RHEIN TECH LABORATORIES, INC.

Engineering Solutions & Electromagnetic Compatibility Services

FCC Class 2 Test Report

STI Engineering Pty Ltd.
22 Boulder Road
Malaga, Western Australia 6090
Australia

FCC ID: P5MRFI148

Model: RFI-148 250

November 4, 2019

Standards Referenced for this Report	
Part 2: 2018	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
Part 90: 2018	Private Land Mobile Radio Services
ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

Frequency Range (MHz)	Rated Conducted Output Power (W)	Frequency Tolerance (ppm)	Transmit Mode	Emission Designator
153.5-159.5	250	1.0	FSK	4K86F1D

Report Prepared By: Daniel W. Baltzell

Document Number: 2019148

These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by ANAB.
Refer to certificate and scope of accreditation AT-1445.

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1 Test Result Summary

Test	FCC Reference	Result
RF Power Output	2.1046, 90.205	Complies
Spurious Emissions at Antenna Terminals	2.1051, 90.210	Complies
Field Strength of Spurious Radiation	2.1053	Complies
Occupied Bandwidth/ Emission Masks	2.1049	Complies
Frequency Stability vs. Temperature and Voltage	2.1055, 90.213	Complies
Transient Frequency Behavior	90.214	Complies

2 General Information

The following Class 2 report is prepared on behalf of STI Engineering Pty Ltd. in accordance with the Federal Communications Commission rules and regulations. The Equipment Under Test (EUT) was Model RFI-148 250; FCC ID: P5MRFI148.

All measurements contained in this application were conducted in accordance with the applicable sections of FCC Rules and Regulations CFR 47 Parts 2 and 90. Calibration checks are performed regularly on the instruments, and all accessories including high pass filter, coaxial attenuator, preamplifier and cables.

2.1 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc., 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report submitted to, and approved by, the Federal Communications Commission to perform AC line conducted and radiated emissions testing.

2.2 Related Submittal(s)/Grant(s)

This is a Class 2 application. The original FCC grant was issued January 31, 2013. The change was the addition of a 6.25 kHz mode. There were no hardware changes done to implement this change.

2.3 Grant Notes

The output power is variable from 20 W to 250 W. Output power is conducted. The antenna(s) used for this transmitter must be fixed-mounted on outdoor permanent structures. RF exposure compliance is addressed at the time of licensing.

2.4 Tested System Details

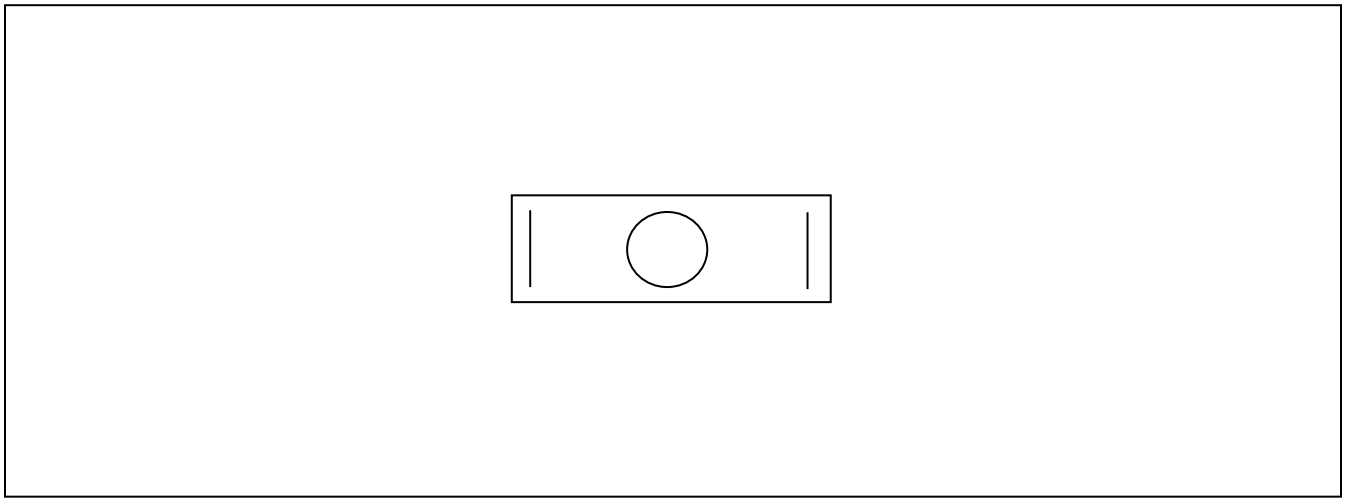
The test sample was received on October 17, 2019. Listed below are the identifiers and descriptions of all equipment, cables, and internal devices used with the EUT for this test, as applicable.

The EUT was programmed with 178 bps 2200 Hz deviation and CW mode of operation.

Table 2-1: Equipment Under Test (EUT)

Part	Manufacturer	Model	FCC ID	Serial Number	RTL Bar Code
VHF Paging Transmitter	STI Engineering Pty Ltd.	RFI-148 250	P5MRFI148	F00012K00891	23487

Figure 2-1: Configuration of Tested System



3 FCC Part 2.1046(a): RF Power Output: Conducted; Part 90.205

3.1 Test Procedure

ANSI 63.26, section 5.2

The EUT was connected to a coaxial attenuator having a 50 Ω load impedance.

Manufacturer's rated power: 250 W

3.2 Test Data

Table 3-1: RF Conducted Output Power – Measured

Frequency (MHz)	Power (dBm)	Power (W)
153.5	53.7	236.6
156.5	53.8	239.9
159.5	53.8	239.9

Measurement uncertainties shown for these tests are expanded uncertainties expressed at the 95% confidence level using a coverage factor K=2. Measurement uncertainty: ±0.5 dB

Notes: Data presented is for analog mode. All other modes were investigated and found to have equivalent power within measurement tolerances.

Result: PASS

Table 3-2: Test Equipment Used for Testing RF Power Output – Conducted

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21
901355	JFW Industries	50FH-003-300	300W 3DB DC1000 MHz Attenuator	N/A	10/9/20
901291	Pasternack	PE7031-20	300W Attenuator, DC - 1 GHz, 20 dB	NA	8/10/20
901724	Weinschel Corporation	48-40-34	Attenuator DC-18 GHz 40 dB 100W	CJ8921	9/9/20
901235	IW Microwave Products	KPS-1503-360-KPS	High Frequency RF Cable	36"	8/21/20

Test Personnel:

Daniel W. Baltzell		October 24, 2019
EMC Test Engineer	Signature	Date of Test

4 FCC Part 2.1051: Spurious Emissions at Antenna Terminals; Part 90.210: Emission Limitations

4.1 Test Procedure

ANSI 63.26, section 5.2

The transmitter is terminated with a 50 Ω load and interfaced with a spectrum analyzer.

Device with digital modulation: Modulated to its maximum extent using a pseudo-random data sequence.

4.2 Test Data

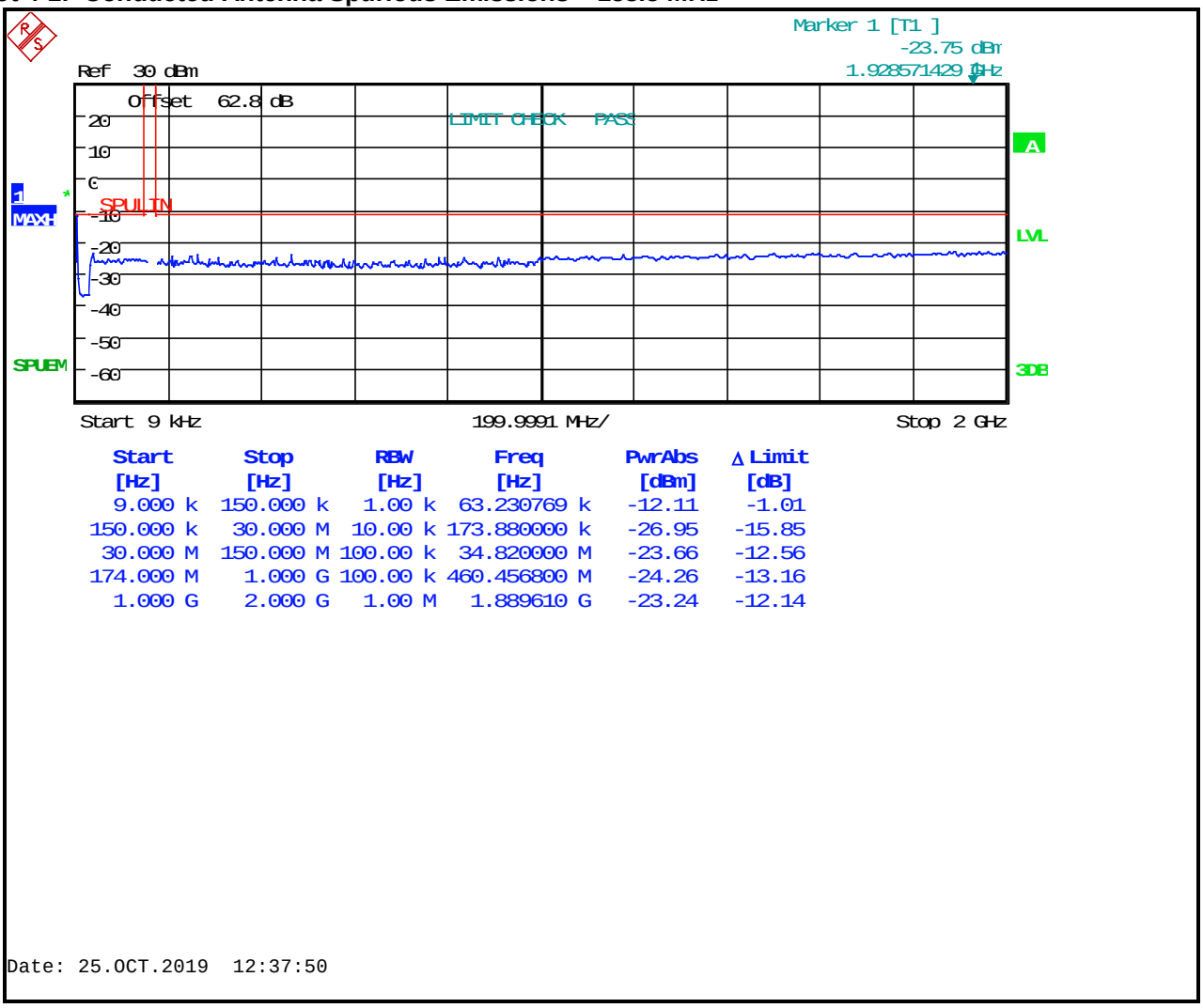
Frequency range of measurement per Part 2.1057: 9 kHz to 10 x Fc

