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Confidential ReportClient:Test of:Schrader Electronics LtdCRMRS232 Receiver11 Technology ParkCRMRS232 ReceiverBelfast RoadTo:AntrimTo:Northern IrelandFCC CFR 47 Part 15BT41 1QSRSS GenAtt: James KyleImage: Confidential Report

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|------------------|--------------------------|------------------------|-------------------|
| REPORT REF: | 15E5409-2 | TESTED BY: | M Kirby |
| DATE RECEIVED: | 7 th Jan 2015 | REPORT BY: | M Kirby |
| ISSUE DATE: | 6 th Feb 2015 | APPROVED SIGNATORY: | J McAuley |
| | | JOB TITLE: | Technical Manager |
| | | SIGNATURE: | John the anley |

Executive Summary

Emissions Testing performed according to FCC Part 15

| Result: | Test standard referenced: | Test Title |
|----------|---------------------------|--------------------|
| Complied | FCC Part 15.109 | Radiated Emissions |
| Complied | RSS Gen, | Radiated Emissions |

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- Section 5: Results
- Section 6: Analysis of Test Results, Conclusions

Appendix A: Test Equipment Used

<u>1</u> Equipment Under Test (EUT)

1.1 Identification of EUT

| FCCID : | MRXCRMRS232 |
|---------------------------|--------------------------|
| Manufacturer: | Schrader Electronics Ltd |
| Model Name or Number: | CRMRS232 |
| Power Supply Requirement: | 24 V Battery |

1.2 Description of E.U.T.

The EUT purpose is to receive data from Schrader tyre sensors over a radio link and to relay this data onto a controller over RS232 link.

1.3 Modifications

There were no modifications on the EUT

1.4 Date of Test

The tests were carried out on dates of the 8th and 9th January 2015.

2 Test Specification, Methods and Procedures

2.1 Emissions

Emissions were assessed to the following standards:

FCC CFR 47 Part 15.109 Federal Communications Commission: Part 15 Radio Frequency Devices Radiated Emissions Limits

RSS Gen Issue 4 — General Requirements and Information for the Certification of Radio Apparatus

ANSI C63.4-2014

"Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electri-cal and Electronic Equipment in the Range of 9 kHz to 40 GHz"

3 Deviations and Exclusions from the Test Specifications

3.1 Deviations

There were no deviations from the test specification.

3.2 Exclusions

There were no exclusions from the test specification.

4 Operation of E.U.T. During Testing

4.1 **Operating Environment**

The EUT was powered using a 24 Volt battery.

4.2 Operating Mode:

The EUT was connected to a laptop via a RS232 connection and a Schrader tyre sensor (TMS truck sensor) provided pulses to the EUT over radio link.

Note the laptop was used solely to exercise the EUT and in normal operation, the EUT would not connect to or exchange data with a laptop.

5 Results

5.1 Radiated Emissions

Compliant measurements of radiated emissions were carried out in an anechoic chamber from 30 MHz to 4.5GHz. The equipment and cable orientation were investigated to ensure that maximum emissions were obtained at critical frequencies.

The receiver bandwidth was set to 120 kHz for frequencies between 30 MHz and 1 GHz.

For frequencies between 1GHz and 6 GHz, the resolution bandwidth was 1MHz and video bandwidth was 1MHz. for peak measurements. The Video bandwidth was changed to 10Hz for Average measurements (as per ANSI 63.4-2014 Section 4.2.3 e).

5.2.1 Measurement Uncertainty

The measurement uncertainty (with a 95% confidence level) for the radiated emissions test was ± 5.3 dB (from 30 to 100 MHz), ± 4.7 dB (from 100 to 300 MHz), ± 3.9 dB (from 300 to 1000 MHz) and ± 3.8 dB (from 1 to 12.75 GHz).

5.3 Radiated Emissions

Exploratory radiated emissions were carried out to determine the orientation that maximised the emissions.

Final radiated emissions measurements were carried out on the EUT in the orientation determined from the exploratory measurements.

