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## Report On

FCC Testing of the Sharp SHV31 Dual-band UMTS (FDDI, FDDV) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Quad-band LTE (B1,B3, B17, B26) & AXGP (TDD41) multi mode cellular phone with Bluetooth, ANT+, WLAN, SRD (NFC, FeliCa) and GPS  
In accordance with FCC CFR 47 Part 2 and FCC CFR 47 Part 24 (PCS 1900)

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FCC ID: APYHRO00214

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November 2014



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**REPORT ON**

FCC Testing of the Sharp SHV31 Dual-band UMTS (FDDI, FDDV) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Quad-band LTE (B1,B3, B17, B26) & AXGP (TDD41) multi mode cellular phone with Bluetooth, ANT+, WLAN, SRD (NFC, FeliCa) and GPS  
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November 2014

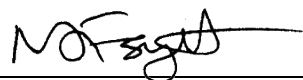
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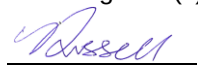
23 December 2014

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**ENGINEERING STATEMENT**

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC CFR 47 Part 2 and FCC CFR 47 Part 24. The sample tested was found to comply with the requirements defined in the applied rules.

Test Engineer(s);

  
M Russell

  
T Guy



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## **SECTION 1**

### **REPORT SUMMARY**

FCC Testing of the  
Sharp SHV31 Dual-band UMTS (FDDI, FDDV) & Quad-band GSM  
(GSM850/GSM900/DCS1800/PCS1900) & Quad-band LTE (B1,B3, B17, B26) & AXGP  
(TDD41) multi mode cellular phone with Bluetooth, ANT+, WLAN, SRD (NFC, FeliCa) and GPS  
In accordance with FCC CFR 47 Part 2 and FCC CFR 47 Part 24 (PCS 1900)



## 1.1 INTRODUCTION

The information contained in this report is intended to show the verification of FCC Testing of the Sharp SHV31 Dual-band UMTS (FDDI, FDDV) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Quad-band LTE (B1,B3, B17, B26) & AXGP (TDD41) multi mode cellular phone with Bluetooth, ANT+, WLAN, SRD (NFC, FeliCa) and GPS to the requirements of FCC CFR 47 Part 2 and FCC CFR 47 Part 24.

|                               |                                                                                                                                                     |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Objective                     | To perform FCC Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out. |
| Manufacturer                  | Sharp Corporation                                                                                                                                   |
| Model Number(s)               | SHV31                                                                                                                                               |
| Serial Number(s)              | IMEI 004401115315372<br>IMEI 004401115315331                                                                                                        |
| Number of Samples Tested      | 2                                                                                                                                                   |
| Test Specification/Issue/Date | FCC CFR 47 Part 2 (2013)<br>FCC CFR 47 Part 24 (2013)                                                                                               |
| Disposal                      | Held Pending Disposal                                                                                                                               |
| Reference Number              | Not Applicable                                                                                                                                      |
| Date                          | Not Applicable                                                                                                                                      |
| Order Number                  | 10329                                                                                                                                               |
| Date                          | 20 October 2014                                                                                                                                     |
| Start of Test                 | 10 November 2014                                                                                                                                    |
| Finish of Test                | 15 November 2014                                                                                                                                    |
| Name of Engineer(s)           | M Russell<br>T Guy                                                                                                                                  |
| Related Document(s)           | ANSI C63.4: 2003                                                                                                                                    |



## 1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC CFR 47 Part 2 and FCC CFR 47 Part 24 is shown below.

| Section  | Spec Clause |                   | Test Description                                 | Result | Comments/Base Standard |
|----------|-------------|-------------------|--------------------------------------------------|--------|------------------------|
|          | Pt 2        | Pt 24             |                                                  |        |                        |
| PCS 1900 |             |                   |                                                  |        |                        |
| 2.1      | 2.1055      | 24.235            | Frequency Stability                              | Pass   |                        |
| 2.2      | 2.1051      | 24.229 and 24.238 | Spurious Emissions at Band Edge                  | Pass   |                        |
| 2.3      | -           | 24.232(c)         | Effective Isotropic Radiated Power               | Pass   |                        |
| 2.4      | 2.1046      | 24.232            | Maximum Peak Output Power - Conducted            | Pass   |                        |
| 2.5      | 2.1047(d)   |                   | Modulation Characteristics                       | -      | Customer Declaration   |
| 2.6      | 2.1051      | 24.238            | Emission Limitations for Broadband PCS Equipment | Pass   |                        |
| 2.7      | 2.1051      | 24.238(a)         | Conducted Spurious Emissions                     | Pass   |                        |
| 2.8      | 2.1049(h)   | 24.238(b)         | Emission Bandwidth                               | Pass   |                        |



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### **1.3 PRODUCT TECHNICAL DESCRIPTION**

Please refer to the SHV31 Model Description Form.

### **1.4 PRODUCT INFORMATION**

#### **1.4.1 Technical Description**

The Equipment Under Test (EUT) was a Sharp SHV31 Dual-band UMTS (FDDI, FDDV) & Quad-band GSM (GSM850/GSM900/DCS1800/PCS1900) & Quad-band LTE (B1,B3, B17, B26) & AXGP (TDD41) multi mode cellular phone with Bluetooth, ANT+, WLAN, SRD (NFC, FeliCa) and GPS. A full technical description can be found in the manufacturer's documentation.

### **1.5 TEST CONDITIONS**

For all tests the EUT was set up in accordance with the relevant test standard and to represent typical operating conditions. Tests were applied with the EUT situated in a shielded enclosure.

The EUT was powered from a 4.0 V DC supply.

FCC Measurement Facility Registration Number  
90987 Octagon House, Fareham Test Laboratory

### **1.6 DEVIATIONS FROM THE STANDARD**

No deviations from the applicable test standard were made during testing.

### **1.7 MODIFICATION RECORD**

Modification 0 - No modifications were made to the test sample during testing.



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## **SECTION 2**

### **TEST DETAILS**

FCC Testing of the  
Sharp SHV31 Dual-band UMTS (FDDI, FDDV) & Quad-band GSM  
(GSM850/GSM900/DCS1800/PCS1900) & Quad-band LTE (B1,B3, B17, B26) & AXGP  
(TDD41) multi mode cellular phone with Bluetooth, ANT+, WLAN, SRD (NFC, FeliCa) and GPS  
In accordance with FCC CFR 47 Part 2 and FCC CFR 47 Part 24 (PCS 1900)



Product Service

## **2.1 FREQUENCY STABILITY**

### **2.1.1 Specification Reference**

FCC CFR 47 Part 2, Clause 2.1055  
FCC CFR 47 Part 24, Clause 24.235

### **2.1.2 Equipment Under Test and Modification State**

SHV31 S/N: IMEI 004401115315372 - Modification State 0

### **2.1.3 Date of Test**

15 November 2014

### **2.1.4 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.1.5 Test Procedure**

The test was applied in accordance with the test method requirements of FCC CFR 47 Part 24.135(a) and FCC CFR 47 Part 2.1055.

The EUT was configured in a GSM circuit switched voice call using GMSK modulation at maximum output power on the middle channel using a communications test set. The communications test set was connected to an external 10 MHz rubidium frequency standard to increase accuracy of the measurement. The Tx measurement function of the communications tester was then used and the maximum frequency error was then recorded.

### **2.1.6 Environmental Conditions**

|                     |        |
|---------------------|--------|
| Ambient Temperature | 21.4°C |
| Relative Humidity   | 48.4%  |



### 2.1.7 Test Results

4.0 V DC Supply

Under Temperature Variations

1880.0 MHz

| Temperature Interval (°C) | Mode | Deviation (ppm) |
|---------------------------|------|-----------------|
| -30                       | GMSK | 0.027           |
| -20                       | GMSK | 0.029           |
| -10                       | GMSK | 0.028           |
| 0                         | GMSK | 0.031           |
| +10                       | GMSK | 0.031           |
| +20                       | GMSK | 0.030           |
| +30                       | GMSK | 0.031           |
| +40                       | GMSK | 0.034           |
| +50                       | GMSK | 0.031           |

Under Voltage Variations

1880.0 MHz

| DC Voltage (V) | Mode | Deviation (ppm) |
|----------------|------|-----------------|
| 4.0            | GMSK | 0.030           |
| 3.7            | GMSK | 0.032           |

Limit Clause

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorised frequency block.



## **2.2 SPURIOUS EMISSIONS AT BAND EDGE**

### **2.2.1 Specification Reference**

FCC CFR 47 Part 2, Clause 2.1051  
FCC CFR 47 Part 24, Clause 24.229 and 24.238

### **2.2.2 Equipment Under Test and Modification State**

SHV31 S/N: IMEI 004401115315372 - Modification State 0

### **2.2.3 Date of Test**

14 November 2014

### **2.2.4 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.2.5 Test Procedure**

Measurements were performed in accordance with KDB 971168 v02r02 clause 6.

The EUT was connected to a spectrum analyser via a cable, combiner and attenuator. The other port of the combiner was connected to a communications test set which was configured with a circuit switched voice call at maximum output power. The path loss was calibrated using a vector network analyser and was entered as a reference level offset on the spectrum analyser. Using a peak detector and max hold with an RBW not less than 1% of the emission bandwidth it was verified that all emissions in the 1 MHz immediately adjacent to the authorized bandwidth were below  $43 + 10 \log(P)$ .

### **2.2.6 Environmental Conditions**

|                     |        |
|---------------------|--------|
| Ambient Temperature | 22.3°C |
| Relative Humidity   | 47.8%  |



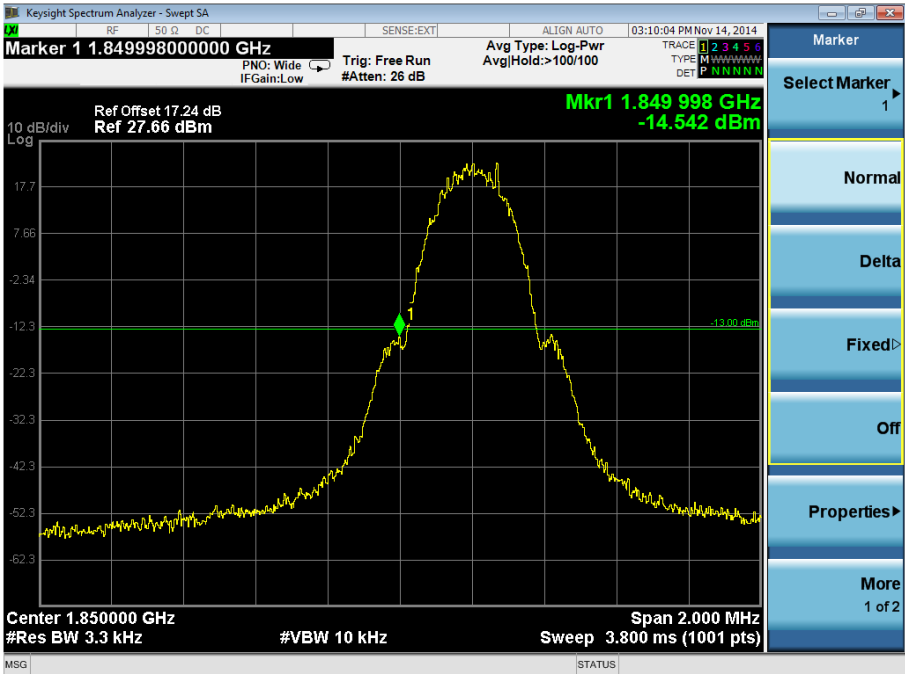
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2.2.7 Test Results