Limits: 55 + 10 LOG P(W))

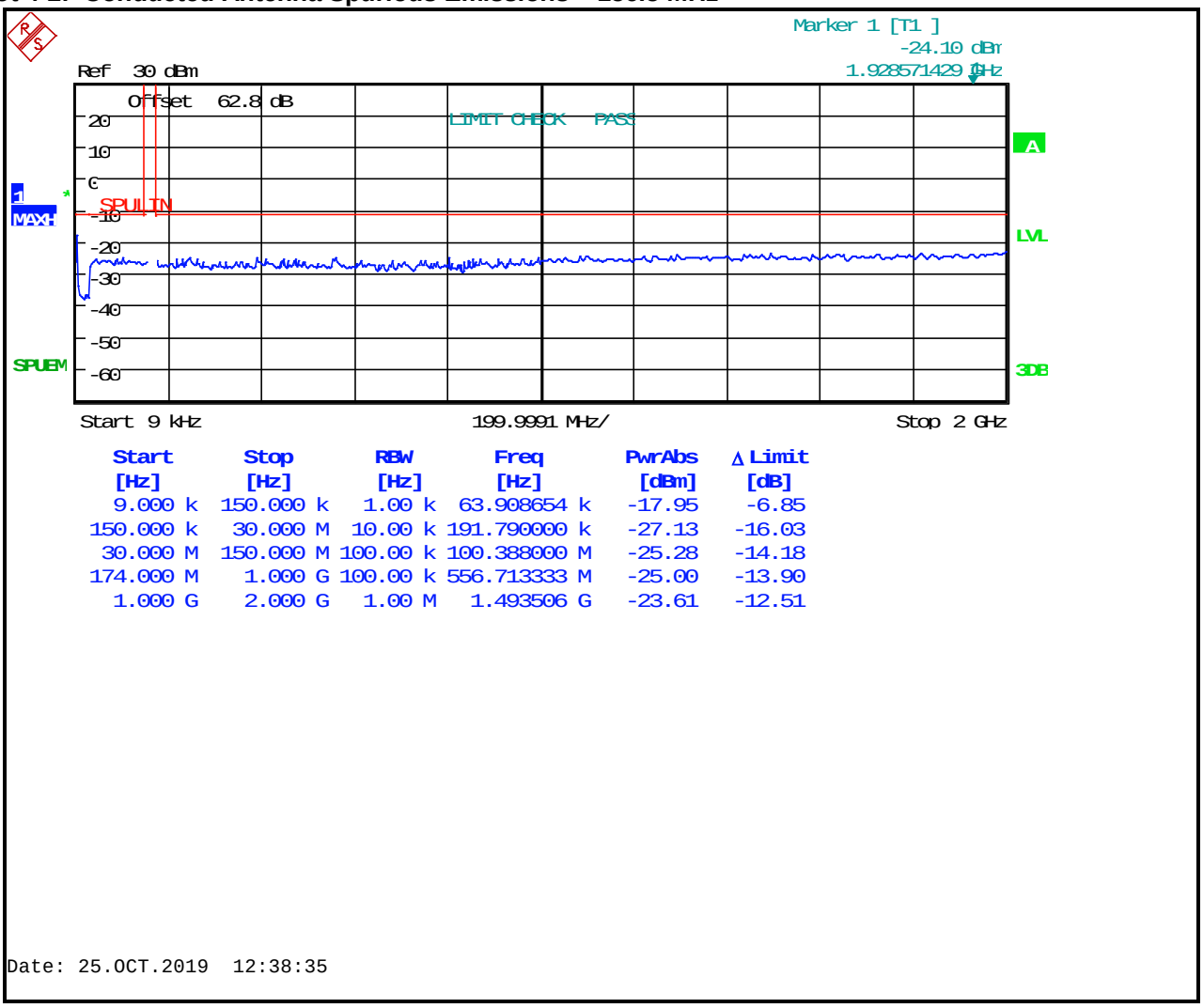
The following frequencies (in MHz) were investigated: 153.5, 156.5, and 159.5.

All modes and powers were investigated; high power is presented as worst case.

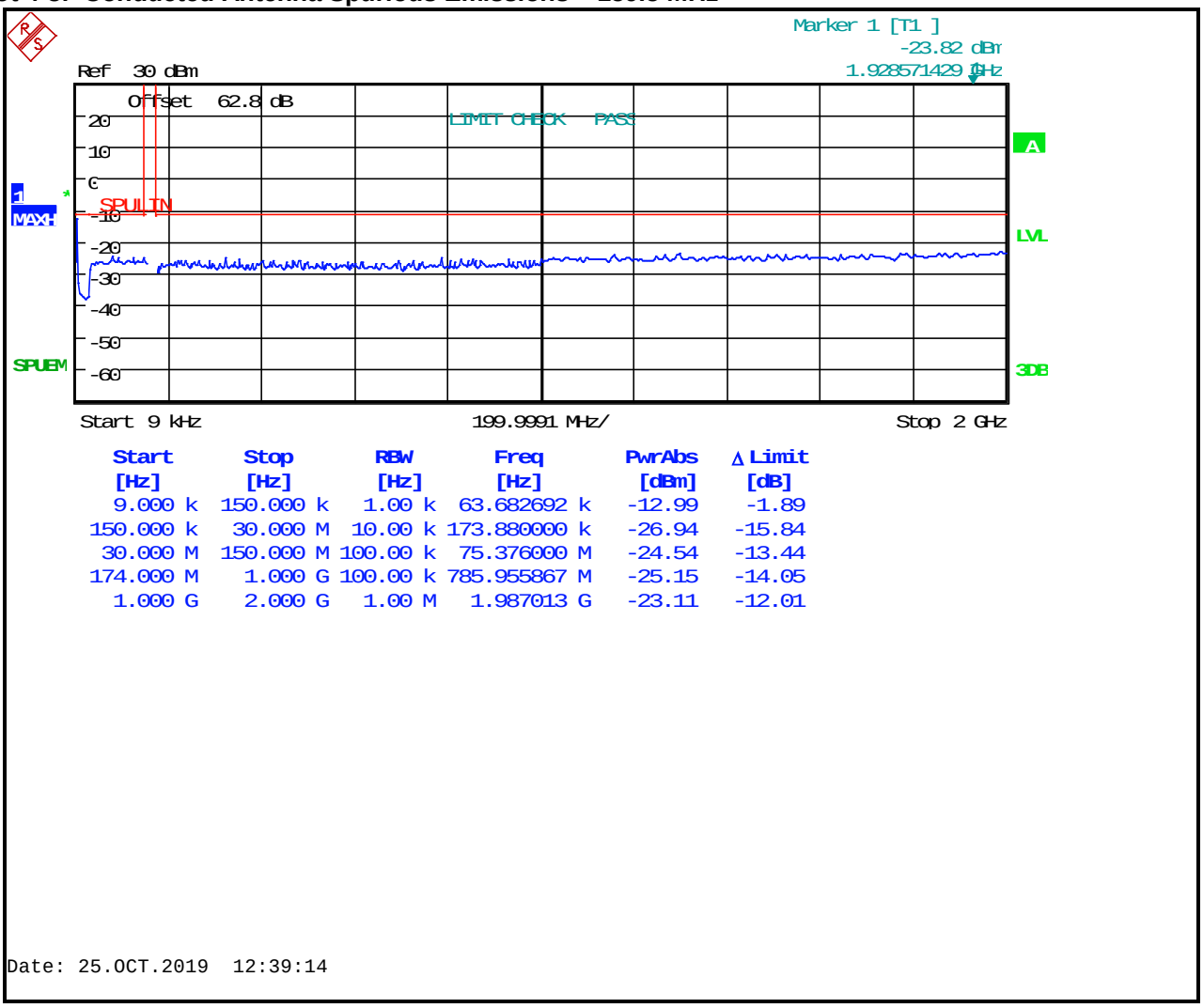
Plot 4-1: Conducted Antenna Spurious Emissions – 153.5 MHz



