Electromagnetic compatibility and Radio Spectrum Matters ERM

ERM TEST REPORT

287407-1-1

SGS Fimko Ltd. | Särkiniementie 3, P.O.Box 30, FI-00210 Helsinki Finland
t +358 9 6963 361 **f** +358 9 692 5474 www.sgsfimko.fi

Member of SGS Group (Société Générale de Surveillance)

Test Report

Electromagnetic compatibility and Radio spectrum Matters (ERM)

FINAS
Finnish Accreditation Service
T004 (EN ISO/IEC 17025)

Equipment Under Test:	Bluetooth Smart Module
Model:	BGM11S1A BGM11S2A BGM11S1N BGM11S2N
Trade Mark:	Silicon Labs
Manufacturer/Customer:	Silicon Laboratories Finland Oy Bertel Jungin aukio 3 FI-02600, ESPOO FINLAND

Tests have been performed according to the following standard(s)

Title of the standard	Reference standard	Version
Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive	EN 300 328	V2.1.1

Date:	17 May 2017	Date:	17 May 2017
Issued by:	Emil Haverinen Testing Engineer	Checked by:	Rauno Repo Testing Engineer

These test results are valid for the tested unit only.
This report shall not be reproduced, except in full, without a written permission of SGS Fimko.

Disclaimer

This document is issued by the Company under its General Conditions of service accessible at ***http://www.sgs.com/terms_and_conditions.htm****. attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.*

Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only. This document cannot be reproduced except in full, without prior approval of the Company.

Table of Contents

GENERAL REMARKS **3**
Disclaimer 3

TABLE OF CONTENTS **4**

PRODUCT DESCRIPTION **5**
Equipment under test (EUT) 5
General description 5
Samples and modifications incorporated in the EUT 5
Specifications of the EUT 5
Power requirements 5
Equipment category and characteristics 5
Cables 5
Peripherals 5
Photographs of the EUT 6

SUMMARY OF TESTING **7**
Test conditions 7
Test suite 8

TEST RESULTS **9**
RF Output Power 9
Power Spectral Density 10
Occupied Channel Bandwidth 11
Transmitter unwanted spurious emissions in the out-of-band domain 13
Transmitter unwanted spurious emissions in the spurious domain 14
Receiver spurious emissions 16
Receiver Blocking 17

TEST EQUIPMENT **18**
RF Test Equipment 18

Equipment under test (EUT)

Trade mark:	Silicon Labs
Model:	BGM11S1A, BGM11S2A, BGM11S1N, BGM11S2N
Type:	Bluetooth Smart Module
Serial no:	-

General description

BGM11S1A, BMG11S2A, BGM11S1N and BGM11S2N is a family of Bluetooth 4.2 compliant Bluetooth SiP modules. The difference between A-variant and N-variant modules is that A has integrated antenna and N has RF connector for use of external antenna. Max power for S1 variants is 3 dBm and for S2 variants 10 dBm.

Samples and modifications incorporated in the EUT

Two samples were used in the testing. During the tests the EUT was set into continuous transmit and was set to the channel under test. Normal test modulation and maximum transmit power was used in all tests.

Specifications of the EUT

Antenna type:	Intergrated chip antenna (A-variant) Removable whip antenna (N-variant)
Antenna gain:	1 dBi (A-variant) 2.14 dBi (N-variant)
EUT dimensions:	6.5 x 6.5 x 1.4 mm

The EUT does not have beamforming capabilities.

Power requirements

Rated voltage:	2.0 - 3.8 V (tested with 3.3V regulated by the development board)
Rated Frequency:	DC

The EUT was powered from the development board which was powered by PC. During radiated measurements the development board was powered by laboratory power supply.

