eurofins | Product Service

# FCC TEST REPORT

**FCC 47 CFR Part 15C**
**Industry Canada RSS-210**
**Digital transmission systems operating within the 2400 – 2483.5 MHz band**

| | |
|---|---|
| **Report Reference No**.....: | G0M-1412-4419-TFC247ZB-V02 |
| **Testing Laboratory**.....: | Eurofins Product Service GmbH |
| Address.....: | Storkower Str. 38c<br>15526 Reichenwalde<br>Germany |
| Accreditation.....: |  <br>A2LA Accredited Testing Laboratory, Certificate No.: 1983.01<br>FCC Filed Test Laboratory, Reg.-No.: 96970<br>IC OATS Filing assigned code: 3470A |
| **Applicant's name**.....: | MKW electronics GmbH |
| Address.....: | Jutogasse 3<br>4675 Weibern<br>Austria |
| **Test specification:** | |
| Standard.....: | ANSI C63.10:2009<br>ANSI C63.4:2009<br>IC RSS-210 Issue 8, Amendment 1 |
| Test scope…….....: | complete Radio compliance test |
| **Equipment under test (EUT):** | |
| Product description | Chirp spread spectrum based transceiver used for wireless location |
| Model No. | W010 |
| Additional Model(s) | None |
| Brand Name(s) | Smartbow |
| Hardware version | BNAHOST03 |
| Firmware / Software version | FW 2.0.7 |
| | FCC-ID: 2ADP3W010 IC: 12561A-W010 |
| **Test result** | **Passed** |

| **Possible test case verdicts:** | |
|---|---|
| - neither assessed nor tested ..... : | N/N |
| - required by standard but not appl. to test object..... : | N/A |
| - required by standard but not tested..... : | N/T |
| - not required by standard for the test object ..... : | N/R |
| - test object does meet the requirement..... : | P (Pass) |
| - test object does not meet the requirement..... : | F (Fail) |

**Testing:**

| | | |
|---|---|---|
| Test Lab Temperature..... : | 20 – 23 °C | |
| Test Lab Humidity ..... : | 32 – 38 % | |
| Date of receipt of test item ..... : | 2015-01-12 | |
| Date (s) of performance of tests ..... : | 2015-01-12 – 2015-04-14 | |
| Compiled by ..... : | Wilfried Treffke | |
| Tested by (+ signature)..... : (Responsible for Test) | Wilfried Treffke | W. Treff ..... |
| Approved by (+ signature) ..... : | Toralf Jahn | T. J ..... |
| Date of issue ..... : | 2015-05-28 | |
| Total number of pages ..... : | 39 | |

**General remarks:**

**The test results presented in this report relate only to the object tested.**

**The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.**

This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.

**Additional comments:**

There are two identical transceivers inside EUT (1 per Antenna).

Pre-compliance measurements were performed to identify the antenna port with the maximum output power and this transceiver and antenna port was used for full compliance testing. Full testing was performed for antenna port 2.

Partial tests were performed for the transceiver at antenna port 1 (output power and all radiated spurious emission tests).

Only one transceiver can transmit at the same time.

# Version History

| Version | Issue Date | Remarks | Revised by |
|---|---|---|---|
| 01 | 2015-05-13 | Initial Release | |
| 02 | 2015-05-28 | Page 36: Test results were corrected. | W. Treffke |

## REPORT INDEX

# 1 Equipment (Test item) Description

| | | |
|---|---|---|
| **Description** | Chirp spread spectrum based transceiver used for wireless location | |
| **Model** | W010 | |
| **Additional Model(s)** | None | |
| **Brand Name(s)** | Smartbow | |
| **Serial number** | 180b52000e2f | |
| **Hardware version** | BNAHOST03 | |
| **Software / Firmware version** | FW 2.0.7 | |
| **FCC-ID** | 2ADP3W010 | |
| **IC** | 12561A-W010 | |
| **Equipment type** | End product | |
| **Radio type** | Transceiver | |
| **Radio technology** | IEEE 802.15.4a Chirp spread spectrum (CSS) | |
| **Operating frequency range** | 2412 - 2468.5 MHz | |
| **Assigned frequency band** | 2400 - 2483.5 MHz | |
| **Main test frequencies** | $F_{MID}$ | 2440 MHz |
| **Spreading** | Chirp | |
| **Modulations** | None | |
| **Number of channels** | 1 | |
| **Number of antennas** | 2 (1 antenna per transceiver) | |
| **Number of transceivers** | 2 identical transceiver inside EUT (1 per Antenna) | |
| **Antenna 1** | Type | external dedicated omnidirectional antenna |
| | Model | OARDSBX244 |
| | Manufacturer | RF Elements |
| | Gain | 4.0 dBi (manufacturer declaration) |
| **Antenna 2** | Type | external dedicated omnidirectional antenna |
| | Model | OARDSBX244 |
| | Manufacturer | RF Elements |
| | Gain | 4.0 dBi (manufacturer declaration) |
| **Manufacturer** | MKW electronics GmbH<br>Jutogasse 3<br>4675 Weibern<br>Austria | |
| **Power supply** | $V_{NOM}$ | 48 VDC (POE) |
| **AC/DC-Adaptor** | Model | N/A |
| | Vendor | N/A |
| | Output | N/A |

## 1.4 Supporting Equipment Used During Testing

| Product Type* | Device | Manufacturer | Model No. | Comments |
|---|---|---|---|---|
| None | | | | |

***Note:** Use the following abbreviations:

AE : Auxiliary/Associated Equipment, or

SIM : Simulator (Not Subjected to Test)

CABL : Connecting cables

### 1.5 Test Modes

| Mode # | Description | |
|---|---|---|
| CSS | General conditions: | EUT powered by power over Ethernet |
| | Radio conditions: | Mode = standalone transmit<br>Spreading = CSS<br>Duty cycle = 100 % (test mode)<br>Power level = Maximum |
| Max Duty Cycle | General conditions: | EUT powered by power over Ethernet |
| | Radio conditions: | Mode = standalone transmit<br>Spreading = CSS<br>Duty cycle = max. duty cycle under normal operating conditions<br>Power level = Maximum |
| Receive | General conditions: | EUT powered by power over Ethernet |
| | Radio conditions: | Mode = standalone receive<br>Spreading = CSS |
| AC-Powerline | General conditions: | EUT powered by power over Ethernet |
| | Radio conditions: | Mode = standalone transmit<br>Spreading = CSS<br>Power level = Maximum |

### 1.6 Test Equipment Used During Testing

| Measurement Software | | | |
|---|---|---|---|
| Description | Manufacturer | Name | Version |
| EMC Test Software | Dare Instruments | Radimation | 2014.1.15 |

| Occupied Bandwidth | | | | | |
|---|---|---|---|---|---|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| Spectrum Analyzer | R&S | FSP 30 | EF00312 | 2015-02 | 2016-02 |

| 6dB Bandwidth | | | | | |
|---|---|---|---|---|---|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| Spectrum Analyzer | R&S | FSP 30 | EF00312 | 2015-02 | 2016-02 |

| Maximum peak conducted power | | | | | |
|---|---|---|---|---|---|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| Spectrum Analyzer | R&S | FSP 30 | EF00312 | 2015-02 | 2016-02 |

| Power spectral density | | | | | |
|---|---|---|---|---|---|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| Spectrum Analyzer | R&S | FSP 30 | EF00312 | 2015-02 | 2016-02 |

| Band edge compliance | | | | | |
|---|---|---|---|---|---|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| Spectrum Analyzer | R&S | FSP 30 | EF00312 | 2015-02 | 2016-02 |

| Conducted spurious emissions | | | | | |
|---|---|---|---|---|---|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| Spectrum Analyzer | R&S | FSP 30 | EF00312 | 2015-02 | 2016-02 |

| Radiated spurious emissions | | | | | |
|---|---|---|---|---|---|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| Semi-anechoic chamber | Frankonia | AC 1 | EF00062 | - | - |
| Spectrum Analyzer | R&S | FSIQ26 | EF00151 | 2015-03 | 2016-03 |
| Biconical Antenna | R&S | HK 116 | EF00012 | 2013-02 | 2016-02 |
| LPD Antenna | R&S | HL 223 | EF00187 | 2014-03 | 2017-03 |
| LPD Antenna | R&S | HL 025 | EF00327 | 2013-02 | 2016-02 |

| AC power line conducted emissions | | | | | |
|---|---|---|---|---|---|
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due |
| AMN | R&S | ESH2-Z5 | EF00182 | 2014-11 | 2016-11 |
| EMI Test Receiver | R&S | ESCS 30 | EF00295 | 2014-10 | 2015-10 |

### 1.7 Sample emission level calculation

The following is a description of terms and a sample calculation, as appears in the radiated emissions data table. The numbers used in the calculation are for example only. There is no direct correlation to the specific data taken for the product described in this document:

Reading:

This is the reading obtained on the spectrum analyzer in dBµV. Any external preamplifiers used are taken into account through internal analyzer settings.

