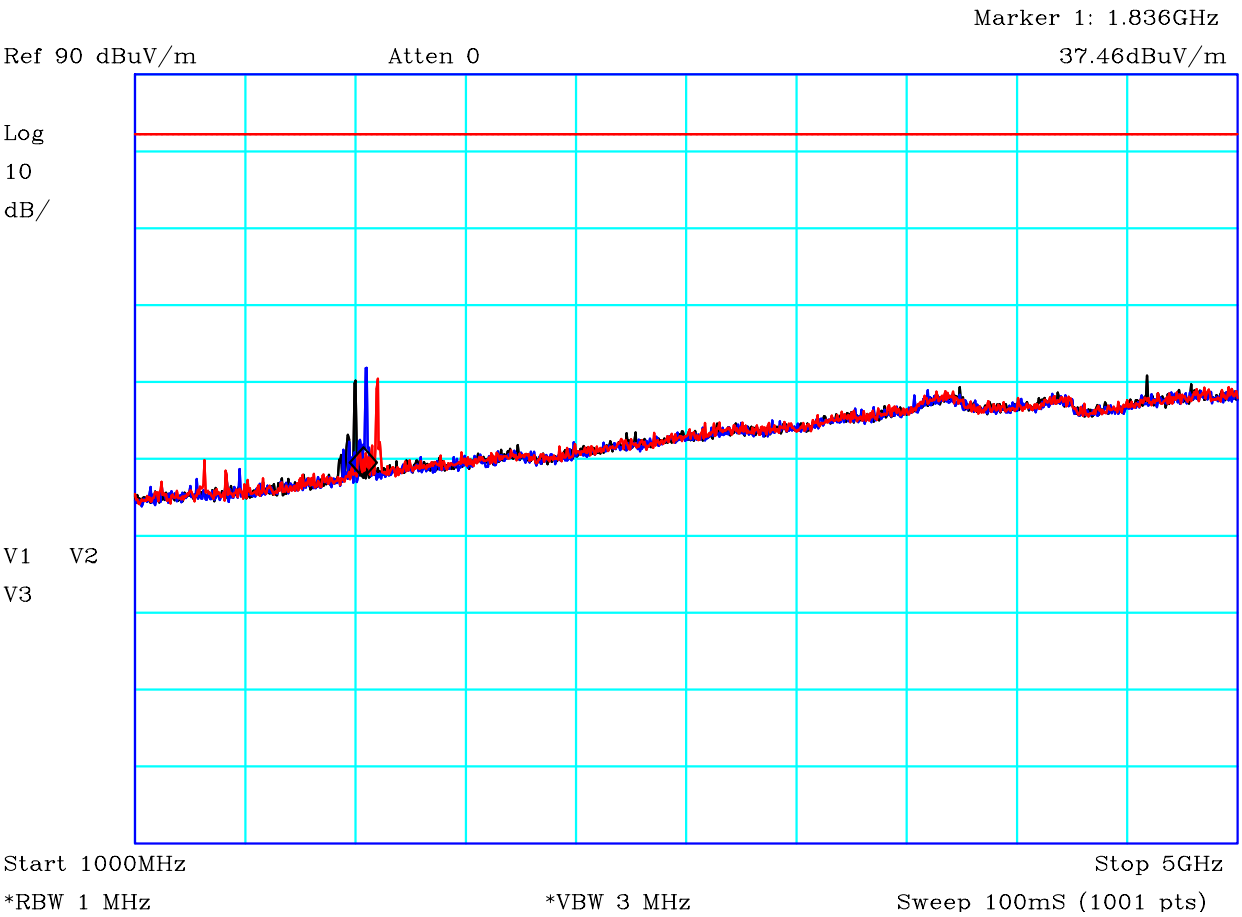

CF1:A8_151015 CF2:BlueCables_140918 CF3:PRE20_151125 CF4:RFF11_140814

PLOT 21 Radiated Emissions - Tx Mode - 1GHz to 5GHz

Company:	Sepura	Product:	SC2024
Date:	30/11/2015	Test Eng:	Dave Smith
Method:	FCC part 90	Method:	
Limit1:(RED)	-13dBm	Limit2:	
Limit3:		Limit4:	

Black: Tx at 450MHz
Blue: Tx at 460MHz
Red: Tx at 470MHz
Maximisation of vertical + horizontal polarisation. Placed in charger. RSM connected. Dummy load on antenna. Normal pulse Tetra modulation.

Facility:	Anech_2	Height	1m,1.4m,2m	Mode:	Tx
Distance	3m	Polarisation	V+H	Modification State:	0
Angle	0-360	File:	H602741C.txt	Analyser:	R13

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