Willow Run Test Labs, LLC
8501 Beck Road, Building 2227
Belleville, Michigan 48111 USA
Tel: (734) 252-9785
Fax: (734) 926-9785
e-mail: info@wrtest.com

Testing of

Electromagnetic Emissions

per

USA: CFR Title 47, Part 15.109

are herein reported for

Schrader Electronics MRXCR4

Test Report No.: 20141002-01

Applicant/Provider:
Schrader Electronics
11 Technology Park, Belfast Road, Antrim Northern Ireland BT41 1QS United Kingdom
Phone: +44 28 9448 3067, Fax: +44 28 9446 8440
Contact Person: James Kyle; jakyle@schrader.co.uk

Measured by:	Dr. Joseph Brunett, EMC-002790-NE	Report Approved by:	Dr. Joseph Brunett, EMC-002790-NE
Report by:	Dr. Joseph Brunett, EMC-002790-NE	Report Date of Issue:	October 02, 2014

Results of testing completed on (or before) October 02, 2014 are as follows.

Emissions: Radiated spurious emissions associated with the receive chain of this device **COMPLY** the regulatory limit(s) by no less than 4.6 dB.

Contents

List of Tables

List of Figures

1 Test Specifications, General Procedures, and Location

1.1 Test Specification and General Procedures

The ultimate goal of Schrader Electronics is to demonstrate that the Equipment Under Test (EUT) complies with the Rules and/or Directives below. Detailed in this report are the results of testing the Schrader Electronics MRXCR4 for compliance to:

Country/Region	Rules or Directive	Referenced Section(s)
United States	Code of Federal Regulations	CFR Title 47, Part 15.109

Schrader Electronics has determined that the equipment under test is subject to the rules and directives above at the date of this testing. In conjunction with these rules and directives, the following specifications and procedures are followed herein to demonstrate compliance (in whole or in part) with these regulations.

ANSI C63.4-2003	"Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"

1.2 Test Location and Equipment Used

Test Location The EUT was fully tested by **Willow Run Test Labs, LLC**, 8501 Beck Road, Building 2227, Belleville, Michigan 48111 USA. The Test Facility description and attenuation characteristics are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: 688478) and with Industry Canada, Ottawa, ON (File Ref. No: IC 8719A-1).

Test Equipment Pertinent test equipment used for measurements at this facility is listed in Table 1. The quality system employed at Willow Run Test Labs, LLC has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to the SI through NIST, other recognized national laboratories, accepted fundamental or natural physical constants, ratio type of calibration, or by comparison to consensus standards.

Table 1: Willow Run Test Labs, LLC Equipment List.

