

RF Test Report

regarding

USA: CFR Title 47, Part 15.249 (Emissions)

Canada: ISED RSS-210/GENe (Emissions)

for



Base3

Category: Remote Control Gateway

Judgments:

Aligns with FCC Part 15.249, ISED RSS-210/GENe

Testing Completed: September 8, 2023



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Revision History

Rev. No.	Date	Details	Revised By
r0	September 8, 2023	Initial Release.	J. Nantz
r1	September 29, 2023	Updated model/misc corrections.	J. Nantz

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1 Test Report Scope and Limitations

1.1 Laboratory Authorization

Test Facility description and attenuation characteristics are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: US5348 and US5356) and with ISED Canada, Ottawa, ON (File Ref. No: 3161A and 24249). Amber Helm Development L.C. holds accreditation under NVLAP Lab Code 200129-0.

1.2 Report Retention

For equipment verified to comply with the regulations herein, the manufacturer is obliged to retain this report with the product records for the life of the product, and no less than ten years. A copy of this Report will remain on file with this laboratory until October 2033.

1.3 Subcontracted Testing

This report does not contain data produced under subcontract.

1.4 Test Data

This test report contains data included within the laboratory's scope of accreditation. Any data in this report that is not covered under the laboratory's scope is clearly identified.

1.5 Limitation of Results

The test results contained in this report relate only to the item(s) tested. Any electrical or mechanical modification made to the test item subsequent to the test date shall invalidate the data presented in this report. Any electrical or mechanical modification made to the test item subsequent to this test date shall require reevaluation.

1.6 Copyright

This report shall not be reproduced, except in full, without the written approval of Amber Helm Development L.C.

1.7 Endorsements

This report shall not be used to claim product endorsement by any accrediting, regulatory, or governmental agency.

1.8 Test Location

The EUT was fully tested by **Amber Helm Development L.C.**, headquartered at 92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA. Table 1 lists all sites employed herein. Specific test sites utilized are also listed in the test results sections of this report where needed.

Table 1: Test Site List.

Description	Location	Quality Num.
OATS (3 meter)	3615 E Grand River Rd., Williamston, Michigan 48895	OATSC

1.9 Traceability and Equipment Used

Pertinent test equipment used for measurements at this facility is listed in Table 2. The quality system employed at Amber Helm Development L.C. 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 2: Equipment List.

Description	Manufacturer/Model	SN	Quality Num.	Cal/Ver By / Date Due
Spectrum Analyzer	R & S / FSV30	101660	RSFSV3001	RS / Apr-2024
EMI Receiver	R & S / ESW26	101313	RSESW2601	RS / October-2023
Quad Ridge Horn	Singer / A6100	C35200	HQR1TO18S01	Keysight / Aug-2024
Biconical	EMCO / 93110B	9802-3039	BICEMCO01	Keysight / Aug-2025
Log Periodic Antenna	EMCO / 3146	9305-3614	LOGEMCO01	Keysight / Aug-2025
K-Band Horn	JEF / NRL Std.	001	HRNK01	AHD / Jul-2024
LISN	Solar / 8012-50-R-24-BNC	970917	LISNB	AHD / February-2024
BNC-BNC Coax	WRTL / RG58/U	001	CAB001-BLACK	AHD / Dec-2023
3.5-3.5MM Coax	PhaseFlex / PhaseFlex	001	CAB015-PURP	AHD / Dec-2023

2 Test Specifications and Procedures

2.1 Test Specification and General Procedures

The goal of Lionel, LLC 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 Lionel, LLC Base3 for compliance to:

Country/Region	Rules or Directive	Referenced Section(s)
United States	Code of Federal Regulations	CFR Title 47, Part 15.249
Canada	ISED Canada	ISED RSS-210/GENe

It has been 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 C63.4:2014	"Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
ANSI C63.10:2013	"American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices"
TP0102RA	"AHD Internal Document TP0102 - Radiated Emissions Test Procedure"
ICES-003; Issue 7 (2020)	"Information Technology Equipment (ITE) - Limits and methods of measurement"

3 Configuration and Identification of the Equipment Under Test

3.1 Description and Declarations

The equipment under test is an remote control gateway module for controlling multiple train systems containing BLE, Wifi and 2 proprietary 2.4 GHz radios. The EUT is approximately 26 x 13.5 x 5.5 cm (approx.) in dimension, and is depicted in Figure 1. It is powered by 120 VAC mains. In use, this device allows an existing Lionel remote control or smart device to operate all Lionel existing wireless train system architectures, regardless of protocol standard, with a single device controller. Table 3 outlines provider declared EUT specifications.



Figure 1: Photos of EUT.

Table 3: EUT Declarations.

