**Amber Helm Development L.C.**
92723 Michigan Hwy-152
Sister Lakes, Michigan 49047 USA
Tel: 888-847-8027

# EMC Test Report

**FOBIK-1802249TX**
Issued: **June 4, 2018**

regarding

**USA: CFR Title 47, Part 15.231** (Emissions)
**Canada: ISED RSS-210v9/GENv5** (Emissions)

for


# MY19 HD FOBIK

**Category: Keyless Entry Transmitter**

Judgements:
**15.231/RSS-210v9 Compliant Transmitter**
Tested: June 1, 2018

TESTING No. 200129-0

Prepared for:

## TRW Automotive

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Prepared by: _____ Date of Issue: June 4, 2018
Dr. Joseph Brunett, EMC-002790-NE

## Revision History

| Rev. No. | Date | Details | Revised By |
|---|---|---|---|
| r0 | June 4, 2018 | Initial Release. | J. Brunett |

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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: 90413) and with ISED Canada, Ottawa, ON (File Ref. No: IC3161). Amber Helm Development L.C. holds accreditation under NVLAP Lab Code 200129-0 and includes within its scope CFR Title 47 Part 15 Subparts B and C.

## 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 June 2028.

## 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 laboratories scope of accreditation.

## 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



## 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.**, 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.

Table 1: Test Site List.

| Description | Location | Quality Num. |
|---|---|---|
| OATS (3m & 10m) | 92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA | OATSA |

### 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. | Last Cal By / Date Due |
|---|---|---|---|---|
| Biconical | EMCO / 93110B | 9802-3039 | BICEMCO01 | Lib. Labs / Aug-2018 |
| Log Periodic Antenna | EMCO / 3146 | 9305-3614 | LOGEMCO01 | Lib. Labs / Aug-2018 |
| (3m) RG8 Coax | CS-3227 / CS-3227 | C060914 | CS3227 | AHD / Sept-2018 |
| EMI Receiver | HP / 85460A/85462A | 3704A00422, 3807A00465 | HP8546A | Std and Cal / May-2019 |
| Spectrum Analyzer | Rohde & Schwarz / FSV30 | 101660 | RSFSV30001 | RS / Apr-2019 |
| (3m) LMR-400 Coax | AHD / LMR400 | C090804 | LMR400 | AHD / Sept-2018 |
| (LCI) DS Coax | AHD / RG58/U | 920809 | RG58U | AHD / Jul-2018 |
| (10-m) Amelco Coax | AHD / RG213U | 9903-10ab | RG213U | AHD / Sept-2018 |
| Double Ridged Horn | EMCO / 3115 | 2788 | RH3115 | Lib.Labs. / July-2018 |

# 2 Test Specifications and Procedures

## 2.1 Test Specification and General Procedures

The ultimate goal of TRW Automotive 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 TRW Automotive MY19 HD FOBIK for compliance to:

| **Country/Region** | **Rules or Directive** | **Referenced Section(s)** |
|---|---|---|
| United States | Code of Federal Regulations | CFR Title 47, Part 15.231 |
| Canada | ISED Canada | ISED RSS-210v9/GENv5 |

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 (USA) | "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices" |
| TP0102RA | "AHD Internal Document TP0102 - Radiated Emissions Test Procedure" |
| ISED Canada | "The Measurement of Occupied Bandwidth" |
| ICES-003; Issue 6 (2016) | "Information Technology Equipment (ITE) Limits and methods of measuremen" |

# 3 Configuration and Identification of the Equipment Under Test

## 3.1 Description and Declarations

The equipment under test is a UHF transmitter for automotive remote access and remote start. The EUT is approximately 4.5 x 8 x 2 cm (approx.) in dimension, and is depicted in Figure 1. It is powered by 3 VDC Lithium cell battery. In use, this device is hand held. Table 3 outlines provider declared EUT specifications.


Figure 1: Photos of EUT.

Table 3: EUT Declarations.

| **General Declarations** | | | |
|---|---|---|---|
| **Equipment Type:** | Keyless Entry Transmitter | **Country of Origin:** | Mexico |
| **Nominal Supply:** | 3 VDC | **Oper. Temp Range:** | $-40°$C to $+80°$C |
| **Frequency Range:** | 433.92 MHz | **Antenna Dimension:** | Not Declared |
| **Antenna Type:** | PCB Trace | **Antenna Gain:** | $-20$ dBi (approx) |
| **Number of Channels:** | 1 | **Channel Spacing:** | Not Applicable |
| **Alignment Range:** | Not Declared | **Type of Modulation:** | ASK, FSK |
| **United States** | | | |
| **FCC ID Number:** | GQ4-76T | **Classification:** | DSC |
| **Canada** | | | |
| **IC Number:** | 1470A-76T | **Classification:** | Remote Control Device, Vehicular Device |

### 3.1.1 EUT Configuration

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

### 3.1.2 Modes of Operation

This device is capable of two modes of activation, and two power levels. First, when manually activated by button press the EUT transmits a ASK set of frames at either a high power (REMOTE START) or low power (LOCK/UNLOCK) level. Second, when manually activated by LF interrogation (i.e. when user lifts a door handle or presses a button on the vehicle which in turn causes a module in the vehicle to transmit encoded LF to the EUT) the EUT transmits a low power short FSK Transmission. Both ASK power levels and the FSK transmission are fully evaluated herein.

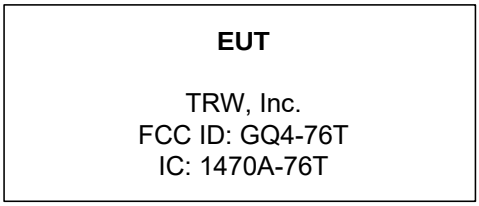



Figure 2: EUT Test Configuration Diagram.

### 3.1.3 Variants

There are a total of nine (9) variants of the EUT. All 9 variants are electrically identical except for variations in the number of SMT switches populated and minor variations in housing appearance, as described in the labeling exhibit

### 3.1.4 Test Samples

Seven samples in total were provided; two samples capable of CW transmission (one with 1 button and one with 5 buttons), 2 normal operating samples actuated by button press, one modified sample that transmits only the LF actuated transmission for passive entry, and two additional samples that were dismantled for photos. Both 1 button (lowest populated) and 5 button (highest populated) variants are fully tested to ensure compliance.

### 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 a production ready sample.

### 3.1.8 Declared Exemptions and Additional Product Notes

None.