A.F.:

This is the antenna factor for the receiving antenna. It is a conversion factor, which converts electric fields strengths to voltages, which can be measured directly on the spectrum analyzer. It is treated as a loss in dB. Cable losses have been included with the A.F. to simplify the calculations. The antenna factor is used in calculations as follows:

Reading on Analyzer (dBµV) + A.F. (dB) = Net field strength (dBµV/m)

Net:

This is the net field strength measurement (as shown above).

Limit:

This is the FCC Class B radiated emission limit (in units of dBµV/m). The FCC limits are given in units of µV/m. The following formula is used to convert the units of µV/m to dBµV/m:

Limit (dBµV/m) = 20*log (µV/m)

Margin:

This is the margin of compliance below the FCC limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.

Example only:

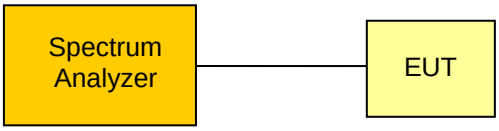
| Reading | + | AF | = | Net Reading | : | Net reading - FCC limit | = Margin |
|---|---|---|---|---|---|---|---|
| 21.5 dBµV | + | 26 dB | = | 47.5 dBµV/m | : | 47.5 dBµV/m - 57.0 dBµV/m | = -9.5 dB |

## 2 Result Summary

| FCC 47 CFR Part 15C, IC RSS-210 | | | | |
|---|---|---|---|---|
| **Product Specific Standard Section** | **Requirement – Test** | **Reference Method** | **Result** | **Remarks** |
| RSS-Gen 6.6 | Occupied Bandwidth | RSS-Gen 6.6 | N/R | Informational only |
| FCC § 15.247(a)(2)<br>IC RSS-210 § A8.2 | 6dB Bandwidth | ANSI C 63.10 | PASS | |
| FCC § 15.247(b)(3)<br>IC RSS-210 § A8.4 | Maximum peak conducted power | ANSI C 63.10 | PASS | |
| FCC § 15.247(e)<br>IC RSS-210 § A8.2 | Power spectral density | ANSI C 63.10 | PASS | |
| 47 CFR 15.207<br>RSS-Gen 8.8 | AC power line conducted emissions | ANSI C 63.4 | PASS | |
| FCC § 15.247(d)<br>IC RSS-210 § A8.5 | Band edge compliance | ANSI C 63.10 | PASS | |
| FCC § 15.247(d)<br>IC RSS-210 § A8.5 | Conducted spurious emissions | ANSI C 63.10 | PASS | |
| FCC § 15.247(d)<br>FCC § 15.209<br>IC RSS-210 A8.5<br>IC RSS-Gen 6.13 | Transmitter radiated spurious emissions | ANSI C 63.4 | PASS | |
| IC RSS-Gen 7.1 | Receiver radiated spurious emissions | ANSI C 63.4 | PASS | |
| **Remarks:** | | | | |

# 3 Test Conditions and Results

## 3.1 Test Conditions and Results – Occupied Bandwidth

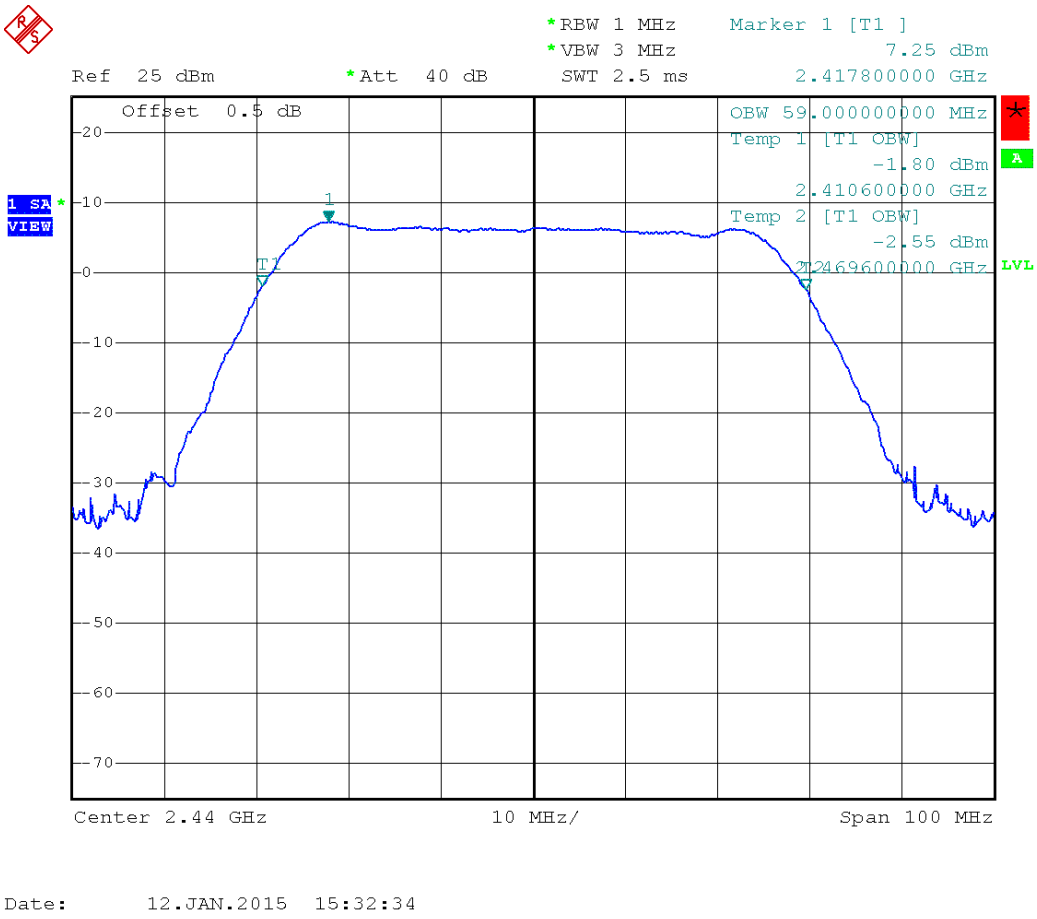
| **Occupied Bandwidth acc. to IC RSS-Gen** | | | **Verdict: PASS** |
|---|---|---|---|
| Test according to measurement reference | Reference Method | | |
| | RSS-Gen 6.6 | | |
| Test frequency range | Tested frequencies | | |
| | $F_{MID}$ | | |
| **Limits** | | | |
| None (Informational only) | | | |
| **Test setup** | | | |
|  | | | |
| **Test procedure** | | | |
| 1. EUT set to test mode (Communication tester is used if needed)<br>2. Span set to at least twice the emission spectrum<br>3. Resolution bandwidth set to 1 % of span<br>4. Occupied Bandwidth (99 %) measurement with spectrum analyzer built in measurement function | | | |
| **Test results** | | | |
| Channel | Frequency [MHz] | Mode | Occupied Bandwidth [MHz] |
| $F_{MID}$ | 2440 | CSS | 59.0 |
| Comments: | | | |

**Occupied Bandwidth – CSS $F_{MID}$**

## Occupied Bandwidth acc. to RSS-Gen

Project Number: G0M-1412-4419

| | |
|---|---|
| Applicant: | MKW electronics GmbH |
| EUT Name: | Shirp spred spectrum based transceiver for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Wilfried Treffke |
| Test Conditions: | Tnom / Vnom |
| Mode: | Tx, CSS, 2440 MHz, Ant.2 |
| Test Date: | 2015-01-12 |
| Verdict: | PASS |
| Note 1: | A spectrum analyzer with an integrated 99% power bandwidth function is used |
| Note 2: | OBW= 59.000 MHz |



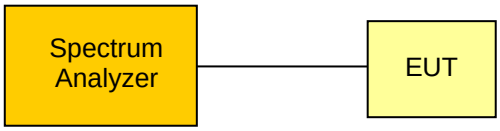
### 3.2 Test Conditions and Results – 6 dB Bandwidth

| **6dB Bandwidth acc. to FCC 15.247 / IC RSS-210** | **Verdict: PASS** |
|---|---|
| EUT requirement rule parts and clause | Reference |
| | FCC 15.247(a)(2) / IC RSS-210 A8.2 |
| Test according to measurement reference | Reference Method |
| | ANSI C63.10 |
| Test frequency range | Tested frequencies |
| | $F_{MID}$ |

**Limits**

≥ 500kHz

**Test setup**




**Test procedure**

1. EUT set to test mode
2. Span set to at least twice the emission spectrum
3. Detector set to peak and max hold and RBW is set to 100 kHz
4. Envelope peak value of emission spectrum is selected
5. Marker on envelope of spectrum is set to level of -6 dB to the left of the peak
6. Marker on envelope of spectrum is set to level of -6 dB to the right of the peak
7. 6 dB Bandwidth is determined by marker frequency separation