General Declarations	
Equipment Type:	Remote Control Gateway
Country of Origin:	China
Nominal Supply:	120 VAC
Oper. Temp Range:	Not Declared
Frequency Range:	2404 – 2480 MHz
Antenna Dimension:	11 cm
Antenna Type:	RP-SMA Stub Antenna
Antenna Gain:	3 dBi
Number of Channels:	150
Channel Spacing:	500 kHz
Alignment Range:	Not Declared
Type of Modulation:	MSK
United States	
FCC ID Number:	LIV-BASE3
Classification:	DXX
Canada	
IC Number:	7032A-BASE3
Classification:	Remote Control Device, Low Power Device (2400-2483.5 MHz)

3.1.1 EUT Configuration

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

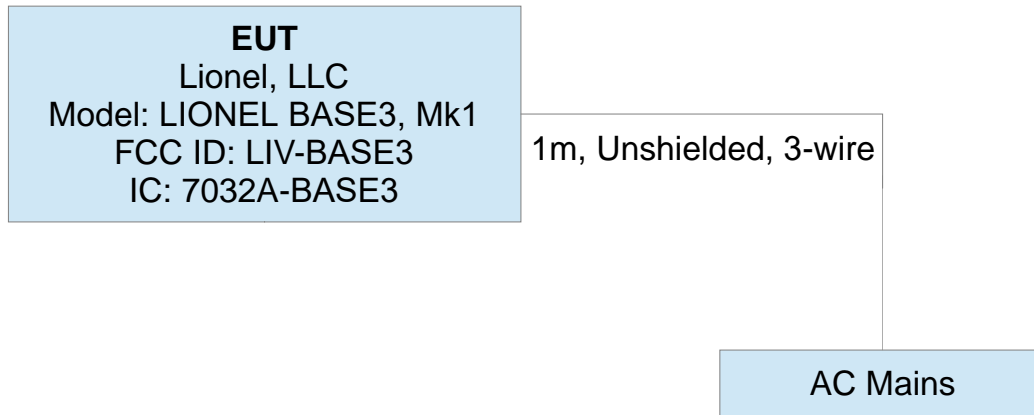


Figure 2: EUT Test Configuration Diagram.

3.1.2 Modes of Operation

The EUT employs 4 radios with the following operating modes: BLE, Wifi, RF proprietary 2.4 GHz (RFM75) and an additional RF proprietary 2.4 GHz radio (TICC) for controlling multiple train systems. This report only addresses the RF Proprietary TICC radio, as well as intermodulation measurements made with the other radios active.

3.1.3 Variants

There is only a single electrical variant of the EUT.

3.1.4 Test Samples

Two samples were provided: One normal operating sample (SN: 27) and one sample (SN: 20) provided with custom software (FW revision "FCC Mode Test") to enable continuous modulated transmission of either low, middle or high channels of every radio. Channel selection was accomplished via a USB connection between the EUT and a manufacturer supplied laptop using the termite terminal application. The manufacturer declares the signals observed for the different radios and channel selections represents the maximum values possible for this EUT.

3.1.5 Functional Exerciser

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

3.1.6 Modifications Made

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

3.1.7 Production Intent

The EUT appears to be production ready.

3.1.8 Declared Exemptions and Additional Product Notes

In addition to the 2404-2480 MHz TICC radio tested herein, the EUT employs the following additional radios: Pre-approved BLE modular radio (FCC ID: X8WBM832, IC: 4100A-BM832) to interface with existing BLE train control systems, a pre-approved WiFi modular radio (FCC ID:RI7WE310F5, IC: 5131A-WE310F5) to interface to a phone or other smart device via a manufacturer provided APP, a proprietary radio module (See report no: LBASE3 - Exh 06 - AHD LB3RFM-WR2325TXAr1 RF Test Report), and a Carrier Current transmitter operating at 455 kHz. All radios may be active at the same time in this product, and thus are tested for intermodulation products and RF exposure to confirm co-location requirements are met. The Carrier Current transmitter is handled through manufacturer SDoC.

4 Emissions

4.1 General Test Procedures

4.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first pre-scanned in our screen room. Spectrum and modulation characteristics of all emissions are recorded. Instrumentation, including spectrum analyzers and other test equipment as detailed in Section 1.8 are employed. After pre-scan, emission measurements are made on the test site of record. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in relevant test standards 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 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.

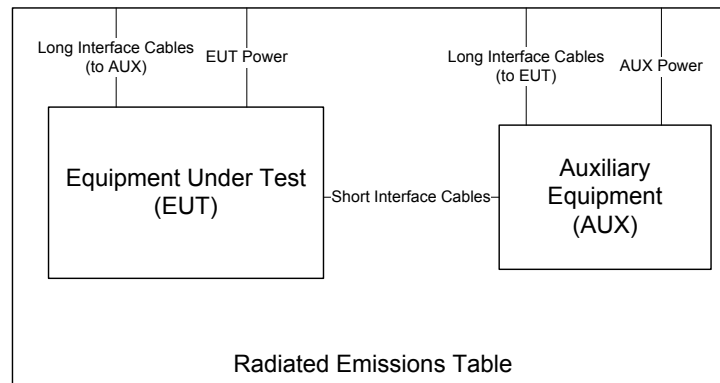


Figure 3: Radiated Emissions Diagram of the EUT.

For devices with intentional emissions below 30 MHz, a shielded loop antenna and/or E-field and H-Field broadband probes are used depending on the regulation. Shielded loops are placed at a 1 meter receive height at the desired measurement distance. For exposure in this band, 10cm diameter single-axis broadband probes meeting the requirements of ISED SPR-002 section 5.2 are employed. Measurements are repeated and summed over three axes, and the entire frequency range is measured with and without the EUT transmitting.