4.0 V DC Supply

| Frequency Block (MHz) | Mode | Lower Block Edge Test Channels/Frequencies | Upper Block Edge Test Channels/Frequencies |
|-----------------------|------|--------------------------------------------|--------------------------------------------|
| A :(1850 - 1865)      | GMSK | Channel : 512<br>Frequency : 1850.2 MHz    | N/A                                        |
| C :(1895 - 1910)      | GMSK | N/A                                        | Channel : 810<br>Frequency : 1909.8 MHz    |

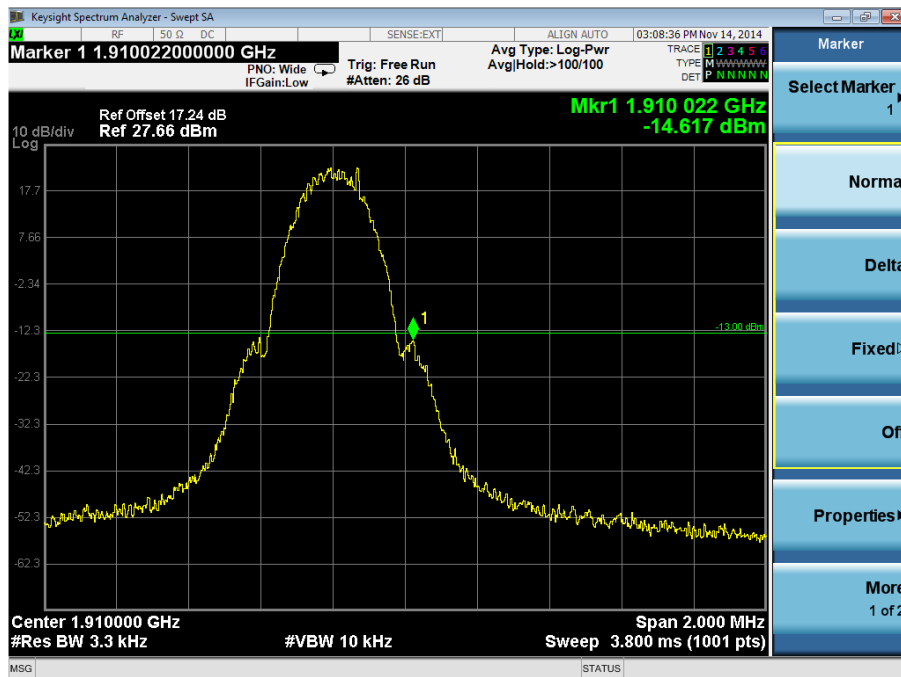
Frequency Block A





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### Frequency Block C



### Limit Clause

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.



## **2.3 EFFECTIVE ISOTROPIC RADIATED POWER**

### **2.3.1 Specification Reference**

FCC CFR 47 Part 24, Clause 24.232(c)

### **2.3.2 Equipment Under Test and Modification State**

SHV31 S/N: IMEI 004401115315331 - Modification State 0

### **2.3.3 Date of Test**

15 November 2014

### **2.3.4 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.3.5 Test Procedure**

Measurements of the fundamental from the EUT were obtained with the Measurement Antenna in both Horizontal and Vertical Polarisations. The fundamental frequency was maximised by adjusting the antenna height, antenna polarisation and turntable azimuth. A peak detector was used with the trace set to max hold. The maximum result was recorded.

The EUT was then removed from the chamber and replaced with a substitution antenna. Using a signal generator the level was adjusted to achieve the same value on the measuring instrument as previously recorded with the EUT. The final result (ERP) was determined by a calculation using the signal generator level, antenna gain and cable loss.

The measurements were performed at a 3m distance unless otherwise stated.

### **2.3.6 Environmental Conditions**

|                     |        |
|---------------------|--------|
| Ambient Temperature | 20.3°C |
| Relative Humidity   | 47.0%  |

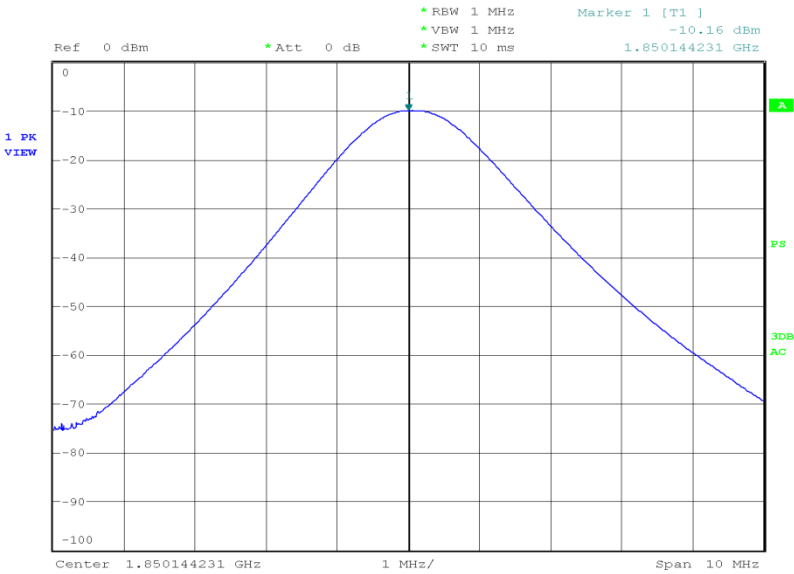


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2.3.7 Test Results

1850.2 MHz

| Result (dBm) | Result (W) |
|--------------|------------|
| 31.88        | 1.541      |



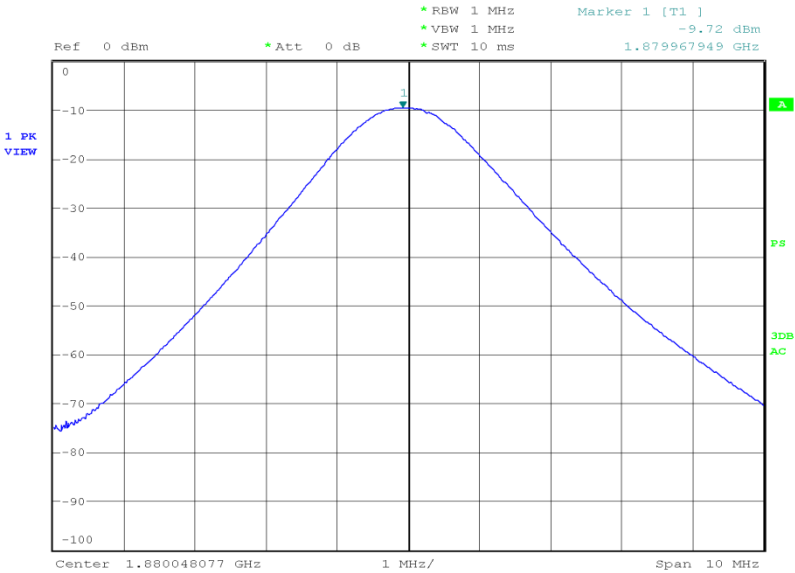
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1880.0 MHz

| Result (dBm) | Result (W) |
|--------------|------------|
| 32.66        | 1.845      |



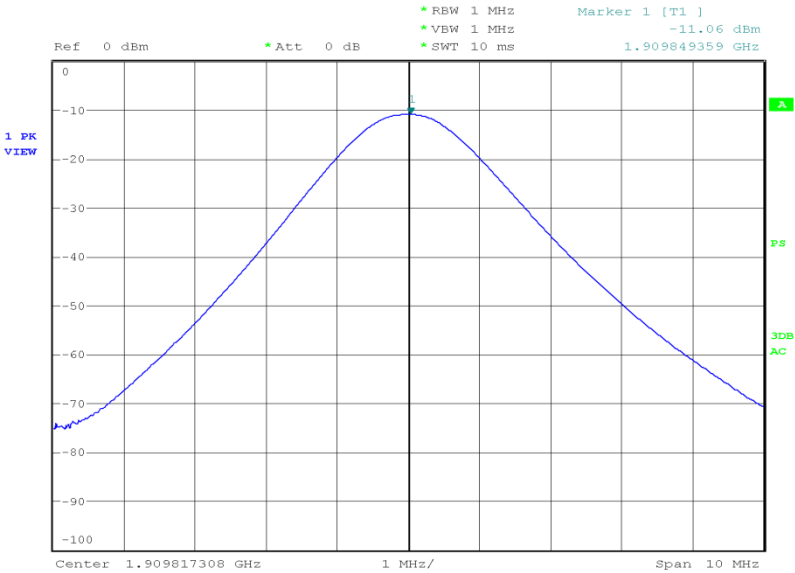
Date: 15.NOV.2014 00:02:51



Product Service

1909.8 MHz

| Result (dBm) | Result (W) |
|--------------|------------|
| 31.0         | 1.258      |



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Limit Clause

Mobile and portable stations are limited to 2 Watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.



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## **2.4 MAXIMUM PEAK OUTPUT POWER - CONDUCTED**

### **2.4.1 Specification Reference**

FCC CFR 47 Part 2, Clause 2.1046  
FCC CFR 47 Part 24, Clause 24.232

### **2.4.2 Equipment Under Test and Modification State**

SHV31 S/N: IMEI 004401115315372 - Modification State 0

### **2.4.3 Date of Test**

10 November 2014

### **2.4.4 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.4.5 Test Procedure**

This test was performed with the test method requirements as stated in KDB 971168 D01 v02r01 clause 5.1.2.

The EUT was connected to a broadband peak power meter via a cable, combiner and attenuator. The other port of the combiner was connected to a communications test set which was configured with a circuit switched voice call at maximum output power. The path loss was calibrated using a vector network analyser and was entered as an offset on the power meter. The peak power was then recorded as shown in the table below.

### **2.4.6 Environmental Conditions**

|                     |        |
|---------------------|--------|
| Ambient Temperature | 22.2°C |
| Relative Humidity   | 46.9%  |



## 2.4.7 Test Results

4.0 V DC Supply

### 1850.2 MHz

| Mode | Result (dBm) | Result (W) |
|------|--------------|------------|
| GMSK | 29.23        | 0.838      |

### 1880.0 MHz

| Mode | Result (dBm) | Result (W) |
|------|--------------|------------|
| GMSK | 29.32        | 0.855      |

### 1909.8 MHz

| Mode | Result (dBm) | Result (W) |
|------|--------------|------------|
| GMSK | 29.38        | 0.867      |

### Limit Clause

Mobile and portable stations are limited to 2 Watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.