# 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.

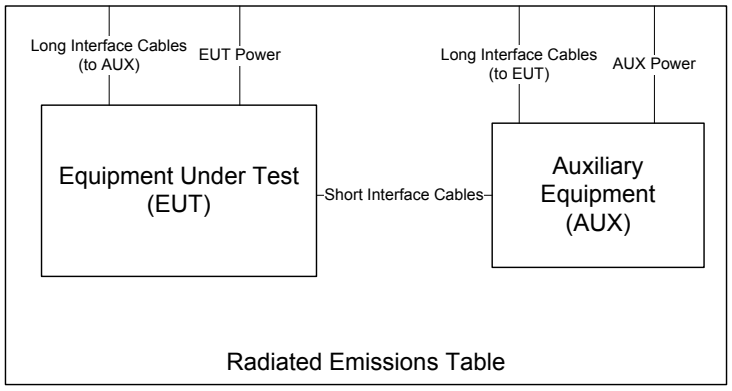



Figure 3: Radiated Emissions Diagram of the EUT.

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 regulations. Shielded loops are placed at a 1 meter receive height at the desired measurement distance. For exposure in this band, the broadband probes employed are 10cm diameter single-axis shielded transducers and measurements are repeated and summed over three axes.

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 $360^o$ 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 or broadband ridge-horn antennas on our OATS with a $4 \times 5$ 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 dB$\mu$V/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

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

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

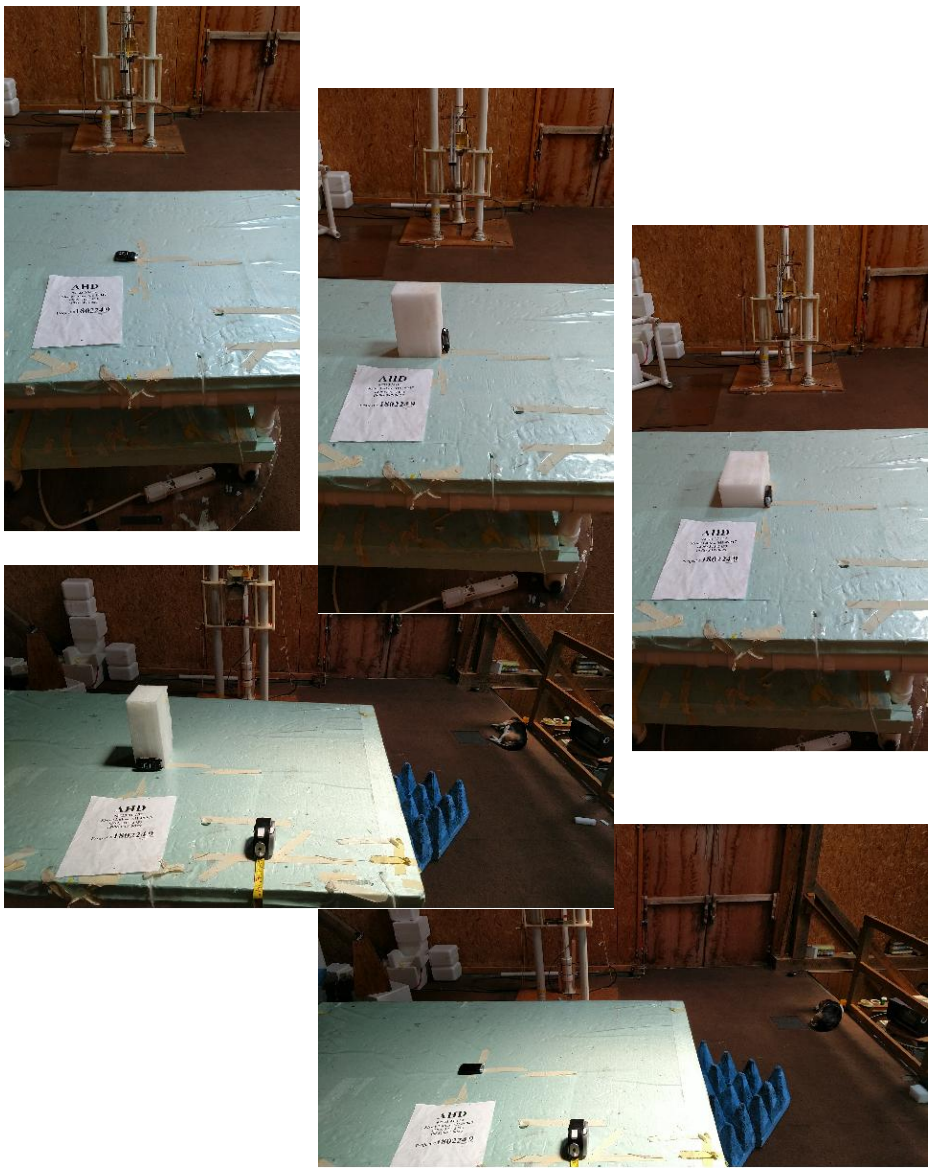


Figure 4: Radiated Emissions Test Setup Photograph(s).

### 4.1.2 Conducted Emissions Test Setup and Procedures

**Battery Power Conducted Spurious** The EUT is not subject to measurement of power line conducted emissions as it is powered solely by its internal battery.

### 4.1.3 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.

In the case the EUT is designed for operation from a battery power source, the extreme test voltages are evaluated over the range specified in the test standard; no less than ±10% of the nominal battery voltage declared by the manufacturer. For all battery operated equipment, worst case intentional and spurious emissions are re-checked employing a new (fully charged) battery.

## 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, LOGEMCO01.

**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 5.

Table 4: Fundamental Emission Pulsed Operation.

| Detector | Span | IF Bandwidth | Video Bandwidth |
|---|---|---|---|
| Pk | 0 | 1 MHz | 3 MHz |

**Test Date:** 1-Jun-18
**Test Engineer:** Joseph Brunett
**EUT:** TRW HD FOBIK
**EUT Mode:** All
**Meas. Distance:** 10 cm

FCC/IC

| # | Frequency | EUT Test Mode* | Overall Transmission: Min. Repetition Rate (sec) | Overall Transmission: Max. No. of Frames | Overall Transmission: Total Transmission Length (sec) | Internal Frame Characteristics: Max. Frame Length (ms) | Internal Frame Characteristics: Min. Frame Period (ms) | Internal Frame Characteristics: Frame Encoding | Computed Duty Cycle*: (%) | Computed Duty Cycle*: (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 433.92 MHz | Manual Activated ASK Frame Set (Low & High Power) | - | 5 | 0.56 | 46.7 | >100 | Worst Case transmission consists of five ASK frames, each with >100 ms period after a single button press. Longest ASK frame is 46.7 ms with 209 us / 419 us duty. | 23.3 | **-12.7** |
| 2 | 433.92 MHz | Manual Activated FSK Frame Set | - | 2 | 0.09 | 10.6 | - | Worst Case transmission consists of a single pair of FSK frames within 90 ms of activation. The first frame is 1.71 ms, the second is 10.6 ms. | 12.3 | -18.2 |