Equipment category and characteristics

Operating Frequency Range (OFR):	2402 - 2480 MHz
Channels:	40
Channel separation:	2 MHz
Channel bandwidth:	1.111432706 MHz
Conducted power:	9.0 dBm (BGM11S2A) 7.9 dBm (BGM11S2N)
Transmission technique:	DSSS
Modulation:	GFSK
Geo-location capability:	None

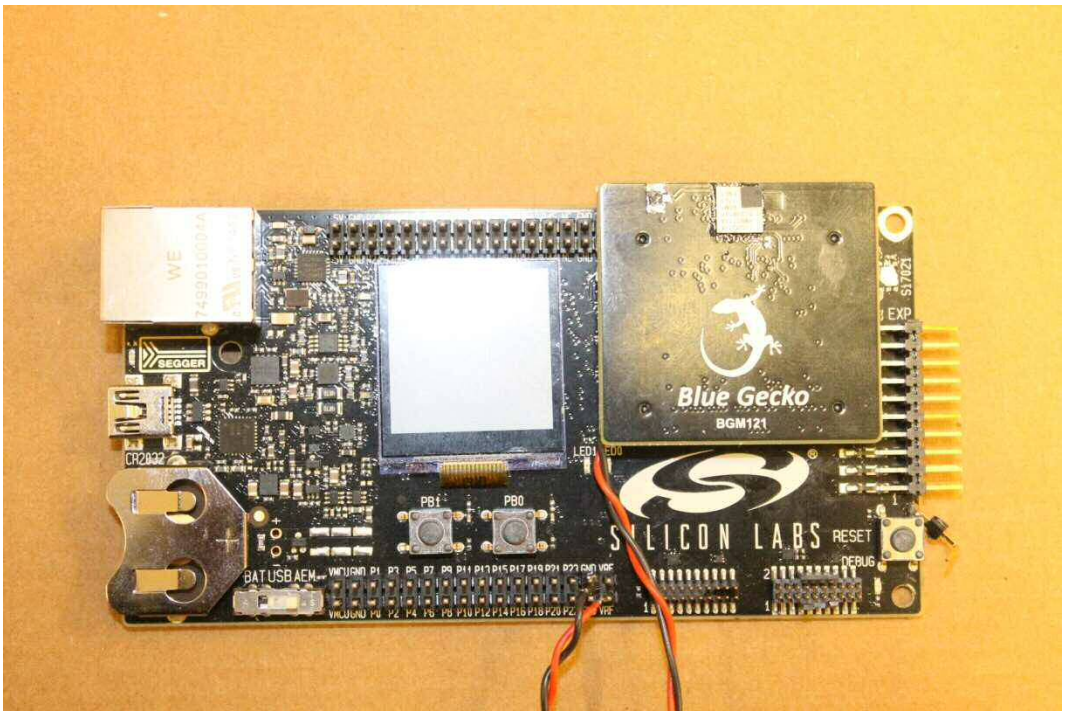
Cables

USB cable	1m	Twisted pair, shielded, from supply to dev board

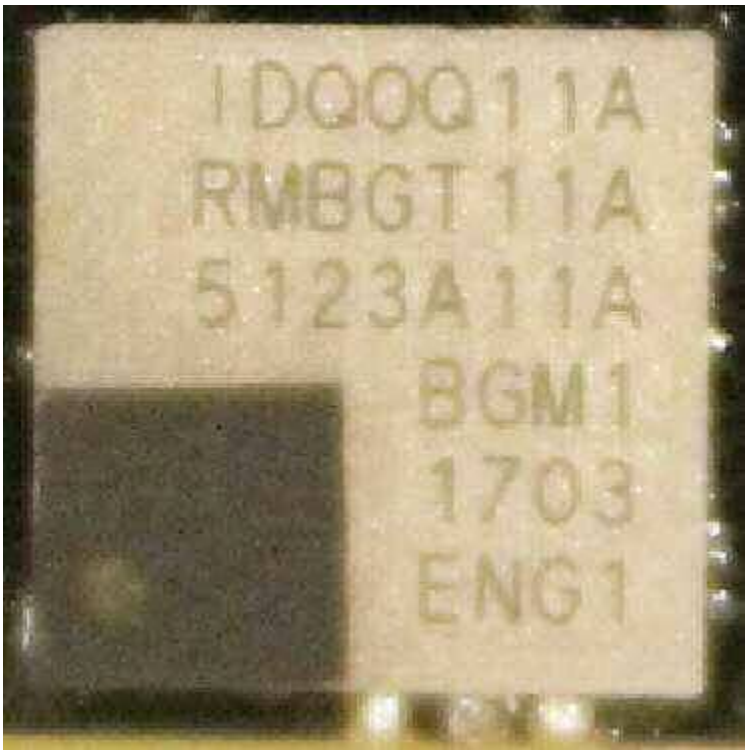
Peripherals

PC	HP ProBook

Photographs of the EUT



Photograph 1: The equipment under test (EUT) and supportive development board



Photograph 2: The EUT

Test conditions

During radiated measurements, configuration of the EUT was made to correspond to the actual assembling conditions as far as possible. The EUT was set on 150 cm table in semi anechoic chamber with floor absorbers. All tests were performed while the EUT was connected to the development board.

