



a Laird Business



TESTING CERT #1255.01

W66 N220 Commerce Court • Cedarburg, WI 53012 • USA

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ENGINEERING TEST REPORT # TR316062 D

LSR Job #: C-2411

Compliance Testing of:
RM186-SM

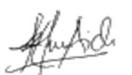
Test Date(s):
3/28/16 – 4/22/16

Prepared For:
Attention: N. Zach Hogya
Laird Technologies
W66 N220 Commerce Court
Cedarburg, Wisconsin 53012

This Test Report is issued under the Authority of:
Shane Dock, EMC Engineer

Signature:  Date: 5/6/16

Test Report Reviewed by:
Khairul Aidi Zainal, Engineering Manager
– Test Services

Signature:  Date: 5/6/16

Report by:
Shane Dock, EMC Engineer

Signature:  Date: 5/6/16

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Prepared For: Laird Technologies

Report: 316062D

LSR: C-2411

Model: RM186-SM

Serial: RM186-SM

Table of Contents

Title Page	1
ii. Table of Contents	2
LS Research, LLC	3
1.0 Summary of Test Report	5
2.0 Test Facilities	6
3.0 Client Information	6
3.1 Equipment Under Test (EUT) Information	6
3.2 Product Description	6
3.3 Modifications Incorporated In the EUT for Compliance Purposes	7
3.4 Deviations & Exclusions from Test Specifications	7
3.5 Additional Information	7
4.0 Conditions of Test	7
5.0 Test Equipment	7
6.0 Conformance Summary	8
Appendix A – Test Equipment and Setup	9
Appendix B – General Description of Measurement	11
B.1 – RF Conducted measurements	11
B.2 – Radiated Emissions	12
Appendix C – Test Data	13
C.1.1 – Frequency Error	13
C.1.2 – Average Conducted Power	14
C.1.3 – Effective Radiated Power	16
C.1.4 – Spread Spectrum Modulation	16
C.1.5 – Transient Power	17
C.1.6 – Adjacent Channel Power	20
C.1.7 – Modulation Bandwidth	20
C.1.8 – Unwanted Emissions in the Spurious Domain	20
C.1.9 – Frequency Stability under Low Voltage Conditions	36
C.1.10 – Duty Cycle	39
C.1.11 – Time-out Timer	39
C.1.12 – Receiver Sensitivity	40
C.1.13 – Receiver LBT Threshold	40

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

C.1.14 – Adjacent Channel Selectivity.....	40
C.1.15 – Receiver Blocking	41
C.1.16 – Spurious Response Rejection.....	43
C.1.17 – Receiver Spurious Radiation.....	45
Appendix D - Uncertainty Summary.....	49
Appendix E - References	50

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:



TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation

A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948

FCC Registration Number: 90756



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Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-GEN – Issue 4

File Number: IC 3088-2

On file, 3 Meter Semi-Anechoic Chamber based on RSS-GEN – Issue 4

File Number: IC 3088-3



Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

1.0 Summary of Test Report

The EUT, the RM186-SM, was tested and MEETS the following ETSI EN 300 220-2 v.2.4.1 requirements, tested per the requirements of ETSI EN 300 220-1 v.2.4.1:

EN 300 220-2 Technical Requirement Section	EN 300 220-1 Technical Requirement Description	EN 300 220-1 Test Procedure Section Used	Test Report Section	Note
5.1.3.1	Frequency Error	7.1	1.1	Not Tested Per 220-1 Section 7.7
5.1.3.2	Average Power (Conducted)	7.2	1.2	2
5.1.3.3	Effective Radiated Power	7.3	1.3	Not Applicable
(EN 220-1) 7.4	Spread Spectrum Modulation	7.4	1.4	Not Applicable
5.1.3.4	Transient Power	7.5	1.5	2
5.1.3.5	Adjacent Channel Power	7.6	1.6	EUT is not narrowband
5.1.3.6	Modulation Bandwidth	7.7	1.7	2
5.1.3.7	Unwanted Emissions in the Spurious Domain	7.8	1.8	2,3
5.1.3.8	Frequency Stability Under Low Voltage Conditions	7.9	1.9	2
(EN 220-1) 7.10	Duty Cycle	7.10	1.10	4
(EN 220-1) 7.11	Time-Out Timer	7.11	1.11	Not Applicable
5.1.4.1, 5.1.4.2, 5.1.4.3, 5.1.4.5	Receiver Sensitivity, LBT Threshold, Selectivity and Spurious Rejection	8.1, 8.2, 8.3, 8.5	1.12, 1.13, 1.14, 1.16	Not Applicable for Receiver Category 3
5.1.4.4, 5.1.4.6	Receiver Blocking and Spurious Radiation	8.4, 8.6	1.15, 1.17	2,3

Note 0: Gray does not apply to EUT

Note 1: Tested with normal and extreme conditions

Note 2: RF Conducted Measurement

Note 3: Radiated Measurement

Note 4: Manufacturer declaration

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

2.0 Test Facilities

All testing was performed at:

LSR
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to the requirements of ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted.

3.0 Client Information

Manufacturer Name:	Laird Technologies
Address:	W66 N220 Commerce Court Cedarburg, Wisconsin 53012
Contact Person:	N. Zach Hogya

3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	RM186-SM
Model Number:	RM186-SM
Serial Number:	LEN DVT 29 (Radiated) LEN DVT 20 (Conducted) LEN DVT 30 (Blocking)

3.2 Product Description

The RM186-SM module is designed to enable OEMs to add a long range LoRa radio link as well as central role Bluetooth Low Energy (BLE) to small, portable, power-conscious devices. The RM186-SM module is enabled with Laird's smart BASIC, an event-driven programming language that enables OEMs to make their product development quicker and simpler, significantly reducing time to market. smartBASIC enables customers to develop a complete embedded application inside the compact RM191 hardware, connecting to a wide array of external sensors via its I2C, SPI, UART, ADC or GPIO interfaces. The module is based on the world-leading Nordic Semiconductor nRF51822 (BLE) and Semtech Sx1272 (LoRa) chipsets, the RM186-SM module provides ultra-low power consumption with outstanding wireless range using the LoRa radio link and local BLE connections.

The module operates in the 863 – 870 MHz band, and can operate with either a 125 kHz modulation, a 250kHz modulation, or a GFSK modulation.

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

3.3 Modifications Incorporated In the EUT for Compliance Purposes

None noted at time of test

3.4 Deviations & Exclusions from Test Specifications

None noted at time of test

3.5 Additional Information

Bands

6 bands were investigated:

Band	Frequency (MHz)	GFSK/125 kHz Range (MHz)	250kHz Range (MHz)	ERP (mW)
1	863-870	863.1-869.9	863.2-869.8	25
2	865-868	865.1-867.9	865.2-867.8	25
3	868-868.6	868.1-868.5	868.2-868.4	25
4	868.7-869.2	868.8-869.1	868.9-869	25
5	869.4-869.65	869.5-869.55	N/A	25
6	869.7-870	869.8-869.9	N/A	5 / 25

4.0 Conditions of Test

Environmental:

Temperature: 20-25° C

Relative Humidity: 30-60%

Atmospheric Pressure: 86-106 kPa

Supply to EUT: 3.6 to 1.8VDC provided by Generic DC Supply

Extreme Environmental:

Temperature: -40°C to +85°C

5.0 Test Equipment

All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO 17025. For a complete list of test equipment and calibration dates, see Appendix A. Unless otherwise noted, resolution bandwidth of measuring instrument used during testing for given frequency range, see below.

6.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of ETSI EN 300 220-2 v.2.4.1.

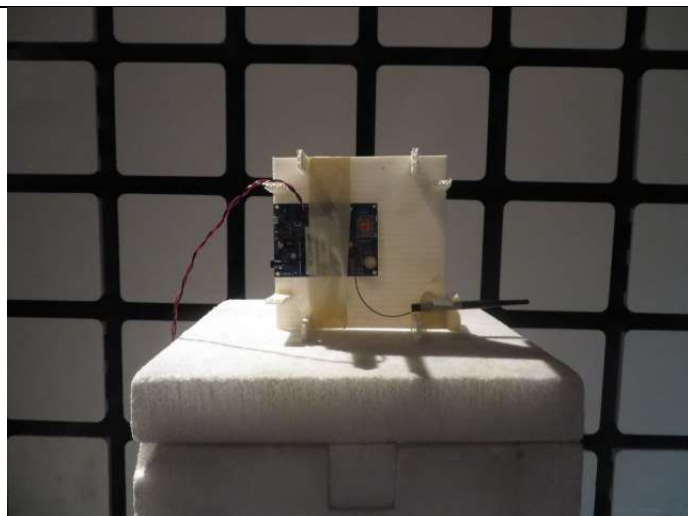
If some emissions are seen to be within 3 dB of their respective limits:

As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

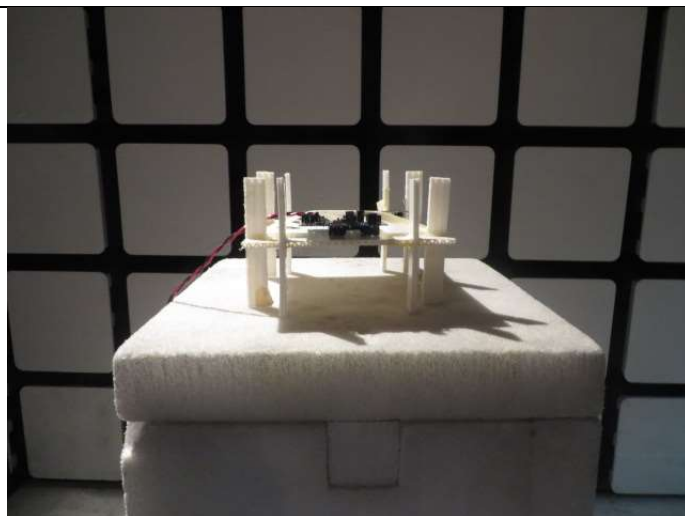
LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

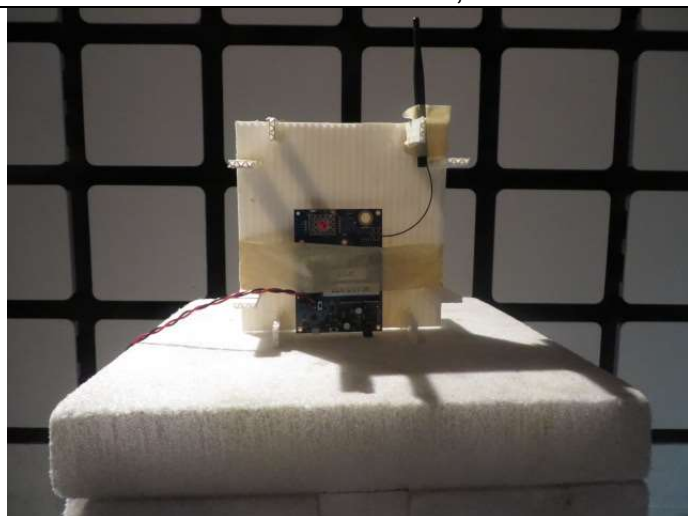
Appendix A – Test Equipment and Setup



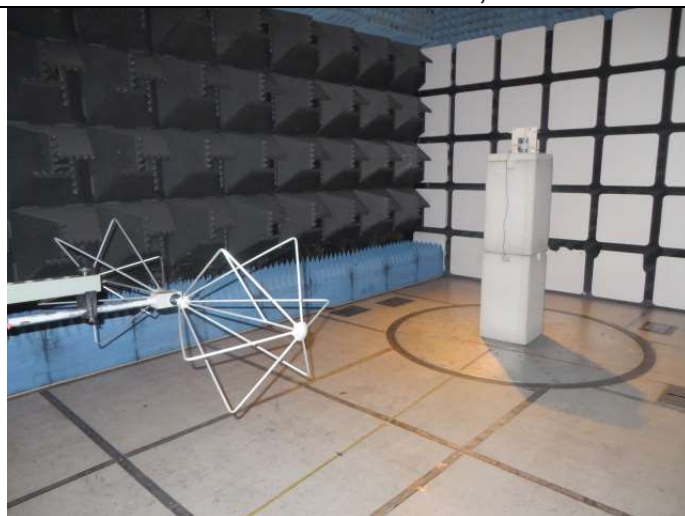
Radiated measurement, vertical



Radiated measurement, Flat



Radiated measurement, side



Radiated measurement

Pictures above show only the orientation. The unit was tested with the LoRa Radio terminated with a 50 ohm terminator, not with an antenna.