* Worst Case ASK duty cycle applied throughout to demonstrate compliance for all variants.
Example Calculation: Worst Case ASK Duty (%) = 46.7 ms x (0.209 ms / 0.419 ms) / 100 ms = 23.3%
Example Calculation: Worst Case FSK Duty (%) = (1.71 ms + 10.6 ms) / 100 ms = 12.3 %

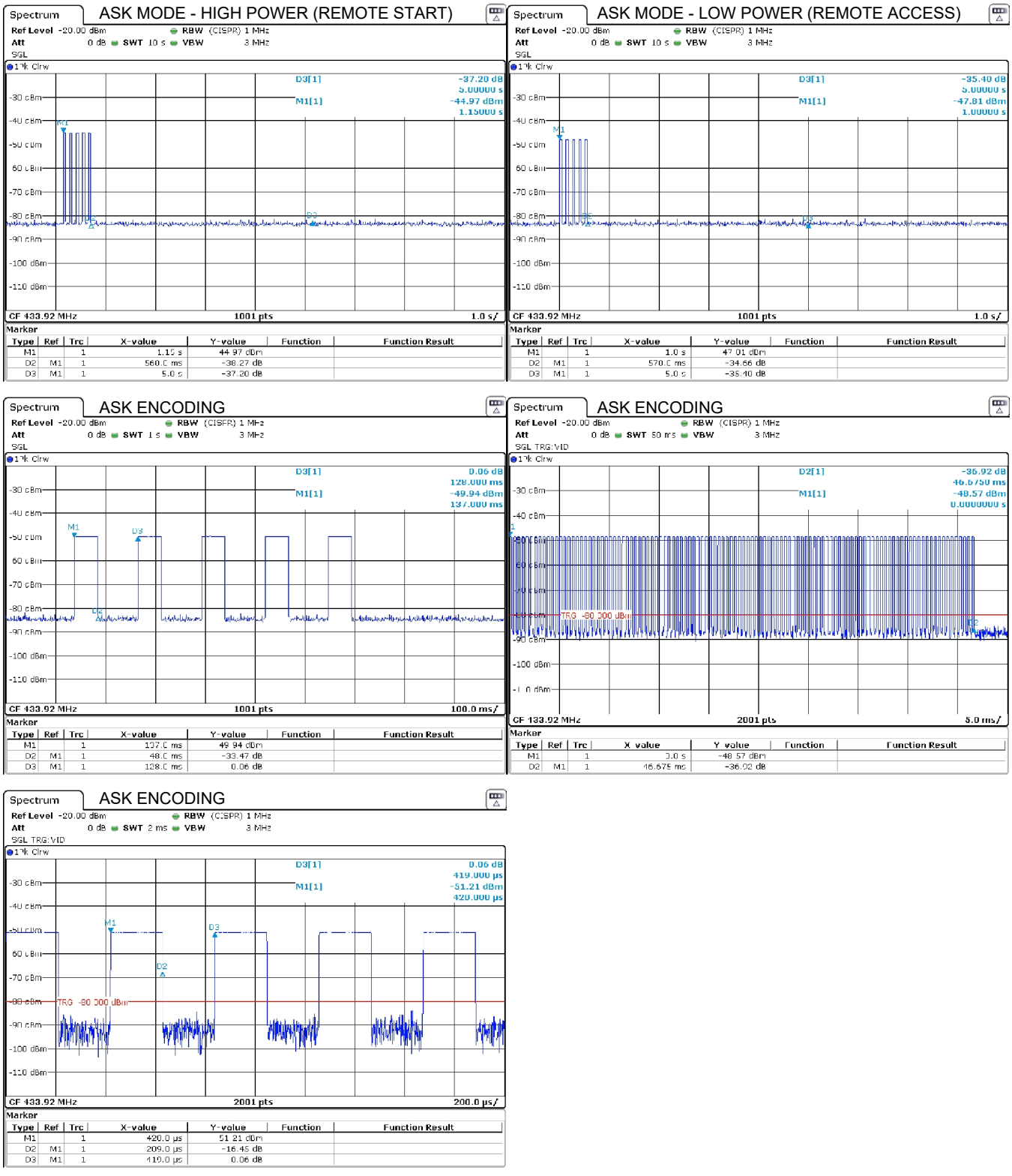



Figure 5(a): Fundamental Emission Pulsed Operation.