Description	Manufacturer/Model	SN	Quality Number	Last Cal By / Date Due
Antennas				
Shielded Loop (9 kHz - 50 MHz)	EMCO/6502	2855	UMLOOP1	UMRL / July-2015
Dipole Set (20 MHz - 1000 MHz)	EMCO/3121C	9504-1121	DIPEMC001	Liberty Labs / Sept-2016
Bicone (20 MHz - 250 MHz)	JEF	1	BICJEF001	UMRL / July-2015
Bicone (200 MHz - 1000 MHz)	JEF	1	SBICJEF001	UMRL / July-2015
Log-Periodic Array (0.2 – 1 GHz)	JEF/Isbell	1	LOGJEF001	UMRL / July-2015
Ridge-Horn Antenna	Univ. of Michigan	5	UMHORN005	UMRL / July-2015
L-Band	JEF		HRNL001	WRTL / July-2015*
LS-Band Horns	JEF/NRL	001, 002	HRN15001, HRN15002	WRTL / July-2015*
S-Band Horns	Scientific-Atlanta	1854	HRNSB001	WRTL / July-2015*
C-Band	JEF/NRL	1	HRNC001	WRTL / July-2015*
XN-Band Horns	JEF/NRL	001, 002	HRNXN001, HRNXN002	WRTL / July-2015*
X-Band Horns	JEF/NRL	001, 002	HRNXB001, HRNXB002	WRTL / July-2015*
Ku-Band Horns	JEF/NRL	001, 002	HRNKU001, HRNKU002	WRTL / July-2015*
K-Band Horns	JEF/NRL	001, 002	HRNK001, HRNK002	WRTL / July-2015*
Ka-Band Horns	JEF/NRL	001, 002	HRNKA001, HRNKA002	WRTL / July-2015*
U-Band Horns	Microwave Associates	-	HRNU001	WRTL / July-2015*
V-Band Horns	Microwave Associates	-	HRNV001	WRTL / July-2015*
W-Band Horns	Microwave Associates	-	HRNW001	WRTL / July-2015*
Quad-Ridge Horns	Condor AS-48461	C35200	QRH218001	WRTL / July-2015
Analyzers & Generators				
Spectrum Analyzer	HP/8593E	3649A02722	HP8593E001	DTI / Nov-2014
Spectrum Analyzer	R&S/FSV30	101660	RSFSV30001	R&S / Mar-2015
Power Meter (Thermistor)	HP/432B	-	HP432B001	WRTL / as used
Signal Generator	R&S/SMATE200A	-	RSSMATE001	WRTL / as used
Radio Test Set	R&S/CMU200	100104	RSCMU20001	Not Necessary
Additional Equipment				
Ka-Band Harmonic Mixer	HP/11970A	-	MIXA001, MIXA002	WRTL / July-2015
U-Band Harmonic Mixer	HP/11970U	-	MIXU001, MIXU002	WRTL / July-2015
V-Band Harmonic Mixer	Hughes/47434H-1003	-	MIXV001	WRTL / July-2015
W-Band Harmonic Mixer	Hughes/47436H-1003	-	MIXW001	WRTL / July-2015
Thermal Chamber	Thermotron / S1.2	18706	TC001	as used
Shaker Table	APS Dynamics / APS-300	-	VIB001	as used
Vibration Meter	Extech / SDL800	-	EXTECH1	Extech / 2015
LISN	EMCO	9304-2081	LISNEM001	WRTL / Jan-2015

* Verification Only - Standard Gain Horn Antennas

2 Configuration and Identification of the Equipment Under Test

2.1 Description and Declarations

The equipment under test is a superheterodyne receiver. The EUT is approximately 8 x 4 x 1.5 cm in dimension, and is depicted in Figure 1. It is powered by a 13.4 VDC vehicular power system. In use, this device is permanently affixed inside a motor vehicle. Table 2 outlines provider declared EUT specifications.

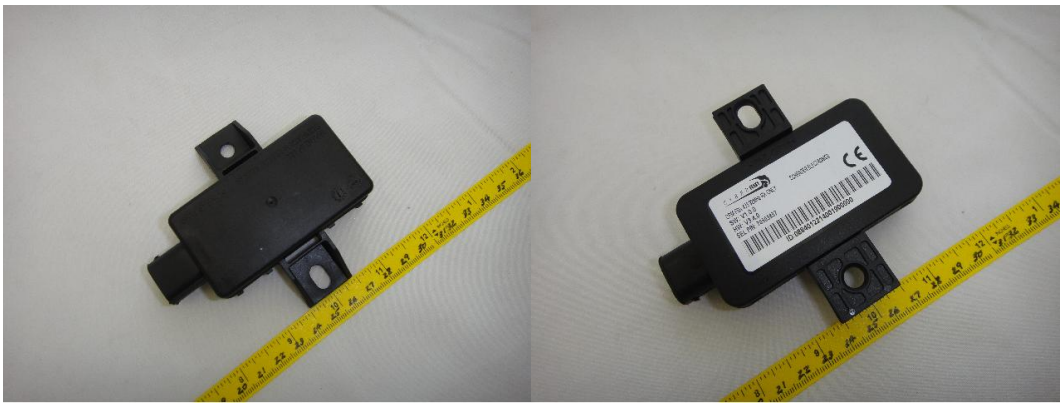

Figure 1: Photos of EUT.

Table 2: EUT Declarations.

General Declarations			
Equipment Type:	Receiver	**Country of Origin:**	UK
Nominal Supply:	13.4 VDC	**Oper. Temp Range:**	Not Declared
Frequency Range:	433.92 MHz	**Antenna Dimension:**	6 cm
Antenna Type:	wire loop	**Antenna Gain:**	Not Declared
United States			
FCC ID Number:	MRXCR4	**Classification:**	CYY

2.1.1 EUT Configuration

The EUT is configured for testing as depicted in Figure 2.