Instrumentation Sheets



Date : 29-Mar-2016

Type Test : Spurious Emissions (Tx)

Job # : C-2411

Prepared By: Shane Dock

Customer : Laird

Quote #: 316062

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/24/2017	Active Calibration
2	AA 960005	Biconical Antenna	EMCO	93110B	9601-2280	1/14/2016	1/14/2017	Active Calibration
3	EE 960081	24V/15A DC Power Supply	Tenma	72-7700	1001514	Verification	Verification	System
4	AA 960004	Log Periodic Antenna (NSA)	EMCO	93146	9512-4276	4/15/2014	4/15/2016	Active Calibration
5	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	8/4/2015	8/4/2016	Active Calibration
6	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/6/2015	5/6/2016	Active Calibration
7	AA 960144	Phasellex	Gore	EKD01D010720	5800373	Verification	Verification	System
8	AA 960162	EM Series Cable	MegaPhase	EM26-S1S1-120	12024301 001	6/30/2015	6/30/2016	Active Calibration
9	AA 960154	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-02	8/4/2015	8/4/2016	Active Calibration
10	EE 960160	0.8-21GHz LNA	Mini-Circuits	ZVA-213K-S+	977711030	8/4/2015	8/4/2016	Active Calibration
11	AA 960153	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-04	4/15/2015	4/15/2016	Active Calibration
12	EE 960087	44GHz EXA Spectrum Analyzer	Agilent	N9010A	MY53400296	12/18/2015	12/18/2016	Active Calibration



Date : 29-Mar-2016

Type Test : Conducted Measurements

Job # : C-2411

Prepared By: Shane Dock

Customer : Laird

Quote #: 316062

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	44GHz EXA Spectrum Analyzer	Agilent	N9010A	MY53400296	12/18/2015	12/18/2016	Active Calibration
2	AA 960143	Phasellex	Gore	EKD01D01048.0	5546519	6/26/2015	6/26/2017	Active Calibration
3	AA 960144	Phasellex	Gore	EKD01D010720	5800373	Verification	Verification	System
4	EE 960090	Power Meter	Anritsu	ML2495A	1335006	3/25/2016	3/25/2017	Active Calibration
5	EE 960091	Power Sensor (For Power Meter ML2495A (EE 960K Anritsu	Anritsu	MA2491A	1249277	3/25/2016	3/25/2017	Active Calibration

Project Engineer:

Quality Assurance:

Prepared For: Laird Technologies

Report: 316062D

LSR: C-2411

Model: RM186-SM

Serial: RM186-SM

Appendix B – General Description of Measurement

B.1 – RF Conducted measurements

Test Location	LS Research, LLC
Standard	ETSI EN 300 220-1 v.2.4.1
Section	
General Description of Measurement	A direct measurement of the transmitted signal was performed at the antenna port of the EUT via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

B.2 – Radiated Emissions

Standard	ETSI EN 300 220-1 2.4.1			
Section				
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber			
Test Distance	3 meter			
EUT Placement	150 cm height non-conductive table above reference ground plane			
Frequency Range of Measurement	Biconical: 30-200 MHz	Log Periodic Dipole Array: 200-1000 MHz	Double-Ridged Waveguide Horn: 1-18 GHz	
Description of Radiated Measurement	1) The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed. The data is gathered and reported as the corrected values. 2) The EUT is placed on a non-conductive pedestal centered on a turn-table in the test location with the antenna at the test distance from the EUT 3) Maximum radiated RF emissions are determined by rotation of azimuth and scanning the sense antenna between 1 and 4 meters in height using both horizontal and vertical antenna polarities. Maximized levels are manually noted at degree values of azimuth and at sense antenna height.			
Description of Substitution Measurement	1) The EUT is replaced by an antenna of known gain connected to a calibrated signal source. 2) The antenna is oriented in the polarization of the receive antenna. 3) The frequency if the signal generator is adjusted to the measurement frequency. 4) The test antenna is raised and lowered to ensure maximum signal is received. 5) The input signal to the substitution antenna is adjusted in level until an equal or known related level to that detected from the transmitter is obtained in the test receiver. Or the equation $EIRP [dBm] = E [dB\mu V/m] + 20 \cdot \log(D[meters]) - 104.77$ was utilized.			
Example Calculations	Reported Measurement data = Raw receiver measurement + Antenna Correction Factor + Cable factor (dB) - amplification factor (when applicable) + Additional factor (when applicable)			

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

Appendix C – Test Data

C.1.1 – Frequency Error

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable to EUT since modulation bandwidth was performed under extreme condition

C.1.2 – Average Conducted Power

Manufacturer	Laird Technologies
Date	3/28/16 – 4/8/16
Operator	Shane Dock
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Harmonized Standard	ETSI EN 300 220-2 v2.4.1
Technical characteristics and Test Methods	ETSI EN 300 220-1 v2.4.1
Harmonized requirement	4.2.1.2
Test Procedure Section	7.2.2
Additional Notes	Measurements done at 22, -40, and 85 degrees.

Frequency (MHz)	Meas. Type	Output Power (dBm)	Gdbi	Gdbd	ERP (dBm)	ERP (mW)	Limit (mW)	Temp
863.3	Unmod	13.67	2.00	-0.15	13.52	22.49	25.00	22 C
865.7	Unmod	13.67	2.00	-0.15	13.52	22.49	25.00	
867.7	Unmod	13.66	2.00	-0.15	13.51	22.44	25.00	
868.9	Unmod	13.65	2.00	-0.15	13.50	22.39	25.00	
869.7	Unmod	13.64	2.00	-0.15	13.49	22.34	25.00	
868.1	Unmod	13.66	2.00	-0.15	13.51	22.44	25.00	
868.3	Unmod	13.66	2.00	-0.15	13.51	22.44	25.00	
868.5	Unmod	13.66	2.00	-0.15	13.51	22.44	25.00	
869.5	Unmod	13.65	2.00	-0.15	13.50	22.39	25.00	
869.9	Unmod	6.21	2.00	-0.15	6.06	4.04	5.00	
863.3	Unmod	13.13	2.00	-0.15	12.98	19.86	25.00	-40 C
865.7	Unmod	13.12	2.00	-0.15	12.97	19.82	25.00	
867.7	Unmod	13.11	2.00	-0.15	12.96	19.77	25.00	
868.9	Unmod	13.10	2.00	-0.15	12.95	19.72	25.00	
869.7	Unmod	13.09	2.00	-0.15	12.94	19.68	25.00	
868.1	Unmod	13.02	2.00	-0.15	12.87	19.36	25.00	
868.3	Unmod	13.03	2.00	-0.15	12.88	19.41	25.00	
868.5	Unmod	13.03	2.00	-0.15	12.88	19.41	25.00	
869.5	Unmod	13.03	2.00	-0.15	12.88	19.41	25.00	
869.9	Unmod	5.62	2.00	-0.15	5.47	3.52	5.00	
863.3	Unmod	12.97	2.00	-0.15	12.82	19.14	25.00	85 C
865.7	Unmod	12.96	2.00	-0.15	12.81	19.10	25.00	
867.7	Unmod	12.93	2.00	-0.15	12.78	18.97	25.00	
868.9	Unmod	12.94	2.00	-0.15	12.79	19.01	25.00	
869.7	Unmod	12.94	2.00	-0.15	12.79	19.01	25.00	
868.1	Unmod	12.99	2.00	-0.15	12.84	19.23	25.00	
868.3	Unmod	12.99	2.00	-0.15	12.84	19.23	25.00	
868.5	Unmod	12.99	2.00	-0.15	12.84	19.23	25.00	
869.5	Unmod	12.99	2.00	-0.15	12.84	19.23	25.00	
869.9	Unmod	5.75	2.00	-0.15	5.60	3.63	5.00	

C.1.3 – Effective Radiated Power

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable to EUT since EUT does not have an integral antenna.

C.1.4 – Spread Spectrum Modulation

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable to EUT since it is classified as non-specific use

C.1.5 – Transient Power

Manufacturer	Laird Technologies
Date	4/4/16 – 4/6/16Shane Dock
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Harmonized Standard	ETSI EN 300 220-2 v2.4.1
Technical characteristics and Test Methods	ETSI EN 300 220-1 v2.4.1
Harmonized Requirement	4.2.1.5
Test Procedure Section	7.5.2
Additional Notes	Limit = -36.1 dBm

Band	Band Frequency Tested - 125kHz/GFSK (MHz)	Band Frequency Tested - 250kHz (MHz)	Band Range (MHz)
1	863.1	863.2	863 - 870
2	865.1	865.2	865 - 868
3	868.1	868.2	868 - 868.6
4	868.8	868.9	868.7 - 869.2
5	869.5	N/A	869.4 - 869.65
6	869.8	N/A	869.7 - 870

Note: For each modulation type (125kHz/250kHz/GFSK) the frequency shown above was tested in each given band.

Band 6 is tested at 25mW mode (A) and 5 mW mode (B).

Modulation Type	Maximum Transient Power Level (dBm)
125kHz	-43.24
GFSK	-40.81
250kHz	-43.85

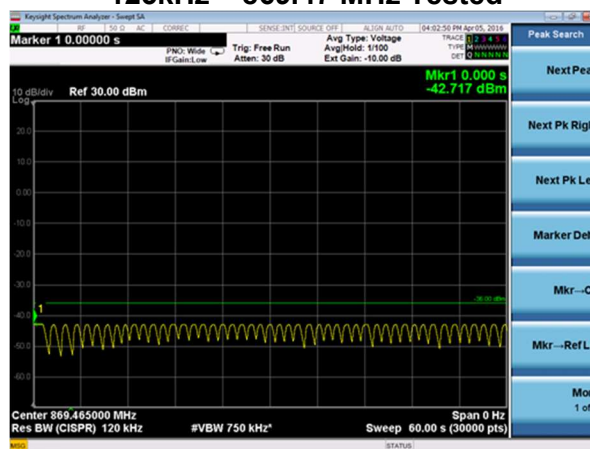
Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

Band	125kHz			GFSK			250 kHz			Limit (dBm)
	-30dB Freq. (MHz)	Test Freq. (MHz)	Test Level (dBm)	-30dB Freq. (MHz)	Test Freq. (MHz)	Test Level (dBm)	-30dB Freq. (MHz)	Test Freq. (MHz)	Test Level (dBm)	
1	862.84	862.74	-43.80	862.89	862.79	-41.20	862.83	862.73	-45.72	-36.01
	863.37	863.47	-43.24	863.30	863.40	-41.28	863.59	863.69	-45.08	-36.01
2	864.80	864.70	-45.88	864.89	864.79	-41.04	864.81	864.71	-46.59	-36.01
	865.41	865.51	-46.42	865.30	865.40	-41.13	865.59	865.69	-45.33	-36.01
3	867.83	867.73	-44.13	867.89	867.79	-43.39	867.86	867.76	-43.89	-36.01
	868.37	868.47	-44.57	868.29	868.39	-40.81	868.59	868.69	-44.66	-36.01
4	868.55	868.45	-46.56	868.59	868.49	-40.95	868.54	868.44	-45.34	-36.01
	869.07	869.17	-44.41	869.00	869.10	-41.42	869.29	869.39	-44.72	-36.01
5	869.24	869.14	-43.73	869.29	869.19	-41.02				-36.01
	869.77	869.87	-44.30	869.70	869.80	-40.96				-36.01
6A	869.57	869.47	-42.72	869.59	869.49	-40.92				-36.01
	870.07	870.17	-44.34	869.99	870.09	-40.88				-36.01
6B	869.57	869.47	-49.20	869.61	869.51	-47.26				-36.01
	870.03	870.13	-49.50	869.98	870.08	-48.72				-36.01

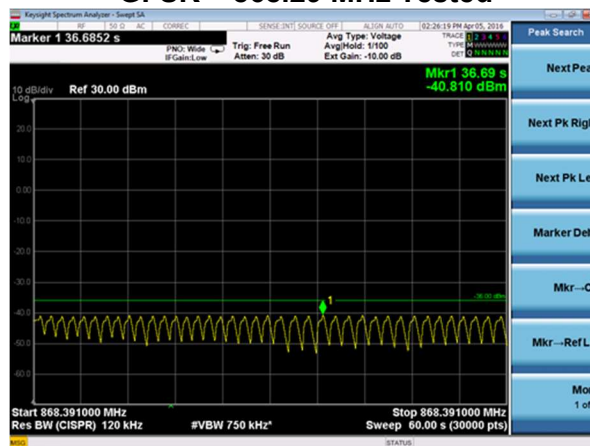
Highlighted rows above are the worst-case emissions per band.

Worst Case Emissions

125kHz – 869.47 MHz Tested



GFSK – 868.29 MHz Tested



Prepared For: Laird Technologies

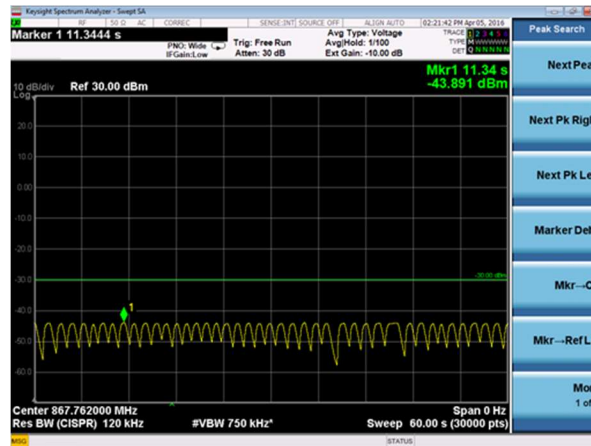
Report: 316062D

LSR: C-2411

Model: RM186-SM

Serial: RM186-SM

250kHz – 867.86 MHz Tested



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Report: 316062D

LSR: C-2411

Model: RM186-SM

Serial: RM186-SM

C.1.6 – Adjacent Channel Power

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	ETSI EN 300 220-1 v2.4.1
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable – EUT is not a Narrowband System

C.1.7 – Modulation Bandwidth

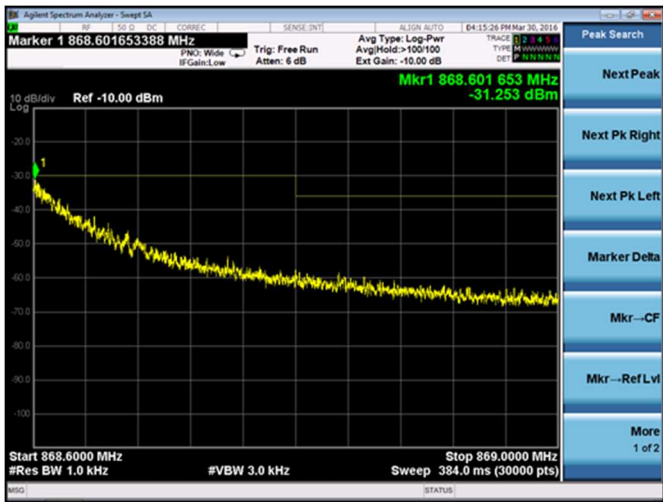
Manufacturer	Laird Technologies
Date	3/28/16 – 4/1/16
Operator	Shane Dock
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Harmonized Standard	ETSI EN 300 220-2 v2.4.1
Technical characteristics and Test Methods	ETSI EN 300 220-1 v2.4.1
Technical Requirement Section	4.2.1.7
Test Procedure Section	7.7.2
Additional Notes	The six bands were tested at the channel closest to the band edge for each modulation. Each of the windows of each band end (1kHz/10 kHz/100kHz RBW) was checked over its respective frequency range. The 1 kHz window (ranging from the lower band edge to 400k under the lower band edge) proved to be the worst case scenario. All of the data reported represents the 1 kHz emissions of the worst band for each modulation at each temperature. The highlighted bands show the worst emission per modulation.