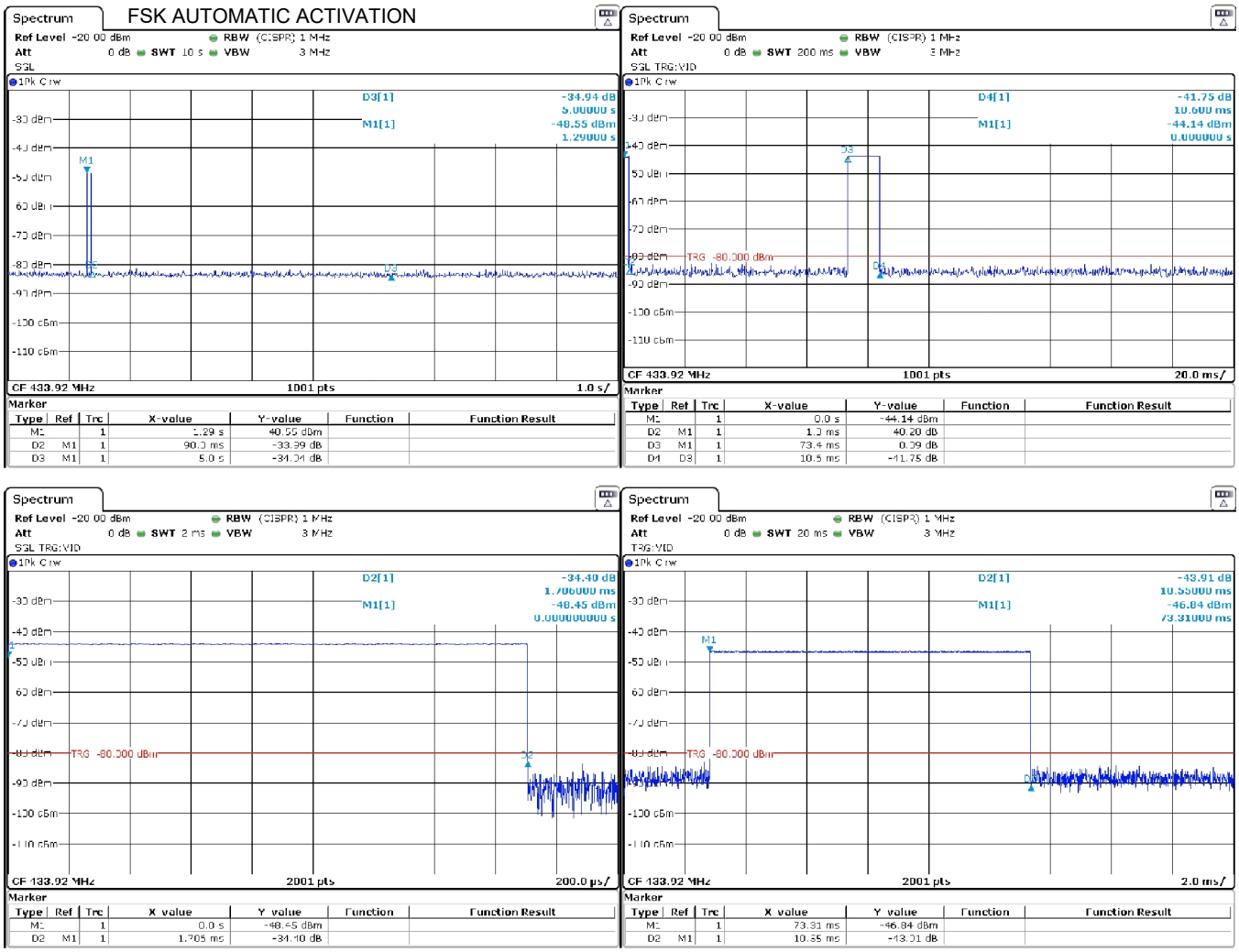



Figure 5(b): Fundamental Emission Pulsed Operation.

### 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, LOGEMCO01.

**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 6.

Table 5: Fundamental Emission Bandwidth.

| Detector | IF Bandwidth | Video Bandwidth | | |
|---|---|---|---|---|
| Pk | 10 kHz | 30 kHz | | |

| | |
|---|---|
| **Test Date:** | 1-Jun-18 |
| **Test Engineer:** | Joseph Brunett |
| **EUT:** | TRW HD FOBIK |
| **EUT Mode:** | All |
| **Meas. Distance:** | 10 cm |

| | | | | | | | FCC/IC |
|---|---|---|---|---|---|---|---|
| # | Modulation | Center Frequency (MHz) | 20 dB EBW (MHz) | EBW Limit (MHz) | 99% OBW (MHz) | | |
| 1 | ASK Low Power | 433.92 | 0.059 | 1.0848 | 0.256 | | |
| 2 | ASK High Power | 433.92 | 0.063 | 1.0848 | 0.287 | | |
| 3 | FSK Low Power | 433.92 | 0.125 | 1.0848 | 0.151 | | |

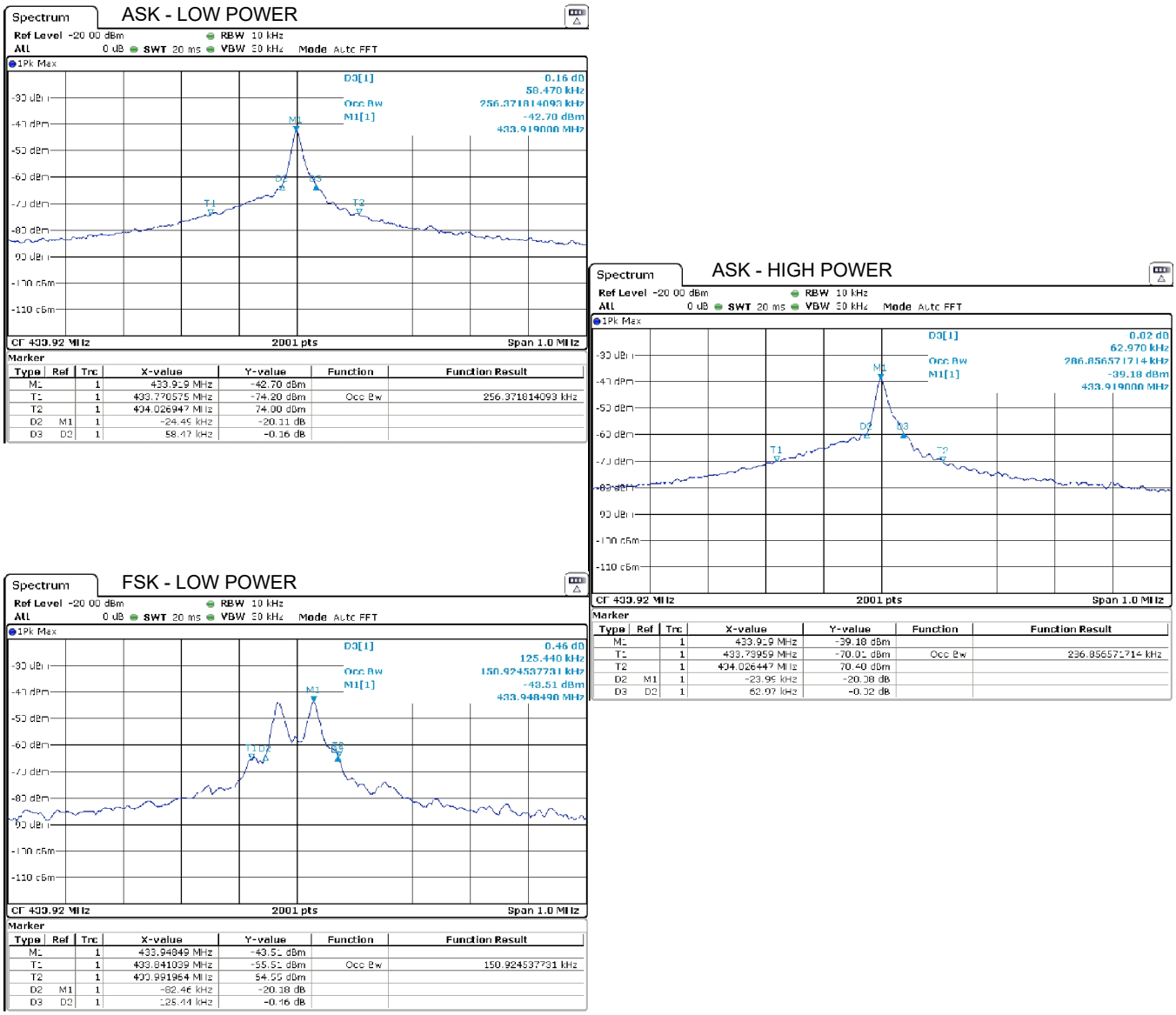



Figure 6: Fundamental Emission Bandwidth.

### 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 HP8546A, LOGEMCO01.

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

Table 6: Fundamental Emission Field Strength.