For the spurious and harmonics measurements, below 1000 MHz, the EUT was set up at a 3 metre distance from the receiving antenna, in a semi Anechoic Chamber, with the EUT running in a receive mode. The EUT was rotated 360 degrees azimuth and the search antenna height varied 1 to 4m in order to maximize the emissions.

For measurements above 1000MHz, the EUT was set up at a 3 metre distance from the antenna, in a fully anechoic chamber, with the EUT running in receive mode. The EUT was rotated 360 degrees azimuth in order to maximize the emissions.

Significant peaks from the EUT were then recorded to determine margin to the limits.

Results

| Frequency MHz | Quasi Peak Level dBuV/m | Antenna Polarity | Antenna Factor dB | Cable loss dB | Final Field Strength Quasi Peak dBuV/m | Quasi Peak Limit dBuV/m | Margin dB |
|------------------|-------------------------------|---------------------|-------------------------|---------------------|---|----------------------------------|--------------|
| 433.768 | -3.3 | Vertical | 16.1 | 1.2 | 14 | 46.0 | 32.0 |
| 715.306 | -3.35 | Vertical | 20.6 | 1.4 | 18.65 | 46.0 | 27.4 |
| 828.681 | -4.6 | Vertical | 22.2 | 1.4 | 19 | 46.0 | 27.0 |
| 885.581 | -0.17 | Vertical | 22 | 1.4 | 23.23 | 46.0 | 22.8 |
| 433.981 | 11.9 | Horizontal | 16.1 | 1.2 | 29.2 | 46.0 | 16.8 |
| 828.006 | 1.4 | Horizontal | 22.2 | 1.4 | 25 | 46.0 | 21.0 |
| 921.106 | 4.84 | Horizontal | 22.9 | 1.4 | 29.14 | 46.0 | 16.9 |

Table 1 Results for spurious emissions below 1 GHz (3 metre)

| Frequency | Measured Peak Level | Antenna Factor | Preamp Gain | Cable Loss | Antenna Polarity | Final Peak Level | Average Limit+20dB | Margin |
|-----------|---------------------------|-------------------|----------------|---------------|---------------------|------------------------|-----------------------|--------|
| GHz | dBuV/m | dB | dB | dB | | dBuV/m | dBuV/m | dB |
| 2.113 | 42.7 | 28 | 39 | 3.2 | Vertical | 50.5 | 74.0 | 23.4 |
| 3.265 | 50.3 | 30.6 | 37.4 | 4.4 | Vertical | 52.7 | 74.0 | 21.3 |
| 3.895 | 53.0 | 30.6 | 37.7 | 4.8 | Vertical | 55.3 | 74.0 | 18.6 |
| 2.110 | 41.3 | 28 | 39 | 3.2 | Horizontal | 49.1 | 74.0 | 24.9 |
| 3.527 | 50.5 | 30.6 | 37.8 | 4.5 | Horizontal | 53.2 | 74.0 | 20.8 |
| 3.681 | 51.8 | 30.6 | 37.4 | 4.5 | Horizontal | 54.1 | 74.0 | 19.8 |

| Frequency | Measured Average Level | Antenna Factor | Preamp Gain | Cable Loss | Antenna Polarity | Final Average Level | Average Limit | Margin |
|-----------|------------------------------|-------------------|----------------|---------------|---------------------|---------------------------|------------------|--------|
| GHz | dBuV/m | dB | dB | dB | | dBuV/m | dBuV/m | dB |
| 2.113 | 31.0 | 28 | 39 | 3.2 | Vertical | 38.8 | 54.0 | 15.1 |
| 3.265 | 38.0 | 30.6 | 37.4 | 4.4 | Vertical | 40.4 | 54.0 | 13.6 |
| 3.895 | 40.4 | 30.6 | 37.7 | 4.8 | Vertical | 42.7 | 54.0 | 11.3 |
| 2.110 | 32.2 | 28 | 39 | 3.2 | Horizontal | 40.0 | 54.0 | 14.0 |
| 3.527 | 37.8 | 30.6 | 37.8 | 4.5 | Horizontal | 40.5 | 54.0 | 13.5 |
| 3.681 | 39.7 | 30.6 | 37.4 | 4.5 | Horizontal | 42.0 | 54.0 | 12.0 |

Table 2 Results for spurious emissions above 1 GHz (3 metre)

The plots are shown on the following pages.