Modulation Type	Band Edges	22 degrees Celsius				-40 degrees Celsius				85 degrees Celsius			
		Freq. (MHz)	Worst Case Band	Emission Level (dBm)	Limit (dBm)	Freq. (MHz)	Worst Case Band	Emission Level (dBm)	Limit (dBm)	Freq. (MHz)	Worst Case Band	Emission Level (dBm)	Limit (dBm)
125kHz	Lower	868.00	3	-32.95	-30.00	868.70	4	-37.60	-30.00	869.70	6	-36.76	-30.00
	Upper	870.00	1	-33.35	-30.00	868.00	2	-37.33	-30.00	868.60	3	-31.25	-30.00
GFSK	Lower	867.99	3	-39.77	-30.00	864.98	2	-41.70	-30.00	869.70	6	-40.06	-30.00
	Upper	868.00	2	-48.09	-30.00	870.00	6	-50.95	-30.00	868.60	3	-40.01	-30.00
250kHz	Lower	863.00	1	-34.30	-30.00	862.99	1	-34.38	-30.00	865.00	2	-34.86	-30.00
	Upper	870.00	1	-38.13	-30.00	868.00	2	-41.57	-30.00	868.61	3	-37.75	-30.00

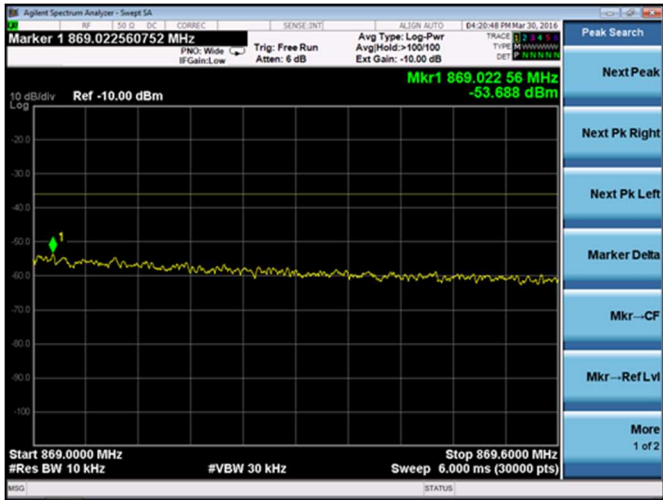
Worst Case Emissions shown. Highlighted bands are shown in plots.

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

125kHz Worst Case- Upper Band Edge 85 degrees Celsius

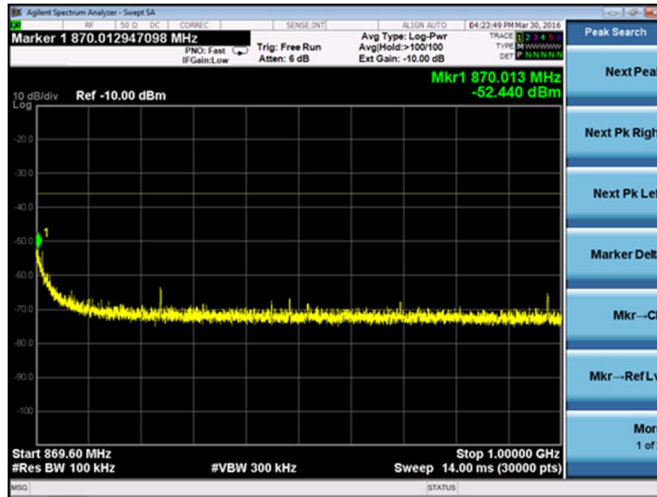


Reference Bandwidth 1kHz



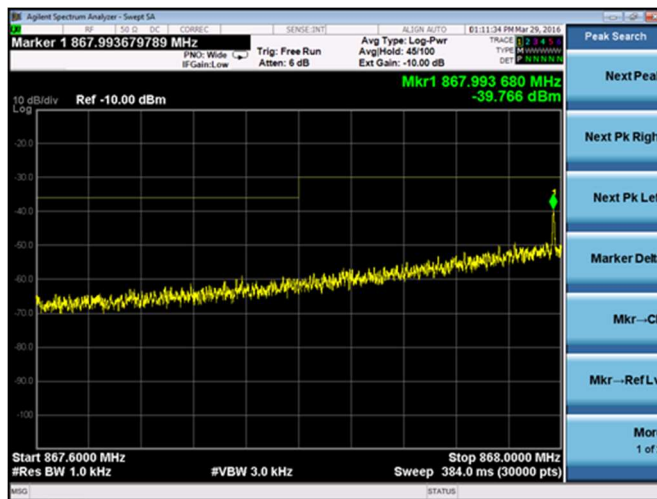
Reference Bandwidth 10kHz

Prepared For: Laird Technologies	Model: RM186-SM
Report: 316062D	Serial: RM186-SM
LSR: C-2411	

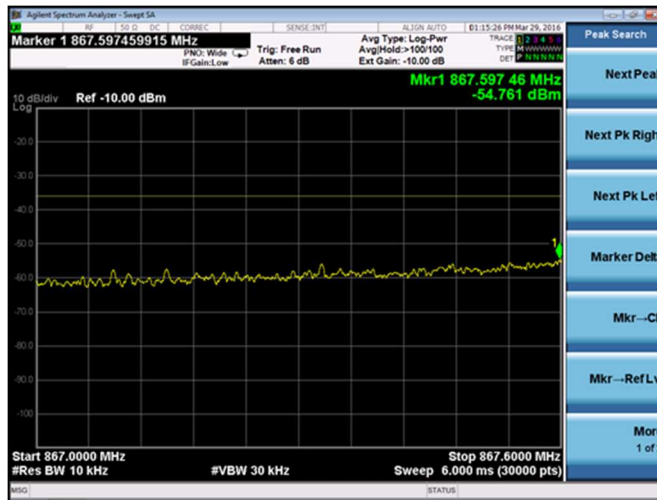


Reference Bandwidth 100kHz

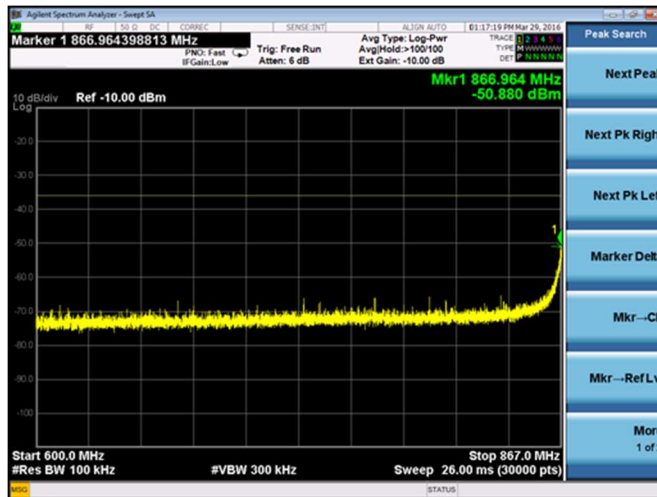
GFSK Worst Case – Lower Band 22 degrees Celsius



Reference Bandwidth 1kHz

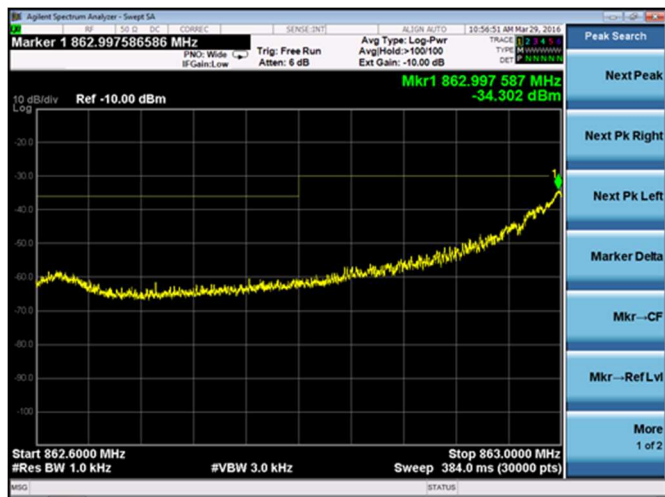


Reference Bandwidth 10kHz

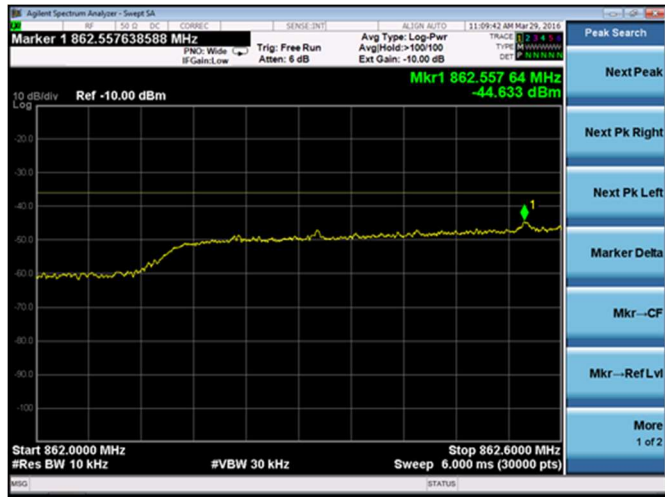


Reference Bandwidth 100kHz

250kHz Worst Case – Lower Band 22 degrees Celsius

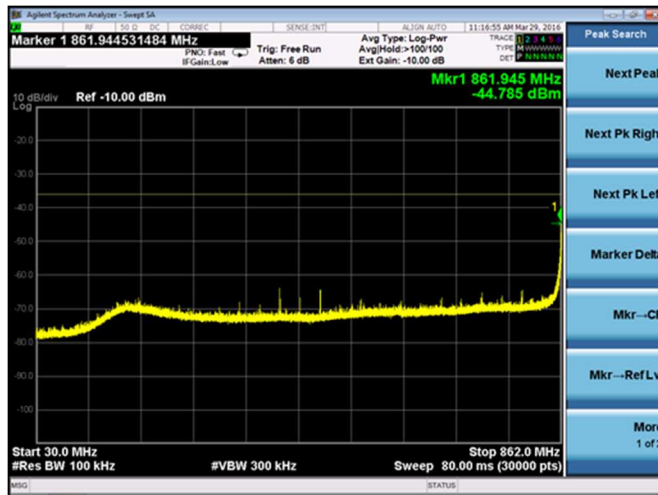


Reference Bandwidth 1kHz



Reference Bandwidth 10kHz

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM



Reference Bandwidth 100kHz

Prepared For: Laird Technologies

Report: 316062D

LSR: C-2411

Model: RM186-SM

Serial: RM186-SM

C.1.8 – Unwanted Emissions in the Spurious Domain

Manufacturer	Laird Technologies
Date	4/11/16 – 4/14/16
Operator	Shane Dock
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Harmonized Standard	ETSI EN 300 220-2 v2.4.1
Technical characteristics and Test Methods	ETSI EN 300 220-1 v2.4.1
Harmonized Requirement	4.2.1.8
Test Procedure Section	7.8.2
Additional Notes	All four modulations checked in TX as well as standby. Only worst case emissions shown in plots.

Calculation of Limits:

The limits provided in ETSI EN 300 220-1 v2.4.1:

Table 11: Spurious domain emission limits

Frequency \ State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
Operating	4 nW	250 nW	1 µW
Standby	2 nW	2 nW	20 nW

Limits seen below are either expressed in terms of dBm (conducted measurements) or dBuV/m (radiated measurements).

For dBm:

$$P(\text{dBm}) = 10 \log (P(\text{mW})/1\text{mW})$$

For dBuV/m:

$$\text{Field Strength (dBuV/m)} = (104.77 - 10 \log d) + 10 \log (P(\text{mW})/1\text{mW})$$

D = measurement distance

So for the 4 nW limit for operating mode, above:

$$P(\text{dBm}) = 10 \log (.000004\text{mW} / 1 \text{ mW}) = -53.98 \text{ dBm}$$

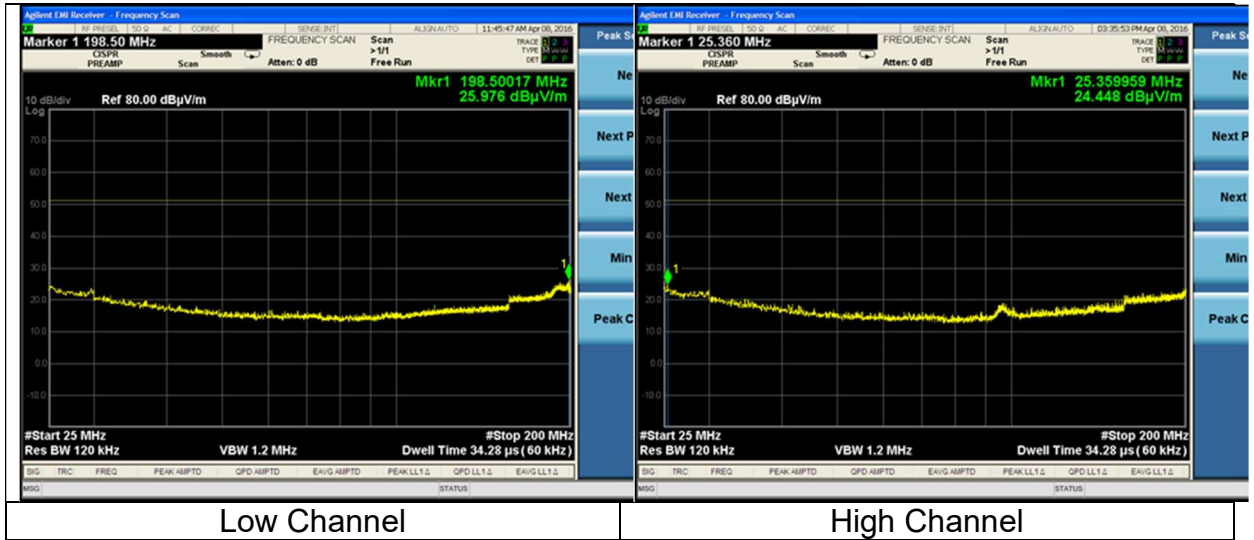
$$P(\text{dBuV/m}) = 10 \log (.000004\text{mW} / 1 \text{ mW}) + 95.23 \text{ dBm} = 41.25 \text{ dBuV/m}$$