Plot 4-2: Conducted Antenna Spurious Emissions – 156.5 MHz



Plot 4-3: Conducted Antenna Spurious Emissions – 159.5 MHz



Measurement uncertainties shown for these tests are expanded uncertainties expressed at the 95% confidence level using a coverage factor K=2. Measurement uncertainty: ±0.5 dB

Result: PASS

Table 4-1: Test Equipment Used for Testing Antenna Port Spurious Emissions

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21
901355	JFW Industries	50FH-003-300	300W 3DB DC1000 MHz Attenuator	N/A	10/9/20
901291	Pasternack	PE7031-20	300W Attenuator, DC - 1 GHz, 20 dB	NA	8/10/20
901724	Weinschel Corporation	48-40-34	Attenuator DC-18 GHz 40 dB 100W	CJ8921	9/9/20
901235	IW Microwave Products	KPS-1503-360-KPS	High Frequency RF Cable	36"	8/21/20

Test Personnel:

Daniel W. Baltzell		October 25, 2019
EMC Test Engineer	Signature	Date of Test

5 FCC Part 2.1049(c)(1): Occupied Bandwidth; Part 90.210(e): Emission Masks

ANSI C63.26 5.4.3

5.1 Test Procedure

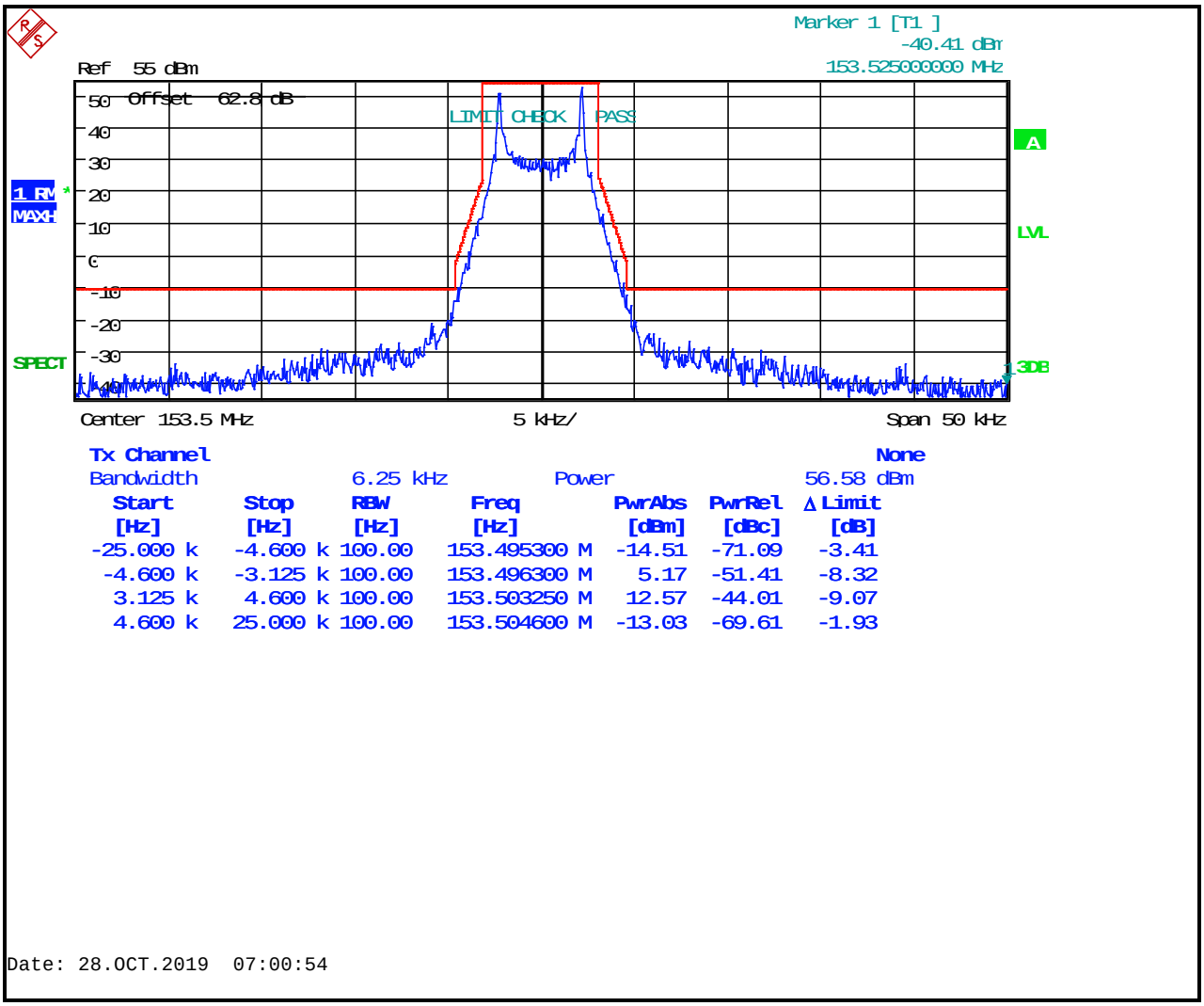
The transmitter is terminated with a 50 Ω load and interfaced with a spectrum analyzer.

Device with digital modulation: Modulated to its maximum extent using a pseudo-random data sequence.

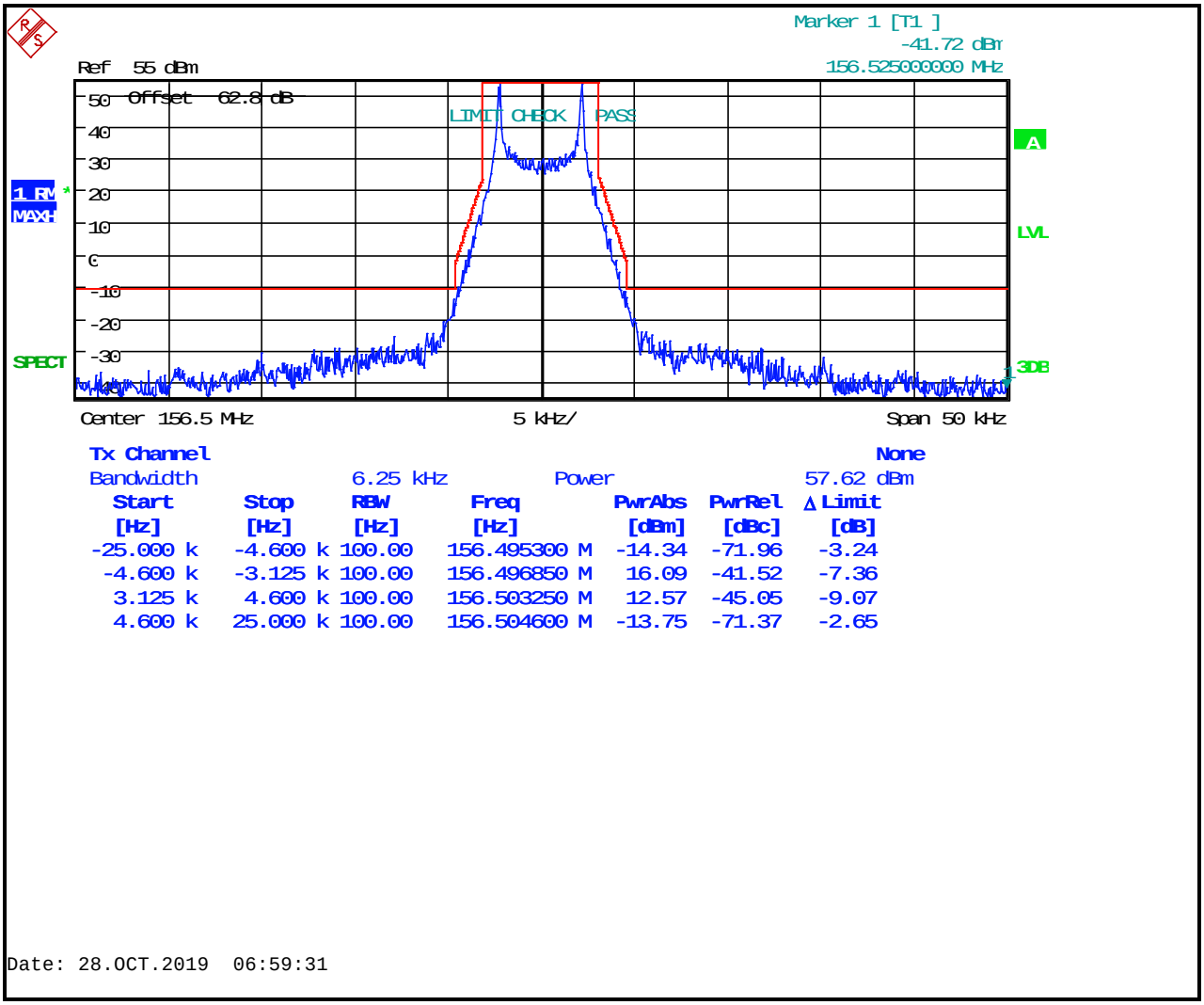
Part 90.210(e): ***Emission Mask E—6.25 kHz or less channel bandwidth equipment.***
For transmitters designed to operate with a 6.25 kHz or less bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:
(1) On any frequency from the center of the authorized bandwidth f0 to 3.0 kHz removed from f0: Zero dB.
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 3.0 kHz but no more than 4.6 kHz: At least 30 + 16.67(fd-3 kHz) or 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.
(3) On any frequency removed from the center of the authorized bandwidth by more than 4.6 kHz: At least 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.
(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two or three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emission mask, up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (o) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, an alternate procedure may be used provided prior Commission approval is obtained.