Emissions between 30 MHz and 1 GHz are measured using 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° 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 or broadband ridge-horn antennas on our OATS with a 4×5 m rectangle of ECCOSORB absorber covering the OATS ground screen and a 1.5m table height. 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 $\text{dB}\mu\text{V}/\text{m}$ 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 computed, it is computed as

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

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).

4.1.2 Conducted Emissions Test Setup and Procedures

AC Port Conducted Spurious For this device, AC power line conducted emissions are measured in our screen room. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 / CISPR 22 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 5.

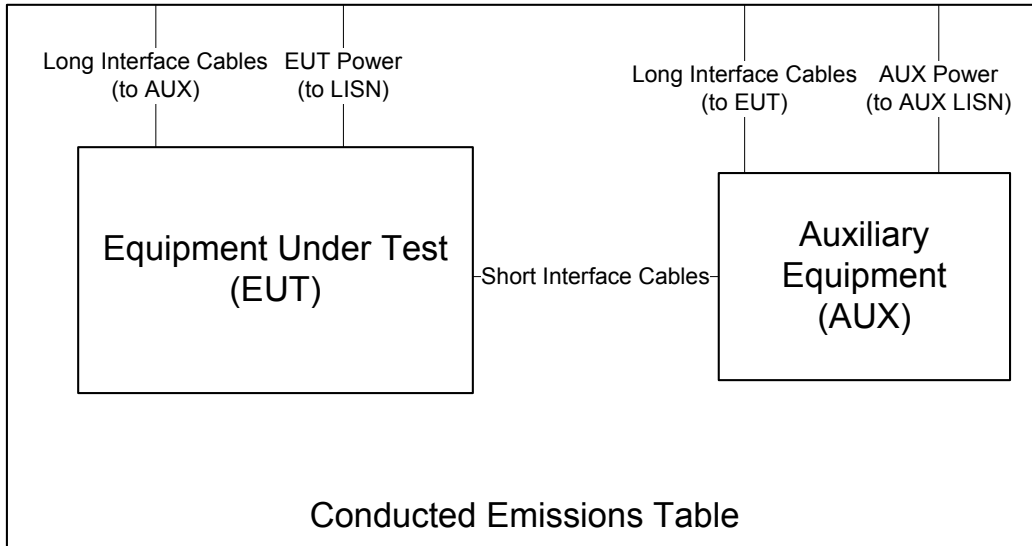


Figure 5: Conducted Emissions Setup Diagram of the EUT.

Conducted emissions are measured and recorded for each AC mains power source over the spectrum 0.15 MHz to 30 MHz for both the ungrounded (HI/PHASE) and grounded (LO/GND) conductors with the EUT placed in its highest current draw operating mode(s). The test receiver is set to peak-hold mode in order to record the peak emissions throughout the course of functional operation. Only if an emission exceeds or is near the limit are quasi-peak and average detection applied. Photographs of the test setup employed are depicted in Figure 6.



Figure 6: Conducted Emissions Test Setup Photograph(s).

4.1.3 Power Supply Variation

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

In the case of this EUT, measurements of the worst-case radiated emissions are performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value for devices connecting to AC power mains.

4.2 Intentional Emissions

4.2.1 Fundamental Emission Pulsed Operation

Test Setup & Procedure The test equipment and facilities were setup in accordance with the standards and procedures listed in Section 2.1. Environmental conditions were set at the appropriate temperature and thermal balance was checked with a thermocouple based probe. Duty cycle is reported for all relevant modes of operation. The test equipment employed includes RSFSV30001, HQR1TO18S01.

Measurement Results The details and results of testing the EUT are summarized in Table 4. Plots showing the measurements made to obtain these values are provided in Figure 7.

Table 4: Fundamental Emission Pulsed Operation.

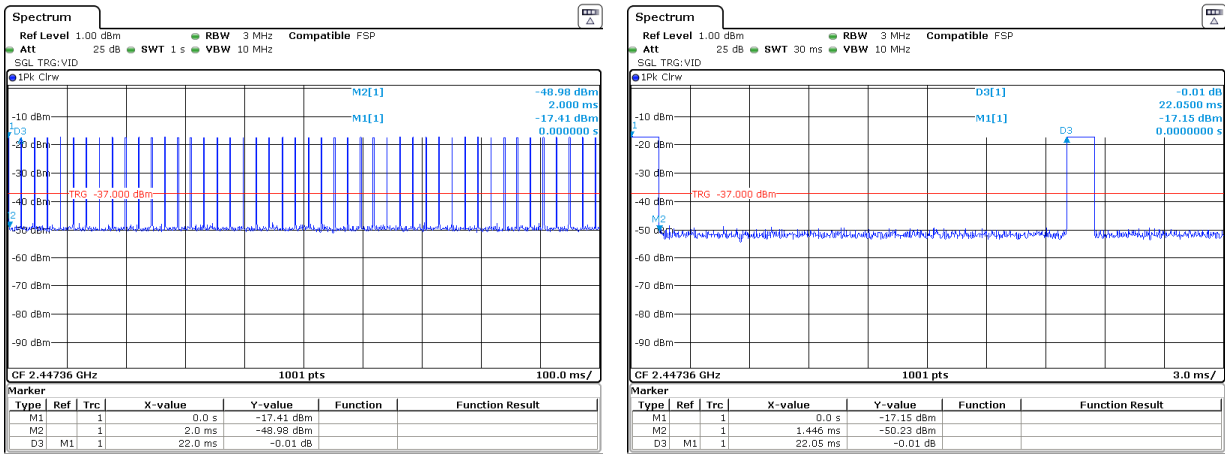
Test Date: 5-Sep-23
Test Engineer: John Nantz
EUT: BASE3 - TICC
Meas. Distance: 10cm