**Test results**

| Channel | Frequency [MHz] | Mode | 6 dB Bandwidth [kHz] | Limit [kHz] | Result |
|---|---|---|---|---|---|
| $F_{MID}$ | 2440 | CSS | 55920 | 500 | PASS |

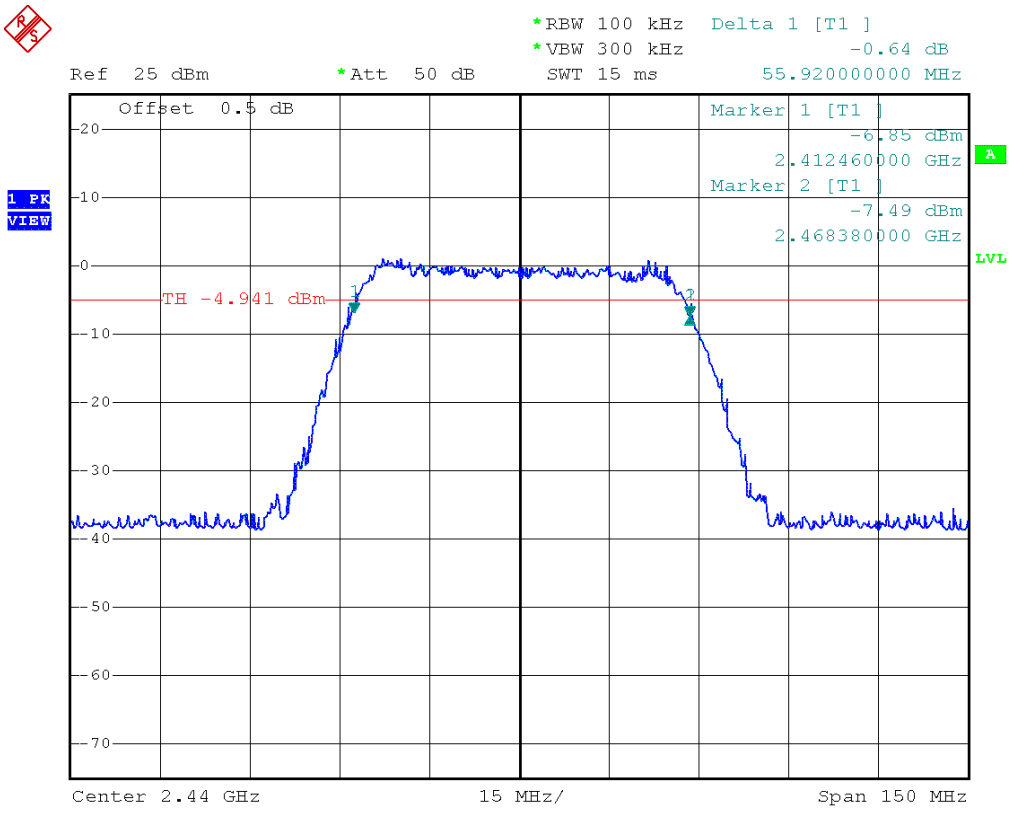
Comments:

## 6 dB Bandwidth – CSS $F_{MID}$

# Minimum 6 dB Bandwidth acc. to FCC 15.247

Project Number: G0M-1412-4419

| | |
|---|---|
| Applicant: | MKW electronics GmbH |
| EUT Name: | Shirp spred spectrum based transceiver for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Wilfried Treffke |
| Test Conditions: | Tnom / Vnom |
| Mode: | Tx, CSS, 2440 MHz, modulated |
| Test Date: | 2015-01-12 |
| Verdict: | PASS |
| Note 1: | -6 dB BW= 55.92MHz |
| Note 2: | Minimum 6 dB Bandwidth conducted |




Comment: 6 dB bandwidth: 55920 KHz > 500 KHz; verdict: PASS
Date: 12.JAN.2015 15:24:05

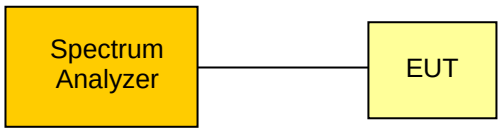
### 3.3 Test Conditions and Results – Duty Cycle

| **Duty cycle correction acc. to FCC 15.247** | **Verdict: PASS** |
|---|---|
| Test according referenced standards | Reference Method |
| | ANSI C63.10 |
| Test frequency range | Tested frequencies |
| | $F_{MID}$ |
| EUT test mode | Max Duty Cycle |

**Limits**

None (only for peak to average correction, 20dB max)

**Test setup**




**Test procedure**

1. EUT set to test mode
2. Center frequency is set to test frequency
3. Span it set to zero span
4. Resolution bandwidth is set large enough to accurately capture transmission burts
5. Total transmission time is measured

**Test results**

| Channel | Frequency [MHz] | Duty Cycle [@ 100ms] | Duty Cycle correction [dB] |
|---|---|---|---|
| $F_{MID}$ | 2440 | 0.0029 corresponds to -50.7dB | -20 * |

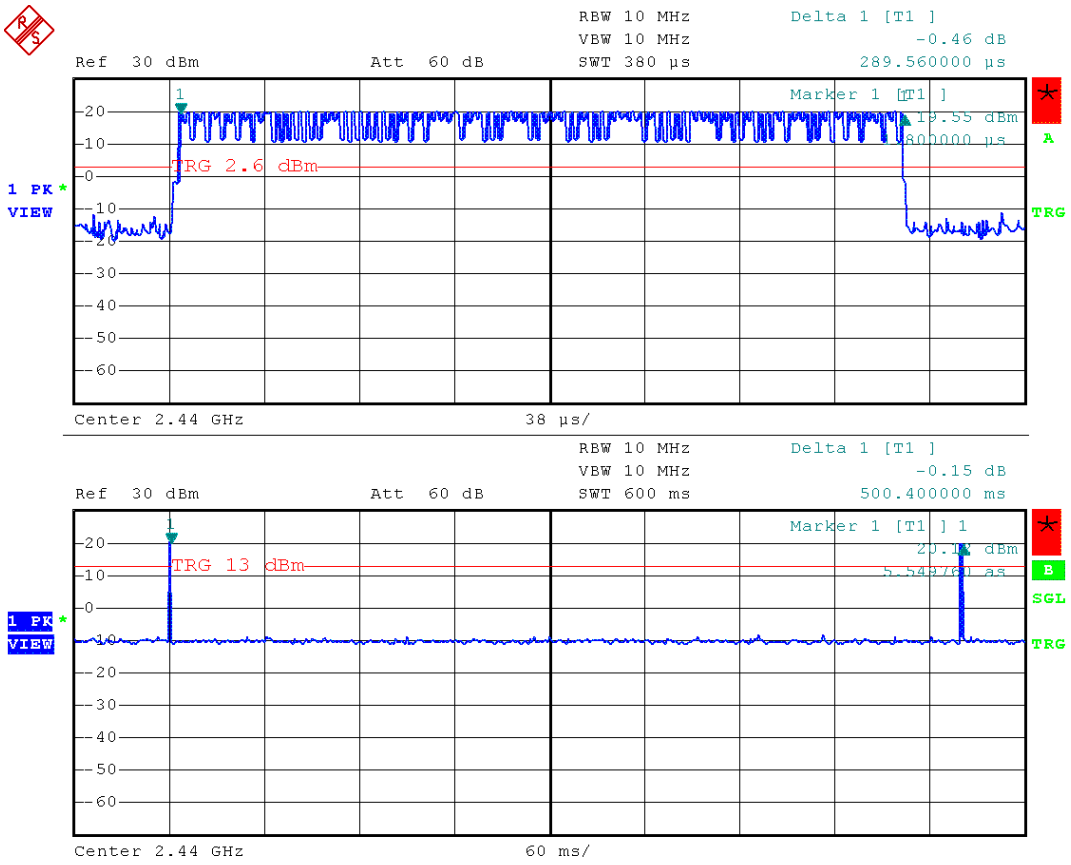
Comments: * maximum allowed duty cycle correction acc. to ANSI C63.10

## Duty Cycle - $F_{MID}$

## Duty cycle info

Project Number: G0M-1412-4419

| | |
|---|---|
| Applicant: | MKW electronics GmbH |
| EUT Name: | Shirp spred spectrum based transceiver for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Wilfried Treffke |
| Test Conditions: | Tnom / Vnom |
| Mode: | Tx, CSS, 2440 MHz, normal signal |
| Test Date: | 2015-01-12 |
| Verdict: | PASS |
| Note 1: | Duty cycle =0.0029 corresponds to -50.7dB (used correction -20dB) |
| Note 2: | Tx on=289.56µs, Tx on+Txoff=500.4 ms (100ms for calculation) |