5.2 Test Data

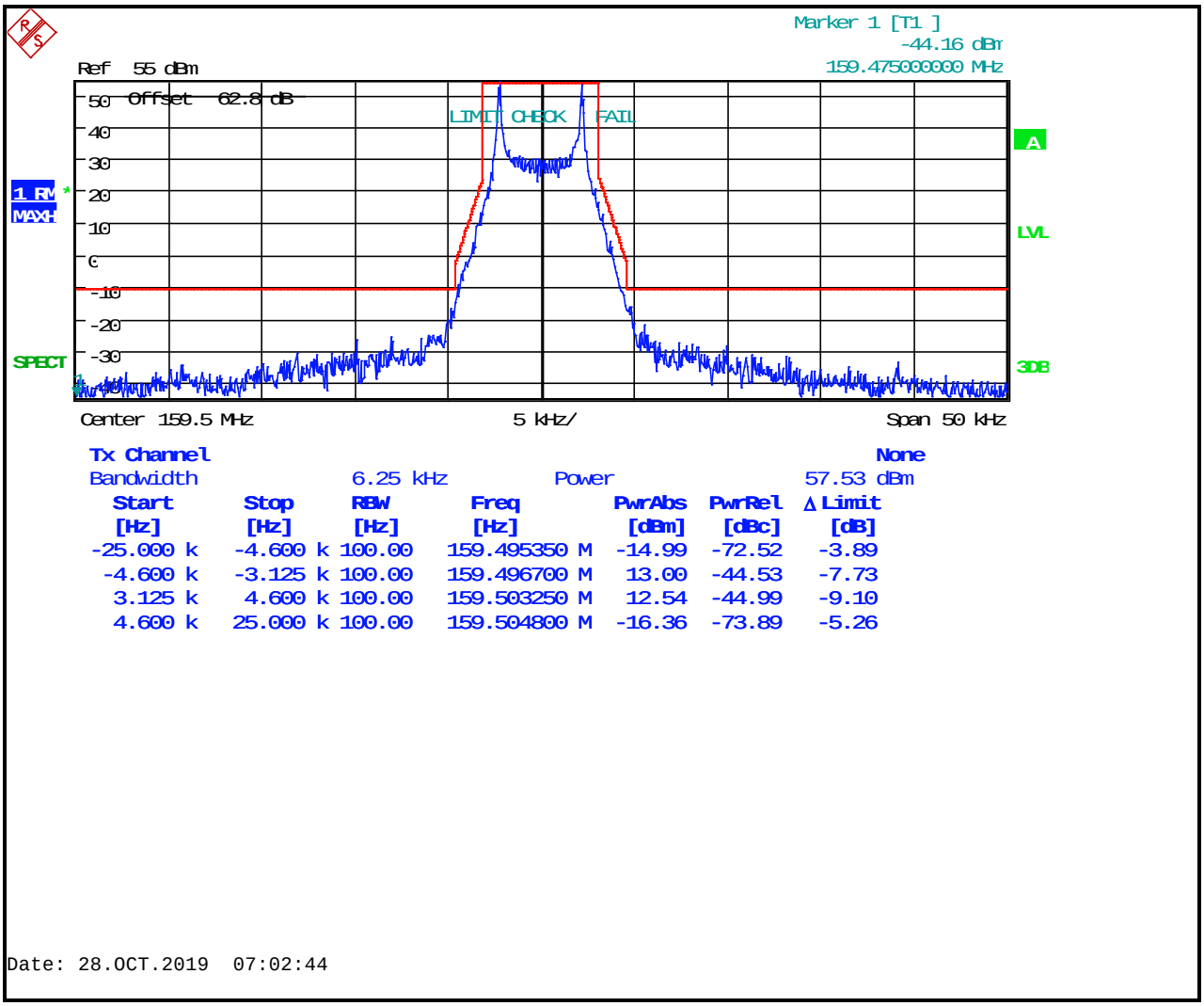
Plot 5-1: Emission Masks - 153.5 MHz



Plot 5-2: Emission Masks - 156.5 MHz



Plot 5-3: Emission Masks - 159.5 MHz



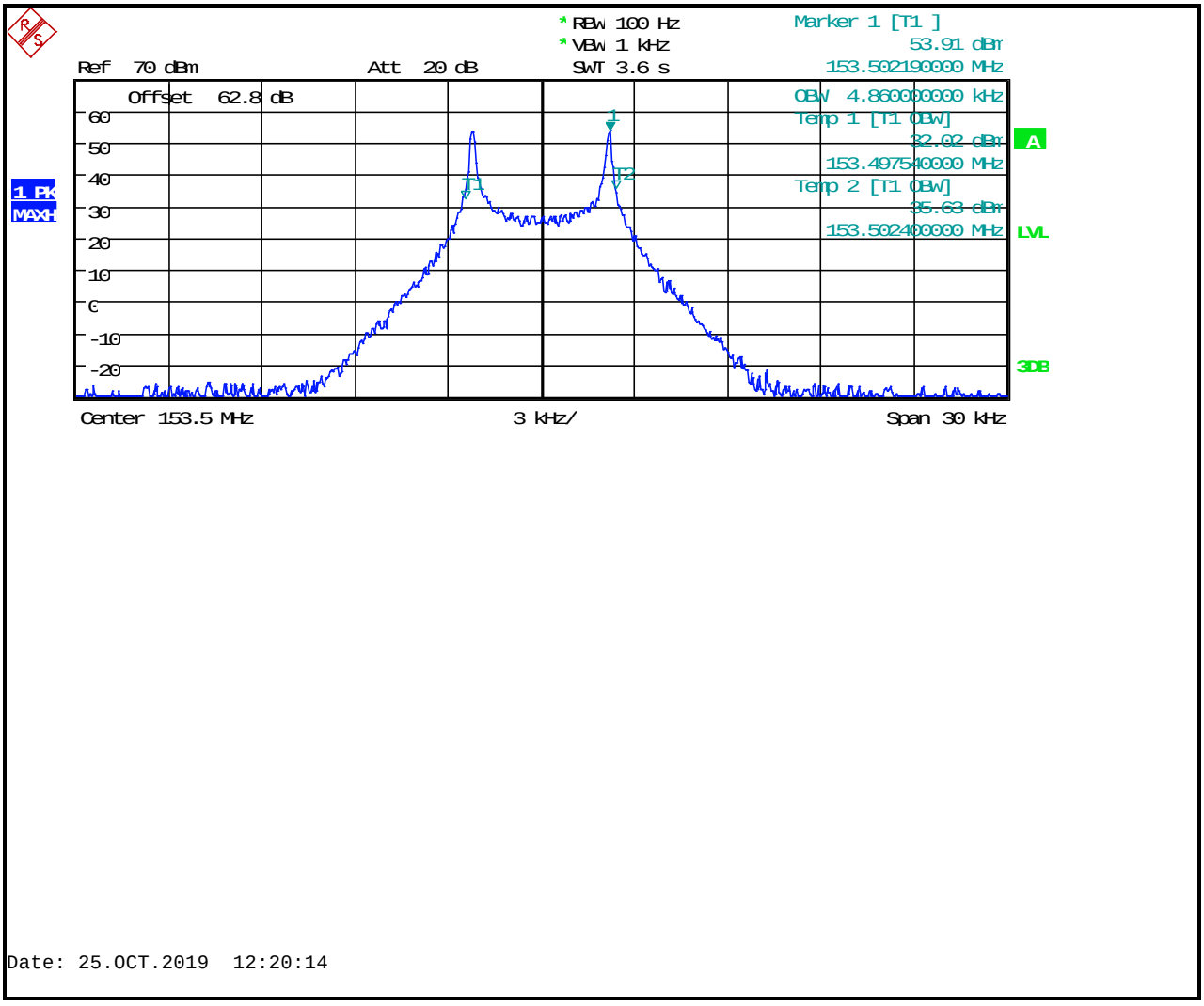
5.2.1 99% Bandwidth

The following frequencies (in MHz) were investigated: 153.5, 156.5, and 159.5 MHz.