Test Mode Pulsed Operation / Average Measurement Duty Cycle									
R0	Mode	Data Rate Mbps	Voltage V	Oper. Freq MHz	Pulse Length (ms)	Pulse Period (ms)	Duty Cycle %	Power Duty Correction dB	Exposure Duty Correction dB
R1	CM	0.125	120.0	2447.6	1.4	22.1	6.4	-20.0	-11.9
#	C1	C3	C4	C5	C6	C7	C8	C9	C10

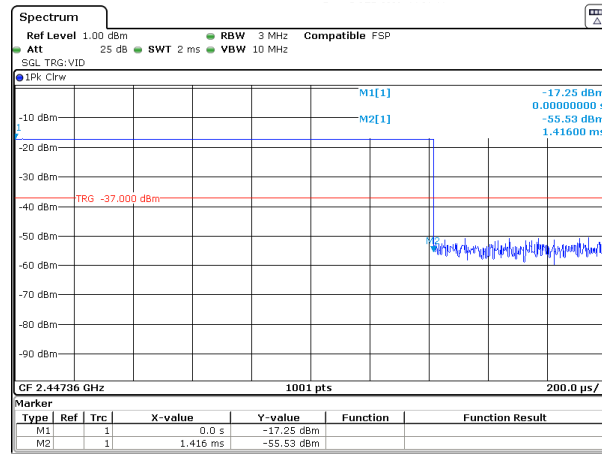
(ROW) (COLUMN) (NOTE)

R0 C9 E-field duty cycle correction (due to burst-modulated carrier) computed as $20 \cdot \log(\text{On-Time}/\text{Cycle-Time})$

R0 C10 Exposure duty cycle correction (due to burst-modulated carrier) computed as $10 \cdot \log(\text{On-Time}/\text{Cycle-Time})$



Date: 5.SEP.2023 14:23:04



Date: 5.SEP.2023 14:23:32

Figure 7: Fundamental Emission Pulsed Operation.

4.2.2 Fundamental Emission Bandwidth

Test Setup & Procedure The test equipment and facilities were setup in accordance with the standards and procedures listed in Section 2.1. Environmental conditions were set at the appropriate temperature and thermal balance was checked with a thermocouple based probe. Emission bandwidth (EBW) of the EUT is measured with the device placed in the test mode(s) with the shortest available frame length and minimum frame spacing. The 20 dB EBW is measured as the max-held peak-detected signal when the IF bandwidth is greater than or equal to 1% of the receiver span. For complex modulations other than ASK and FSK, the 99% emission bandwidth per IC test procedures has a different result, and is also reported. The test equipment employed includes RSFSV30001, HQR1TO18S01.

Measurement Results The details and results of testing the EUT are summarized in Table 5. Plots showing the measurements made to obtain these values are provided in Figure 8.

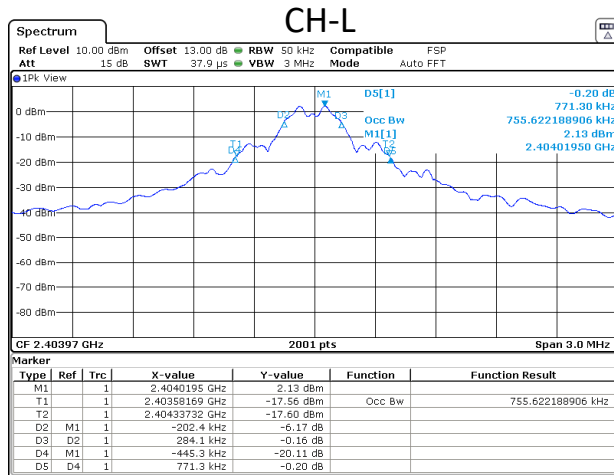
Table 5: Fundamental Emission Bandwidth.

Test Date: 5-Sep-23
Test Engineer: John Nantz
EUT: BASE3 - TICC
Meas. Distance: 10cm

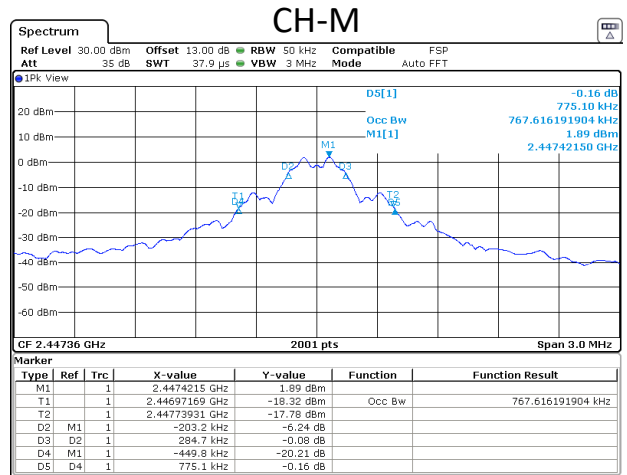
Occupied Bandwidth										
R0	Transmit Mode	Data Rate (Mbps)	Voltage (V)	Oper. Freq (MHz)	20 dB BW (MHz)	FL (MHz)	FL Limit (MHz)	FH (MHz)	FL Limit (MHz)	Pass/Fail
R1	MSK	0.125	120.0	2404.0	0.771	2403.5742	2400.000	2404.346	2483.500	Pass
R2				2447.6	0.775	2446.9717	2400.000	2447.747	2483.500	Pass
R3				2480.0	0.780	2479.5682	2400.000	2480.348	2483.500	Pass
#	C1	C2	C3	C4	C5	C6	C7	C8	C9	