2.1.2 Modes of Operation

This device is capable of only a single mode of operation, as a UHF superheterodyne receiver.

2.1.3 Variants

There is only a single variant of the EUT.

2.1.4 Test Samples

Two samples were provided; one normal sample capable of normal operation and one sample that could be opened for testing and photographs.

2.1.5 Functional Exerciser

Normal operating EUT functionality was verified by observation of transmitted signal.

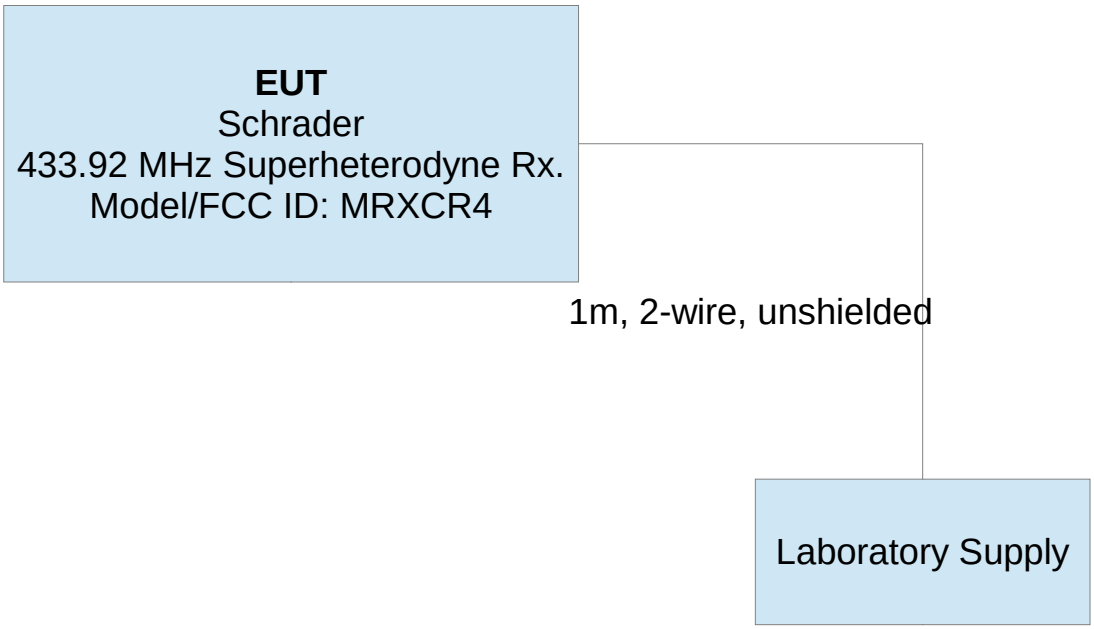

Figure 2: EUT Test Configuration Diagram.

2.1.6 Modifications Made

There were no modifications made to the EUT by this laboratory.

2.1.7 Production Intent

The EUT appears to be a production ready sample.

2.1.8 Declared Exemptions and Additional Product Notes

The EUT is permanently installed in a transportation vehicle. As such, digital emissions are exempt from US and Canadian digital emissions regulations (per FCC 15.103(a) and IC correspondence on ICES-003).

3 Emissions

3.1 General Test Procedures

3.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first evaluated in our shielded fully anechoic chamber. Spectrum and modulation characteristics of all emissions are recorded, and emissions above 1 GHz are fully characterized. The anechoic chamber contains a set-up similar to that of our outdoor 3-meter site, with a turntable and antenna mast. Instrumentation, including spectrum analyzers and other test equipment as detailed in Section 1.2 are employed. After indoor pre-scans, emission measurements are made on our outdoor 3-meter Open Area Test Site (OATS). If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 / CISPR-22 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 3. All