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| | Spectrum | × | | | ₩ | | | | | | |
|---|--|---|---|---|---|--|--|--|--|--|--|
| Ref Level 77.00 | dBµ∨ | Mode Auto FFT | Input 1 AC | | | | | | | | |
| STOP | | | | | | | | | | | |
| U Max | | DARS | | | | | | | | | |
| 70 dBuye SPURIC | US LINE ABS | PASS | | | | | | | | | |
| 60 dBµV | | | | | | | | | | | |
| 50 dBµV | | | | | | | | | | | |
| | | | | | | | | | | | |
| 30 dBµV | B3 | | | | | | | | | | |
| 20 dBµV | | a de la constante de set | ner de la contra de | The local scale resident strate photons | and the second second second second | | | | | | |
| 10 dвµV | and a sublemail of the second | | | | and the constraints and the second | | | | | | |
| O dBµV | | | | | | | | | | | |
| -10 dBµV | | | | | | | | | | | |
| -20 dBuV | | | | | | | | | | | |
| Start 30.0 MHz | 3 | 5 | 600 pts | | Stop 300.0 MHz | | | | | | |
| Spurious Emissio | าร | | | | - | | | | | | |
| Range Low | Range Up | RBW | Frequency | Power Abs | ∆Limit | | | | | | |
| 30.000 MHz | 47.000 MH | z 100.000 kHz | 2 39.74312 MH | z 18.19 dBµ | √ -21.81 dB | | | | | | |
| 47.000 MHz | 74.000 MH | z 100.000 kHz | 2 54.98188 MH | z 19.62 dBµ\ | V -20.38 dB | | | | | | |
| 29,000 MHz | | Z 100.000 KHZ | 80.62375 MF | z 15,17 dBµv | V -24.83 QB | | | | | | |
| 118.000 MHz | 174.000 MH | z 100.000 kHz | 155.69500 MH | z 20.22 dBuV | √ -23.28 dB | | | | | | |
| 174.000 MHz | 216.000 MH | z 100.000 kHz | 207.99375 MH | z 19.83 dBµ | v -23.67 dB | | | | | | |
| 216.000 MHz | 300.000 MH | z 100.000 kHz | 287.97750 MH | z 21.40 dBµ\ | √ -24.60 dB | | | | | | |
| | | Fig 1 Scan 3 | 0MHz – 300MHz Vertica | | | | | | | | |
| | | | | | | | | | | | |
| Receiver | Spectrum (| ×) | | | | | | | | | |
| Ref Level 77.00 d | lВµ∨ | Mode Auto FFT | Input 1 AC | | Ref Level 77.00 dBuV Mode Auto FFT Input 1 AC | | | | | | |
| STOP | STOP | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| Limit Check | | PASS | | | | | | | | | |
| 70 dBHYe _SPURIO | US_LINE_ABS_ | PASS PASS | | | | | | | | | |
