NVLAP Lab Code 200087-0

ROGERS LABS, INC.

4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214

Test Report For Application of Certification 47CFR Part 87

Aviation Transponder

1090 MHz

FCC ID: VZI01905

Trig Avionics Limited

Heriot Watt Research Park, Riccarton
Currie EH14 4AP United Kingdom

FCC Designation: US5305
ISED Registration: 3041A-1

Test Report Number: 210712

Test Date: July 12, 2021

Certifying Engineer: Scot D Rogers

Scot D. Rogers
Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053
Telephone/Facsimile: (913) 837-3214

Table of Contents

Revision History

Revision 1 Issued July 30, 2021

Executive Summary

In accordance with the Federal Communications, Code of Federal Regulations dated March 20. 2018, Part 2 Subpart J, Paragraphs 2.907, 2.911, 2.915, 2.925, 2.926, 2.1031 through 2.1057, and Part 87, Subchapter D, Paragraphs 87.131 through 87.147. The following information is submitted for consideration on obtaining Grant of Certification.

Opinion / Interpretation of Results

Tests Performed	Results
Emissions Tests	
Requirements per 47CFR paragraphs 2.1031-2.1057	Complies
Requirements per 47CFR paragraphs 87.131	Complies
Requirements per 47CFR paragraphs 87.133	Complies
Requirements per 47CFR paragraphs 87.135	Complies
Requirements per 47CFR paragraphs 87.139	Complies
Requirements per 47CFR paragraphs 87.141	Complies

Equipment Tested

Equipment	Model / PN	Serial Number
EUT	TT32	4
Interface cables	Manufacturer provided	N/A
DC Power Supply	BK 1745A	209C13
Laptop Computer	Dell E6410	6JX50P1

Different models are function of face plate and GPS receiver option. Transmitter is identical in all.

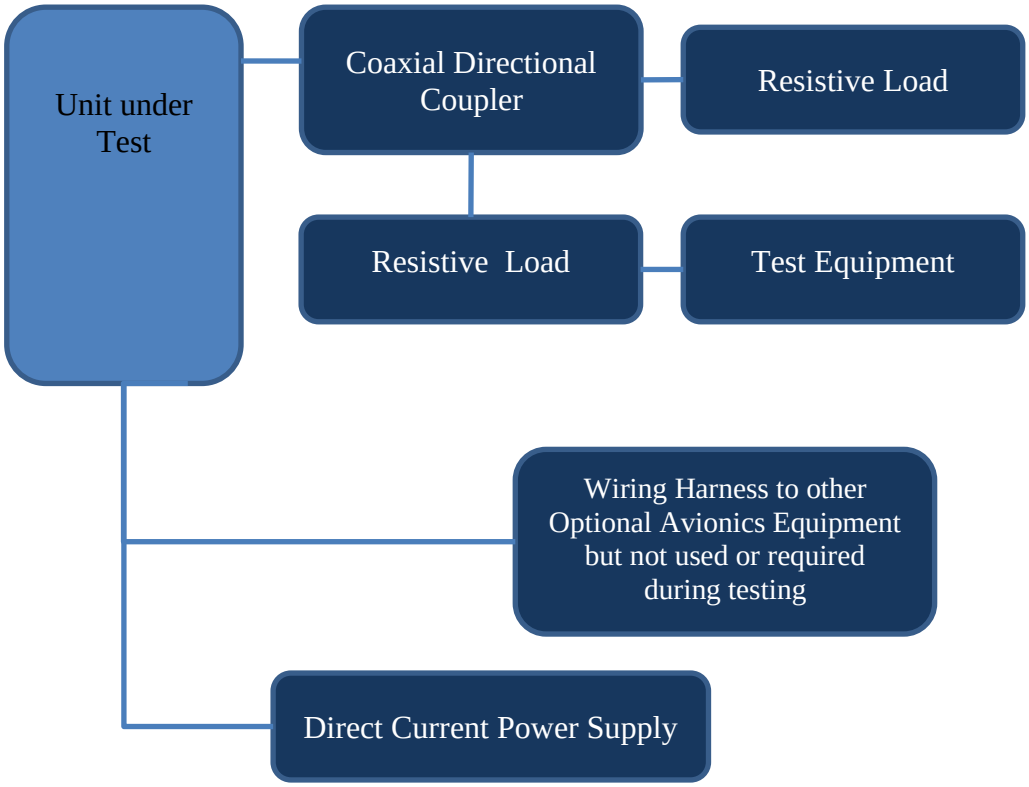
Test results in this report relate only to the items tested

Equipment Function

The EUT is a Mode A and Mode S Avionics transponder. The design is provided under four models representing the similar variant , TT32, TT32G, KT86, and KT86G. The differences between the models relates to the fitment of a GPS receiver and branding of the front faceplate. The transponder design provides a coded response when it receives a radio-frequency interrogation from outside the craft to assist in identifying the aircraft to others. The unit operates on aviation-defined frequencies, receiving radar interrogations at 1030 MHz and transmitting a coded response of pulses back at 1090 MHz. This report documents operation of the transmitter for this application as authorized in 47CFR 87 Subpart D.

Equipment Configuration

1) EUT powered by Bench DC power supply and connected to interface cabling



Applicable Standards & Test Procedures

Applicable requirements include the 47CFR Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.915, 2.925, 2.926, 2.1031 through 2.1057, and applicable paragraphs of Part 87. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.26-2015 and C63.4-2014.

Environmental Conditions

Ambient Temperature	23.1° C
Relative Humidity	46%
Atmospheric Pressure	1018.3 mb

Units of Measurements

AC Line Conducted EMI	Data is in dBµV; dB referenced to one microvolt.
Radiated EMI	Data is in dBµV/m; dB/m referenced to one microvolt per meter
Antenna Conducted	Data is in dBm, dB referenced to one milliwatt

Test Site Locations

Conducted EMI	Conducted emission testing was performed in a shielded screen room located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS
Radiated EMI	Radiated emission testing was performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 West 259th Terrace, Louisburg, KS
Site Registration	FCC Site Designation US5305, Industry Canada Registration: 3041A-1
NVLAP Accreditation	Lab code 200087-0

Application for Certification

(1) The full name and mailing address of the manufacturer of the device and the applicant for certification.

Applicant	Manufacturer
Trig Avionics Limited	Trig Avionics Europe B.V.
Heriot Watt Research Park, Riccarton	Hardwareweg 3
Currie EH14 4AP United Kingdom	3821 BL Amersfoort Netherlands

(2) FCC identifier. FCC I.D.: VZI01905

(3) A copy of the installation and operating instructions to be furnished the user. A draft copy of the instructions may be submitted if the actual document is not available. The actual document shall be furnished to the FCC when it becomes available.

Refer to exhibit for Draft Instruction Manual.

(4) Type or types of emission. 9M04M1D

(5) Frequency range. 1090 MHz

(6) Range of operating power values or specific operating power levels, and description of any means provided for variation of operating power.

288 Watts peak, 2.88 Watts average power

(7) Maximum power rating as defined in the applicable part(s) of the rules.

Maximum power output as determined by appropriate standards during

certification per CFR 47 paragraph 87.131.

(8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

Power delivered into final amplifier 50.0 Volts @ 9.0 Amps (450 Watts peak)

(9) Tune-up procedure over the power range, or at specific operating power levels.

Refer to Exhibit for Transceiver Alignment Procedure.

(10) A schematic diagram and a description of all circuitry and devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation, and for limiting power.

Refer to Exhibit for Circuit Schematic and Theory of Operation.

(11) A photograph or drawing of the equipment identification plate or label showing the information to be placed thereon.

Refer to Exhibit for Photograph or Drawing of Label exhibit

(12) Photographs (8″ × 10″) of the equipment of sufficient clarity to reveal equipment construction and layout, including meters, if any, and labels for controls and meters and sufficient views of the internal construction to define component placement and chassis assembly. Insofar as these requirements are met by photographs or drawings contained in instruction manuals supplied with the certification request, additional photographs are necessary only to complete the required showing.

Refer to Exhibit for Components Layout and Chassis Drawings.

(13) For equipment employing digital modulation techniques, a detailed description of the modulation system to be used, including the response characteristics (frequency, phase and amplitude) of any filters provided, and a description of the modulating wave train, shall be submitted for the maximum rated conditions under which the equipment will be operated.

Not applicable

(14) The data required by §2.1046 through 2.1057, inclusive, measured in accordance with the procedures set out in §2.1041.

Data is contained in this application

(15) The application for certification of an external radio frequency power amplifier under part 97 of this chapter need not be accompanied by the data required by paragraph (b)(14) of this section. In lieu thereof, measurements shall be submitted to show compliance with the technical specifications in subpart C of part 97 of this chapter and such information as required by §2.1060 of this part.

Does not apply to this device or application.

(16) An application for certification of an AM broadcast stereophonic exciter-generator intended for interfacing with existing certified, or formerly type accepted or notified transmitters must include measurements made on a complete stereophonic transmitter. The instruction book must include complete specifications and circuit requirements for interconnecting with existing transmitters. The instruction book must also provide a full description of the equipment and measurement procedures to monitor modulation and to verify that the combination of stereo exciter-generator and transmitter meet the emission limitations of §73.44.

Does not apply to this device or application.

(17) Applications for certification required by §25.129 of this chapter shall include any additional equipment test data required by that section.

Does not apply to this device or application.

(18) An application for certification of a software defined radio must include the information required by §2.944.

Does not apply to this device or application.

(19) Applications for certification of equipment operating under part 27 of this chapter, that a manufacturer is seeking to certify for operation in the:

(i) 1755-1780 MHz, 2155-2180 MHz, or both bands shall include a statement indicating compliance with the pairing of 1710-1780 and 2110-2180 MHz specified in §§27.5(h) and 27.75 of this chapter.

(ii) 1695-1710 MHz, 1755-1780 MHz, or both bands shall include a statement indicating compliance with §27.77 of this chapter.

(iii) 600 MHz band shall include a statement indicating compliance with §27.75 of this chapter.

Does not apply to this device or application.

(20) Before equipment operating under part 90 of this chapter and capable of operating on the 700 MHz interoperability channels (See §90.531(b)(1) of this chapter) may be marketed or sold, the manufacturer thereof shall have a Compliance Assessment Program Supplier's Declaration of

Conformity and Summary Test Report or, alternatively, a document detailing how the manufacturer determined that its equipment complies with §90.548 of this chapter and that the equipment is interoperable across vendors. Submission of a 700 MHz narrowband radio for certification will constitute a representation by the manufacturer that the radio will be shown, by testing, to be interoperable across vendors before it is marketed or sold.

Does not apply to this device or application.

(21) Contain at least one drawing or photograph showing the test set-up for each of the required types of tests applicable to the device for which certification is requested. These drawings or photographs must show enough detail to confirm other information contained in the test report. Any photographs used must be focused originals without glare or dark spots and must clearly show the test configuration used.

Data is contained in this application or application exhibits.

