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Labs
LLC

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**REPORT OF
ELECTROMAGNETIC INTERFERENCE AND
SUSCEPTIBILITY TESTS**

ON

Atom 2

Part Number: US007-0001

Serial Number: 180007

PREPARED FOR:

SHOTOVER Systems
5660 Airport Boulevard, Suite 101
Boulder, CO 80301

PREPARED BY:

NTS LABS, LLC
EMI/EMC TEST GROUP
1736 Vista View Drive
Longmont, CO 80504-5242

02/08/2023

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SIGNATURE PAGE

Service For: SHOTOVER Systems
5660 Airport Boulevard, Suite 101
Boulder, CO 80301

Purchase Order No: 1064 dated 07/25/2022
1066 dated 10/10/2022
PO-5375 dated 10/23/2022
PO-5510 dated 11/28/2022
Signed COS dated 12/14/2022

This is to certify that the preceding report is true and correct to the best of my knowledge.

Andrew Garcia
Preparer

Eugene DeVito
Program Manager

REVISIONS

Revision	Reason for Revision	Date
0	Original	02/08/2023
1	Revised EUT name	03/08/2023
2	Revisions per Ryan Locker email on 03/17/2023	03/17/2023
3	Updated EUT name and Section Titles	04/03/2023

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1.0 SCOPE

The ATOM2 was tested from 08/23/2022 through 01/30/2023, in accordance with the tests and requirements of RTCA/DO-160G and OP0613097 dated 04/06/2022, which shall be referred to as the subject specifications for the remainder of this test report.

The applicable test requirements of the subject specification are presented here for convenience.

TEST REQUIREMENTS

<u>TEST METHOD</u>	<u>SECTIONS</u>	<u>FREQUENCY RANGE</u>	<u>TESTPOINTS</u>
<u>Emissions:</u>			
Magnetic Effects	Section 15	NA	Case and Cables
Conducted Emissions	Section 21	150kHz - 150MHz	Power Leads
Radiated Emissions E-Field	Section 21	100MHz - 6GHz	Case and Cables
<u>Susceptibility:</u>			
Power Inputs	Section 16	NA	Power Leads
Voltage Spike	Section 17	NA	Power Leads
Electrostatic Discharge	Section 25	NA	Case and Cables

2.0 TEST RESULTS

The test results are tabulated in the test summary and the referenced test data and graphs are presented in the relevant section.

	Section	Category	Pass/ Fail
Magnetic Effects	15	Z	Pass
Power Inputs	16	B	Pass
Voltage Spikes	17	B	Pass
Conducted Emissions	21	M	Pass
Radiated Emissions	21	M	Pass
Electrostatic Discharge	25	A	Pass

The decision rule used to state compliance is in accordance with the test specification used for testing and customer provided pass/fail functional criteria of the equipment under test.

MODIFICATIONS:

There were no modifications during the test.

3.0 DISPOSITION OF TEST SAMPLE

Upon conclusion of the testing, the test item was returned to:

SHOTOVER Systems
5660 Airport Boulevard, Suite 101
Boulder, CO 80301

4.0 GENERAL INFORMATION OF TESTING

4.1 *Security Classification*

The test sample was Unclassified.

4.2 *Test Facility*

One of NTS' 20' x 20' x 12' Semi-Anechoic enclosures was used for testing covered by this report. The enclosures are manufactured of zinc plated 20 gauge cold-rolled steel panels. The ambient level is at least 6 dB below the specification limit.

4.3 *Ground Plane*

The ground plane used for the tests covered by this report was a 3' x 12' x 0.065" copper sheet (the top of the bench) bonded to the shielded enclosure in accordance with the specification requirements.

4.4 *Test Equipment*

The test instruments used during testing covered by this report are presented in the equipment list in the relevant section.

4.5 *Instrumentation Calibration Policy*

National Technical Systems adheres to a standard calibration cycle. Each category "A" instrument undergoes recalibration every 12 months. All calibration is traceable to the National Institute of Standards and Technology (NIST).

4.6 *Test Setup*

The test setups required for the various tests conformed to the test provisions stated in the subject specification. Typical test setup photographs showing the test sample and associated equipment used are included in the relevant section.

4.7 *Emissions Setup for TILE Automated System*

The values included in the emission setup are actual values of particular transducers used at the time of testing, and actual value of the pre-amplifier gain. The TILE (Total Integrated Laboratory Environment) Software was used for Radiated and Conducted Emissions Testing. The version of the software used is TILE6.

5.0 TEST DATA

5.1 RTCA/DO-160G Section 15 Magnetic Effect

5.1.1 Purpose of the Test

This test determines the magnetic effect of the equipment and is mainly intended for finding or proving the closest distance to compasses or compass sensors (flux gates) at which that unit is allowed to be install. This test ensures that equipment can operate properly without interference which may affect the nearby equipment, determining equipment compliance with the applicable equipment performance standard or assisting the installer in choosing the proper location of the equipment in the aircraft.

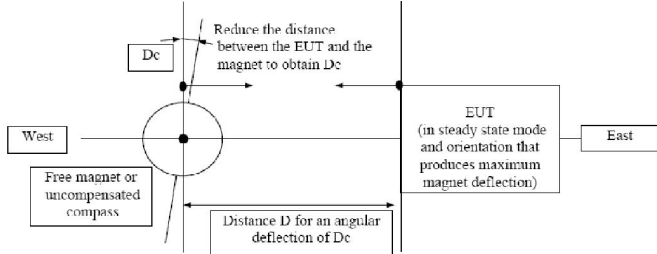
5.1.2 Test Description

The magnetic effect of the equipment shall be determined in terms of the deflection of a free magnet in a uniform magnetic fields (as produced by the earth) having a horizontal intensity of $14.4 \text{ A/m} \pm 10\%$ when the equipment under test is positioned on the east-west line through the pivot of a magnet. This measurement may be performed with either an uncompensated compass or an equivalent magnetic sensor.

		National Technical Systems				
		Magnetic Effect Data Sheet				
The Following is the process for determining the free field A/M used for test Section 15. The process will Calculate the Deflection to use for testing using a calibrated Magnetometer.						
Dc = the equivalent deflection angle to be used in determining equipment category						
HCFAS = Horizontal Component of Ambient Field Strength						
A/M = the measured Gauss field converted to A/M (Gauss Field/(4*pi*0.001))						
Minimum Ambient Field = 14.4 - (14.4 * 0.1)						
Maximum Ambient Field = 14.4 + (14.4 * 0.1)						
Angular Deflection To Use For Testing = 14.4/(HCAFS A/M). If the calculated value falls between 14.4 +/-10%, 1 degree will be used for the Dc. If the calculated value falls outside of that range, the calculated value will be used as the Dc.						
Measured Values		Calculations		Ambient Field Calculations		Observations
Gauss Field:	0.1785	A/M:	14.20	HCAFS A/M:	14.2046	
				Minimum Ambient Field:	12.9600	
				Maximum Ambient Field:	15.8400	
				Dc:	1.0138	
Angular Deflection to use for testing:			1.00			
Test Performed By:		Jon Tanner				

5.1.3 Test Procedure

The EUT is to be powered with the same or an identical cable harness used for section 20 testing. All cables and extended power leads for the EUT are to be placed in one bundle for the test. This bundle is to be routed along the east to west axis of the compass.

National Technical Systems				
Magnetic Effect Data Sheet				
Remarks: The magnetic effect of the equipment shall be determined in terms of the deflection of a compass in a uniform magnetic field (as produced by earth). The horizontal intensity shall be 14.4 A/m +/- 10% when the equipment under test (EUT) is positioned on the East/West line through the pivot of a magnet.				
<u>Equipment Category</u> Y Z A B C	<u>Distance for a Deflection of Dc</u> D = 0.0m 0 < D ≤ 0.3m 0.3 < D ≤ 1m 1m < D ≤ 3m greater than 3.0 m			
				
Angular Deflection to use for testing:				
1.00				
Orientation	Initial Distance	Distance at Deflection (Dc)	Category	
Left Side	3m	0.020	Category Z	0 < D ≤ 0.3m
Right Side	3m	0.020	Category Z	0 < D ≤ 0.3m
Front	3m	0.020	Category Z	0 < D ≤ 0.3m
Rear	3m	0.020	Category Z	0 < D ≤ 0.3m
Top	3m	0.020	Category Z	0 < D ≤ 0.3m
Test Performed By:		Jon Tanner		

5.1.4 Test Data

Date of Test: 08/23/2022

Operator: Jon Tanner, EMC Test Technician

		National Technical Systems						
		Section 15 Magnetic Effect (Magnetometer Method) Log						
Temp:	26.1	° C	Humidity:	48.2	% RH	Baromete	30.14	inHg
Date	Time	Log Entries						Initials
8/23/22	0900	Setup outside 10m2 for Magnetic Effect						JT
	0915	Run Magnetometer Method Calibration						JT
		Waiting on client arrival						JT
	1150	Client arrived, setup for Section 15 Magnetic Effect						JT
	1215	Run Section 15 Magnetic Effect						JT
	1230	Test Complete						JT
Test Performed By:		Jon Tanner						

5.1.5 Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059715	Chamber (EMI, Anechoic)OTA	Rayproof	SR 1	07/13/2015	NCR
WC070448	Measurement Tools (Compass)	Sunol Sciences	KB-143/360R G	NCR	NCR

5.1.6 Test Pictures Setup



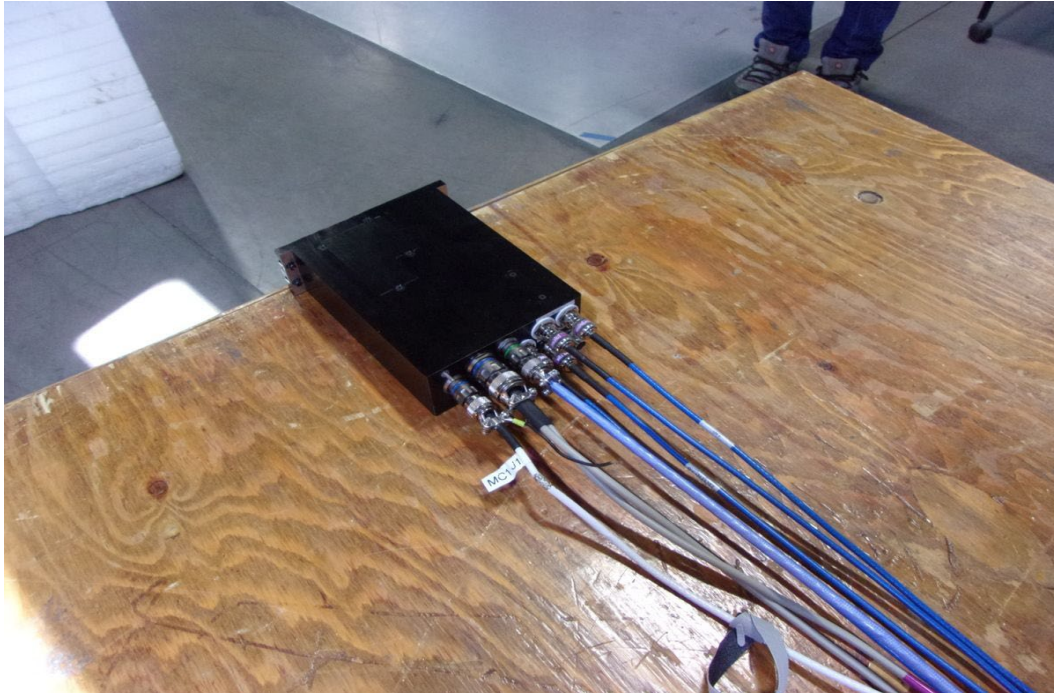
General Test Setup for Magnetic Effects



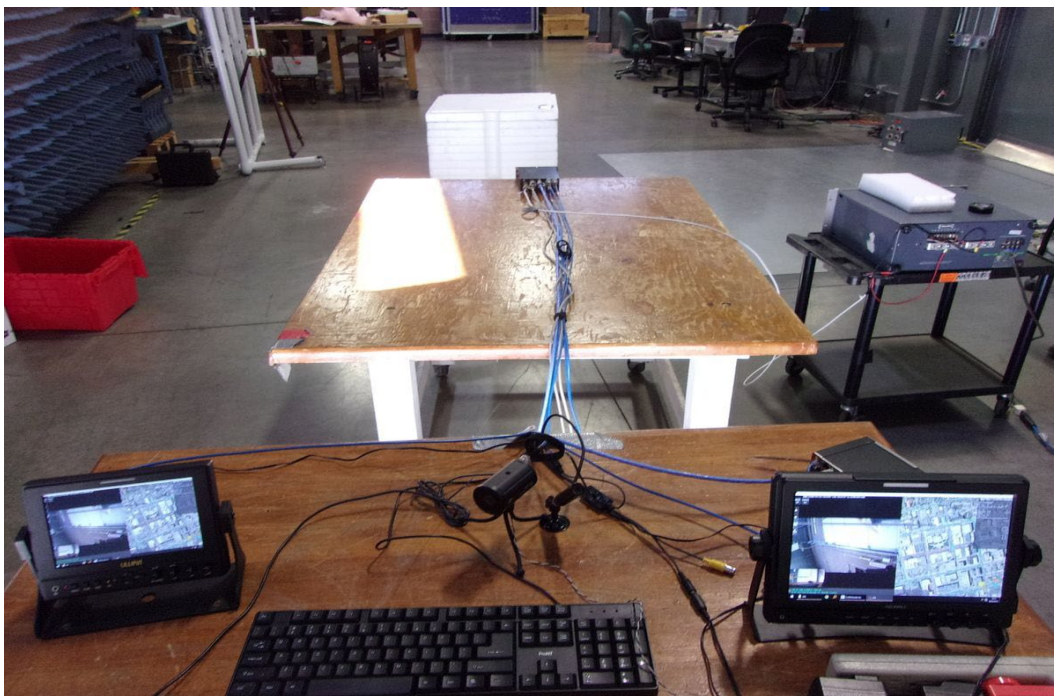
General Test Setup for Magnetic Effects



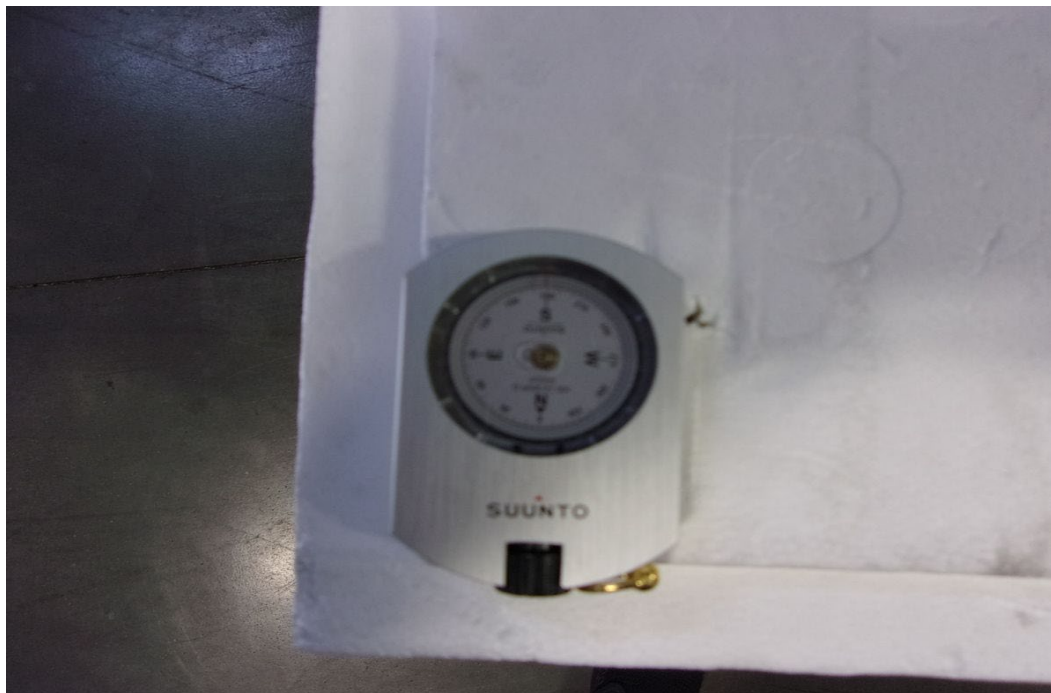
General Test Setup for Magnetic Effects



General Test Setup for Magnetic Effects



General Test Setup for Magnetic Effects



General Test Setup for Magnetic Effects



General Test Setup for Magnetic Effects

5.1.7 Comments

The EUT met the requirement of RTCA/DO-160G, Section 15 Category A.

5.2 RTCA/DO-160G Section 16 Power Input

5.2.1 Purpose of the Test

This section defines test conditions and procedures for AC and DC electrical power applied to the terminals of the equipment under test. It covers the following electrical power supplies:

14 VDC, 28 VDC and 270VDC

115 V_{RMS} AC and 230 V_{RMS} AC at either a nominal 400 Hz frequency or over a variable frequency range which includes 400 Hz.

Equipment categories and frequency classes, test conditions and procedures for equipment using other electrical power supplies must be defined in applicable equipment performance standards.

5.2.2 Equipment Categories

Test designation for the EUT:

Category reference:

- For DC equipment: B

All DC equipment categories are to be followed by an additional letter to indicate if the equipment has to be submitted to:

- DC current ripple tests (letter R) or not (letter X),
- DC inrush tests (letter I) or not (letter X)

AC only equipment test designations (such as the letter H) are not to be marked after DC equipment categories (such as A, B, D or Z). DC only equipment test designations (such as the letter R) are not to be marked after AC equipment categories (such as A (CF), A (NF) or A (WF)).

Should the unit accept both AC and DC power, the marking should first list the AC equipment category followed by all of the AC test designations then list the DC equipment category, or categories, followed by all of the DC test designations.

Category B

14V or 28V DC equipment intended for use on aircraft electrical systems supplied by engine-driven alternator/rectifiers, or DC generators where a battery of significant capacity is floating on the DC bus at all times, is identified as Category B.

Standard Test Tolerances:

Unless otherwise specified in the controlling equipment specification or in the DO-160 test procedure:

- For nominal voltages greater than or equal to 100V AC or dc, all input power voltages shall be held to the higher of $\pm 1.0\%$ of the test voltage or $\pm 1.0\%$ of the nominal operating voltage, (i.e. 0V AC on a 115V system is 0 V ± 1.15 V ac.)
- For nominal voltages less than 100V AC or dc, all input power voltages shall be held to the higher of $\pm 2.0\%$ of the test voltage or $\pm 2.0\%$ of the nominal operating voltage, (i.e. 0 V DC on a 28 V DC system is 0 V ± 0.56 V dc.)
- All time durations shall be held to within $\pm 10\%$ of the specified amount
- All rise and fall times shall be less than 1.5msec between the 10% and 90% points of the actual voltage transition.
- All frequencies shall be held to within $\pm 1.0\%$ of the specified value

Note: These tolerances are for the purpose of applying standard test procedures to the equipment under test and do not reflect the actual tolerances of the aircraft power source.

Manual Reset:

Manual Reset is the act of cycling all power to the EUT from on to off back to on to clear a EUT fault condition or a EUT latch up. Entering data into the EUT after a test, such as a power interrupt, is not considered to be a Manual Reset unless otherwise specified in applicable equipment performance standards.

5.2.3 Test Data

Normal Operating Conditions (RTCA/DO-160G Section 16.6.1)

Date of Test: 01/20/2023-01/24/2023

Operator: Corey Shelton, EMC Test Technician

National Technical Systems						
Section 16 Power Input DC Log						
Temp:	22.7	° C	Humidity:	12.2	% RH	
Date	Time	Log Entries				Initials
1/20/23	0800	Begin setup for Section 16.6.1 testing				CS
	0913	Voltage waveforms collected for pretest 16.6.1.1 (28V, 30.3V, 22V, 18V)				CS
	0929	Begin 30 min test for section 16.6.1.1 at 30.3Vdc				CS
	0959	30.3Vdc test complete - pass				CS
	1000	Begin 30 min test for section 16.6.1.1 at 22Vdc				CS
	1030	22Vdc test complete - pass				CS
	1035	Begin 30 min test for section 16.6.1.1 at 18Vdc				CS
	1106	18Vdc test complete - pass				CS
	1108	Begin setup for Section 16.6.1.3 testing				CS
	1445	Voltage waveforms collected for pretest 16.6.1.3 (Test 1 - Test 19)				CS
	1525	16.6.1.3 Test 1 - unit shuts down and reboots				CS
	1529	16.6.1.3 Test 2 - unit shuts down and reboots				CS
	1533	16.6.1.3 Test 3 - unit shuts down and reboots				CS
	1534	16.6.1.3 Test 4 - unit shuts down and reboots				CS
	1541	16.6.1.3 Test 5 - unit shuts down and reboots				CS
	1543	16.6.1.3 Test 6 - unit shuts down and reboots				CS
	1544	16.6.1.3 Test 7 - unit shuts down and reboots				CS
	1546	16.6.1.3 Test 8 - unit shuts down and reboots				CS
	1547	16.6.1.3 Test 9 - complete - pass				CS
	1549	16.6.1.3 Test 10 - unit shuts down and reboots				CS
	1550	16.6.1.3 Test 11 - unit shuts down and reboots				CS
	1552	16.6.1.3 Test 12 - unit shuts down and reboots				CS
	1553	16.6.1.3 Test 13 - unit shuts down and reboots				CS
	1554	16.6.1.3 Test 14 - unit shuts down and reboots				CS
	1556	16.6.1.3 Test 15 - unit shuts down and reboots				CS
	1557	16.6.1.3 Test 16 - complete - pass				CS
	1558	16.6.1.3 Test 17 - complete - pass				CS
	1559	16.6.1.3 Test 18 - unit shuts down and reboots				CS
	1601	16.6.1.3 Test 19 - unit shuts down and reboots				CS
	1612	End of day				CS
1/23/23	0730	Begin measurement equipment warmup				CS
	0759	16.6.1.3 50mS waveform captured				CS
	0818	16.6.1.3 50mS test complete (5 repetitions) - unit shuts down and reboots				CS

	1003	16.6.1.3 Table 16-7 waveforms captured	CS
	1028	16.6.1.3 Test 1 10ms - unit shuts down and reboots	CS
	1029	16.6.1.3 Test 1 50ms - unit shuts down and reboots	CS
	1031	16.6.1.3 Test 2 10ms - unit shuts down and reboots	CS
	1033	16.6.1.3 Test 2 50ms - unit shuts down and reboots	CS
	1034	16.6.1.3 Test 3 10ms - unit shuts down and reboots	CS
	1036	16.6.1.3 Test 3 50ms - unit shuts down and reboots	CS
	1037	16.6.1.3 Test 4 10ms - unit shuts down and reboots	CS
	1039	16.6.1.3 Test 4 50ms - unit shuts down and reboots	CS
	1040	16.6.1.3 Test 6 10ms - unit shuts down and reboots	CS
	1041	16.6.1.3 Test 6 50ms - unit shuts down and reboots	CS
	1043	16.6.1.3 Test 10 10ms - unit shuts down and reboots	CS
	1044	16.6.1.3 Test 10 50ms - unit shuts down and reboots	CS
	1046	16.6.1.3 Test 11 10ms - unit shuts down and reboots	CS
	1047	16.6.1.3 Test 11 50ms - unit shuts down and reboots	CS
	1142	16.6.1.4 waveforms captured	CS
	1154	16.6.1.4 test 47Vdc for 5mS - unit shuts down and reboots	CS
	1155	16.6.1.4 test 17Vdc complete - pass	CS
	1208	16.6.1.5 waveforms captured	CS
	1219	16.6.1.5 test complete - unit stays off during testing and requires manual reboot to turn back on.	CS
	1459	16.6.1.2 waveforms captured from 200Hz to 5kHz	CS
	1500	16.6.1.2 test started from 200Hz to 5kHz	CS
	1559	16.6.1.2 test complete from 200Hz to 5kHz - pass	CS
	1600	End of day	CS
1/24/23	0800	Begin setup for 16.6.1.2 testing (entire range 200Hz to 15kHz)	CS
	1230	Setup complete, pretest waveforms captured	CS
	1310	16.6.1.2 test started 200Hz to 15kHz	CS
	1416	16.6.1.2 test complete from 200Hz to 15kHz - pass	CS
	1433	End of Section 16 testing	CS
Test Performed By: Corey Shelton			

5.2.3.1 Momentary Power Interruption (RTCA/DO-160G Section 16.6.1.4)

National Technical Systems								
Momentary Power Interruptions (dc)								
Test Notes: None								
Category: Category B 28VDC Equipment								
	Nominal Voltage (Vdc)	Interrupt Voltage (Vdc)	Interrupt Period (mS)	Repetition			Pass / Fail	Remarks
	28	0	50	5			Pass	Unit shuts down and reboots
Test Condition	Ti (mS)	Ti (mS)	Tr (mS)	% Vnom (Vmin)	Nominal Voltage (Vdc)	Number of Applications	Pass / Fail	Remarks
1	<1	<1	2	0	28	2	Pass	Unit shuts down and reboots
2	10	0	3	50		2	Pass	Unit shuts down and reboots
3	17	8	4	15		2	Pass	Unit shuts down and reboots
4	18	32	5	10		2	Pass	Unit shuts down and reboots
5	19	56	5	5		2	Pass	Unit shuts down and reboots
6	20	80	5	0		2	Pass	Unit shuts down and reboots
7	20	180	5	0		2	Pass	Unit shuts down and reboots
8	20	980	5	0		2	Pass	Unit shuts down and reboots
9	10	0	4	80		2	Pass	None
10	25	0	10	50		2	Pass	Unit shuts down and reboots
11	50	0	20	0		2	Pass	Unit shuts down and reboots
12	43	33	17	15		2	Pass	Unit shuts down and reboots
13	48	53	19	5		2	Pass	Unit shuts down and reboots
14	50	150	20	0		2	Pass	Unit shuts down and reboots
15	50	950	20	0		2	Pass	Unit shuts down and reboots
16	18	13	7	65		2	Pass	None
17	20	15	2	60		2	Pass	None
18	13	27	13	35		2	Pass	Unit shuts down and reboots
19	5	20	5	0		2	Pass	Unit shuts down and reboots

Double Interrupt Requirements									
Category:		Category B 28VDC Equipment							
Test Condition	T1 (mS)	T2 (mS)	T3 (mS)	Pass / Fail	T1 (mS)	T2 (mS)	T3 (mS)	Pass / Fail	Remarks
1	9000	10	20	Pass	9000	50	20	Pass	Unit shuts down and reboots
2	9000	10	50	Pass	9000	50	50	Pass	Unit shuts down and reboots
3	10	10	10	Pass	10	50	10	Pass	Unit shuts down and reboots
4	10	10	50	Pass	10	50	50	Pass	Unit shuts down and reboots
6	20	10	10	Pass	20	50	10	Pass	Unit shuts down and reboots
10	50	10	10	Pass	50	50	10	Pass	Unit shuts down and reboots
11	50	10	50	Pass	50	50	50	Pass	Unit shuts down and reboots
Technician:		Corey Shelton							

5.2.3.2 Normal Surge Voltage (RTCA/DO-160G Section 16.6.1.5.1)

National Technical Systems								
Normal Surge Voltage (dc)								
Test Notes: Only Applicable for Category A, B, and Z equipment.								
Category:		Category B 28VDC Equipment						
Nominal Voltage (Vdc)	Surge (Vdc)	Duration (mS)	Surge (Vdc)	Duration (mS)	Rise Time (mS)	Fall Time (mS)	Pass / Fail	Remarks
Positive Surge								
28	47	5	40	30	1	5	Pass	Unit shuts down then reboots
Negative Surge								
Nominal Voltage (Vdc)	Surge (Vdc)	Duration (mS)			Rise Time (mS)	Fall Time (mS)	Pass / Fail	Remarks
28	17	30			1	5	Pass	None
Technician:		Corey Shelton						

National Technical Systems							
Engine Starting Undervoltage (dc)							
Test Notes: This requirement is only applicable to Category Z and 28VDC Category B Equipment.							
Category:		Category B 28VDC Equipment					
Nominal Voltage (dc)	Starting Voltage	Rate of Increase (Vdc/sec)	Ending Voltage (dc)	Test Duration (S)		Pass / Fail	Remarks
28	10	0.30	20.5	35		Pass	Unit turns off, and stays off for duration of test. Unit must be power cycled manually to restore functionality.
Technician:		Corey Shelton					

5.2.3.3 Voltage (Average Value DC)(RTCA/DO-160G Section 16.6.1.1)

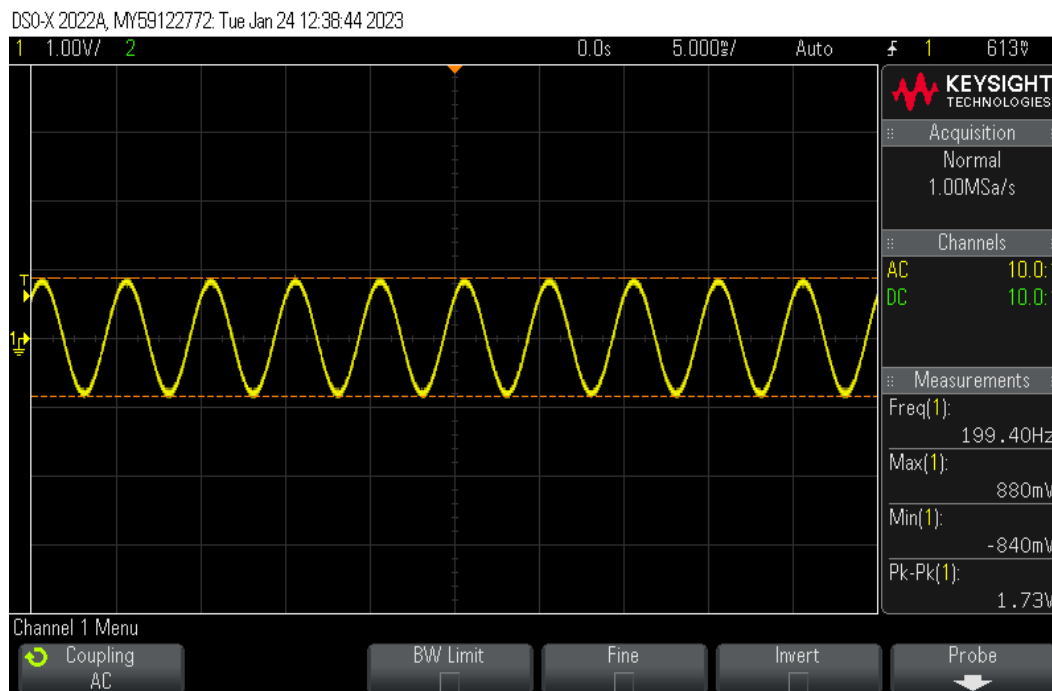
National Technical Systems							
Voltage Average Value (dc)							
Test Notes: None							
Category:		Category B 28VDC Equipment					
Test Condition	Nominal Voltage		Test Voltage (Vdc)		Duration (minutes)	Pass / Fail	Remarks
Maximum	28	Vdc	30.3	Vdc	30	Pass	None
Minimum	28	Vdc	22.0	Vdc	30	Pass	None
Emergency	28	Vdc	18.0	Vdc	30	Pass	None
Technician:		Corey Shelton					

5.2.3.4 Ripple Voltage (RTCA/DO-160G Section 16.6.1.2)

National Technical Systems							
Ripple Voltage (dc)							
Test Notes: Section 16.6.1.2 per Section 18.3.1							
Category:	Category B 28VDC Equipment						
Line Under Test	Test Level	Start Freq (Hz)	Dwell Time (s)	Stop Freq (kHz)		Pass / Fail	Remarks
Positive DC	28Vdc Limit	200	60.0	15		Pass	None
Technician:	Corev Shelton						

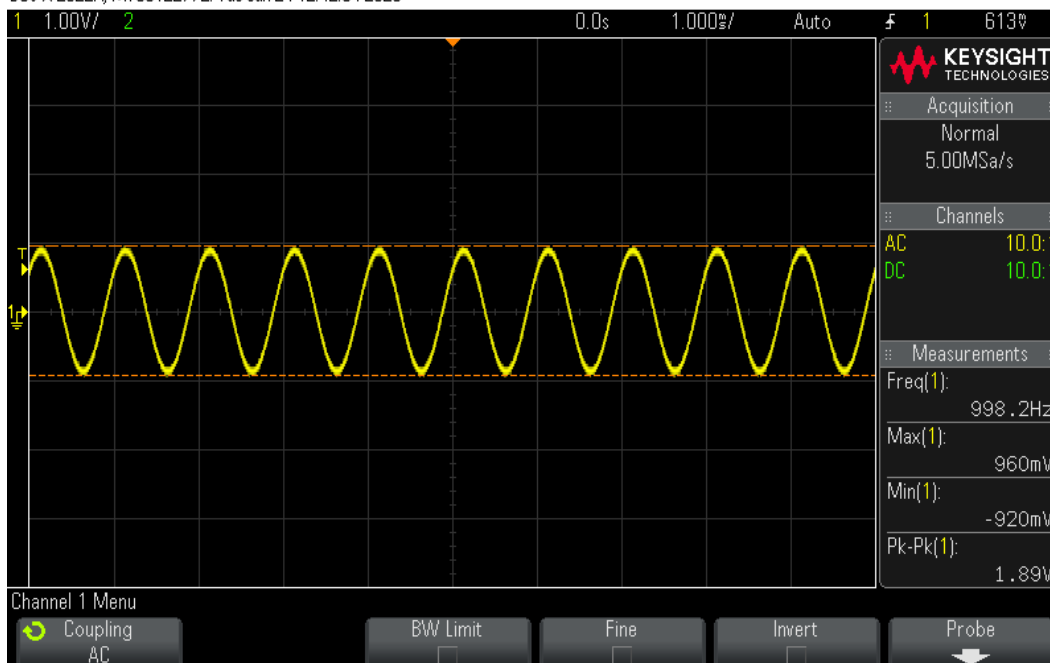
5.2.3.5 Engine Starting Under-Voltage Operation (RTCA/DO-160G Section 16.6.1.5)