| Climit Check 70 dBHYe _\$PURIO | US_LINE_ABS_ | PASS PASS | | | | | | | | | |
| Limit Check 70 dBHYe _sPURIO 60 dBµV | US_LINE_ABS_ | PASS PASS | | | | | | | | | |
| | US_LINE_ABS_ | PASS PASS | | | | | | | | | |
| Limit Check 70 dBHYe _ SPURIO 60 dBHV 50 dBHV SPURIOUS_LINE_AE 30 dBHV | US_LINE_ABS_ | PASS PASS | | | | | | | | | |
| Limit Check 70 dBHYe _ SPURIO 60 dBµV 50 dBµV 50 dBµV 20 dBµV 20 dBµV | US_LINE_ABS_ | PASS | | | | | | | | | |
| Limit Check 70 dBHYe 3PURIO 60 dBHV 50 dBHV 50 dBHV 30 dBHV 20 dBHV 20 dBHV 10 dBHV 10 dBHV | US_LINE_ABS_ | PASS | | | | | | | | | |
| Limit Check 70 dBHYe SPURIO 60 dBµV 50 dBµV 50 dBµV 50 dBµV 30 dBµV 50 dBµV 20 dBµV 10 dBµV 10 dBµV 10 dBµV | US_LINE_ABS_ | PASS PASS | | | | | | | | | |
| Limit Check 70 dBHYe SPURIO 60 dBµV 50 dBµV 50 dBµV SPURIOUS_LINE_AB 30 dBµV 20 dBµV 10 dBµV 10 dBµV -10 dBµV -10 dBµV | US_LINE_ABS_ | PASS PASS | | | | | | | | | |
| Limit Check 70 dB _H YeSPURIO 60 dB _H V 50 dB _H V | US_LINE_ABS_ | PASS PASS | | | | | | | | | |
| Limit Check 70 dB _H YeSPURIO 60 dB _H V 50 dB _H V 50 dB _H V 20 dB _H V 20 dB _H V 10 dB _H V 0 dB _H V -10 dB _H V -20 dB _H V Start 30.0 MHz | US_LINE_ABS_ | PASS PASS | U pts | | ничение и порединие и в порединие и поре | | | | | | |
| Limit Check 70 dBHYe SPURIO 60 dBHV 50 dBHV 50 dBHV SPURIOUS_LINE_AE 30 dBHV 20 dBHV 10 dBHV 10 dBHV 10 dBHV 10 dBHV 20 dBHV 10 dBHV 10 dBHV 10 dBHV -10 dBHV 10 dBHV -20 dBHV Start 30.0 MHz | US_LINE_ABS_ | PASS PASS | 00 pts | | top 300.0 MHz | | | | | | |
| Limit Check 70 dBHY 50 dBHY 50 dBHY 50 dBHY 20 dBHY 10 dBHY -10 dBHY -20 dBHY -20 dBHY Start 30.0 MHz Spurious Emission Range Low | US_LINE_ABS_ 3S_ 3S_ S Range Up | PASS PASS | 00 pts | Power Abs | ΔLimit | | | | | | |
| Limit Check 70 dBHY 50 dBHY 50 dBHY 50 dBHY 20 dBHY 10 dBHY -10 dBHY -20 dBHY -20 dBHY Start 30.0 MHz Spurious Emission Range Low 30.000 MHz | US_LINE_ABS_ 3S_ 3S_ 3S_ 3S_ 3S_ 3S_ 3S_ 3 | PASS PASS | 00 pts | | сор 300.0 MHz | | | | | | |