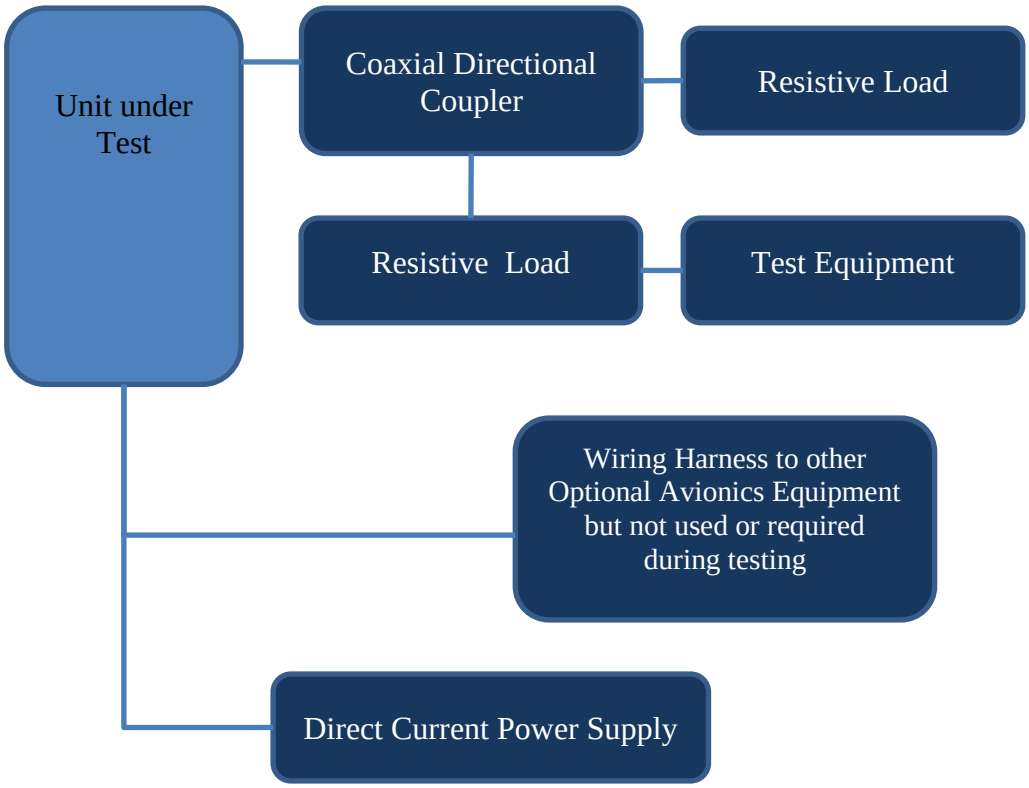
Transmitter Power Output

Measurements Required

Measurements shall be made to establish the radio frequency power delivered by the transmitter into the standard output termination. The power output shall be monitored and recorded, and no adjustment shall be made to the transmitter after the test has begun, except as noted below:

If the power output is adjustable, measurements shall be made for the highest and lowest power levels. The design does not provide power variation so no change made during testing.

Test Arrangement



The radio frequency power output was measured at the antenna terminal by placing a directional coupler (power splitter) and attenuation in the antenna line and observing the transmitter emissions with the spectrum analyzer. The spectrum analyzer and attenuation provided an impedance of 50Ω to match the impedance of the standard antenna. A Rohde & Schwarz ESU40 and/or ESW44 Spectrum Analyzer was used to measure the radio frequency power at the antenna port. Data was taken in dBm and converted to watts as shown in the following table. Refer to Figures one and two showing plots of output power of the transmitter across the frequency band. Data was taken per 47CFR Paragraph 2.1046(a) and applicable paragraphs of Part 87.131.

Peak Output Power:

P_{dBm} = power in dB above 1 milliwatt

Milliwatts = $10^{(PdBm/10)}$

Watts = (Milliwatts)(0.001)(W/mW)

	A-Mode	S-Mode
Milliwatts	$= 10^{(54.54/10)}$	$= 10^{(54.60/10)}$
	= 284,446.14 mW	= 288,403.2 mW
	= 284.4 Watts power	= 288.4 Watts power

Average output power is calculated using 1.0% duty cycle.

Average output power:

A-Mode	S-Mode
284.4*0.01 = 2.84 W (Ave)	288.4*0.01 = 2.88 W (Ave)

Table 1 Transmitter Power Results

Frequency (MHz)	P_{dBm} (Peak)	P_{mw} (Peak)	P_w (Peak)	P_w (Average)
1090 (A-Mode)	54.54	284,446.1	284.4	2.84
1090 (S-Mode)	54.60	288,403.2	288.4	2.89

The EUT demonstrated compliance with specifications of 47CFR Paragraph 2.1046(a) and applicable Parts of 2 and 87.131. There are no deviations to the specifications.

Figure 1 Maximum Power Output Mode-A

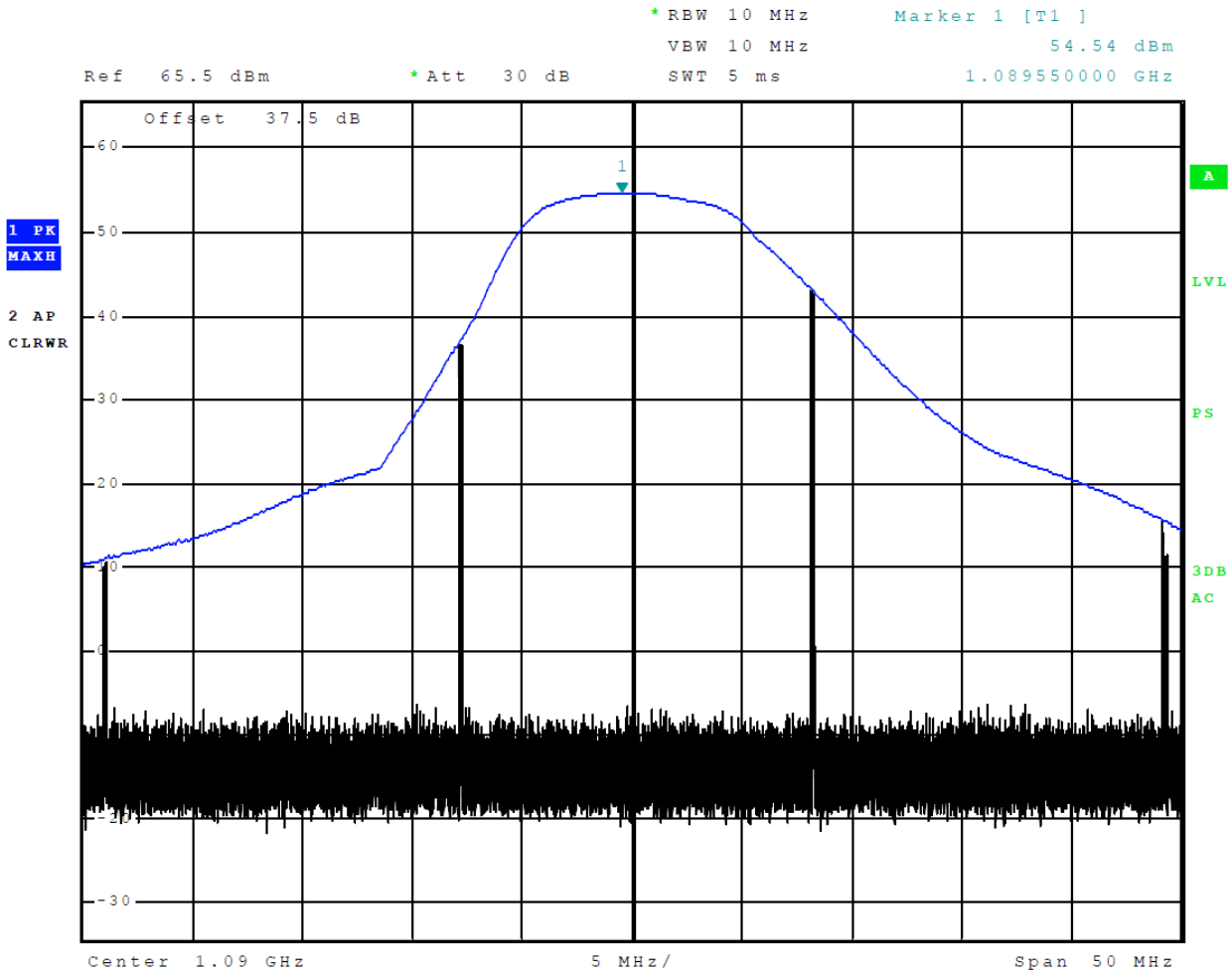
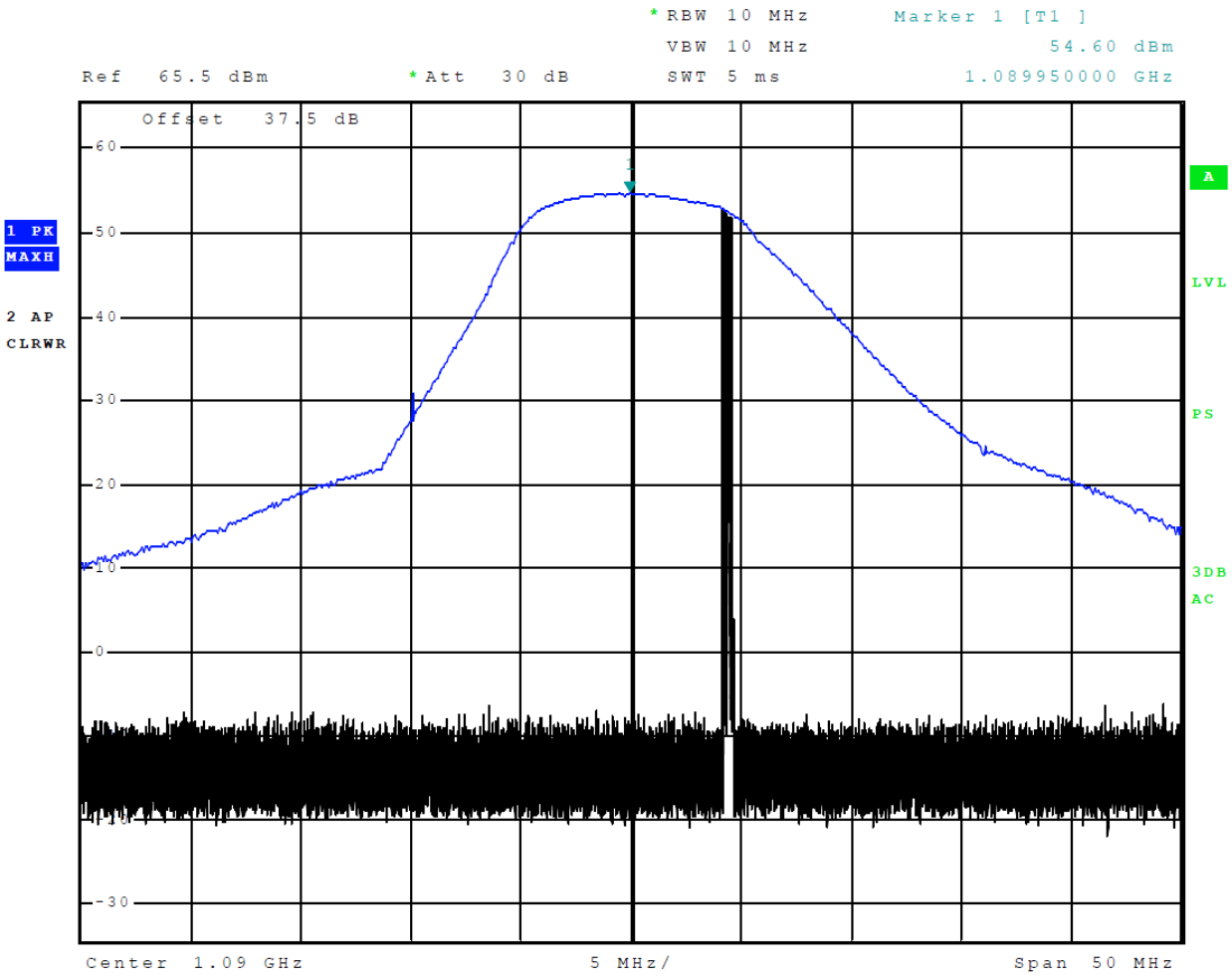


Figure 2 Maximum Power Output mode-S



Modulation Characteristics

A curve or equivalent data, which shows that the equipment will meet the modulation requirements of the rules, under which the equipment is to be licensed, shall be submitted. The modulation specifications are defined by the RTCA.