### 3.4 Test Conditions and Results – Maximum peak conducted power

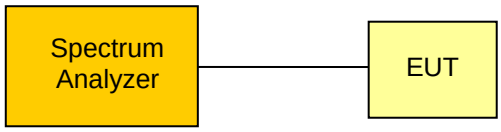
| **Maximum peak conducted power acc. to FCC 15.247 / IC RSS-210** | **Verdict: PASS** |
|---|---|
| EUT requirement rule parts and clause | Reference |
| | FCC 15.247(b)(3) / IC RSS-210 A8.4 |
| Test according to measurement reference | Reference Method |
| | ANSI C63.10 |
| Test frequency range | Tested frequencies |
| | $F_{MID}$ |
| Measurement mode | Peak |
| Maximum antenna gain | 4 dBi ⇒ Limit correction = 0 dB |

**Limits**

1 W (30 dBm)

The conducted output power limit specified above is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in the table, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Test setup**




**Test procedure**

1. EUT set to test mode (Communication tester is used if needed)
2. Center frequency set to test channel center frequency
3. Span set to twice the 20 dB bandwidth and detector to peak and max hold
4. Resolution bandwidth is set to 3 MHz
5. Peak conducted power is determined from peak of spectrum envelope

**Test results antenna 1**

| Channel | Frequency [MHz] | Voltage [VDC] | Mode | Peak power [dbm] | Peak power [W] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| $F_{MID}$ | 2440 | $V_{NOM}$ = 48 | CSS | 19.2 | 0.08318 | 30 | -10.80 |

**Test results antenna 2**

| Channel | Frequency [MHz] | Voltage [VDC] | Mode | Peak power [dbm] | Peak power [W] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| $F_{MID}$ | 2440 | $V_{NOM}$ = 48 | CSS | 19.6 | 0.0912 | 30 | -10.40 |

Comments:

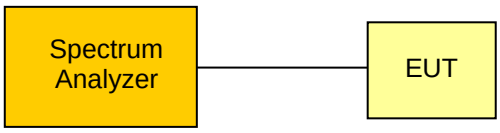
### 3.5 Test Conditions and Results – Power spectral density

| **Power spectral density acc. to FCC 15.247 / IC RSS-210** | **Verdict: PASS** |
|---|---|
| EUT requirement rule parts and clause | Reference |
| | FCC 15.247(e) / IC RSS-210 A8.2 |
| Test according to measurement reference | Reference Method |
| | ANSI C63.10 |
| Test frequency range | Tested frequencies |
| | $F_{MID}$ |
| Measurement mode | Peak |

**Limits**

8 dBm / 3 kHz

**Test setup**




**Test procedure**

1. EUT set to test mode (Communication tester is used if needed)
2. Center frequency set to test channel center frequency
3. Span is set large enough to capture maximum emissions in passband, RBW is set to 3kHz
4. Peak power density is determined from peak emission of envelope

**Test results**

| Channel | Frequency [MHz] | Test mode | Peak frequency [MHz] | Peak power density [dBm/100kHz] | Limit [dBm/3kHz] | Margin [dB] |
|---|---|---|---|---|---|---|
| $F_{MID}$ | 2440 | CSS | 2416.30 | 0.92 | 8.0 | -07.08 |

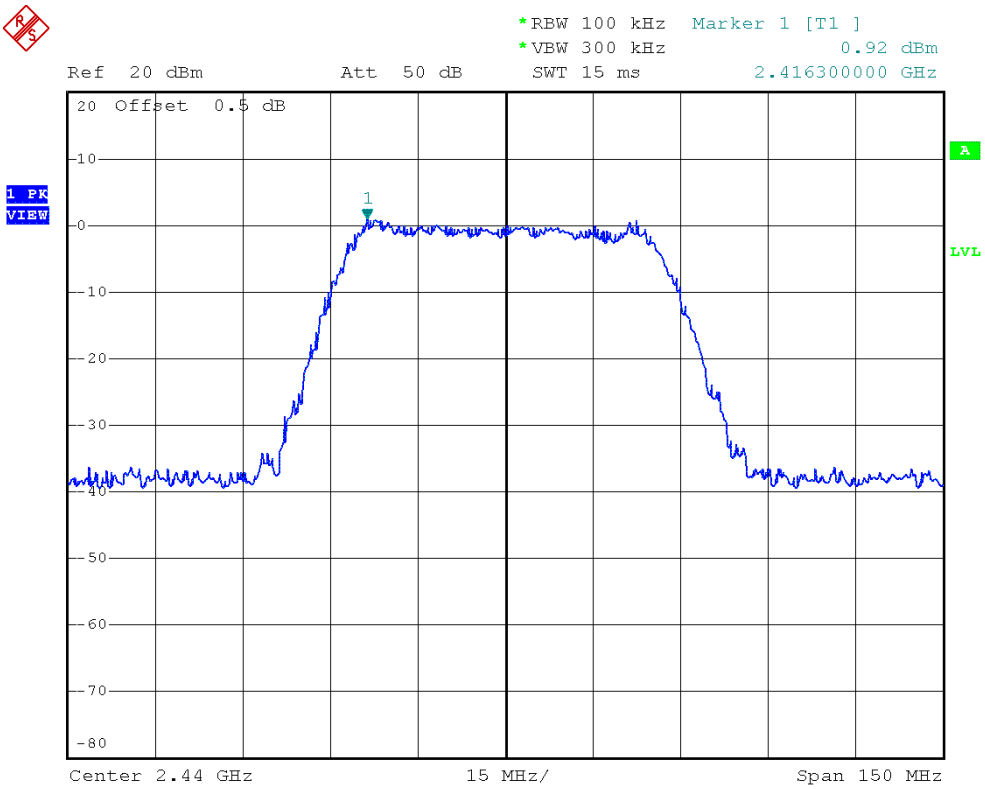
Comments: measurement with RBW=100kHz

**Power spectral density**

## Power spectral density acc. to FCC 15.247

Project Number: G0M-1412-4419

| | |
|---|---|
| Applicant: | MKW electronics GmbH |
| EUT Name: | Shirp spred spectrum based transceiver for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Wilfried Treffke |
| Test Conditions: | Tnom / Vnom |
| Mode: | Tx, CSS, 2440 MHz, ant. 2 |
| Test Date: | 2015-01-12 |
| Verdict: | PASS |
| Note 1: | PSD=0.9dBm |
| Note 2: | Power spectral density conducted |




Comment: Maximum Power Spectral Density=0.92dBm
Comment: f=2.4163GHz RBW= 100kHz , Limit <8dBm/3kHz
Date: 12.JAN.2015 15:36:56

### 3.6 Test Conditions and Results – AC power line conducted emissions

| **Power line conducted emissions acc. to FCC 47 CFR 15.207 / IC RSS-Gen** | | | | **Verdict: PASS** |
|---|---|---|---|---|
| Test according referenced standards | Reference Method | | | |
| | ANSI C63.4 | | | |
| Fully configured sample scanned over the following frequency range | Frequency range | | | |
| | 0.15 MHz to 30 MHz | | | |
| Points of Application | Application Interface | | | |
| AC Mains | LISN | | | |
| EUT test mode | AC-Powerline | | | |
| **Limits and results** | | | | |
| Frequency [MHz] | Quasi-Peak [dBµV] | Result | Average [dBµV] | Result |
| 0.15 to 5 | 66 to 56* | PASS | 56 to 46* | PASS |
| 0.5 to 5 | 56 | PASS | 46 | PASS |
| 5 to 30 | 60 | PASS | 50 | PASS |
| Comments:<br>* Limit decreases linearly with the logarithm of the frequency. | | | | |

## Conducted Emissions

**EMI voltage test in the ac-mains according to FCC Part 15b**

Project number: G0M-1412-4419

| | |
|---|---|
| Applicant: | Nanotron Technologies GmbH |
| EUT Name: | Chirp spread spectrum based transceiver used for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Mr. Zunke |
| Test Conditions: | Tnom: 23°C, Unom: 48VDC via PoE feeding |
| LISN: | ESH2-Z5 N |
| Mode: | power via POE, WLAN active |
| Test Date: | 2015-04-23 |
| Note: | |