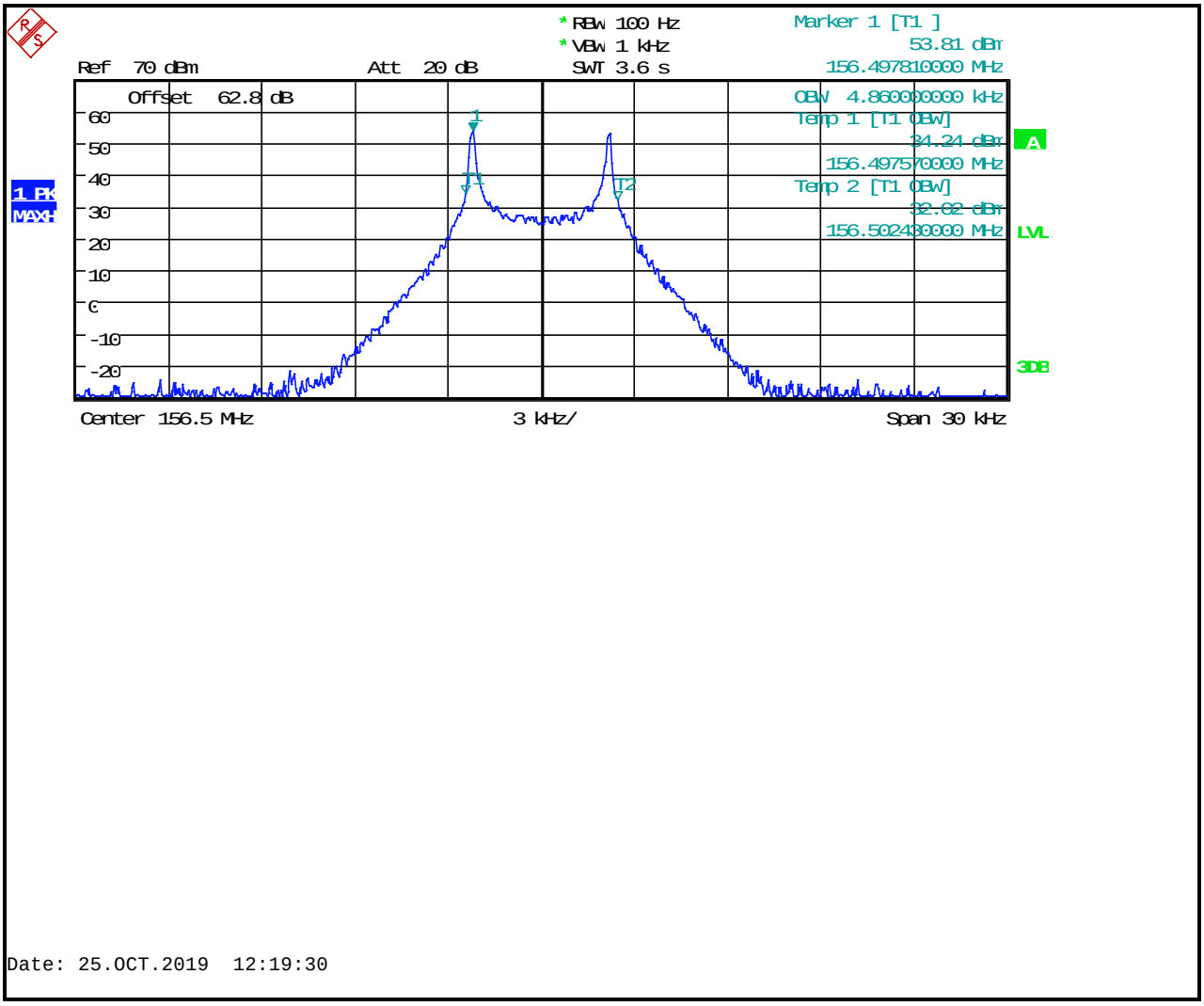
Table 5-1: 99% Bandwidth

Frequency (MHz)	BW (kHz)
153.5	4.86
156.5	4.86
159.5	4.86

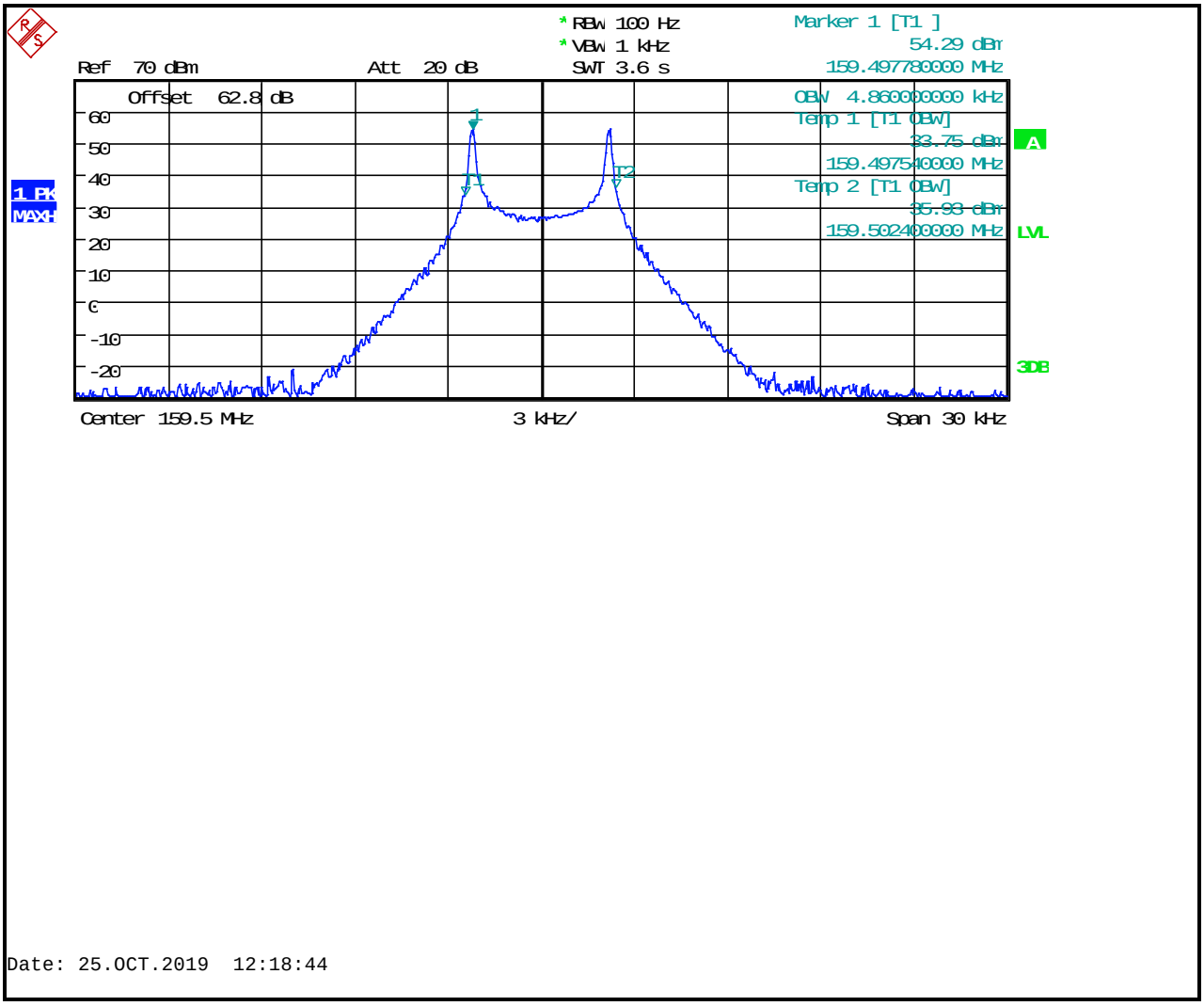
Plot 5-4: 99% Bandwidth – 153.5 MHz



Plot 5-5: 99% Bandwidth – 156.5 MHz



Plot 5-6: 99% Bandwidth – 159.5 MHz



Measurement uncertainties shown for these tests are expanded uncertainties expressed at the 95% confidence level using a coverage factor K=2. Measurement uncertainty: ±0.5 Hz

Result: PASS

Table 5-2: Test Equipment Used for Testing Bandwidth

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	4/26/21
901355	JFW Industries	50FH-003-300	300W 3DB DC1000 MHz Attenuator	N/A	10/9/20
901291	Pasternack	PE7031-20	300W Attenuator, DC - 1 GHz, 20 dB	NA	8/10/20
901724	Weinschel Corporation	48-40-34	Attenuator DC-18 GHz 40 dB 100W	CJ8921	9/9/20
901235	IW Microwave Products	KPS-1503-360-KPS	High Frequency RF Cable	36"	8/21/20

Test Personnel:

Daniel W. Baltzell		October 25, 2019
EMC Test Engineer	Signature	Date of Test

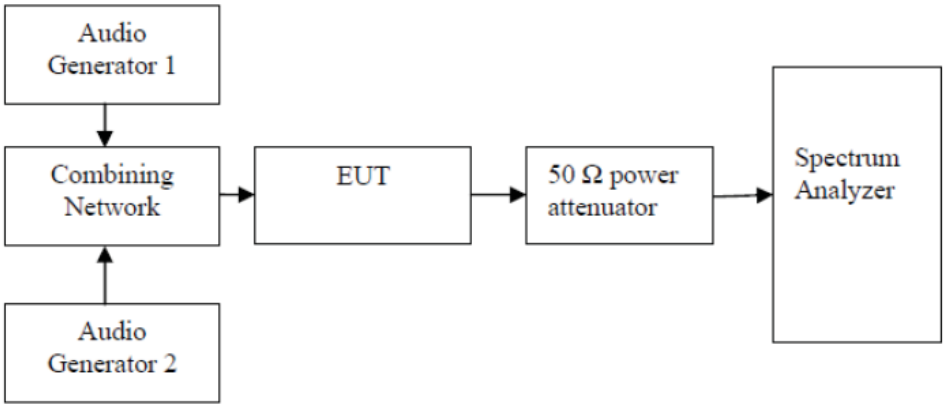
6 FCC Part 90.214: Transient Frequency Behavior