The following specifications apply to Mode-A

The reply function shall use two framing pulses nominally spaced 20.3 µs apart.

Mode A Information Pulses

The designators of the information pulses and their positions from the first framing pulse (F1) are as follows.

Bit X shall not be used

PULSE	POSITION
C1	F1+1.45 µs
A1	F1+2.90 µs
C2	F1+4.35 µs
A2	F1+5.80 µs
C4	F1+7.25 µs
A4	F1+8.70 µs
X	F1+10.15 µs
B1	F1+11.60 µs
D1	F1+13.05 µs
B2	F1+14.50 µs
D2	F1+15.95 µs
B4	F1+17.40 µs
D4	F1 + 18.85 µs

Mode A/C Reply Pulse Shape

All reply pulses including SPI pulses shall have the following characteristics.

Duration: 0.45 ±0.1 µs.
Rise Time: Between 0.05 and 0.1 µs.
Decay Time: Between 0.05 and 0.2 µs.

Specification	Data	Unit
Rise Time (10%/90%)	50-100	ns
Fall Time (90%/10%)	50-200	ns
Pulse width	450 +/- 100	ns

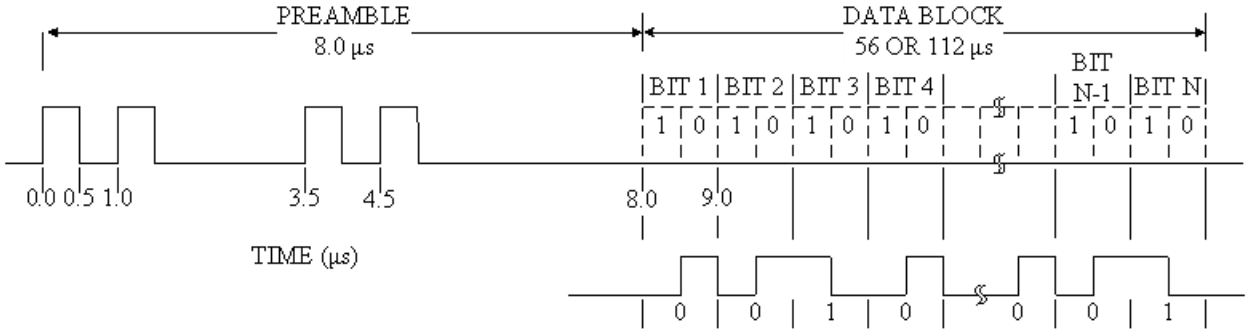
The following specifications apply to Mode-S

Mode S Reply Preamble

a. The preamble shall consist of four 0.5 ±0.05 µs, pulses.

b. The second, third and fourth pulses shall be spaced 1.0, 3.5 and 4.5 µs respectively from the first transmitted pulse.

c. The position tolerance shall be in accordance with §3.6.4.



Example: Reply Data Block Waveform Corresponding to bit sequence 0010...001

Mode S Reply Data Pulses

a. The block of reply data pulses shall begin 8.0 µs after the first transmitted pulse.

b. Either 56 or 112 one-microsecond intervals shall be assigned to each transmission.

c. A pulse with a width of 0.5 ±0.05 µs shall be transmitted either in the first or in the second half of each interval.

d. If a pulse transmitted in the second half of one interval is followed by another pulse transmitted in the first half of the next interval, the two pulses merge and a single 1.0 ±0.05 µs pulse shall be transmitted.

Mode S Reply Pulse Shape

a. The pulse amplitude variation between one pulse and any other pulse in a reply shall be within ±2 dB.

b. The pulse rise time shall be within ±0.1 microsecond.

c. The pulse decay time shall be within ±0.2 microseconds.

d. The spectrum of a reply shall be within the bounds defined in Table 3-1 and Figure 3-1.

Mode S Reply Pulse Intervals

a. Mode S reply pulses shall start at a defined multiple of 0.5 µs from the first transmitted pulse of the preamble.

b. The pulse position tolerance shall be ±0.05 µs, measured from the first transmitted pulse of the preamble.

Modulation Characteristics Results

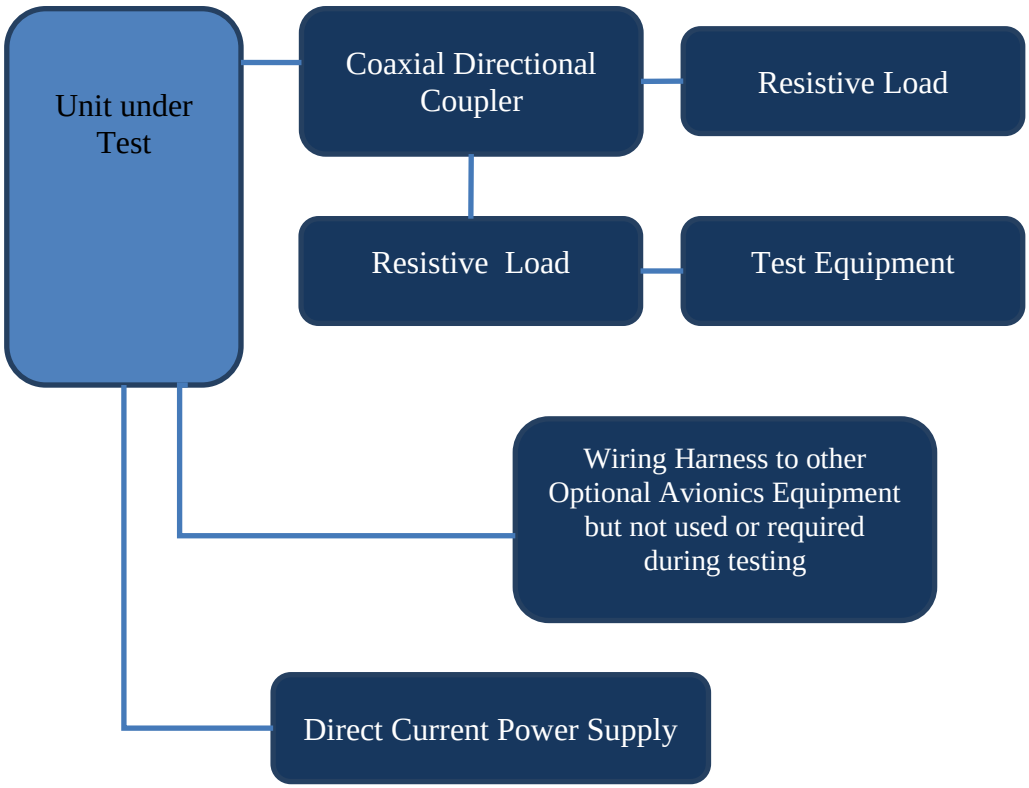
The modulation characteristics are defined in aviation standards and regulations. This equipment complies with the pulse timing requirements as defined above. The requirements of 47CFR 2.1047(d) and applicable paragraphs of Part 87.141 are met. There are no deviations to the specifications.

Occupied Bandwidth

Measurements Required

The occupied bandwidth, that is the frequency bandwidth such that below its lower and above its upper frequency limits, the mean powers radiated are equal to 0.5 percent of the total mean power radiated by a given emission.

Test Arrangement



A spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in all normal modes. The EUT was set to transmit in normal modes while measurements were made. The power ratio in dB representing 99.5% of the total mean power was recorded from the spectrum analyzer. Refer to figures three and four showing the plot of the 99.5% power occupied bandwidth for operational modes.

Table 2 Occupied Bandwidth Results

Frequency (MHz)	Mode	Occupied bandwidth(kHz)	FAA Authorized Occupied bandwidth(kHz)
1090.00	Mode A	9,040.0	12,000.0
1090.00	Mode S	7,850.0	12,000.0

The requirements of 47CFR 2.1049(h) and applicable paragraphs of Part 87.135 are met. There are no deviations to the specifications.