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

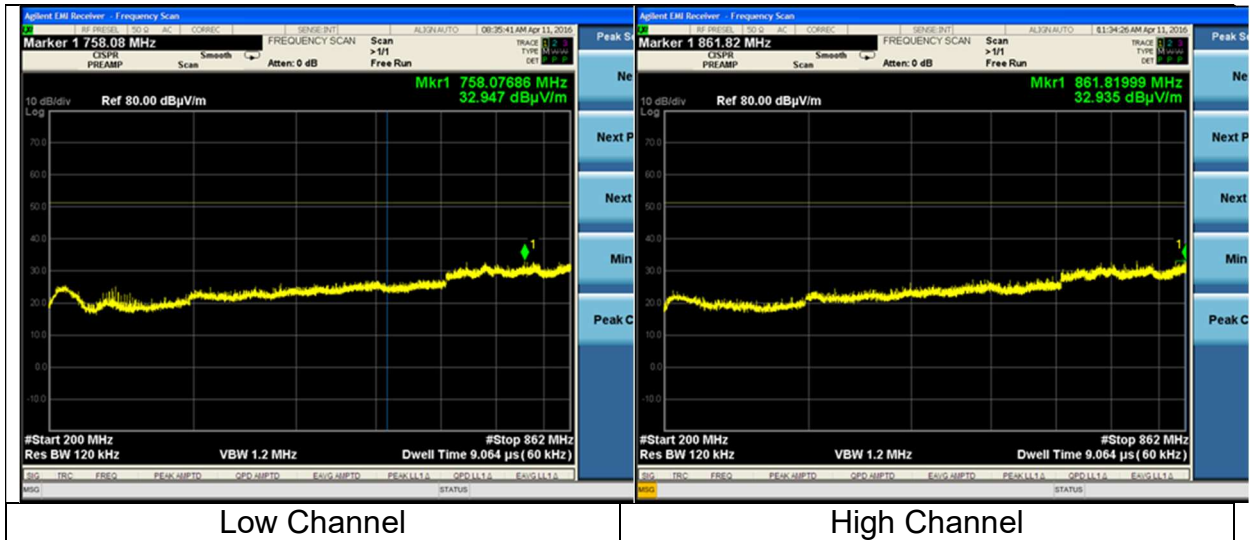
Radiated Measurements:

Frequency (MHz)	Modulation	Height (cm)	Azimuth (degree)	Field Strength (dBuV/m)	Average Limit (dBuV/m)	Antenna	EUT	Noise Floor?
25.48	125k	100.00	0.00	19.60	41.25	H	V	Yes
197.06	125k	100.00	0.00	19.10	41.25	V	V	Yes
964.60	125K	100.00	0.00	27.00	41.25	H	V	Yes
931.18	125k	100.00	0.00	26.70	41.25	V	V	Yes
Frequency (MHz)	Modulation	Height (cm)	Azimuth (degree)	Field Strength (dBuV/m)	Average Limit (dBuV/m)	Antenna	EUT	Noise Floor?
5984.74	125k	100.00	0.00	45.13	65.23	H	V	Yes
5988.00	125k	100.00	0.00	45.90	65.23	V	V	Yes

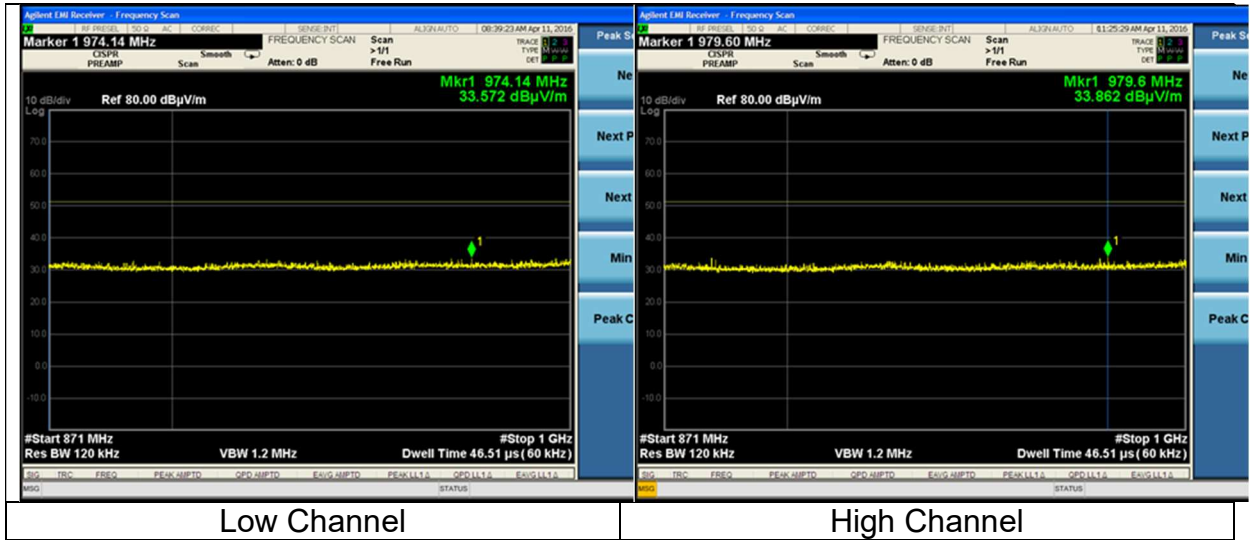
25 to 200 MHz



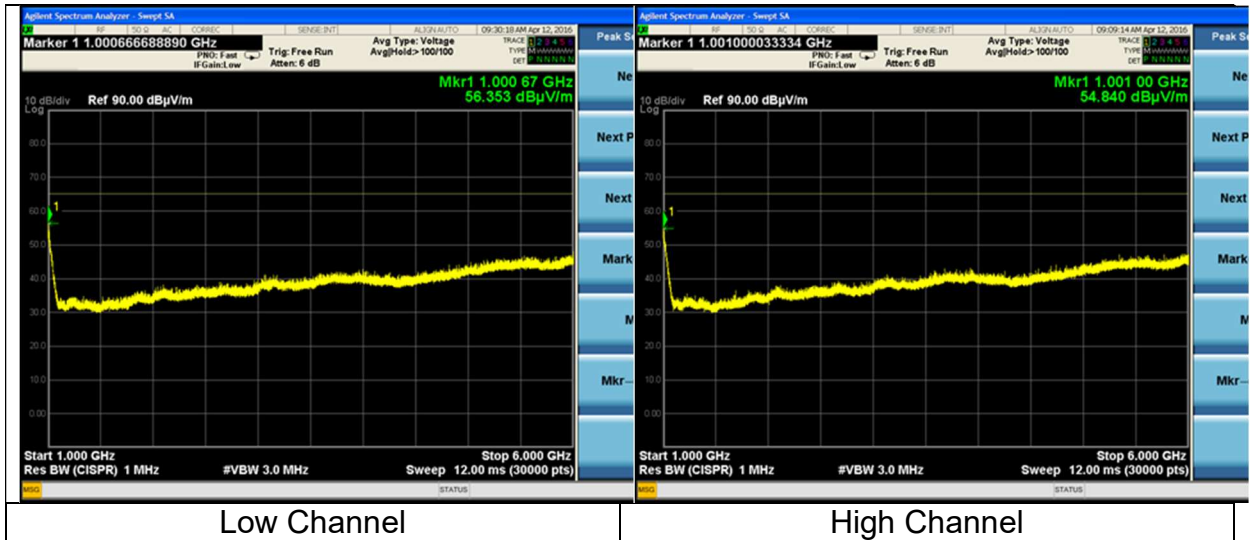
200 to 862 MHz



871 to 1000 MHz



1000 to 6000 MHz



Note: Emissions seen in plots is not a function of the EUT. Below 250 MHz, the emissions are due to the DC supply. Around 1000 MHz, the emission seen is the result of a filter. The range of 1 – 1.2 GHz was visually spotchecked and no emissions were found.

Conducted Measurements:

Modulation	Voltage (VDC)	Frequency (MHz)	Emission Level (dBm)	Emission Level Limit (dBm)	Channel
125k	3.6	1726.44	-41.51	-30.00	Low
GFSK	3.6	1726.12	-41.27	-30.00	Low
250k	3.6	1726.54	-41.38	-30.00	Low
125k	3.6	1739.86	-42.80	-30.00	High
GFSK	3.6	1739.88	-42.66	-30.00	High
250k	3.6	1739.50	-42.53	-30.00	High
Standby	3.6	2413.88	-57.57	-46.99	None
125k	3.6	861.99	-52.22	-43.98	Low
GFSK	3.6	861.99	-52.25	-43.98	Low
250k	3.6	861.96	-52.68	-43.98	Low
125k	3.6	871.08	-52.44	-43.98	High
GFSK	3.6	871.05	-52.29	-43.98	High
250k	3.6	871.07	-52.71	-43.98	High