**EUT Modes:** a1 CM – One Button + Plastic Bezel – Key Inserted – LOW POWER
a2 CM – One Button + Plastic Bezel – No Key – LOW POWER
**Test Date:** 05/30/18 a3 CM – 5 Button + Metal Bezel – Key Inserted – HIGH POWER
**Test Engineer:** J. Brunett, G. Helm a4 CM – 5 Button + Metal Bezel – No Key – HIGH POWER

| | Frequency | | Site | | | | | | EUT | | | Test Antenna | | | | Cable | Receiver | | | | Field Strength @ DR | | | | | | EIRP | | Details |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Start | Stop | Temp. | Table Angle | MR | DR | N/F | CF | Mode see table | Volt. | Dim | Pol. | Dim. | Height | Ka | Kg | Rx Power Pk | Rx Power Avg | Bandwidth RBW | Bandwidth VBW | Pk Meas. | Pk Limit USA | Pk Limit CAN | Avg Calc. | Avg Limit USA | Avg Limit CAN | Calc. | Limit | Pass Fail |
| R0 | MHz | MHz | ( C ) | deg | m | | | dB | table | (V) | cm | H/V | cm | m | dB/m | dB | dBuV/m | | MHz | | dBuV/m | | | | | | dBm | | dB |
| R1 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | EMCOLOG | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R2 | 433.9 | 433.9 | 24 | 260 | 3.0 | 3.0 | | 0.0 | a1 | 3.0 | 6.0 | H | 100.0 | 1.0 | 16.3 | -1.5 | | | 0.12 | 0.30 | 80.0 | 100.8 | 100.8 | 67.3 | 80.8 | 80.8 | -17.6 | | 13.5 |
| R3 | 433.9 | 433.9 | 24 | 350 | 3.0 | 3.0 | | 0.0 | a1 | 3.0 | 6.0 | V | 100.0 | 1.3 | 16.3 | -1.5 | | | 0.12 | 0.30 | 80.5 | 100.8 | 100.8 | 67.8 | 80.8 | 80.8 | -17.1 | | 13.0 |
| R5 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | EMCOLOG | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R6 | 433.9 | 433.9 | 24 | 260 | 3.0 | 3.0 | | 0.0 | a2 | 3.0 | 6.0 | H | 100.0 | 1.0 | 16.3 | -1.5 | | | 0.12 | 0.30 | 81.2 | 100.8 | 100.8 | 68.5 | 80.8 | 80.8 | -16.4 | | 12.3 |
| R7 | 433.9 | 433.9 | 24 | 350 | 3.0 | 3.0 | | 0.0 | a2 | 3.0 | 6.0 | V | 100.0 | 1.3 | 16.3 | -1.5 | | | 0.12 | 0.30 | 80.8 | 100.8 | 100.8 | 68.1 | 80.8 | 80.8 | -16.8 | | 12.7 |
| R8 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | EMCOLOG | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R9 | 433.9 | 433.9 | 24 | 30 | 3.0 | 3.0 | | 0.0 | a3 | 3.0 | 6.0 | H | 100.0 | 1.0 | 16.3 | -1.5 | | | 0.12 | 0.30 | 83.0 | 100.8 | 100.8 | 70.3 | 80.8 | 80.8 | -14.6 | | 10.5 |
| R10 | 433.9 | 433.9 | 24 | 0 | 3.0 | 3.0 | | 0.0 | a3 | 3.0 | 6.0 | V | 100.0 | 1.4 | 16.3 | -1.5 | | | 0.12 | 0.30 | 83.5 | 100.8 | 100.8 | 70.8 | 80.8 | 80.8 | -14.1 | | 10.0 |
| R11 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | EMCOLOG | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R12 | 433.9 | 433.9 | 24 | 350 | 3.0 | 3.0 | | 0.0 | a4 | 3.0 | 6.0 | H | 100.0 | 1.0 | 16.3 | -1.5 | | | 0.12 | 0.30 | 84.6 | 100.8 | 100.8 | 71.9 | 80.8 | 80.8 | -13.0 | | **8.9** |
| R13 | 433.9 | 433.9 | 24 | 350 | 3.0 | 3.0 | | 0.0 | a4 | 3.0 | 6.0 | V | 100.0 | 1.6 | 16.3 | -1.5 | | | 0.12 | 0.30 | 82.8 | 100.8 | 100.8 | 70.1 | 80.8 | 80.8 | -14.8 | | 10.7 |
| R14 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| R15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| # | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 | C26 | C27 | C28 |

| (ROW) | (COLUMN) | NOTE: |
|---|---|---|
| R0 | C5 | MR is Measurement Range, which may be reduced from DR to achieve necessary SNR. |
| R0 | C6 | DR is the regulatory Desired Range measurement distance. |
| R0 | C7 | N/F is Near-Field / Far-Field distance computed for max of EUT Antenna Dimension (C10) and Test Antenna dimension (C12), where applicable. |
| R0 | C8 | CF is computed using a 20 dB/decade Decay Rate. |
| R0 | C16 | 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 | C23 | Average Field Strength computed from Peak via Duty Cycle. |

## 4.3 Unintentional Emissions

### 4.3.1 Transmit Chain Spurious Emissions

**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. Spurious radiated emissions measurements are performed to 10 times the highest fundamental operating frequency. The test equipment employed includes HP8546A, LOGEMCO01, RH3115.

**Measurement Results** The details and results of testing the EUT are summarized in Table 7.

Table 7(a): Transmit Chain Spurious Emissions.

**EUT Modes:** a1 CM – One Button + Plastic Bezel – Key Inserted – LOW POWER
a2 CM – One Button + Plastic Bezel – No Key – LOW POWER
**Test Date:** 05/31/18 a3
**Test Engineer:** J. Brunett, G. Helm a4