Figure 3 Occupied Band Width Mode A

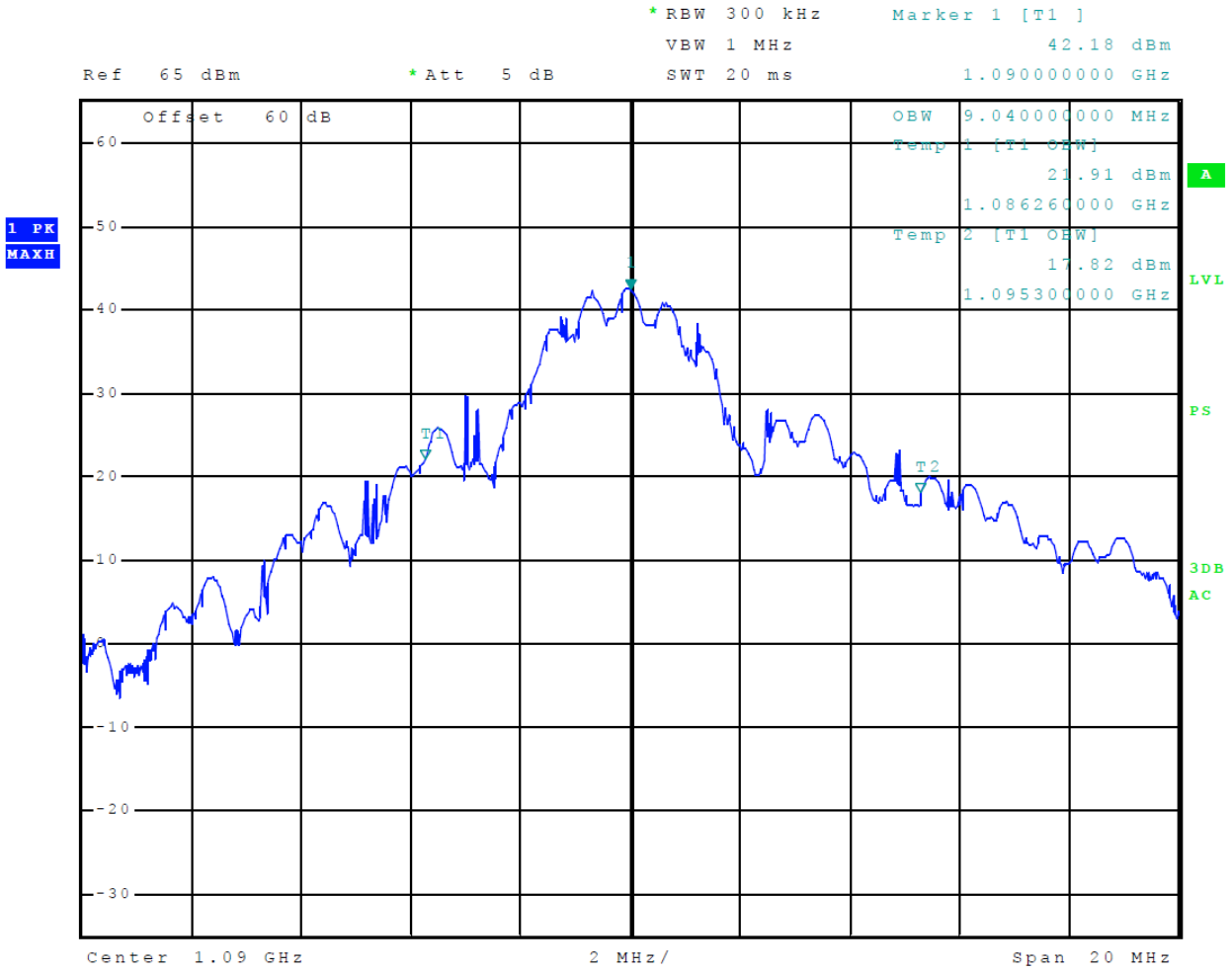
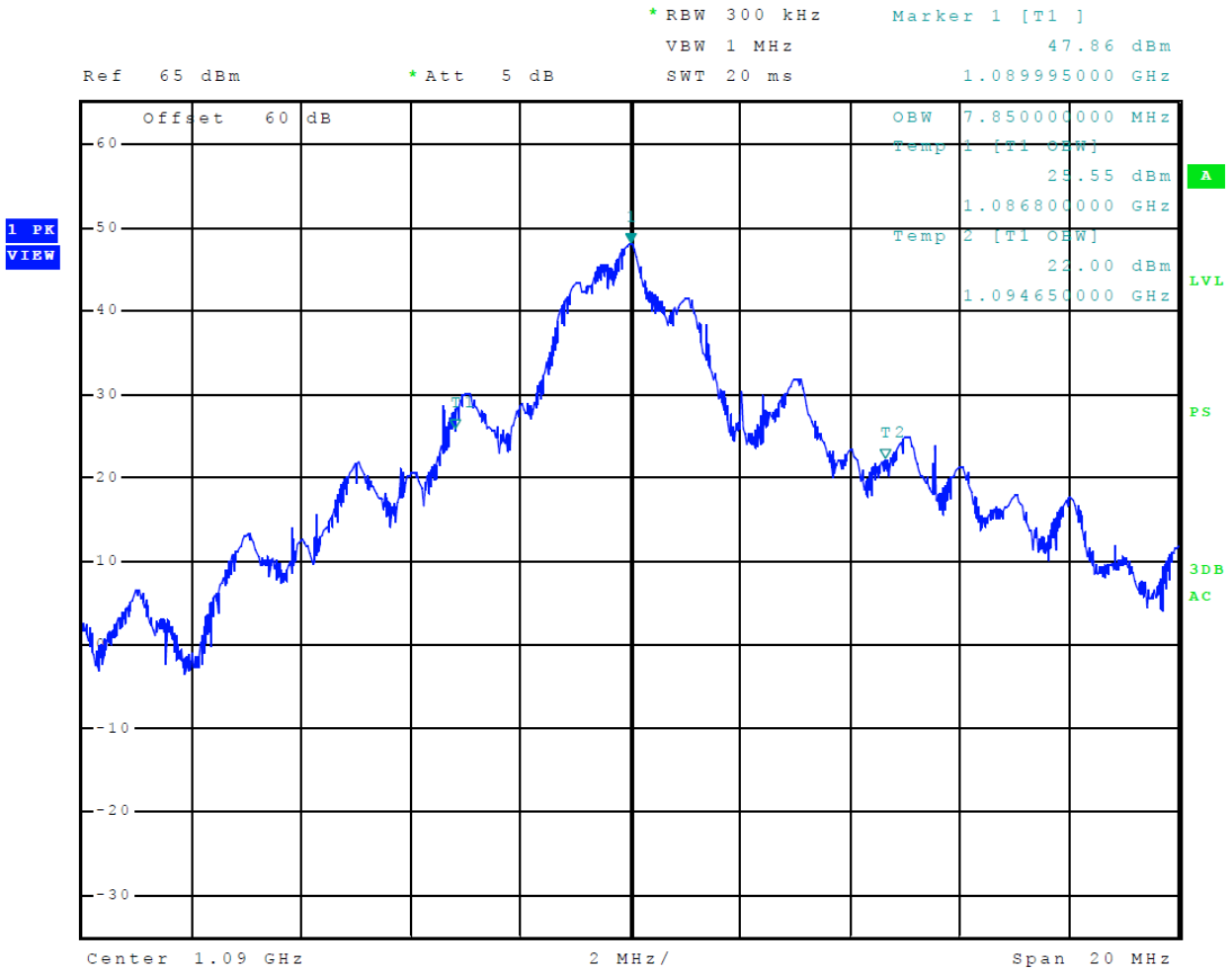


Figure 4 Occupied Band Width Mode S



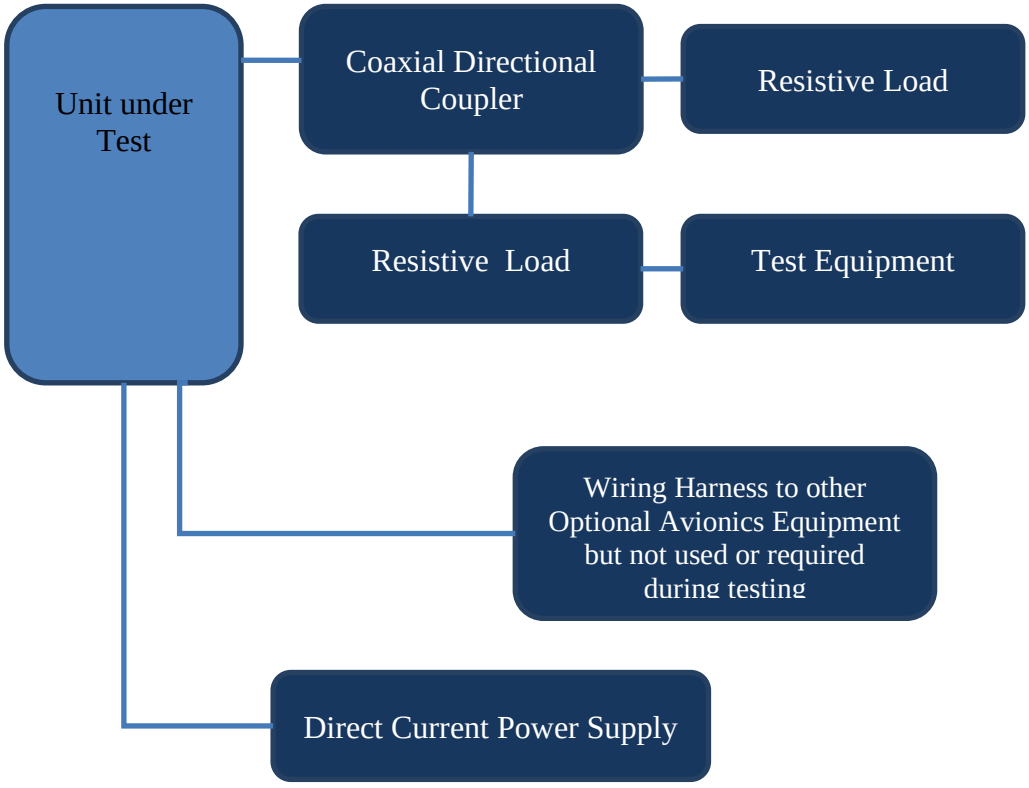
Spurious Emissions at Antenna Terminals

Measurements Required

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. All spurious emissions must be attenuated at least 43 +10log (pY) [pY=mean power, p denotes power expressed in watts] below the fundamental emission power level. The following equations represent the calculated attenuation level for the equipment operating with rated average output power of 2.88 W.

Limit (dBc) = 43 + 10 Log (pY)
= 43 + 10 Log (2.88)
= 47.6 dBc

Test Arrangement



The radio frequency output was coupled to a Rohde & Schwarz ESU40 Spectrum Analyzer during antenna port conducted emissions measurements. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operated in all normal modes. The frequency spectrum from 30 MHz to 12,000 MHz was observed and plots produced of the frequency spectrum displayed on the test equipment. Refer to figures five through twelve for plots of the spurious emissions at antenna port. Data was taken per 47CFR 2.1051, 2.1057, and applicable paragraphs of Part 87.139. There are no deviations to the specifications.