The EUT's radio was configured with software provided by the manufacturer. Normal modulation and maximum transmit power was used during the tests.

All tests were performed to BGM11S2A or BGM11S2N modules since the only difference is the transmit power which is higher in tested models.

The power settings:
BGM11S2A: 87
BGM11S2N: 80

Radiated spurious emission measurements were performed with power setting 104 for both models.

Table 1: Normal and extreme test

Test conditions:		Temperature [ºC]:	Voltage [V]:
Normal		+20 - 25	3.3
Extreme	Minimum	- 40	3.3
	Maximum	+85	3.3

Extreme temperature and voltage ranges were provided by the customer.

Table 2: The test frequencies used in the tests

Frequency [MHz]:	Channel:
2402	Low
2440	Middle
2480	High

Test suite

Measurement/Test	Test Specification	Result
RF Output Power	EN 300 328 V2.1.1 (2016-11)	PASS
Power Spectral Density	EN 300 328 V2.1.1 (2016-11)	PASS
Duty cycle, Tx-sequence, Tx-gap	EN 300 328 V2.1.1 (2016-11)	N/A(1)
Accumulated Transmit Time, Frequency Occupation and Hopping Sequence	EN 300 328 V2.1.1 (2016-11)	N/A(2)
Hopping Frequency Separation	EN 300 328 V2.1.1 (2016-11)	N/A(2)
Medium Utilisation (MU) factor	EN 300 328 V2.1.1 (2016-11)	N/A(3)
Adaptivity	EN 300 328 V2.1.1 (2016-11)	N/A(4)
Occupied Channel Bandwidth	EN 300 328 V2.1.1 (2016-11)	PASS
Transmitter unwanted spurious emissions in the out-of-band domain	EN 300 328 V2.1.1 (2016-11)	PASS
Transmitter unwanted spurious emissions in the spurious domain	EN 300 328 V2.1.1 (2016-11)	PASS
Receiver spurious emissions	EN 300 328 V2.1.1 (2016-11)	PASS
Receiver blocking	EN 300 328 V2.1.1 (2016-11)	PASS

Possible test case verdicts:

Test case does not apply to the EUT:	N/A
EUT does meet the requirement:	P (Pass)
EUT does not meet the requirement:	F (Fail)
Test was not performed by SGS Fimko:	N/T

1) These requirements apply to non-adaptive equipment or to adaptive equipment operating in a non-adaptive mode. Also these requirements do not apply for equipment with a maximum declared RF Output power of less than 10 dBm E.I.R.P.

2) This requirement applies to all types of frequency hopping equipment.

3) This requirement does not apply to adaptive equipment unless operating in a non-adaptive mode. Also this requirement does not apply for equipment with a maximum declared RF Output power of less than 10 dBm E.I.R.P.

4) This requirement do not apply to non-adaptive equipment or to adaptive equipment operating in a non-adaptive mode providing the equipment complies with the requirements and/or restrictions applicable to non-adaptive equipment. Also this requirement does not apply for equipment with a maximum declared RF Output power of less than 10 dBm E.I.R.P.

Testing location / address: SGS Fimko Ltd
Karakaarenkuja 4
FI-02610, ESPOO
FINLAND

RF Output Power

Standard: EN 300 328 V2.1.1
Tested by: EHA
Date: 27 February 2017
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

Test result: **PASS**
Measurement uncertainty: ± 0.349 dB Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 V2.1.1 clause 5.4.2.2.1

The RF output power is defined as the mean equivalent isotropically radiated power (E.I.R.P.) of the equipment during a transmission burst.

The transmitter is connected via the 50 Ω -power attenuator to the measuring equipment. The power is measured with the highest operating power level. The maximum isotropic radiated power of the equipment is calculated from the measured power (P) added by antenna gain (G) and beamforming gain (Y).