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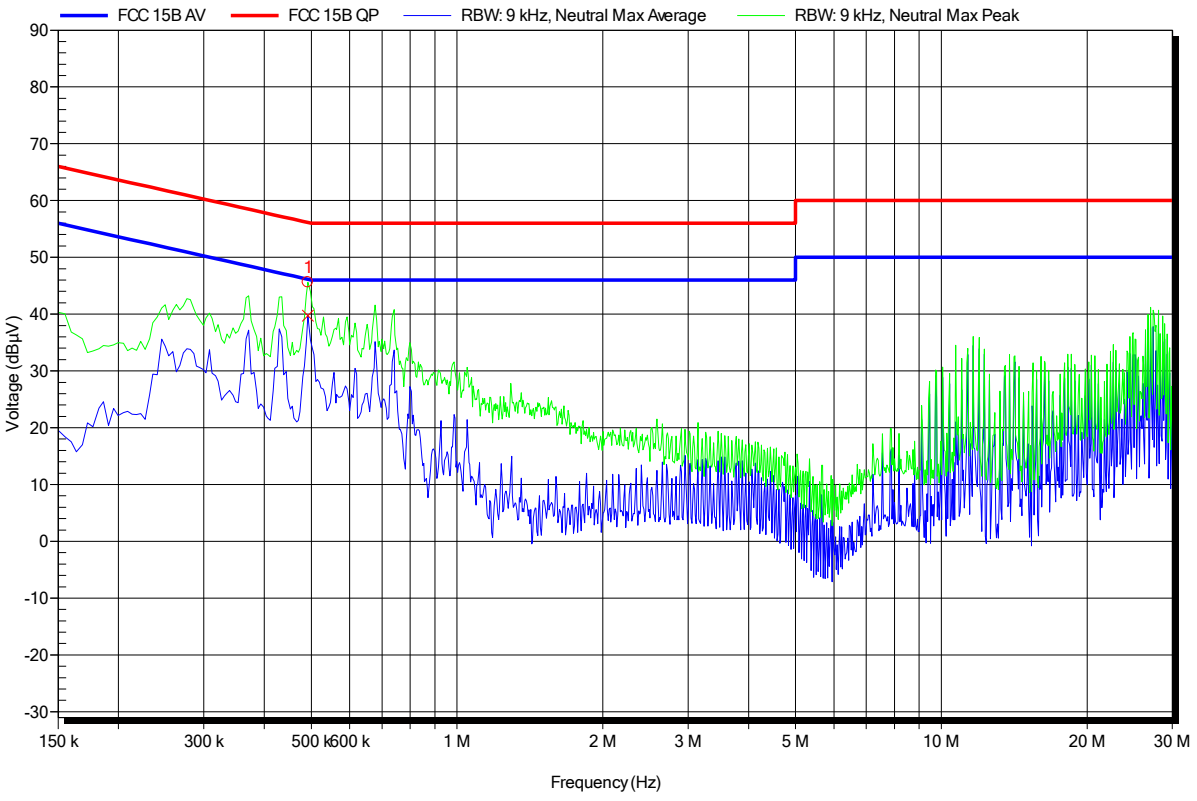


| Frequency | Average | Average Limit | Average Difference | Average Status |
|---|---|---|---|---|
| 492 kHz | 39.71 dBµV | 46.13 dBµV | -6.42 dB | Pass |

## Conducted Emissions

**EMI voltage test in the ac-mains according to FCC Part 15b**

Project number: G0M-1412-4419

| | |
|---|---|
| Applicant: | Nanotron Technologies GmbH |
| EUT Name: | Chirp spread spectrum based transceiver used for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Mr. Zunke |
| Test Conditions: | Tnom: 23°C, Unom: 48VDC via PoE feeding |
| LISN: | ESH2-Z5 L |
| Mode: | power via POE, WLAN active |
| Test Date: | 2015-04-23 |
| Note: | |

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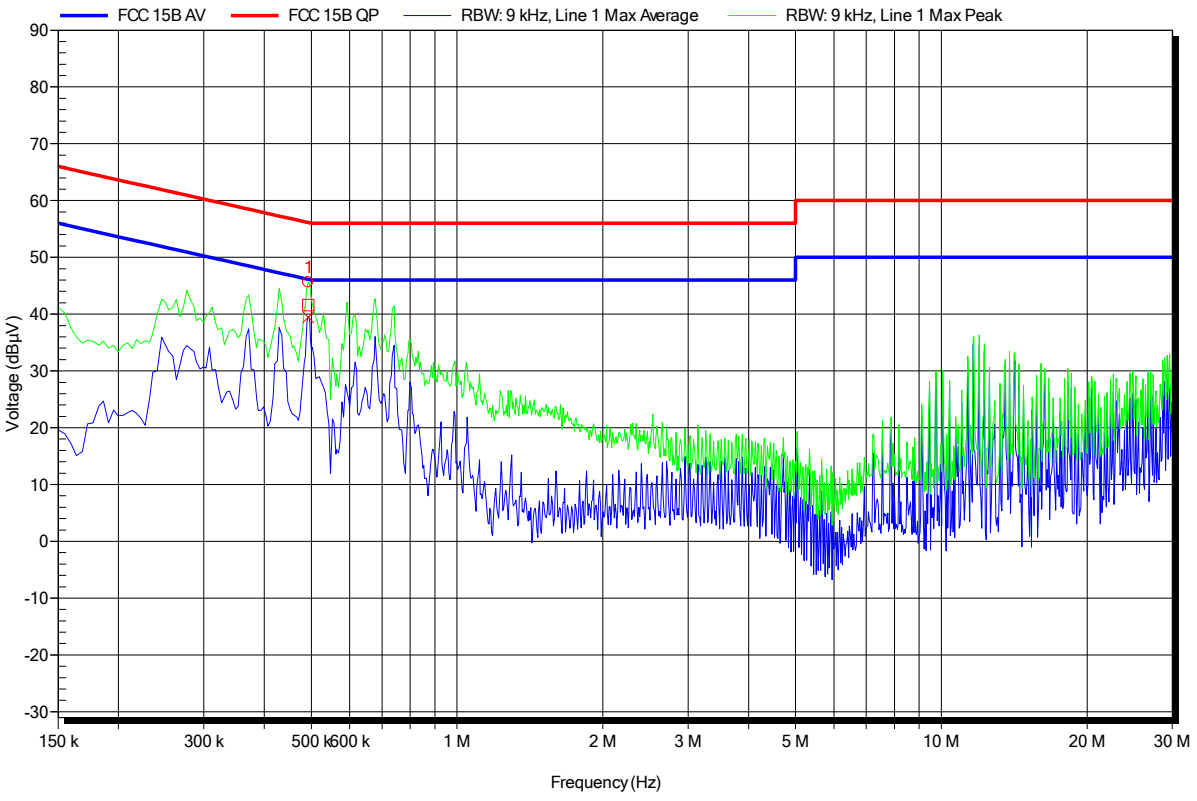



| Frequency | Quasi-Peak | Quasi-Peak Limit | Quasi-Peak Difference | Quasi-Peak Status |
|---|---|---|---|---|
| 492.9 kHz | 41.61 dBµV | 56.12 dBµV | -14.51 dB | Pass |

| Frequency | Average | Average Limit | Average Difference | Average Status |
|---|---|---|---|---|
| 492.9 kHz | 39.47 dBµV | 46.12 dBµV | -6.65 dB | Pass |

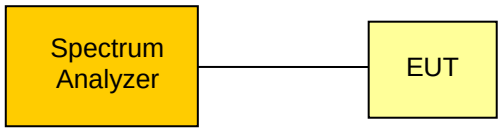
### 3.7 Test Conditions and Results – Band edge compliance

| **Band-edge compliance acc. to FCC 15.247 / IC RSS-210** | **Verdict: PASS** |
|---|---|
| EUT requirement rule parts and clause | Reference |
| | FCC 15.247(d) / IC RSS-210 A8.5 |
| Test according to measurement reference | Reference Method |
| | ANSI C63.10 |
| Test frequency range | Tested frequencies |
| | $F_{MID}$ |
| Measurement mode | Peak |

**Limits**

| Limit | Condition |
|---|---|
| ≤ -20 dB / 100 kHz | Peak power measurement detector = Peak |
| ≤ -30 dB / 100 kHz | Peak power measurement detector = RMS |

**Test setup**




**Test procedure**

1. EUT set to test mode (Communication tester is used if needed)
2. Span set around lower band edge and detector is set to peak and max hold
3. Resolution bandwidth is set to 100 kHz
4. Markers are set to peak emission levels within frequency band and outside frequency band
5. Band edge attenuation is determined from level difference

**Test results**

| Band egge | Frequency [MHz] | Mode | Level [dBc] | Limit [dBc] | Margin [dB] |
|---|---|---|---|---|---|
| $F_{LOW}$ | 2440 | CSS | -35.5 | -20 | -15.50 |
| $F_{HIGH}$ | 2440 | CSS | -36.8 | -20 | -16.80 |