Figure 5 Spurious Emissions at Antenna Terminal (A-Mode)

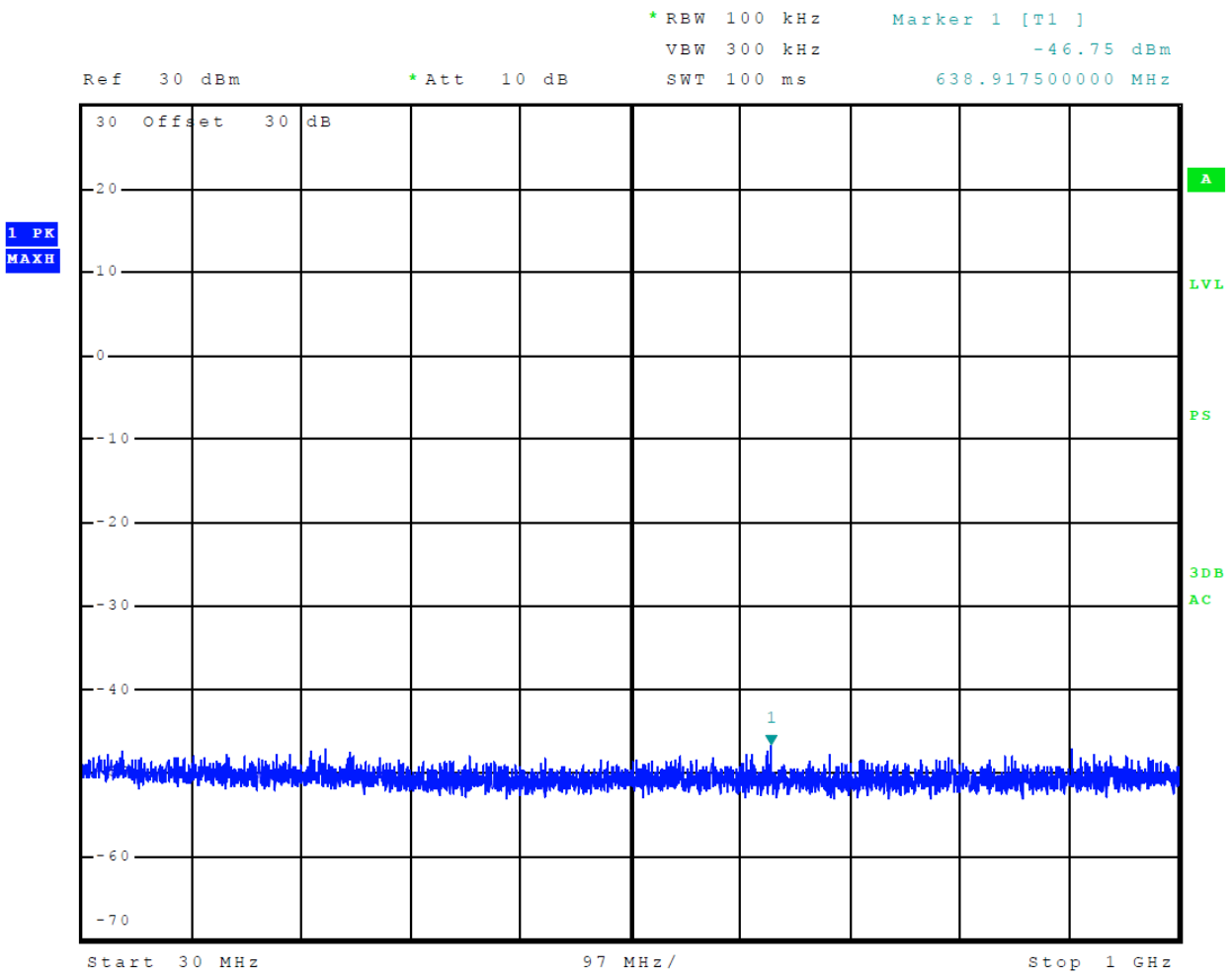


Figure 6 Spurious Emissions at Antenna Terminal (A-Mode)

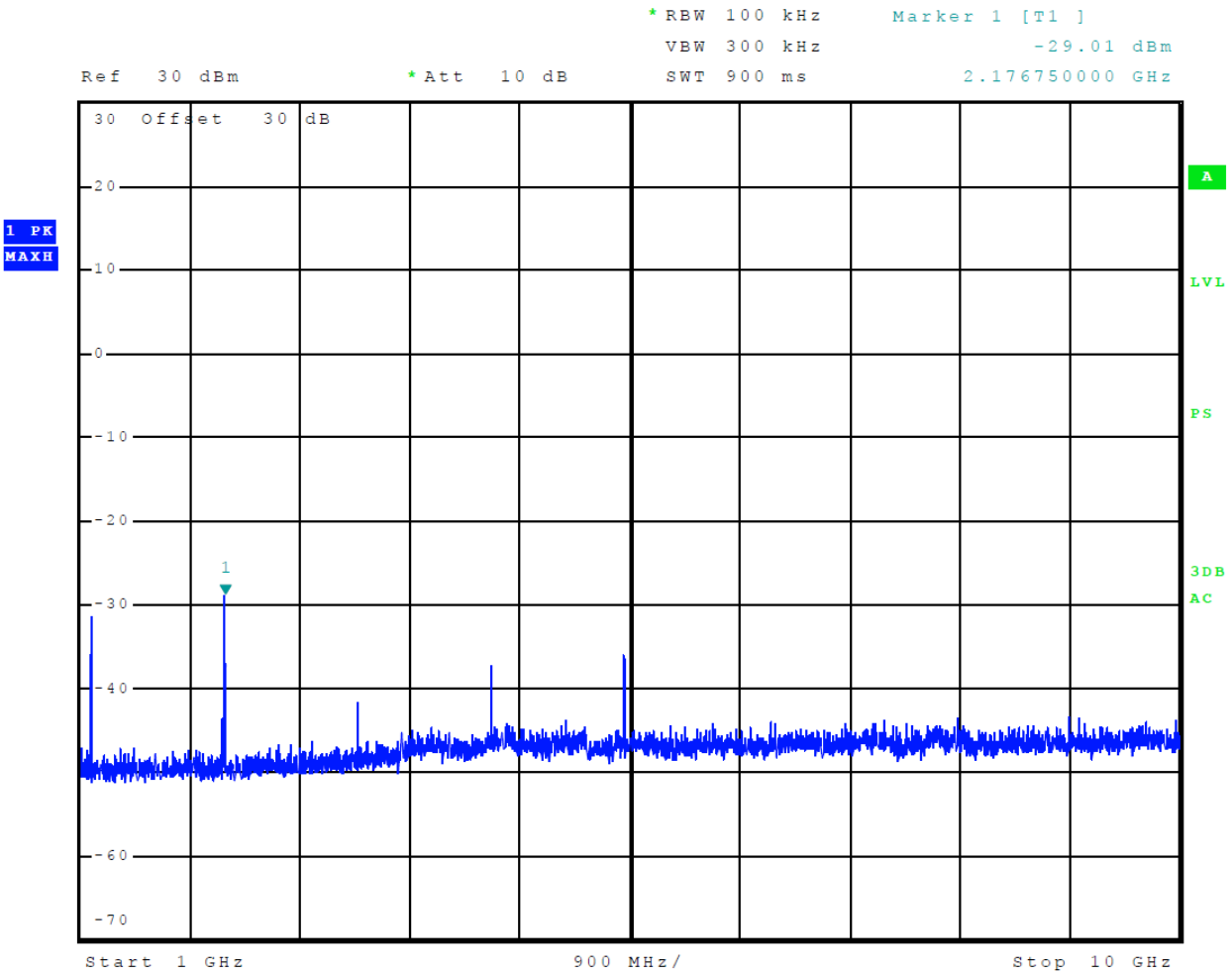


Figure 7 Spurious Emissions at Antenna Terminal (S-Mode)

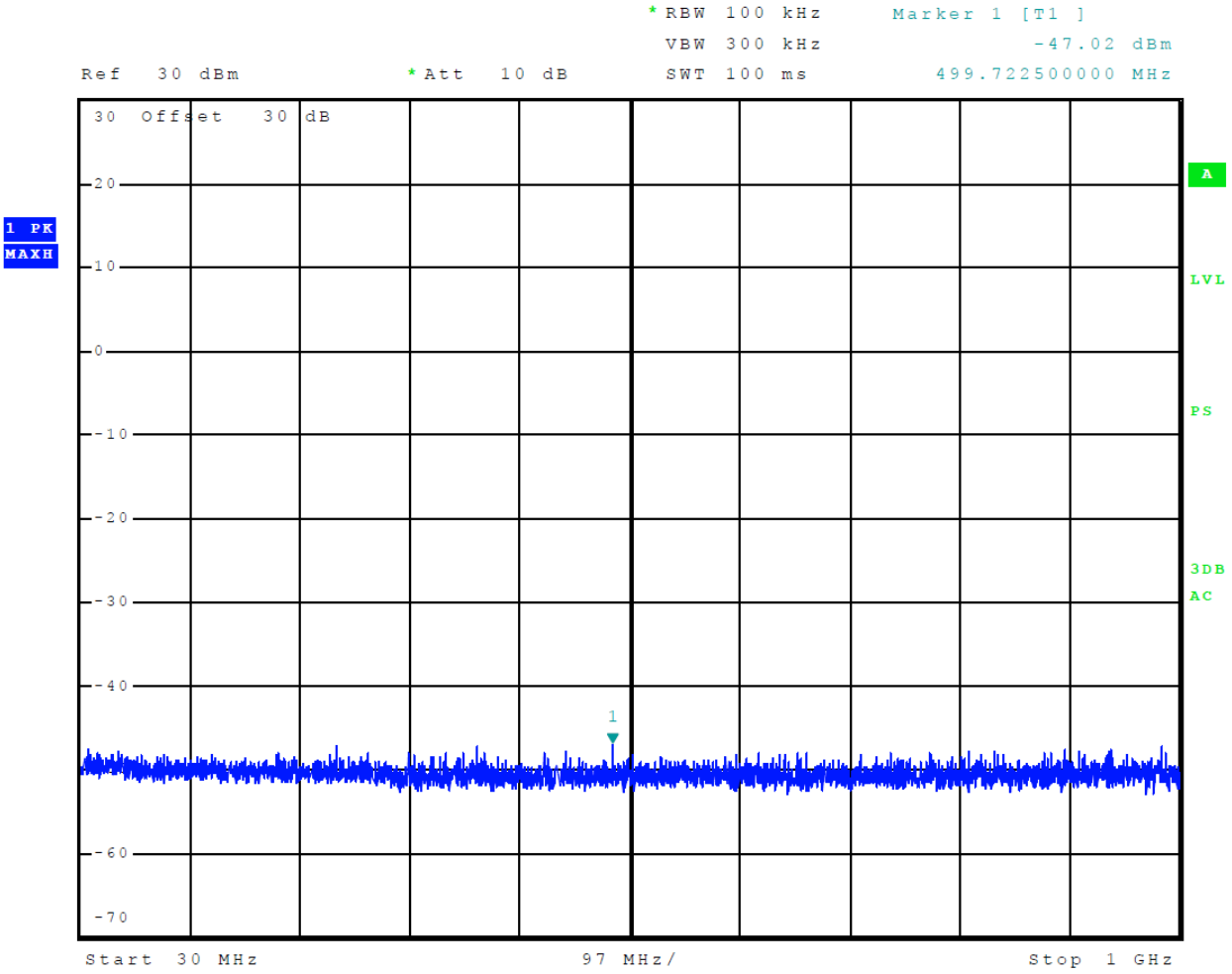


Figure 8 Spurious Emissions at Antenna Terminal (S-Mode)