## 2.5 MODULATION CHARACTERISTICS

### 2.5.1 Specification Reference

FCC CFR 47 Part 2 and FCC CFR 47 Part 24, Clause 2.1047(d)

### 2.5.2 Equipment Under Test

SHV31

### 2.5.3 Test Results

#### Customer Description

#### Description Of Modulation Technique

The modulation scheme used in GSM is called Gaussian Minimum Shift Keying (GMSK). GMSK facilitates the use of narrow bandwidth and allows for both coherent and non coherent detection capabilities. It is a scheme in which the transitions from One to Zero or Zero to One do not occur quickly, but over a period of time. If pulses are transmitted quickly harmonics are transmitted. The power spectrum for a square wave is rich in harmonics, and the power within the side lobes is wasted, and can be a cause of potential interference.

A method to reduce the harmonics is to round off the edges of the pulses thus lowering the spectral components of the signal. In GSM this is done by using a Gaussian pre-filter which typically has a bandwidth of 81.25kHz. The output from the Gaussian filter then phase modulates the carrier. As there are no dramatic phase transitions of the carrier this gives a constant envelope and low spectral component output from the transmitter.

The spectral efficiency is calculated by

$\text{bit rate} / \text{Channel bandwidth} = 270.83333 \text{ kbit/s} / 200 \text{ kHz} = 1.354 \text{ bit/s/Hz}.$

The bandwidth product  $BT = \text{Bandwidth} \times \text{bit duration} = 81.25 \text{ kHz} \times 3.6923 \text{ micros} = 0.3$

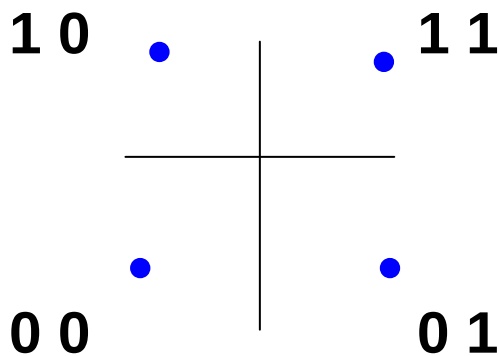
### **GMSK OVERVIEW**

The modulation scheme used for the EUT is GMSK.

A brief overview of how GMSK works is shown below.

#### **GMSK (Gaussian Minimum Shift Keying)**

The fundamental principal behind GMSK is Phase shift keying. This splits a data stream into a series of 2-digit phase shifts, using the following phase shifts to represent data pairs.



Therefore for the BIT sequence 0 0 1 1 1 0 0 1 The corresponding phase shift will be used

|              |      |     |      |      |
|--------------|------|-----|------|------|
| BIT SEQUENCE | 0 0  | 1 1 | 1 0  | 0 1  |
| PHASE        | 225° | 45° | 135° | 315° |

This is called QPSK (Quadratic Phase Shift Keying)

#### However

There is a problem with QPSK: transition from e.g. 00 to 11 gives phase shift of  $180^\circ$  ( $\pi$  radians). This has the effect of inverting the carrier waveform and this can lead to detection errors at the receiver.

Solution: restrict phase changes to  $\pm 90^\circ$

1. Split bitstream into 2 streams e.g.

|          | 0 0 |   | 1 1 |   | 0 1 |   | 1 0 |   |
|----------|-----|---|-----|---|-----|---|-----|---|
| I Stream | 0   |   | 1   |   | 0   |   | 1   |   |
| Q stream |     | 0 |     | 1 |     | 1 |     | 0 |

2. Modulate each stream with PSK (1 =  $90^\circ$  or  $\pi/2$ , 0 =  $-90^\circ$  or  $-\pi/2$  phase shift)

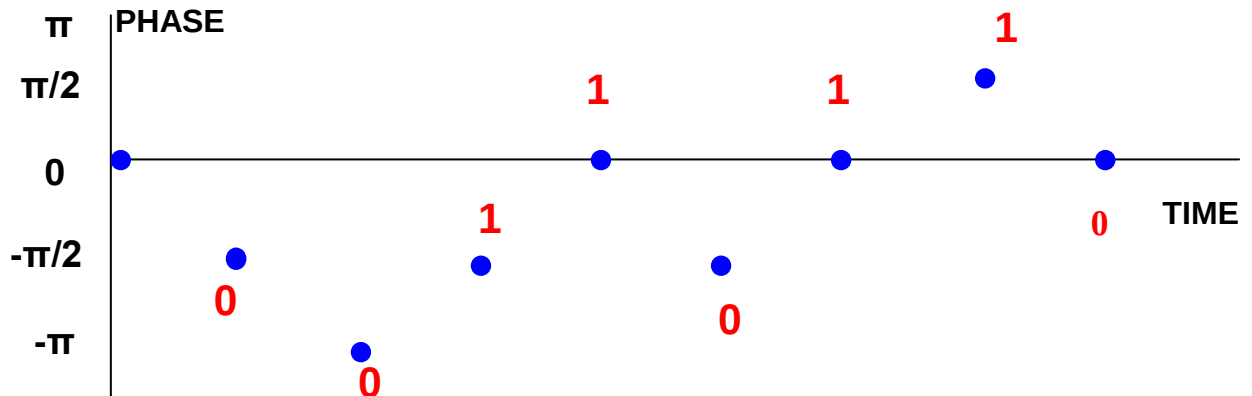
|          |          |          |          |         |          |         |         |          |
|----------|----------|----------|----------|---------|----------|---------|---------|----------|
| I Stream | 0        |          | 1        |         | 0        |         | 1       |          |
|          | $-\pi/2$ |          | $-\pi/2$ |         | $-\pi/2$ |         | $\pi/2$ |          |
| Q stream |          | 0        |          | 1       |          | 1       |         | 0        |
|          |          | $-\pi/2$ |          | $\pi/2$ |          | $\pi/2$ |         | $-\pi/2$ |



3. Combine (add) the two PSK signals:

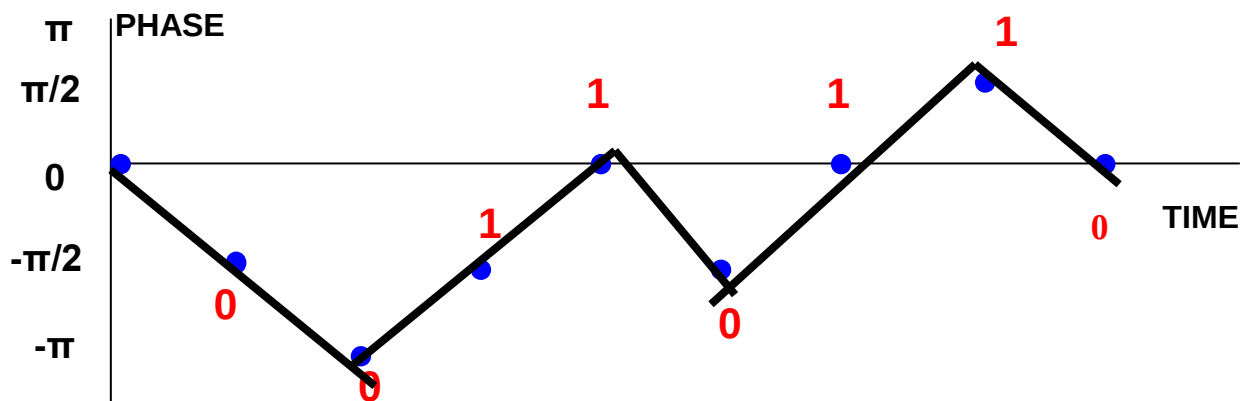
| Combined Phase | $-\pi/2$ | $-\pi$ | $-\pi/2$ | 0 | $-\pi/2$ | 0 | $\pi/2$ | 0 |
|----------------|----------|--------|----------|---|----------|---|---------|---|
|----------------|----------|--------|----------|---|----------|---|---------|---|

Result: offset - QPSK, phase change is restricted to  $\pm \pi/2$  radians:



It would be preferable to have "gradual" changes in place between each pair of bits (Continuous-phase modulation). Replacing each "rectangular" shaped pulse (for 1 or 0) with a sinusoidal pulse can do this:

Result: Minimum Shift Keying (MSK):



#### Gaussian Minimum Shift Keying

MSK has high sidebands relative to the main lobes in the frequency domain - this can lead to interference with adjacent signals.

If the rectangular pulses corresponding to the bitstream are filtering using a Gaussian-shaped impulse response filter, we get Gaussian MSK (GMSK) - this has low sidelobes compared to MSK.

#### Limit Clause

A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.



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## **2.6 EMISSION LIMITATIONS FOR BROADBAND PCS EQUIPMENT**

### **2.6.1 Specification Reference**

FCC CFR 47 Part 2, Clause 2.1051  
FCC CFR 47 Part 24, Clause 24.238

### **2.6.2 Equipment Under Test and Modification State**

SHV31 S/N: IMEI 004401115315331 - Modification State 0

### **2.6.3 Date of Test**

15 November 2014

### **2.6.4 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.6.5 Test Procedure**

A preliminary profile of the Spurious Radiated Emissions was obtained up to the 10th harmonic by operating the EUT on a remotely controlled turntable within a semi-anechoic chamber. Measurements of emissions from the EUT were obtained with the Measurement Antenna in both Horizontal and Vertical Polarisations. The profiling produced a list of the worst-case emissions together with the EUT azimuth and antenna polarisation.

Using the information from the preliminary profiling of the EUT, the list of emissions was then confirmed or updated under Alternative Open Site conditions. Emission levels were maximised by adjusting the antenna height, antenna polarisation and turntable azimuth.

The EUT was set to transmit on maximum power with modulation. The EUT was tested on bottom, middle and top channels at maximum power.

For any emissions found the EUT was then removed from the chamber and replaced with a substitution antenna. Using a signal generator the level was adjusted to achieve the same value on the measuring instrument as previously recorded with the EUT. The final result was determined by a calculation using the signal generator level, antenna gain and cable loss.

The measurements were performed at a 3m distance unless otherwise stated.