The measurements are done under normal and extreme test conditions. For systems using FHSS modulation, the measurements shall be performed during normal operation (hopping). For systems using wide band modulations other than FHSS, the measurement shall be performed at the lowest, the middle, and the highest channel on which the equipment can operate. E.I.R.P = P + G + Y

Test results

Table 3: Test results and calculations of RF output power, BGM11S2A

Antenna gain (G):	1	dBi

Test conditions		**Transmit power E.I.R.P. [dBm]**		
Temperature	**Voltage**	**Low**	**Mid**	**High**
-40 ºC	3.3 V	10.0	9.9	9.6
+20 – 25 ºC	3.3 V	9.4	9.2	8.9
+85 ºC	3.3 V	8.5	8.3	8.0
Limit:		+20 dBm		
Maximum transmit power E.I.R.P		**10.0 dBm**		
Measurement uncertainty (Level of confidence 95 % k = 2)		±0.349 dBm		

Table 4: Test results and calculations of RF output power, BGM11S2N

Antenna gain (G):	2.14	dBi

Test conditions		**Transmit power E.I.R.P. [dBm]**		
Temperature	**Voltage**	**Low**	**Mid**	**High**
-40 ºC	3.3 V	10.0	9.8	9.6
+20 – 25 ºC	3.3 V	9.5	9.3	9.0
+85 ºC	3.3 V	8.6	8.4	8.1
Limit:		+20 dBm		
Maximum transmit power E.I.R.P		**10.0 dBm**		
Measurement uncertainty (Level of confidence 95 % k = 2)		±0.349 dBm		

Power Spectral Density

Standard: EN 300 328 V2.1.1
Tested by: EHA
Date: 27 February 2017
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

Test result: PASS
Measurement uncertainty: ± 0.372 dB Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 V2.1.1 clause 5.4.3.2.1

The Power spectral density is the mean equivalent isotropically radiated power (e.i.r.p) spectral density during a transmission burst. The maximum power spectral density is limited to 10 dBm per MHz.

Test results

Measurement option 2 of the standard was used.
Measured constant duty cycle used in calculations: 61.8%

Table 5: Power spectral density, BGM11S2A

DUT Frequency (MHz)	Center Frequency of Segment (MHz)	Level (dBm)	Limit (dBm)	Result
2402.000000	2401.94790	8.69	<= 10.0	PASS
2440.000000	2439.95520	8.13	<= 10.0	PASS
2480.000000	2479.93770	8.08	<= 10.0	PASS

Table 6: Power spectral density, BGM11S2N

DUT Frequency (MHz)	Center Frequency of Segment (MHz)	Level (dBm)	Limit (dBm)	Result
2402.000000	2401.94220	8.74	<= 10.0	PASS
2440.000000	2439.96090	8.14	<= 10.0	PASS
2480.000000	2479.94500	8.13	<= 10.0	PASS

Occupied Channel Bandwidth

Standard: EN 300 328 V2.1.1
Tested by: EHA
Date: 27 February 2017
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

Test result: PASS
Measurement uncertainty: ± 2.24E+05 Hz Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 V2.1.1 clause 5.4.7.2.1

The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal. The Occupied Channel Bandwidth shall fall completely within the assigned band.

In addition, for non-adaptive systems using wide band modulations other than FHSS and with E.I.R.P greater than 10 dBm, the occupied channel bandwidth shall be less than 20 MHz.

The measurements are done under normal test conditions. The transmitter is connected via the 50 Ω - power attenuator to the measuring equipment.

Test results

Table 7: Occupied Channel Bandwidth

DUT Frequency (MHz)	Nominal Bandwidth (MHz)	Channel Center Frequency (MHz)	Occupied Channel Bandwidth (MHz)	Result	Comment
2402.000000	2.000000	2401.94210	1.111432706	PASS	< 10 dBm EIRP
2480.000000	2.000000	2479.94210	1.111432706	PASS	< 10 dBm EIRP

Figure 1: 99% OBW Channel Low

Figure 2: 99% OBW Channel High

Transmitter unwanted spurious emissions in the out-of-band domain

Standard: EN 300 328 V2.1.1
Tested by: EHA
Date: 27 February 2017
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

Test result: **PASS**
Measurement uncertainty: ± 1.39 dB Level of confidence 95 % (k = 2)

Test plan

Measurements are performed according to ETSI EN 300 328 V2.1.1 clause 5.4.8.2.1

Transmitter unwanted emissions in the out-of-band domain are emissions when the equipment is in Transmit mode, on frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious.