(ROW) (COLUMN) (NOTE)
 R0 C7/C9 Limits are according to FCC part 15.215(c)

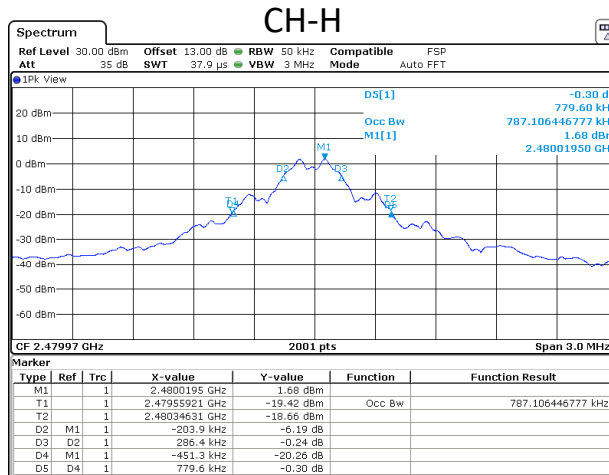
Emission Bandwidth



Date: 5 SEP 2023 12:41:44



Date: 5 SEP 2023 12:36:39



Date: 5 SEP 2023 12:39:48

Figure 8: Fundamental Emission Bandwidth.

4.2.3 Fundamental Emission Field Strength

Test Setup & Procedure The test equipment and facilities were setup in accordance with the standards and procedures listed in Section 2.1. Environmental conditions were set at the appropriate temperature and thermal balance was checked with a thermocouple based probe. Fundamental emissions are measured at the regulatory distance on our OATS. The test equipment employed includes RSFSV30001, HQR1TO18S01.

Measurement Results The details and results of testing the EUT are summarized in Table 6.

Table 6: Fundamental Emission Field Strength.

Frequency Range	Det	IF Bandwidth	Video Bandwidth	Test Date:	5-Sep-23
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	Test Engineer:	John Nantz
f > 1 000 MHz	Pk/Avg	1 MHz	3 MHz	EUT:	BASE3 - TICC
				Meas. Distance:	3m

	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Ka dB/m	Kg dB	Duty Factor dB	E3(Pk) dBμV/m	E3 Pk Lim dBμV/m	E3(Avg) dBμV/m	E3 Avg Lim dBμV/m	Pass dB	Comments
R0													
R1	2404.0	2404.0	HQR1TO18S01	H/V	31.4	-1.1	-20.0	98.4	114.0	78.4	94.0	15.6	side
R2	2447.6	2447.6	HQR1TO18S01	H/V	31.6	-1.1	-20.0	98.2	114.0	78.2	94.0	15.8	flat
R3	2480.0	2480.0	HQR1TO18S01	H/V	31.7	-1.1	-20.0	97.9	114.0	77.9	94.0	16.1	flat
#	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14

(ROW) (COLUMN) (NOTE)

- R0 C10 When E-field or EIRP is reported directly from Spectrum Analyzer, Antenna Factors and Cable losses are included directly in SA settings and Pr is not reported.
- R0 C11 Avg computed from Pk measurement by applying duty cycle correction.

4.3 Unintentional Emissions

4.3.1 Transmit Chain Spurious Emissions

The results for the measurement of transmit chain spurious emissions at the nominal voltage and temperature are provided in Table 7.

Table 7(a): Transmit Chain Spurious Emissions.

Frequency Range
30 MHz < f < 1 000 MHz
f > 1 000 MHz

Det
Pk/Opk
Pk/Avg

Test Date:
Test Engineer:
EUT:
Meas. Distance:

5-Sep-23
John Nantz
BASE3 - TICC
3m

FCC/IC														
R0	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Pr (Pk) dBm	Pr (Avg) dBm	Ka dB/m	Kg dB	E3(Pk) dBµV/m	E3 Pk Lim dBµV/m	E3(Avg) dBµV/m	E3 Avg Lim dBµV/m	Pass dB	Comments
R1	Fundamental Restricted Band Edge (Low Side)													
R2	2400.0	2400.0	HQRITO18S01	H/V			31.3	-1.1	73.4	74.0	33.6	54.0	0.6	max all - baud rates/L,M,H channels/noise
R3	Fundamental Restricted Band Edge (High Side)													
R4	2483.5	2483.5	HQRITO18S01	H/V			31.8	-1.1	70.8	74.0	31.9	54.0	3.2	max all - baud rates/L,M,H channels/noise
R5	Harmonic / Spurious Emissions													
R6	4808.0	4808.0	HQRITO18S01	H/V			35.5	-1.3	34.1	74.0	14.1	54.0	39.9	max all - baud rates/L,M,H channels/noise
R7	4895.2	4895.2	HQRITO18S01	H/V			35.1	-1.3	35.5	74.0	15.5	54.0	38.5	max all - baud rates/L,M,H channels/noise
R8	4960.0	4960.0	HQRITO18S01	H/V			34.8	-1.3	37.3	74.0	17.3	54.0	36.7	max all - baud rates/L,M,H channels/noise
R9	4000.0	6000.0	HQRITO18S01	H/V			32.8	-1.6	36.6	74.0	16.6	54.0	37.4	max all - baud rates/L,M,H channels/noise
R10	7212.0	7212.0	HQRITO18S01	H/V			33.3	-1.7	36.3	74.0	16.3	54.0	37.7	max all - baud rates/L,M,H channels/noise
R11	7342.8	7342.8	HQRITO18S01	H/V			33.4	-1.7	36.8	74.0	16.8	54.0	37.2	max all - baud rates/L,M,H channels/noise
R12	7440.0	7440.0	HQRITO18S01	H/V			33.5	-1.7	37.2	74.0	17.2	54.0	36.8	max all - baud rates/L,M,H channels/noise
R13	6000.0	8400.0	HQRITO18S01	H/V			34.3	-1.8	39.3	74.0	19.3	54.0	34.7	max all - baud rates/L,M,H channels/noise
R14	8400.0	12500.0	HQRITO18S01	H/V			35.6	-2.2	43.7	74.0	23.7	54.0	30.3	max all - baud rates/L,M,H channels/noise
R15	12500.0	18000.0	HQRITO18S01	H/V			34.3	-2.9	44.5	74.0	24.5	54.0	29.5	max all - baud rates/L,M,H channels/noise
R16	18000.0	26500.0	HRNK001	H/V			33.7	-3.9	45.1	74.0	25.1	54.0	28.9	max all - baud rates/L,M,H channels/noise
R17														
R18														
R19														
R20														
#	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14

(ROW) (COLUMN) NOTE:

R0 C5-C6 When E-field or EIRP is reported directly from Spectrum Analyzer, Antenna Factors and Cable losses are included directly in SA settings and Pr is not reported.

R0 C11 Avg computed from Pk measurement by applying duty cycle correction factor except for Bandedges where the measurements were made using the average detector of the SA.

Table 7(b): Transmit Chain Spurious Emissions.

Frequency Range 30 MHz < f < 1 000 MHz f > 1 000 MHz	Det Pk/Qpk Pk/Avg	IF Bandwidth 120 kHz 1 MHz	Video Bandwidth 300 kHz 3 MHz	Test Date: Test Engineer: EUT: Meas. Distance:	3-Sep-23 J. Brunett BASE 3 – All Radios 10cm
-------------------------------------------------------------------	--------------------------------	-----------------------------------------	--------------------------------------------	-------------------------------------------------------------------------------------	-------------------------------------------------------

													FCC/IC
R0	Mode	Freq. Start MHz	Freq. Stop MHz	Ant. Used	Ant. Pol.	Ka dB/m	Kg dB	E3(Pk) dBµV/m	E3 Pk Lim dBµV/m	E3(Avg) dBµV/m	E3 Avg Lim dBµV/m	Pass dB	Comments
R1	Fundamental Restricted Band Edge (Low Side / High Side)												
R2	RFM + BLE	2280.0	2400.0	HQR1TO18S01	H/V	31.3	-1.1	68.9	74.0	27.3	54.0	5.1	LMH Channels, Both Radios
R3	RFM + BLE	2483.5	2550.0	HQR1TO18S01	H/V	32.1	-1.1	71.5	74.0	27.8	54.0	2.5	LMH Channels, Both Radios
R4	RFM + WIFib	2280.0	2400.0	HQR1TO18S01	H/V	31.3	-1.1	69.0	74.0	27.3	54.0	5.0	LMH Channels, Both Radios
R5	RFM + WIFib	2483.5	2550.0	HQR1TO18S01	H/V	32.1	-1.1	71.3	74.0	27.6	54.0	2.7	LMH Channels, Both Radios
R6	RFM + WIFlg	2280.0	2400.0	HQR1TO18S01	H/V	31.3	-1.1	68.5	74.0	27.3	54.0	5.5	LMH Channels, Both Radios
R7	RFM + WIFlg	2483.5	2550.0	HQR1TO18S01	H/V	32.1	-1.1	71.6	74.0	27.5	54.0	2.4	LMH Channels, Both Radios
R8	RFM + WIFIn	2280.0	2400.0	HQR1TO18S01	H/V	31.3	-1.1	68.8	74.0	27.4	54.0	5.2	LMH Channels, Both Radios
R9	RFM + WIFIn	2483.5	2550.0	HQR1TO18S01	H/V	32.1	-1.1	71.8	74.0	27.6	54.0	2.2	LMH Channels, Both Radios
R10	RFM + TICC	2280.0	2400.0	HQR1TO18S01	H/V	31.3	-1.1	68.3	74.0	27.4	54.0	5.7	LMH Channels, Both Radios
R11	RFM + TICC	2483.5	2550.0	HQR1TO18S01	H/V	32.1	-1.1	72.2	74.0	27.7	54.0	1.8	LMH Channels, Both Radios
R12	RFM + TICC +BLE +WIFib	2280.0	2400.0	HQR1TO18S01	H/V	31.3	-1.1	68.1	74.0	27.4	54.0	5.9	LMH Channels, ALL Radios
R13	RFM + TICC +BLE +WIFib	2483.5	2550.0	HQR1TO18S01	H/V	32.1	-1.1	72.1	74.0	27.6	54.0	1.9	LMH Channels, ALL Radios
R14													
R15													
R16													
R17													
R18													
R19													
R20													
#	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13