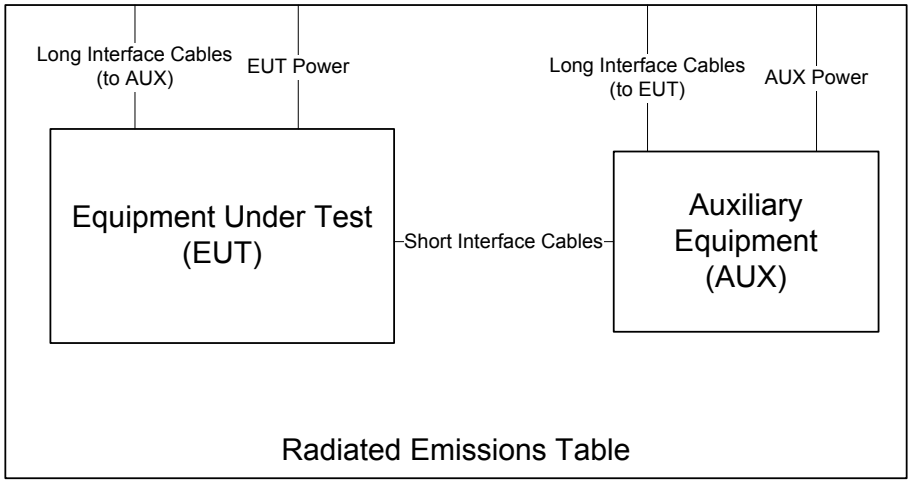

Figure 3: Radiated Emissions Diagram of the EUT.

intentionally radiating elements that are not fixed-mounted in use are placed on the test table lying flat, on their side, and on their end (3-axes) and the resulting worst case emissions are recorded. If the EUT is fixed-mounted in use, measurements are made with the device oriented in the manner consistent with installation and then emissions are recorded.

If the EUT exhibits spurious emissions due to internal receiver circuitry, such emissions are measured with an appropriate carrier signal applied. For devices with intentional emissions below 30 MHz, a shielded loop antenna is used as the test antenna. It is placed at a 1 meter receive height and appropriate low frequency magnetic field extrapolation to the regulatory limit distance is employed. Emissions between 30 MHz and 1 GHz are measured using tuned dipoles and/or calibrated broadband antennas. For both horizontal and vertical polarizations, the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected. The EUT is then rotated through 360^o in azimuth until the highest emission is detected. The test antenna is then raised and lowered one last time from 1 to 4 m and the worst case value is recorded. Emissions above 1 GHz are characterized using standard gain horn antennas or calibrated broadband ridge-horn antennas. Care is taken to ensure that test receiver resolution and video bandwidths meet the regulatory requirements, and that the emission bandwidth of the EUT is not reduced. Photographs of the test setup employed are depicted in Figure 4.

Where regulations allow for direct measurement of field strength, power values (dBm) measured on the test receiver / analyzer are converted to dBμV/m at the regulatory distance, using

$$E_{dist} = 107 + P_R + K_A - K_G + K_E - C_F$$

where P_R is the power recorded on spectrum analyzer, in dBm, K_A is the test antenna factor in dB/m, K_G is the combined pre-amplifier gain and cable loss in dB, K_E is duty correction factor (when applicable) in dB, and C_F is

a distance conversion (employed only if limits are specified at alternate distance) in dB. This field strength value is then compared with the regulatory limit. If effective isotropic radiated power (EIRP) is compute, it is computed as

$$EIRP(dBm) = E_{3m}(dB\mu V/m) - 95.2.$$

When presenting data at each frequency, the highest measured emission under all possible EUT orientations (3-axes) is reported.

Figure 4: Radiated Emissions Test Setup Photograph(s).

3.1.2 Conducted Emissions Test Setup and Procedures

Vehicle Power Conducted Spurious The EUT is not subject to power line conducted emissions regulations as it is powered solely by the vehicle power system for use in said motor vehicle.

3.1.3 Power Supply Variation

Tests at extreme supply voltages are made if required by the the procedures specified in the test standard, and results of this testing are detailed in this report.

3.1.4 Thermal Variation

Tests at extreme temperatures are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report. The provider has declared that the EUT is designed for operation over the temperature range Not Declared. Before any temperature measurements are made, the equipment is allowed to reach a thermal balance in the test chamber, temperature and humidity are recorded, and thermal balance is verified via a thermocouple based probe.