National Technical Systems						
Engine Starting Undervoltage (dc)						
Test Notes: This requirement is only applicable to Category Z and 28VDC Category B Equipment.						
Category: Category B 28VDC Equipment						
Nominal Voltage (dc)	Starting Voltage	Rate of Increase (Vdc/sec)	Ending Voltage (dc)	Test Duration (S)	Pass / Fail	Remarks
28	10	0.30	20.5	35	Pass	Unit turns off, and stays off for duration of test. Unit must be power cycled manually to restore functionality.
Technician: Corey Shelton						



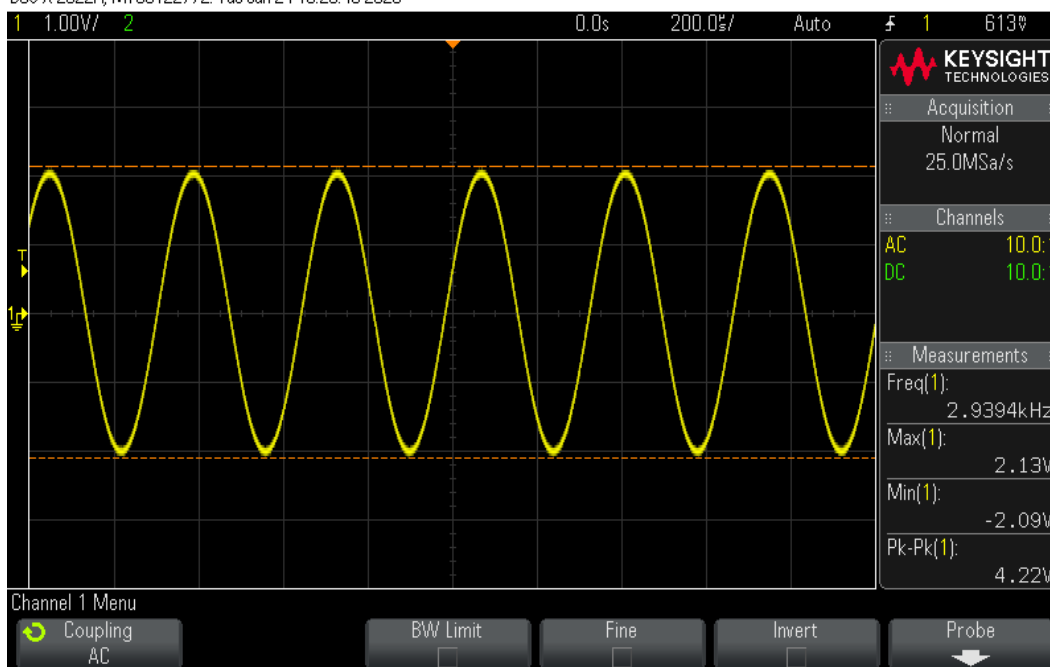
Waveform Verification 1

DSO-X 2022A, MY59122772: Tue Jan 24 12:42:54 2023

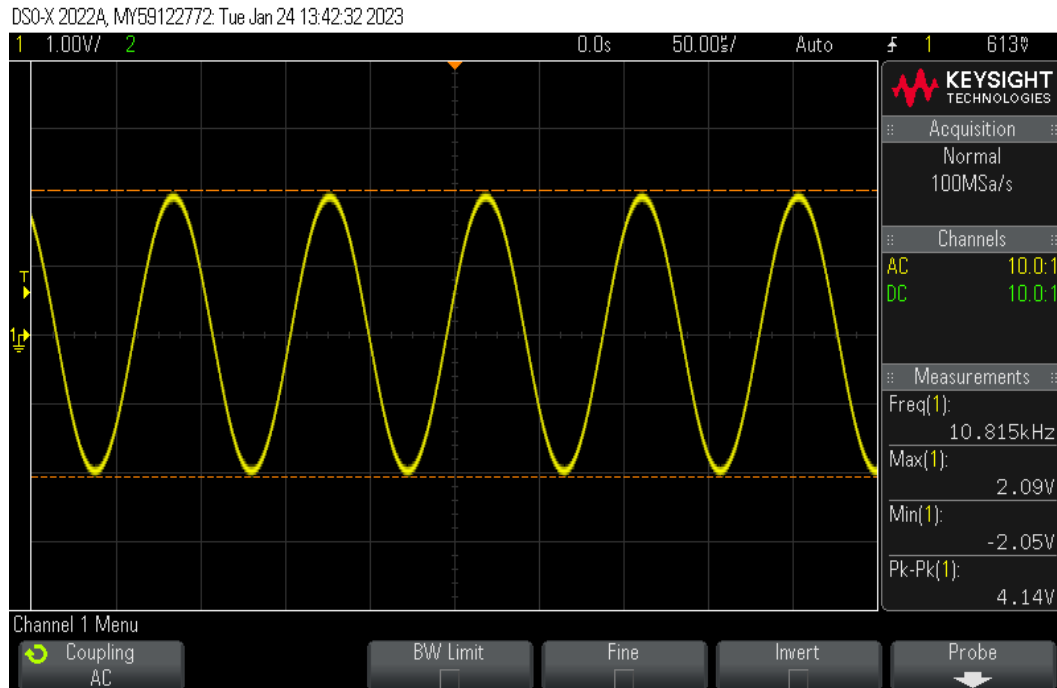


Waveform Verification 2

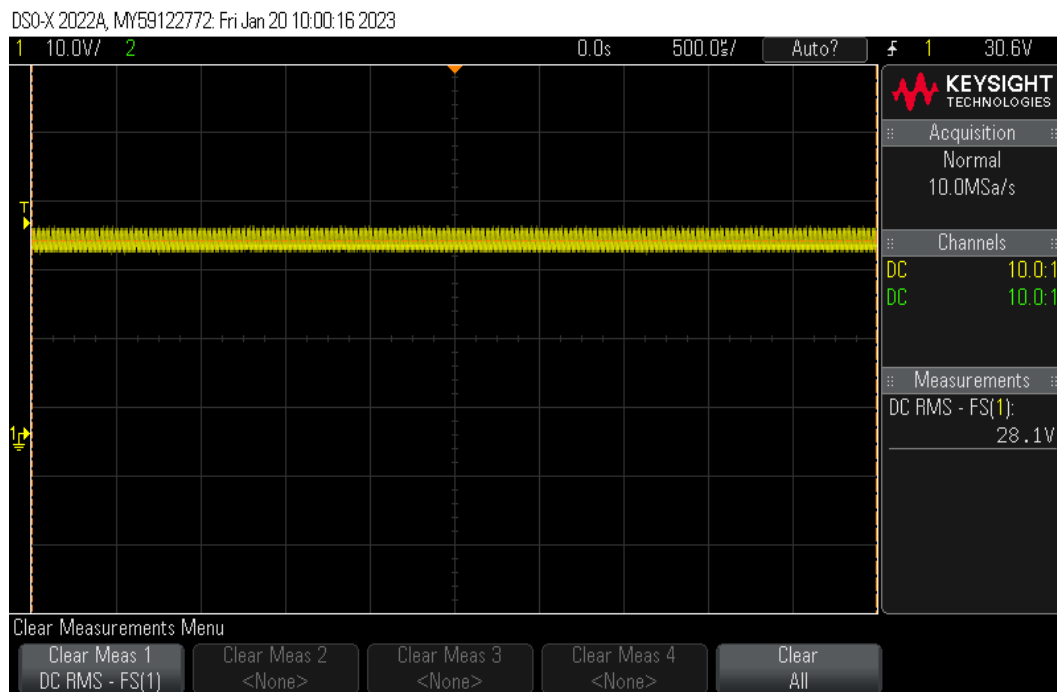
DSO-X 2022A, MY59122772: Tue Jan 24 13:28:40 2023



Waveform Verification 3

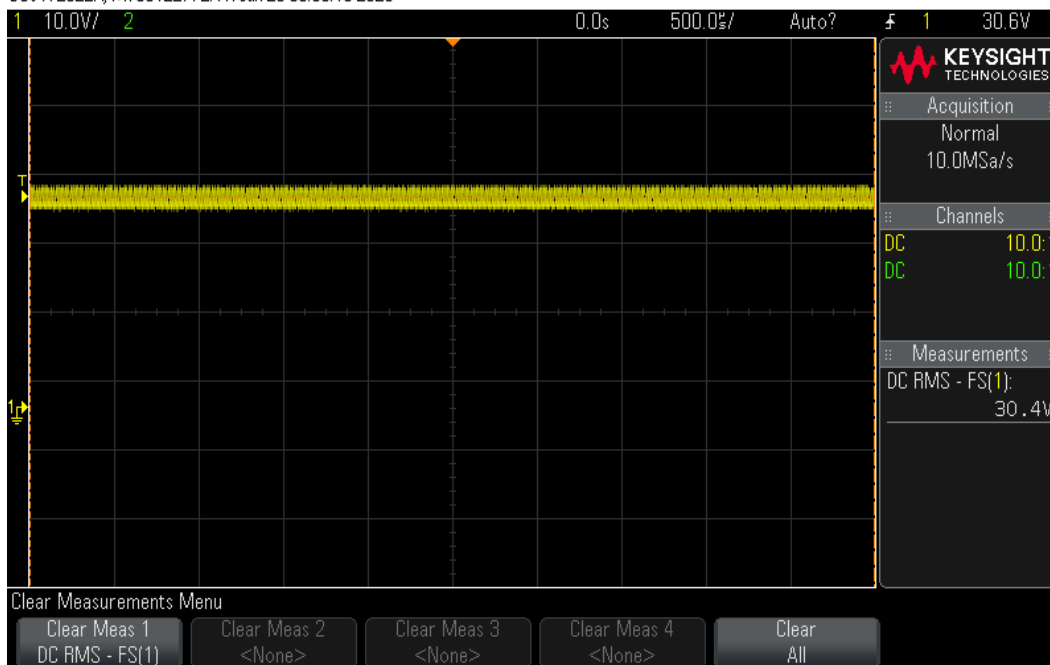


Waveform Verification 4



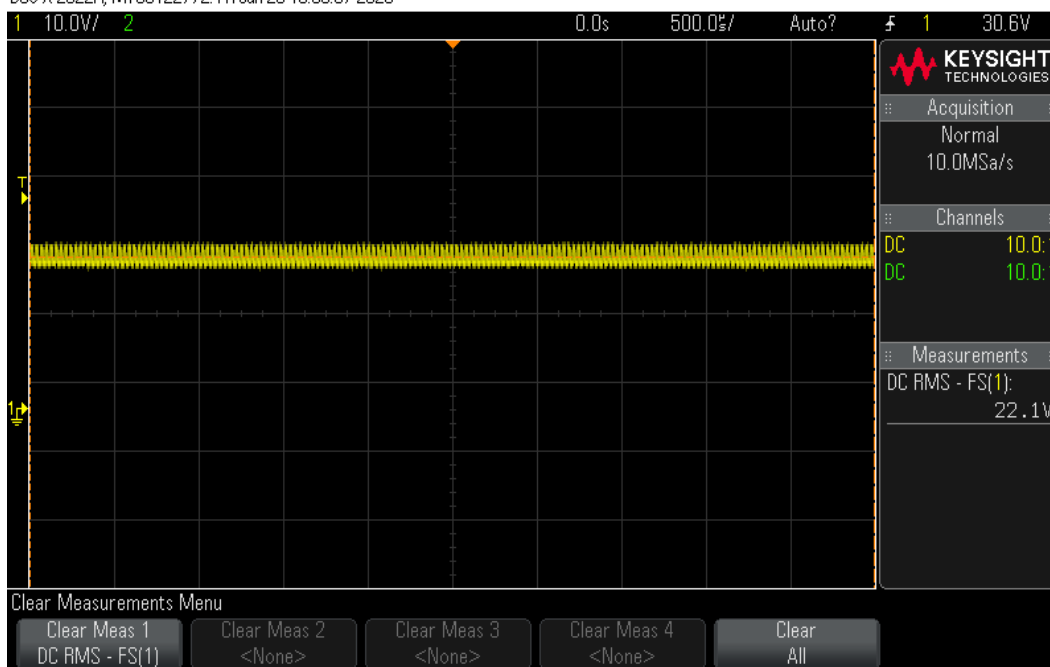
a 28V

DSO-X 2022A, MY59122772: Fri Jan 20 09:59:13 2023



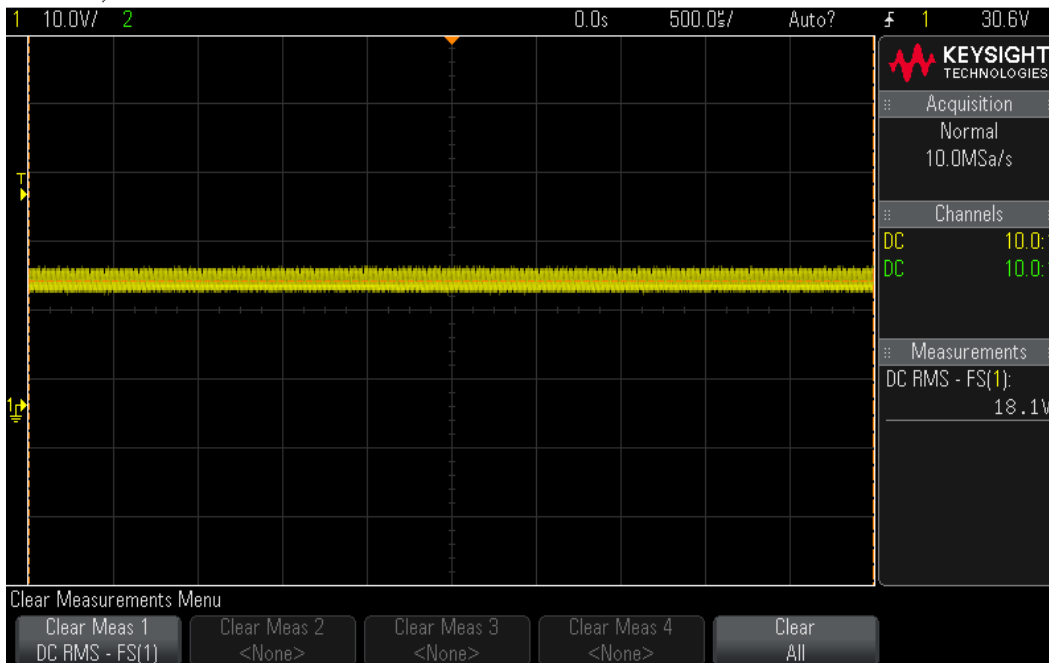
b 30.3V

DSO-X 2022A, MY59122772: Fri Jan 20 10:00:37 2023



c 22V

DSO-X 2022A, MY59122772: Fri Jan 20 10:14:36 2023



d 18V

NTS Longmont

Section 16.6.1.2 - Ripple Voltage (Hz)

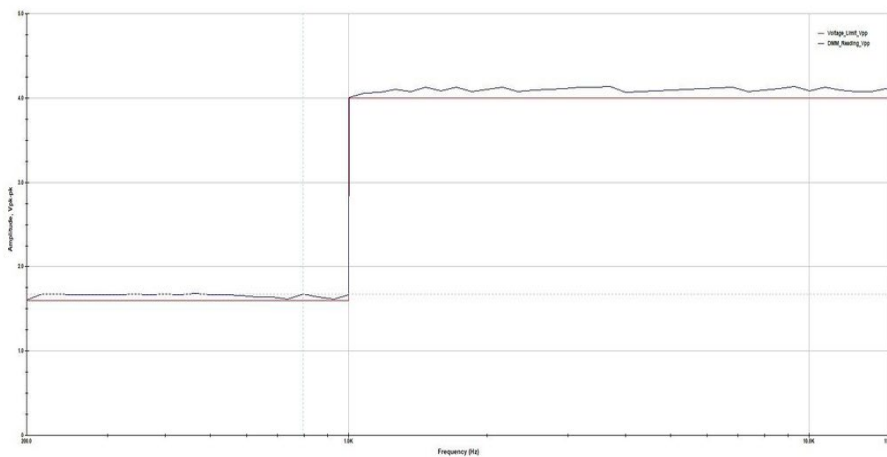
DO-160G

Equipment ID - Atom2 Case

Part Number - U3007-0001

Serial Number - 180007

Job Number - PR163195



Operator: Corey Shelton

PR163195 DO-160G Section 16 Ripple Voltage (Hz)

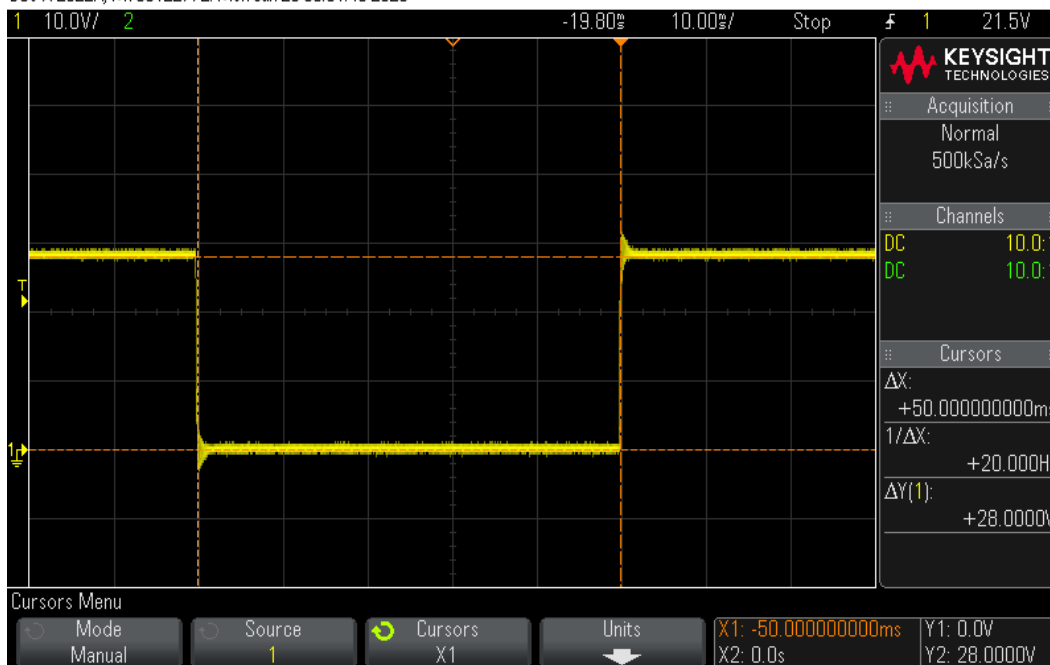
Last Data Update 02:13:54 PM, Tuesday, January 24, 2023