Prepared For: Laird Technologies

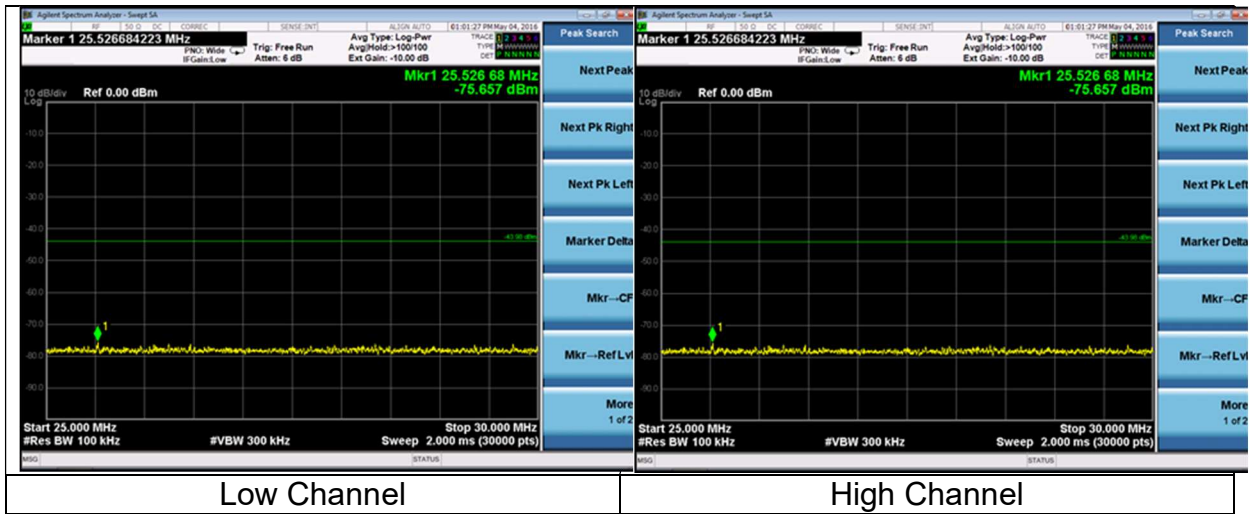
Report: 316062D

LSR: C-2411

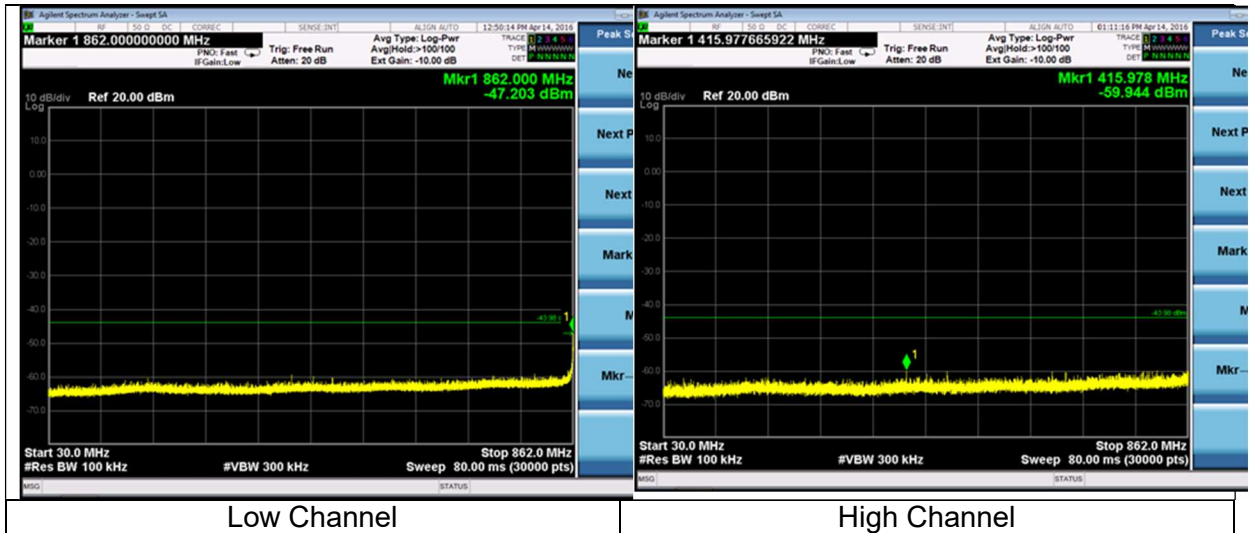
Model: RM186-SM

Serial: RM186-SM

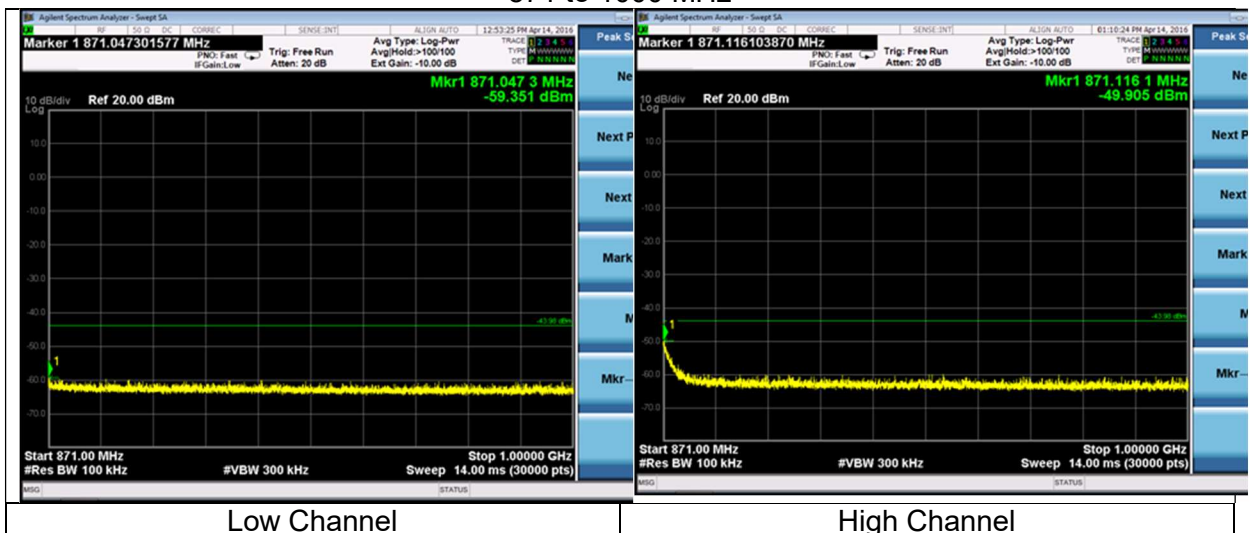
125kHz*
25 to 30 MHz



30 to 862 MHz



871 to 1000 MHz



1000 to 6000 MHz

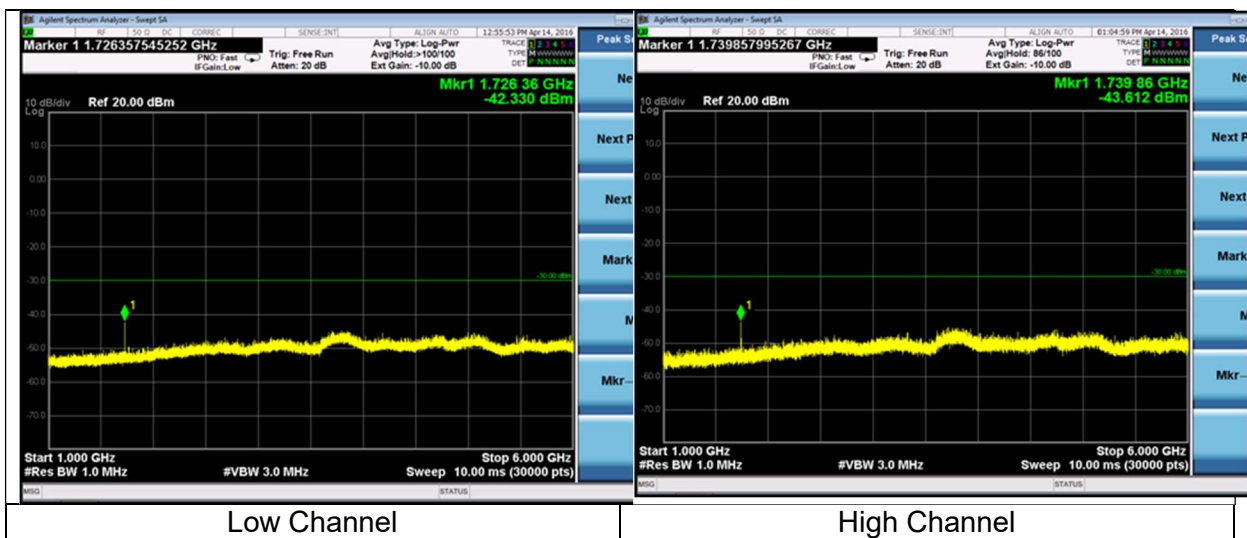
Prepared For: Laird Technologies

Report: 316062D

LSR: C-2411

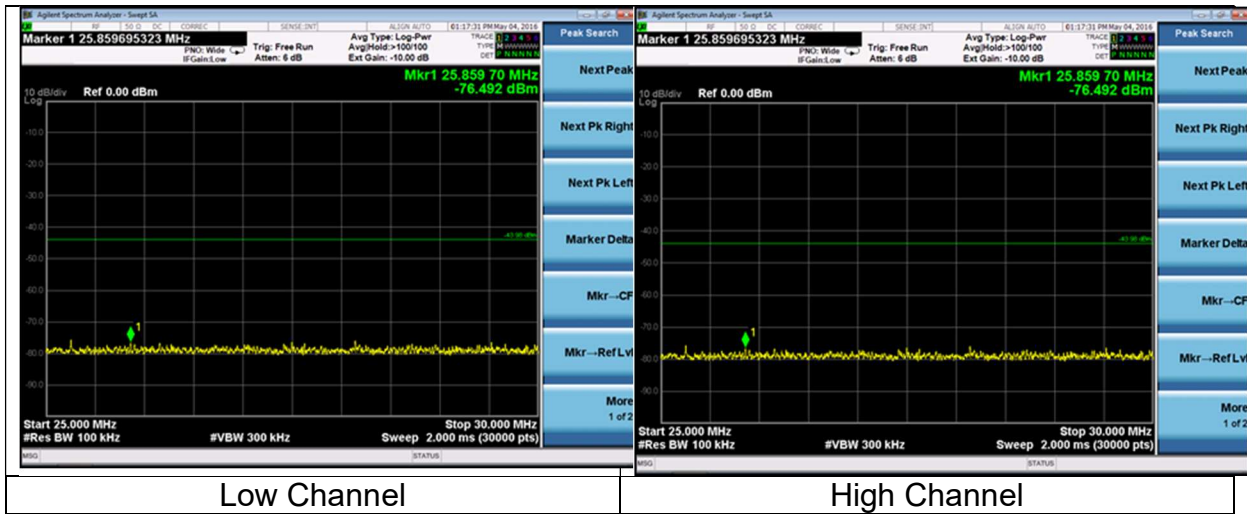
Model: RM186-SM

Serial: RM186-SM

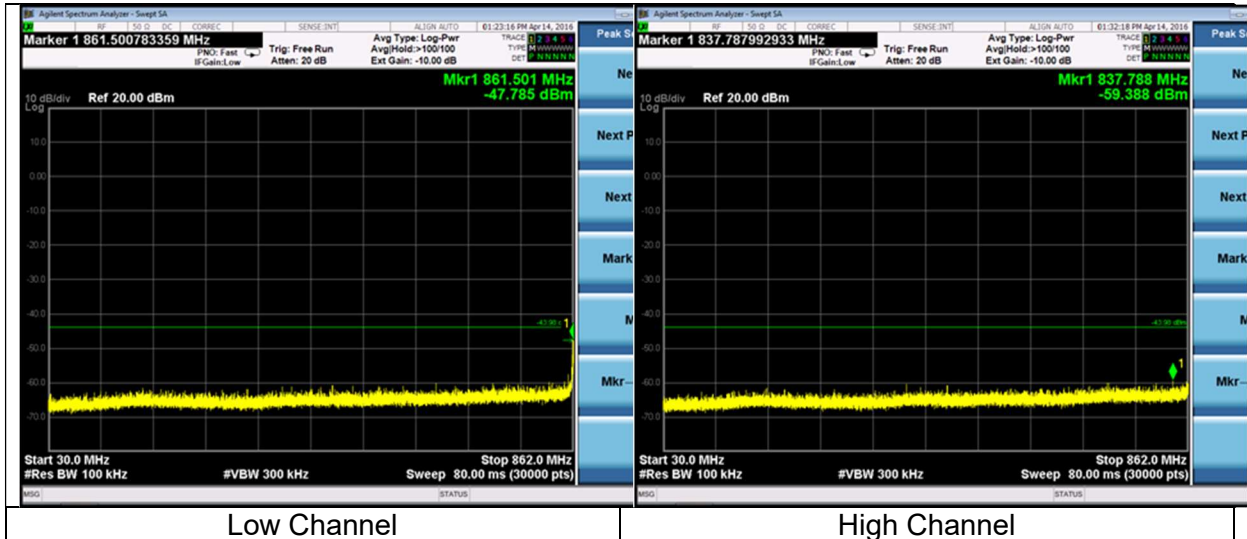


Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

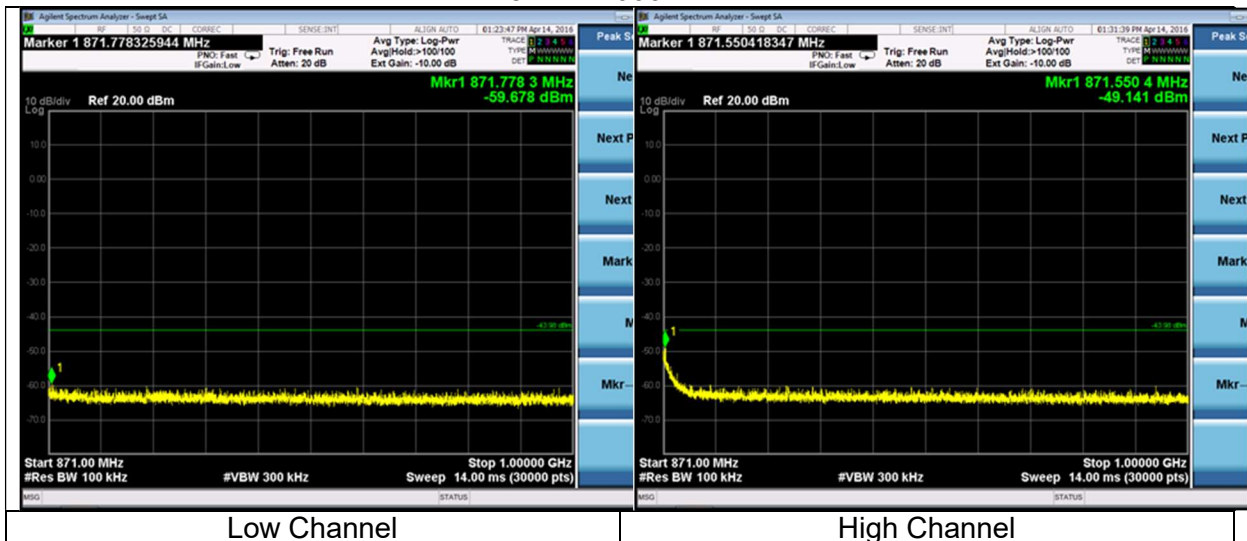
250kHz
25 to 30 MHz



30 to 862 MHz



871 to 1000 MHz



Prepared For: Laird Technologies

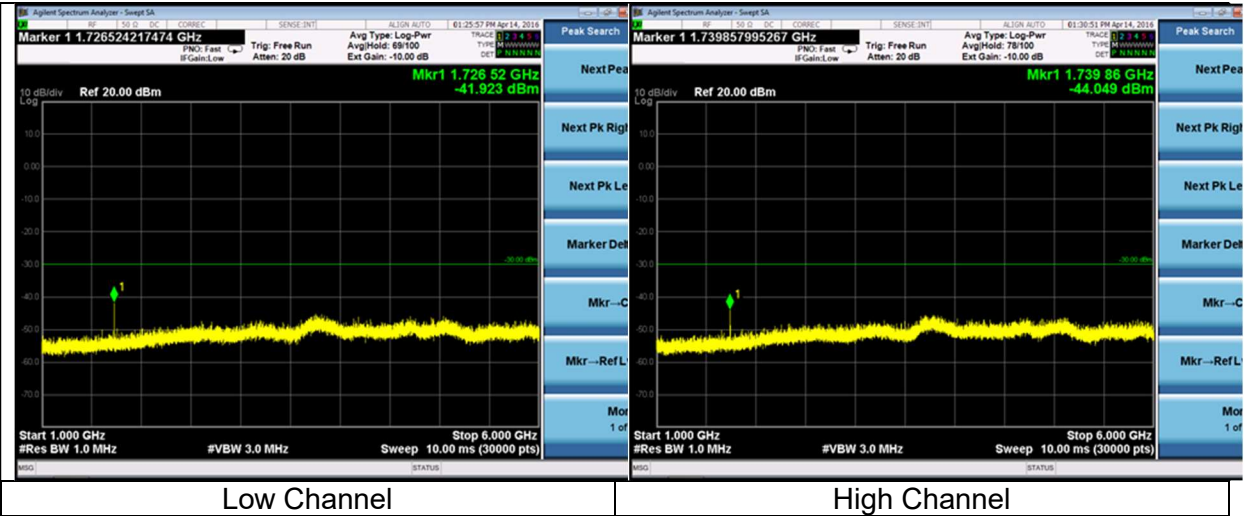
Report: 316062D

LSR: C-2411

Model: RM186-SM

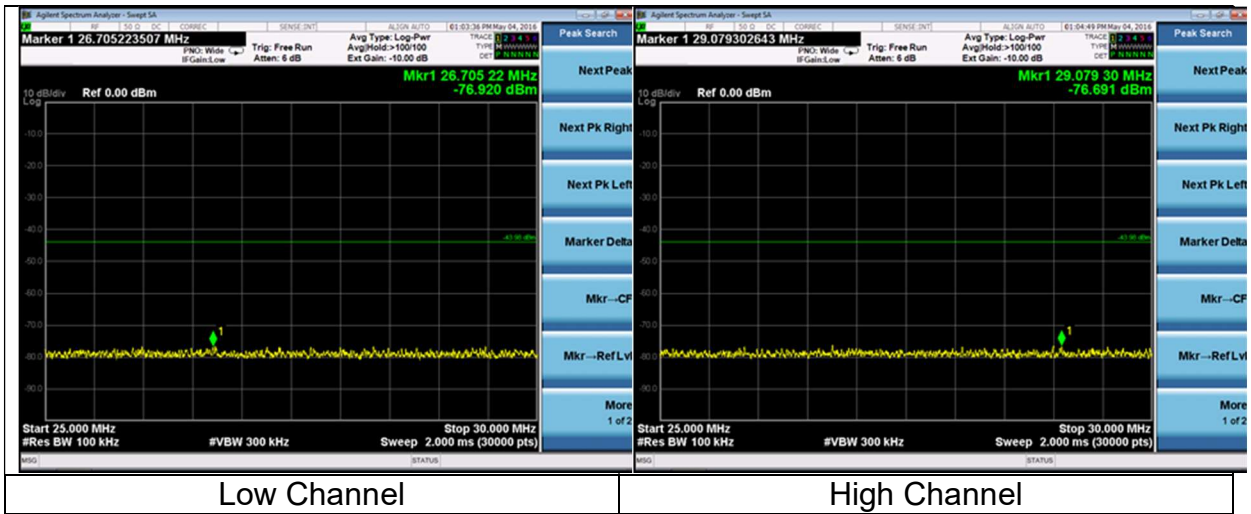
Serial: RM186-SM

1000 to 6000 MHz

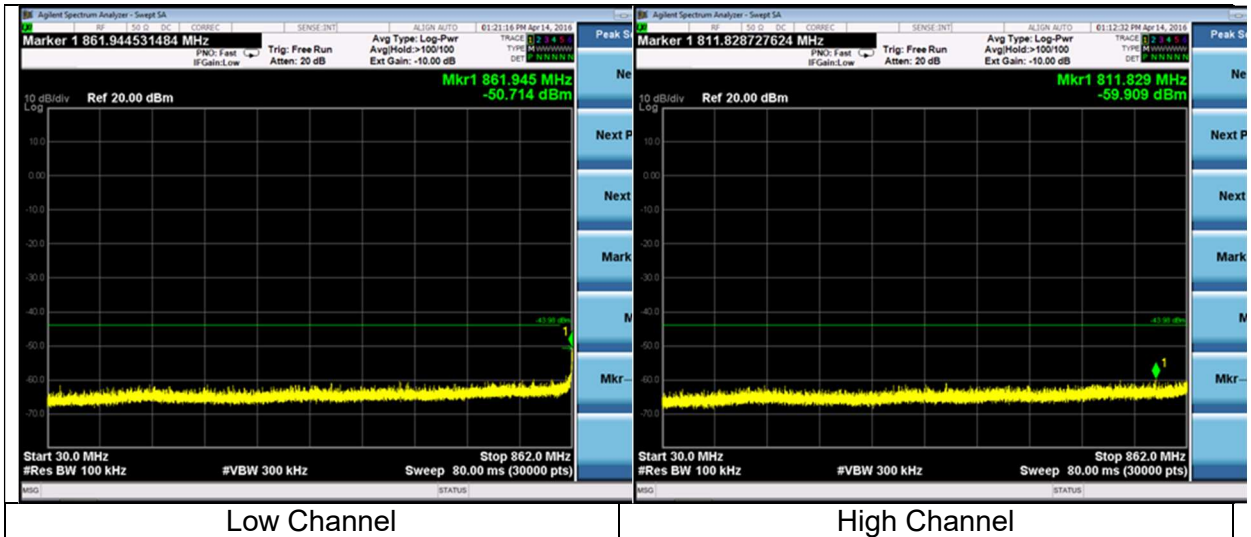


Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

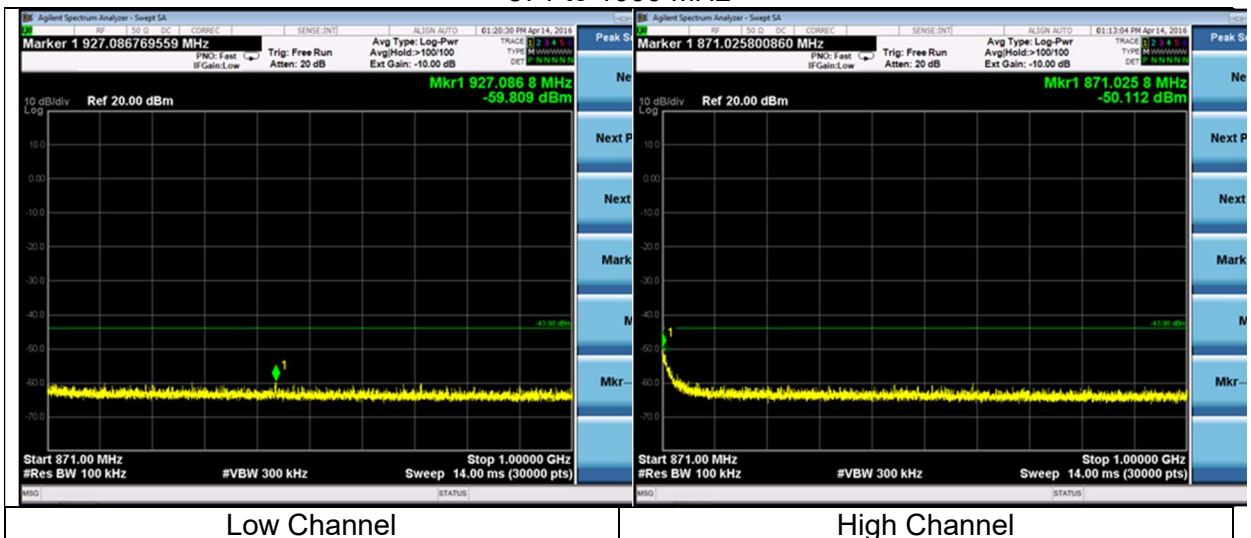
GFSK 25 to 30 MHz



30 to 862 MHz



871 to 1000 MHz



Prepared For: Laird Technologies

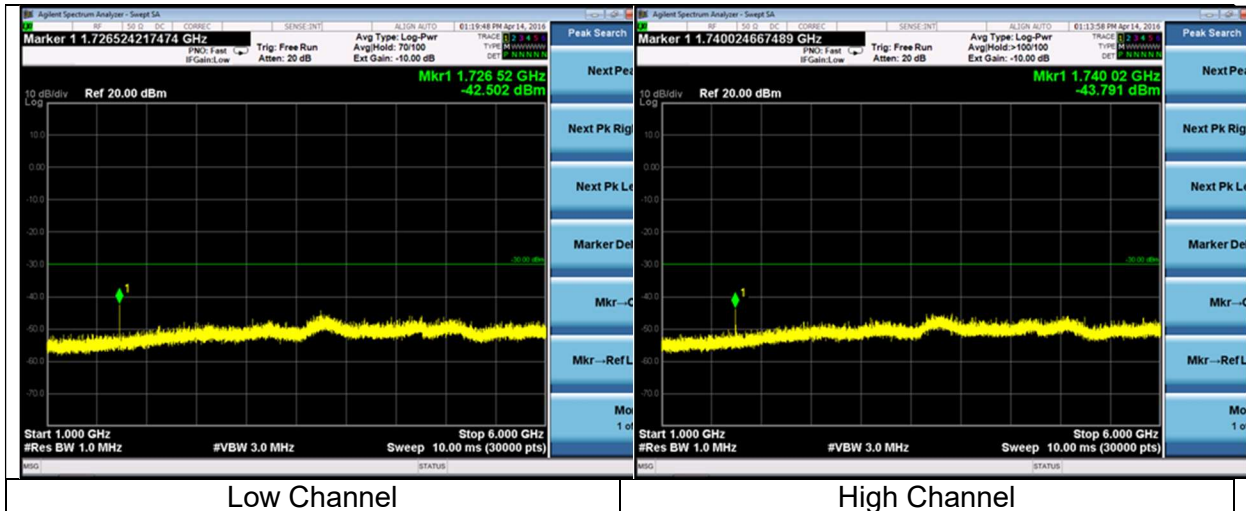
Report: 316062D

LSR: C-2411

Model: RM186-SM

Serial: RM186-SM

1000 to 6000 MHz



C.1.9 – Frequency Stability under Low Voltage Conditions

Manufacturer	Laird Technologies