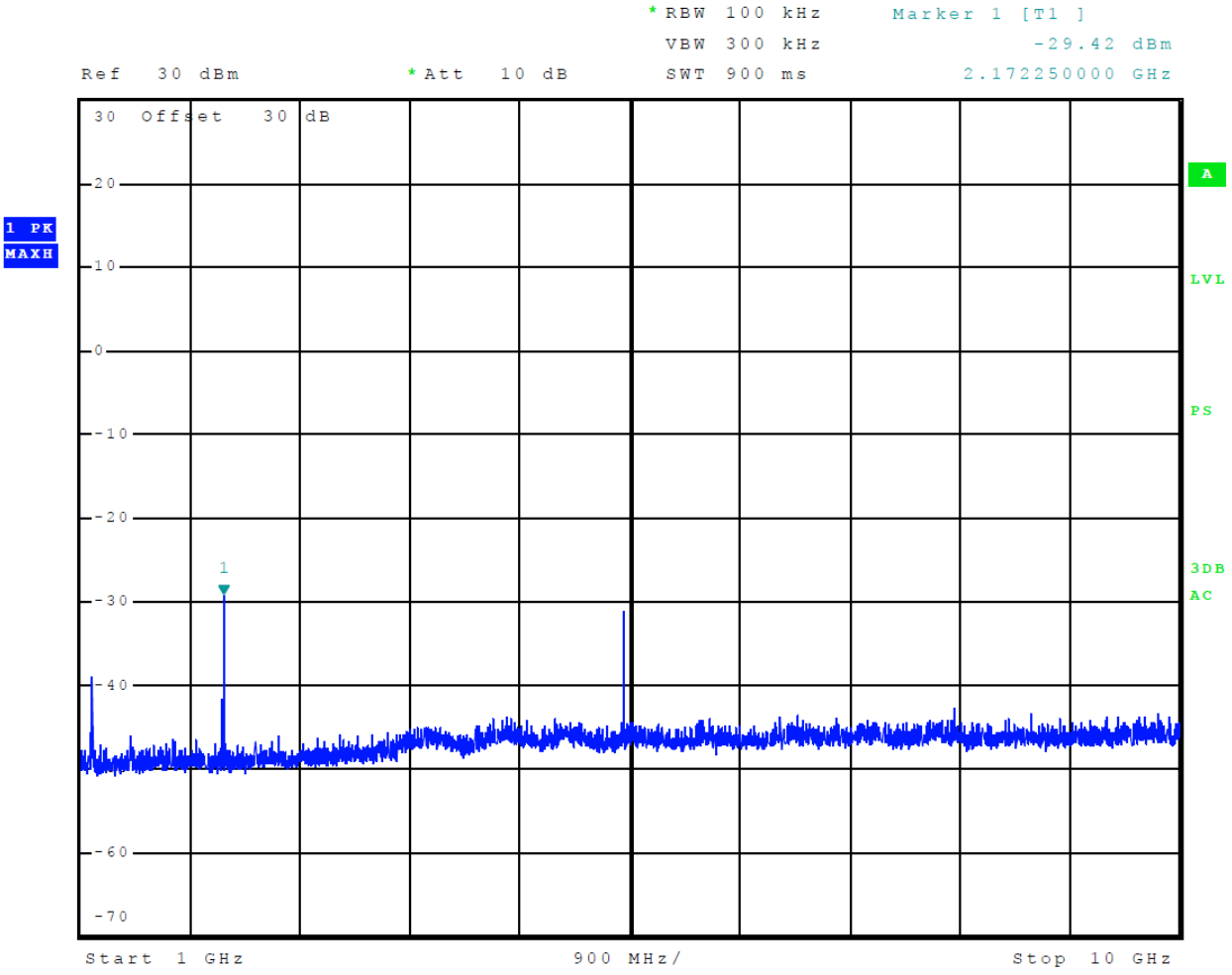
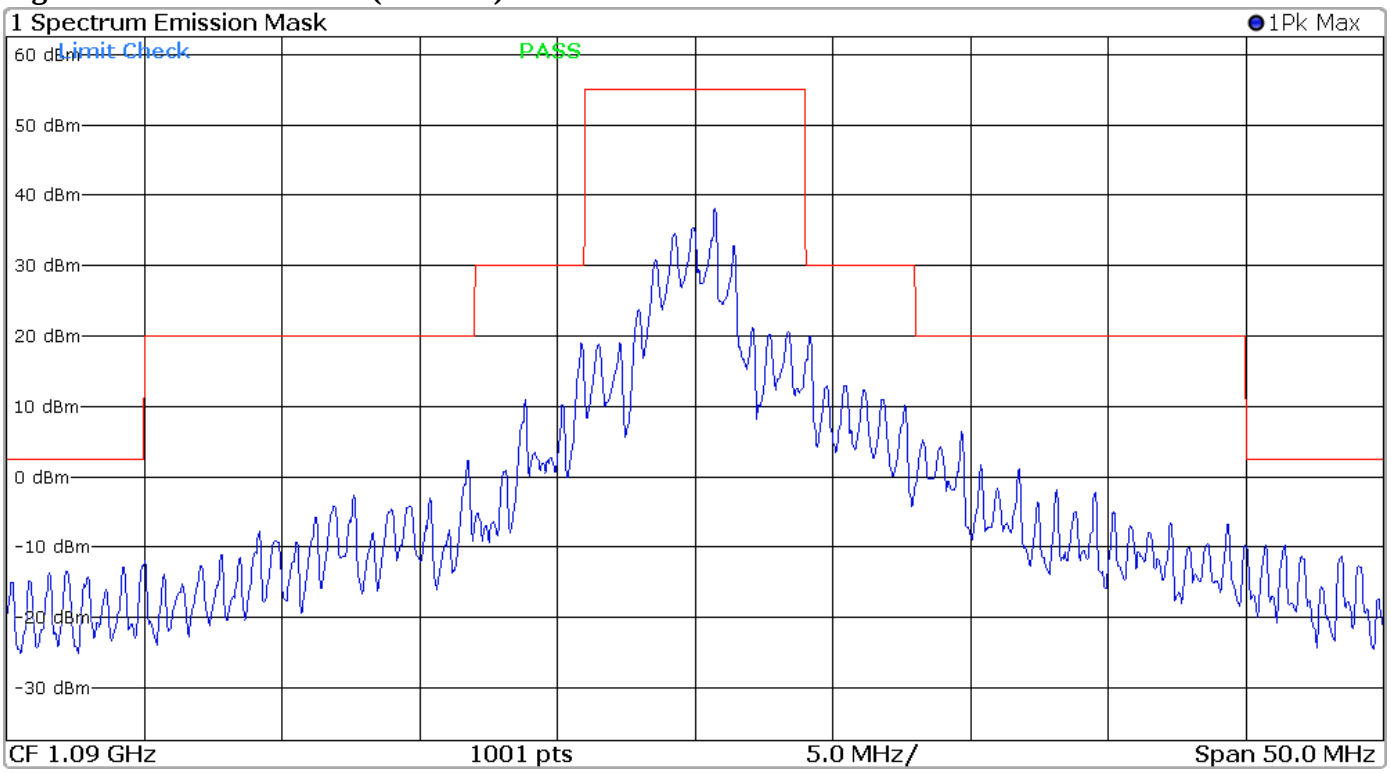


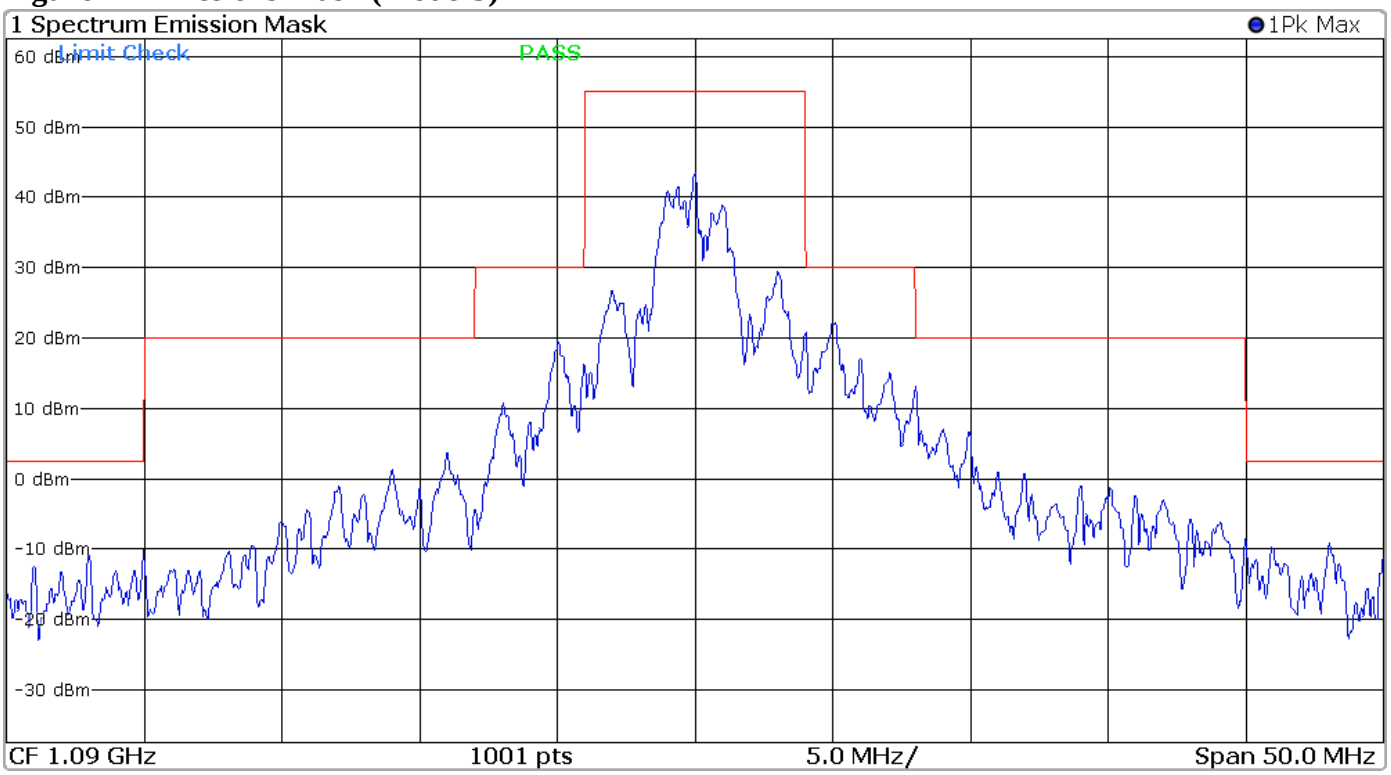
Figure 9 Spurious Emissions at Antenna Terminal (S-Mode)

Figure 10 Emissions Mask (Mode-A)



Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	Delta Limit
-25 MHz	-20 MHz	100 kHz	1.07 GHz	-12.63 dBm	-50.76 dB	-15.13 dB
-20 MHz	-8 MHz	100 kHz	1.082 GHz	2.251 dBm	-35.88 dB	-17.75 dB
-8 MHz	-4 MHz	100 kHz	1.086 GHz	19.04 dBm	-19.09 dB	-10.96 dB
4 MHz	8 MHz	100 kHz	1.094 GHz	19.98 dBm	-18.15 dB	-10.02 dB
8 MHz	20 MHz	100 kHz	1.1 GHz	6.319 dBm	-31.81 dB	-13.68 dB
20 MHz	25 MHz	100 kHz	1.111 GHz	-9.743 dBm	-47.87 dB	-12.24 dB

Figure 11 Emissions Mask (Mode-S)



Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	Delta Limit
-25 MHz	-20 MHz	100 kHz	1.07 GHz	-10.06 dBm	-53.5 dB	-12.56 dB
-20 MHz	-8 MHz	100 kHz	1.081 GHz	3.63 dBm	-39.81 dB	-16.37 dB
-8 MHz	-4 MHz	100 kHz	1.085 GHz	19.51 dBm	-23.94 dB	-10.49 dB
4 MHz	8 MHz	100 kHz	1.095 GHz	22.18 dBm	-21.26 dB	-7.82 dB
8 MHz	20 MHz	100 kHz	1.098 GHz	13.05 dBm	-30.4 dB	-6.952 dB
20 MHz	25 MHz	100 kHz	1.113 GHz	-9.17 dBm	-52.61 dB	-11.67 dB

All spurious emissions must be attenuated at least 43 +10log (pY) [pY=mean power] below the fundamental emission power level. The following equations represent the calculated attenuation levels for the equipment.