ANSI C63.26 6.5.2.3

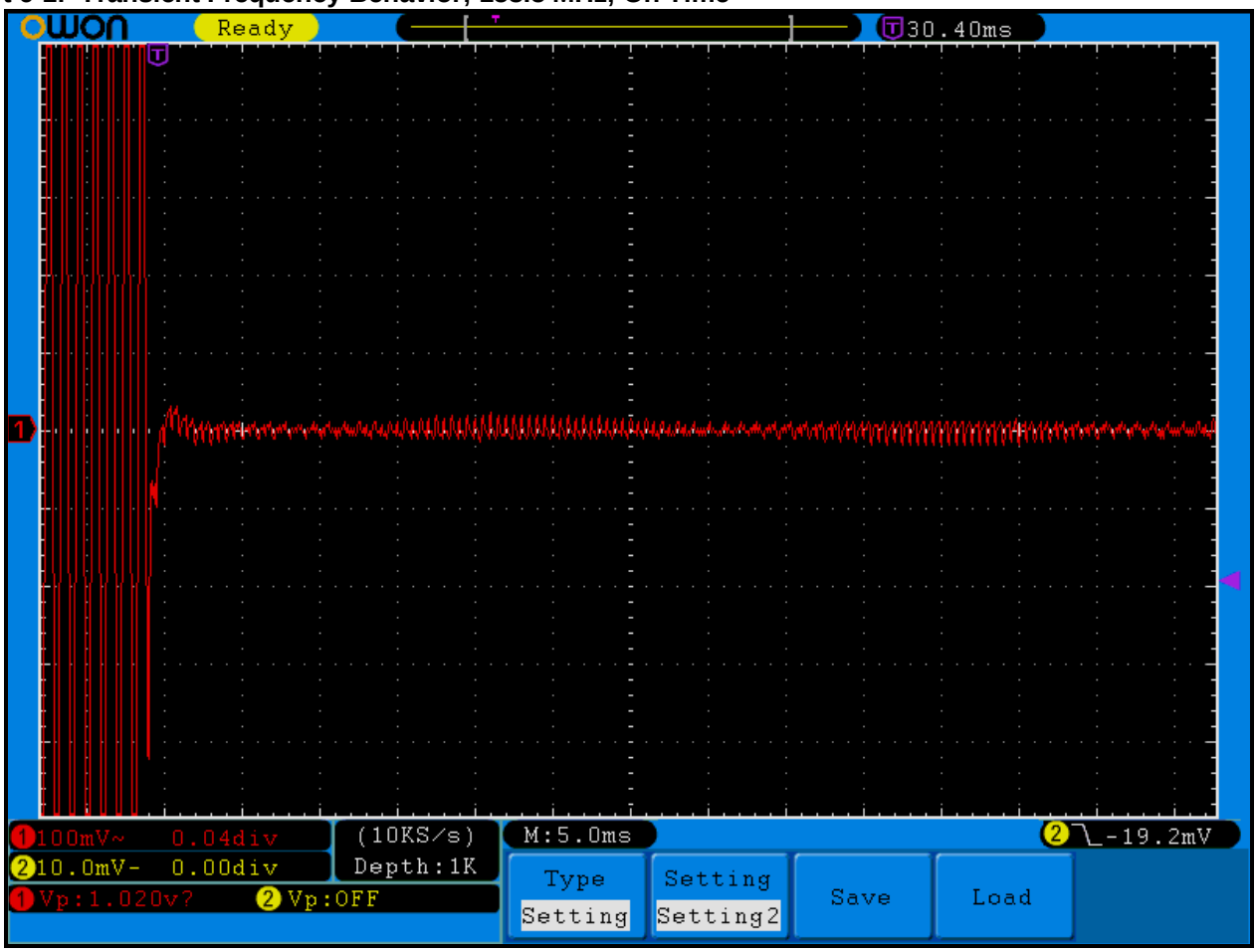
6.1 Test Procedure

This method uses a test receiver and a signal generator to indicate the moment the transmitter turns on and locks to the assigned frequency, and the moment the transmitter turns off and is no longer on the assigned frequency.
a) Connect test equipment as shown in Figure 13.
b) Verify RF attenuator power rating for EUT providing adequate protection to the combining network and measurement equipment.
c) Tune test receiver to transmitter assigned frequency, set it to measure FM deviation with the audio bandwidth set at ≤ 50 Hz to ≥ 15 000 Hz, set detector to positive peak.
d) Set the signal generator to the assigned transmitter frequency, enable FM and modulate it with a 1 kHz tone and applicable channel size. (e.g., ±25 kHz deviation). Set RF output level to -100 dBm or equivalent according to combining network RF losses.
e) Connect combining network output to RF power meter input.
f) Turn on transmitter.
g) Verify the RF attenuator can provide an input level to the test receiver that is 40 dB below the test receiver maximum allowed input power when the transmitter is operating at its rated power level. Verify this power level on the RF power meter. Adjust attenuation as required.
h) Turn off transmitter.
i) Adjust signal generator RF level until the RF power meter equal to the level noted in step g). This signal generator RF level shall be maintained throughout the rest of the measurement.
j) Disconnect RF combiner from power meter and connect it to test receiver RF input.
k) Adjust storage oscilloscope horizontal sweep rate and display to 10 ms per division to continuously view the 1000 Hz tone from the demodulator output port (DOP). Center the vertical amplitude to display the 1000 Hz at plus or minus four divisions vertically.
l) Adjust the oscilloscope trigger on an increasing magnitude from the RF peak detector at 1 division from the left side of the display, at the moment the transmitter is turned on. Enable oscilloscope to store the display.
m) Reduce the attenuation of the RF attenuator so the input to the RF peak detector and the RF combiner is increased by 30 dB when the transmitter is turned on.
n) Turn on the transmitter and observe the stored display. The output of the test receiver at the DOP, due to the change in the ratio of power between the signal generator input power and the transmitter output power will change because of the capture effect of the test receiver, produce a change in oscilloscope display. Note that the first part of the sweep will show the 1 kHz test signal from the signal generator. Then after the receiver's demodulator has been captured by the transmitter power, the display will show the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The moment when the 1 kHz test signal is completely suppressed (including any capture time due to phasing) is considered to be t_{on}. The trace should be maintained within the allowed divisions during the period t_1 and t_2.
o) The time from the end of t_2 to the beginning of t_3 the frequency difference should not exceed the applicable limits. The allowed limit is equal to the transmitter frequency multiplied by its applicable frequency tolerance times plus or minus four display divisions (e.g., divided by 25 kHz). For example, at a transmitter assigned frequency of 500 MHz and a frequency tolerance of 5 ppm, gives (500 MHz × 5 ppm × ± 4 divisions ÷ 25 kHz); this equals ±0.4 divisions in this example. Adjust oscilloscope vertical sensitivity to view this accurately.
p) Turn on transmitter and observe the stored display. The new trace should be maintained within the allowed divisions after the end of t_2 and remain within until the end of the trace. Turn off transmitter.
q) Turn on transmitter to test the transient frequency behavior during the period t_3.
r) Adjust the oscilloscope trigger controls so it will trigger on a decreasing magnitude from the RF peak detector, at 1 division from the right side of the display, when the transmitter is turned off. Set the controls to store the display. The moment when the 1 kHz test signal starts to rise is considered to provide t_{off}.
s) The transmitter shall be turned off.
t) The new displayed trace should remain within the allowed divisions during period t_3.

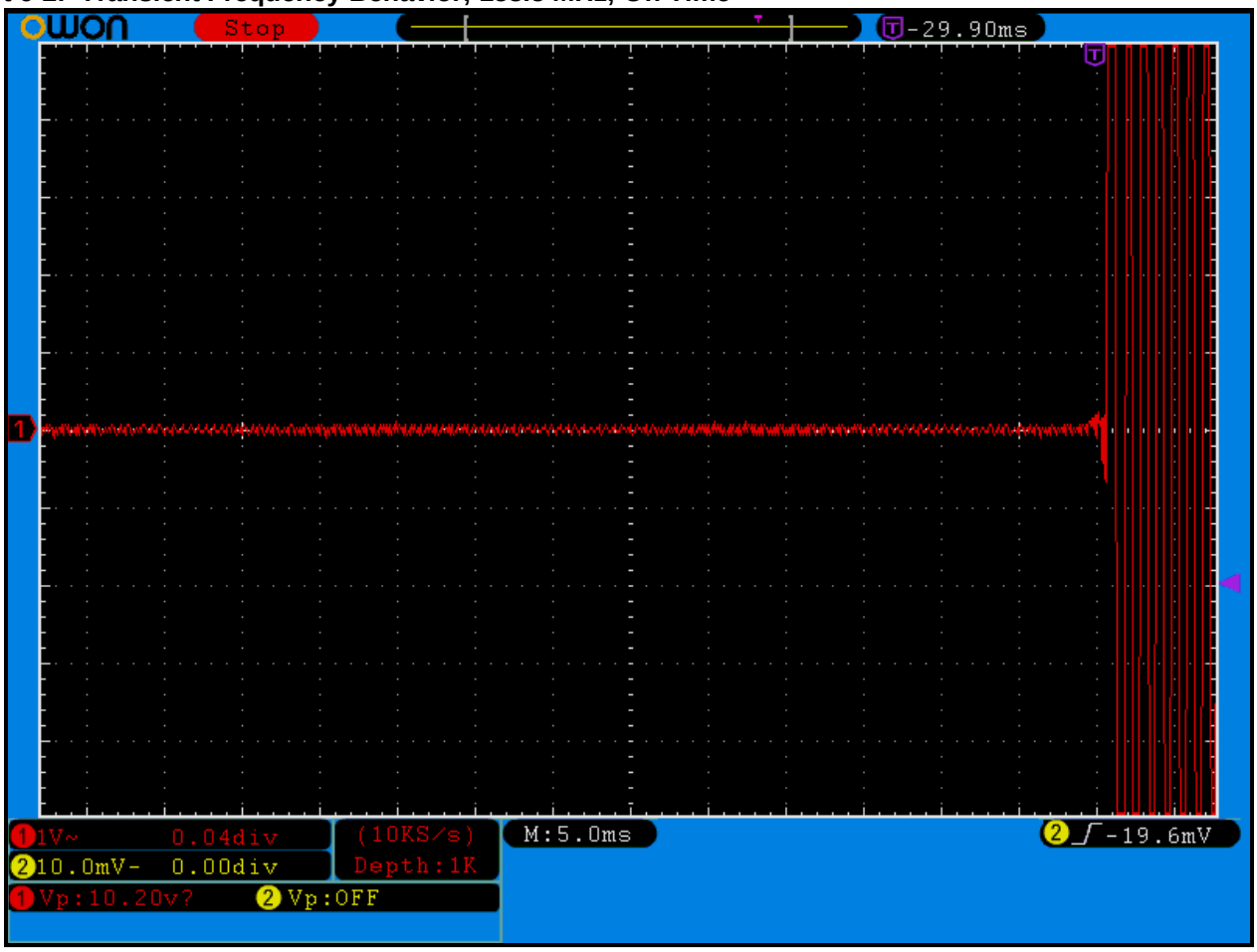
Figure 6-1: Configuration for Transient Frequency Behavior