Date	4/22/16
Operator	Shane Dock
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Harmonized Standard	ETSI EN 300 220-2 v2.4.1
Technical characteristics and Test Methods	ETSI EN 300 220-1 v2.4.1
Harmonized Requirement	4.2.1.9
Test Procedure Section	7.9.2
Additional Notes	Tested Channels are 868.1, 868.3, and 868.5. Manufacturer's lowest declared voltage is 1.8V. 1.5 VDC tested to surpass the -15% requirement.

Prepared For: Laird Technologies

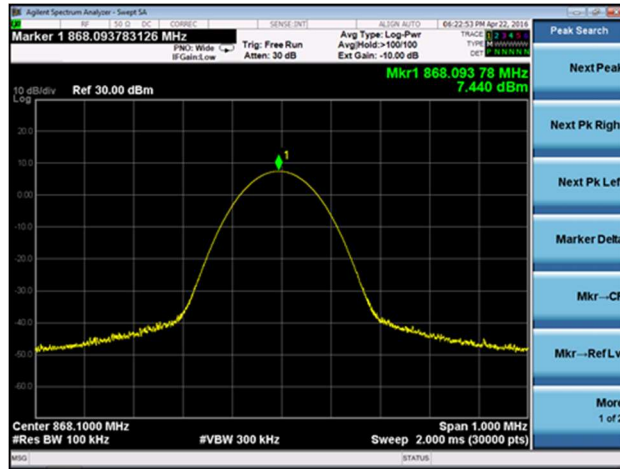
Report: 316062D

LSR: C-2411

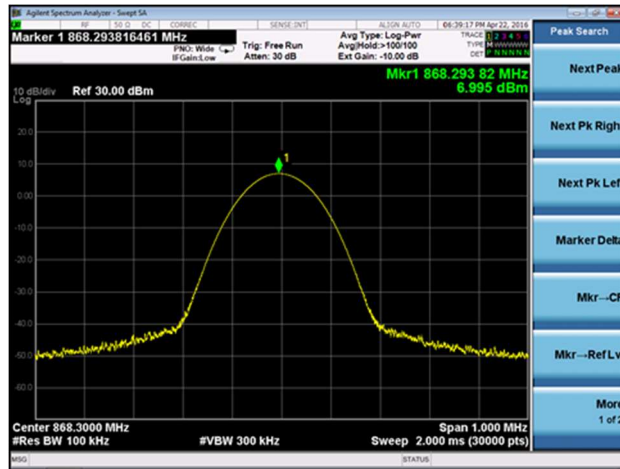
Model: RM186-SM

Serial: RM186-SM

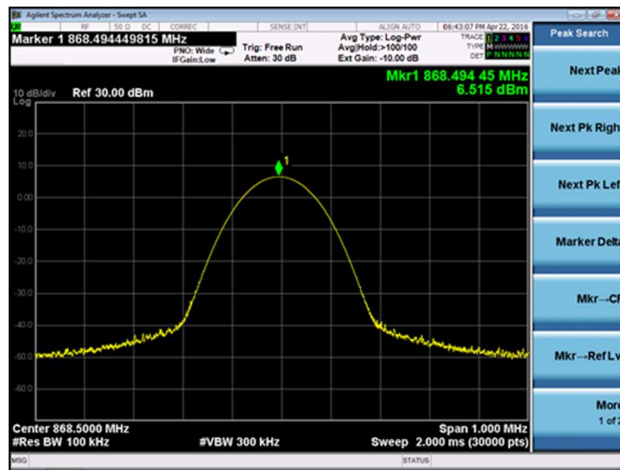
1.8V (Minimum) 868.1 MHz



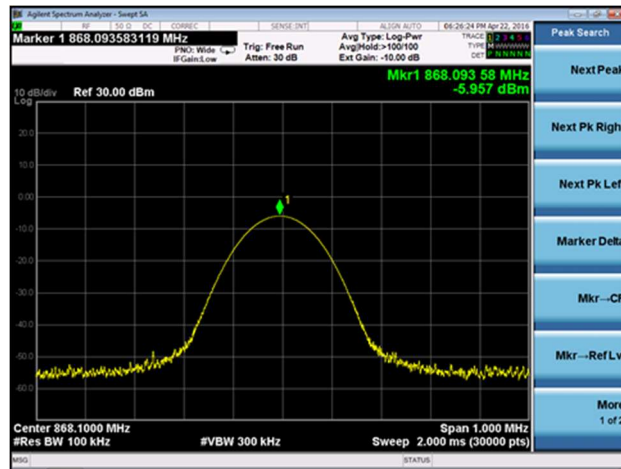
868.3 MHz



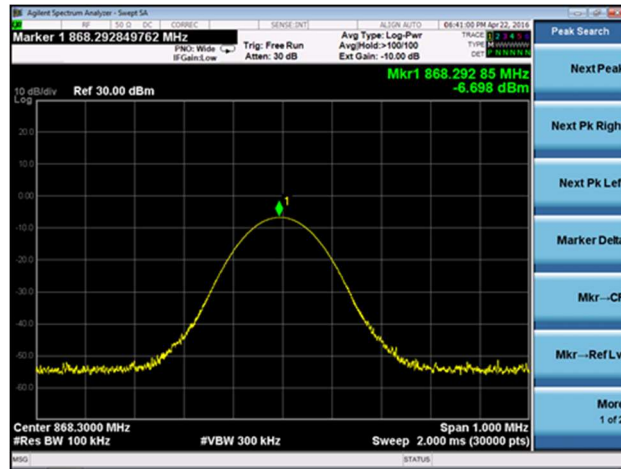
868.5 MHz



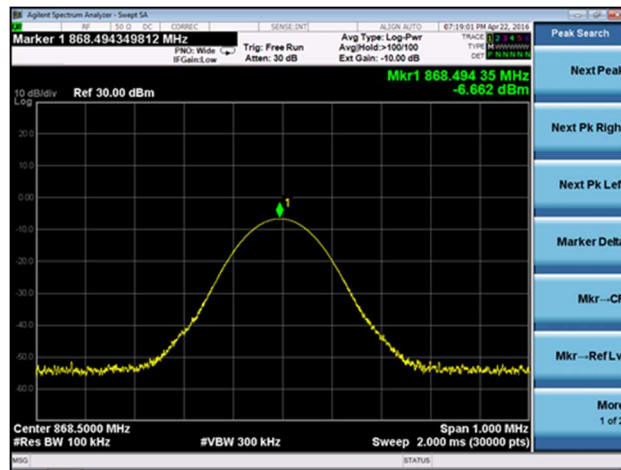
1.5 V 868.1 MHz



868.3 MHz



868.5 MHz



C.1.10 – Duty Cycle

Manufacturer	Laird Technologies
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Harmonized Standard	ETSI EN 300 220-2 v2.4.1
Technical characteristics and Test Methods	ETSI EN 300 220-1 v2.4.1
Harmonized Requirement	4.2.1.10
Test Procedure Section	7.10.2
Additional Notes	

Laird Technologies declares that all 6 bands meet the respective duty cycle requirements stated in ETSI EN 300 220-1 v2.4.1 Section 7.2.3 in Table 5 for non-specific use.