The transmitter is connected via the 50 Ω -power attenuator to a spectrum analyzer. The out-of-band spurious emissions are measured by using the time domain power function of the spectrum analyzer.

Test results

Table 8: Transmitter unwanted emissions in the out-of-band domain

DUT Frequency (MHz)	Nominal Bandwidth (MHz)	Frequency (MHz)	Level (dBm)	Limit (dBm)	Result
2402.000000	2.000000	2398.298275	-43.3	-20.0	PASS
2402.000000	2.000000	2398.399138	-43.5	-20.0	PASS
2402.000000	2.000000	2399.399138	-42.4	-10.0	PASS
2402.000000	2.000000	2399.500000	-41.9	-10.0	PASS
2402.000000	2.000000	2484.000000	-60.5	-10.0	PASS
2402.000000	2.000000	2484.100862	-68.8	-10.0	PASS
2402.000000	2.000000	2485.100862	-60.6	-20.0	PASS
2402.000000	2.000000	2485.201725	-60.3	-20.0	PASS
2480.000000	2.000000	2398.304274	-61.4	-20.0	PASS
2480.000000	2.000000	2398.402137	-61.5	-20.0	PASS
2480.000000	2.000000	2399.402137	-61.6	-10.0	PASS
2480.000000	2.000000	2399.500000	-61.4	-10.0	PASS
2480.000000	2.000000	2484.000000	-46.3	-10.0	PASS
2480.000000	2.000000	2484.097863	-49.1	-10.0	PASS
2480.000000	2.000000	2485.097863	-49.6	-20.0	PASS
2480.000000	2.000000	2485.195726	-49.5	-20.0	PASS

Transmitter unwanted spurious emissions in the spurious domain

Standard: EN 300 328 V2.1.1
Tested by: RRE / EHA
Date: 20 - 22 February 2017
Temperature: 23 ± 3 °C
Humidity: 20 - 60 % RH

Test result: **PASS**
Measurement uncertainty: Radiated: ± 5.29 dB Level of confidence 95 % (k = 2)
Conducted: ± 2.05dB

Test plan

Measurements are performed according to ETSI EN 300 328 V2.1.1 clause 5.4.9.2

Transmitter unwanted emissions in the spurious domain are emissions outside the allocated band and outside the Out-of-band Domain when the equipment is in transmit mode.

The transmitter is operating at the maximum rated carrier power. First all frequencies where a spurious emission component is detected are recorded in both measuring antenna polarization. Then each spurious frequency level is measured. The highest level of the spurious component is searched by rotating transmitter 360º with both measuring antenna polarization.

The spurious emissions are measured under normal conditions. Test will be made in lowest and highest operation frequencies. Emissions are measured in the frequency range 30 - 12 750 MHz.

Test results

Radiated test results, BGM11S2A:

Table 9: Radiated transmitter unwanted spurious emissions in the spurious domain (ch low)

Frequency (MHz)	Detector	Result (dBm)	Polarization	Margin (dB)	RMS Limit (dBm)	Result	Notes
4804.50	Peak	-43.9	H	13.9	-30	PASS	-

Table 10: Radiated transmitter unwanted spurious emissions in the spurious domain (ch high)

Frequency (MHz)	Detector	Result (dBm)	Polarization	Margin (dB)	RMS Limit (dBm)	Result	Notes
4960.4375	Peak	-49.3	V	19.3	-30	PASS	-

Conducted test results, BGM11S2A:

No final measurements were made; no emissions near the limit.

Radiated test results, BGM11S2N:

Table 11: Radiated transmitter unwanted spurious emissions in the spurious domain (ch low)

Frequency (MHz)	Detector	Result (dBm)	Polarization	Margin (dB)	RMS Limit (dBm)	Result	Notes
4803.4375	Peak	-46.3	V	16.3	-30	PASS	-

Table 12: Radiated transmitter unwanted spurious emissions in the spurious domain (ch high)

Frequency (MHz)	Detector	Result (dBm)	Polarization	Margin (dB)	RMS Limit (dBm)	Result	Notes
4960.4375	Peak	-45.0	V	15.0	-30	PASS	-

Conducted test results, BGM11S2N:

No final measurements were made; no emissions near the limit.