Company: Stedover Systems

Contact: Ken Haan

Test Graph

DSO-X 2022A, MY59122772: Mon Jan 23 09:01:43 2023



50mS Test

DSO-X 2022A, MY59122772: Fri Jan 20 14:49:19 2023



Table 16-3 Test 1

DSO-X 2022A, MY59122772: Fri Jan 20 14:55:17 2023

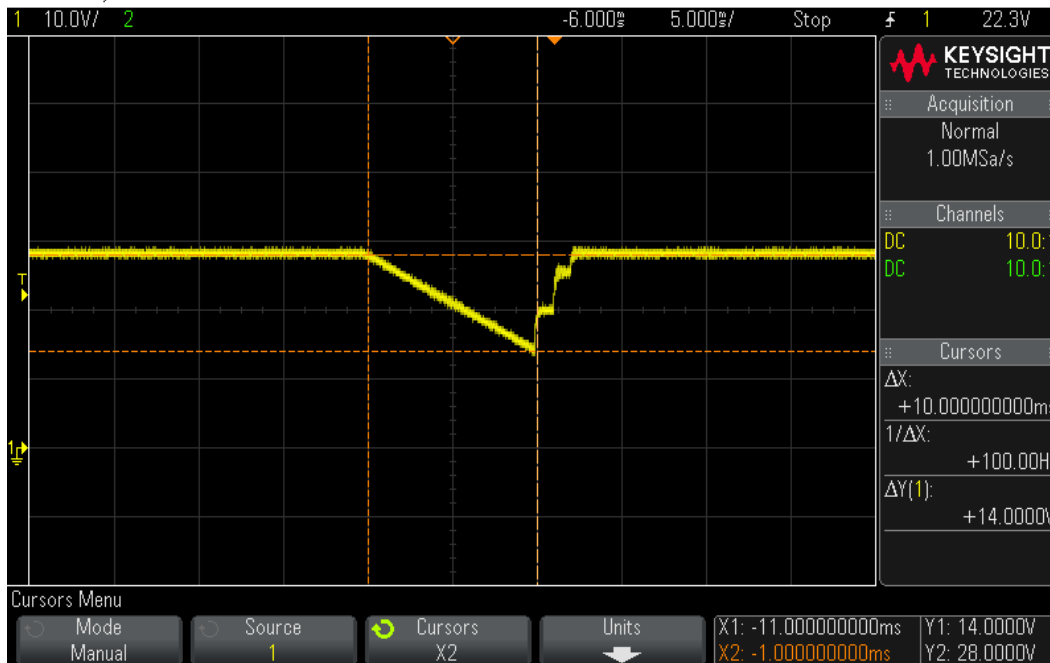


Table 16-3 Test 2

DSO-X 2022A, MY59122772: Fri Jan 20 14:57:55 2023

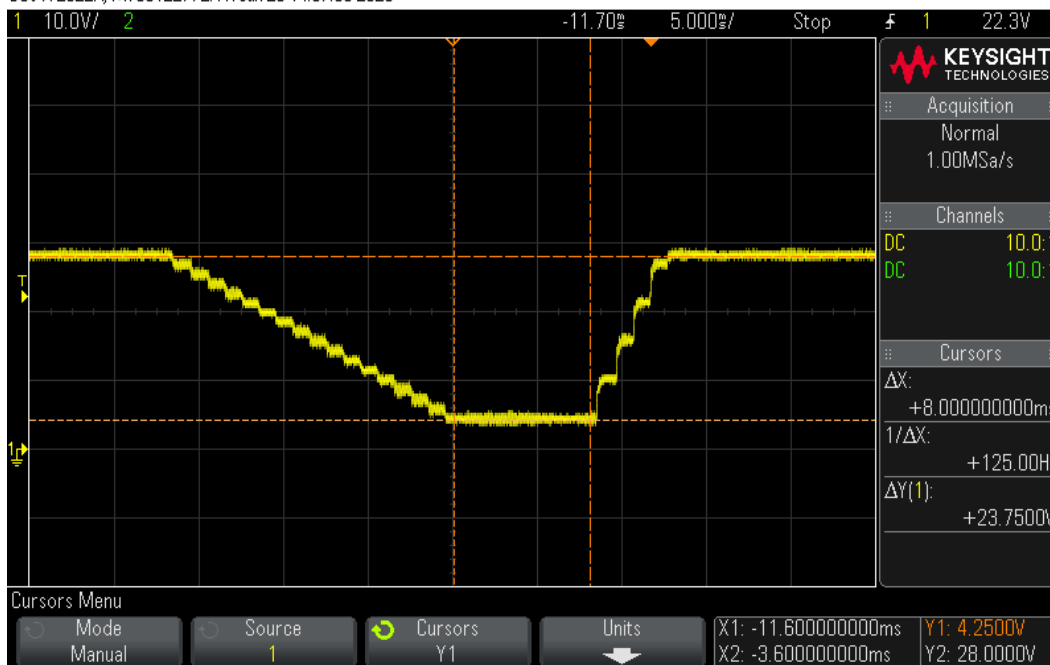


Table 16-3 Test 3

DSO-X 2022A, MY59122772: Fri Jan 20 14:59:24 2023

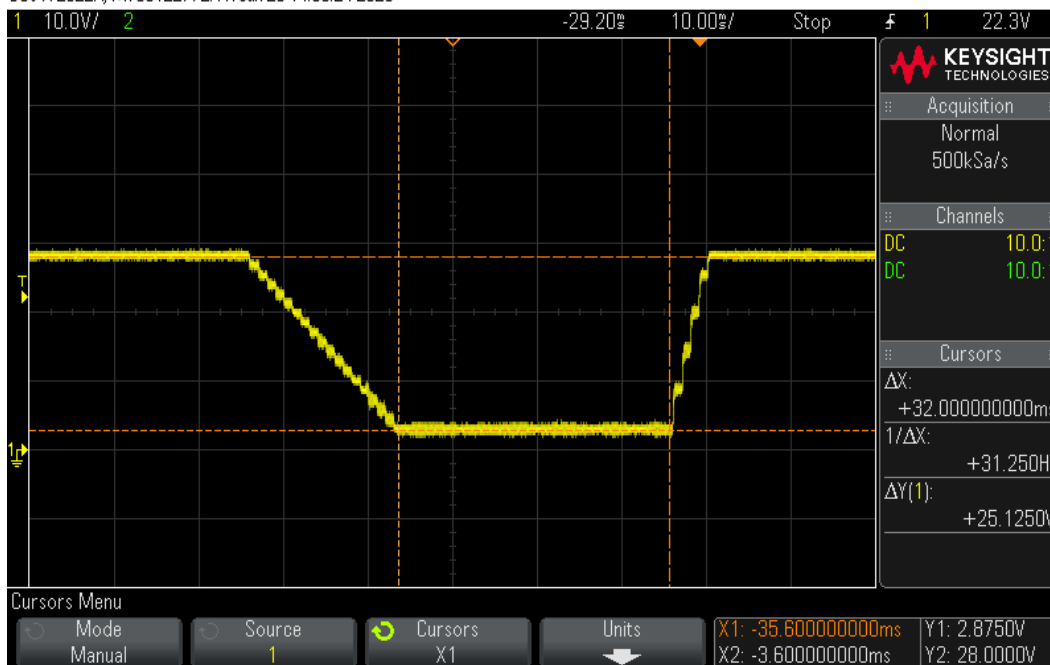


Table 16-3 Test 4

DSO-X 2022A, MY59122772: Fri Jan 20 15:00:50 2023

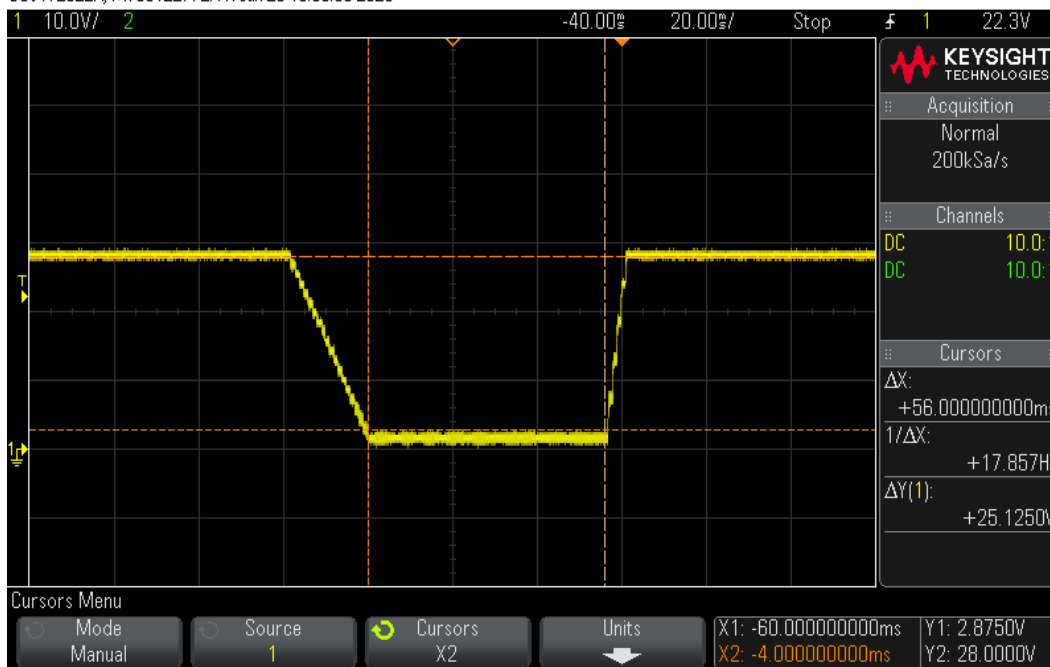


Table 16-3 Test 5

DSO-X 2022A, MY59122772, Fri Jan 20 15:02:29 2023

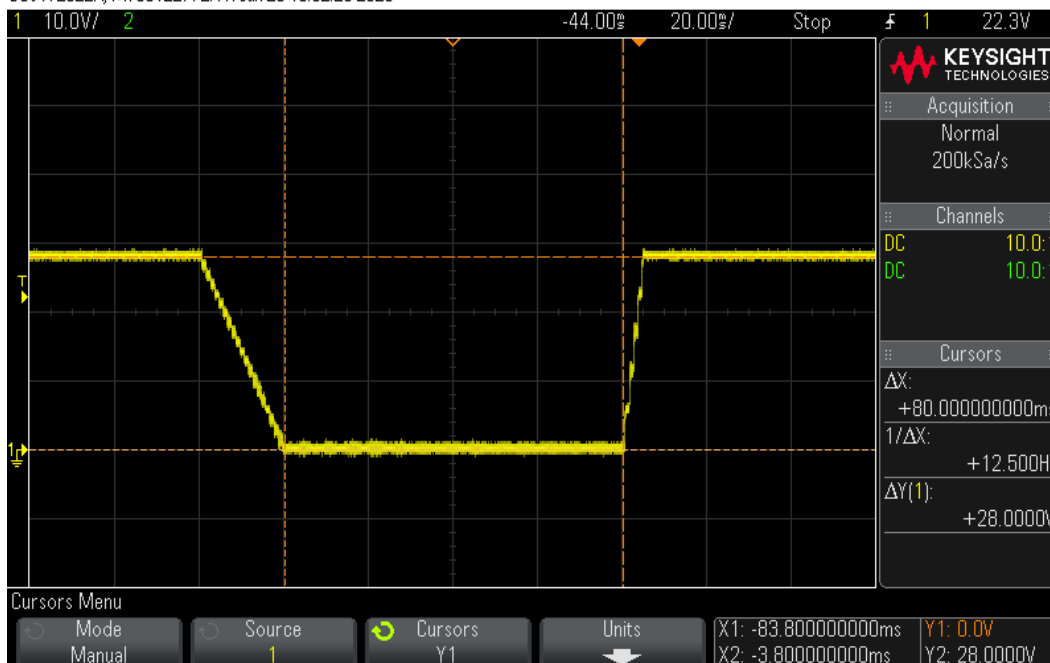


Table 16-3 Test 6

DSO-X 2022A, MY59122772, Fri Jan 20 15:03:41 2023

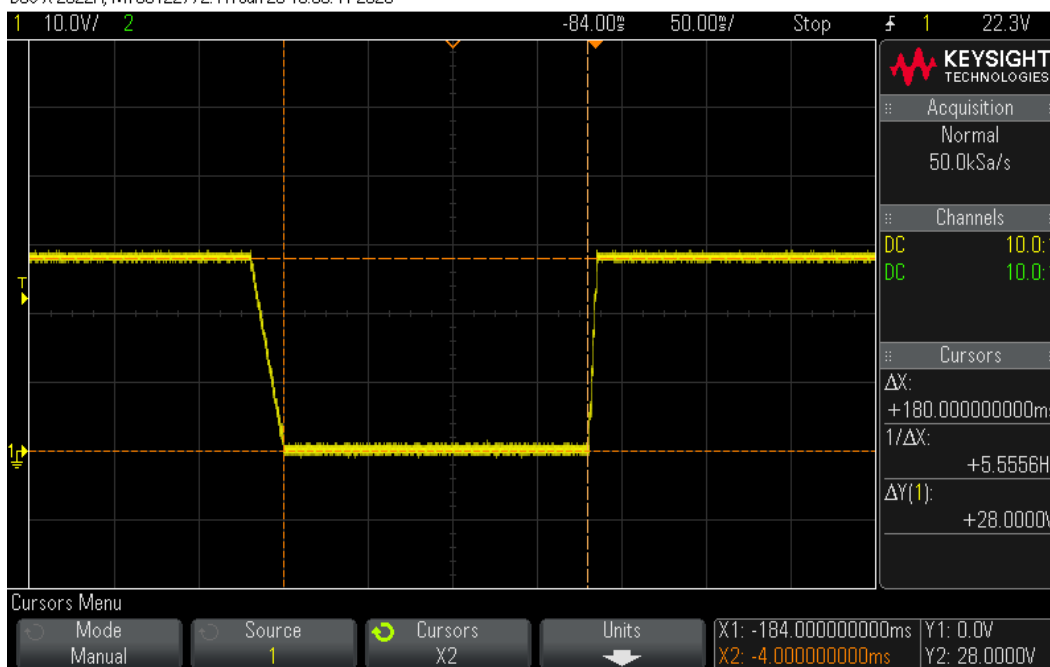


Table 16-3 Test 7

DSO-X 2022A, MY59122772: Fri Jan 20 15:10:59 2023

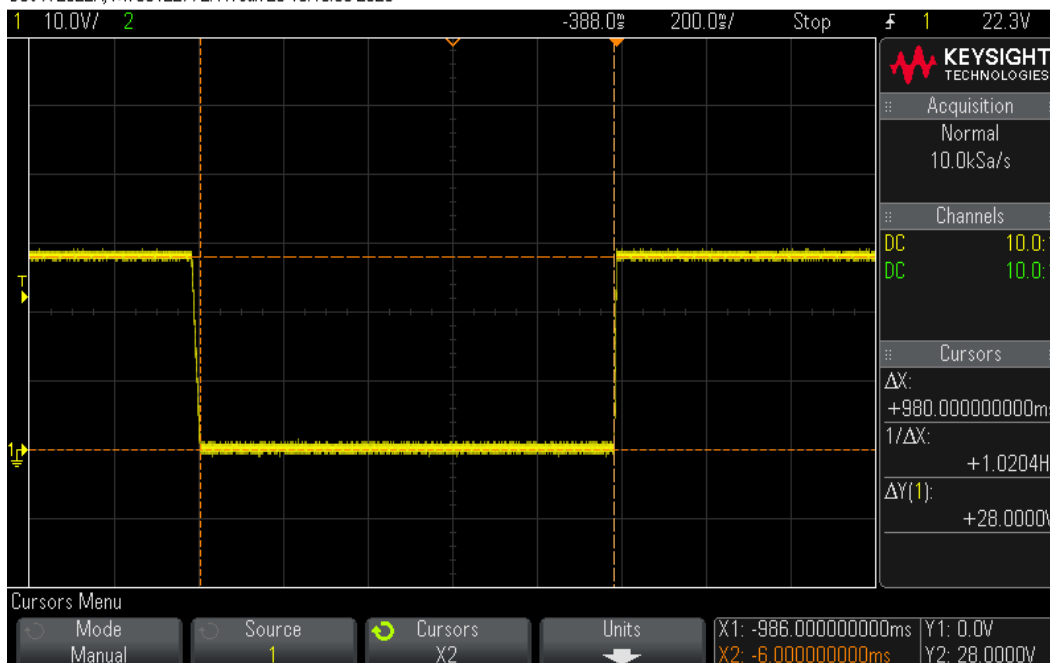


Table 16-3 Test 8

DSO-X 2022A, MY59122772: Fri Jan 20 15:14:03 2023

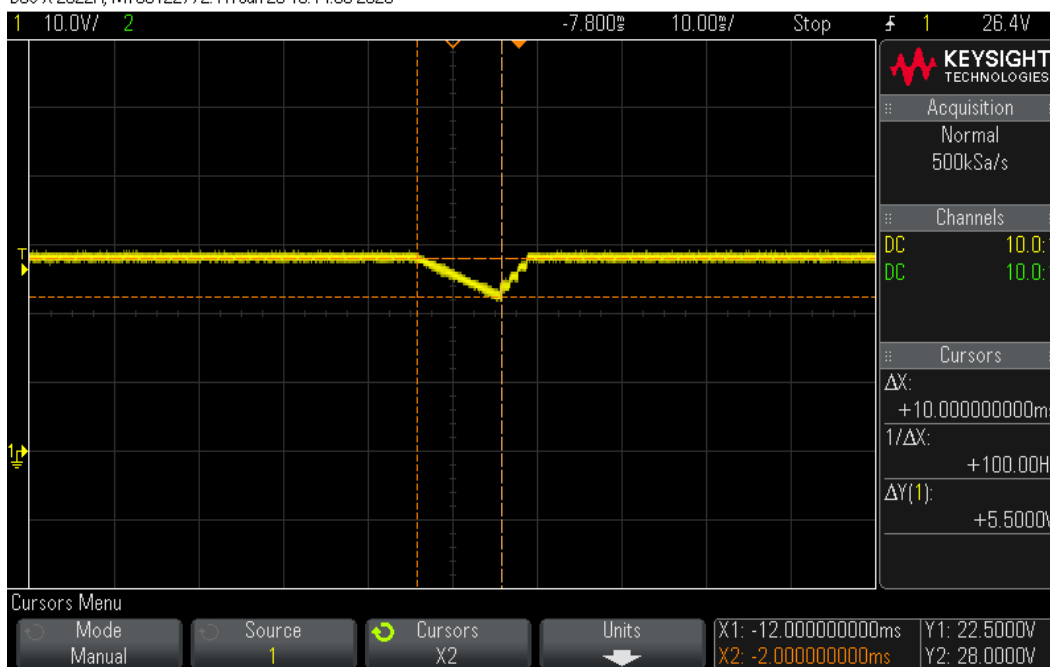


Table 16-3 Test 9

DSO-X 2022A, MY59122772, Fri Jan 20 15:15:27 2023

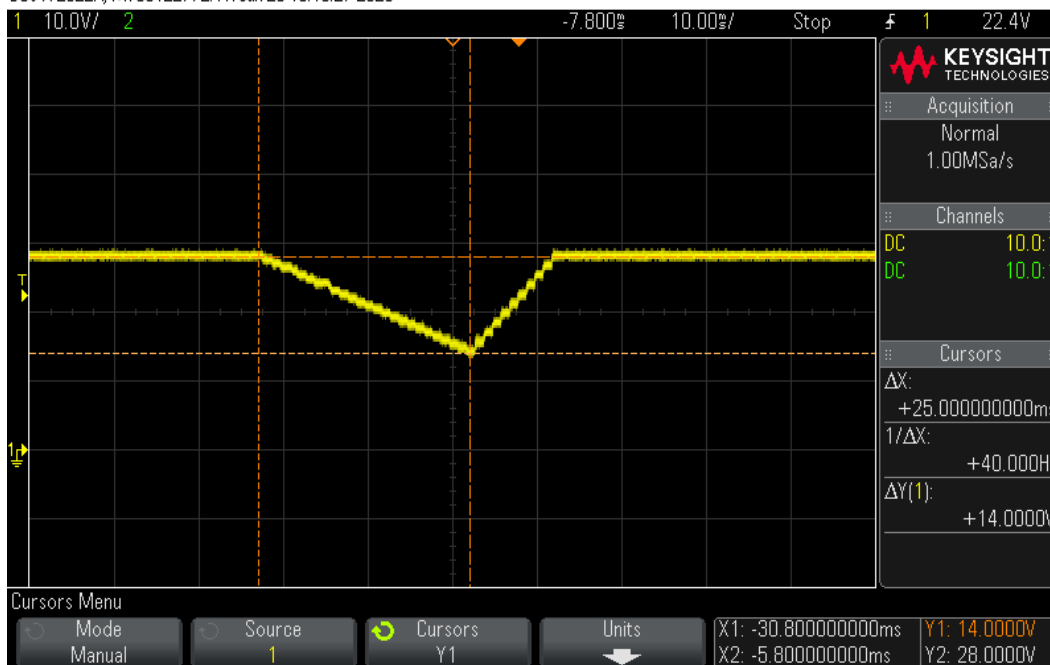


Table 16-3 Test 10

DSO-X 2022A, MY59122772, Fri Jan 20 15:16:47 2023



Table 16-3 Test 11

DSO-X 2022A, MY59122772: Fri Jan 20 15:18:27 2023

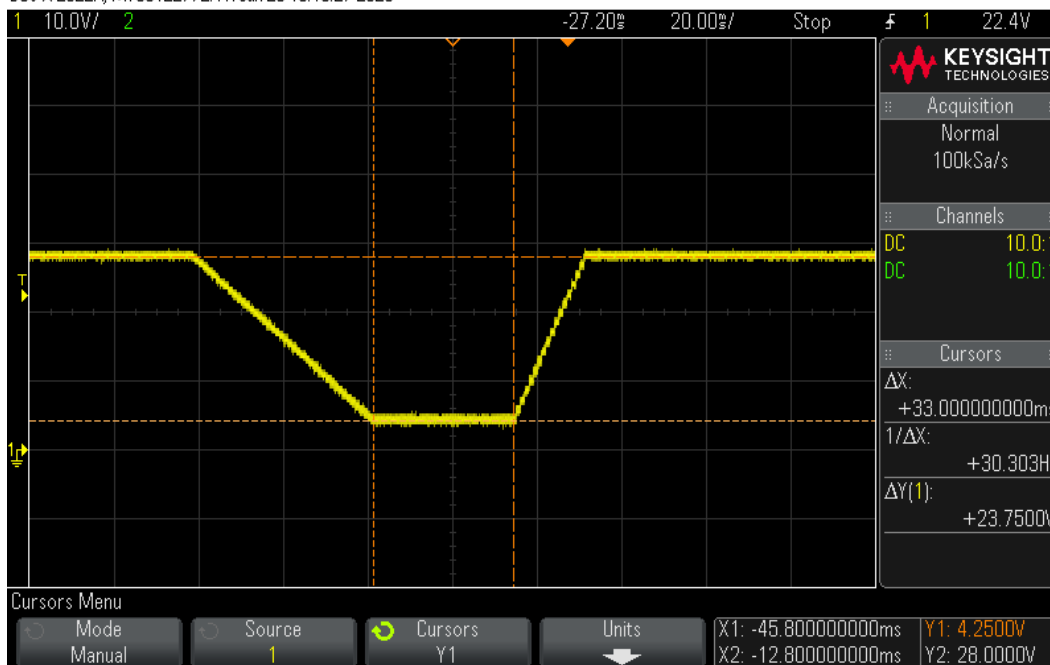


Table 16-3 Test 12

DSO-X 2022A, MY59122772: Fri Jan 20 15:19:38 2023