### **2.6.6 Environmental Conditions**

|                     |        |
|---------------------|--------|
| Ambient Temperature | 20.3°C |
| Relative Humidity   | 47.0%  |



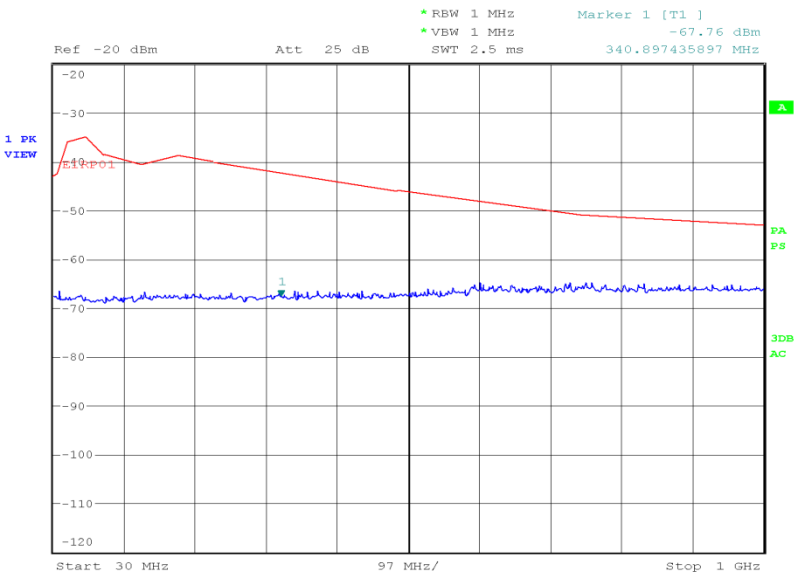
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2.6.7 Test Results

1850.2 MHz

| Frequency (MHz) | Result (dBm) | Limit (dBm) | Azimuth (degrees) | Height (cm) | Polarisation |
|-----------------|--------------|-------------|-------------------|-------------|--------------|
| 9251.00         | -28.51       | -13.00      | 80                | 140         | Vertical     |

30 MHz to 1 GHz

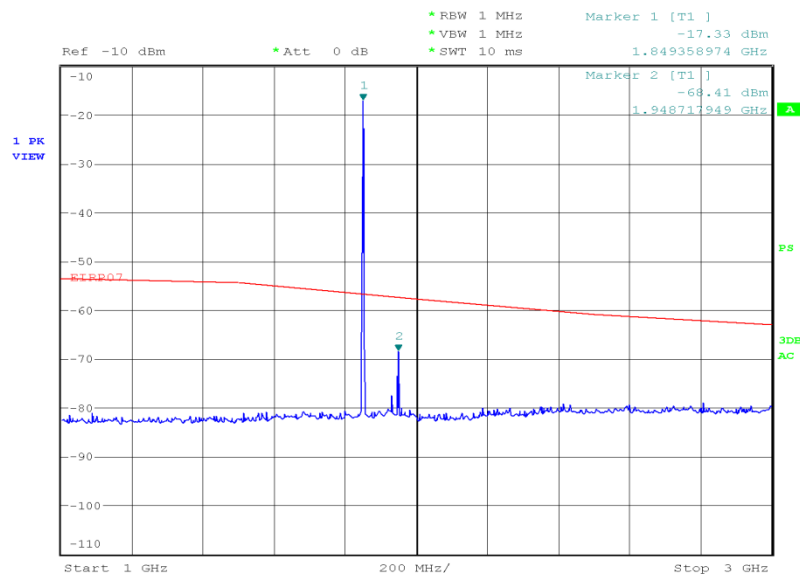


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1 GHz to 3 GHz

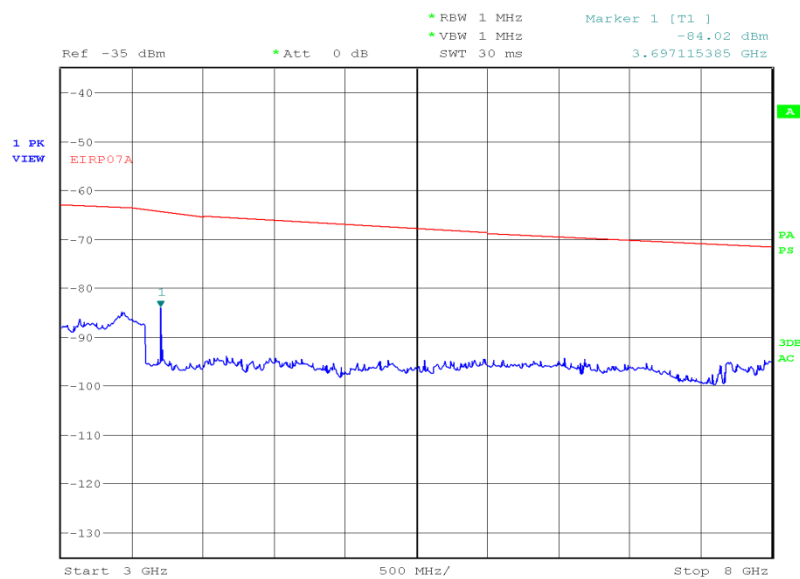


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### 3 GHz to 8 GHz

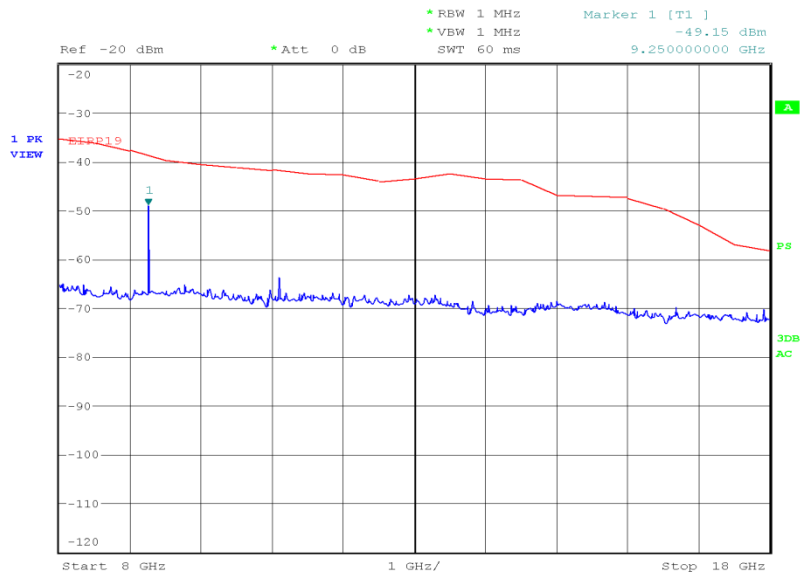


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### 8 GHz to 18 GHz



Product Service

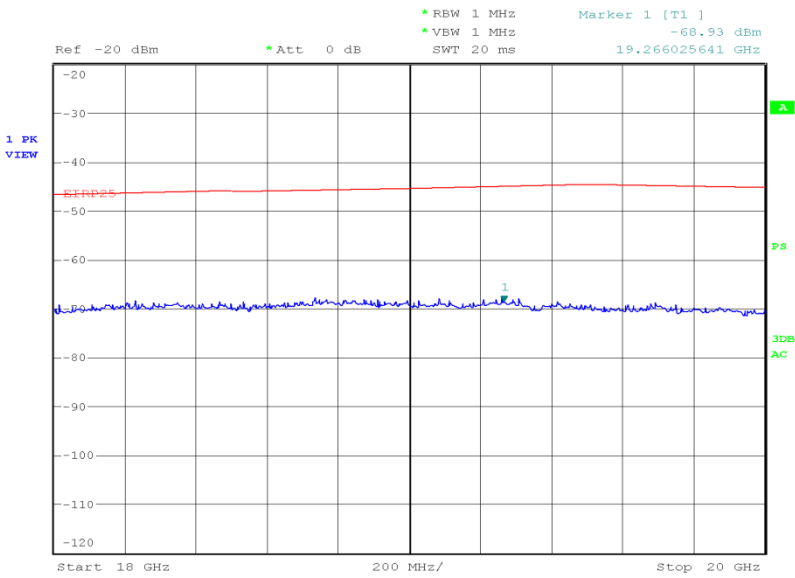


Date: 15.NOV.2014 01:41:51



Product Service

18 GHz to 20 GHz



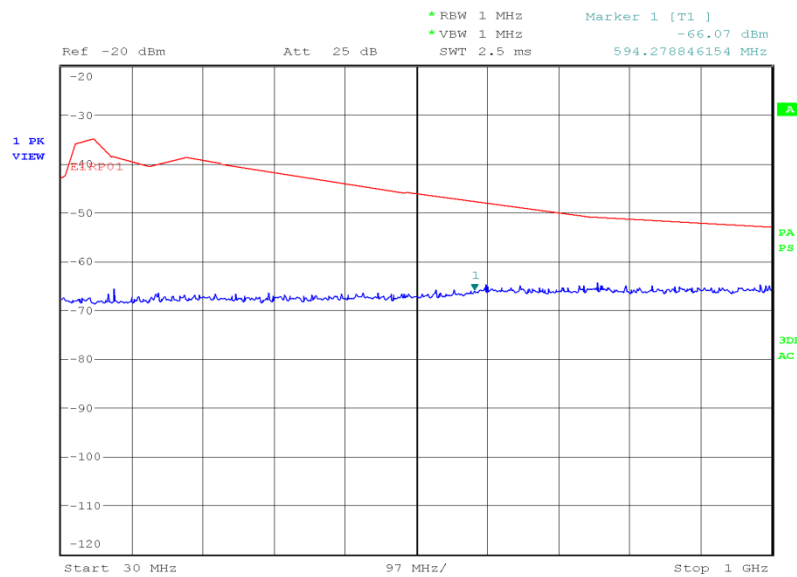
Date: 15.NOV.2014 04:20:22



1880.0 MHz

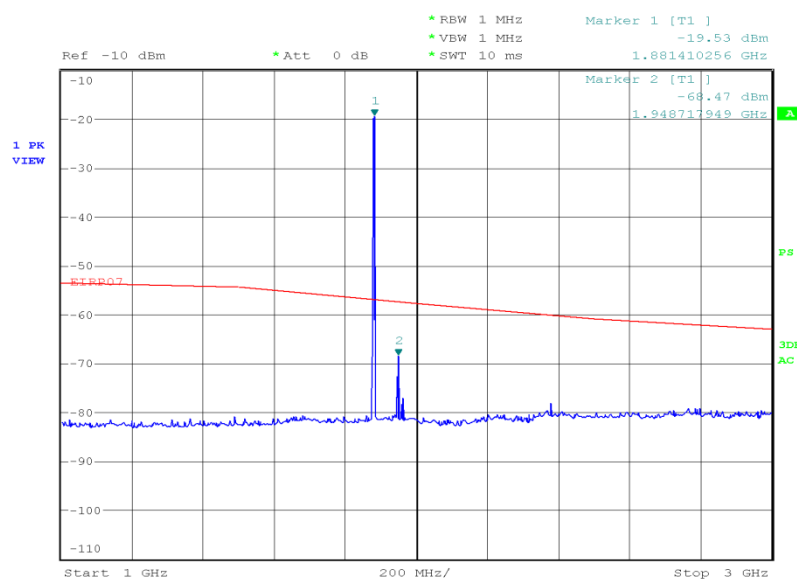
| Frequency (MHz) | Result (dBm) | Limit (dBm) | Azimuth (degrees) | Height (cm) | Polarisation |
|-----------------|--------------|-------------|-------------------|-------------|--------------|
| 9400.00         | -30.80       | -13.00      | 252               | 150         | Vertical     |