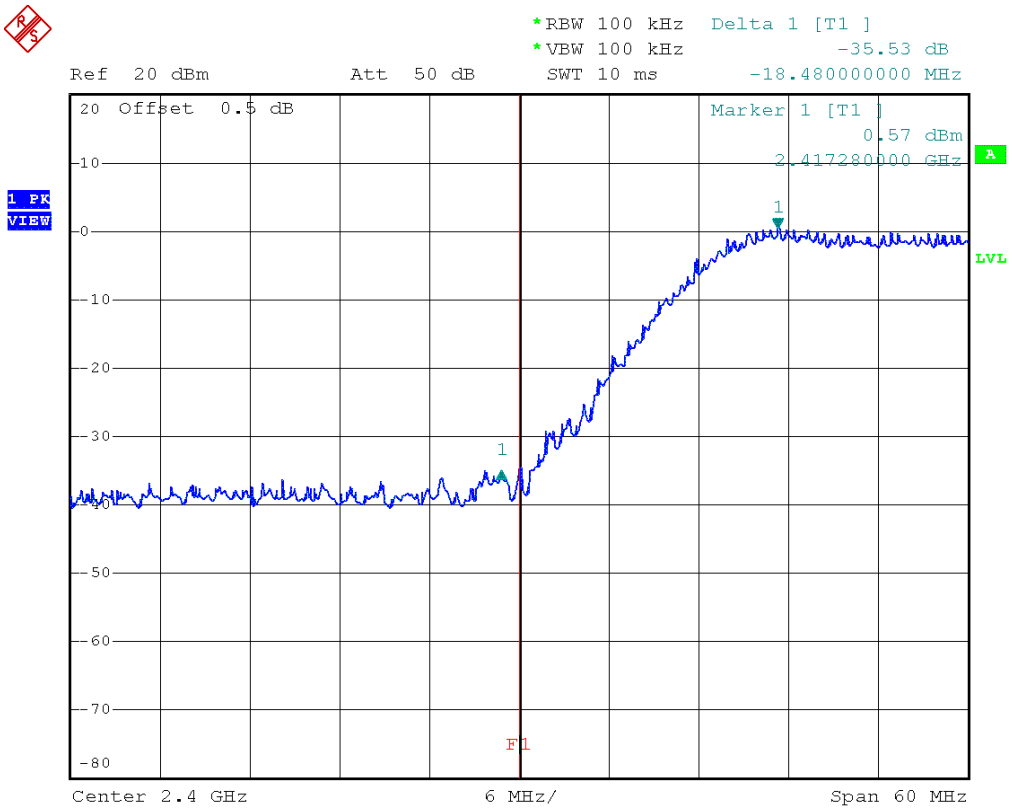
Comments:

**Band-edge compliance – CSS $F_{LOW}$**

## Band-edge compliance acc. to FCC 15.247

Project Number: G0M-1412-4419

| | |
|---|---|
| Applicant: | MKW electronics GmbH |
| EUT Name: | Shirp spred spectrum based transceiver for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Wilfried Treffke |
| Test Conditions: | Tnom / Vnom |
| Mode: | Tx, CSS, 2440 MHz, modulated |
| Test Date: | 2015-01-12 |
| Verdict: | PASS |
| Note 1: | Delta marker: -35.53 dB |
| Note 2: | lower Band-edge, conducted measurement |



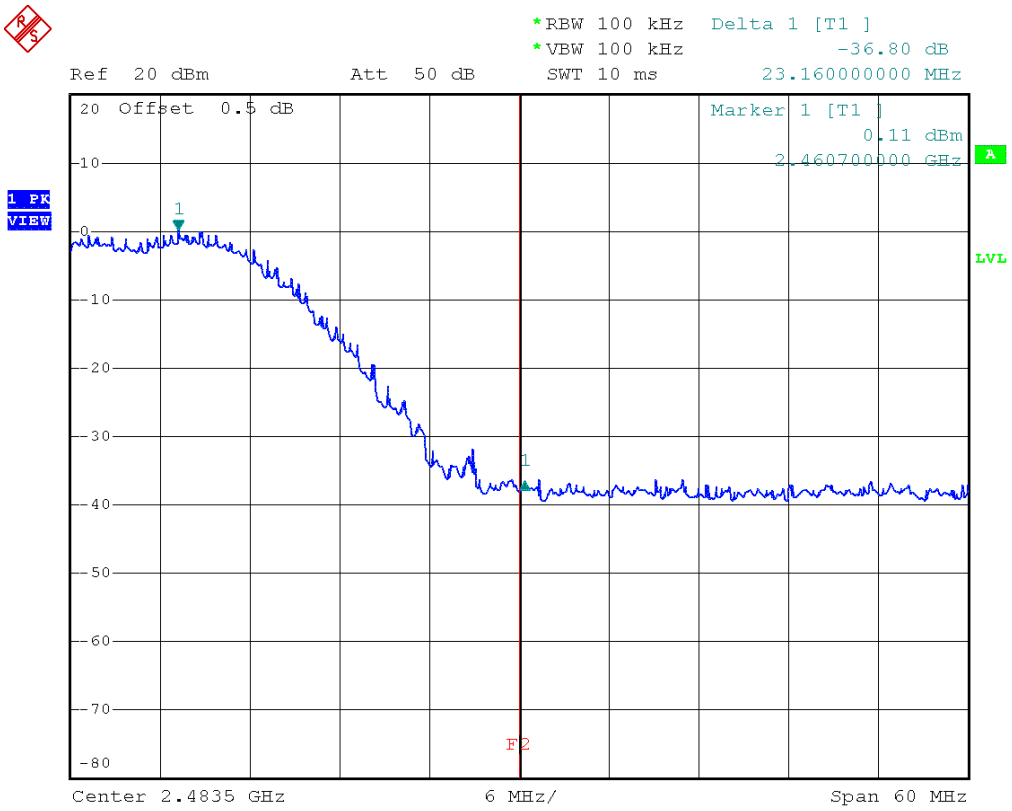

Comment: Limit: Marker Delta value >20 dB; Result: PASS
Date: 12.JAN.2015 16:07:36

**Band-edge compliance – CSS $F_{HIGH}$**

## Band-edge compliance acc. to FCC 15.247

Project Number: G0M-1412-4419

| | |
|---|---|
| Applicant: | MKW electronics GmbH |
| EUT Name: | Shirp spred spectrum based transceiver for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Wilfried Treffke |
| Test Conditions: | Tnom / Vnom |
| Mode: | Tx, CSS, 2440 MHz, modulated |
| Test Date: | 2015-01-12 |
| Verdict: | PASS |
| Note 1: | Delta marker: -36.80 dB |
| Note 2: | upper Band-edge, conducted measurement |




Comment: Limit: Marker Delta value >20 dB; Result: PASS
Date: 12.JAN.2015 16:10:56

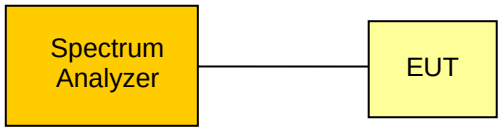
### 3.8 Test Conditions and Results – Conducted spurious emissions

| **Conducted spurious emissions acc. to FCC 15.247 / IC RSS-210** | **Verdict: PASS** |
|---|---|
| EUT requirement rule parts and clause | Reference |
| | FCC 15.247(d) / IC RSS-210 A8.5 |
| Test according to measurement reference | Reference Method |
| | ANSI C63.10 |
| Test frequency range | Tested frequencies |
| | 10 MHz – 10th Harmonic |
| Measurement mode | Peak |

**Limits**

| Limit | Condition |
|---|---|
| ≤ -20 dB / 100 kHz | Peak power measurement detector = Peak |
| ≤ -30 dB /100 kHz | Peak power measurement detector = RMS |

**Test setup**




**Test procedure**

1. EUT set to test mode (Communication tester is used if needed)
2. Span it set according to measurement range
3. Resolution bandwidth is set to 100 kHz and detector to peak and max hold
4. Markers are set to peak emission levels within frequency band
5. Emission level is determined by second marker on emission peak
6. Attenuation is determined from level difference

**Test results**

| Channel | Frequency [MHz] | Mode | Emission [MHz] | Emission Level [dbm] | Peak power [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| $F_{MID}$ | 2440 | CSS | 2272.14 | -38.08 | 1 | -19.0 | -19.08 |