| | Frequency | | Site | | | | | | EUT | | | Test Antenna | | | | Cable | Receiver | | | | Field Strength @ DR | | | | | | EIRP | | Details |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Start | Stop | Temp. | Table Angle | MR | DR | N/F | CF | Mode | Volt. | Dim | Pol. | Dim. | Height | Ka | Kg | Rx Power Pk | Rx Power Avg | Bandwidth RBW | Bandwidth VBW | Pk Meas. | Pk Limit USA | Pk Limit CAN | Avg Meas. | Avg Limit USA | Avg Limit CAN | Calc. | Limit | Pass Fail |
| R0 | | | | | | | | | see | | | | | | | | | | | | | | | | | | | | |
| | MHz | MHz | ( C ) | deg | m | | | dB | table | (V) | cm | H/V | cm | m | dB/m | dB | dBuV/m | | MHz | | dBuV/m | | | | | | dBm | | dB |
| R1 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | EMCOLOG | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R2 | 867.8 | 867.8 | 24 | 45 | 3.0 | 3.0 | | 0.0 | a1 | 3.0 | 6.0 | H | 22.0 | 1.0 | 22.2 | -2.8 | | | 0.12 | 0.30 | 58.0 | 80.8 | 80.8 | 45.3 | 60.8 | 60.8 | -37.2 | | 15.5 |
| R3 | 867.8 | 867.8 | 24 | 45 | 3.0 | 3.0 | | 0.0 | a1 | 3.0 | 6.0 | V | 22.0 | 1.0 | 22.2 | -2.8 | | | 0.12 | 0.30 | 58.0 | 80.8 | 80.8 | 45.3 | 60.8 | 60.8 | -37.2 | | 15.5 |
| R4 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | HP3115 | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R5 | 1301.8 | 1301.8 | 24 | all | 3.0 | 3.0 | 0.2 | 0.0 | a1 | 3.0 | 6.0 | H/V | 15.0 | all | 26.7 | -1.5 | | | 1.00 | 3.00 | 42.6 | 74.0 | 74.0 | 29.9 | 54.0 | 54.0 | -52.6 | | 24.1 |
| R6 | 1735.7 | 1735.7 | 24 | all | 3.0 | 3.0 | 0.3 | 0.0 | a1 | 3.0 | 6.0 | H/V | 15.0 | all | 27.5 | -1.8 | | | 1.00 | 3.00 | 48.5 | 80.8 | 80.8 | 35.8 | 60.8 | 60.8 | -46.7 | | 25.0 |
| R7 | 2169.6 | 2169.6 | 24 | all | 3.0 | 3.0 | 0.3 | 0.0 | a1 | 3.0 | 6.0 | H/V | 15.0 | all | 28.3 | -2.2 | | | 1.00 | 3.00 | 51.4 | 80.8 | 80.8 | 38.7 | 60.8 | 60.8 | -43.8 | | 22.1 |
| R8 | 2603.5 | 2603.5 | 24 | all | 3.0 | 3.0 | 0.4 | 0.0 | a1 | 3.0 | 6.0 | H/V | 15.0 | all | 28.9 | -2.5 | | | 1.00 | 3.00 | 46.2 | 80.8 | 80.8 | 33.5 | 60.8 | 60.8 | -49.0 | | 27.3 |
| R9 | 3037.4 | 3037.4 | 24 | all | 3.0 | 3.0 | 0.5 | 0.0 | a1 | 3.0 | 6.0 | H/V | 15.0 | all | 29.3 | -2.8 | | | 1.00 | 3.00 | 53.8 | 80.8 | 80.8 | 41.1 | 60.8 | 60.8 | -41.4 | | 19.7 |
| R10 | 3471.4 | 3471.4 | 24 | all | 3.0 | 3.0 | 0.5 | 0.0 | a1 | 3.0 | 6.0 | H/V | 15.0 | all | 29.8 | -3.0 | | | 1.00 | 3.00 | 63.7 | 80.8 | 80.8 | 51.0 | 60.8 | 60.8 | -31.5 | | 9.8 |
| R11 | 3905.3 | 3905.3 | 24 | all | 3.0 | 3.0 | 0.6 | 0.0 | a1 | 3.0 | 6.0 | H/V | 15.0 | all | 30.1 | -3.3 | | | 1.00 | 3.00 | 46.6 | 74.0 | 74.0 | 33.9 | 54.0 | 54.0 | -48.6 | | 20.1 |
| R12 | 4339.2 | 4339.2 | 24 | all | 3.0 | 3.0 | 0.7 | 0.0 | a1 | 4.0 | 6.0 | H/V | 15.0 | all | 30.6 | -3.5 | | | 1.00 | 3.00 | 58.6 | 74.0 | 74.0 | 45.9 | 54.0 | 54.0 | -36.6 | | **8.1** |
| R13 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| R14 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | EMCOLOG | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R15 | 867.8 | 867.8 | 24 | 45 | 3.0 | 3.0 | | 0.0 | a2 | 3.0 | 6.0 | H | 22.0 | 1.0 | 22.2 | -2.8 | | | 0.12 | 0.30 | 61.5 | 80.8 | 80.8 | 48.8 | 60.8 | 60.8 | -33.7 | | 12.0 |
| R16 | 867.8 | 867.8 | 24 | 45 | 3.0 | 3.0 | | 0.0 | a2 | 3.0 | 6.0 | V | 22.0 | 1.0 | 22.2 | -2.8 | | | 0.12 | 0.30 | 61.5 | 80.8 | 80.8 | 48.8 | 60.8 | 60.8 | -33.7 | | 12.0 |
| R17 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | HP3115 | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R18 | 1301.8 | 1301.8 | 24 | all | 3.0 | 3.0 | 0.2 | 0.0 | a2 | 3.0 | 6.0 | H/V | 15.0 | all | 26.7 | -1.5 | | | 1.00 | 3.00 | 45.0 | 74.0 | 74.0 | 32.3 | 54.0 | 54.0 | -50.2 | | 21.7 |
| R19 | 1735.7 | 1735.7 | 24 | all | 3.0 | 3.0 | 0.3 | 0.0 | a2 | 3.0 | 6.0 | H/V | 15.0 | all | 27.5 | -1.8 | | | 1.00 | 3.00 | 44.9 | 80.8 | 80.8 | 32.2 | 60.8 | 60.8 | -50.3 | | 28.6 |
| R20 | 2169.6 | 2169.6 | 24 | all | 3.0 | 3.0 | 0.3 | 0.0 | a2 | 3.0 | 6.0 | H/V | 15.0 | all | 28.3 | -2.2 | | | 1.00 | 3.00 | 55.0 | 80.8 | 80.8 | 42.3 | 60.8 | 60.8 | -40.3 | | 18.6 |
| R21 | 2603.5 | 2603.5 | 24 | all | 3.0 | 3.0 | 0.4 | 0.0 | a2 | 3.0 | 6.0 | H/V | 15.0 | all | 28.9 | -2.5 | | | 1.00 | 3.00 | 48.9 | 80.8 | 80.8 | 36.2 | 60.8 | 60.8 | -46.3 | | 24.6 |
| R22 | 3037.4 | 3037.4 | 24 | all | 3.0 | 3.0 | 0.5 | 0.0 | a2 | 3.0 | 6.0 | H/V | 15.0 | all | 29.3 | -2.8 | | | 1.00 | 3.00 | 50.8 | 80.8 | 80.8 | 38.1 | 60.8 | 60.8 | -44.4 | | 22.7 |
| R23 | 3471.4 | 3471.4 | 24 | all | 3.0 | 3.0 | 0.5 | 0.0 | a2 | 3.0 | 6.0 | H/V | 15.0 | all | 29.8 | -3.0 | | | 1.00 | 3.00 | 63.1 | 80.8 | 80.8 | 50.4 | 60.8 | 60.8 | -32.1 | | 10.4 |
| R24 | 3905.3 | 3905.3 | 24 | all | 3.0 | 3.0 | 0.6 | 0.0 | a2 | 3.0 | 6.0 | H/V | 15.0 | all | 30.1 | -3.3 | | | 1.00 | 3.00 | 45.1 | 74.0 | 74.0 | 32.4 | 54.0 | 54.0 | -50.1 | | 21.6 |
| R25 | 4339.2 | 4339.2 | 24 | all | 3.0 | 3.0 | 0.7 | 0.0 | a2 | 4.0 | 6.0 | H/V | 15.0 | all | 30.6 | -3.5 | | | 1.00 | 3.00 | 58.3 | 74.0 | 74.0 | 45.6 | 54.0 | 54.0 | -36.9 | | 8.4 |
| R26 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| # | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 | C26 | C27 | C28 |

| (ROW) | (COLUMN) | NOTE: |
|---|---|---|
| R0 | C5 | MR is Measurement Range, which may be reduced from DR to achieve necessary SNR. |
| R0 | C6 | DR is the regulatory Desired Range measurement distance. |
| R0 | C7 | N/F is Near-Field / Far-Field distance computed for max of EUT Antenna Dimension (C10) and Test Antenna dimension (C12), where applicable. |
| R0 | C8 | CF is computed using a 20 dB/decade Decay Rate. |
| R0 | C16 | 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 | C23 | Average Field Strength computed from Peak via Duty Cycle. |