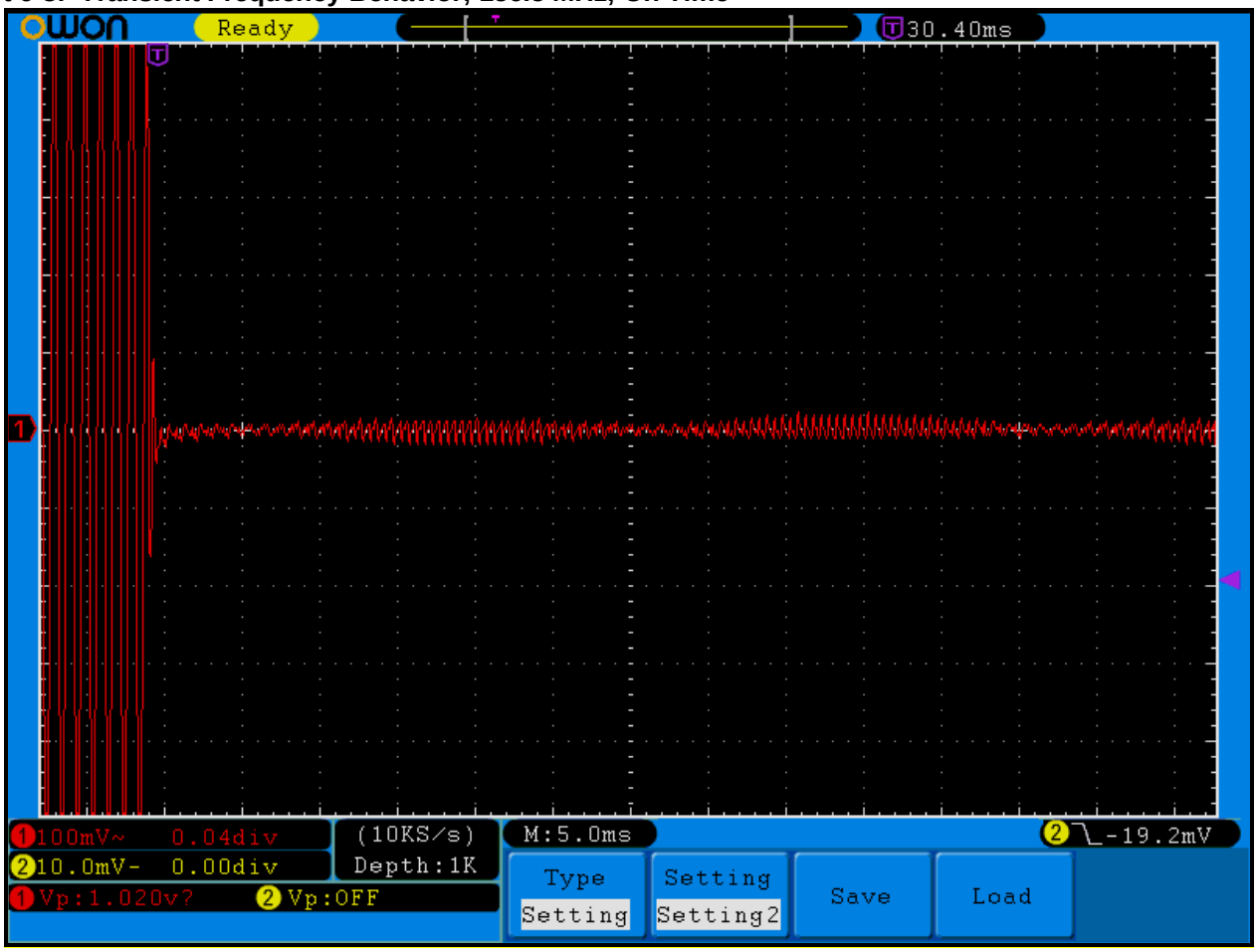
Plot 6-1: Transient Frequency Behavior; 153.5 MHz; On Time



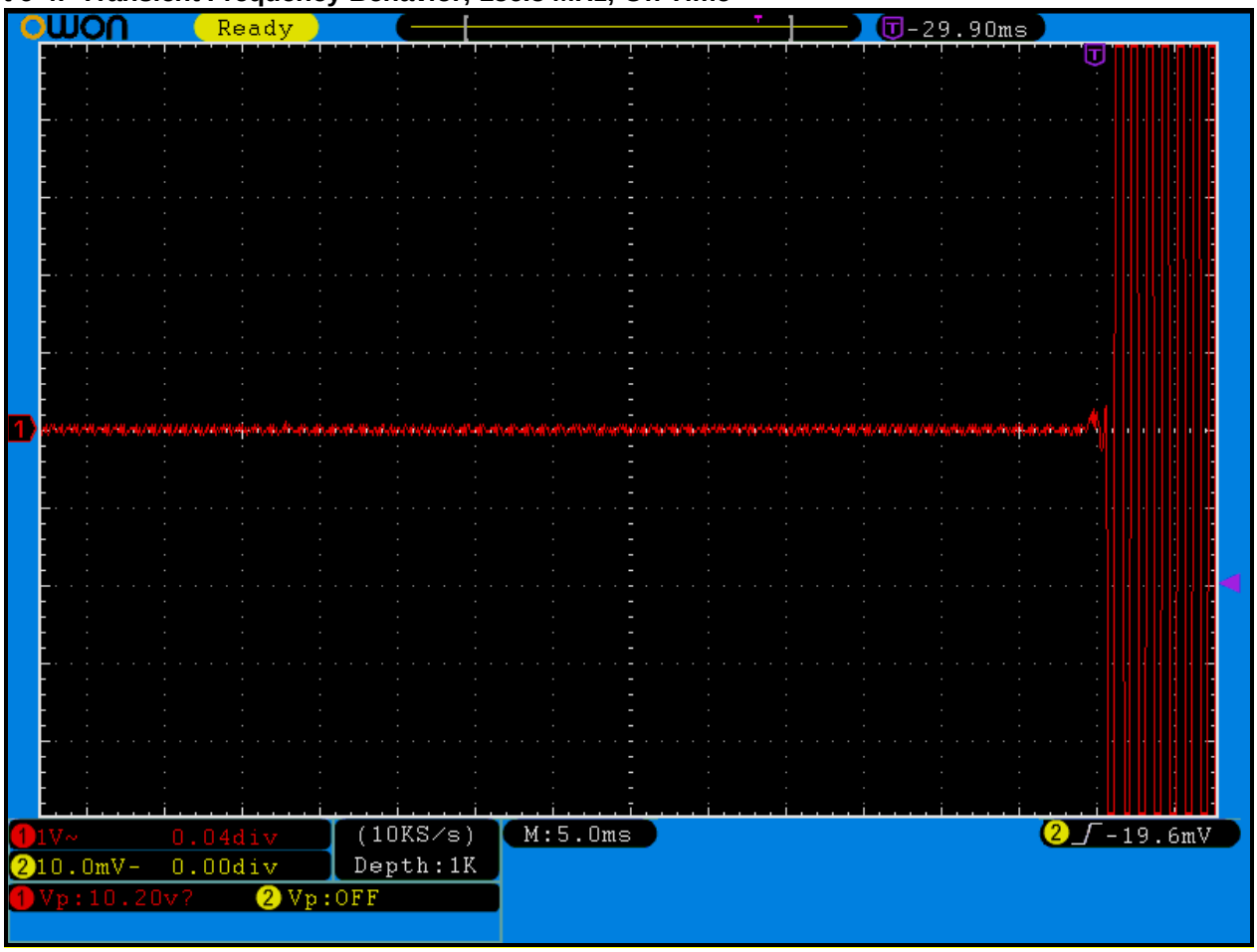
Plot 6-2: Transient Frequency Behavior; 153.5 MHz; Off Time