3.2 Unintentional Emissions

3.2.1 Radiated Receiver Spurious

The results for the measurement of radiated receiver spurious emissions (emissions arrising from the receiver chain, e.g. LO or VCO) at the nominal voltage and temperature are reported in Table 3. Receive chain emissions are measured to 5 times the highest receive chain frequency employed or 4 GHz, whichever is higher. If no emissions are detected, only those noise floor emissions at the LO/VCO frequency are reported. Relative relative emissions are depicted in Figure 5.

Table 3: Receiver Chain Spurious Emissions $\geq$ 30 MHz.

Frequency Range	Det	IF Bandwidth	Video Bandwidth		
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	**Test Date:**	2-Oct-14
f > 1 000 MHz	Pk/Avg	1 MHz	3 MHz	**Test Engineer:**	Joseph Brunett
				EUT:	Schrader MRXCR4
				Mode:	Awake
				Meas. Distance:	3m

Receiver Spurious

	Frequency Band		Test Antenna + Cable				Rx. Power*		Distance			E-Field**		EIRP		E-Field Limit		
	Start	Stop	Type	Pol.	Ka	Kg	Peak	Qpk/Avg	Meas.	Des.	CF	Pk	Avg/QPk	Pk	Avg	FCC	Pass By	
#	MHz	MHz		H/V	dB/m	dB	dBm	dBm	m	m	dB	dBuV/m	dBuV/m	dBm	dBm	dBuV/m	dB	Comments
1	423.2	423.2	Log-Per	H	17.0	32.5	-71.2		3.0	3.0	.0	20.3				46.0	25.7	noise
2	423.2	423.2	Log-Per	V	17.0	32.5	-68.3		3.0	3.0	.0	23.2				46.0	22.8	noise
3	846.4	846.4	Log-Per	H	21.5	28.4	-58.7		3.0	3.0	.0	41.4				46.0	4.6	background
4	846.4	846.4	Log-Per	V	21.5	28.4	-59.2		3.0	3.0	.0	40.9				46.0	5.1	background
5	1000.0	2400.0	Horn-R	H/V	23.5	26.3	-65.9		3.0	3.0	.0	38.3				54.0	15.7	noise
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		

*QPk detection below 1 GHz, Avg detection at or above 1 GHz with receiver bandwidth as specified at top of table.

** When E-field is reported directly from Spectrum Analyzer, Antenna Factors and Cable losses are included directly in SA settings.

Equipment Used: BICJEF001, LOGJEF001, RHORN001, RSFSV30001

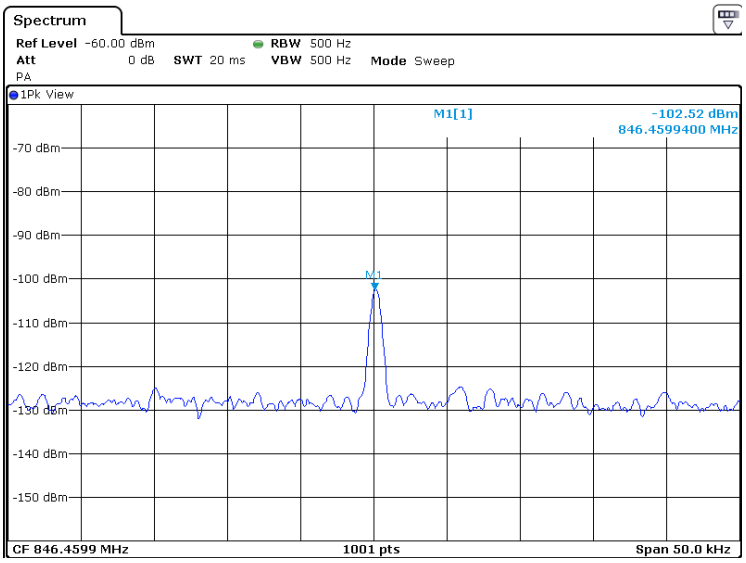

Figure 5: Receiver LO (or VCO) relative emission.