Spurious Emissions Limit shall be attenuated at least 47.6 dB below fundamental carrier (dBc).

Limit (dBc) = 43 + 10 Log (Po)
= 43 + 10 Log (2.88)
= 47.6 dBc

Table 3 Spurious Emissions at Antenna Terminal Results Mode-A

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
1090.00	2180.0	-27.90	82.4
	3270.0	-41.30	95.8
	4360.0	-34.40	88.9
	5450.0	-33.30	87.8
	6540.0	-44.90	99.4
	7630.0	-44.40	98.9
	8720.0	-44.30	98.8
	9810.0	-43.80	98.3
	10900.0	-44.30	98.8

Table 4 Spurious Emissions at Antenna Terminal Results Mode-S

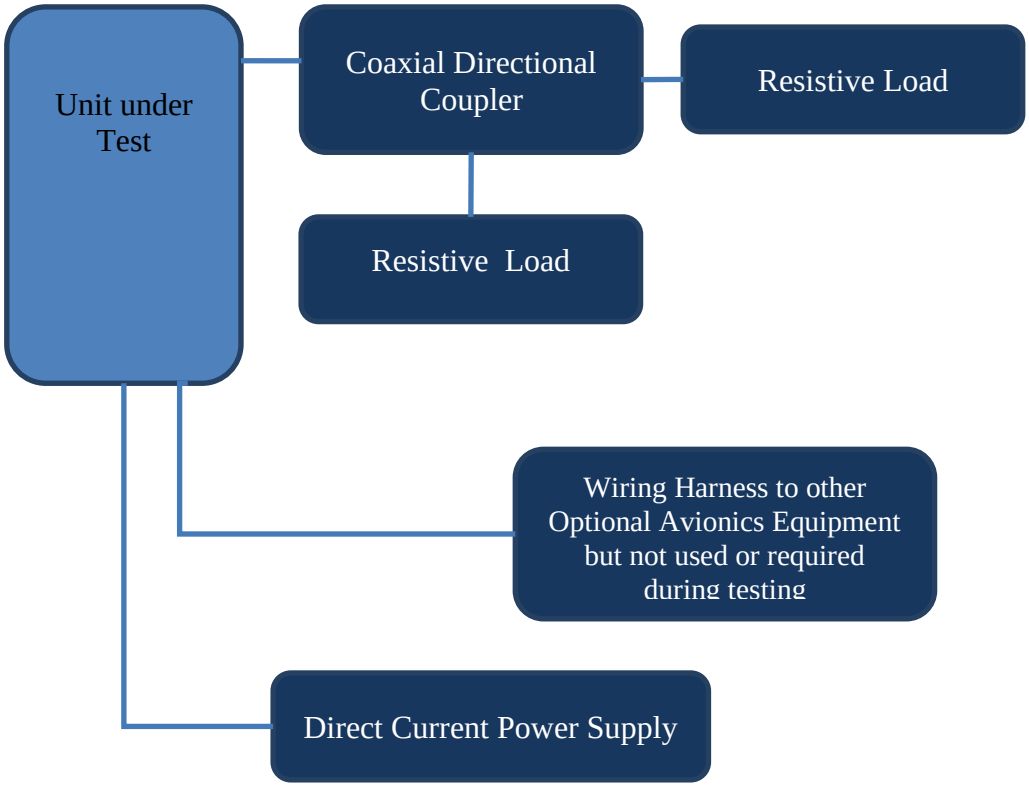
Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dBc)
1090.00	2180.0	-25.70	80.3
	3270.0	-37.10	91.7
	4360.0	-29.50	84.1
	5450.0	-28.60	83.2
	6540.0	-44.40	99.0
	7630.0	-47.40	102.0
	8720.0	-44.70	99.3
	9810.0	-44.80	99.4
	10900.0	-25.70	80.3

Field Strength of Spurious Radiation (Unwanted Emissions)

Measurements Required

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. The sample offered for testing utilized interfacing with laptop computer to provide operational control with all functions of the transmitter.

Test Arrangement



The test setup was assembled in a screen room for preliminary screening. The transmitter was placed on a supporting platform 0.8 meters above the ground plane and at a distance of 1 meter from the receive antenna, plots were taken of the general radiated emissions. Final radiated emission testing was performed with the transmitter placed on a supporting turntable platform

0.8 meters above the ground plane at a distance of 3 meters from the Field Strength Measuring (FSM) antenna. The EUT was operational and radiating into a 50Ω load during testing. The receiving antenna was raised and lowered from 1-meter to 4-meter in height to obtain the maximum reading of spurious radiation from the EUT, cabinet, and interface cabling. The turntable was rotated though 360 degrees to locate the position registering the highest amplitude of emission. The frequency spectrum was then searched for spurious emissions generated from the transmitter, interface cabling, and test setup. The amplitude of each spurious emission was maximized by raising and lowering the FSM antenna, and rotating the turntable before final data was recorded. The frequency spectrum from 9 kHz to 11 GHz was investigated during radiated emissions testing. A loop antenna was used for measuring frequencies from 9 kHz to 30 MHz, a Biconilog antenna was used for frequency measurements of 30 to 1000 MHz. Double-ridge horns were used for measuring frequencies above 1000 MHz. Emission levels were measured and recorded from the spectrum analyzer in dBµV. Data was taken at the Rogers Labs, Inc. 3 meters open area test site (OATS). The transmitter was then removed and replaced with a substitution antenna, amplification as required, and signal generator. The signal from the generator was then adjusted such that the amplitude received was the same as that previously recorded for each frequency. This step was repeated for both horizontal and vertical polarizations. The power in dBm required to produce the desired signal level was then recorded from the signal generator. The power in dBm was then calculated by reducing the previous readings by the gain in the substitution antenna.

All spurious emissions must be attenuated at least 43 +10log (pY) [pY=mean power, p denotes power expressed in watts] below the fundamental emission power level. The following equation represents the calculated attenuation levels for the equipment.

Limit (dBc) = 43 + 10 Log (pY)
= 43 + 10 Log (2.88)
= 47.6 dBc

Requirement based on average output power 34.6 dBm, spurious emissions must be less than 47.6 dBc which equates to an absolute level of -13 dBm.

Table 5 General Spurious Radiated Emission Results

Frequency	Amplitude of Emission (dBµV)		Signal Level to dipole required to Reproduce(dBm)		Emission level below carrier (dBc)		Limit (dBc)
MHz	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	
120.0	20.2	24.8	-75.0	-70.4	109.6	105.0	47.6
180.0	19.9	20.2	-75.3	-75.0	109.9	109.6	47.6
195.5	15.4	14.0	-79.8	-81.2	114.4	115.8	47.6
200.0	23.6	20.8	-71.6	-74.4	106.2	109.0	47.6
244.7	30.7	21.6	-64.5	-73.6	99.1	108.2	47.6
260.0	38.2	33.8	-57.0	-61.4	91.6	96.0	47.6
2260.0	50.0	48.6	-45.2	-46.6	79.8	81.2	47.6

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded above for frequencies below 1000 MHz. Peak and Average amplitude emissions are recorded above for frequencies above 1000 MHz.

Table 6 Spurious Radiated Emission Results Harmonics

Frequency	Amplitude of Emission (dBµV)		Signal Level to dipole required to Reproduce(dBm)		Emission level below carrier (dBc)		Limit (dBc)
MHz	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	
2180.0	35.7	35.3	-59.53	-59.93	94.1	94.5	47.6
3270.0	33.4	33.7	-61.83	-61.53	96.4	96.1	47.6
4360.0	35.3	35.6	-59.93	-59.63	94.5	94.2	47.6
5450.0	36.6	36.6	-58.63	-58.63	93.2	93.2	47.6
6540.0	39.0	38.8	-56.23	-56.43	90.8	91.0	47.6
7630.0	40.1	40.1	-55.13	-55.13	89.7	89.7	47.6

The EUT demonstrated compliance with specifications of 47CFR Paragraph 2.1053, 2.1057, and 87.139. There are no deviations to the specifications. There are no deviations or exceptions to the specifications.

Frequency Stability

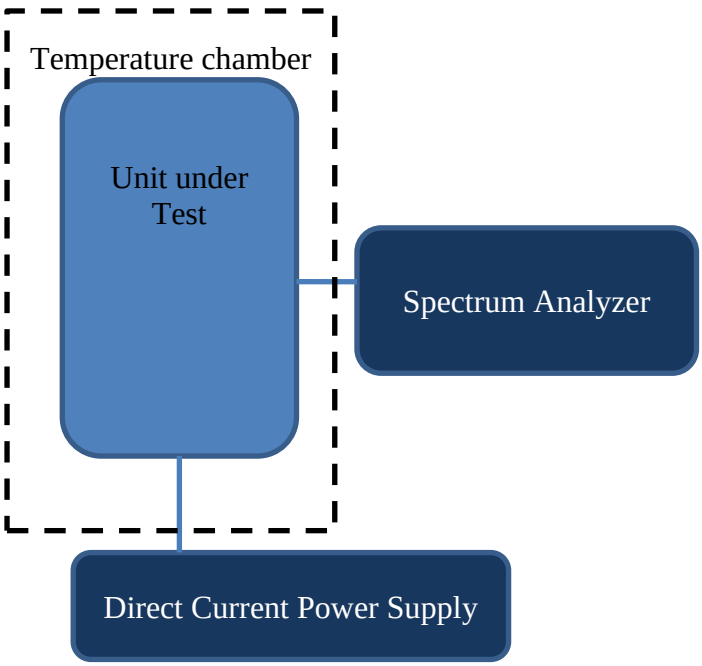
Measurements Required

The frequency stability shall be measured with variations of ambient temperature from -30° to +50° centigrade. Measurements shall be made at the extremes of the temperature range and at intervals of not more than 10° centigrade through the range. A period sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. In addition to temperature stability, the frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value.

(2) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided.

Test Arrangement



The measurement procedure outlined below shall be followed.

Step 1: The transmitter shall be installed in an environmental test chamber whose temperature is controllable. Provision shall be made to measure the frequency of the transmitter.

Step 2: With the transmitter inoperative (power switched "OFF"), the temperature of the test chamber shall be adjusted to +25°C. After a temperature stabilization period of one hour at +25°C, the transmitter shall be switched "ON" with standard test voltage applied.

Step 3: The carrier shall be keyed "ON", and the transmitter shall be operated at full radio frequency power output at the duty cycle, for which it is rated, for duration of at least 5 minutes. The radio frequency carrier frequency shall be monitored, and measurements shall be recorded.