30 MHz to 1 GHz



Date: 15.NOV.2014 04:37:53

1 GHz to 3 GHz

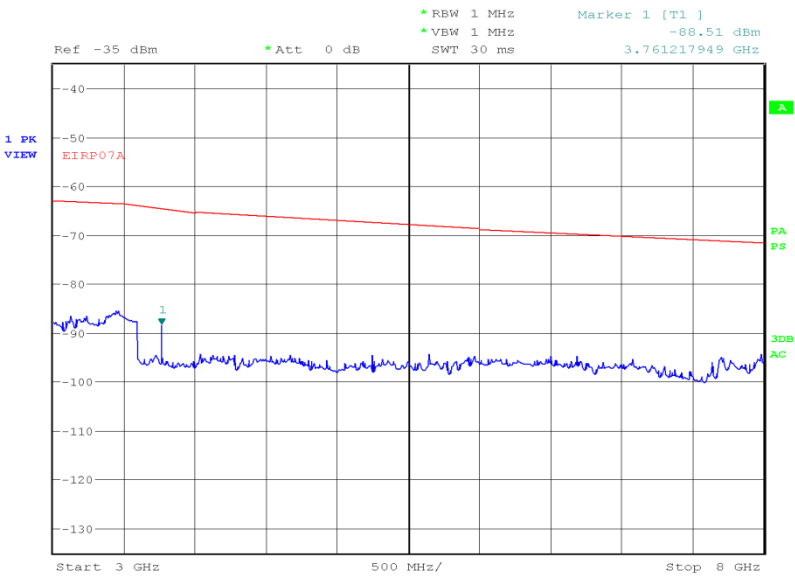


Date: 15.NOV.2014 00:24:31



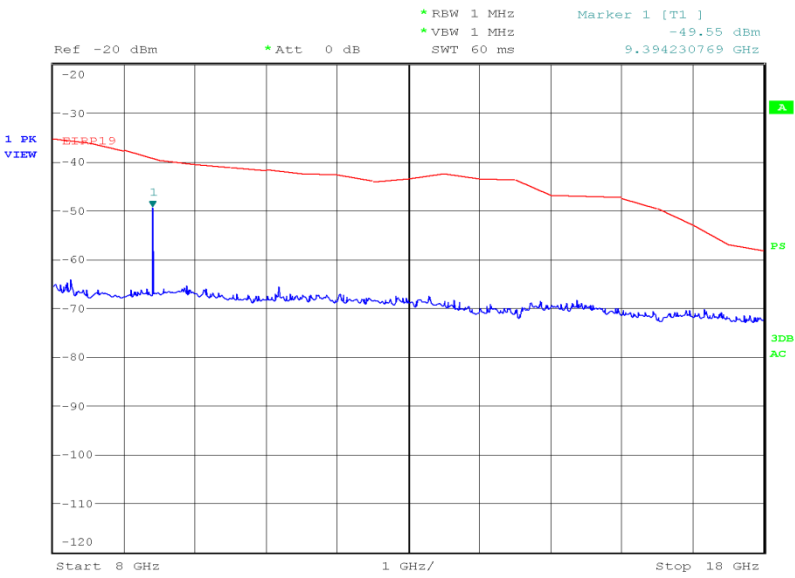
Product Service

3 GHz to 8 GHz



Date: 15.NOV.2014 01:12:53

8 GHz to 18 GHz

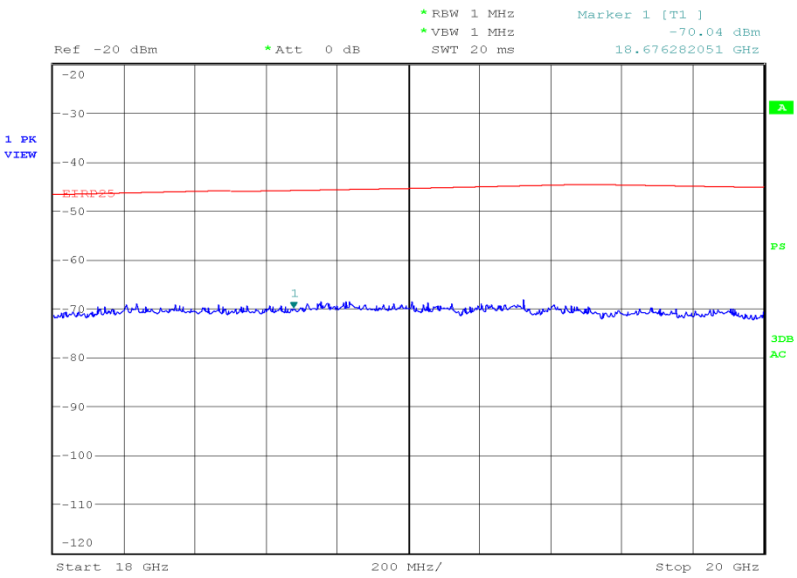


Date: 15.NOV.2014 01:54:29



Product Service

18 GHz to 20 GHz

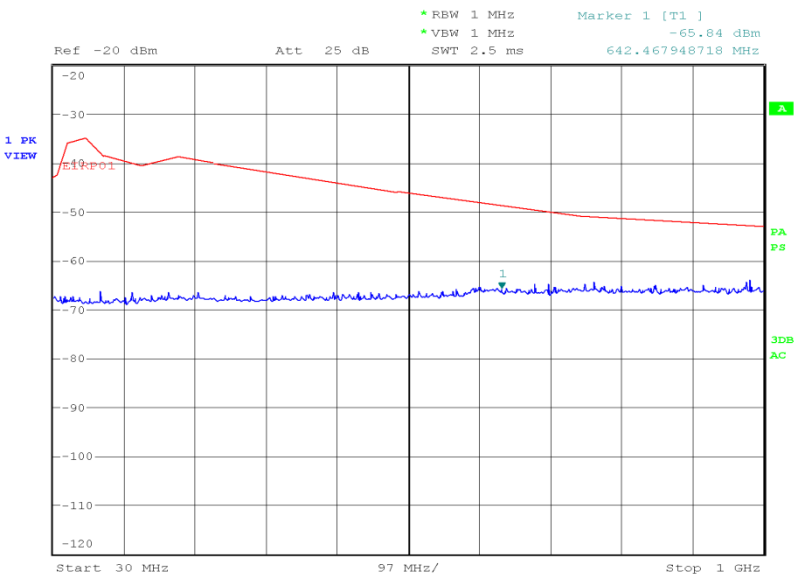


Date: 15.NOV.2014 03:37:37

1909.8 MHz

| Frequency (MHz) | Result (dBm) | Limit (dBm) | Azimuth (degrees) | Height (cm) | Polarisation |
|-----------------|--------------|-------------|-------------------|-------------|--------------|
| 9548.00         | -32.01       | -13.00      | 41                | 100         | Vertical     |

30 MHz to 1 GHz

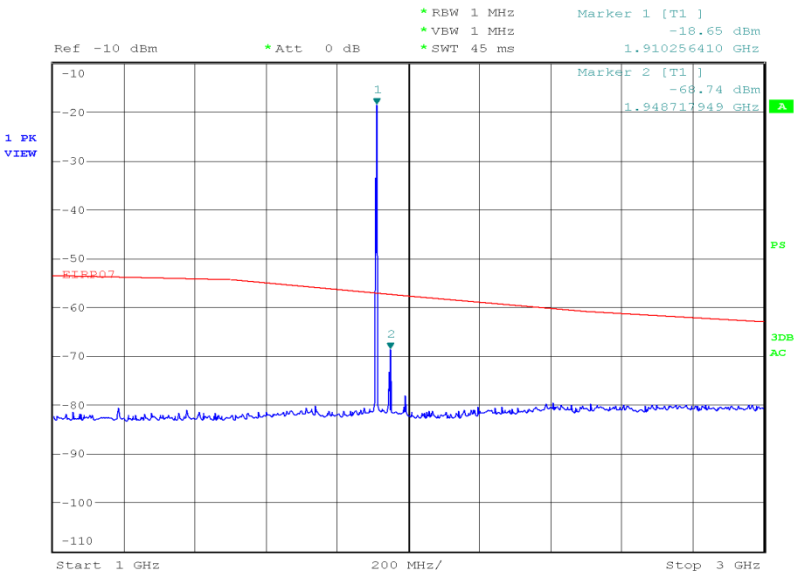


Date: 15.NOV.2014 04:45:39



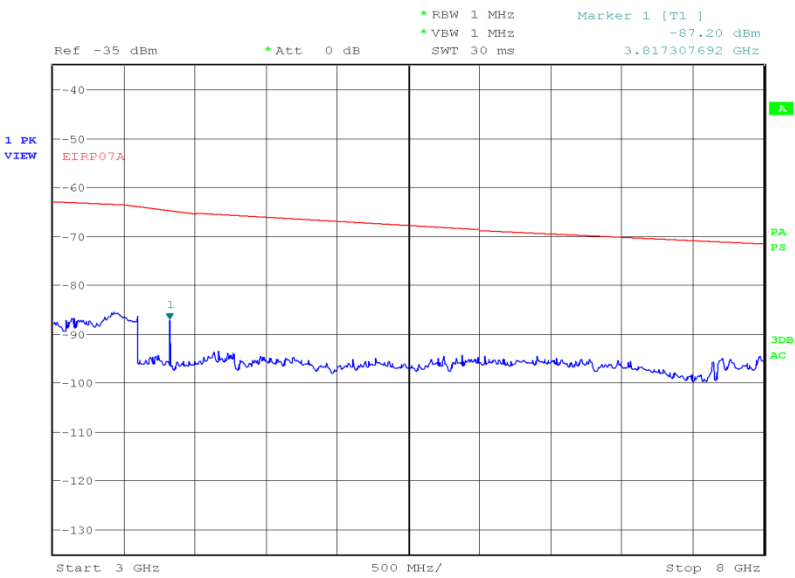
Product Service

1 GHz to 3 GHz



Date: 15.NOV.2014 00:48:45

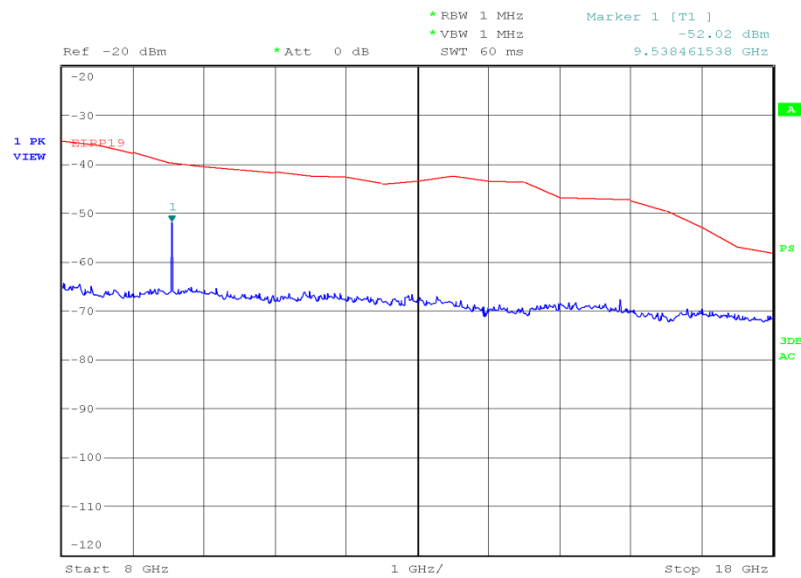
3 GHz to 8 GHz



Date: 15.NOV.2014 01:00:18

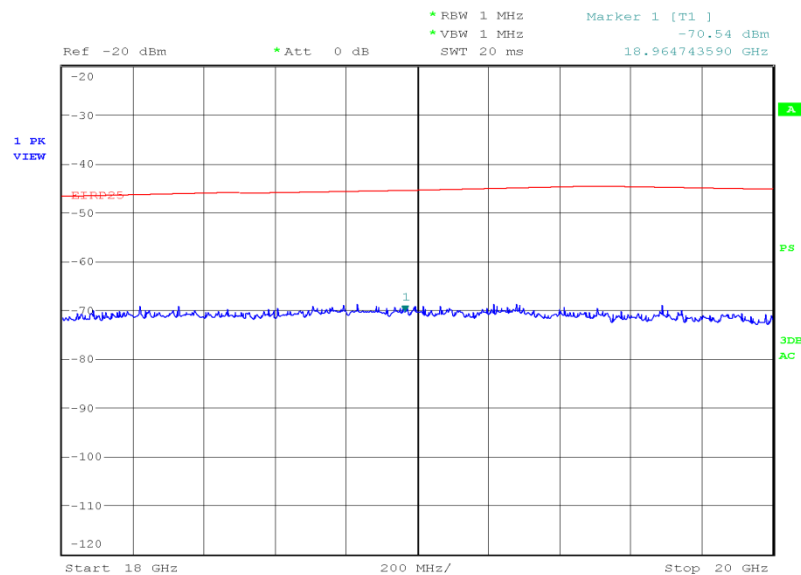


### 8 GHz to 18 GHz



Date: 15.NOV.2014 02:11:09

### 18 GHz to 20 GHz



Date: 15.NOV.2014 04:25:53

### Limit Clause

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.