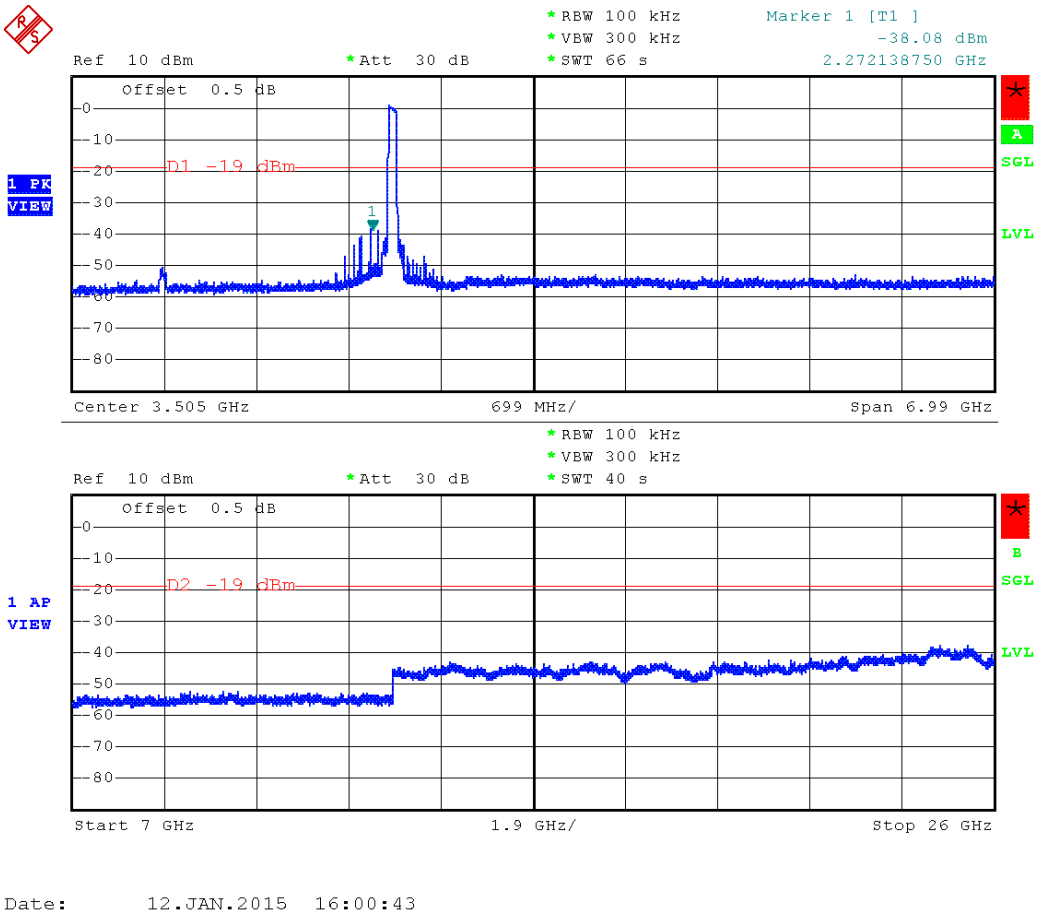
Comments:

**Conducted spurious emissions – CSS $F_{MID}$**

## Spurious Emissions acc. to FCC 15.247

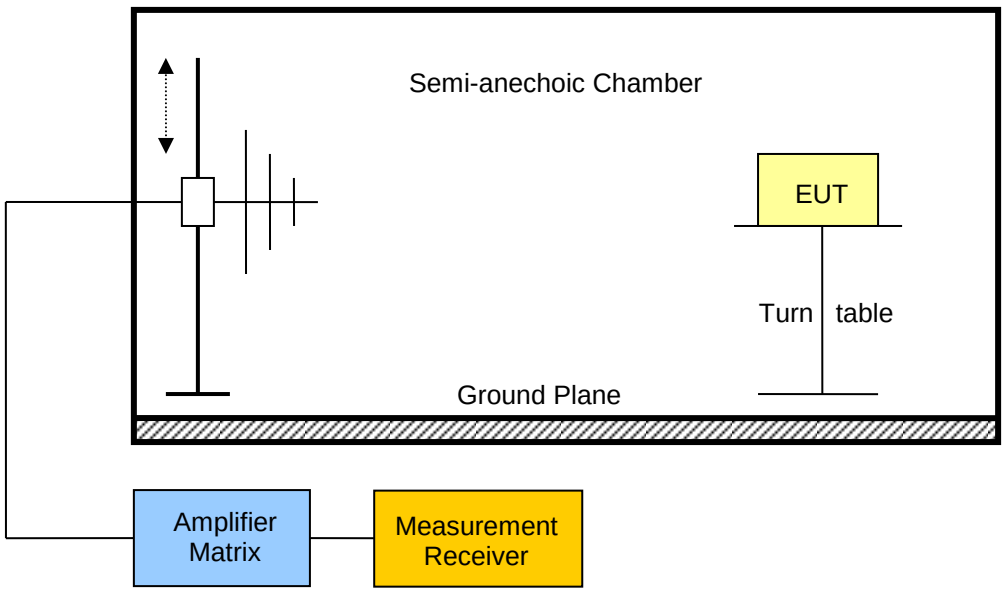
Project Number: G0M-1412-4419

| | |
|---|---|
| Applicant: | MKW electronics GmbH |
| EUT Name: | Shirp spred spectrum based transceiver for wireless location |
| Model: | W010 |
| Test Site: | Eurofins Product Service GmbH |
| Operator: | Wilfried Treffke |
| Test Conditions: | Tnom / Vnom |
| Mode: | Tx, CSS, 2440 MHz, Ant.2 |
| Test Date: | 2015-01-12 |
| Verdict: | PASS |
| Note 1: | Spurious in non-restricted frequency bands |
| Note 2: | conducted measurement |



### 3.9 Test Conditions and Results – Transmitter radiated emissions

| **Transmitter radiated emissions acc. to FCC 47 CFR 15.247 / IC RSS-210** | | | | **Verdict: PASS** |
|---|---|---|---|---|
| Test according referenced standards | | Reference Method | | |
| | | FCC 15.247(d) / IC RSS-210 A8.5 | | |
| Test according to measurement reference | | Reference Method | | |
| | | ANSI C63.10 / ANSI C63.4 | | |
| Test frequency range | | Tested frequencies | | |
| | | 30 MHz – 10th Harmonic | | |
| **Limits** | | | | |
| Frequency range [MHz] | Detector | Limit [µV/m] | Limit [dBµV/m] | Limit Distance [m] |
| 30 – 88 | Quasi-Peak | 100 | 40 | 3 |
| 88 – 216 | Quasi-Peak | 150 | 43.5 | 3 |
| 216 – 960 | Quasi-Peak | 200 | 46 | 3 |
| 960 – 1000 | Quasi-Peak | 500 | 54 | 3 |
| > 1000 | Average | 500 | 54 | 3 |
| Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).<br>When average radiated emission measurements are specified, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. | | | | |
| **Test setup** | | | | |



| Test procedure |
|---|
| 1. EUT set to test mode (Communication tester is used if needed)<br>2. Span it set according to measurement range<br>3. Resolution bandwidth below 1 GHz is set according to CISPR 16 with peak/quasi-peak detector and RBW of 1 MHz with peak/average detector is used above 1 GHz<br>4. Markers are set to peak emission levels within restricted bands |