Step 4: The test procedures outlined in Steps 2 and 3, shall be repeated after stabilizing the transmitter at the environmental temperatures specified, -30°C to +50°C in 10-degree increments.

The frequency stability was measured with variations in the power supply voltage from 85 to 115 percent of the nominal value. The frequency was measured and the variation in parts per million calculated. Data was taken per 47CFR Paragraphs 2.1055 and applicable paragraphs of part 87.133.

Table 7 Frequency Stability vs. Temperature Results

Frequency 1090 MHz	Frequency Stability Vs. Temperature Ambient Frequency (1090.003859 MHz)								
Temperature °C	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (Hz)	-329	358	-417	600	408	-638	-391	-1,037	-1,254
PPM	-0.302	0.328	-0.383	0.550	0.374	-0.585	-0.359	-0.951	-1.150
Limit (PPM)	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table 8 Frequency Stability vs. Input Power Supply Voltage Results

Frequency 1089.974 MHz	Frequency Stability Vs. Voltage Variation 28.0 volts nominal; Results in Hz change		
Voltage V_{dc}	23.8	28.0	32.2
Change (kHz)	0	0	0
PPM	0	0	0
Limit (PPM)	1000	1000	1000

The EUT demonstrated compliance with specifications of 47CFR Paragraph 2.1055 and applicable Parts of 87.133(a). There are no deviations or exceptions to the specifications.

Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Test Equipment
- Annex C Rogers Qualifications
- Annex D Certificate of Accreditation

Annex A Measurement Uncertainty Calculations

The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16–4. Result of measurement uncertainty calculations are recorded below. Component and process variability of production devices similar to those tested may result in additional deviations. The manufacturer has the sole responsibility of continued compliance.

Measurement	Expanded Measurement Uncertainty $U_{(lab)}$
3 Meter Horizontal 0.009-1000 MHz Measurements	4.16
3 Meter Vertical 0.009-1000 MHz Measurements	4.33
3 Meter Measurements 1-18 GHz	5.14
3 Meter Measurements 18-40 GHz	5.16
10 Meter Horizontal Measurements 0.009-1000 MHz	4.15
10 Meter Vertical Measurements 0.009-1000 MHz	4.32
AC Line Conducted	1.75
Antenna Port Conducted power	1.17
Frequency Stability	1.00E-11
Temperature	1.6˚C
Humidity	3%

Annex B Test Equipment

Equipment	Manufacturer	Model (SN)	Band	Cal Date(m/d/y)	Due
☐ LISN	FCC	FCC-LISN-50-25-10(1PA) (160611)	.15-30MHz	4/6/2021	4/6/2022
☐ LISN	Compliance Design	FCC-LISN-2.Mod.cd,(126)	.15-30MHz	10/14/2020	10/14/2021
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(L10M)(303073)	9kHz-40 GHz	10/14/2020	10/14/2021
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303069)	9kHz-40 GHz	10/14/2020	10/14/2021
☒ Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303070)	9kHz-40 GHz	10/14/2020	10/14/2021
☐ Cable	Belden	RG-58 (L1-CAT3-11509)	9kHz-30 MHz	10/14/2020	10/14/2021
☐ Cable	Belden	RG-58 (L2-CAT3-11509)	9kHz-30 MHz	10/14/2020	10/14/2021
☒ Antenna	Com Power	AL-130 (121055)	.001-30 MHz	10/14/2020	10/14/2021
☐ Antenna:	EMCO	6509	.001-30 MHz	10/14/2020	10/14/2022
☐ Antenna	ARA	BCD-235-B (169)	20-350MHz	10/14/2020	10/14/2021
☐ Antenna:	Schwarzbeck Model	VHBB 9124 (1468)		10/14/2020	10/14/2022
☒ Antenna	Sunol	JB-6 (A100709)	30-1000 MHz	10/14/2020	10/14/2021
☐ Antenna	ETS-Lindgren	3147 (40582)	200-1000MHz	10/14/2020	10/14/2022
☐ Antenna:	Schwarzbeck Model:	VULP 9118 A (VULP 9118 A-534)		10/14/2020	10/14/2022
☒ Antenna	ETS-Lindgren	3117 (200389)	1-18 GHz	4/21/2020	4/21/2022
☐ Antenna	Com Power	AH-118 (10110)	1-18 GHz	10/14/2020	10/14/2022
☐ Antenna	Com Power	AH-840 (101046)	18-40 GHz	4/6/2021	4/6/2023
☒ Analyzer	Rohde & Schwarz	ESU40 (100108)	20Hz-40GHz	5/20/2021	5/20/2022
☒ Analyzer	Rohde & Schwarz	ESW44 (101534)	20Hz-44GHz	1/12/2021	1/12/2022
☐ Analyzer	Rohde & Schwarz	FS-Z60, 90, 140, and 220	40GHz-220GHz	12/22/2017	12/22/2027
☒ Amplifier	Com-Power	PA-010 (171003)	100Hz-30MHz	10/14/2020	10/14/2021
☒ Amplifier	Com-Power	CPPA-102 (01254)	1-1000 MHz	10/14/2020	10/14/2021
☒ Amplifier	Com-Power	PAM-118A (551014)	0.5-18 GHz	10/14/2020	10/14/2021
☐ Amplifier	Com-Power	PAM-840A (461328)	18-40 GHz	10/14/2020	10/14/2021
☐ Power Meter	Agilent	N1911A with N1921A	0.05-40 GHz	4/6/2021	4/6/2022
☒ Generator	Rohde & Schwarz	SMB100A6 (100150)	20Hz-6 GHz	4/6/2021	4/6/2022
☐ Generator	Rohde & Schwarz	SMBV100A6 (260771)	20Hz-6 GHz	4/6/2021	4/6/2022
☐ RF Filter	Micro-Tronics	BRC50722 (009).9G notch	30-18000 MHz	4/6/2021	4/6/2022
☒ RF Filter	Micro-Tronics	HPM50114 (017)1.5G HPF	30-18000 MHz	4/6/2021	4/6/2022
☐ RF Filter	Micro-Tronics	HPM50117 (063) 3G HPF	30-18000 MHz	4/6/2021	4/6/2022
☐ RF Filter	Micro-Tronics	HPM50105 (059) 6G HPF	30-18000 MHz	4/6/2021	4/6/2022
☐ Attenuator	Fairview	SA6NFNF100W-40 (1625)	30-18000 MHz	4/6/2021	4/6/2022
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1436)	30-6000 MHz	4/6/2021	4/6/2022
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1445)	30-6000 MHz	4/6/2021	4/6/2022
☐ Attenuator	Mini-Circuits	VAT-3W2+ (1735)	30-6000 MHz	4/6/2021	4/6/2022
☐ Attenuator	Mini-Circuits	VAT-6W2+ (1438)	30-6000 MHz	4/6/2021	4/6/2022
☐ Attenuator	Mini-Circuits	VAT-6W2+ (1736)	30-6000 MHz	4/6/2021	4/6/2022
☒ Weather station	Davis	6312 (A81120N075)		11/4/2020	11/4/2021

List of Test Equipment			Calibration	Date (m/d/y)	Due
☐ Antenna:	Schwarzbeck Model VHBB 9124 (9124-627)			4/21/2020	4/21/2022
☐ Antenna:	Schwarzbeck Model: VULP 9118 A (VULP 9118 A-534)			4/21/2020	4/21/2022
☐ Frequency Counter: Leader LDC-825 (8060153				4/6/2021	4/6/2022
☐ LISN: Com-Power Model LI-220A				10/14/2020	10/14/2021
☐ LISN: Com-Power Model LI-550C				10/14/2020	10/14/2021
☐ ISN: Com-Power Model ISN T-8				4/6/2021	4/6/2022
☐ LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08				4/6/2021	4/6/2022
☐ Cable	Huber & Suhner Inc.	Sucoflex102ea(1.5M)(303072)	9kHz-40 GHz	10/14/2020	10/14/2021
☐ Cable	Huber & Suhner Inc.	Sucoflex102ea(L1M)(281183)	9kHz-40 GHz	10/14/2020	10/14/2021
☐ Cable	Huber & Suhner Inc.	Sucoflex102ea(L4M)(281184)	9kHz-40 GHz	10/14/2020	10/14/2021
☐ Cable	Huber & Suhner Inc.	Sucoflex102ea(L10M)(317546)	9kHz-40 GHz	10/14/2020	10/14/2021
☐ Cable	Time Microwave	4M-750HF290-750 (4M)	9kHz-24 GHz	10/14/2020	10/14/2021
☐ RF Filter	Micro-Tronics	BRC17663 (001) 9.3-9.5 notch	30-1800 MHz	4/6/2021	4/6/2022
☐ RF Filter	Micro-Tronics	BRC19565 (001) 9.2-9.6 notch	30-1800 MHz	10/16/2018	4/6/2022
☐ Analyzer	HP	8562A (3051A05950)	9kHz-125GHz	4/6/2021	4/6/2022
☐ Analyzer	HP External Mixers	11571, 11970	25GHz-110GHz	4/18/2015	4/18/2025
☐ Analyzer	HP	8591EM (3628A00871)		4/21/2020	4/21/2022
☐ Wave Form Generator Keysight		33512B (MY57400128)		4/21/2020	4/6/2022
☐ Antenna: Solar 9229-1 & 9230-1				2/22/2021	2/22/2022
☐ CDN: Com-Power Model CDN325E				10/14/2020	10/14/2021
☐ Injection Clamp Luthi Model EM101				10/14/2020	10/14/2021
☐ Oscilloscope Scope: Tektronix MDO 4104				2/22/2021	2/22/2022
☐ EMC Transient Generator HVT TR 3000				2/22/2021	2/22/2022
☐ AC Power Source (Ametech, California Instruments)				2/22/2021	2/22/2022
☐ Field Intensity Meter: EFM-018				2/22/2021	2/22/2022
☐ R.F. Power Amp A.R. Model: 10W 1010M7				not required	
☐ R.F. Power Amp A.R. Model: 50U1000				not required	
☐ Tenney Temperature Chamber				not required	
☒ Shielded Room				not required	

Annex C Rogers Qualifications

Scot D. Rogers, Engineer

Rogers Labs, Inc.

Mr. Rogers has approximately 35 years' experience in the field of electronics. Engineering experience includes six years in the automated controls industry and remaining years working with the design, development and testing of radio communications and electronic equipment.

Positions Held

Systems Engineer:	A/C Controls Mfg. Co., Inc.	6 Years
Electrical Engineer:	Rogers Consulting Labs, Inc.	5 Years
Electrical Engineer:	Rogers Labs, Inc.	Current

Educational Background

1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.

2) Bachelor of Science Degree in Business Administration Kansas State University.

3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.

Scot D Rogers

Scot D. Rogers

Annex D Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 200087-0

Rogers Labs, Inc.
Louisburg, KS

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 17025:2017. 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 2009).

2021-02-19 through 2022-03-31
Effective Dates

For the National Voluntary Laboratory Accreditation Program