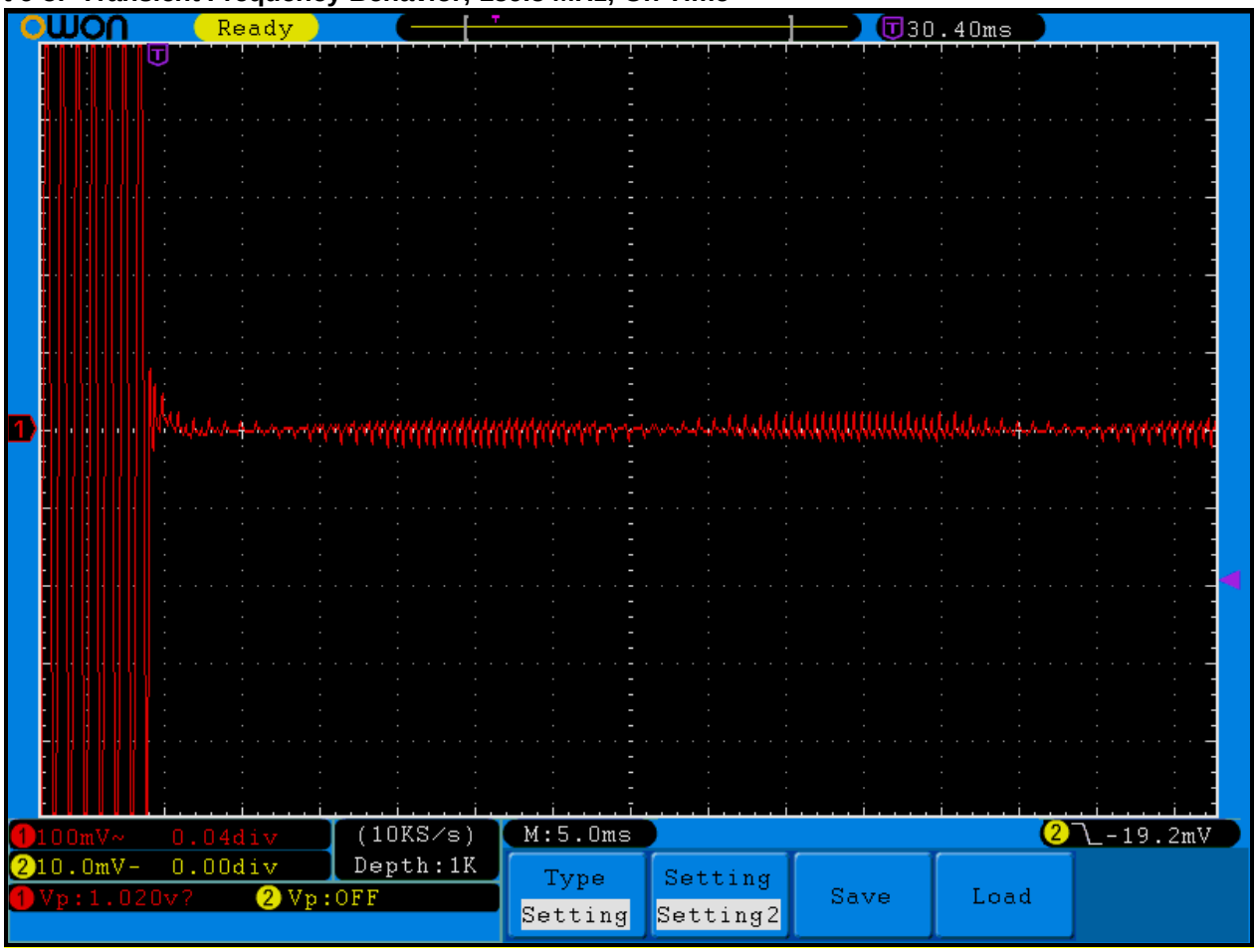
Plot 6-3: Transient Frequency Behavior; 156.5 MHz; On Time



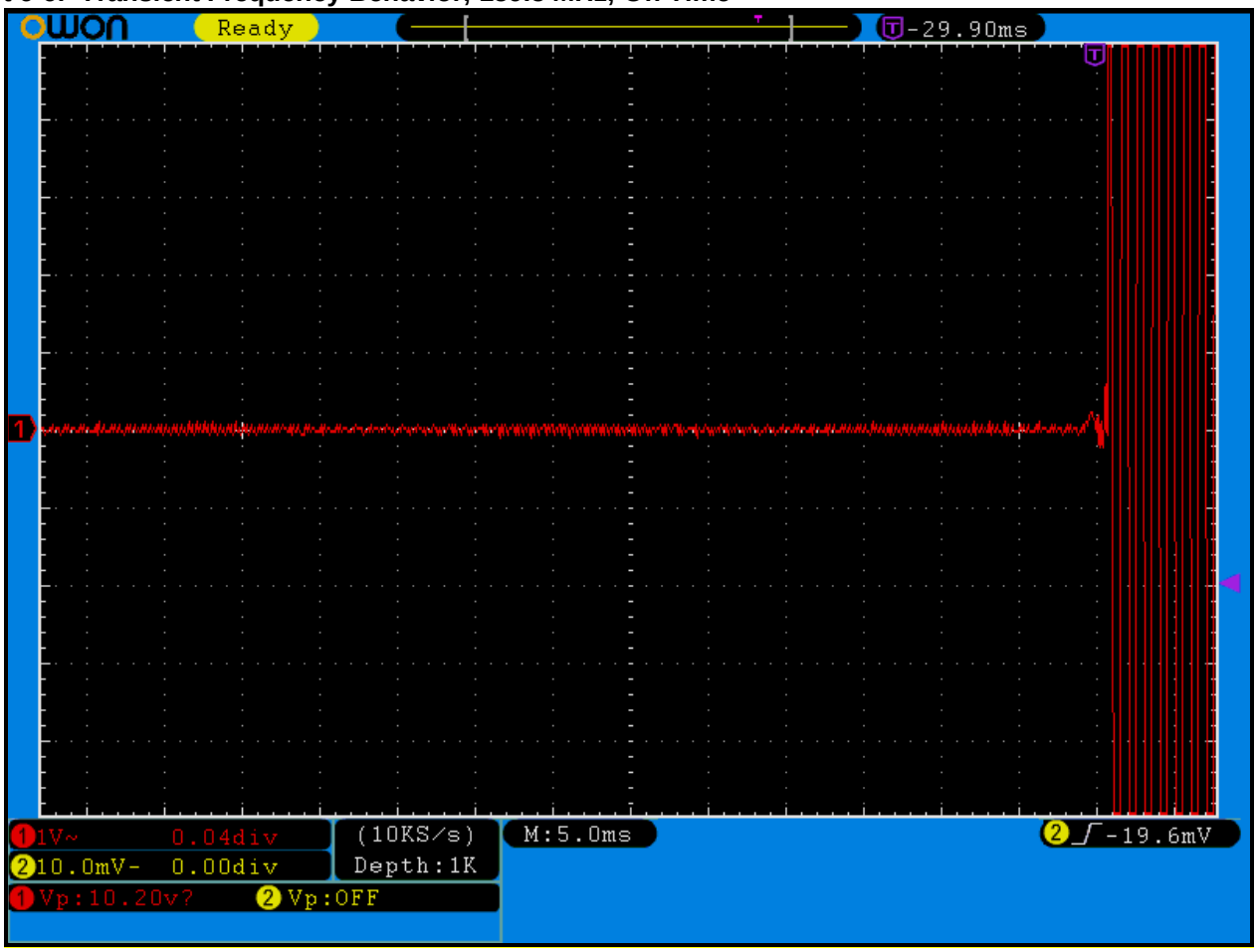
Plot 6-4: Transient Frequency Behavior; 156.5 MHz; Off Time



Plot 6-5: Transient Frequency Behavior; 159.5 MHz; On Time



Plot 6-6: Transient Frequency Behavior; 159.5 MHz; Off Time



Result: PASS

Table 6-1: Test Equipment Used for Testing Transient Frequency Behavior

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901118	Hewlett Packard	HP8901B	Modulation Analyzer	2406A00178	1/31/20
901582	Rohde & Schwarz	1167.0000.02	Signal Generator	101903	4/24/21
901355	JFW Industries	50FH-003-300	300W 3DB DC1000 MHz Attenuator	N/A	10/9/20
901291	Pasternack	PE7031-20	300W Attenuator, DC - 1 GHz, 20 dB	NA	8/10/20
901724	Weinschel Corporation	48-40-34	Attenuator DC-18 GHz 40 dB 100W	CJ8921	9/9/20
901463	Werlatone Inc.	C1795	Directional coupler, 100W, 40 dB	4067	9/9/20
901651	OWON	SmartDS7102V	Oscilloscope	SDS71021434850	4/2/21

Test Personnel:

Daniel W. Baltzell		October 25, 2019
EMC Test Engineer	Signature	Date of Test

7 Conclusion

The data in this Class 2 report shows that the STI Engineering Pty Ltd. Model RFI-148 250, FCC ID: P5MRFI148, complies with the applicable requirements of FCC Parts 2 and 90 of the FCC Rules.