Product Service

## **2.7 CONDUCTED SPURIOUS EMISSIONS**

### **2.7.1 Specification Reference**

FCC CFR 47 Part 2, Clause 2.1051  
FCC CFR 47 Part 24, Clause 24.238(a)

### **2.7.2 Equipment Under Test and Modification State**

SHV31 S/N: IMEI 004401115315372 - Modification State 0

### **2.7.3 Date of Test**

14 November 2014

### **2.7.4 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.7.5 Test Procedure**

Measurements were performed in accordance with KDB 971168 v02r02 clause 6.

The EUT was connected to a spectrum analyser via a cable, combiner and attenuator, additionally between 3GHz and 9GHz a 1.5GHz high pass filter was used. The other port of the combiner was connected to a communications test set which was configured with a circuit switched voice call at maximum output power. The path loss was calibrated using a vector network analyser and the value with the highest loss for the frequency range of interest was entered as a reference level offset on the spectrum analyser. The RBW was configured with an RBW of 1 MHz using a peak detector and max hold trace.

### **2.7.6 Environmental Conditions**

|                     |        |
|---------------------|--------|
| Ambient Temperature | 23.3°C |
| Relative Humidity   | 40.7%  |



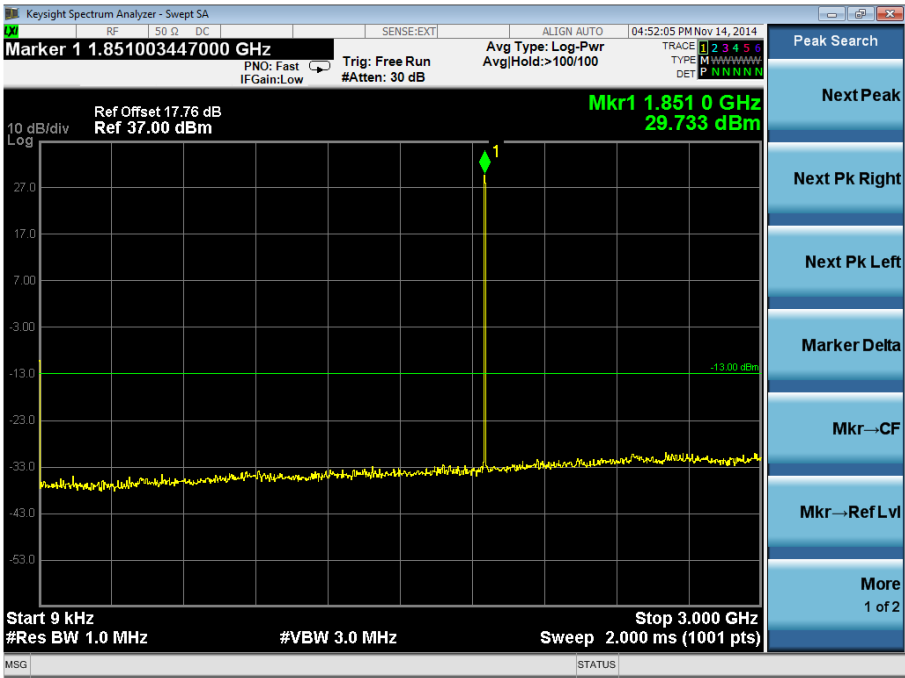
Product Service

2.7.7 Test Results

4.0 V DC Supply

1850.2 MHz

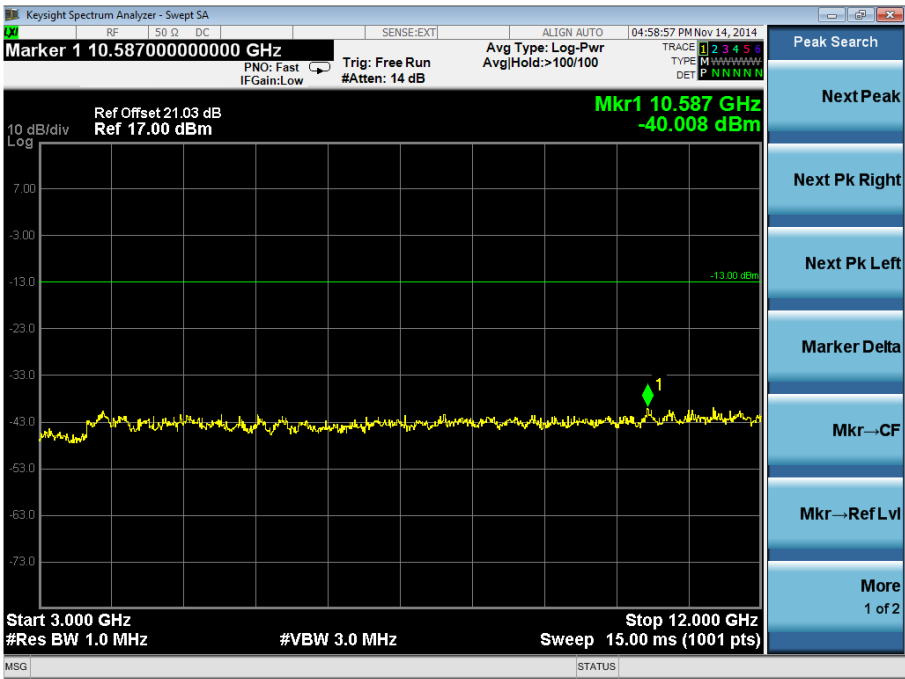
9 kHz to 3 GHz





Product Service

3 GHz to 12 GHz



12 GHz to 20 GHz

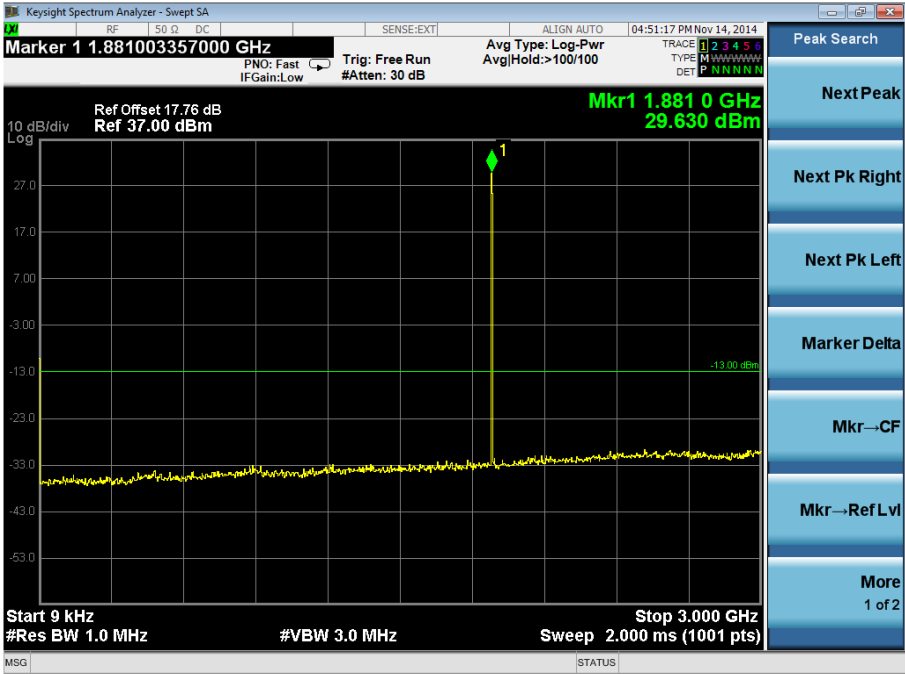




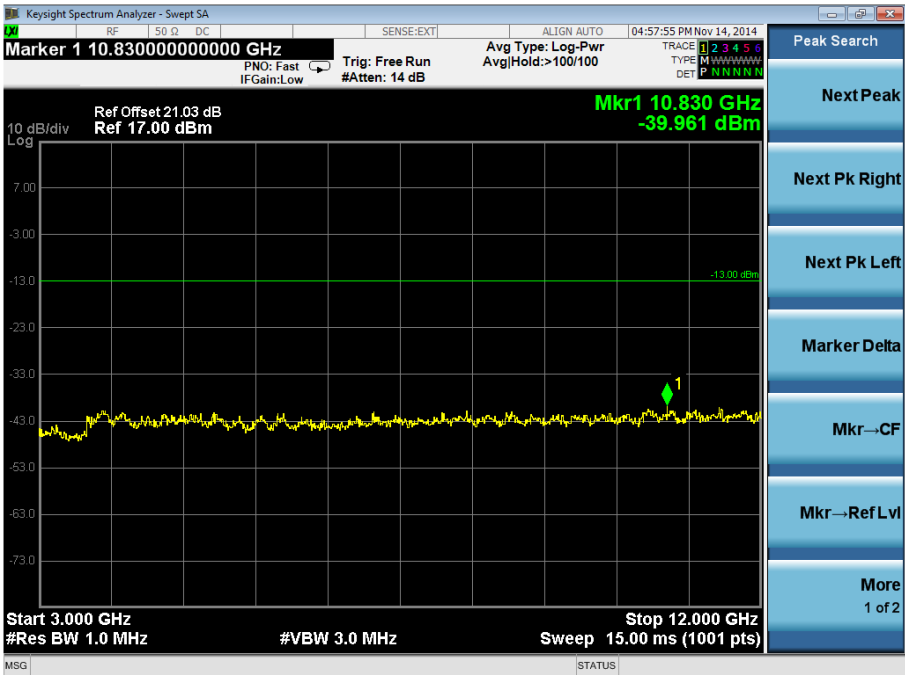
Product Service

1880.0 MHz

9 kHz to 3 GHz



3 GHz to 12 GHz





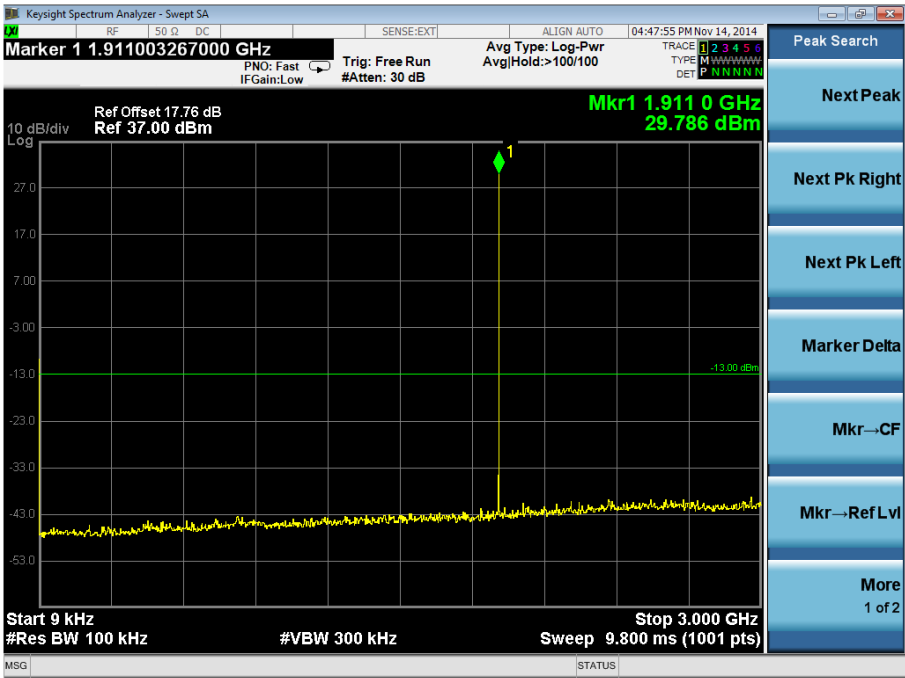
Product Service

12 GHz to 20 GHz



1909.8 MHz

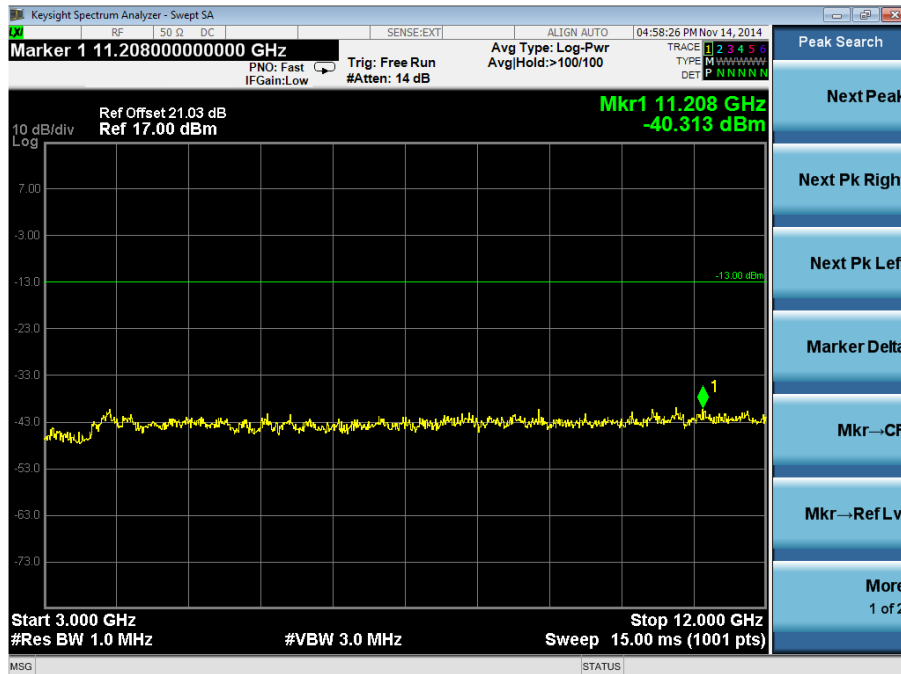
9 kHz to 3 GHz





Product Service

### 3 GHz to 12 GHz



### 12 GHz to 20 GHz



### Limit Clause

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.



Product Service