Band	Frequency (MHz)	ERP (mW)	Duty Cycle
1	863-870	25	0.1%
2	865-868	25	1.0%
3	868-868.6	25	1.0%
4	868.7-869.2	25	0.1%
5	869.4-869.65	25	10.0%
6	869.7-870	5 / 25	100.0% / 1.0%

C.1.11 – Time-out Timer

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable since EUT implements duty cycle restrictions

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

C.1.12 – Receiver Sensitivity

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable to Receiver Category 3

C.1.13 – Receiver LBT Threshold

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable since EUT does not implement LBT

C.1.14 – Adjacent Channel Selectivity

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable to Receiver Category 3

C.1.15 – Receiver Blocking

Manufacturer	Laird Technologies
Date	4/22/16
Operator	Shane Dock
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Harmonized Standard	ETSI EN 300 220-2 v2.4.1
Technical characteristics and Test Methods	ETSI EN 300 220-1 v2.4.1
Harmonized Requirement	4.3.5
Test Procedure Section	8.4.2
Additional Notes	

Test Setup

The unit was setup to communicate with a gate device in order to allow the device to function as intended. The signal being sent to the EUT from the gate was operating between 867.1 to 868.5,MHz and was outputting about -2.6 dBm. The gate was used with a series of attenuators to set the device to act as a signal generator set for -98 dBm. This was done because the EUT receiver sensitivity actually surpassed the value given in Section 8.1.4, so the value in Section 8.1.4 was used in place of the actual receiver sensitivity. This is derived from the equation for maximum usable sensitivity given in Section 8.1.4 from EN 300 220-1:

$S = 10 \log (BW/16) - 107 \text{ dBm}$, where $BW = 125$.

This signal was sent into a splitter with the blocking signal to run the test. The blocking signal was set with an offset of +/-2 MHz and 10 MHz, and each of these offsets was applied from the opposite band end (The +10 MHz offset fell 877.1 and the -10 MHz offset landed at 858.5

Prepared For: Laird Technologies	
Report: 316062D	Model: RM186-SM
LSR: C-2411	Serial: RM186-SM

Test Results

Offset	Signal Gen B Frequency (MHz)	Signal Gen A (dBm)	Sig Gen B (Measured) (dBm)	Diff (B-A) (dBm)	Limit (dBm)
+2 MHz	869.1	-98	-25.962	72.038	15.0721
+10 MHz	877.1	-98	-6.95	91.05	35.0721
-2 MHz	866.5	-98	-18.42	79.58	15.0721
-10 MHz	858.5	-98	-17.169	80.831	35.0721

Prepared For: Laird Technologies

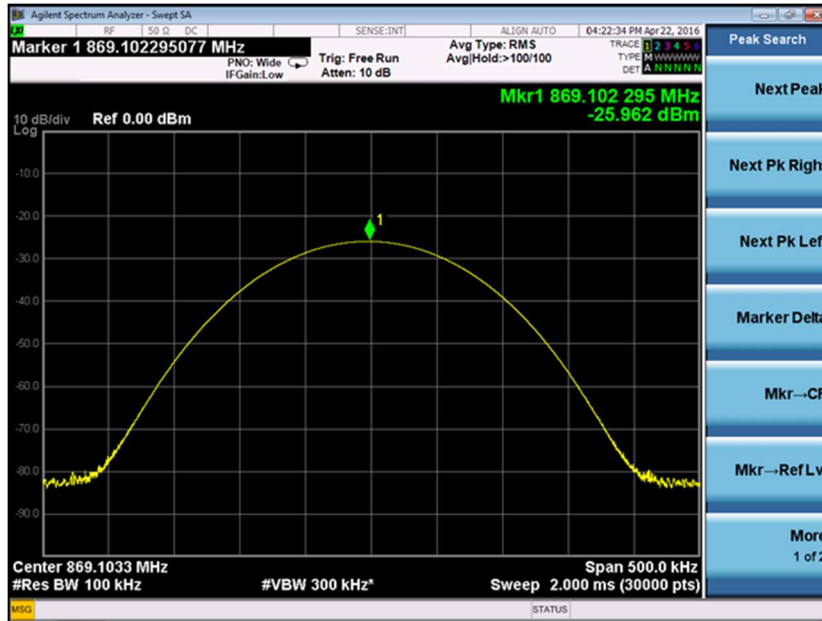
Report: 316062D

LSR: C-2411

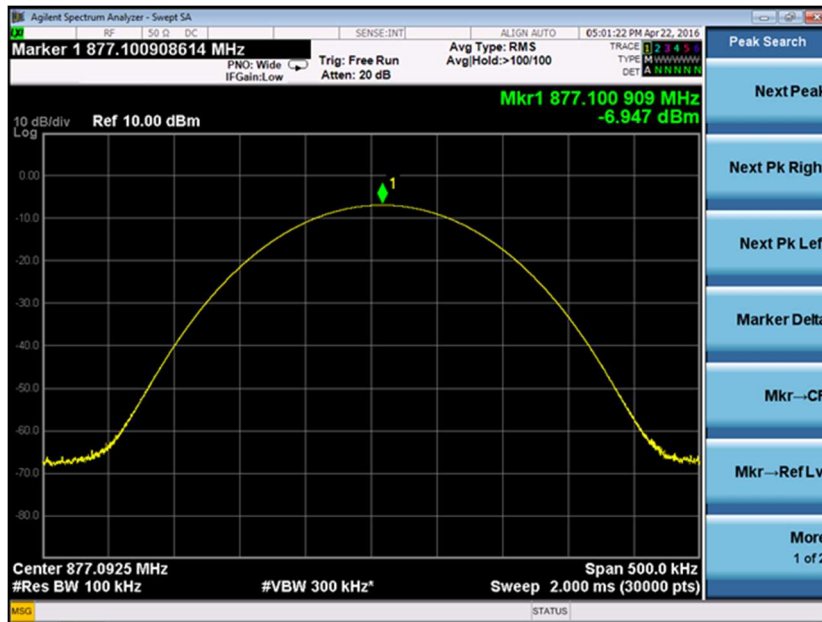
Model: RM186-SM

Serial: RM186-SM

Screen Captures with Inserted Signal +2 MHz Offset



-2 MHz Offset



Prepared For: Laird Technologies

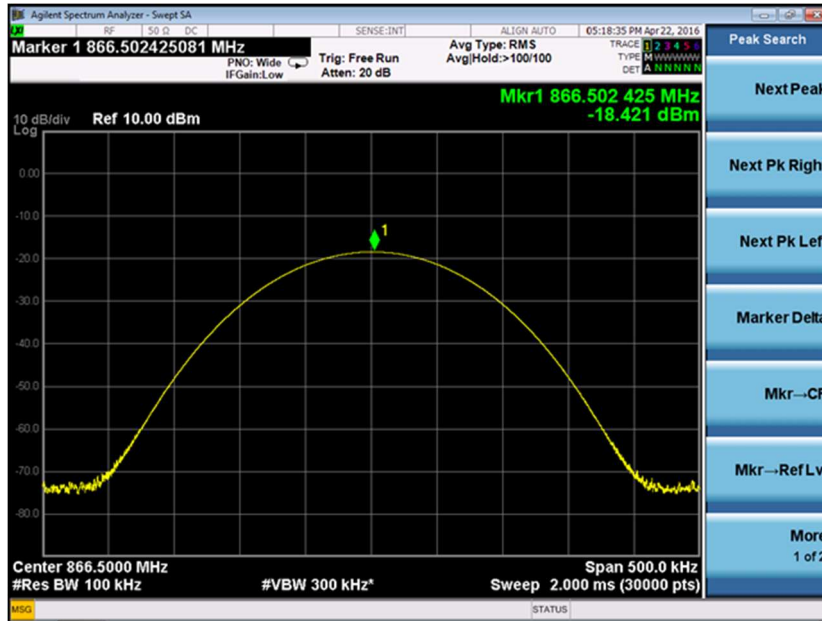
Report: 316062D

LSR: C-2411

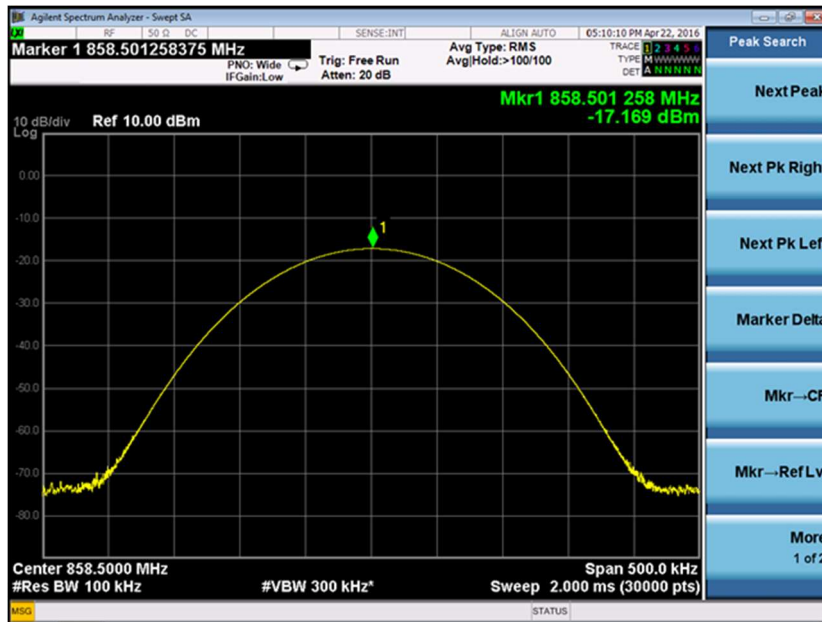
Model: RM186-SM

Serial: RM186-SM

+10 MHz Offset



-10 MHz Offset



Prepared For: Laird Technologies

Report: 316062D

LSR: C-2411

Model: RM186-SM

Serial: RM186-SM

C.1.16 – Spurious Response Rejection

Manufacturer	
Date	
Operator	
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Standard	ETSI EN 300 220-1 v2.4.1
Technical Requirement Section	
Test Procedure Section	
Additional Notes	Not Applicable to Receiver Category 3

C.1.17 – Receiver Spurious Radiation

Manufacturer	Laird Technologies
Date	4/11/16 – 4/14/16
Operator	Shane Dock
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Harmonized Standard	ETSI EN 300 220-2 v2.4.1
Technical characteristics and Test Methods	ETSI EN 300 220-1 v2.4.1
Harmonized Requirement	4.3.7
Test Procedure Section	8.6.2
Additional Notes	Only worst case emissions shown in plots.

Radiated Measurements:

Frequency (MHz)	Modulation	Height (cm)	Azimuth (degree)	Field Strength (dBuV/m)	Field Strength Limit (dBuV/m)	Antenna	EUT	Noise Floor?
25.48	125k	100.00	0.00	19.60	41.25	H	V	Yes
197.06	125k	100.00	0.00	19.10	41.25	V	V	Yes
964.60	125K	100.00	0.00	27.00	41.25	H	V	Yes
931.18	125k	100.00	0.00	26.70	41.25	V	V	Yes
Frequency (MHz)	Modulation	Height (cm)	Azimuth (degree)	Field Strength (dBuV/m)	Field Strength Limit (dBuV/m)	Antenna	EUT	Noise Floor?
5984.74	125k	100.00	0.00	45.13	65.23	H	V	Yes
5988.00	125k	100.00	0.00	45.90	65.23	V	V	Yes