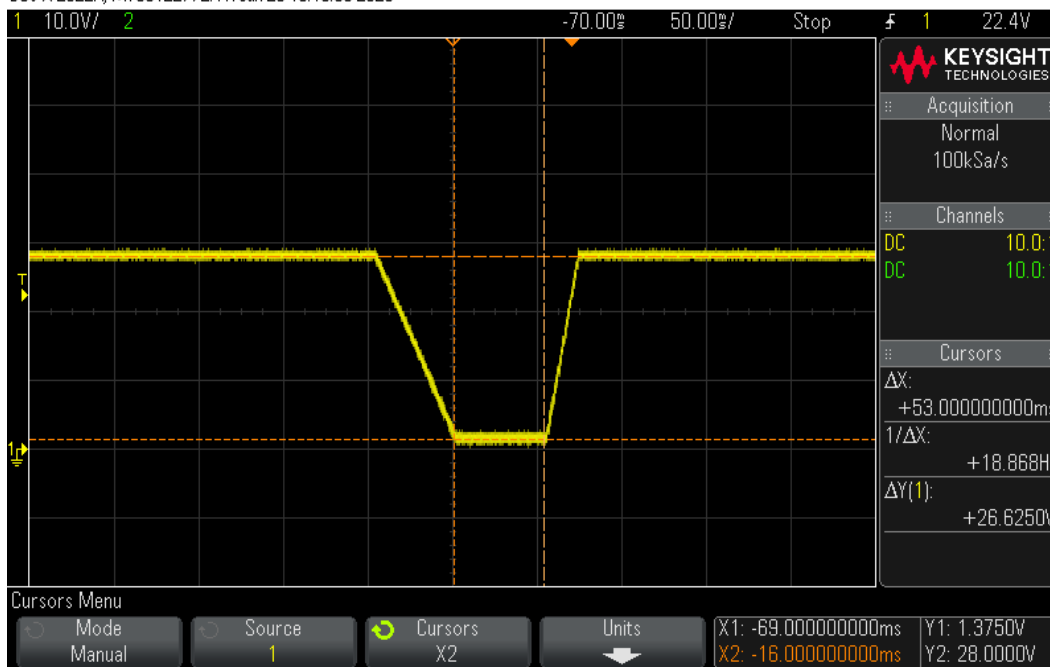


Table 16-3 Test 13

DSO-X 2022A, MY59122772: Fri Jan 20 15:20:47 2023

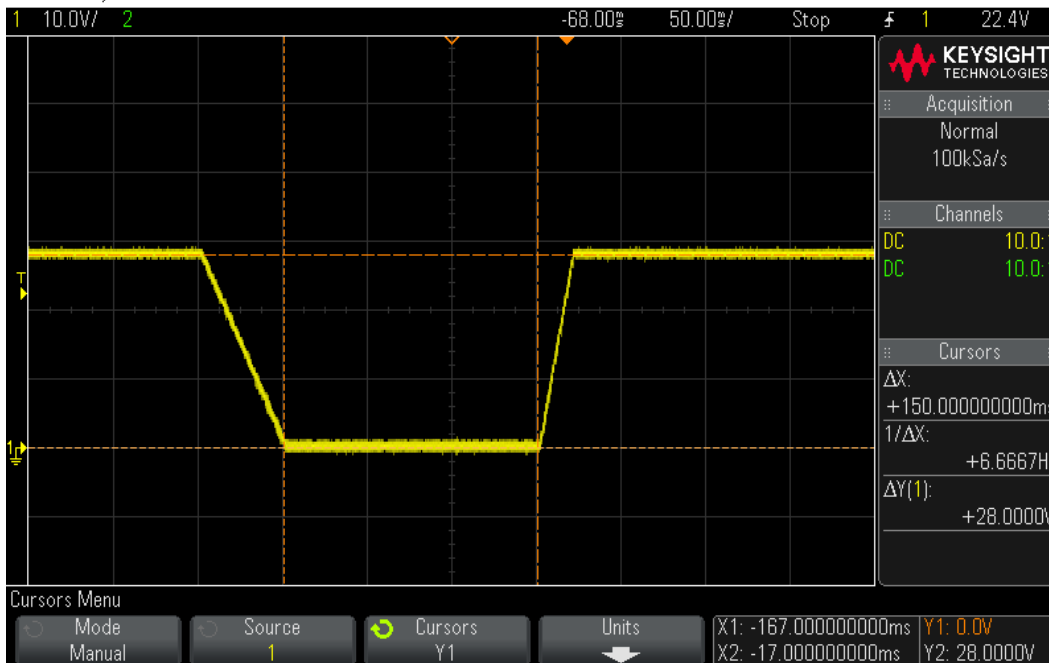


Table 16-3 Test 14

DSO-X 2022A, MY59122772: Fri Jan 20 15:24:47 2023

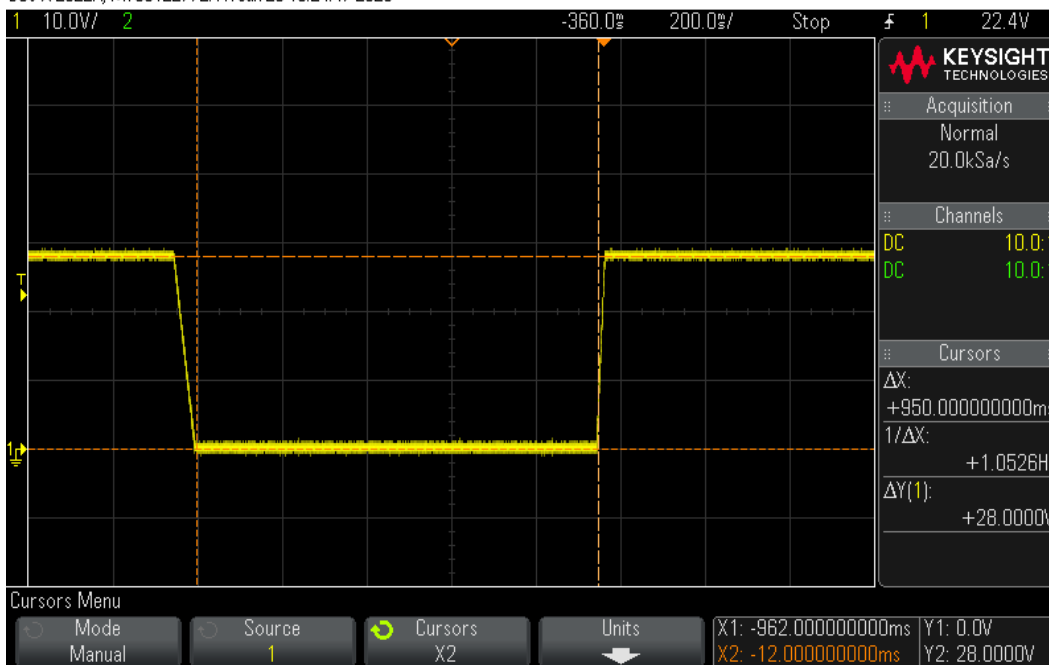


Table 16-3 Test 15

DSO-X 2022A, MY59122772: Fri Jan 20 15:27:30 2023

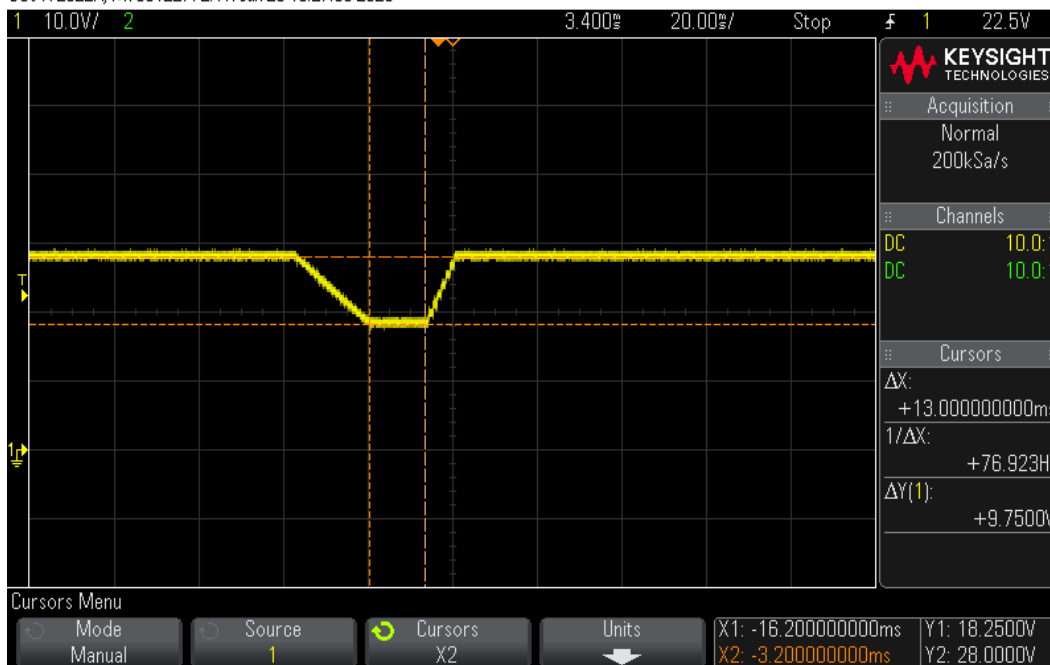


Table 16-3 Test 16

DSO-X 2022A, MY59122772: Fri Jan 20 15:28:36 2023

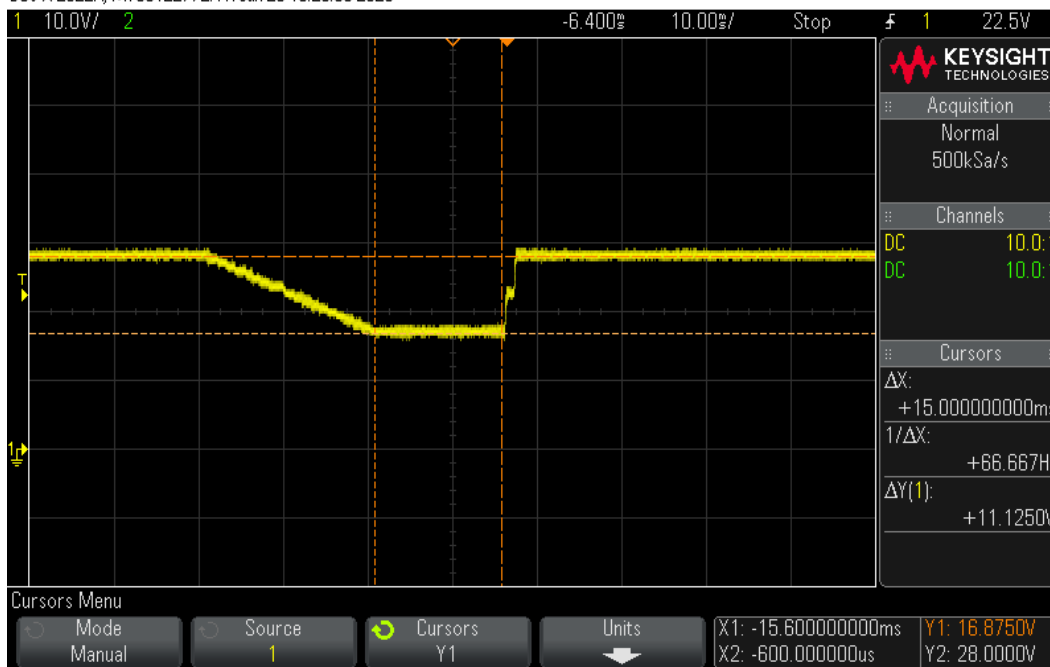


Table 16-3 Test 17

DSO-X 2022A, MY59122772: Fri Jan 20 15:29:31 2023

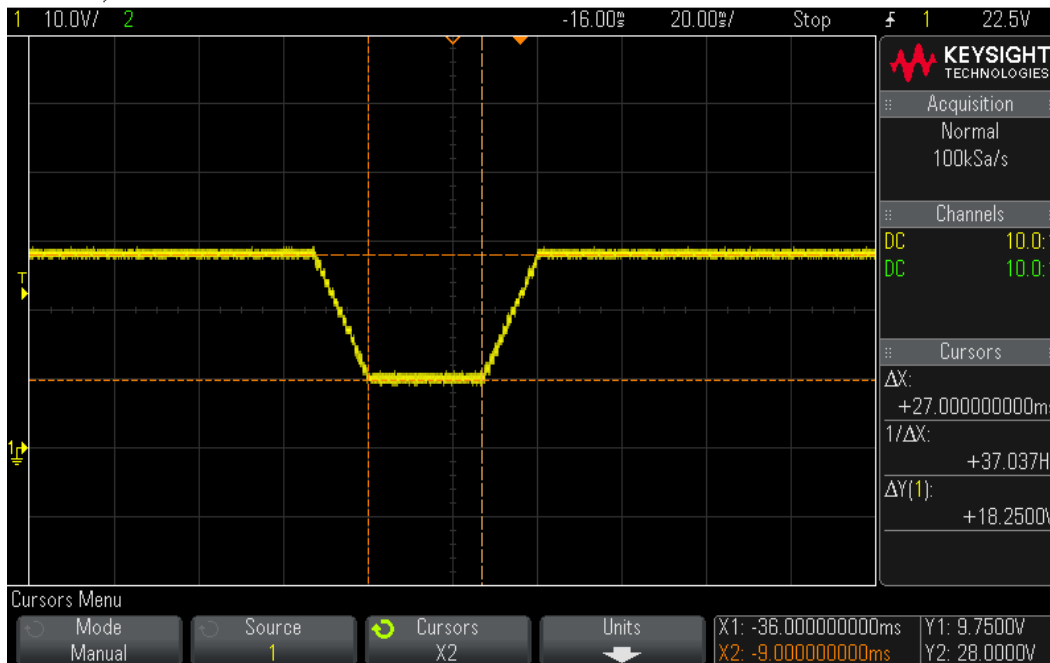


Table 16-3 Test 18

DSO-X 2022A, MY59122772: Fri Jan 20 15:32:57 2023

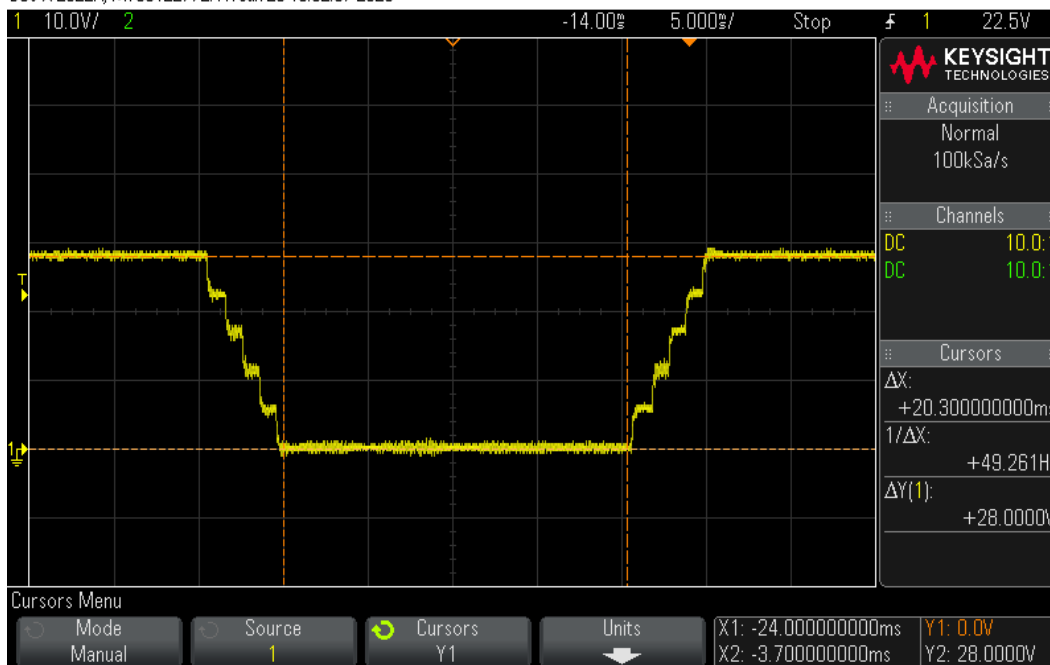


Table 16-3 Test 19

DSO-X 2022A, MY59122772, Mon Jan 23 09:51:54 2023

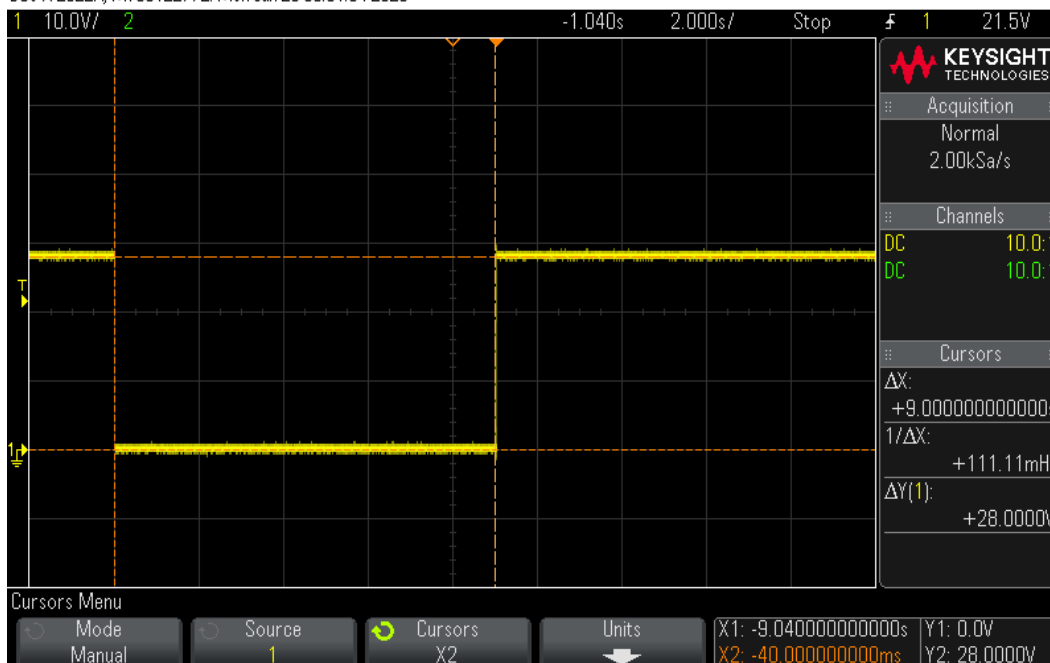


Table 16-7 a Test 1 T1

DSO-X 2022A, MY59122772, Mon Jan 23 09:53:25 2023

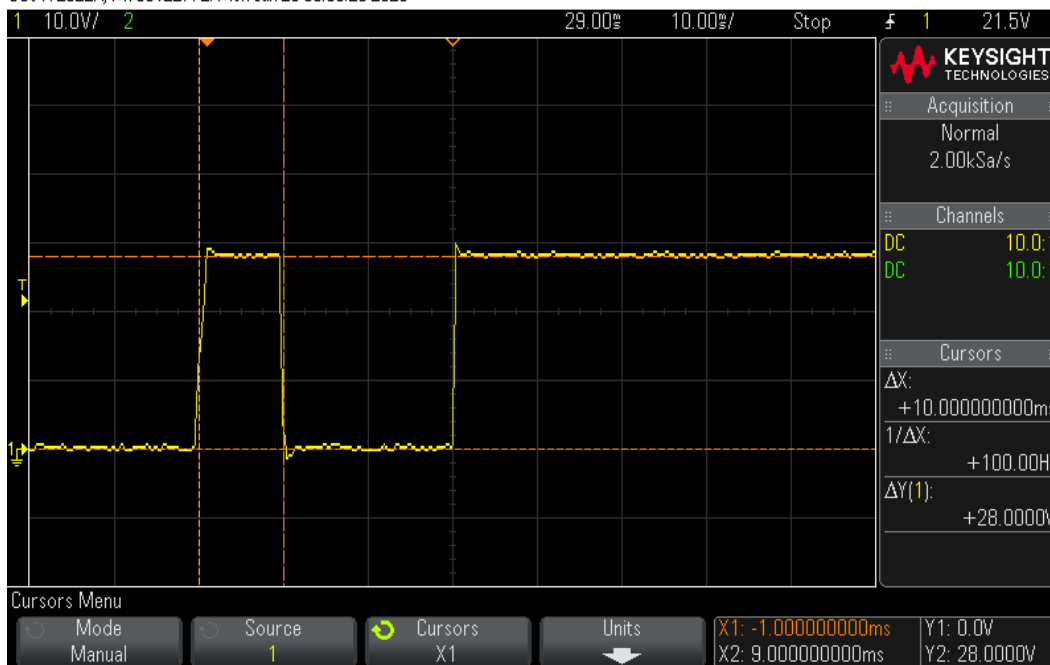


Table 16-7 b Test 1 T2

DSO-X 2022A, MY59122772: Mon Jan 23 09:54:16 2023

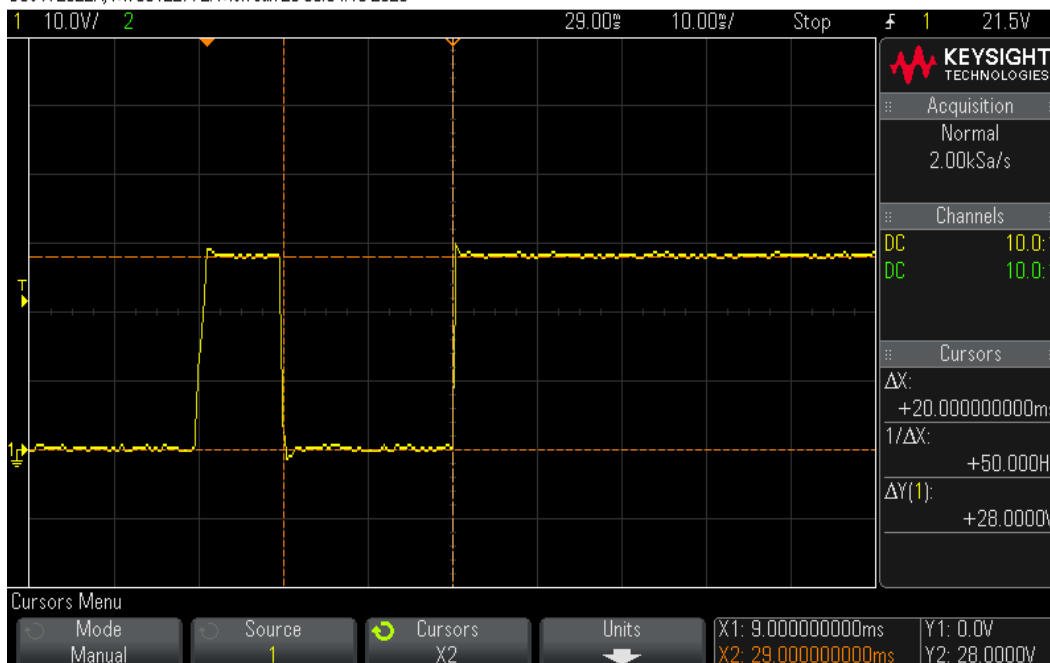


Table 16-7 c Test 1 T3

DSO-X 2022A, MY59122772: Mon Jan 23 09:55:43 2023

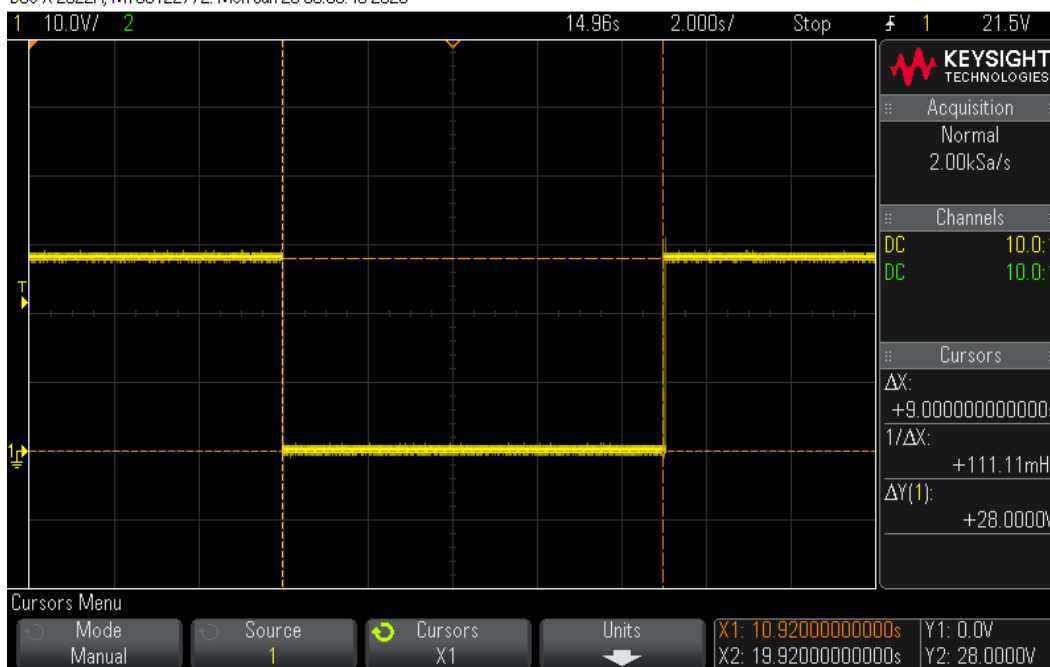
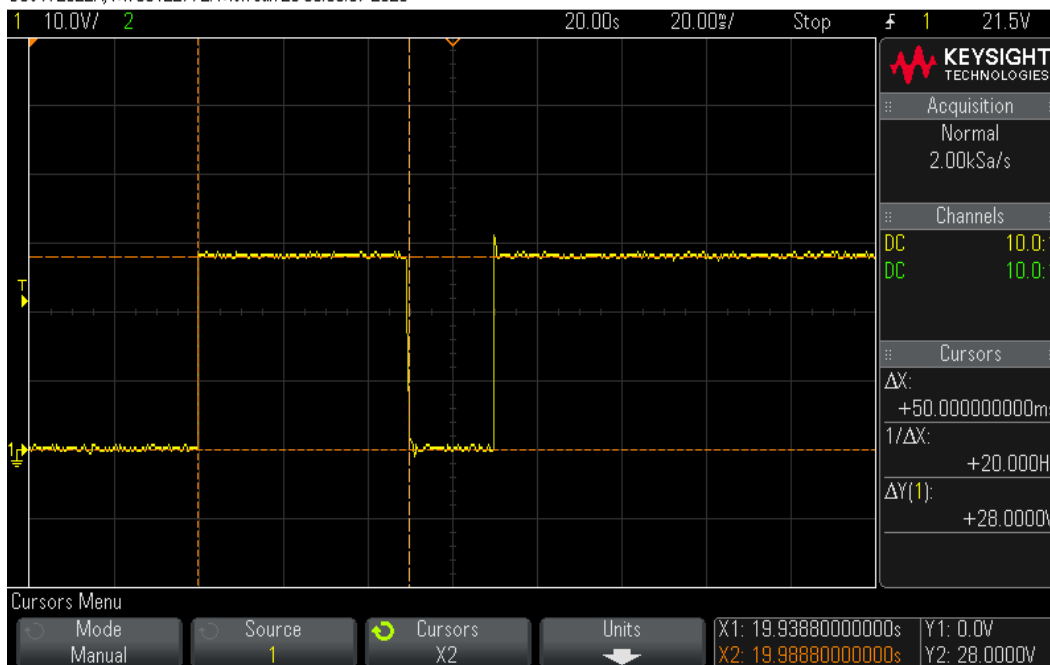
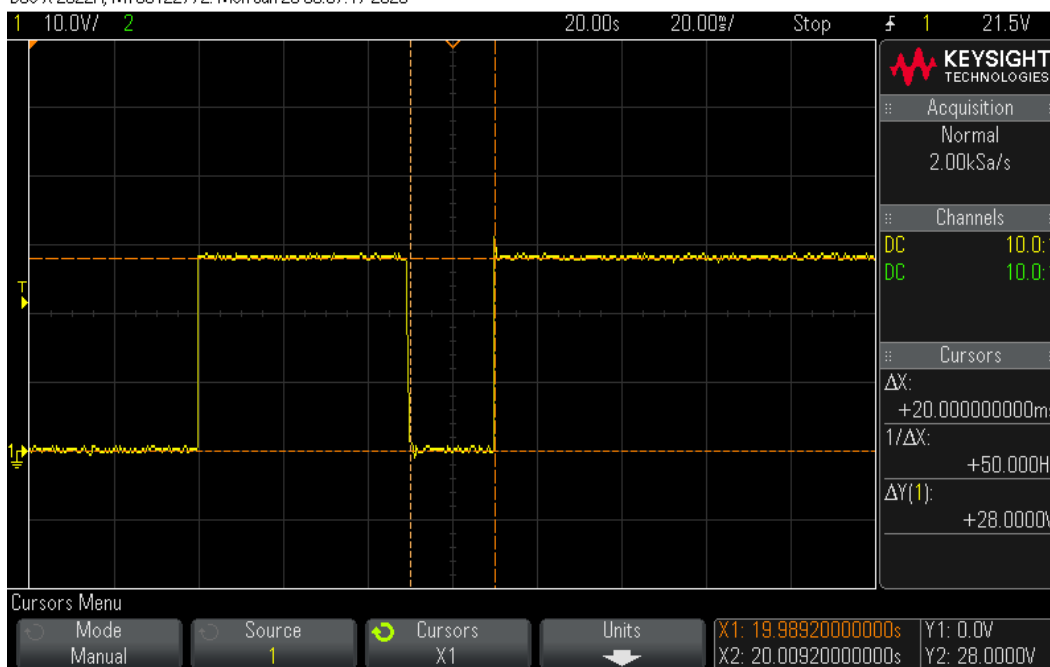


Table 16-7 d Test 1 T1

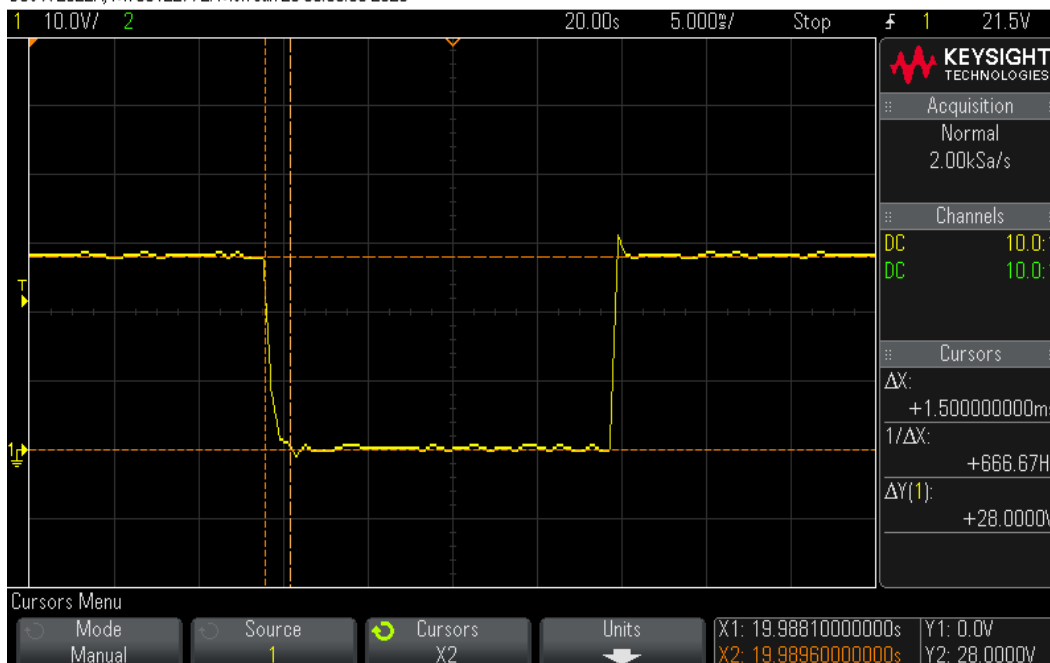
DSO-X 2022A, MY59122772, Mon Jan 23 09:56:37 2023



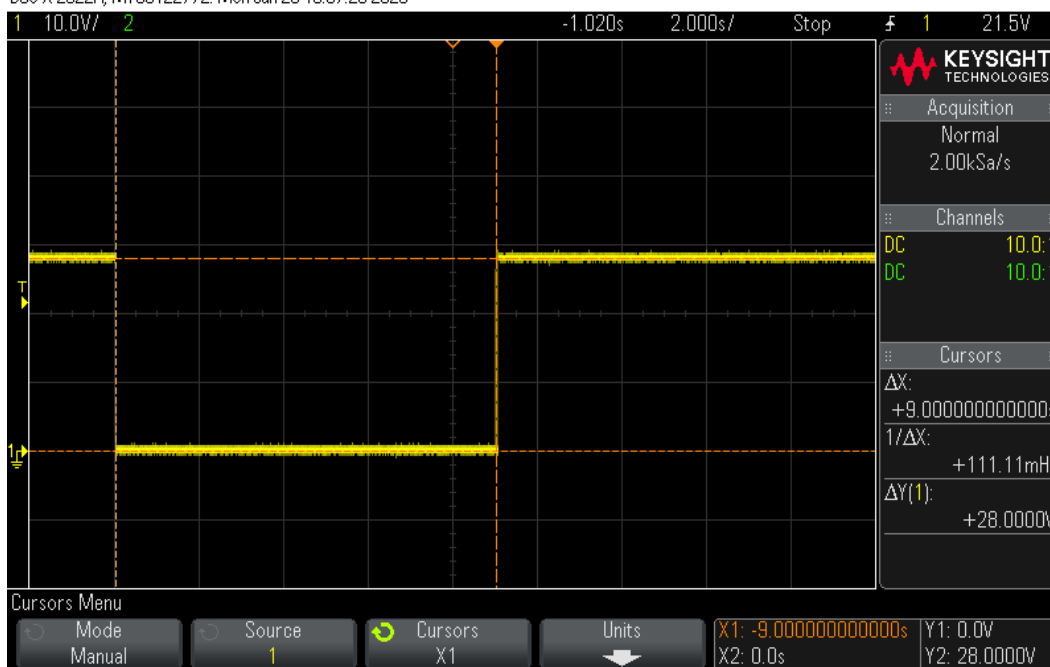
DSO-X 2022A, MY59122772, Mon Jan 23 09:57:17 2023