**Test results – Antenna 1**

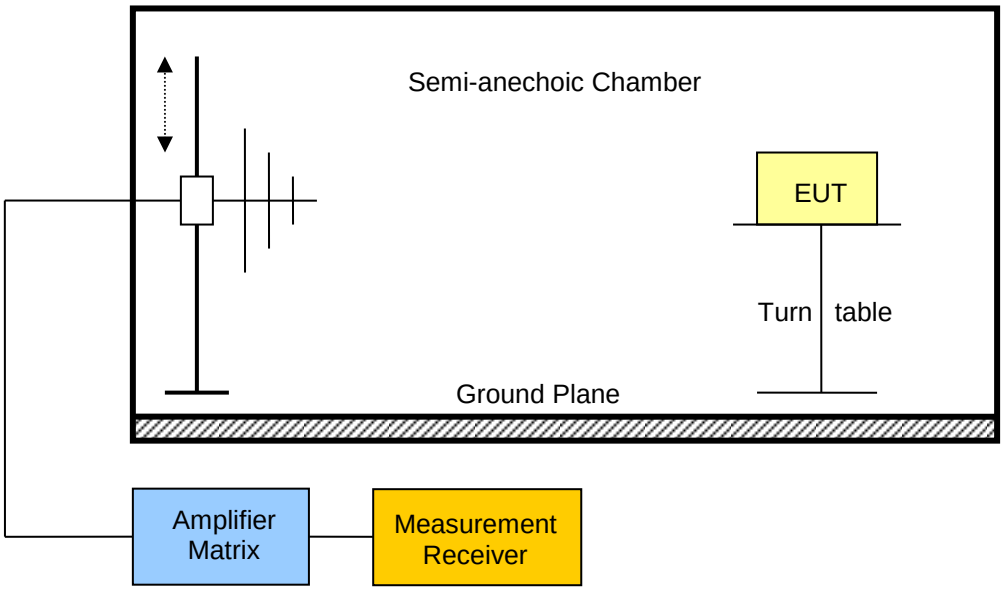
| Channel | Frequency [MHz] | Mode | Emission [MHz] | Level [dbµV/m] | Det. | Pol. | Limit [dbµV/m] | Limit dist. [m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| $F_{MID}$ | 2440 | CSS | 249.6 | 35.47 | pk | ver | 46.00 | 3 | -10.53 |
| $F_{MID}$ | 2440 | CSS | 250.004 | 41.88 | qpk | hor | 46.00 | 3 | -04.12 |
| $F_{MID}$ | 2440 | CSS | 336 | 39.85 | pk | ver | 74.00 | 3 | -34.15 |
| $F_{MID}$ | 2440 | CSS | 2271.5 | 58.92 | pk | ver | 74.00 | 3 | -15.08 |
| $F_{MID}$ | 2440 | CSS | 2271.5 | 38.92* | av | ver | 54.00 | 3 | -15.08 |
| $F_{MID}$ | 2440 | CSS | 2374 | 72.58 | pk | ver | 74.00 | 3 | -01.42 |
| $F_{MID}$ | 2440 | CSS | 2374 | 52.58* | av | ver | 54.00 | 3 | -01.42 |
| $F_{MID}$ | 2440 | CSS | 2383 | 69.20 | pk | ver | 74.00 | 3 | -04.80 |
| $F_{MID}$ | 2440 | CSS | 2383 | 49.20* | av | ver | 54.00 | 3 | -04.80 |
| $F_{MID}$ | 2440 | CSS | 2388 | 71.65 | pk | ver | 74.00 | 3 | -02.35 |
| $F_{MID}$ | 2440 | CSS | 2388 | 51.65* | av | ver | 54.00 | 3 | -02.35 |
| $F_{MID}$ | 2440 | CSS | 2484.4 | 71.67 | pk | ver | 74.00 | 3 | -02.33 |
| $F_{MID}$ | 2440 | CSS | 2484.4 | 51.67* | av | ver | 54.00 | 3 | -02.33 |
| $F_{MID}$ | 2440 | CSS | 2486.4 | 72.53 | pk | ver | 74.00 | 3 | -01.47 |
| $F_{MID}$ | 2440 | CSS | 2486.4 | 52.53* | pk | ver | 54.00 | 3 | -01.47 |
| $F_{MID}$ | 2440 | CSS | 2496.7 | 70.76 | pk | ver | 74.00 | 3 | -03.24 |
| $F_{MID}$ | 2440 | CSS | 2496.7 | 50.76* | pk | ver | 54.00 | 3 | -03.24 |
| $F_{MID}$ | 2440 | CSS | 2500 | 66.21 | pk | ver | 74.00 | 3 | -07.80 |
| $F_{MID}$ | 2440 | CSS | 2500 | 46.21* | pk | ver | 54.00 | 3 | -07.80 |
| $F_{MID}$ | 2440 | CSS | 4878 | 38.50 | pk | ver | 74.00 | 1 | -35.50 |
| $F_{MID}$ | 2440 | CSS | 4886 | 39.12 | pk | hor | 74.00 | 1 | -34.88 |

Comments: * calculated from peak value by duty cycle correction of -20dB

| Test results – Antenna 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Channel | Frequency [MHz] | Mode | Emission [MHz] | Level [dbµV/m] | Det. | Pol. | Limit [dbµV/m] | Limit dist. [m] | Margin [dB] |
| $F_{MID}$ | 2440 | CSS | 249.6 | 36.91 | pk | ver | 46.00 | 3 | -09.09 |
| $F_{MID}$ | 2440 | CSS | 250.004 | 41.88 | qpk | hor | 46.00 | 3 | -04.12 |
| $F_{MID}$ | 2440 | CSS | 2271.5 | 59.00 | pk | ver | 74.00 | 3 | -15.00 |
| $F_{MID}$ | 2440 | CSS | 2271.5 | 39.00* | av | ver | 54.00 | 3 | -15.00 |
| $F_{MID}$ | 2440 | CSS | 2336 | 65.20 | pk | ver | 74.00 | 3 | -08.80 |
| $F_{MID}$ | 2440 | CSS | 2336 | 45.20* | av | ver | 54.00 | 3 | -08.80 |
| $F_{MID}$ | 2440 | CSS | 2387 | 67.67 | pk | ver | 74.00 | 3 | -06.33 |
| $F_{MID}$ | 2440 | CSS | 2387 | 47.67* | av | ver | 54.00 | 3 | -06.33 |
| $F_{MID}$ | 2440 | CSS | 2483.9 | 70.39 | pk | ver | 74.00 | 3 | -03.61 |
| $F_{MID}$ | 2440 | CSS | 2483.9 | 50.39* | av | ver | 54.00 | 3 | -03.61 |
| $F_{MID}$ | 2440 | CSS | 2495.9 | 67.84 | pk | ver | 74.00 | 3 | -06.16 |
| $F_{MID}$ | 2440 | CSS | 2495.9 | 47.84* | pk | ver | 54.00 | 3 | -06.16 |
| $F_{MID}$ | 2440 | CSS | 2503 | 65.62 | pk | ver | 95.00 | 3 | -29.38 |
| $F_{MID}$ | 2440 | CSS | 4871 | 41.77 | pk | hor | 74.00 | 3 | -32.23 |
| $F_{MID}$ | 2440 | CSS | 4876 | 41.62 | pk | ver | 74.00 | 3 | -32.38 |
| $F_{MID}$ | 2440 | CSS | 7314 | 43.26 | pk | ver | 74.00 | 3 | -30.74 |
| Comments: * calculated from peak value by duty cycle correction -20dB | | | | | | | | | |

### 3.10 Test Conditions and Results – Receiver radiated emissions

| **Receiver radiated emissions acc. to IC RSS-210** | | | | **Verdict: PASS** |
|---|---|---|---|---|
| Test according referenced standards | Reference Method | | | |
| | IC RSS-210 A8.5 | | | |
| Test according to measurement reference | Reference Method | | | |
| | ANSI C63.4 | | | |
| Test frequency range | Tested frequencies | | | |
| | 30 MHz – 3th Harmonic | | | |
| EUT test mode | Receive | | | |
| **Limits** | | | | |
| Frequency range [MHz] | Detector | Limit [µV/m] | Limit [dBµV/m] | Limit Distance [m] |
| 30 – 88 | Quasi-Peak | 100 | 40 | 3 |
| 88 – 216 | Quasi-Peak | 150 | 43.5 | 3 |
| 216 – 960 | Quasi-Peak | 200 | 46 | 3 |
| 960 – 1000 | Quasi-Peak | 500 | 54 | 3 |
| > 1000 | Average | 500 | 54 | 3 |
| **Test setup** | | | | |



| Test procedure |
|---|
| 1. EUT set to receive mode (Communication tester is used if needed)<br>2. Span it set according to measurement range<br>3. Resolution bandwidth below 1 GHz is set according to CISPR 16 with peak/quasi-peak detector and RBW of 1 MHz with peak/average detector is used above 1 GHz<br>4. Markers are set to peak emission levels |

**Test results**

| Channel | Frequency [MHz] | Emission [MHz] | Emission Level [dBµV/m] | Pol. | Det. | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| $F_{MID}$ | Scan | 149.68 | 35.26 | ver | pk | 43.50 | -08.24 |
| $F_{MID}$ | Scan | 200 | 31.86 | hor | pk | 43.50 | -11.64 |
| $F_{MID}$ | Scan | 249.6 | 39.80 | hor | pk | 46.00 | -06.20 |
| $F_{MID}$ | Scan | 249.6 | 36.88 | ver | pk | 46.00 | -09.12 |
| $F_{MID}$ | Scan | 304 | 34.63 | ver | pk | 46.00 | -11.37 |
| $F_{MID}$ | Scan | 348.8 | 32.91 | hor | pk | 46.00 | -13.09 |
| $F_{MID}$ | Scan | 499.2 | 34.42 | hor | pk | 46.00 | -11.58 |
| $F_{MID}$ | Scan | 499.2 | 33.05 | ver | pk | 46.00 | -12.95 |
| $F_{MID}$ | Scan | 748.8 | 34.00 | hor | pk | 46.00 | -12.00 |
| $F_{MID}$ | Scan | 748.8 | 33.82 | ver | pk | 46.00 | -12.18 |
| $F_{MID}$ | Scan | 873.6 | 34.43 | ver | pk | 46.00 | -11.57 |
| $F_{MID}$ | Scan | 2194 | 45.42 | hor | pk | 53.98 | -08.56 |
| $F_{MID}$ | Scan | 2332 | 45.04 | hor | pk | 53.98 | -08.94 |
| $F_{MID}$ | Scan | 2434 | 45.30 | hor | pk | 53.98 | -08.68 |
| $F_{MID}$ | Scan | 5672 | 41.83 | ver | pk | 53.98 | -12.15 |
| $F_{MID}$ | Scan | 7432 | 45.43 | ver | pk | 53.98 | -08.55 |
| $F_{MID}$ | Scan | 7736 | 46.41 | hor | pk | 53.98 | -07.57 |

Comments:
* Physical distance between EUT and measurement antenna.