Prepared For: Laird Technologies

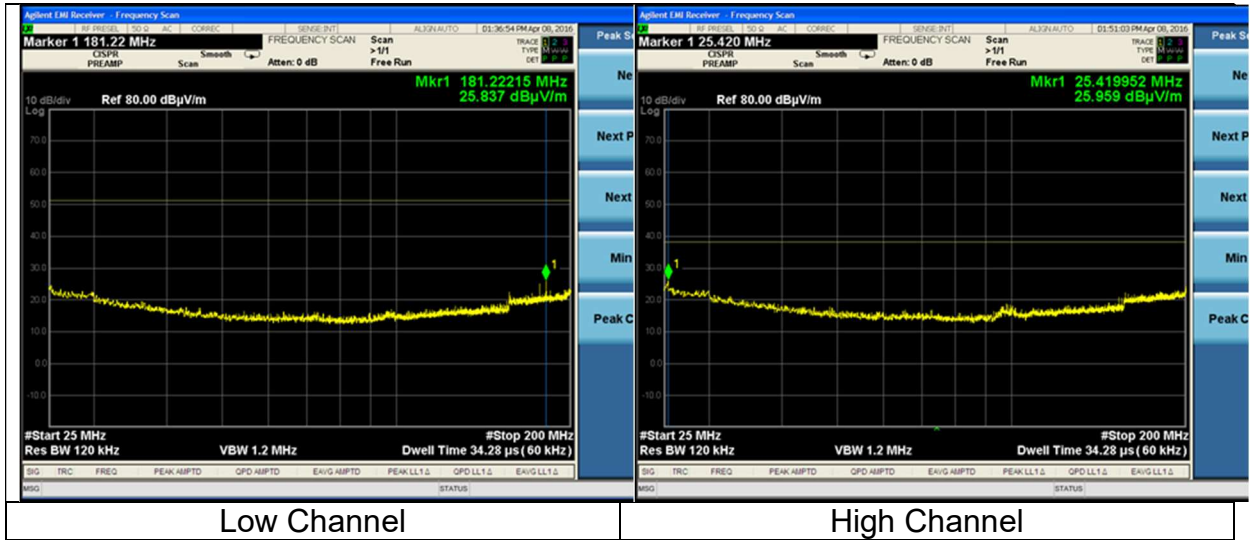
Report: 316062D

LSR: C-2411

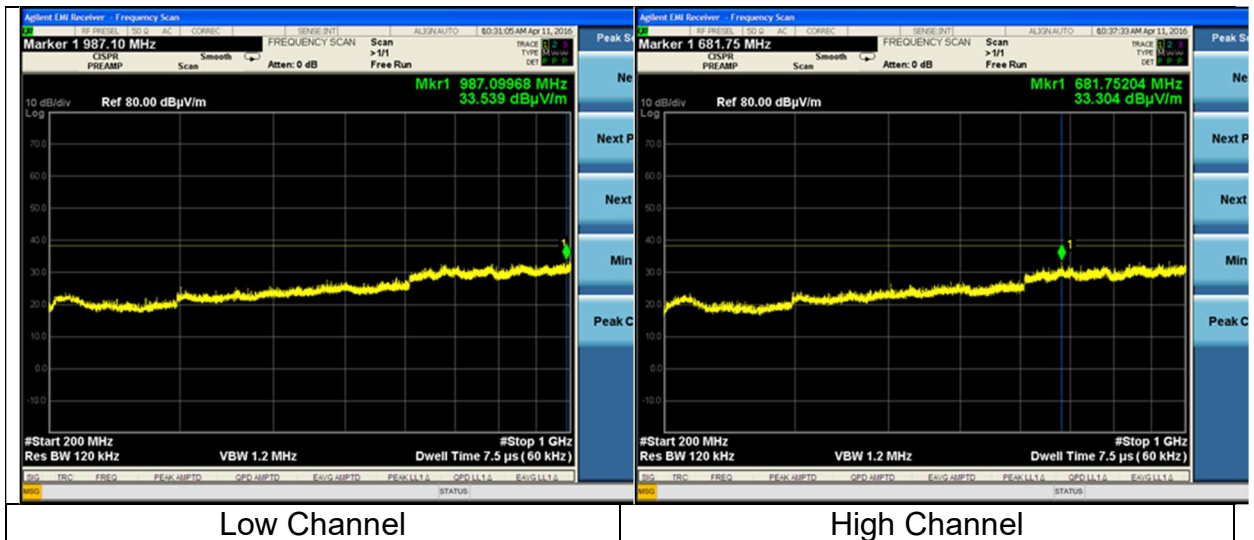
Model: RM186-SM

Serial: RM186-SM

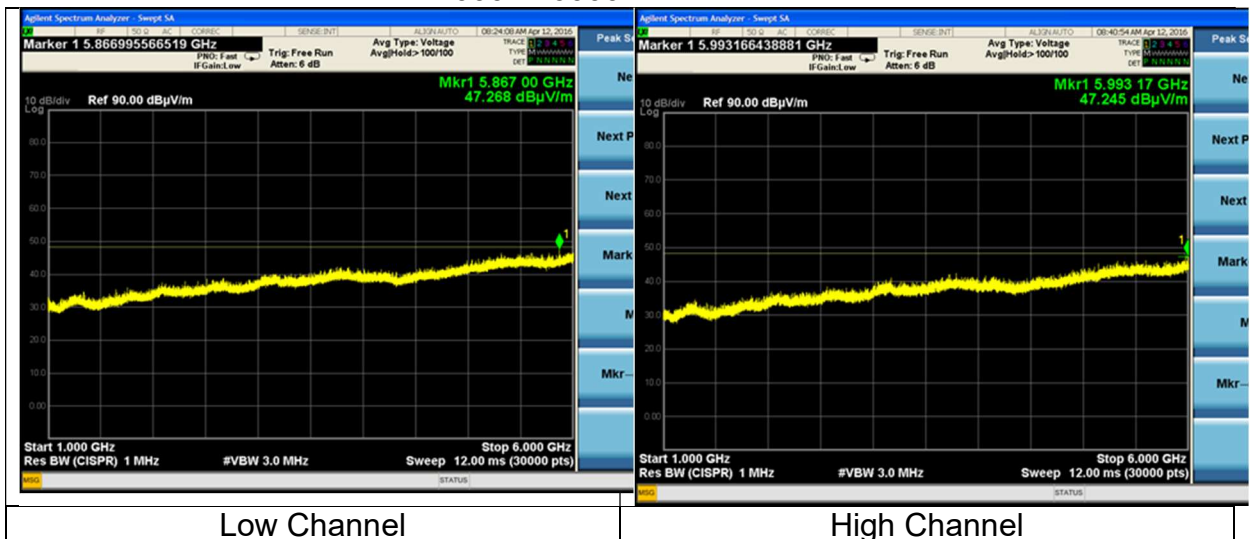
25 to 200 MHz



200 to 1000 MHz



1000 to 6000 MHz



Prepared For: Laird Technologies

Report: 316062D

LSR: C-2411

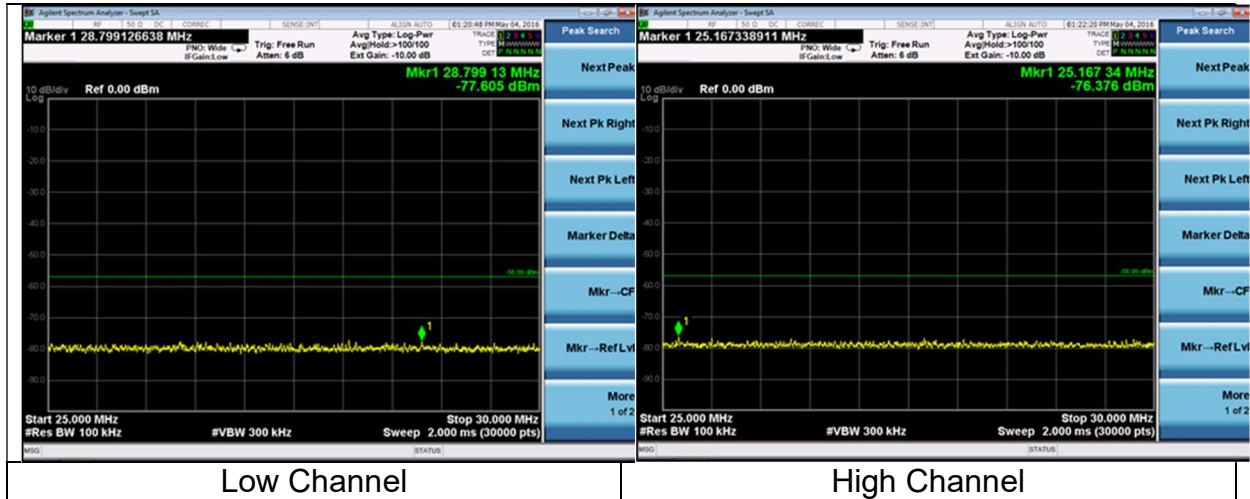
Model: RM186-SM

Serial: RM186-SM

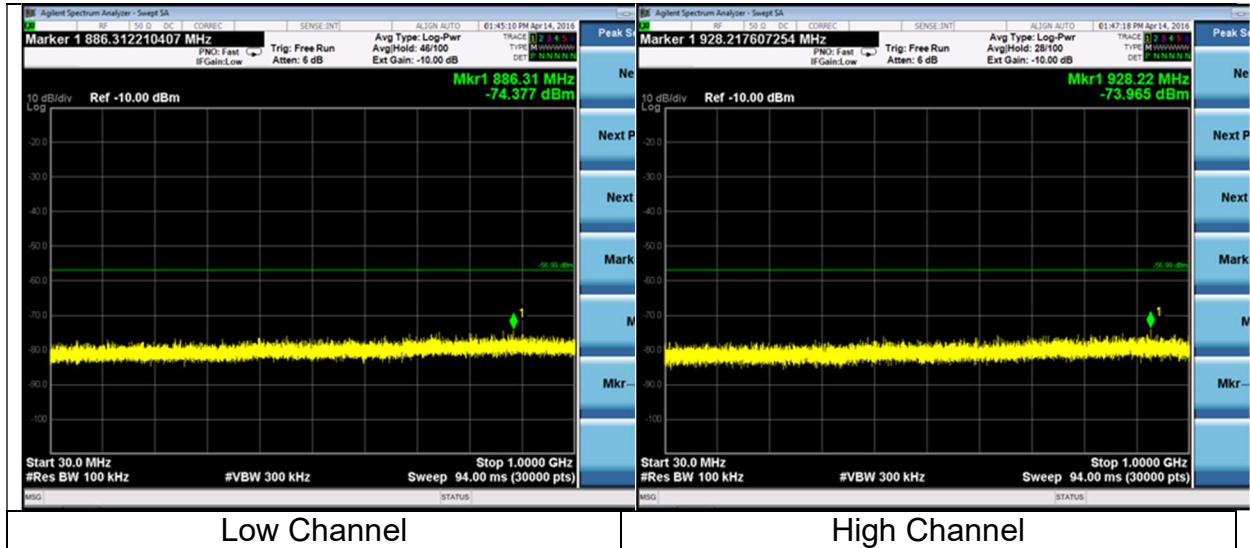
Conducted Measurements:

Voltage (VDC)	Frequency (MHz)	Emission Level (dBm)	Emission Level Limit (dBm)	Channel
3.6	810.16	-73.89	-56.99	Low
3.6	29.38	-79.17	-56.99	Low
3.6	3753.09	-58.48	-46.99	Low
3.6	28.77	-78.04	-56.99	High
3.6	830.90	-72.78	-56.99	High
3.6	3900.00	-58.89	-46.99	High

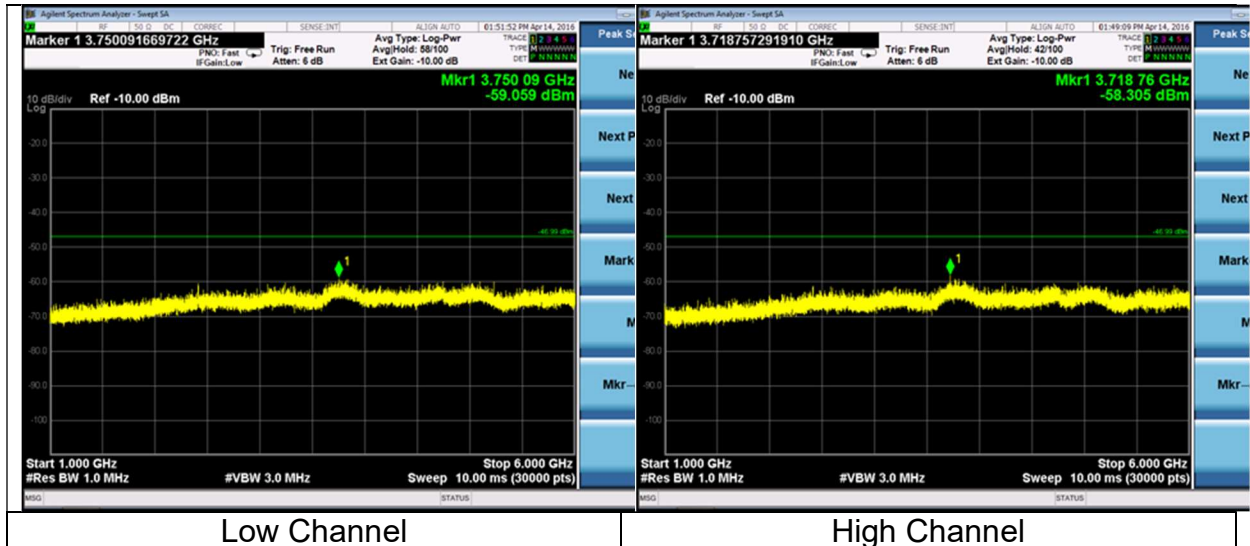
25 to 30 MHz



30 to 1000 MHz



1000 to 6000 MHz



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Appendix D - Uncertainty Summary

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

	PARAMETER	ETSI ± Uncertainty	LSR ± Uncertainty
1	Radio Frequency, from F0	$\pm 1 \times 10^{-5}$	$\pm 1.3 \times 10^{-7}$
2	Total RF conducted Power	± 1.5 dB	± 1.38 dB
3	RF conducted power density	± 3.0 dB	± 1.38 dB
4	Conducted spurious emissions	± 3.0 dB	± 1.38 dB
5	Radiated emissions	± 6.0 dB	± 4.87 dB
6	Temperature	$\pm 1^{\circ}$ C	$\pm 0.64^{\circ}$ C
7	Humidity	± 5 %	± 2.9 %
8	DC voltage	± 3 %	± 0.03 %
9	Low frequency voltage	± 3 %	± 0.1 %

Appendix E - References

Publication	Year	Title
ETSI EN 300 220-2 v2.4.1	(2012-05)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW; Part 1: Technical characteristics and test methods
ETSI EN 300 220-2 v2.4.1	(2012-05)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive

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LSR: C-2411	Serial: RM186-SM

END OF REPORT

Date	Version	Comments	Person
4/28/16	V0	Initial Draft Release	Shane Dock
5/3/16	V0	First review	Aidi Z.
5/4/16	V2	Revised	Shane Dock
5/6/16	V3	Final	Shane Dock

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