DSO-X 2022A, MY59122772: Mon Jan 23 09:58:09 2023



DSO-X 2022A, MY59122772: Mon Jan 23 10:07:28 2023



DSO-X 2022A, MY59122772, Mon Jan 23 10:08:22 2023

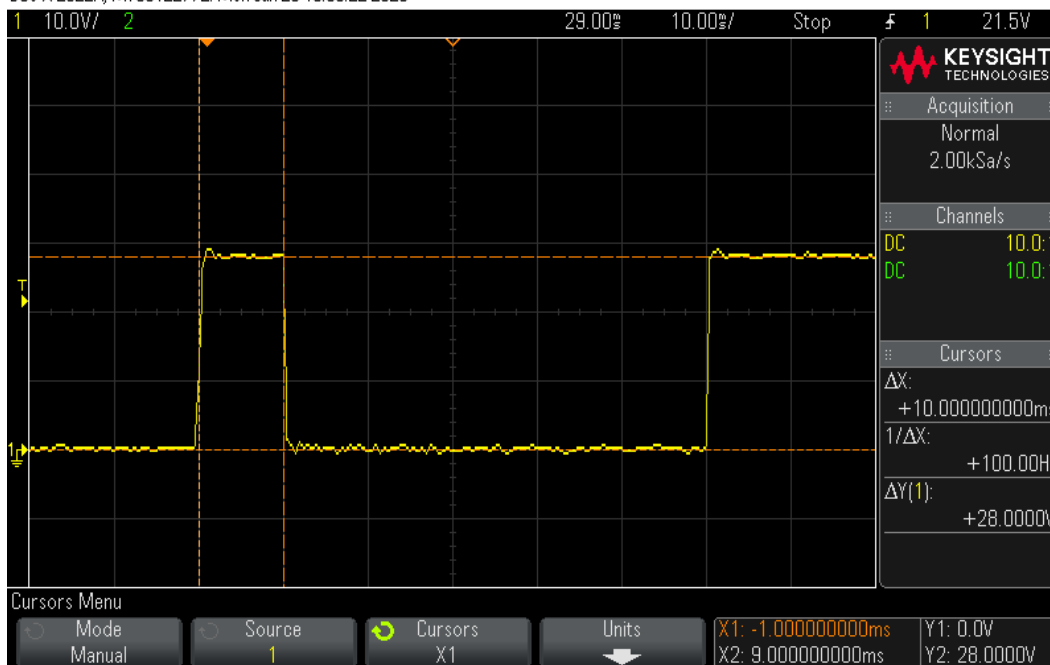


Table 16-7 i Test 2 T2

DSO-X 2022A, MY59122772, Mon Jan 23 10:08:56 2023

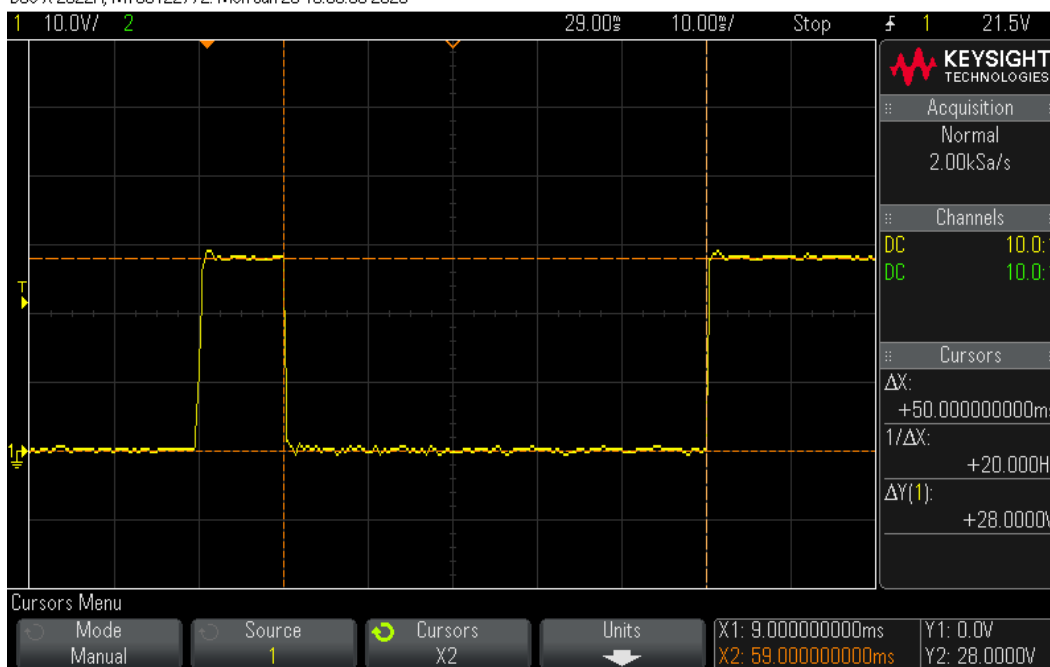


Table 16-7 j Test 2 T3

DSO-X 2022A, MY59122772: Mon Jan 23 10:10:29 2023

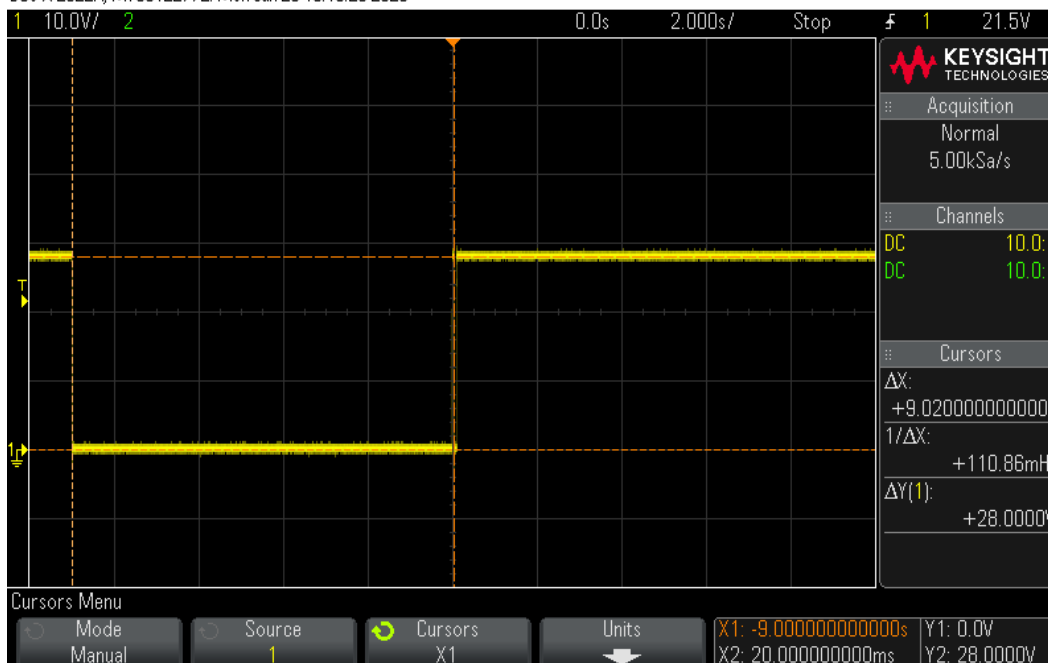


Table 16-7 k Test 2 T1

DSO-X 2022A, MY59122772: Mon Jan 23 10:11:14 2023

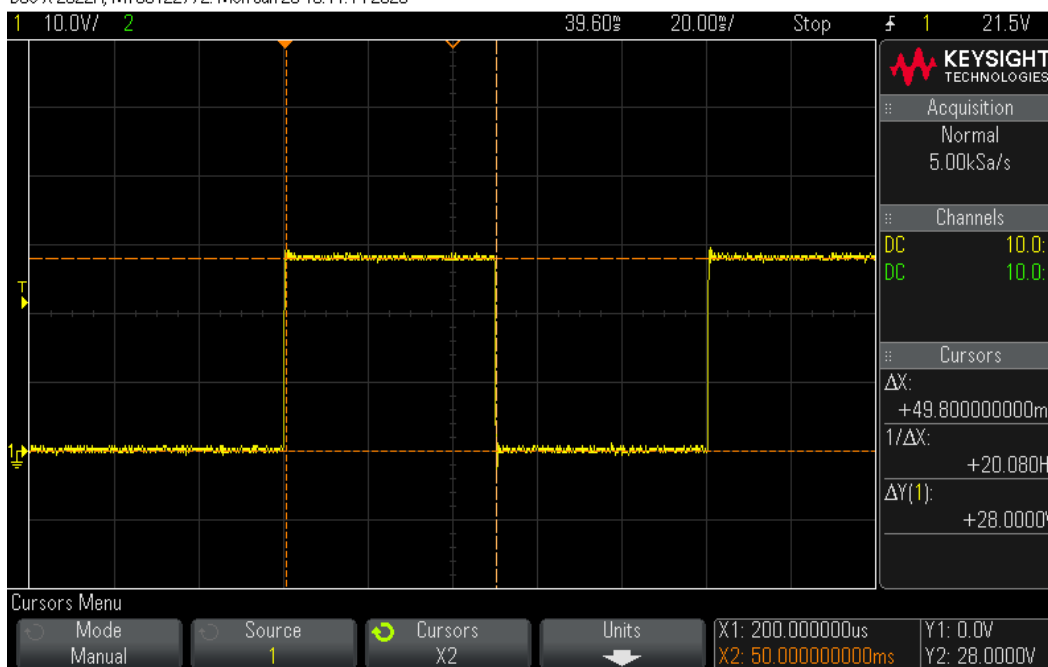


Table 16-7 l Test 2 T2

DSO-X 2022A, MY59122772, Mon Jan 23 10:11:50 2023

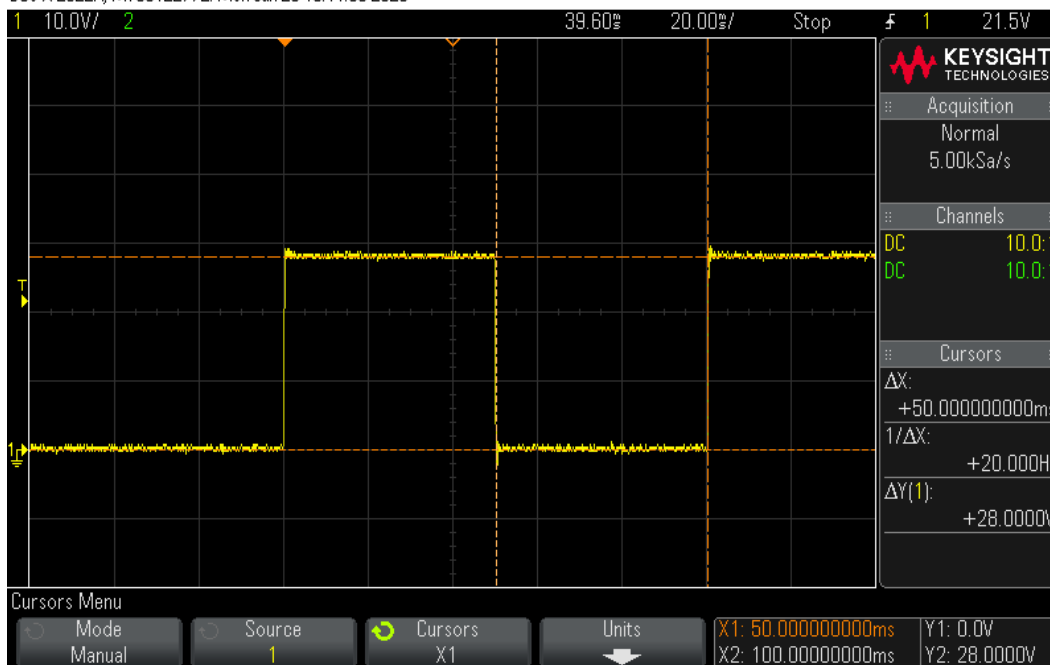


Table 16-7 m Test 2 T3

DSO-X 2022A, MY59122772, Mon Jan 23 10:12:45 2023

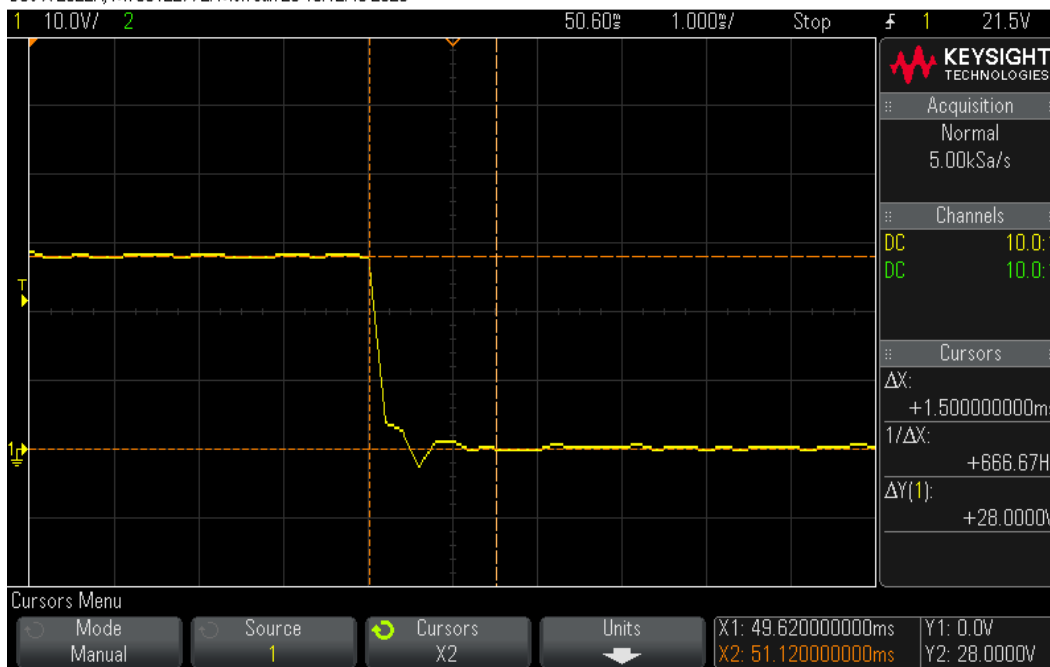


Table 16-7 n Test 2 d

DSO-X 2022A, MY59122772, Mon Jan 23 10:17:23 2023

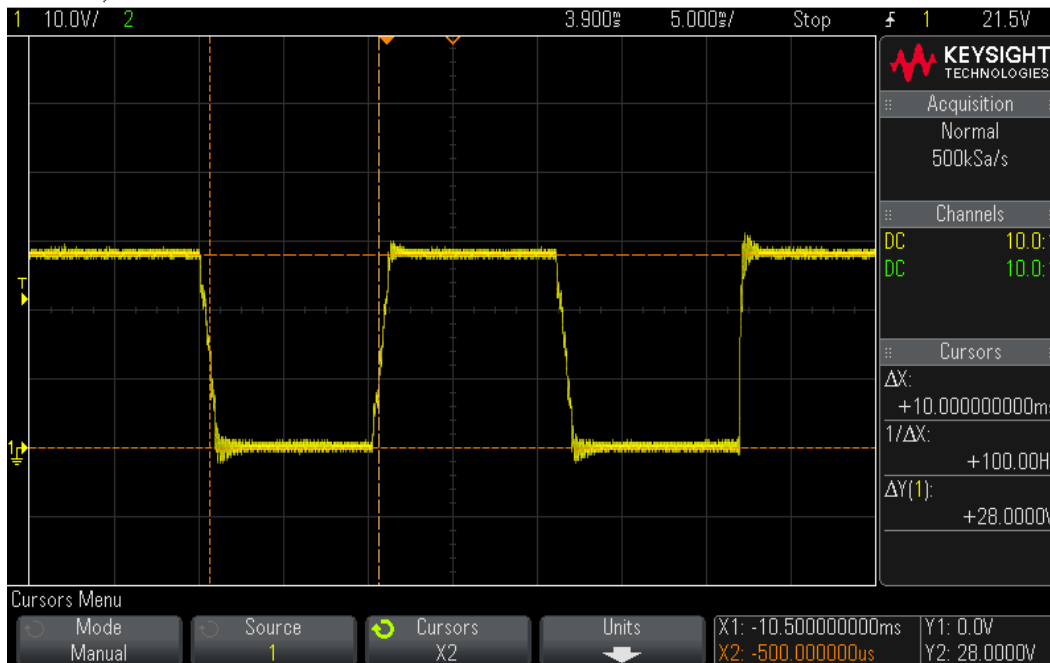


Table 16-7 o Test 3 T1

DSO-X 2022A, MY59122772, Mon Jan 23 10:18:24 2023

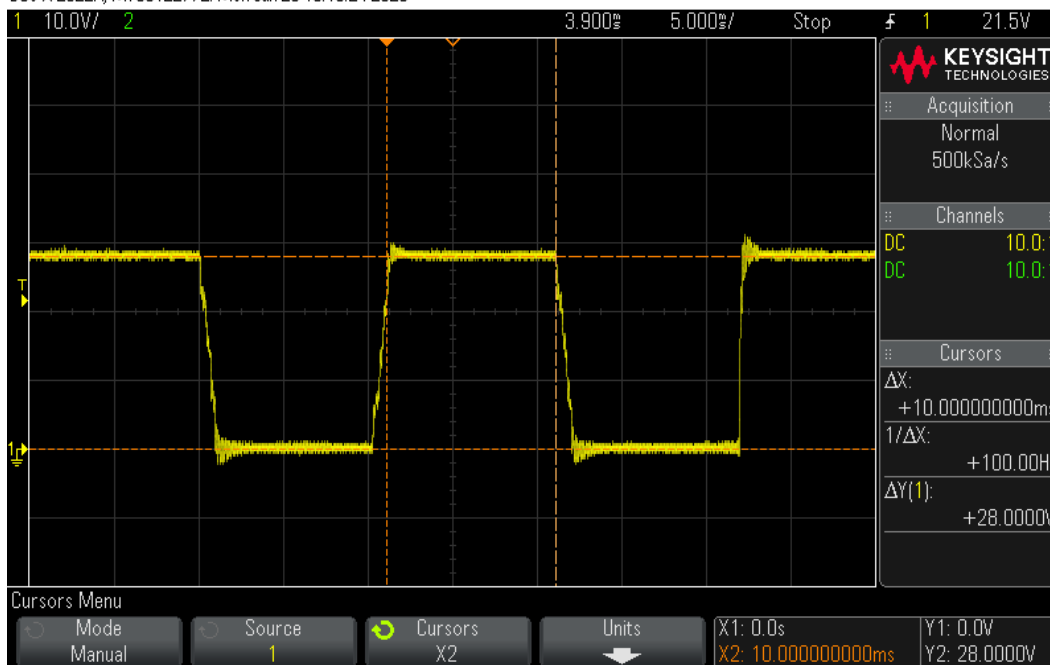


Table 16-7 p Test 3 T2

DSO-X 2022A, MY59122772: Mon Jan 23 10:19:35 2023

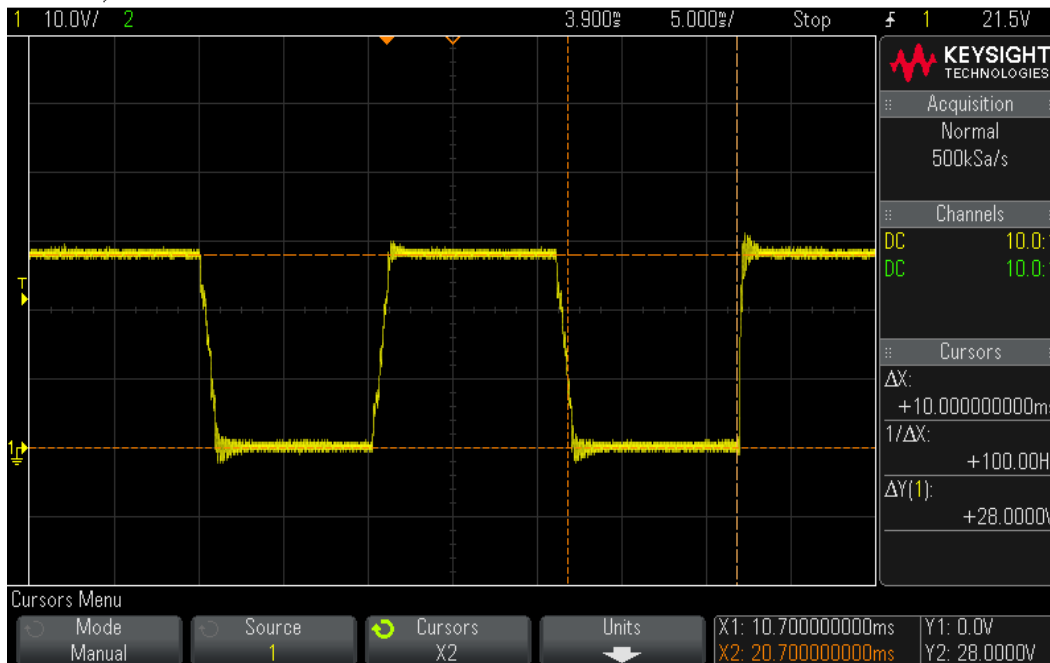


Table 16-7 q Test 3 T3

DSO-X 2022A, MY59122772: Mon Jan 23 10:21:42 2023

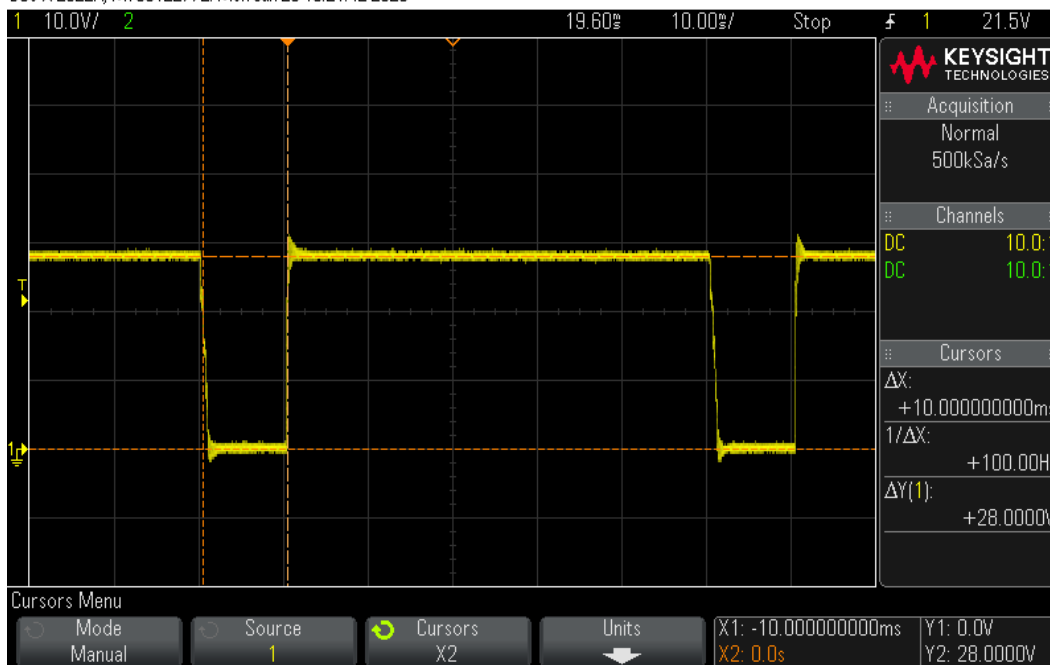


Table 16-7 r Test 3 T1

DSO-X 2022A, MY59122772: Mon Jan 23 10:22:21 2023

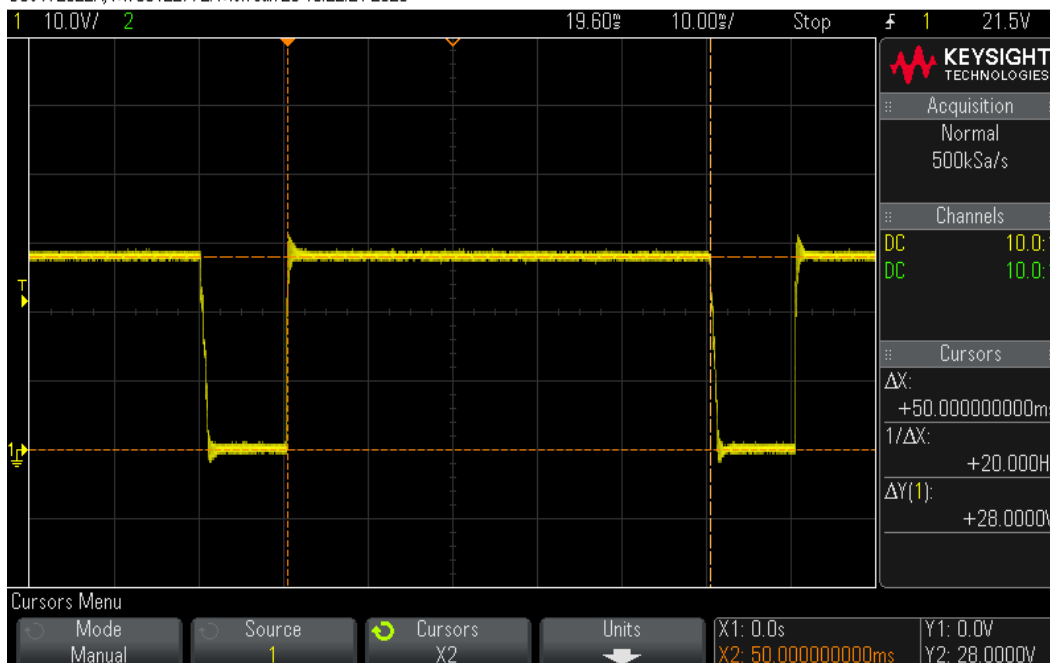


Table 16-7 s Test 3 T2

DSO-X 2022A, MY59122772: Mon Jan 23 10:22:59 2023

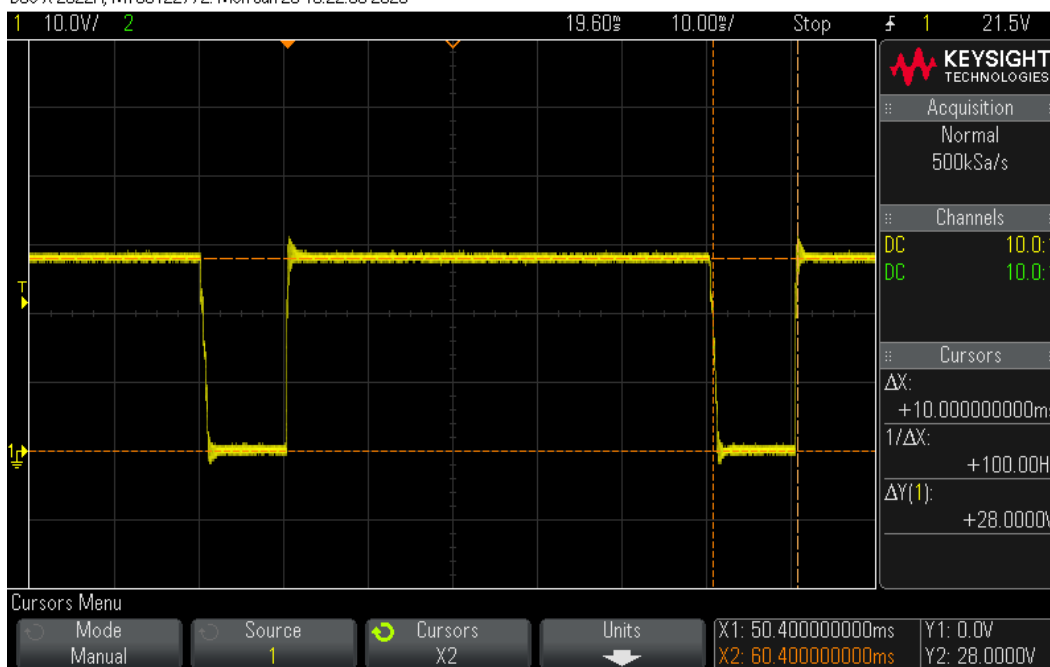
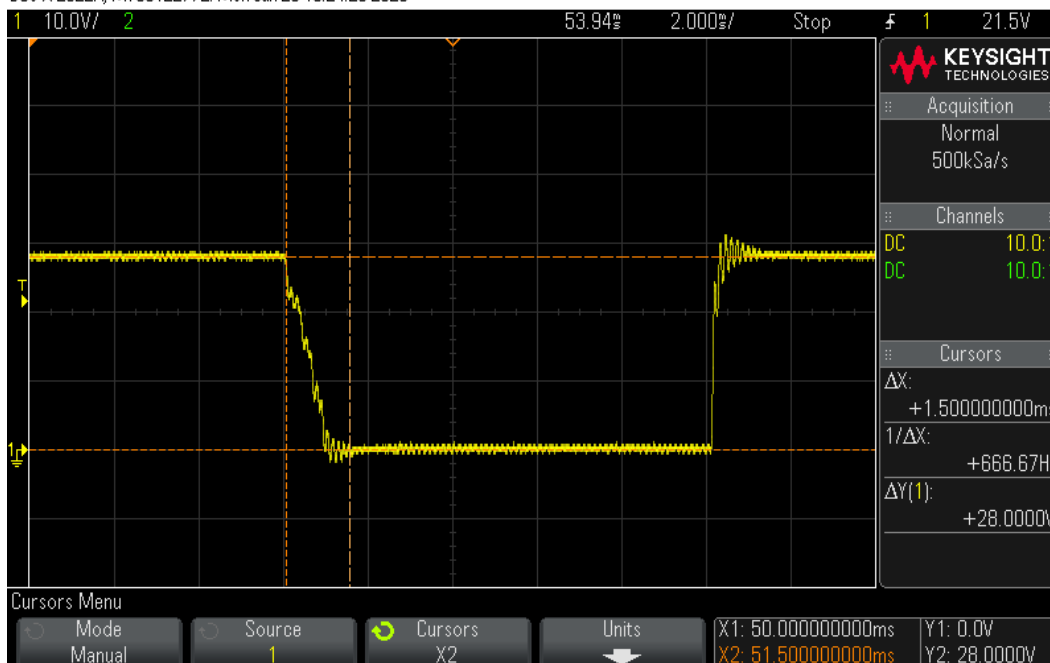
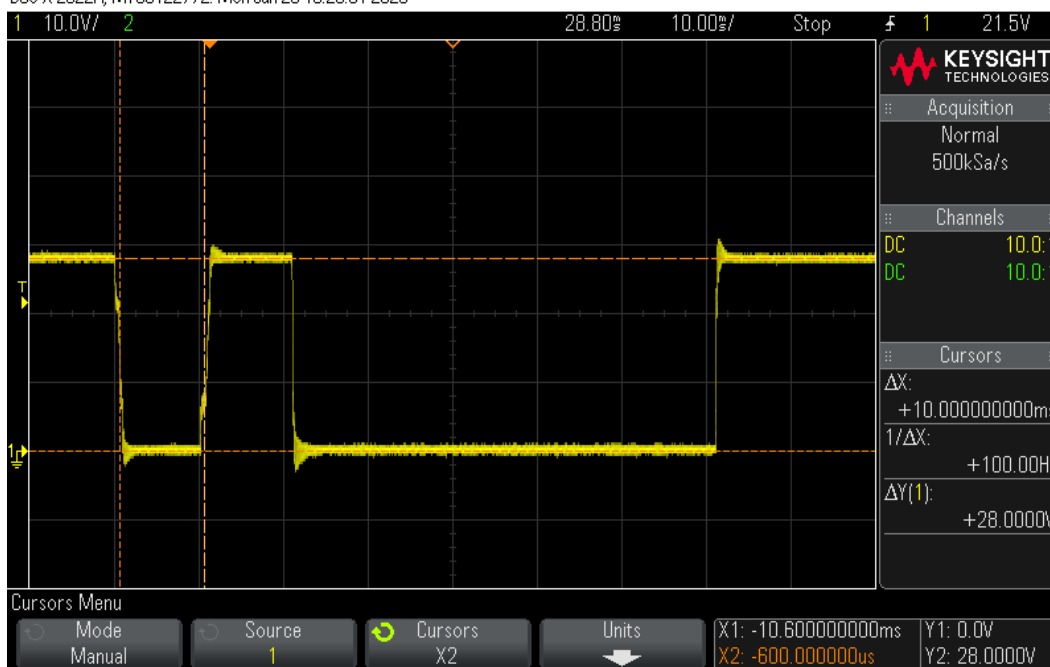