| Limit Check 70 dBHY 50 dBHY 50 dBHY 50 dBHY 50 dBHY 20 dBHY 10 dBHY -10 dBHY -10 dBHY 50 dBHY 50 dBHY 10 dBHY 50 dBH | US_LINE_ABS_ 3S_ 3S_ 3S_ 3S_ 3S_ 3S_ 3S_ 3 | PASS PASS PASS 56 RBW 100.000 kHz 100.000 kHz | 00 pts Frequency 39.50937 MHz 50.66188 MHz | Power Abs | ΔLimit -22.06 dB -21.86 dB -21.86 dB | | | | | | |
| Limit Check 70 dBHY 50 dBHY 50 dBHY 50 dBHY 50 dBHY 20 dBHY 20 dBHY 10 dBHY -10 dBHY -10 dBHY 50 dBH | US_LINE_ABS_ 35_ 5 Range Up 47.000 MHz 74.000 MHz 88.000 MHz 110.000 MHz | PASS PASS PASS 56 RBW 100.000 kHz 100.000 kHz 100.000 kHz | 00 pts Frequency 39.50937 MHz 50.66188 MHz 74.28875 MHz 106.05625 MHz | Power Abs 17.94 dBµV 13.86 dBµV 17.95 dBµV | top 300.0 MHz ΔLimit -22.06 dB -21.86 dB -26.14 dB -25.94 dB | | | | | | |
| Limit Check 70 dBHY 50 dBHY 50 dBHY 50 dBHY 50 dBHY 20 dBHY 20 dBHY 10 dBHY -10 dBHY -10 dBHY 50 dBHY -10 dBHY -1 | US_LINE_ABS_ 335_ | PASS PASS PASS 56 RBW 100.000 kHz 100.000 kHz 100.000 kHz 100.000 kHz | 00 pts Frequency 39.50937 MHz 50.66188 MHz 74.28875 MHz 106.05625 MHz 144.28500 MHz | | | | | | | | |
| Limit Check 70 dBHY 50 dBHY 50 dBHY 50 dBHY 20 dBHY 20 dBHY 10 dBHY -10 dBHY -10 dBHY -20 dBHY 50 dBHY -10 dBHY - | US_LINE_ABS_ 35_ S Range Up 47.000 MHz 74.000 MHz 118.000 MHz 118.000 MHz 118.000 MHz 118.000 MHz | PASS PASS PASS 56 88W 100.000 kHz 100.000 kHz 100.000 kHz 100.000 kHz 100.000 kHz | 00 pts Frequency 39.50937 MHz 50.66188 MHz 74.28875 MHz 106.05625 MHz 144.28500 MHz 180.43125 MHz | | ΔLimit -22.06 dB -25.94 dB | | | | | | |
| Limit Check 70 dB _H Ye _ 3PURIO 60 dB _H V 50 dB _H V 50 dB _H V 50 dB _H V 20 dB _H V 20 dB _H V 10 dB _H V -10 dB _H V -10 dB _H V -20 dB _H V -20 dB _H V -10 | US_LINE_ABS_ 35_ 35_ 5 Range Up 47.000 MHz 74.000 MHz 118.000 MHz 118.000 MHz 174.000 MHz 118.000 MHz 174.000 MHz | PASS PASS PASS 56 RBW 100.000 kHz 100.000 kHz 100.000 kHz 100.000 kHz 100.000 kHz 100.000 kHz 100.000 kHz 100.000 kHz | Image: Constraint of the second sec | Power Abs 17.94 dBµV 13.86 dBµV 13.86 dBµV 19.98 dBµV 19.98 dBµV 20.91 dBµV | ΔLimit -22.06 dB -21.86 dB -25.94 dB -25.94 dB -25.07 dB -25.09 dB | | | | | | |