ROW) (COLUMN) NOTE:
R0 C5-C6 When E-field or EIRP is reported directly from Spectrum Analyzer, Antenna Factors and Cable losses are included directly in SA settings and Pr is not reported.
R0 C11 Avg computed from Pk measurement by applying duty cycle correction factor except for Bandedges where the measurements were made using the average detector of the S

4.3.2 General Radiated Spurious

The results for the measurement of general spurious emissions (emissions arising from digital circuitry) at the nominal voltage and temperature are provided in Table 8. Radiation from digital components are measured up to 1000 MHz or to the highest frequency required by the applied standards, whichever is greater.

Table 8: Radiated Spurious Emissions.

Frequency Range	Det	IF Bandwidth	Video Bandwidth	Test Date:	24-Aug-23
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	Test Engineer:	J. Nantz
f > 1 000 MHz	Pk	1 MHz	3 MHz	EUT:	LION BASE3
f > 1 000 MHz	Avg/RMS	1 MHz	3 MHz	EUT Mode:	All ports exercised
				Meas. Distance:	3 m
				Temperature:	27C
				Rel. Humidity:	78%

Digital Spurious Emissions														CISPR 11 / EN 55011		
R0	Test Freq. MHz	Antenna QN	Test Pol.	Ka dB/m	Kg dB	E-Field @ 3m**		FCC CLB (QPk/Avg)		CE CLB (QPk/Avg)		FCC CLA (QPk/Avg)		CE CLA (QPk/Avg)		Comments
						Pk dBuV/m	Qpk/Avg dBuV/m	E3lim dBuV/m	Pass dB	E3lim dBuV/m	Pass dB	E3lim dBuV/m	Pass dB	E3lim dBuV/m	Pass dB	
R1	48.8	BICEMCO01	V	9.3	-4	33.6	26.5	40.0	13.5	40.5	14.0	49.5	23.0	50.5	24.0	
R2	63.9	BICEMCO01	H	7.8	-4	42.3	39.4	40.0	0.6	40.5	1.1	49.5	10.1	50.5	11.1	
R3	63.9	BICEMCO01	V	7.8	-4	39.7	34.0	40.0	6.0	40.5	6.5	49.5	15.5	50.5	16.5	
R4	71.7	BICEMCO01	H	7.6	-4	40.0	30.6	40.0	9.4	40.5	9.9	49.5	18.9	50.5	19.9	
R5	71.7	BICEMCO01	V	7.6	-4	37.0	30.0	40.0	10.0	40.5	10.5	49.5	19.5	50.5	20.5	
R6	147.5	BICEMCO01	H	12.3	-7	36.0	26.8	43.5	16.7	40.5	13.7	54.0	27.2	50.5	23.7	
R7	158.7	BICEMCO01	V	13.1	-7	32.5	26.8	43.5	16.7	40.5	13.7	54.0	27.2	50.5	23.7	
R8	168.4	BICEMCO01	H	13.6	-7	31.5	24.7	43.5	18.8	40.5	15.8	54.0	29.3	50.5	25.8	
R9	168.4	BICEMCO01	V	13.6	-7	33.0	24.9	43.5	18.6	40.5	15.6	54.0	29.1	50.5	25.6	
R10	244.5	LOGEMCO01	H	12.3	-1.0	34.2	27.3	46.0	18.7	47.5	20.2	56.9	29.6	57.0	29.7	
R11	244.5	LOGEMCO01	V	12.3	-1.0	32.1	22.6	46.0	23.4	47.5	24.9	56.9	34.3	57.0	34.4	
R12	287.0	LOGEMCO01	V	13.4	-1.1	32.3	21.5	46.0	24.5	47.5	26.0	56.9	35.4	57.0	35.5	
R13	298.0	LOGEMCO01	H	13.7	-1.1	34.5	28.4	46.0	17.6	47.5	19.1	56.9	28.5	57.0	28.6	
R14	457.7	LOGEMCO01	V	16.7	-1.6	33	23.5	46.0	22.5	47.5	24.0	56.9	33.4	57.0	33.5	
R15	772.0	LOGEMCO01	H	21.2	-2.5	34.3	28.1	46.0	17.9	47.5	19.4	56.9	28.8	57.0	28.9	Background Noise
R16																
R17																
R18																
R19																
R20																
R21																
R22																
#	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16