# Table 7(b): Transmit Chain Spurious Emissions.

**EUT Modes:** a1
a2
a3 CM – 5 Button + Metal Bezel – Key Inserted – HIGH POWER
a4 CM – 5 Button + Metal Bezel – No Key – HIGH POWER

**Test Date:** 05/31/18
**Test Engineer:** J. Brunett, G. Helm

| | Frequency | | Site | | | | | | EUT | | | Test Antenna | | | | Cable | Receiver | | | | Field Strength @ DR | | | | | | EIRP | | Details |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Start | Stop | Temp. | Table Angle | MR | DR | N/F | CF | Mode | Volt. | Dim | Pol. | Dim. | Height | Ka | Kg | Rx Power Pk | Rx Power Avg | Bandwidth RBW | Bandwidth VBW | Pk Meas. | Pk Limit USA | Pk Limit CAN | Avg Meas. | Avg Limit USA | Avg Limit CAN | Calc. | Limit | Pass |
| R0 | | | | | | | | | see table | | | | | | | | | | | | | | | | | | | | Fail |
| | MHz | MHz | ( C ) | deg | m | | | dB | table | (V) | cm | H/V | cm | m | dB/m | dB | dBuV/m | | MHz | | dBuV/m | | | | | | dBm | | dB |
| R1 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | EMCOLOG | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R2 | 867.8 | 867.8 | 26 | 45 | 3.0 | 3.0 | | 0.0 | a3 | 3.0 | 6.0 | H/V | 22.0 | 1.0 | 22.2 | -2.8 | | | 0.12 | 0.30 | 54.3 | 80.8 | 80.8 | 41.6 | 60.8 | 60.8 | -40.9 | | 19.2 |
| R3 | 867.8 | 867.8 | 26 | 45 | 3.0 | 3.0 | | 0.0 | a3 | 3.0 | 6.0 | H/V | 22.0 | 1.0 | 22.2 | -2.8 | | | 0.12 | 0.30 | 54.3 | 80.8 | 80.8 | 41.6 | 60.8 | 60.8 | -40.9 | | 19.2 |
| R4 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | HP3115 | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R5 | 1301.8 | 1301.8 | 26 | all | 3.0 | 3.0 | 0.2 | 0.0 | a3 | 3.0 | 6.0 | H/V | 15.0 | | 26.7 | -1.5 | | | 1.00 | 3.00 | 46.5 | 74.0 | 74.0 | 33.8 | 54.0 | 54.0 | -48.7 | | 20.2 |
| R6 | 1735.7 | 1735.7 | 26 | all | 3.0 | 3.0 | 0.3 | 0.0 | a3 | 3.0 | 6.0 | H/V | 15.0 | | 27.5 | -1.8 | | | 1.00 | 3.00 | 48.0 | 80.8 | 80.8 | 35.3 | 60.8 | 60.8 | -47.2 | | 25.5 |
| R7 | 2169.6 | 2169.6 | 26 | all | 3.0 | 3.0 | 0.3 | 0.0 | a3 | 3.0 | 6.0 | H/V | 15.0 | | 28.3 | -2.2 | | | 1.00 | 3.00 | 50.5 | 80.8 | 80.8 | 37.8 | 60.8 | 60.8 | -44.8 | | 23.1 |
| R8 | 2603.5 | 2603.5 | 26 | all | 3.0 | 3.0 | 0.4 | 0.0 | a3 | 3.0 | 6.0 | H/V | 15.0 | | 28.9 | -2.5 | | | 1.00 | 3.00 | 54.4 | 80.8 | 80.8 | 41.7 | 60.8 | 60.8 | -40.8 | | 19.1 |
| R9 | 3037.4 | 3037.4 | 26 | all | 3.0 | 3.0 | 0.5 | 0.0 | a3 | 3.0 | 6.0 | H/V | 15.0 | | 29.3 | -2.8 | | | 1.00 | 3.00 | 45.2 | 80.8 | 80.8 | 32.5 | 60.8 | 60.8 | -50.0 | | 28.3 |
| R10 | 3471.4 | 3471.4 | 26 | all | 3.0 | 3.0 | 0.5 | 0.0 | a3 | 3.0 | 6.0 | H/V | 15.0 | | 29.8 | -3.0 | | | 1.00 | 3.00 | 57.4 | 80.8 | 80.8 | 44.7 | 60.8 | 60.8 | -37.8 | | 16.1 |
| R11 | 3905.3 | 3905.3 | 26 | all | 3.0 | 3.0 | 0.6 | 0.0 | a3 | 3.0 | 6.0 | H/V | 15.0 | | 30.1 | -3.3 | | | 1.00 | 3.00 | 54.7 | 74.0 | 74.0 | 42.0 | 54.0 | 54.0 | -40.5 | | 12.0 |
| R12 | 4339.2 | 4339.2 | 26 | all | 3.0 | 3.0 | 0.7 | 0.0 | a3 | 4.0 | 6.0 | H/V | 15.0 | | 30.6 | -3.5 | | | 1.00 | 3.00 | 56.5 | 74.0 | 74.0 | 43.8 | 54.0 | 54.0 | -38.7 | | **10.2** |
| R13 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| R14 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | EMCOLOG | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R15 | 867.8 | 867.8 | 26 | 250 | 3.0 | 3.0 | | 0.0 | a4 | 3.0 | 6.0 | H/V | 22.0 | 1.0 | 22.2 | -2.8 | | | 0.12 | 0.30 | 55.1 | 80.8 | 80.8 | 42.4 | 60.8 | 60.8 | -40.1 | | 18.4 |
| R16 | 867.8 | 867.8 | 26 | 250 | 3.0 | 3.0 | | 0.0 | a4 | 3.0 | 6.0 | H/V | 22.0 | 1.0 | 22.2 | -2.8 | | | 0.12 | 0.30 | 55.1 | 80.8 | 80.8 | 42.4 | 60.8 | 60.8 | -40.1 | | 18.4 |
| R17 | SETUP | | OATSA | | | | | | TRW HD FOBIK | | | HP3115 | | | | | HP8546A | | | | NOTES: max all orientations of EUT | | | | | | | | |
| R18 | 1301.8 | 1301.8 | 26 | all | 3.0 | 3.0 | 0.2 | 0.0 | a4 | 3.0 | 6.0 | H/V | 15.0 | | 26.7 | -1.5 | | | 1.00 | 3.00 | 47.6 | 74.0 | 74.0 | 34.9 | 54.0 | 54.0 | -47.6 | | 19.1 |
| R19 | 1735.7 | 1735.7 | 26 | all | 3.0 | 3.0 | 0.3 | 0.0 | a4 | 3.0 | 6.0 | H/V | 15.0 | | 27.5 | -1.8 | | | 1.00 | 3.00 | 49.4 | 80.8 | 80.8 | 36.7 | 60.8 | 60.8 | -45.9 | | 24.2 |
| R20 | 2169.6 | 2169.6 | 26 | all | 3.0 | 3.0 | 0.3 | 0.0 | a4 | 3.0 | 6.0 | H/V | 15.0 | | 28.3 | -2.2 | | | 1.00 | 3.00 | 48.4 | 80.8 | 80.8 | 35.7 | 60.8 | 60.8 | -46.8 | | 25.1 |
| R21 | 2603.5 | 2603.5 | 26 | all | 3.0 | 3.0 | 0.4 | 0.0 | a4 | 3.0 | 6.0 | H/V | 15.0 | | 28.9 | -2.5 | | | 1.00 | 3.00 | 52.4 | 80.8 | 80.8 | 39.7 | 60.8 | 60.8 | -42.8 | | 21.1 |
| R22 | 3037.4 | 3037.4 | 26 | all | 3.0 | 3.0 | 0.5 | 0.0 | a4 | 3.0 | 6.0 | H/V | 15.0 | | 29.3 | -2.8 | | | 1.00 | 3.00 | 42.9 | 80.8 | 80.8 | 30.2 | 60.8 | 60.8 | -52.3 | | 30.6 |
| R23 | 3471.4 | 3471.4 | 26 | all | 3.0 | 3.0 | 0.5 | 0.0 | a4 | 3.0 | 6.0 | H/V | 15.0 | | 29.8 | -3.0 | | | 1.00 | 3.00 | 54.8 | 80.8 | 80.8 | 42.1 | 60.8 | 60.8 | -40.4 | | 18.7 |
| R24 | 3905.3 | 3905.3 | 26 | all | 3.0 | 3.0 | 0.6 | 0.0 | a4 | 3.0 | 6.0 | H/V | 15.0 | | 30.1 | -3.3 | | | 1.00 | 3.00 | 56.1 | 74.0 | 74.0 | 43.4 | 54.0 | 54.0 | -39.1 | | 10.6 |
| R25 | 4339.2 | 4339.2 | 26 | all | 3.0 | 3.0 | 0.7 | 0.0 | a4 | 4.0 | 6.0 | H/V | 15.0 | | 30.6 | -3.5 | | | 1.00 | 3.00 | 53.4 | 74.0 | 74.0 | 40.7 | 54.0 | 54.0 | -41.8 | | 13.3 |
| R26 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| # | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 | C26 | C27 | C28 |