Table 16-7 t Test 3 T3

DSO-X 2022A, MY59122772, Mon Jan 23 10:24:29 2023



DSO-X 2022A, MY59122772, Mon Jan 23 10:26:31 2023



DSO-X 2022A, MY59122772: Mon Jan 23 10:27:28 2023

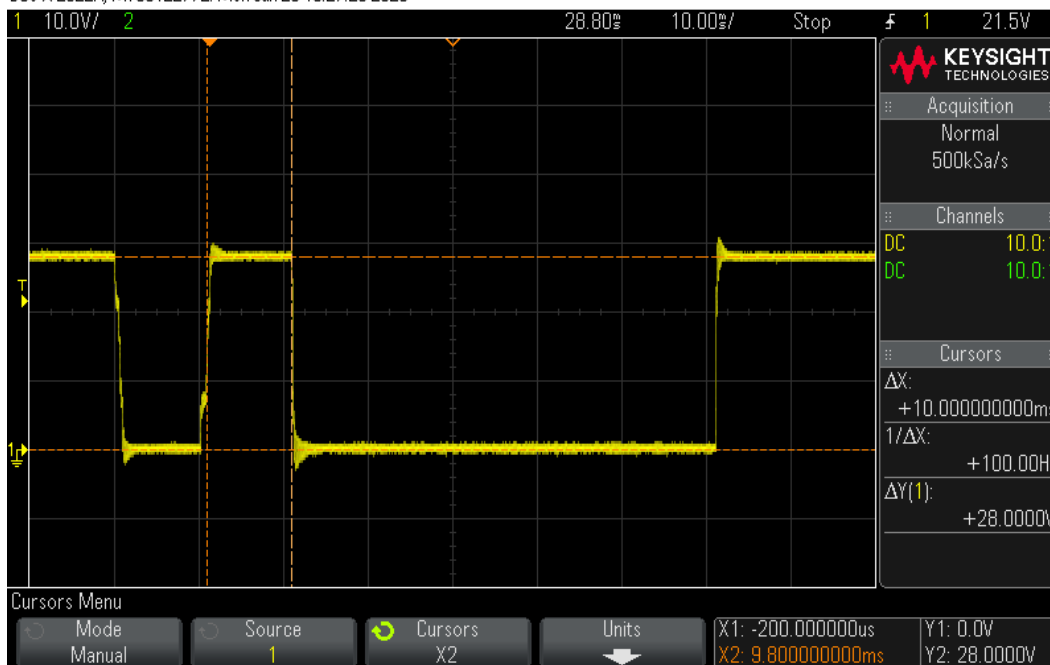


Table 16-7 w Test 4 T2

DSO-X 2022A, MY59122772: Mon Jan 23 10:37:44 2023

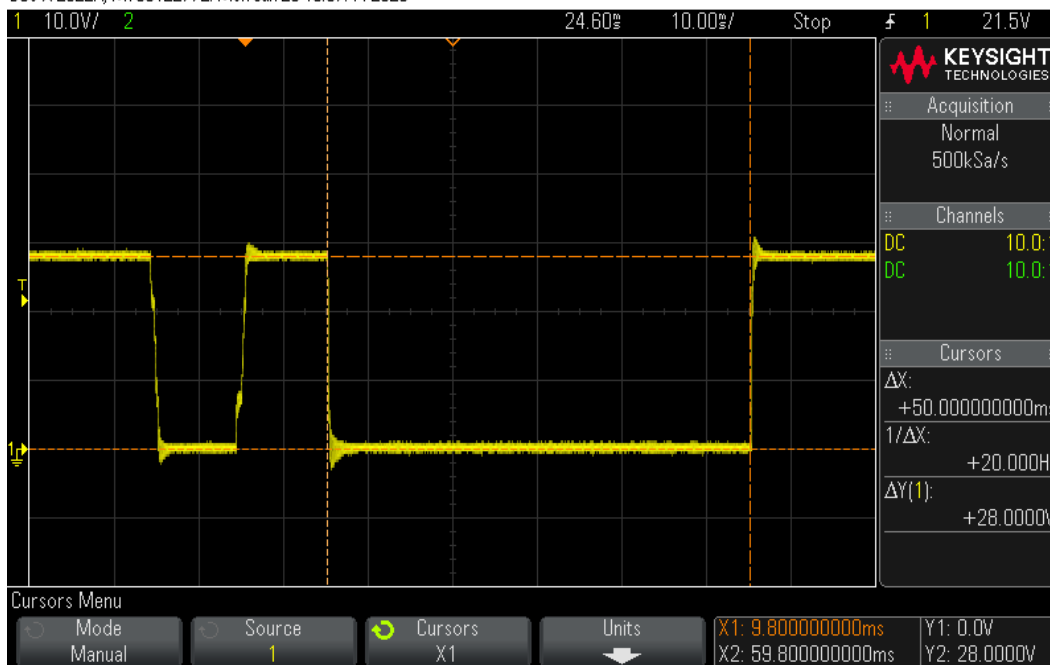


Table 16-7 x Test 4 T3

DSO-X 2022A, MY59122772, Mon Jan 23 10:45:29 2023

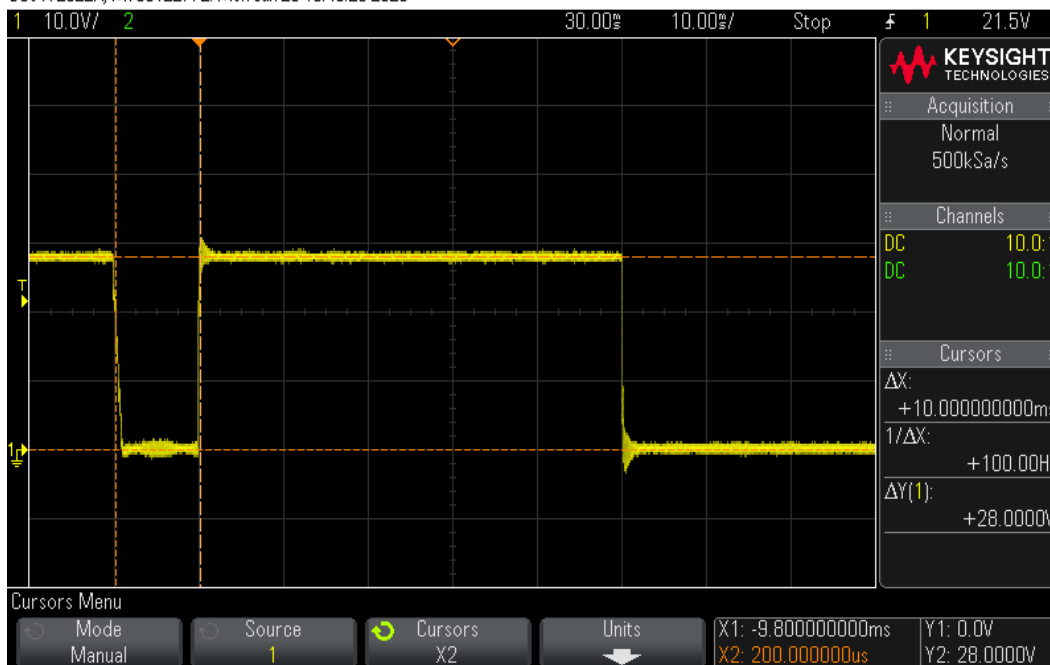


Table 16-7 y Test 4 T1

DSO-X 2022A, MY59122772, Mon Jan 23 10:46:02 2023

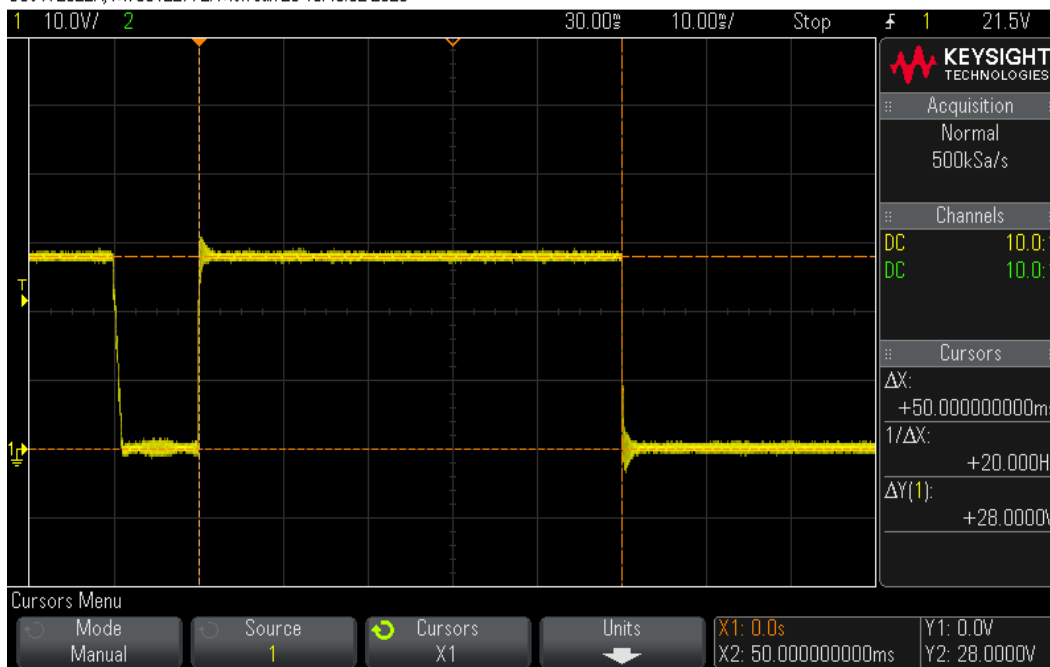


Table 16-7 z Test 4 T2

DSO-X 2022A, MY59122772, Mon Jan 23 10:46:52 2023

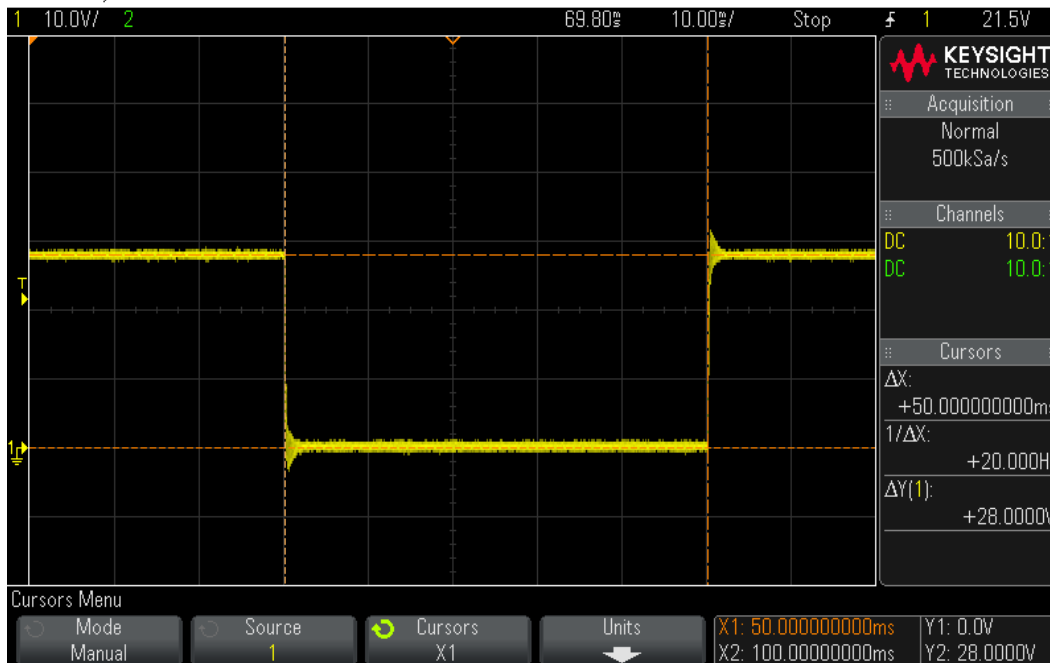


Table 16-7 za Test 4 T3

DSO-X 2022A, MY59122772, Mon Jan 23 10:47:32 2023

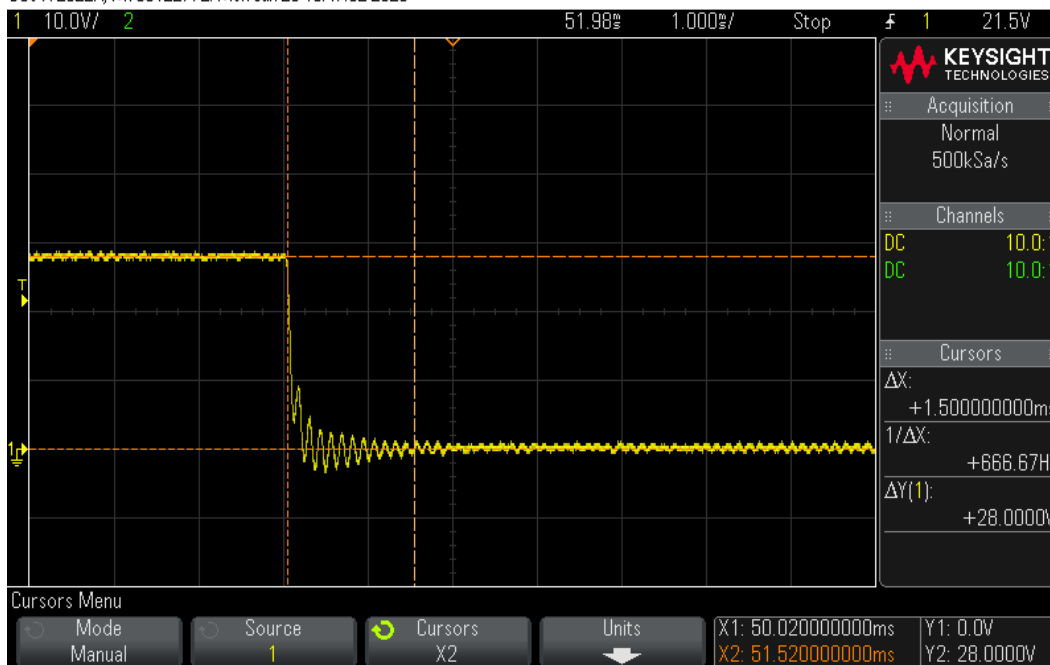


Table 16-7 zb Test 4 d

DSO-X 2022A, MY59122772, Mon Jan 23 10:49:52 2023

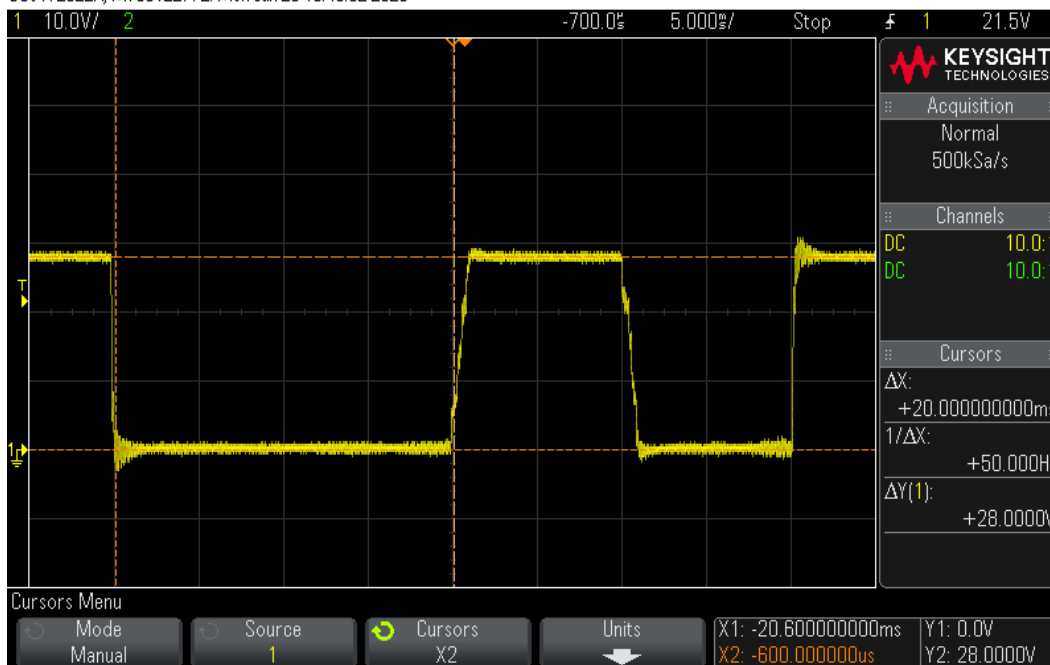


Table 16-7 zc Test 6 T1

DSO-X 2022A, MY59122772, Mon Jan 23 10:50:37 2023

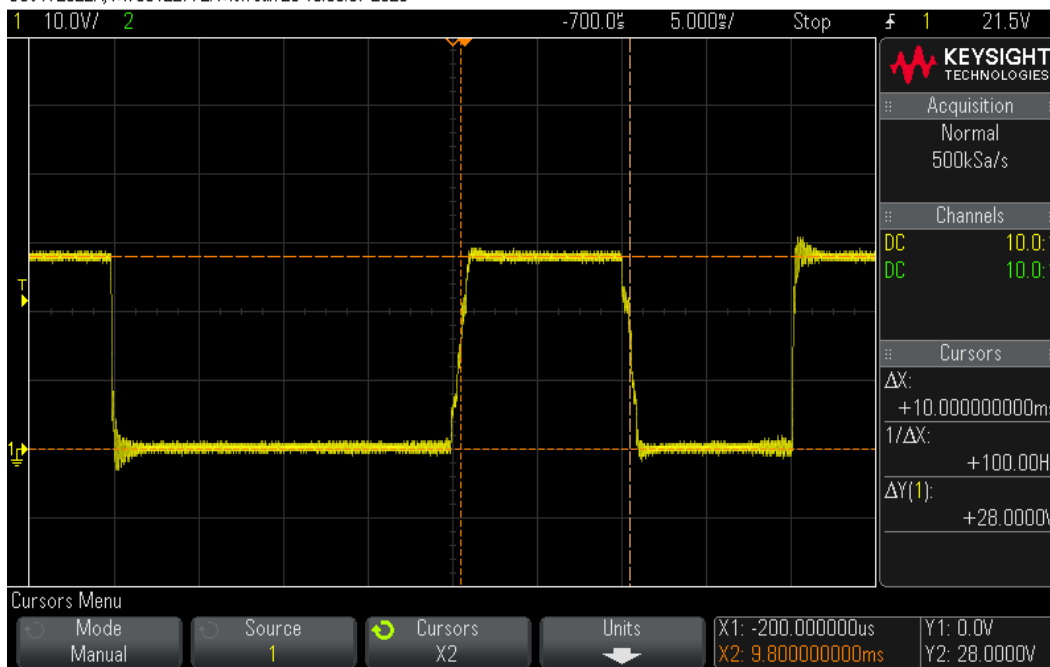


Table 16-7 zd Test 6 T2

DSO-X 2022A, MY59122772, Mon Jan 23 10:51:10 2023

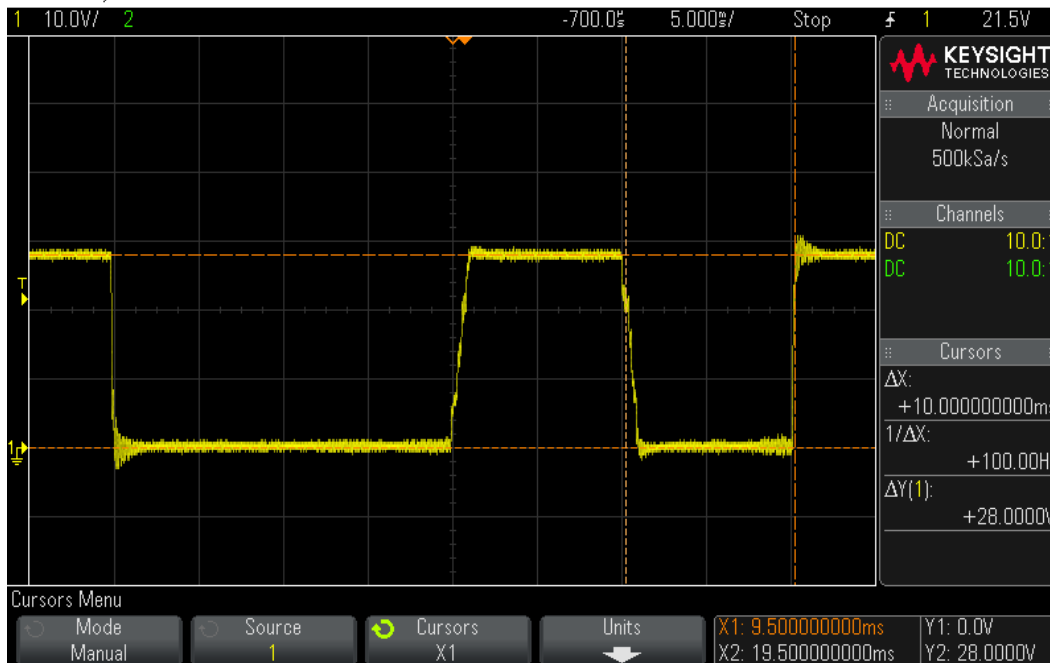


Table 16-7 ze Test 6 T3

DSO-X 2022A, MY59122772, Mon Jan 23 10:53:10 2023

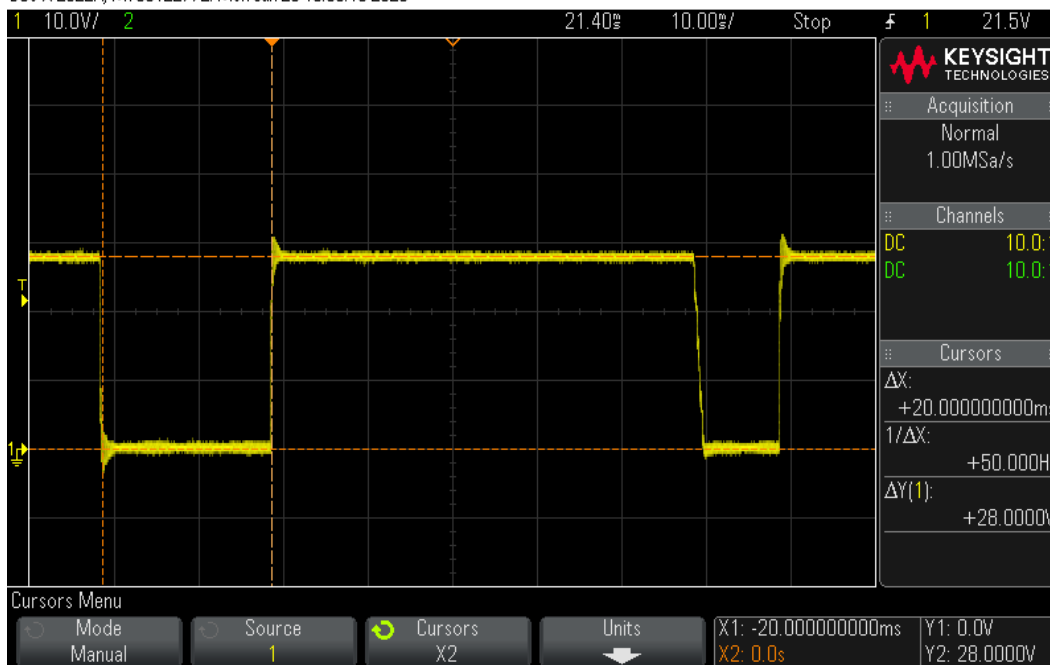


Table 16-7 zf Test 6 T1

DSO-X 2022A, MY59122772, Mon Jan 23 10:53:53 2023

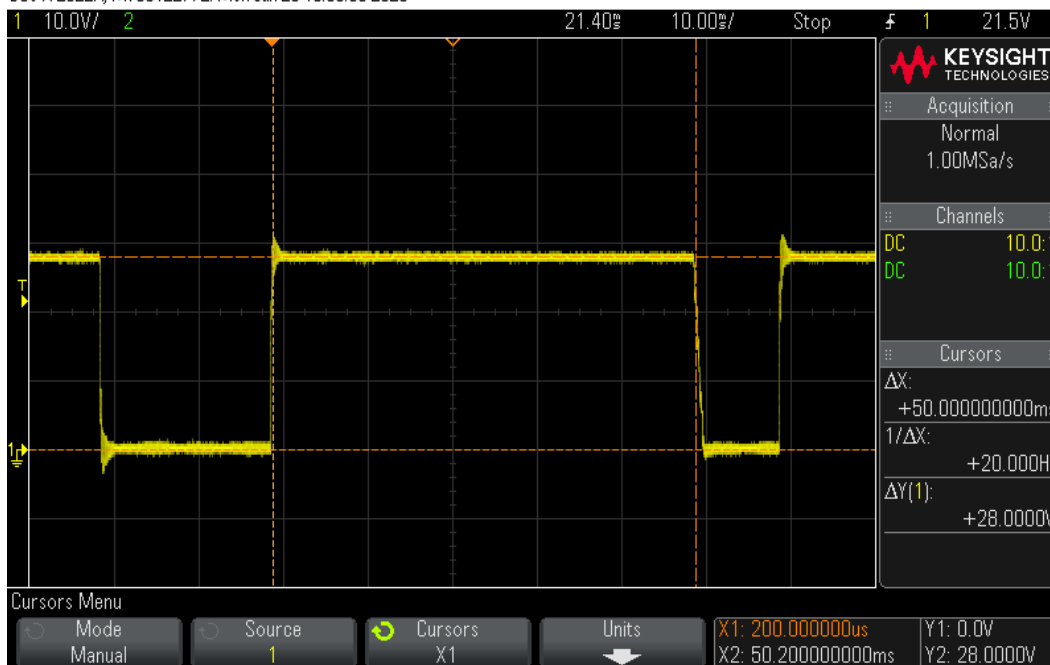


Table 16-7 zg Test 6 T2

DSO-X 2022A, MY59122772, Mon Jan 23 10:54:23 2023

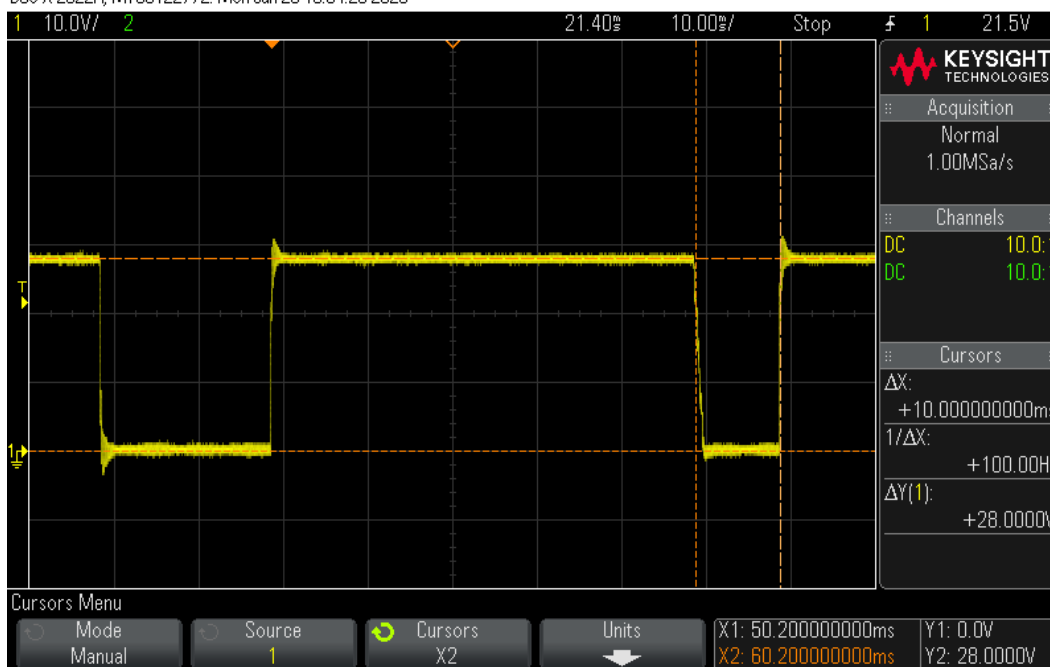


Table 16-7 zh Test 6 T3

DSO-X 2022A, MY59122772, Mon Jan 23 10:55:20 2023

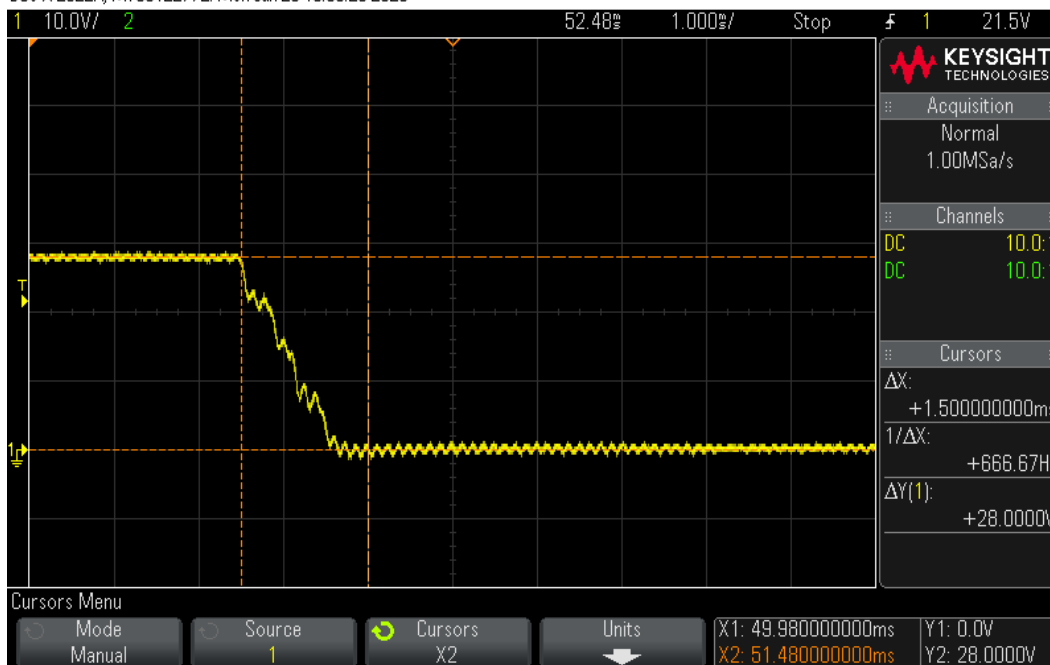


Table 16-7 zi Test 6 d

DSO-X 2022A, MY59122772, Mon Jan 23 10:57:29 2023

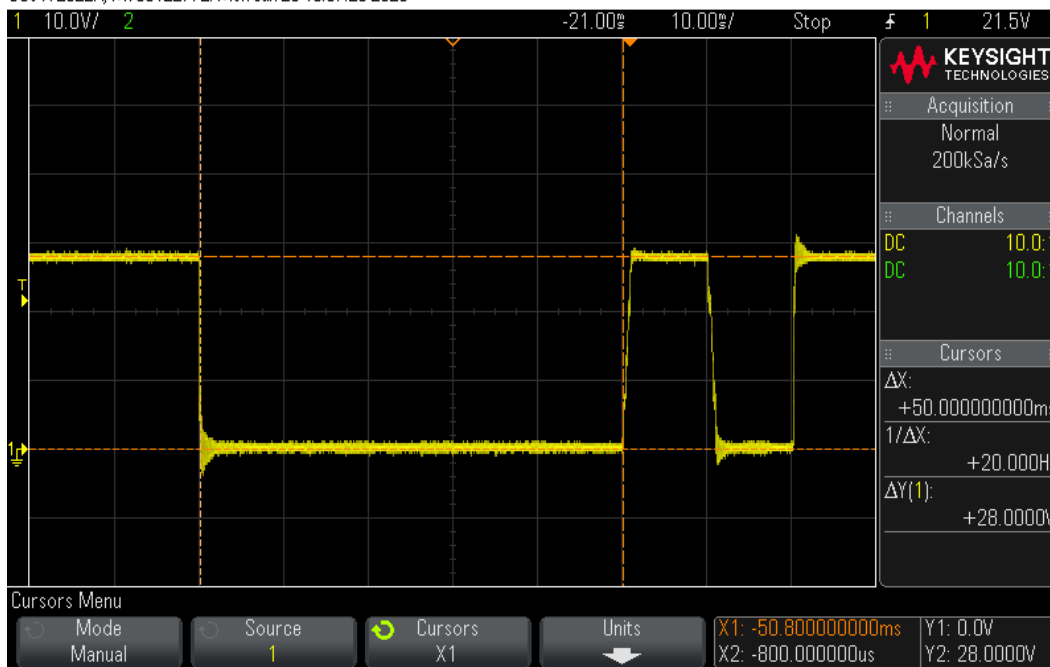


Table 16-7 zj Test 10 T1

DSO-X 2022A, MY59122772, Mon Jan 23 10:58:13 2023

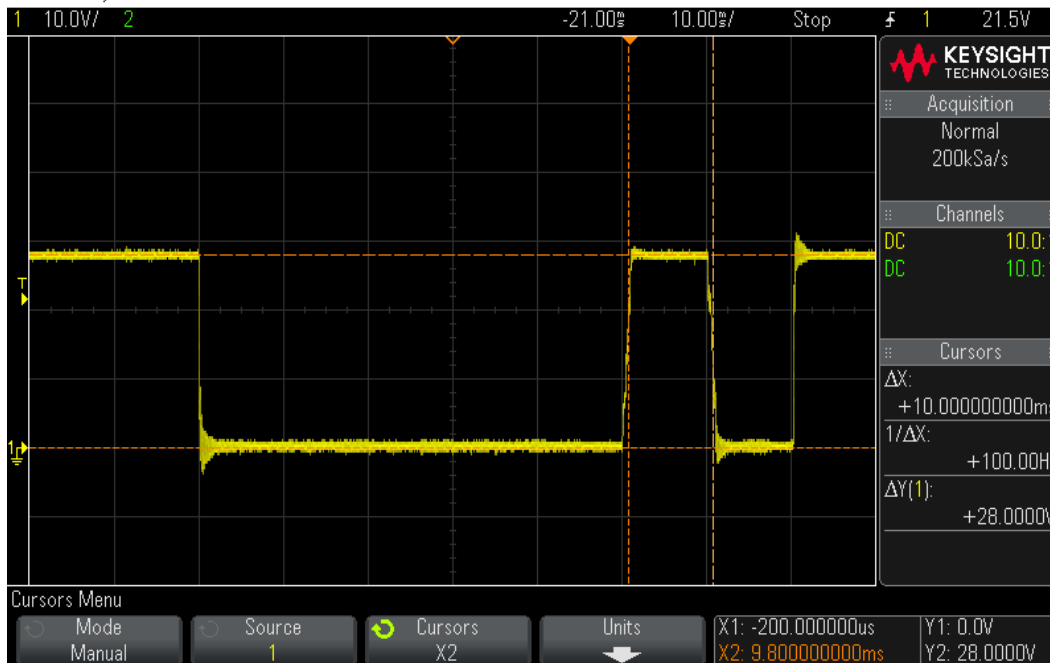


Table 16-7 zk Test 10 T2

DSO-X 2022A, MY59122772, Mon Jan 23 10:58:43 2023

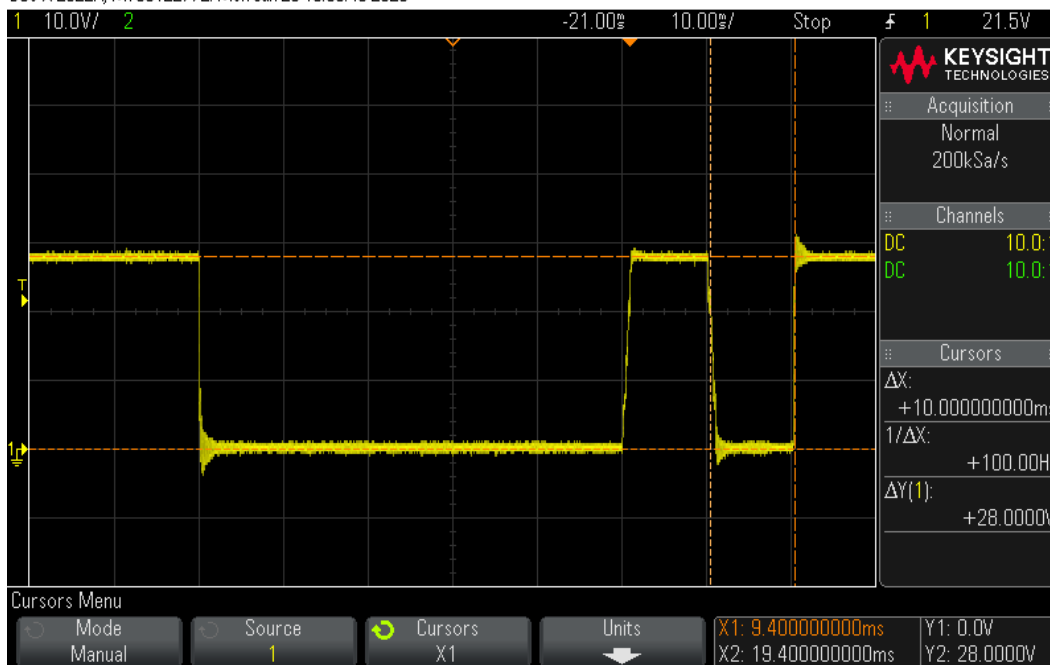


Table 16-7 zl Test 10 T3

1 10.0V/ 2 -10.80ms 10.00ns/ Stop f 1 21.5V

KEYSIGHT TECHNOLOGIES

Acquisition
Normal
200kSa/s

Channels
DC 10.0V
DC 10.0V

Cursors
ΔX:
+50.000000000ms
1/ΔX:
+20.000H
ΔY(1):
+28.0000V

Cursors Menu
Mode Manual Source 1 Cursors X2 Units V
X1: -50.400000000ms Y1: 0.0V
X2: -400.0000000us Y2: 28.0000V