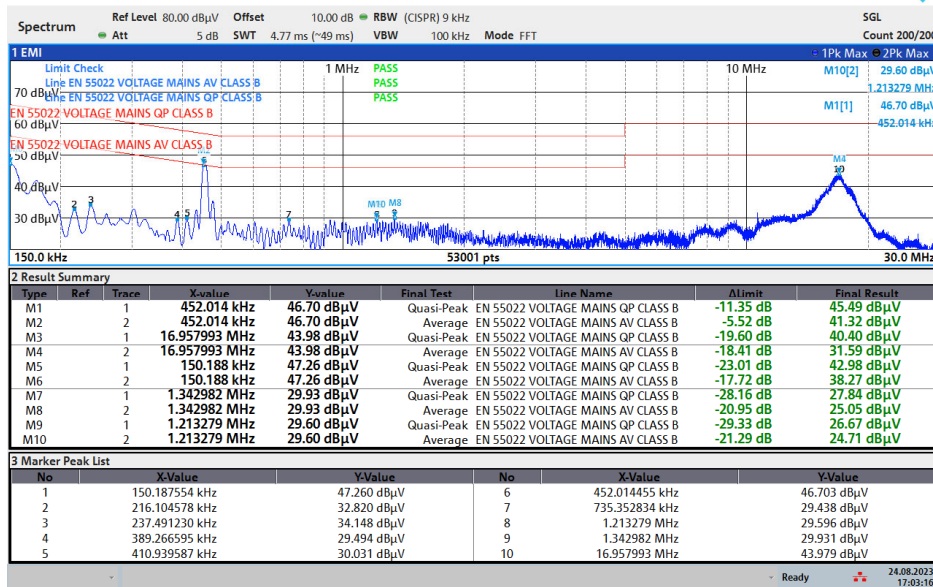
(ROW) (COLUMN) (NOTE)
 R0 C7 Pk+Avg detection (narrowband), Pk + QPk detection (wideband) emissions
 R0 C7 When E-field is reported directly from Spectrum Analyzer, Antenna Factors and Cable losses are included directly in SA settings.
 R0 C7 Emissions > 20dB below the limit are not reported.

4.3.3 Conducted Emissions Test Results - AC Power Port(s)

The results of emissions from the EUT's AC mains power port(s) are reported in Table 9.

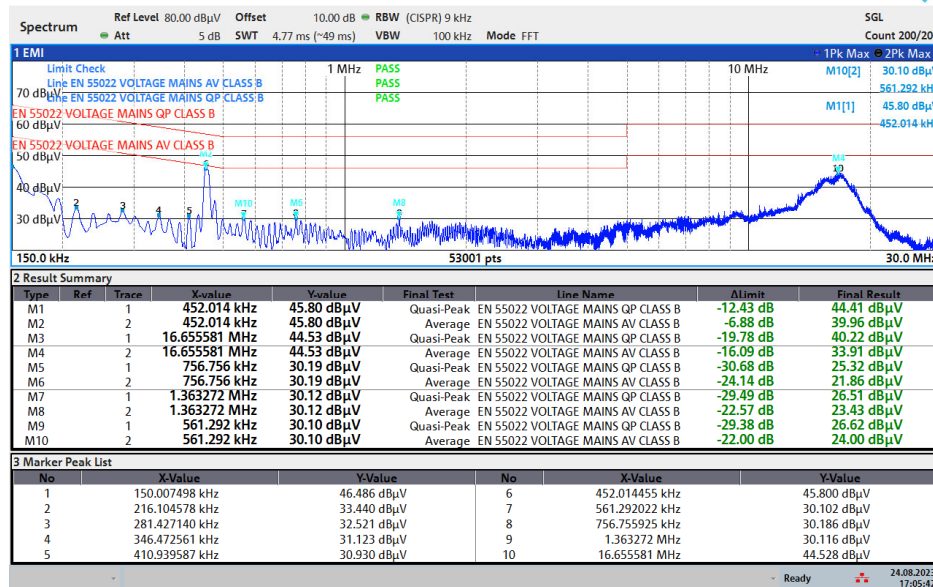
Table 9: AC Mains Power Conducted Emissions Results.

CONDUCTED EMISSIONS – AC PORT – L1



17:03:16 24.08.2023

CONDUCTED EMISSIONS – AC PORT – L2



17:05:42 24.08.2023

5 Measurement Uncertainty and Accreditation Documents

The maximum values of measurement uncertainty for the laboratory test equipment and facilities associated with each test are given in the table below. This uncertainty is computed for a 95.45% confidence level based on a coverage factor of $k = 2$.

Table 10: Measurement Uncertainty.

Measured Parameter	Measurement Uncertainty [†]
Radio Frequency	$\pm(f_{Mkr}/10^7 + RBW/10 + (SPN/(PTS - 1))/2 + 1 \text{ Hz})$
Conducted Emm. Amplitude	$\pm 1.9 \text{ dB}$
Radiated Emm. Amplitude ($f < 30 \text{ MHz}$)	$\pm 3.1 \text{ dB}$
Radiated Emm. Amplitude (30 – 200 MHz)	$\pm 4.0 \text{ dB}$
Radiated Emm. Amplitude (200 – 1000 MHz)	$\pm 5.2 \text{ dB}$
Radiated Emm. Amplitude ($f > 1000 \text{ MHz}$)	$\pm 3.7 \text{ dB}$

[†]Ref: CISPR 16-4-2:2011+A1:2014



Figure 9: Accreditation Documents