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| Receiver | Spectrum | (X) | | | |
|--|--|---|---|--|---|
| Ref Level 77.00 | dBµ∨ | Mode Auto FFT | Input 1 AC | | (* |
| STOP | | | | | 7 |
| O1 Max | | Distances Reven | | | |
| Limit Check | | PASS | | | |
| 70 GEHIE _SPORT | JUS_LINE_ABS_ | PADS | | | |
| 60 dBµV | | | | | |
| | | | | | |
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| | ABS_ | | | | |
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| 20 dBµV | | | | | |
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| -10 dBµV | | | | + + | |
| 20 49.02 | | | | | |
| -20 00µV | | | .00 nts | | Stop 1.0 CH- |
| Sourious Emissio | nc | 24 | 00 pts | | 5(0) 1.0 GHZ |
| Range Low | Range Un | RBW | Frequency | Power Ahs | Al imit |
| 300.000 MHz | 470.000 MH | lz 100.000 kHz | 433.76875 MHz | 32.51 dBµV | -13.49 dB |
| 470.000 MHz | 960.000 MH | łz 100.000 kHz | 885.58125 MHz | 35.79 dBµV | -10.21 dB |
| 470.000 MHz | 960.000 MH | Iz 100.000 kHz | 828.61875 MHz | 32.08 dBµV | -13.92 dB |
| 470.000 MHz | <u> арл.000 MH</u> | 12 100.000 KHZ | 715.30625 MHz | <u>зз.58 авµV</u> | -12.42 dB |
| | | Fig 3 Scan 30 | 00MHz - 1GHz Vertical | | |
| Bacciuar | Spectrum | <u></u> | | | Ē |
| Receiver | opecuum | ۳ <u>۲</u> | | | [▽] |
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| STOP ●1 Max Limit Check 70 dBµV 60 dBµV 50 dBµV 50 dBµV 30 dBµV 20 dBµV 10 dBµV 10 dBµV -10 dBµV -20 dBµV Start 300.0 MHz | | PASS PA33 | Input 1 AC | | Stop 1.0 GHz |
| STOP ●1 Max Limit Check 70 dBµVerse 60 dBµV 50 dBµV 50 dBµV 40 dBµV 30 dBµV 30 dBµV 10 dBµV 10 dBµV -10 dBµV -20 dBµV Start 300.0 MHz | ABS_ | PASS PA33 | Input 1 AC | | Stop 1.0 GHz |
| STOP ● 1 Max Limit Check 70 dBµV 60 dBµV 50 dBµV 50 dBµV 40 dBµV 30 dBµV 20 dBµV 10 dBµV -10 dBµV -20 dBµV Start 300.0 MHz Spurious Emission Range Low | ABS_ | PASS PASS PASS | Input 1 AC | Power Abs | μ |
| STOP ● 1 Max Limit Check 70 dBjAeSPURI 60 dBµV 50 dBµV 50 dBµV 30 dBµV 30 dBµV 10 dBµV 10 dBµV -10 dBµV Start 300.0 MHz 300.000 MHz | ABS_ | PASS PASS PASS <td>Input 1 AC</td> <td>Power Abs 36.50 dBµV</td> <td>κ./u.γ.//ψ./// κ./u.γ.//ψ./// κ./u.γ.//ψ./// κ./u.γ.//ψ.// κ./u.γ.//ψ.// κ./u.γ.// κ./u.γ.//ψ.// κ./u.γ.// κ./u.γ.// κ./u.γ.// κ./u.γ./</td> | Input 1 AC | Power Abs 36.50 dBµV | κ./u.γ.//ψ./// κ./u.γ.//ψ./// κ./u.γ.//ψ./// κ./u.γ.//ψ.// κ./u.γ.//ψ.// κ./u.γ.// κ./u.γ.//ψ.// κ./u.γ.// κ./u.γ.// κ./u.γ.// κ./u.γ./ |
| STOP ●1 Max Limit Check 70 dBµV 60 dBµV 50 dBµV 50 dBµV 30 dBµV 30 dBµV 20 dBµV 10 dBµV -10 dBµV -20 dBµV Start 300.0 MHz 300.000 MHz 470.000 MHz | ABS_ | PASS PASS PASS PASS PASS PASS PASS PASS | Input 1 AC | Power Abs | ΔLimit -9.50 dB -9.59 dB - |
| STOP ● 1 Max Limit Check 70 dBµVe | ABS_ | PASS PA33 | Input 1 AC | Power Abs 36.50 dBµV 31.39 dBµV | μιμιμίνμαν |





6 Analysis of Test Results, Conclusions

6.1 Measurement Uncertainties

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4 with a confidence level of 95%.

6.2 Radiated Emissions to FCC Part 15, Class B

The E.U.T. complied with the radiated emission specification.

Appendix A Test Equipment Used:

| Instrument | Manufacturer. | Model | CEI Ref No. | Cal Due Date |
|----------------------------|-----------------|-----------|-------------|-----------------|
| Preamplifier | Hewlett Packard | 83017A | 805 | 19/09/2015 |
| Spectrum Analyser | Rohde & Schwarz | FSP 40 | 850 | 14/08/2015 |
| Spectrum Analyser/Receiver | Rohde & Schwarz | ESR | 869 | 06/06/2017 |
| Antenna Trilog | Schwarzbeck | VULB 9160 | 889 | 29/07/2017 |
| Anechoic Chamber | CEI | 10M | 845 | 23/09/2015 |
| Antenna Log Periodic | Chase | UPA6108 | 609 | 11/09/2015 |
| Horn Antenna | EMCO | 3115 | 655 | 14/11/2015 |

Table A1

End of Report