Receiver spurious emissions

Standard: EN 300 328 V2.1.1
Tested by: RRE / EHA
Date: 20 - 22 February 2017
Temperature: 23 ± 3 °C
Humidity: 20 - 60 % RH

Test result: PASS
Measurement uncertainty: Radiated: ± 5.29 dB Level of confidence 95 % (k = 2)
Conducted: ± 2.90 dB

Test plan

Measurements are performed according to ETSI EN 300 328 V2.1.1 clause 5.4.10.2

The receiver is connected to its integrated or dedicated antenna and oriented to its normal usage position and height on the turntable in the anechoic chamber. The measurements are made with the receiver on the receiving state. First all frequencies where a spurious emission component are detected are recorded in both measuring antenna polarization. Then each spurious frequency level is measured. The highest level of the spurious component is searched by rotating transmitter 360º with both measuring antenna polarization.

The receiver spurious emissions are measured under normal conditions. Test will be made in lowest and highest operation frequencies. Emissions are measured in the frequency range 30 - 12 750 MHz.

Test results

Radiated test results, BGM11S2A:

No final measurements were made; no emissions near the limit.

Conducted test results, BGM11S2A:

No final measurements were made; no emissions near the limit.

Radiated test results, BGM11S2N:

Table 13: Radiated receiver spurious emissions (ch low)

Frequency (MHz)	Detector	Result (dBm)	Polarization	Margin (dB)	RMS Limit (dBm)	Result	Notes
180.010500	Peak	-66.1	V	9.1	-57	PASS	
300.024500	Peak	-58.6	H	1.6	-57	PASS	

Table 14: Radiated receiver spurious emissions (ch high)

Frequency (MHz)	Detector	Result (dBm)	Polarization	Margin (dB)	RMS Limit (dBm)	Result	Notes
300.024500	Peak	-58.7	H	1.7	-57	PASS	

Conducted test results, BGM11S2N:

No final measurements were made; no emissions near the limit.

Receiver Blocking

Standard: EN 300 328 V2.1.1
Tested by: EHA
Date: 5 April 2017
Temperature: 23 ± 3 °C
Humidity: 20 - 75 % RH

Test result: **PASS**

Test plan

Measurements are performed according to ETSI EN 300 328 V2.1.1 clause 5.4.11.2.1

Minimum performance criteria:
Packet error rate (PER) shall be less than or equal to 10%.
The tests were performed while the EUT was set to low and high channels.
Antenna gain of the EUT was added to the test signal level.

Test results

Table 15: Receiver blocking results, receiver category 2

Blocking signal frequency (MHz)	Blocking signal power (dBm)	Type of blocking signal	Result
2380.0	-57	CW	PASS
2503.5	-57	CW	PASS
2300.0	-47	CW	PASS
2583.5	-47	CW	PASS

RF Test Equipment

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
PREAMPLIFIER	CIAO	CA118-3123	inv:10278	2016-11-28	2017-11-28
DC-POWER SUPPLY	DELTA ELEKTRONIKA	SM 130-25D	sn:03494	-	-
ANTENNA	EMCO	3117	inv:7293	2016-03-16	2018-03-06
TURNTABLE	MATURO	DS430 UPGRADED	inv:10182	-	-
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv:10183	-	-
ANTENNA MAST	MATURO	TAM 4.0E	inv:10181	-	-
ULTRA BROAD BAND POWER DIVIDER	NARDA	4426LB-4	inv:8033	2016-01-21	2018-01-21
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-	-
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESU 26	inv:8453	2016-06-10	2017-06-10
SIGNAL ANALYZER	ROHDE & SCHWARZ	FSV40	inv:9093	2016-06-10	2017-06-10
SWITCH UNIT	ROHDE & SCHWARZ	OSP 120	inv:9289	2016-03-14	2019-03-14
RF SIGNAL GENERATOR	ROHDE & SCHWARZ	SMB100A	inv:9288	2017-02-10	2020-02-10
VECTOR SIGNAL GENERATOR	ROHDE & SCHWARZ	SMBV100A	inv:9290	2016-06-09	2019-06-09
ANTENNA	SCHWARZBECK	VULB 9168	inv:8911	2016-10-25	2018-10-25
HIGH PASS FILTER	WAINWRIGHT	WHKX4.0/18G-10SS	sn:10	2016-01-22	2018-01-22
ATTENUATOR	HUBER&SUHNER	6610.19.AA	sn:RF ATTEN 07	2016-02-02	2018-02-02