DSO-X 2022A, MY59122772: Mon Jan 23 11:00:12 2023

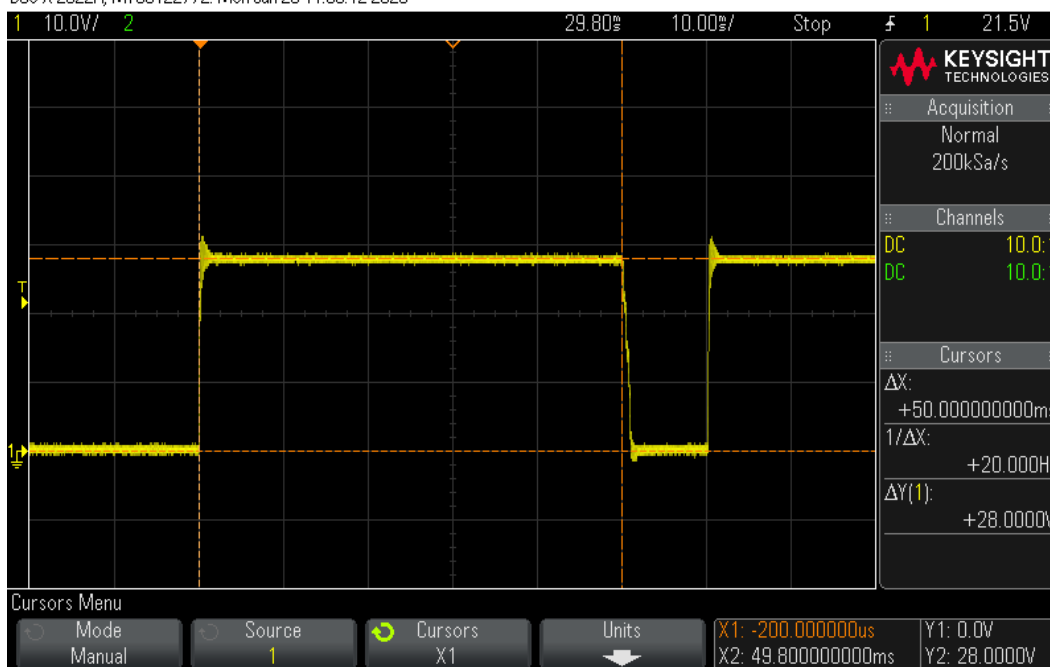


Table 16-7 zn Test 10 T2

DSO-X 2022A, MY59122772, Mon Jan 23 11:00:43 2023

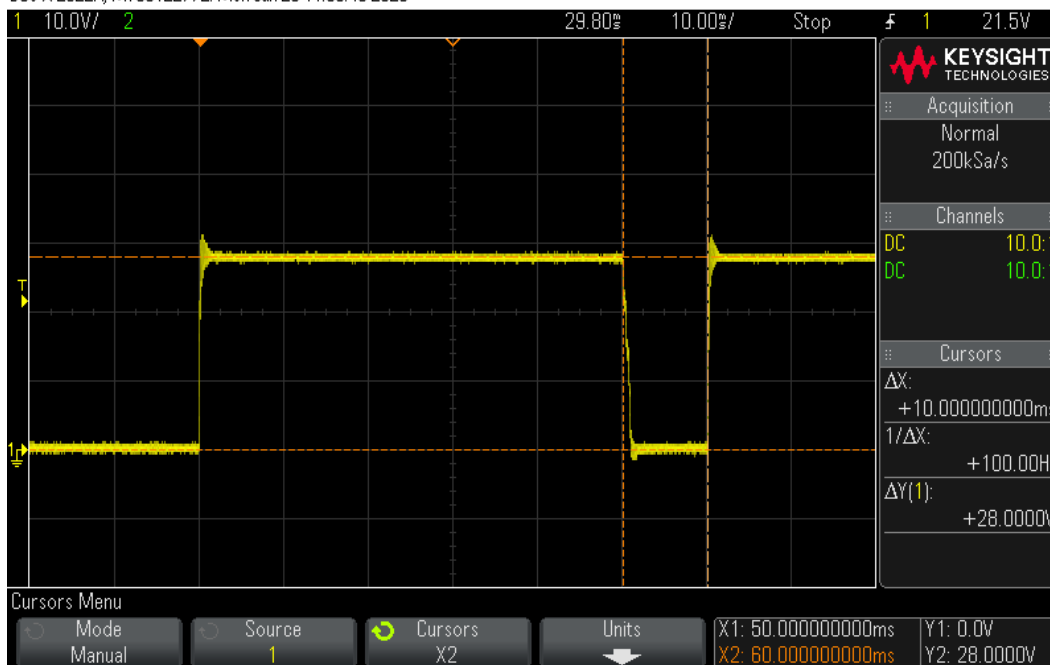


Table 16-7 zo Test 10 T3

DSO-X 2022A, MY59122772, Mon Jan 23 11:01:25 2023



Table 16-7 zp Test 10 d

DSO-X 2022A, MY59122772, Mon Jan 23 11:02:32 2023

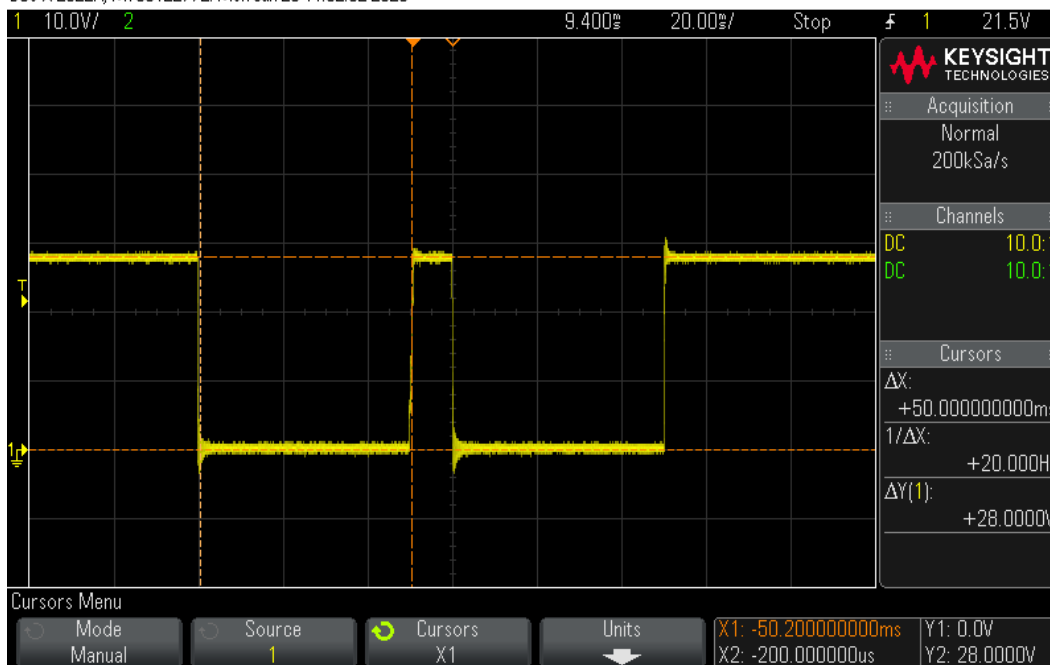


Table 16-7 zq Test 11 T1

DSO-X 2022A, MY59122772, Mon Jan 23 11:03:08 2023

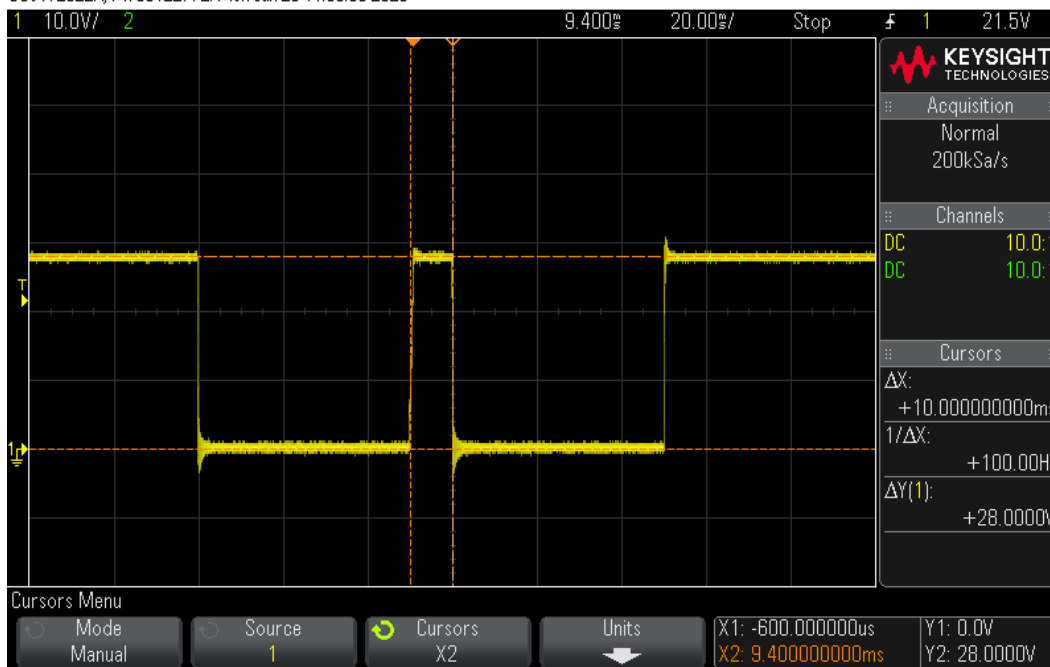


Table 16-7 zr Test 11 T2

DSO-X 2022A, MY59122772, Mon Jan 23 11:03:35 2023

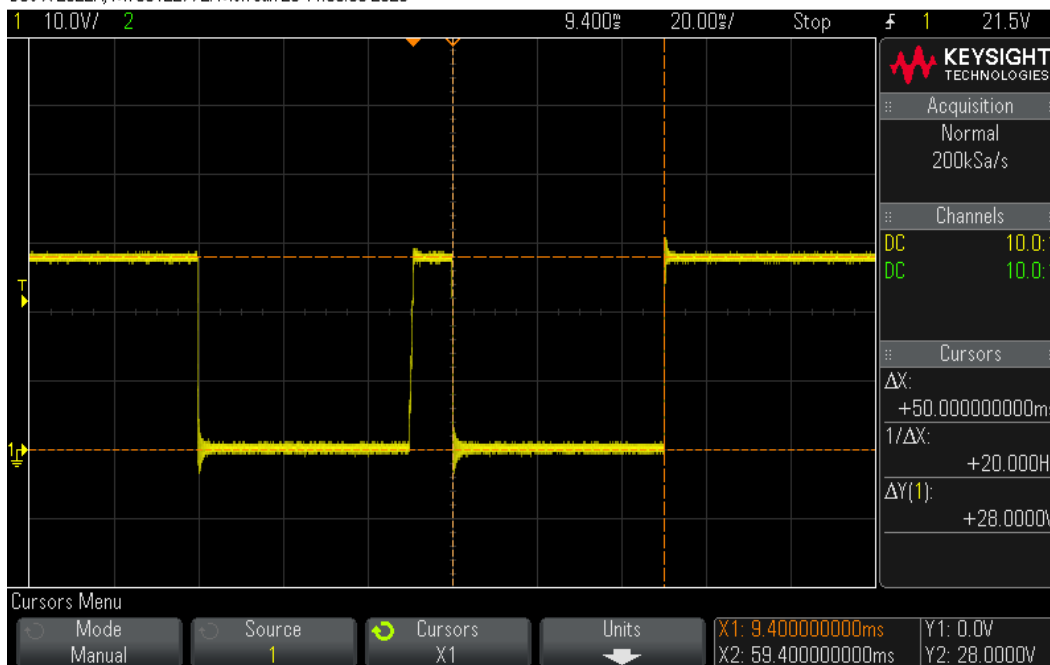


Table 16-7 zs Test 11 T3

DSO-X 2022A, MY59122772, Mon Jan 23 11:05:27 2023

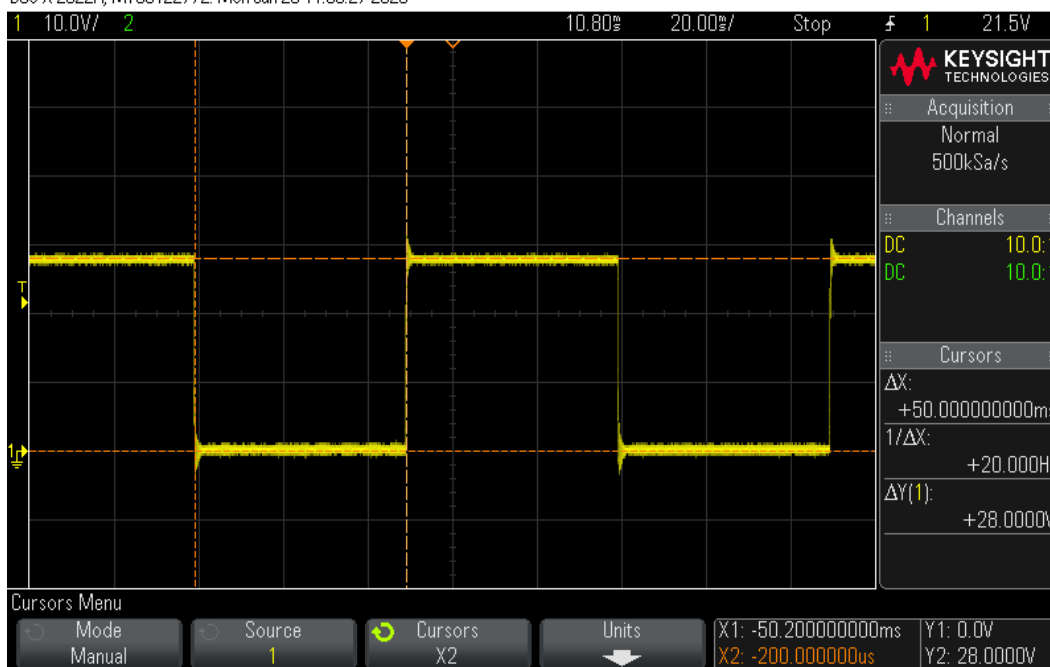


Table 16-7 zt Test 11 T1

DSO-X 2022A, MY59122772, Mon Jan 23 11:05:52 2023

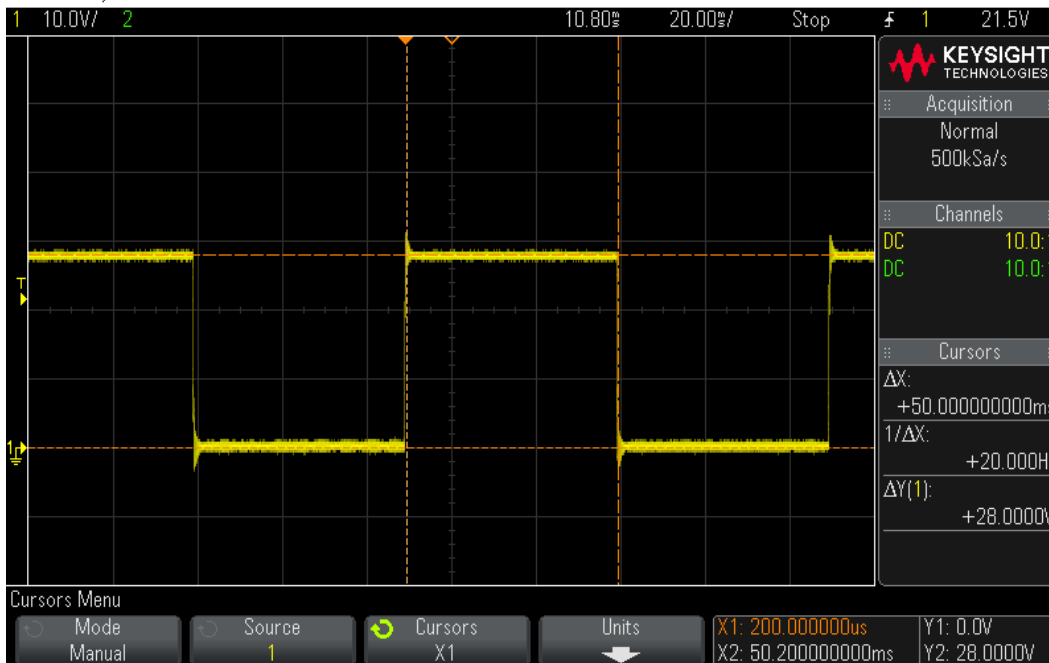


Table 16-7 zu Test 11 T2

DSO-X 2022A, MY59122772, Mon Jan 23 11:06:17 2023

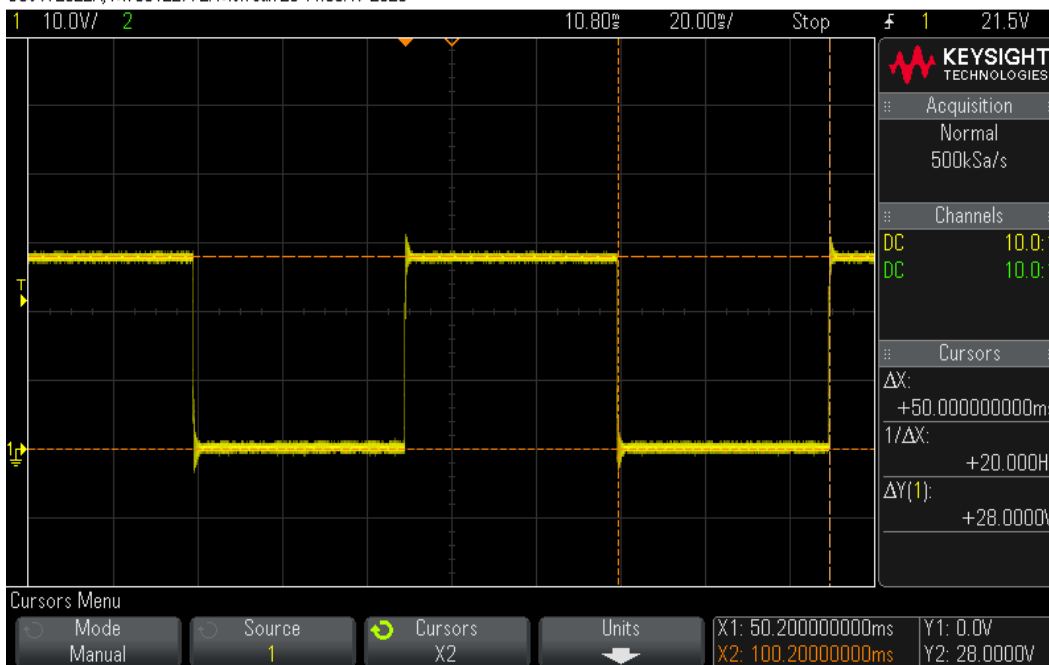
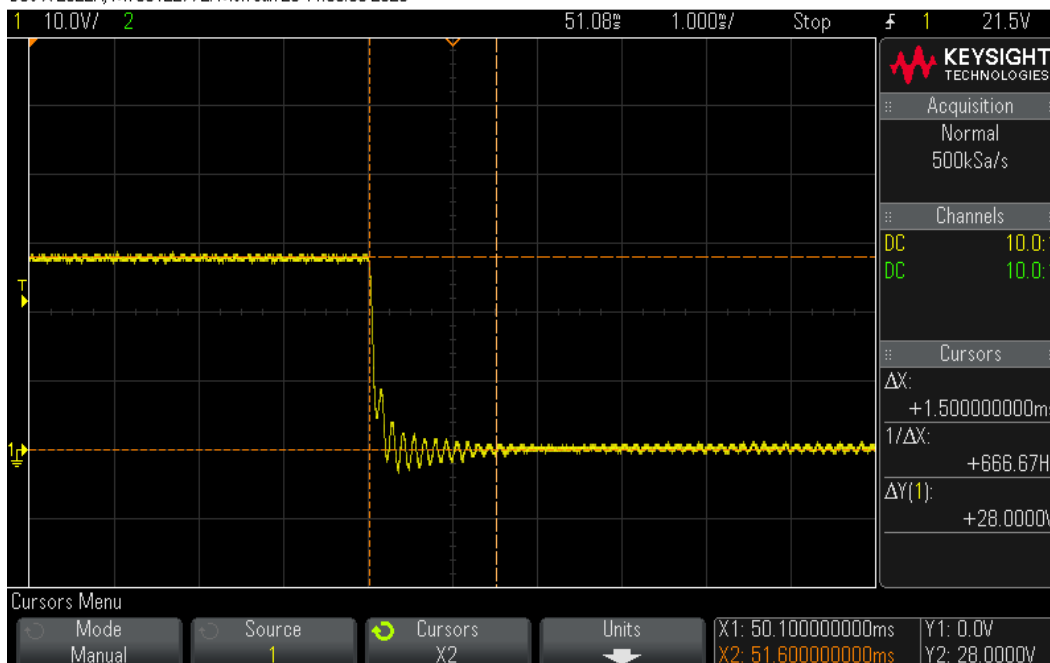
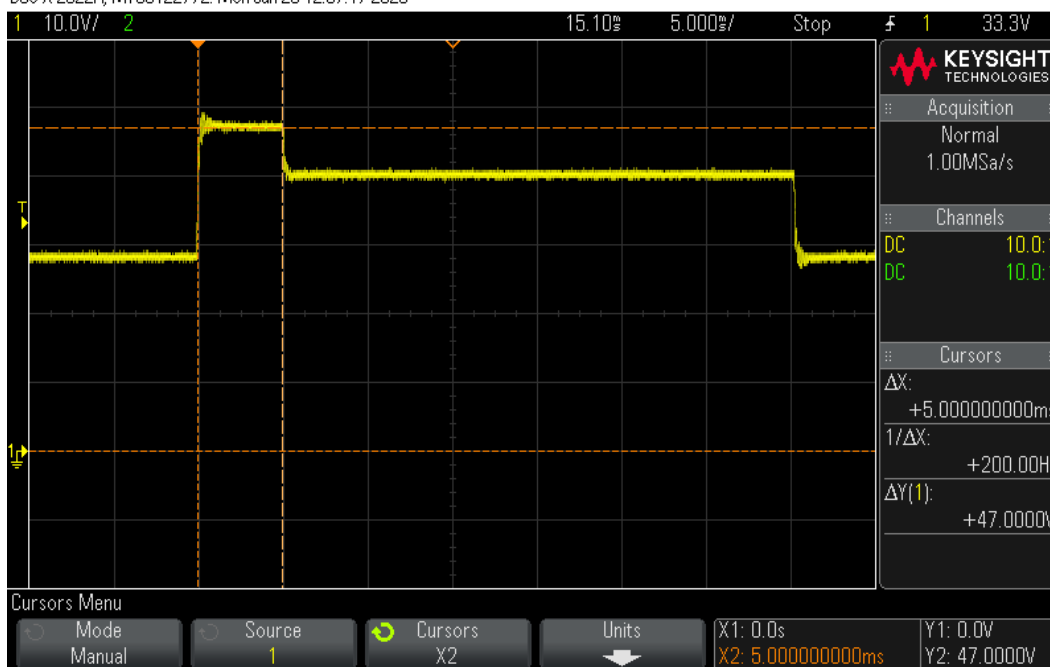


Table 16-7 zv Test 11 T3

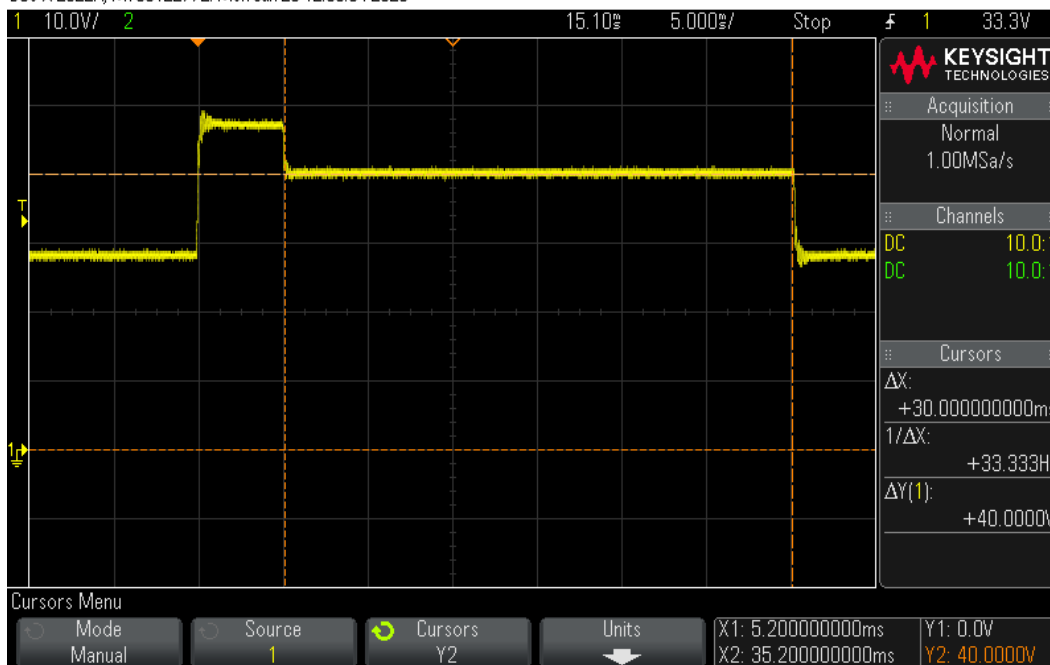
DSO-X 2022A, MY59122772, Mon Jan 23 11:06:53 2023



DSO-X 2022A, MY59122772, Mon Jan 23 12:37:17 2023

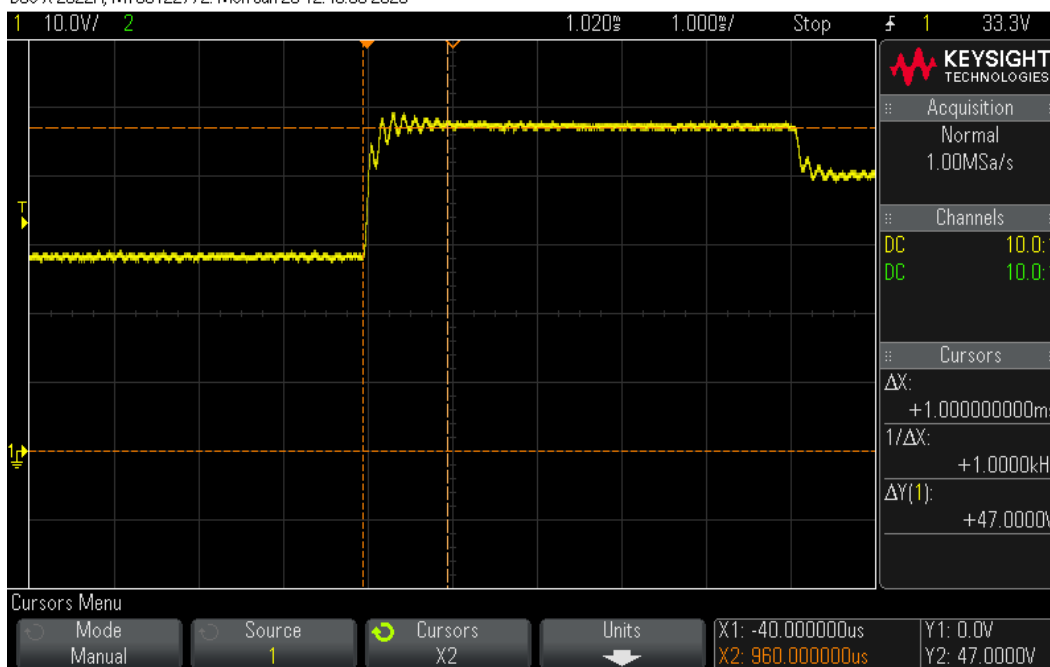


DSO-X 2022A, MY59122772: Mon Jan 23 12:38:34 2023



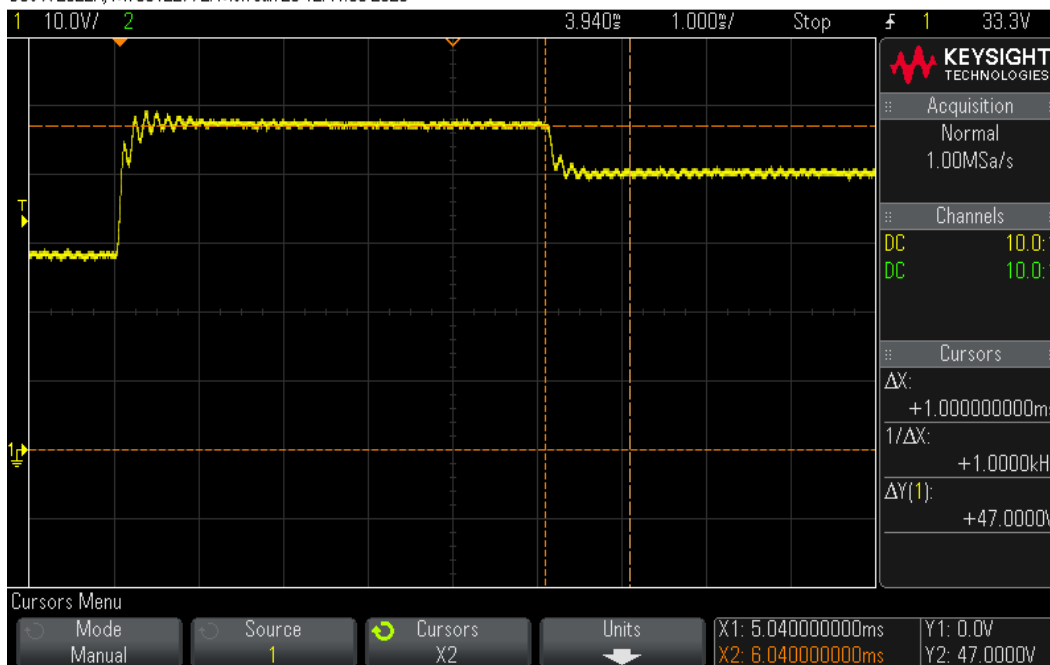
b 40Vdc 30mS

DSO-X 2022A, MY59122772: Mon Jan 23 12:40:55 2023



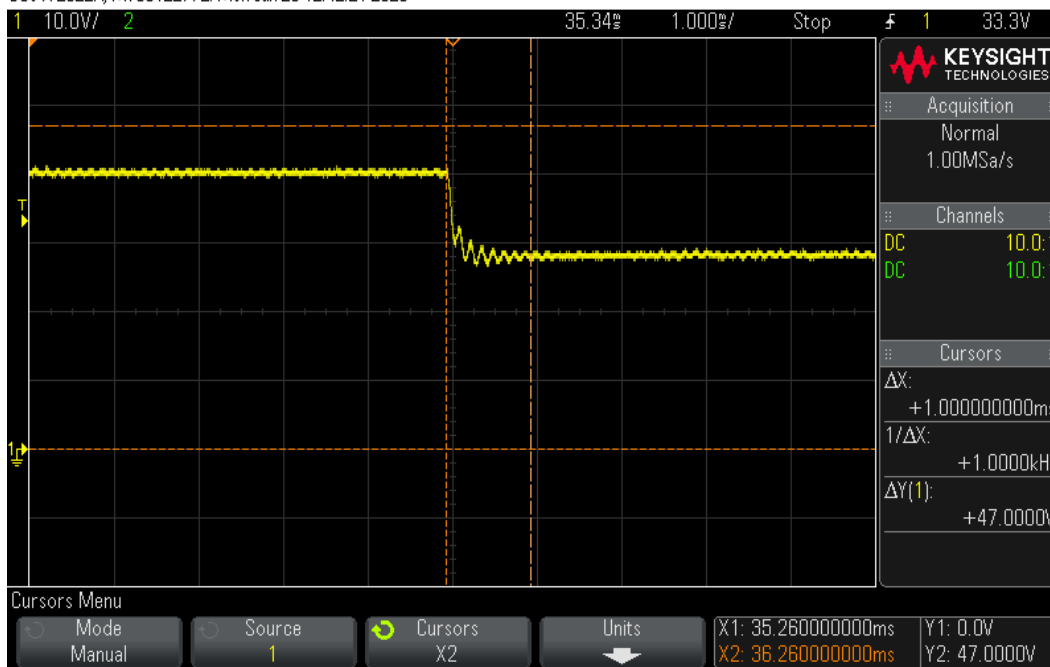
c 47Vdc Rise Time

DSO-X 2022A, MY59122772, Mon Jan 23 12:41:39 2023



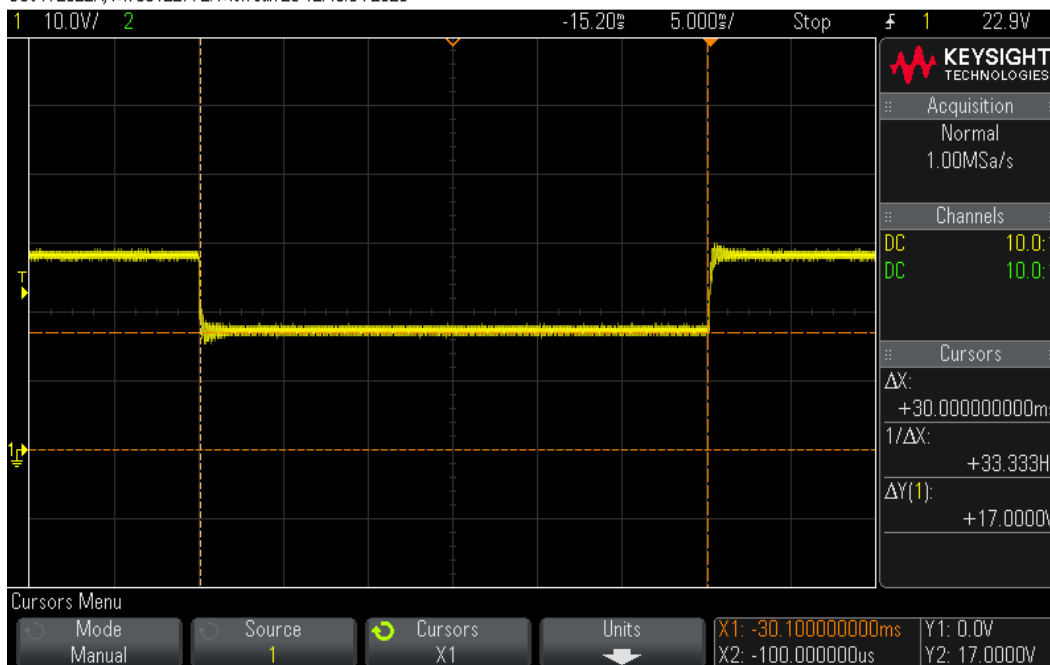
d 47Vdc Fall Time

DSO-X 2022A, MY59122772, Mon Jan 23 12:42:21 2023



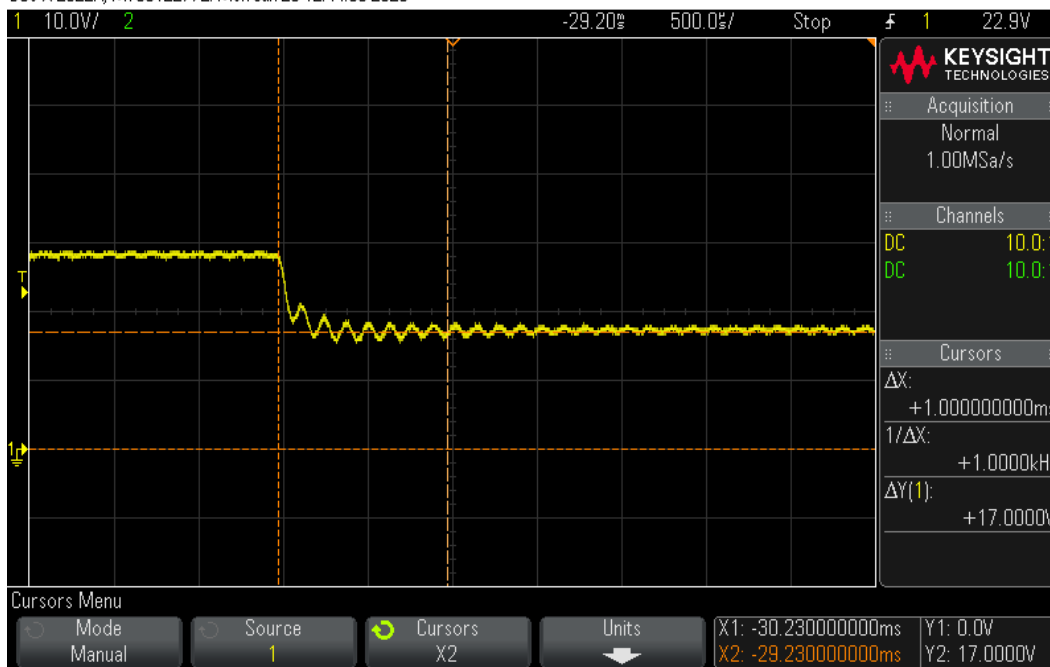
e 40Vdc Fall Time

DSO-X 2022A, MY59122772, Mon Jan 23 12:43:54 2023



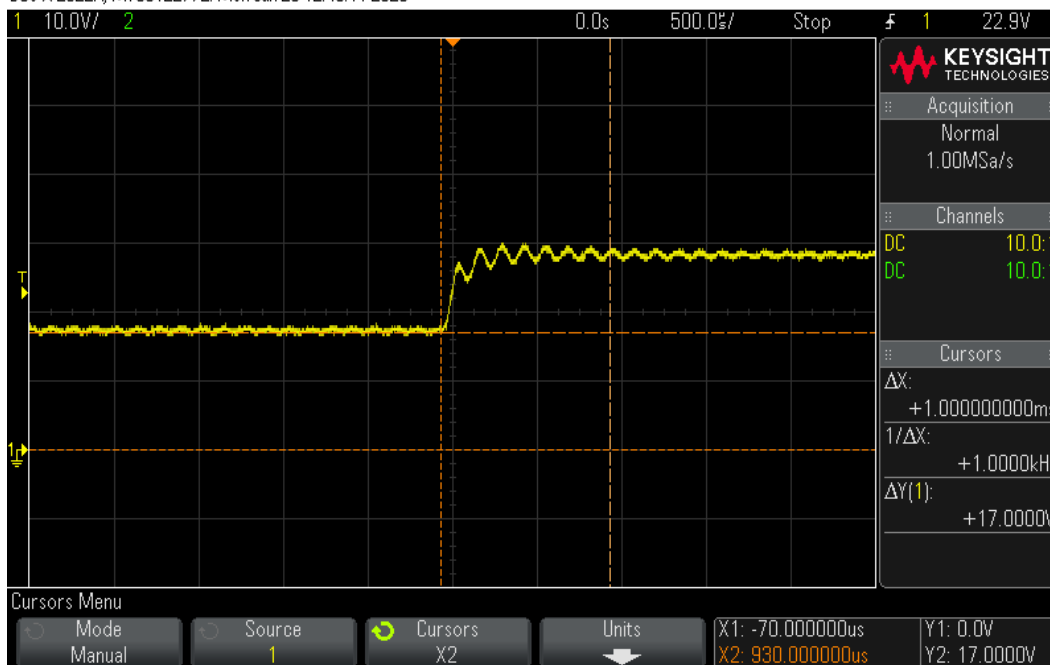
f 17Vdc 30mS

DSO-X 2022A, MY59122772, Mon Jan 23 12:44:38 2023



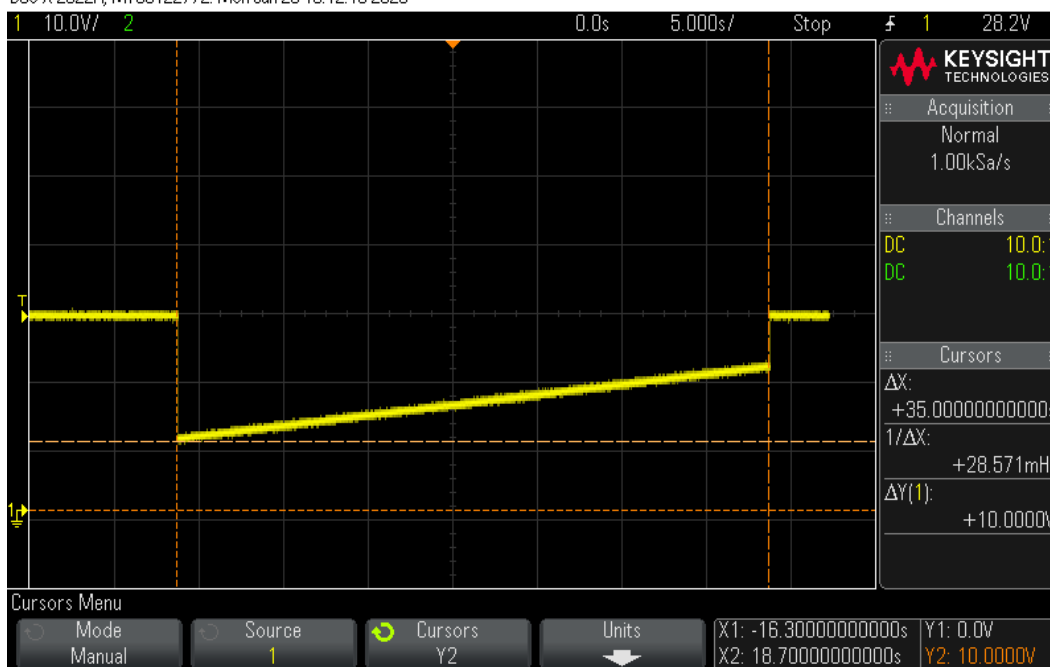
g 17Vdc Fall Time

DSO-X 2022A, MY59122772: Mon Jan 23 12:45:11 2023



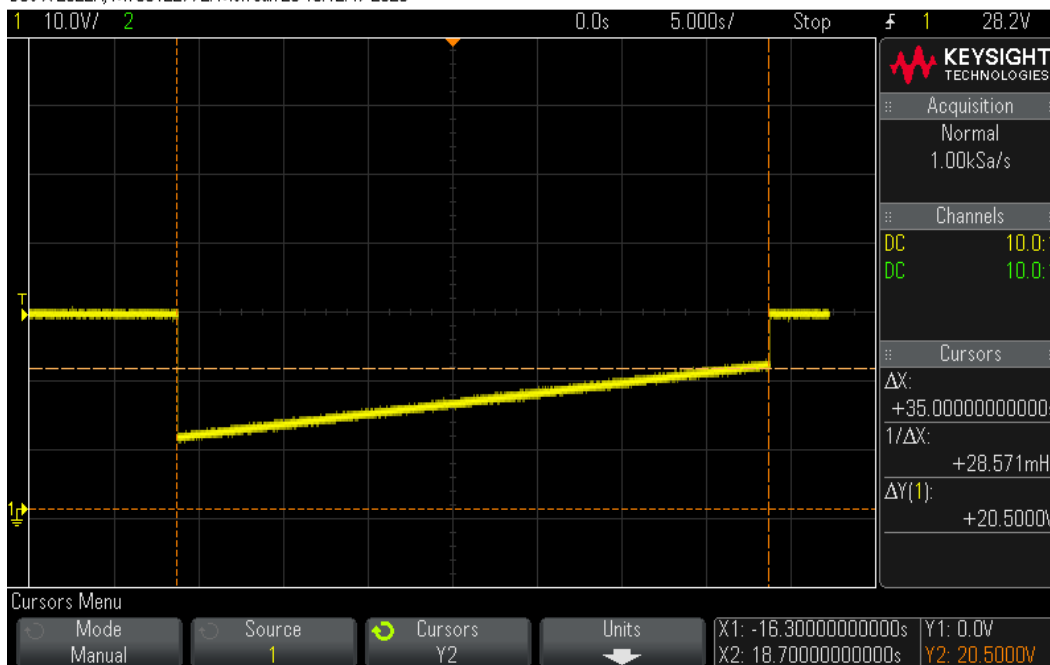
h 17Vdc Rise Time

DSO-X 2022A, MY59122772: Mon Jan 23 13:12:15 2023



10V Start

DSO-X 2022A, MY59122772, Mon Jan 23 13:12:47 2023



5.2.4 Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059715	Chamber (EMI, Anechoic)OTA	Rayproof	SR 1	07/13/2015	NCR
WC059572	Transformer (Isolation)	Solar Electronics	6220-1A	NCR	NCR
WC059612	Amplifier (Audio)	Mcintosh Laboratories	MC2200	NCR	NCR
WC059634	Meter (Digital Multimeter)	Hewlett Packard	34401A	07/30/2021	05/30/2023
WC059669	Meter (Digital Multimeter)	Fluke	83-3	09/12/2022	09/12/2023
WC059770	Power Supply (AC)	California Instruments	5001IX-CTS	03/30/2018	NCR
WC076853	Accelerometer (Tri-Axial)	Yokogawa	700925	11/09/2022	11/09/2024
WC076858	Oscilloscope (Digital)	Agilent Technologies	InfiiVision DSOX 2022A	08/24/2022	12/20/2023
WC080769	Generator (Function)	Stanford Research Systems (SRS)	DS345	08/24/2022	08/24/2023

5.2.5 Test Pictures Setup



16.6.1.1 Waveform Verification



16.6.1.1 Test Setup



16.6.1.3 Waveform Verification



16.6.1.3 Test Setup

5.2.6 Comments

The EUT met the requirement of RTCA/DO-160G, Section 16 Category B paragraph 16.6.1 only.

5.3 RTCA/DO-160G Section 17 Voltage Spike

5.3.1 Purpose of the Test

This test determines whether the equipment can withstand the effects of voltage spikes arriving at the equipment on its power leads, either AC or dc. The main adverse effects to be anticipated are:

- Permanent damage, component failure, insulation breakdown.
- Susceptibility degradation, or changes in equipment performance

5.3.2 Equipment Categories

Category B

Equipment intended primarily for installations where a lower standard of protection against voltage spikes is acceptable is identified as Category B

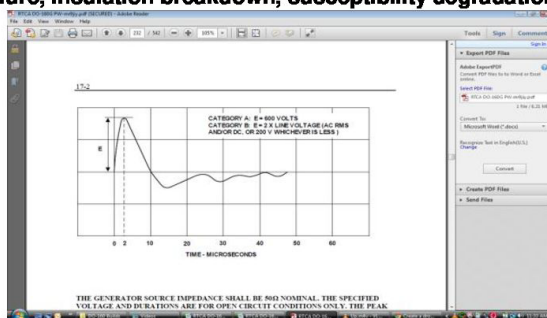
5.3.3 Test Data

Date of Test: 01/30/2023

Operator: Eugene DeVito, EMC Test Technician

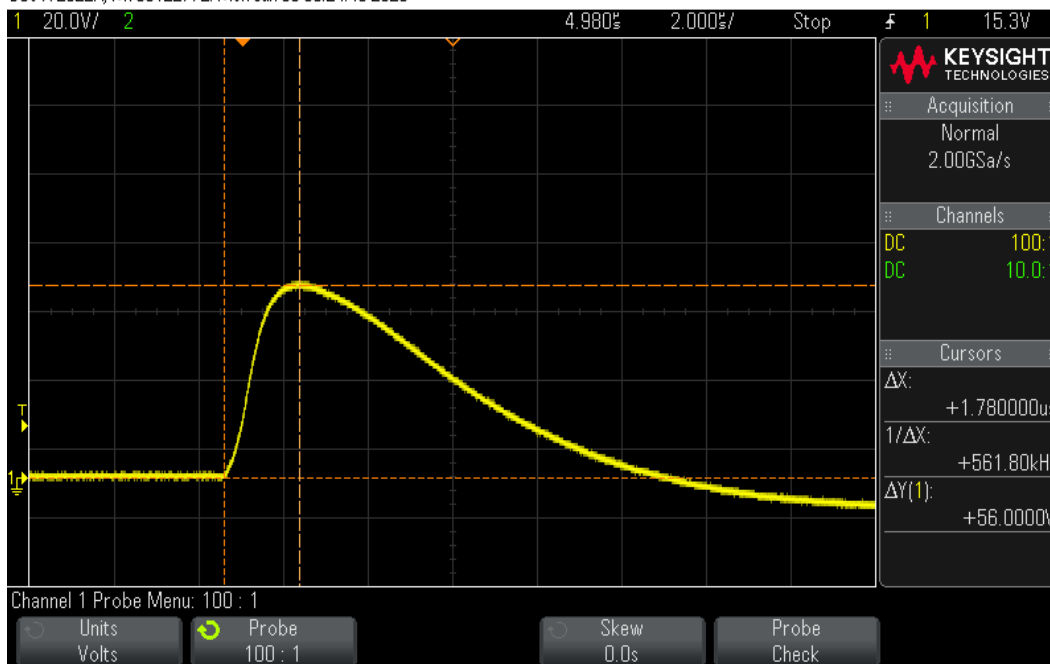
National Technical Systems Section 17 Voltage Spike Log						
Temperature:	20.4	° C	Humidity:	19.3	% RH	
Date	Time	Log Entries				Initials
1/30/23	0730	Setup for Section 17 Voltage Spikes calibration				EDD
	0855	Finished calibration - Pos/Neg & 50Ohm Verification				EDD
	0911	Setup for injection on EUT				EDD
	0908	Tested EUT Positive 28VDC input - Plus and Negative pulses				EDD
	0914	Tested EUT Return 28VDC input - Plus and Negative pulses				EDD
	0925	Section 17 complete - Pass				EDD
Witnessed By:		Ken Haan				
Test Performed By:		Eugene DeVito				
Program Manager:		Joh Hill				

Remarks: The EUT was monitored for susceptibility during the performance of the test, to include permanent damage, component failure, insulation breakdown, susceptibility degradation, or changes in equipment performance.