## **2.8 EMISSION BANDWIDTH**

### **2.8.1 Specification Reference**

FCC CFR 47 Part 2, Clause 2.1049(h)  
FCC CFR 47 Part 24, Clause 24.238(b)

### **2.8.2 Equipment Under Test and Modification State**

SHV31 S/N: IMEI 004401115315372 - Modification State 0

### **2.8.3 Date of Test**

10 November 2014

### **2.8.4 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.8.5 Test Procedure**

Measurements were performed in accordance with KDB 971168 v02r02 clause 4.1.

The EUT was connected to a spectrum analyser via a cable, combiner and attenuator. The other port of the combiner was connected to a communications test set which was configured with a circuit switched voice call at maximum output power. The path loss was calibrated using a vector network analyser and was entered as a reference level offset on the spectrum analyser. The occupied bandwidth measurement function of the spectrum analyser was used and the 26 dB bandwidth was recorded.

### **2.8.6 Environmental Conditions**

|                     |        |
|---------------------|--------|
| Ambient Temperature | 23.5°C |
| Relative Humidity   | 40.7%  |



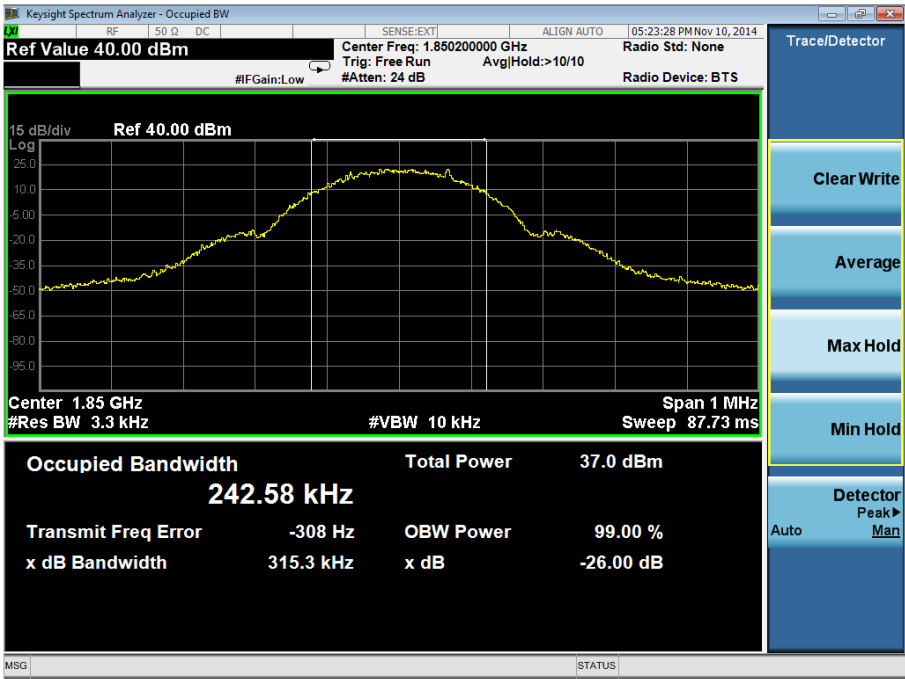
Product Service

2.8.7 Test Results

4.0 V DC Supply

1850.2 MHz

|      |                          |
|------|--------------------------|
| Mode | Emission Bandwidth (kHz) |
| GMSK | 315.3                    |

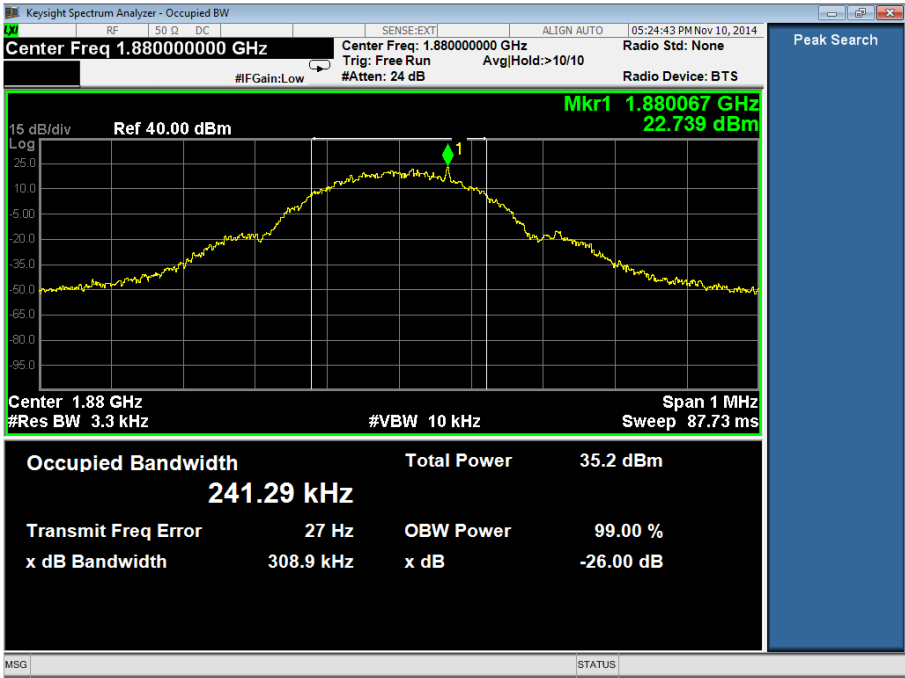




Product Service

1880.0 MHz

|      |                          |
|------|--------------------------|
| Mode | Emission Bandwidth (kHz) |
| GMSK | 308.9                    |

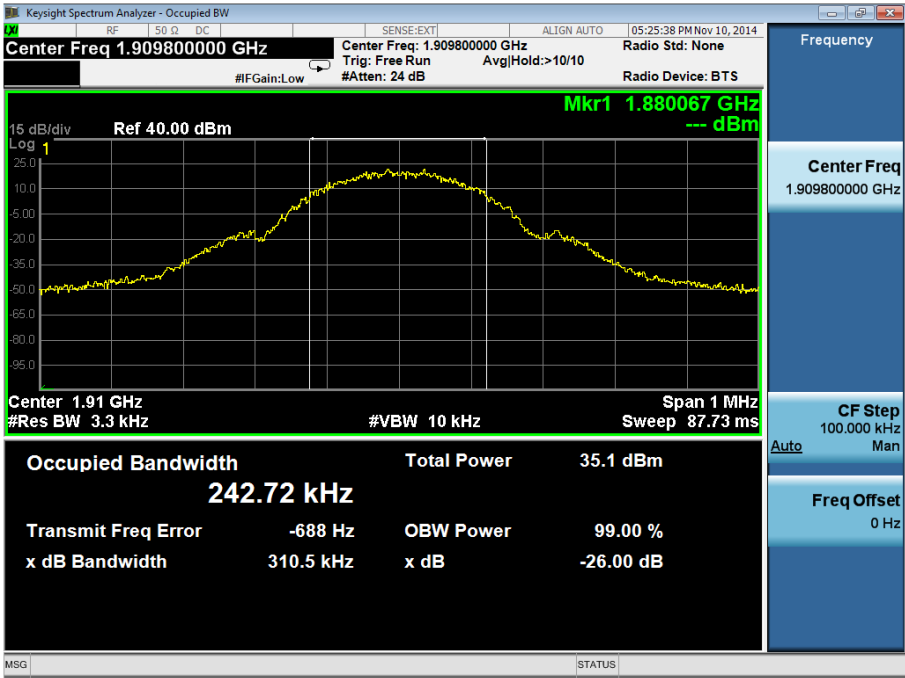




Product Service

1909.8 MHz

|      |                          |
|------|--------------------------|
| Mode | Emission Bandwidth (kHz) |
| GMSK | 310.5                    |



Limit Clause

The emission bandwidth is defined as the width of the signal between two points, one below the carrier centre frequency and one above the carrier centre frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.