| (ROW) | (COLUMN) | NOTE: |
|---|---|---|
| R0 | C5 | MR is Measurement Range, which may be reduced from DR to achieve necessary SNR. |
| R0 | C6 | DR is the regulatory Desired Range measurement distance. |
| R0 | C7 | N/F is Near-Field / Far-Field distance computed for max of EUT Antenna Dimension (C10) and Test Antenna dimension (C12), where applicable. |
| R0 | C8 | CF is computed using a 20 dB/decade Decay Rate. |
| R0 | C16 | 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 | C23 | Average Field Strength computed from Peak via Duty Cycle. |

### 4.3.2 Radiated Digital Spurious

The results for the measurement of digital spurious emissions are not reported herein as all digital emissions were greater than 20 dB below the regulatory limit. Radiation from digital components was measured to 4 GHz, or to five times the maximum digital component operating frequency, whichever is greater.

## 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 8: 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 $(30 - 200\,\text{MHz})$ | $\pm 4.0\,\text{dB}$ |
| Radiated Emm. Amplitude $(200 - 1000\,\text{MHz})$ | $\pm 5.2\,\text{dB}$ |
| Radiated Emm. Amplitude $(f > 1000\,\text{MHz})$ | $\pm 3.7\,\text{dB}$ |

†Ref: CISPR 16-4-2:2011+A1:2014


United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200129-0

AHD (Amber Helm Development, L.C.)
Sister Lakes, MI

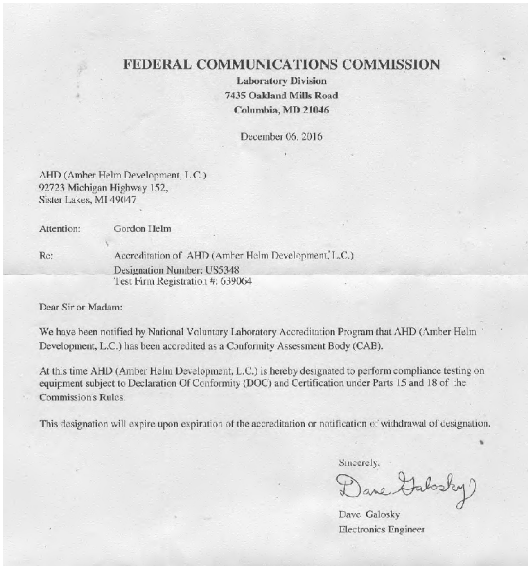
is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2006).

2017-06-28 through 2018-06-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program


FEDERAL COMMUNICATIONS COMMISSION
Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

December 06, 2016

AHD (Amber Helm Development, L.C.)
92723 Michigan Highway 152,
Sister Lakes, MI 49047

Attention: Gordon Helm

Re: Accreditation of AHD (Amber Helm Development, L.C.)
Designation Number: US5348
Test Firm Registration #: 639064

Dear Sir or Madam:

We have been notified by National Voluntary Laboratory Accreditation Program that AHD (Amber Helm Development, L.C.) has been accredited as a Conformity Assessment Body (CAB).

At this time AHD (Amber Helm Development, L.C.) is hereby designated to perform compliance testing on equipment subject to Declaration Of Conformity (DOC) and Certification under Parts 15 and 18 of the Commission's Rules.

This designation will expire upon expiration of the accreditation or notification or withdrawal of designation.

Sincerely,

Dave Galosky
Electronics Engineer


Figure 7: Accreditation Documents