Product Service

### **SECTION 3**

#### **TEST EQUIPMENT USED**



### 3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

| Instrument                                                 | Manufacturer         | Type No.                   | TE No. | Calibration Period (months) | Calibration Due |
|------------------------------------------------------------|----------------------|----------------------------|--------|-----------------------------|-----------------|
| <b>Section 2.1 - Frequency Stability</b>                   |                      |                            |        |                             |                 |
| Communications Tester                                      | Rohde & Schwarz      | CMU 200                    | 442    | 12                          | 8-Dec-2014      |
| Temperature Chamber                                        | Montford             | 2F3                        | 467    | -                           | O/P Mon         |
| Rubidium Standard                                          | Rohde & Schwarz      | XSRM                       | 1316   | 6                           | 18-Jan-2015     |
| Digital Thermometer                                        | Digitron             | T208                       | 2831   | 12                          | 31-Jul-2015     |
| Power Supply                                               | Farnell              | LT30-2                     | 2903   | -                           | TU              |
| Attenuator (30dB/50W)                                      | Aeroflex / Weinschel | 47-30-34                   | 3164   | 12                          | 12-Dec-2014     |
| Hygrometer                                                 | Rotronic             | I-1000                     | 3220   | 12                          | 24-Jul-2015     |
| True RMS Multimeter                                        | Fluke                | 179                        | 4007   | 12                          | 31-Jul-2015     |
| Frequency Standard                                         | Spectracom           | Secure Sync 1200-0408-0601 | 4393   | 6                           | 18-Jan-2015     |
| <b>Section 2.2 - Spurious Emissions at Band Edge</b>       |                      |                            |        |                             |                 |
| Power Supply Unit                                          | Hewlett Packard      | 6282A                      | 132    | -                           | TU              |
| Communications Tester                                      | Rohde & Schwarz      | CMU 200                    | 442    | 12                          | 8-Dec-2014      |
| Attenuator (10dB)                                          | Weinschel            | 47-10-34                   | 481    | 12                          | 28-Mar-2015     |
| Multimeter                                                 | Iso-tech             | IDM101                     | 2419   | 12                          | 7-Oct-2015      |
| Hygrometer                                                 | Rotronic             | I-1000                     | 3220   | 12                          | 24-Jul-2015     |
| Network Analyser                                           | Rohde & Schwarz      | ZVA 40                     | 3548   | 12                          | 3-Sep-2015      |
| Combiner/Splitter                                          | Weinschel            | 1506A                      | 3877   | 12                          | 21-Mar-2015     |
| Calibration Unit                                           | Rohde & Schwarz      | ZV-Z54                     | 4368   | 12                          | 24-Sep-2015     |
| PXA Signal Analyser                                        | Agilent Technologies | N9030A PXA                 | 4409   | 12                          | 27-Feb-2015     |
| <b>Section 2.3 - Effective Isotropic Radiated Power</b>    |                      |                            |        |                             |                 |
| Antenna (Double Ridge Guide, 1GHz-18GHz)                   | EMCO                 | 3115                       | 234    | 12                          | 2-May-2015      |
| Signal Generator (10MHz to 40GHz)                          | Rohde & Schwarz      | SMR40                      | 1002   | 12                          | 19-Sep-2015     |
| Turntable Controller                                       | Inn-Co GmbH          | CO 1000                    | 1606   | -                           | TU              |
| Antenna (DRG Horn)                                         | ETS-LINDGREN         | 3115                       | 3125   | 12                          | 16-Jul-2015     |
| EMI Test Receiver                                          | Rohde & Schwarz      | ESU40                      | 3506   | 12                          | 27-Oct-2015     |
| Tilt Antenna Mast                                          | matur GmbH           | TAM 4.0-P                  | 3916   | -                           | TU              |
| Mast Controller                                            | matur GmbH           | NCD                        | 3917   | -                           | TU              |
| <b>Section 2.4 - Maximum Peak Output Power - Conducted</b> |                      |                            |        |                             |                 |
| Power Supply Unit                                          | Hewlett Packard      | 6282A                      | 132    | -                           | TU              |
| Communications Tester                                      | Rohde & Schwarz      | CMU 200                    | 442    | 12                          | 8-Dec-2014      |
| Hygrometer                                                 | Rotronic             | I-1000                     | 3220   | 12                          | 24-Jul-2015     |
| Attenuator (10dB, 20W)                                     | Lucas Weinschel      | 1                          | 3225   | 12                          | 12-Dec-2014     |
| Network Analyser                                           | Rohde & Schwarz      | ZVA 40                     | 3548   | 12                          | 3-Sep-2015      |
| Combiner/Splitter                                          | Weinschel            | 1506A                      | 3877   | 12                          | 21-Mar-2015     |
| P-Series Power Meter                                       | Agilent Technologies | N1911A                     | 3980   | 12                          | 22-Sep-2015     |
| 50 MHz-18 GHz Wideband Power Sensor                        | Agilent Technologies | N1921A                     | 3982   | 12                          | 22-Sep-2015     |
| Calibration Unit                                           | Rohde & Schwarz      | ZV-Z54                     | 4368   | 12                          | 24-Sep-2015     |



Product Service

| Instrument                                                       | Manufacturer             | Type No.               | TE No. | Calibration Period (months) | Calibration Due |
|------------------------------------------------------------------|--------------------------|------------------------|--------|-----------------------------|-----------------|
| <b>Section 2.6 - Emission Limitations for Cellular Equipment</b> |                          |                        |        |                             |                 |
| Antenna (Double Ridge Guide, 1GHz-18GHz)                         | EMCO                     | 3115                   | 234    | 12                          | 2-May-2015      |
| Dual Power Supply Unit                                           | Thurlby                  | PL320                  | 288    | -                           | TU              |
| Signal Generator (10MHz to 40GHz)                                | Rohde & Schwarz          | SMR40                  | 1002   | 12                          | 19-Sep-2015     |
| Pre-Amplifier                                                    | Phase One                | PS04-0086              | 1533   | 12                          | 19-Dec-2014     |
| Turntable Controller                                             | Inn-Co GmbH              | CO 1000                | 1606   | -                           | TU              |
| Antenna (Bilog)                                                  | Chase                    | CBL6143                | 2904   | 24                          | 10-Jun-2015     |
| Antenna (DRG Horn)                                               | ETS-LINDGREN             | 3115                   | 3125   | 12                          | 16-Jul-2015     |
| EMI Test Receiver                                                | Rohde & Schwarz          | ESU40                  | 3506   | 12                          | 27-Oct-2015     |
| Tilt Antenna Mast                                                | maturo GmbH              | TAM 4.0-P              | 3916   | -                           | TU              |
| Mast Controller                                                  | maturo GmbH              | NCD                    | 3917   | -                           | TU              |
| <b>Section 2.7 - Conducted Spurious Emissions</b>                |                          |                        |        |                             |                 |
| Power Supply Unit                                                | Hewlett Packard          | 6282A                  | 132    | -                           | TU              |
| Communications Tester                                            | Rohde & Schwarz          | CMU 200                | 442    | 12                          | 8-Dec-2014      |
| Attenuator (10dB)                                                | Weinschel                | 47-10-34               | 481    | 12                          | 28-Mar-2015     |
| Multimeter                                                       | Iso-tech                 | IDM101                 | 2419   | 12                          | 7-Oct-2015      |
| Filter                                                           | Daden Anthony Ass        | MH-1500-7SS            | 2778   | 12                          | 4-Feb-2015      |
| Network Analyser                                                 | Rohde & Schwarz          | ZVA 40                 | 3548   | 12                          | 3-Sep-2015      |
| Combiner/Splitter                                                | Weinschel                | 1506A                  | 3877   | 12                          | 21-Mar-2015     |
| Calibration Unit                                                 | Rohde & Schwarz          | ZV-Z54                 | 4368   | 12                          | 24-Sep-2015     |
| PXA Signal Analyser                                              | Agilent Technologies     | N9030A PXA             | 4409   | 12                          | 27-Feb-2015     |
| Suspended Substrate Highpass Filter                              | Advance Power Components | 11SH10-3000/X18000-O/O | 4411   | 12                          | 21-Mar-2015     |
| <b>Section 2.8 - Emission Bandwidth</b>                          |                          |                        |        |                             |                 |
| Power Supply Unit                                                | Hewlett Packard          | 6282A                  | 132    | -                           | TU              |
| Communications Tester                                            | Rohde & Schwarz          | CMU 200                | 442    | 12                          | 8-Dec-2014      |
| Attenuator (10dB)                                                | Weinschel                | 47-10-34               | 481    | 12                          | 28-Mar-2015     |
| Multimeter                                                       | Iso-tech                 | IDM101                 | 2419   | 12                          | 7-Oct-2015      |
| Hygrometer                                                       | Rotronic                 | I-1000                 | 3220   | 12                          | 24-Jul-2015     |
| Combiner/Splitter                                                | Weinschel                | 1506A                  | 3877   | 12                          | 21-Mar-2015     |
| PXA Signal Analyser                                              | Agilent Technologies     | N9030A PXA             | 4409   | 12                          | 27-Feb-2015     |

TU – Traceability Unscheduled

O/P MON – Output Monitored with Calibrated Equipment



### 3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:-

| Test Discipline                                  | MU              |
|--------------------------------------------------|-----------------|
| Modulation Characteristics                       | -               |
| Emission Bandwidth                               | $\pm 10.14$ kHz |
| Maximum Peak Output Power - Conducted            | $\pm 0.70$ dB   |
| Spurious Emissions at Band Edge                  | $\pm 2.20$ dB   |
| Emission Limitations for Broadband PCS Equipment | $\pm 3.08$ dB   |
| Conducted Spurious Emissions                     | $\pm 3.454$ dB  |
| Frequency Stability                              | $\pm 99.54$ Hz  |
| Effective Isotropic Radiated Power               | $\pm 3.08$ dB   |



Product Service

## **SECTION 4**

### **ACCREDITATION, DISCLAIMERS AND COPYRIGHT**



Product Service

#### 4.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



This report relates only to the actual item/items tested.

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA  
(Not UKAS Accredited).

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