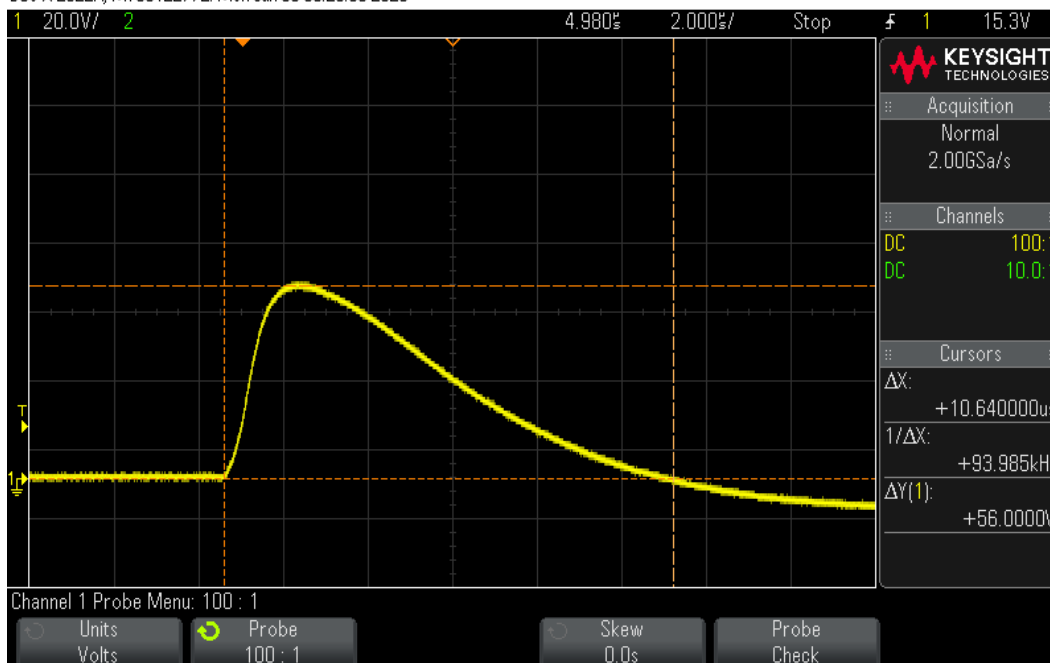
Service Branch: Aerospace				Test Level: Category B			
Nominal Voltage: 28				Test Voltage: 56 V			
Line Under Test	Test Level (V)	Number of Positive Transients	Duration (S)	Number of Negative Transients	Duration (S)	Pass / Fail	Remarks
Line 1	56	50	60	50	60	Pass	None
Return	56	50	60	50	60	Pass	None
Test Performed By: Eugene DeVito							

DSO-X 2022A, MY59122772: Mon Jan 30 09:24:45 2023



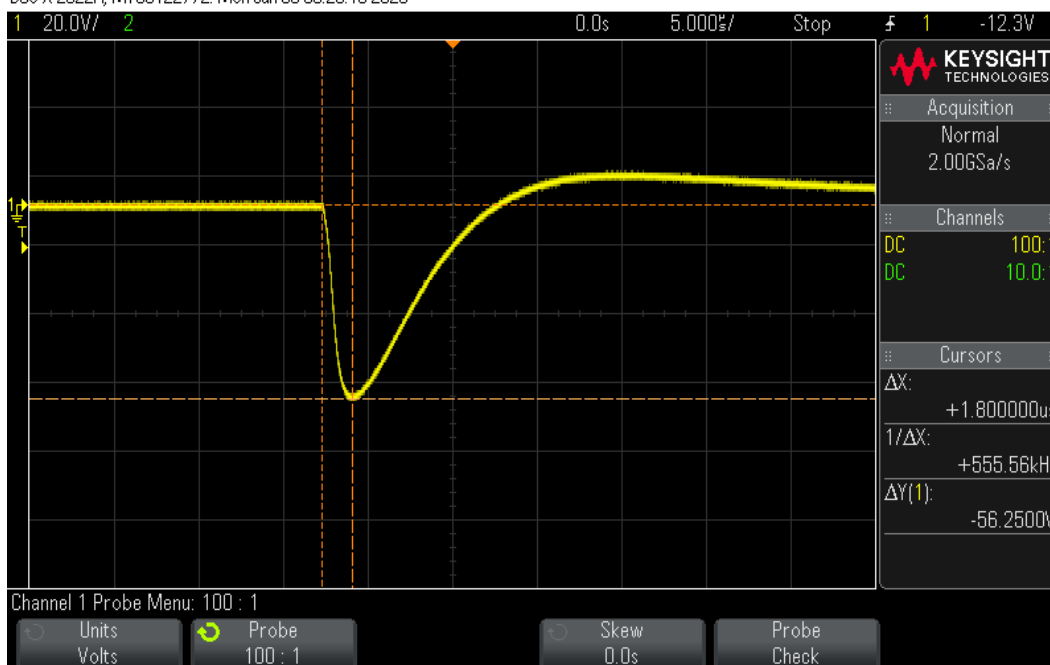
Positive Voltage Spike on 28VDC Input V&2us

DSO-X 2022A, MY59122772: Mon Jan 30 09:25:05 2023



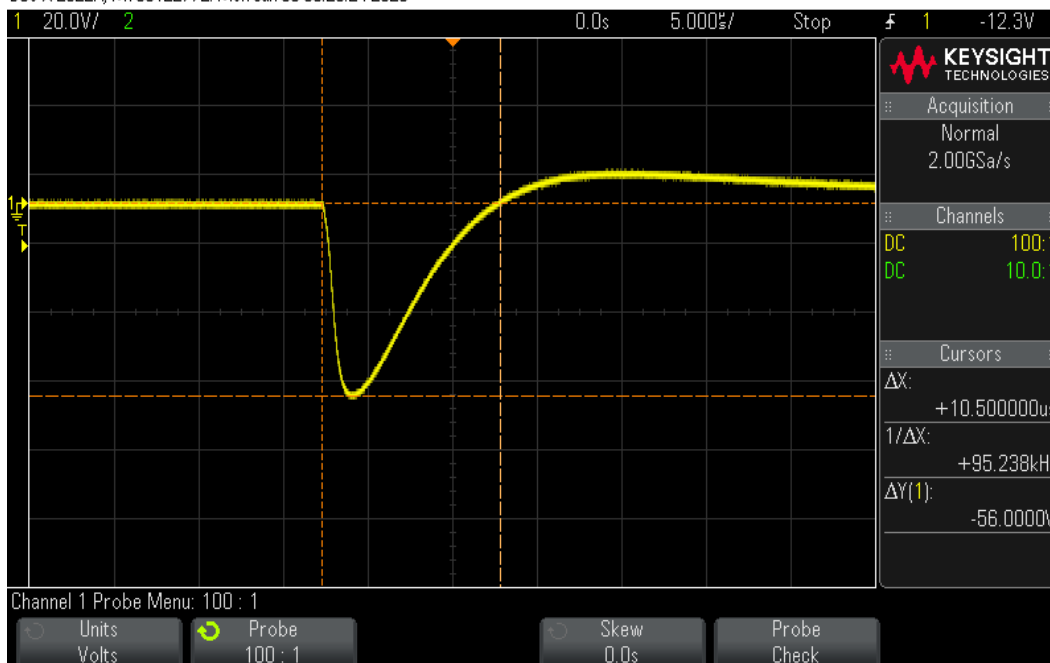
Positive Voltage Spike on 28VDC Input V&10us

DSO-X 2022A, MY59122772: Mon Jan 30 09:26:10 2023



Negative Voltage Spike on 28VDC Input V&2us

DSO-X 2022A, MY59122772: Mon Jan 30 09:26:24 2023



Negative Voltage Spike on 28VDC Input V&10us

DSO-X 2022A, MY59122772: Mon Jan 30 09:38:01 2023



Voltage Spike spacing less than 1.2s

5.3.4 Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059715	Chamber (EMI, Anechoic)OTA	Rayproof	SR 1	07/13/2015	NCR
WC021528	Generator (Pulse)	Solar Electronics	2201-1	NCR	NCR
WC021629	Generator (Spike/Transient)	Solar Electronics	7054-1	NCR	NCR
WC059439	Meter (Digital Multimeter)	Fluke	85	08/15/2022	08/15/2023
WC059770	Power Supply (AC)	California Instruments	5001IX-CTS	03/30/2018	NCR
WC076853	Accelerometer (Tri-Axial)	Yokogawa	700925	11/09/2022	11/09/2024
WC076858	Oscilloscope (Digital)	Agilent Technologies	InfiiVision DSOX 2022A	08/24/2022	12/20/2023
WC078508	Stopwatch (Digital)	Accusplit	AX725BKC	04/14/2022	04/14/2023

5.3.5 Test Pictures Setup



General Test Setup for Section 17 Voltage Spikes Test

5.3.6 Comments

The EUT met the requirement of RTCA/DO-160G, Section 17 Category B.

5.4 RTCA/DO-160G Section 21 Emission of Radio Frequency Energy

5.4.1 Purpose of the Test

These tests determine that the equipment does not emit undesired RF noise in excess of the levels specified below. The notches specified in the radiated emissions limits are included to protect aircraft RF sensors operating frequencies.

5.4.2 Equipment Categories

Categories are defined in terms of location and separation between the equipment and aircraft radio antennas. As these parameters are widely linked to aircraft type and size, some examples are given with each category definition.

Category M

This category is defined for equipment and interconnected wiring located in areas where apertures are EM (electro-magnetically) significant and not directly in view of radio receiver's antenna. This category may be suitable for equipment and associated interconnecting wiring located in the passenger cabin or in the cockpit of a transport aircraft.

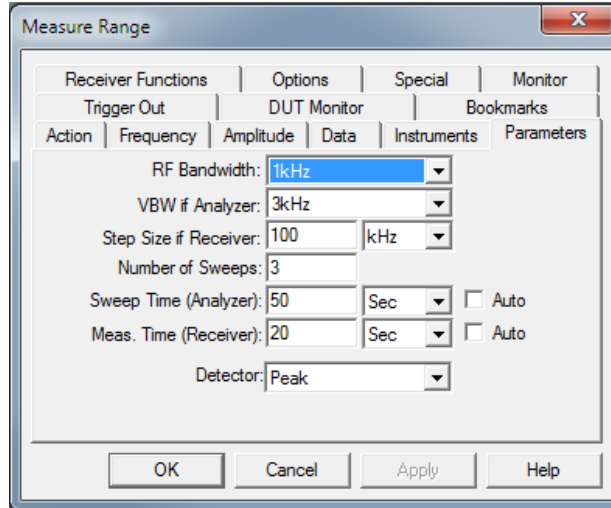
5.4.3 Test Data

5.4.3.1 Test Data for Radio Frequency Conducted Emissions and Factors

Measure conducted emissions from 150 kHz to 152MHz. Interference currents generated by the equipment shall be measured by using a clamp-on interference measuring device.

- a. EUT emissions within the frequency ranges and in excess of the value given shall not appear on any power line normally connected to an aircraft bus.
- b. EUT emissions within the frequency ranges and in excess of the value given shall not appear on any interconnecting cable bundles. Primary power lines are not considered to be interconnecting cable bundles. Antenna feed cable are considered to be interconnecting cables while in a non-transmitting or receive mode.
- c. Section 5.7.3.3 shows a simplified test arrangement for the use of the current probe.
- d. Install the current probe five centimeters from the EUT. If the EUT connector plus back shell length exceeds five centimeters the probe shall be placed as close to the connector back shell as possible and the position noted.
- e. Measure and record the EUT emissions and apply the appropriate limit for the selected category.

5.4.3.2 Conducted Emissions Bandwidths Range

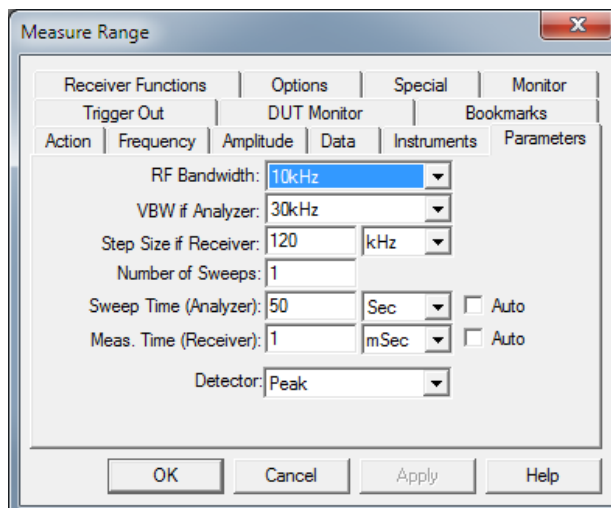


Receiver Functions	Options	Special	Monitor
Trigger Out	DUT Monitor		Bookmarks
Action	Frequency	Amplitude	Data
	Instruments	Parameters	

RF Bandwidth: 1kHz
 VBW if Analyzer: 3kHz
 Step Size if Receiver: 100 kHz
 Number of Sweeps: 3
 Sweep Time (Analyzer): 50 Sec ☐ Auto
 Meas. Time (Receiver): 20 Sec ☐ Auto
 Detector: Peak

OK Cancel Apply Help

Conducted Emissions Bandwidth from 0.15MHz – 30MHz



Receiver Functions	Options	Special	Monitor
Trigger Out	DUT Monitor		Bookmarks
Action	Frequency	Amplitude	Data
	Instruments	Parameters	

RF Bandwidth: 10kHz
 VBW if Analyzer: 30kHz
 Step Size if Receiver: 120 kHz
 Number of Sweeps: 1
 Sweep Time (Analyzer): 50 Sec ☐ Auto
 Meas. Time (Receiver): 1 mSec ☐ Auto
 Detector: Peak

OK Cancel Apply Help

Conducted Emissions Bandwidth from 30MHz – 152MHz

5.4.3.3 Test Data for Conducted Emissions

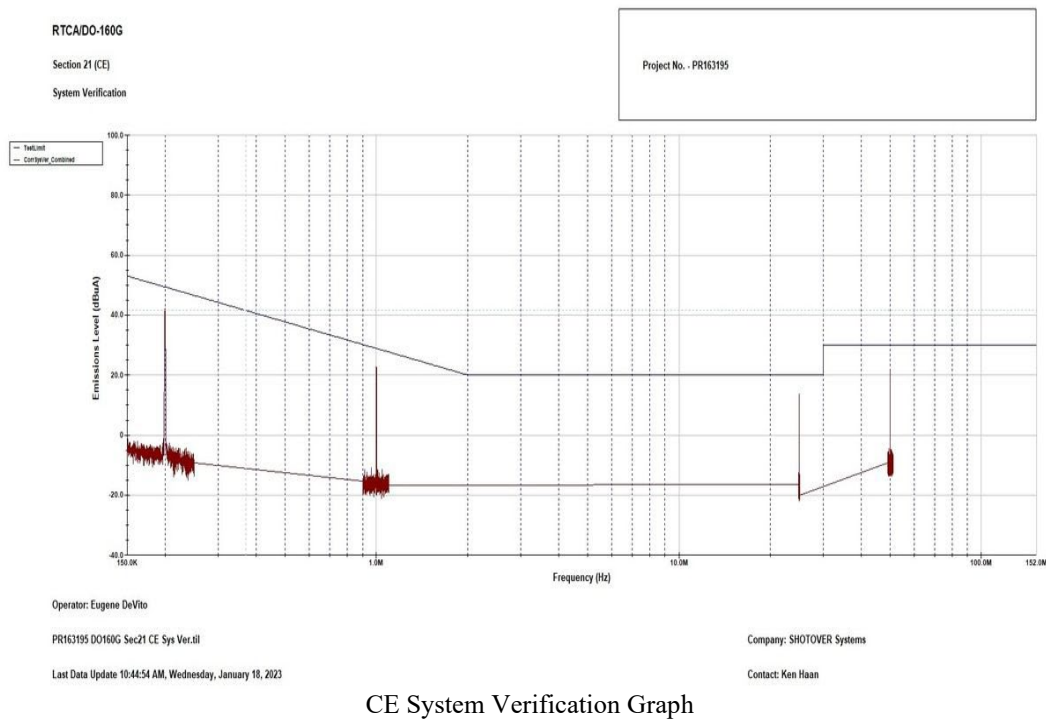
Date of Test: 01/18/2023

Operator: Eugene DeVito, EMC Test Technician

National Technical Systems			
Conducted Emissions Log Sheet			
Temperature: 20.3 ° C		Humidity: 24.6 % RH	
Date	Time	Log Entries	Initials
1/18/23	0800	Start Setup of the EUT	EDD
	0930	Finished Setup	EDD
	1000	Start Sys Ver	EDD
	1100	Finished Sys Ver - Passed	EDD
	1102	EUT bonding too high - 22mOhms	EDD
	1105	LISN - 2.1mOhms	EDD
	1211	EUT bonding reduced to 2.0mOhms	EDD
	1230	J1 tested	EDD
	1310	Break for lunch	EDD
	1310	Back from lunch	EDD
	1410	J2 tested	EDD
	1450	J5 tested	EDD
	1525	J6 tested	EDD
	1556	J7 tested	EDD
	1625	J8 tested	EDD
	1630	CE Complete - EUT Passes	EDD
Witnessed By:		Ken Haan	
Test Performed By:		Eugene DeVito	
Program Manager:		John Hill	

National Technical Systems							
Conducted Emissions Bandwidth and Measurement Time							
Remarks: The purpose of this sheet is to meet the requirements of DO-160G Section 21-3 G: "For emission measurements, the entire frequency range for each applicable test shall be scanned. Minimum measurement time for analog measurement receivers during emission testing shall be as specified in Table 1. Synthesized measurement receivers shall step in one-half bandwidth increments or less, and the measurement dwell time shall be as specified in Table 1. Larger receiver bandwidths may be used: however, they may result in higher measured emission levels. NO BANDWIDTH CORRECTION FACTORS SHALL BE APPLIED TO TEST DATA DUE TO THE USE OF LARGER BANDWIDTHS".							
Start Frequency (MHz)	Stop Frequency (MHz)	Minimum Dwell Time (seconds) for Section 21.4 and 21.5	6dB Resolution Bandwidth (MHz)	Minimum measurement time for this band (seconds)	Minimum Number of ranges needed	Minimum Sweep Time for Frequency Band (seconds) for Section 21.6	Frequency Resolution (MHz)
0.15	30	0.015	0.001	0.44775	60	0.0074625	0.00049750
30	100	0.015	0.01	1.05	14	0.075	0.00500000
100	400	0.015	0.01	4.5	60	9	0.00500000
Test Performed By:		Eugene DeVito					
Program Manager:		John Hill					

National Technical Systems			
Conducted Emissions Data Sheet			
Remarks: The EUT was placed into the normal operating mode during testing.			
Version of NTEC Software used for testing:		DO-160G Section 21 CE 2.0	
Frequency Range Tested	Test Mode or Configuration	Limit Level	Test Result
150 kHz - 152 MHz	Normal Operation	Cat M - Power on J1	Within Limit, Pass
150 kHz - 152 MHz	Normal Operation	Cat M - Interconnect on J2	Within Limit, Pass
150 kHz - 152 MHz	Normal Operation	Cat M - Interconnect on J5	Within Limit, Pass
150 kHz - 152 MHz	Normal Operation	Cat M - Interconnect on J6	Within Limit, Pass
150 kHz - 152 MHz	Normal Operation	Cat M - Interconnect on J7	Within Limit, Pass
150 kHz - 152 MHz	Normal Operation	Cat M - Interconnect on J8	Within Limit, Pass
Test Performed By:		Eugene DeVito	
Program Manager:		John Hill	



CE System Verification Graph

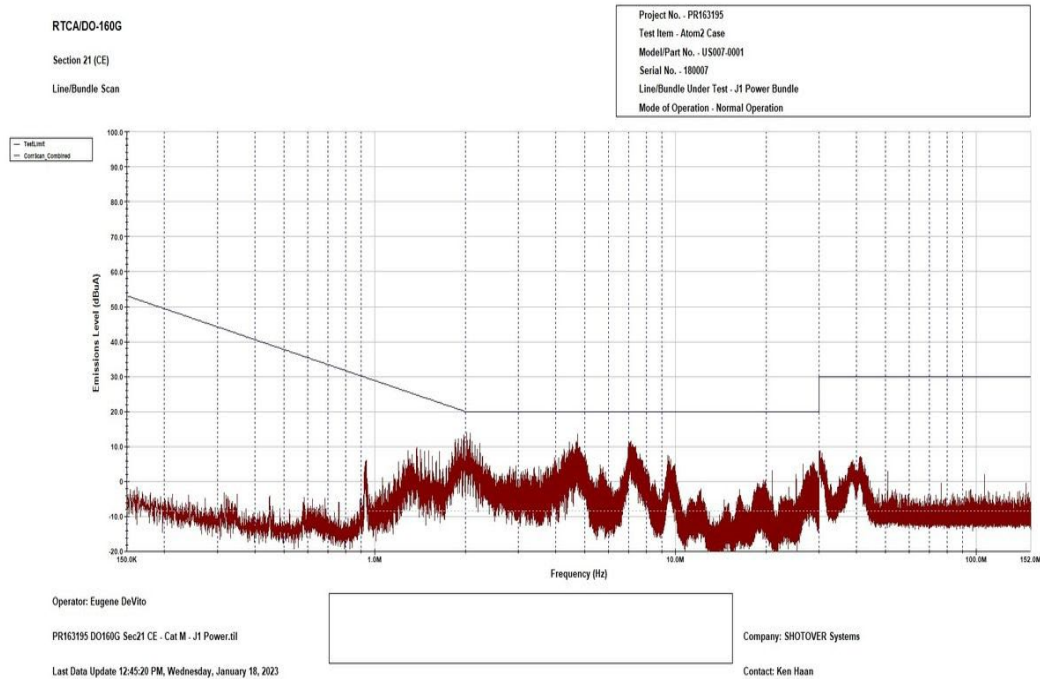
RTCA/DO-160G
Section 21 (CE)
System Verification Peak Signals

Operator: Eugene DeVito
PR163195 DO160G Sec21 CE Sys Ver.tif
10:44:54 AM, Wednesday, January 18, 2023

Contact: Ken Haan
Company: SHOTOVER Systems

Frequency (MHz)	Limit (dBuA)	Signals (dBuA)	Delta (dB)
200.000 KHz	49.334	42.239	-7.095
1.000 MHz	28.830	22.881	-5.949
25.000 MHz	20.000	13.755	-6.245
50.000 MHz	30.000	21.919	-8.081
Project No. - PR163195			

CE System Verification Table



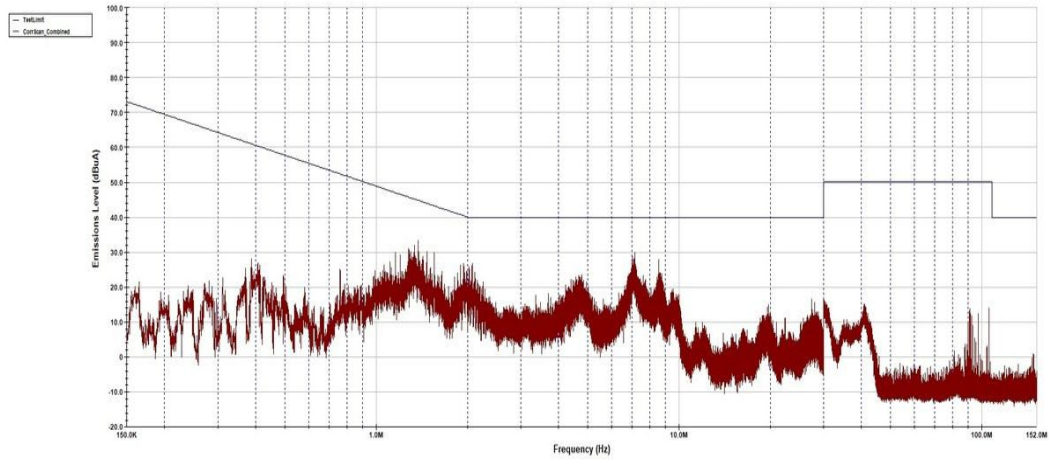
CE - J1

RTCA/DO-160G

Section 21 (CE)

Line/Bundle Scan

Project No. - PR163195
Test Item - Atom2 Case
Model/Part No. - US007.0001
Serial No. - 180007
Line/Bundle Under Test - J2 Network
Mode of Operation - Normal Operation



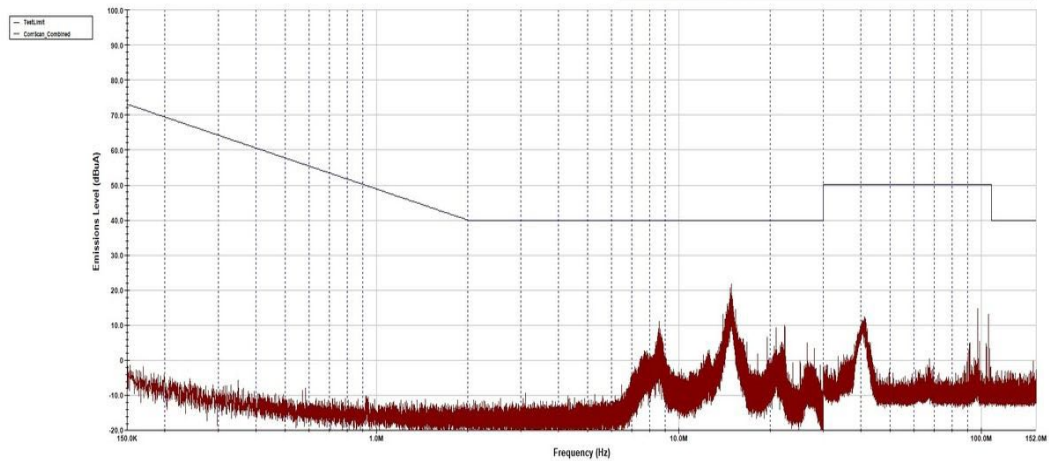
CE - J2

RTCA/DO-160G

Section 21 (CE)

Line/Bundle Scan

Project No. - PR163195
Test Item - Atom2 Case
Model/Part No. - US007.0001
Serial No. - 180007
Line/Bundle Under Test - J5 Video Out.
Mode of Operation - Normal Operation



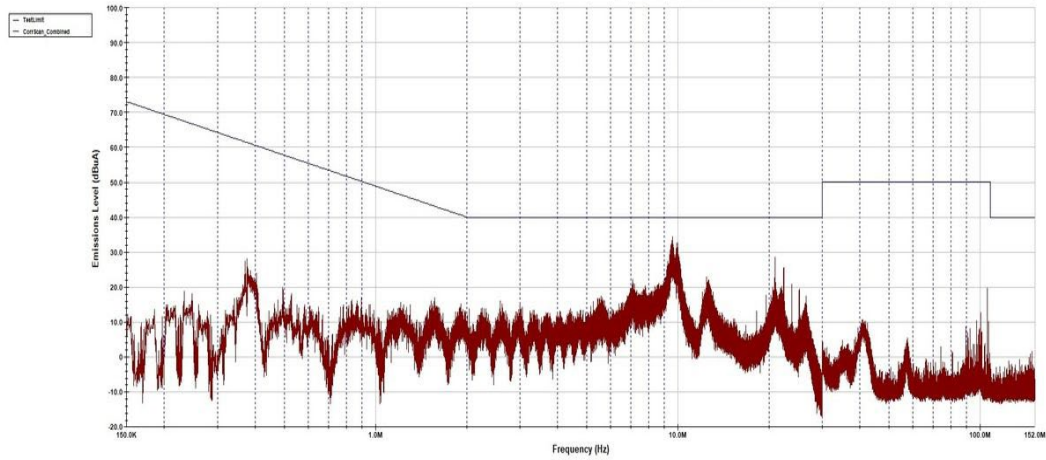
CE - J5

RTCA/DO-160G

Section 21 (CE)

Line/Bundle Scan

Project No. - PR163195
Test Item - Atom2 Case
Model/Part No. - US007.0001
Serial No. - 180007
Line/Bundle Under Test - J6 Video 1 In
Mode of Operation - Normal Operation



Operator: Eugene DeVito

PR163195 DO160G Sec21 CE - Cat M - J6 Video 1 In.ttl

Last Data Update 03:25:00 PM, Wednesday, January 18, 2023

Company: SHOTOVER Systems

Contact: Ken Haan

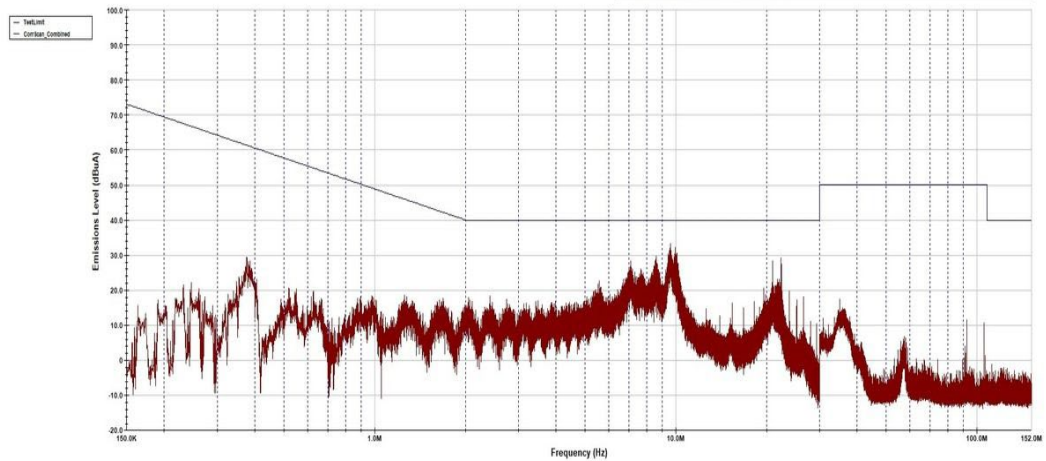
CE - J6

RTCA/DO-160G

Section 21 (CE)

Line/Bundle Scan

Project No. - PR163195
Test Item - Atom2 Case
Model/Part No. - US007.0001
Serial No. - 180007
Line/Bundle Under Test - J7 Video 2 In
Mode of Operation - Normal Operation



Operator: Eugene DeVito

PR163195 DO160G Sec21 CE - Cat M - J7 Video 2 In.ttl

Last Data Update 03:55:51 PM, Wednesday, January 18, 2023

Company: SHOTOVER Systems

Contact: Ken Haan

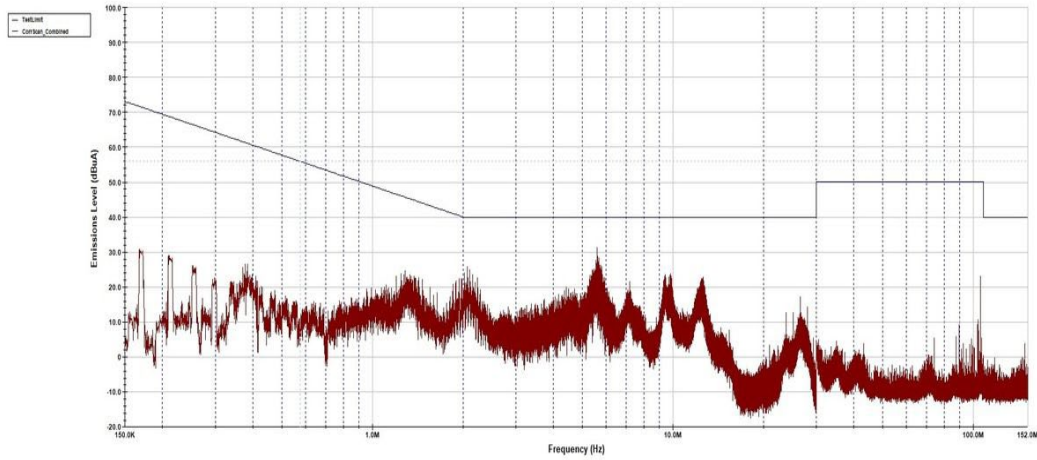
CE - J7

RTCA/DO-160G

Section 21 (CE)

Line/Bundle Scan

Project No. - PR163195
Test Item - Atom2 Case
Model/Part No. - US007.0001
Serial No. - 180007
Line/Bundle Under Test - J8 Video 1 Out
Mode of Operation - Normal Operation



Operator: Eugene DeVito

PR163195 DO160G Sec21 CE - Cat M - J8 Video 1 Out.tif

Last Data Update 04:26:56 PM, Wednesday, January 18, 2023

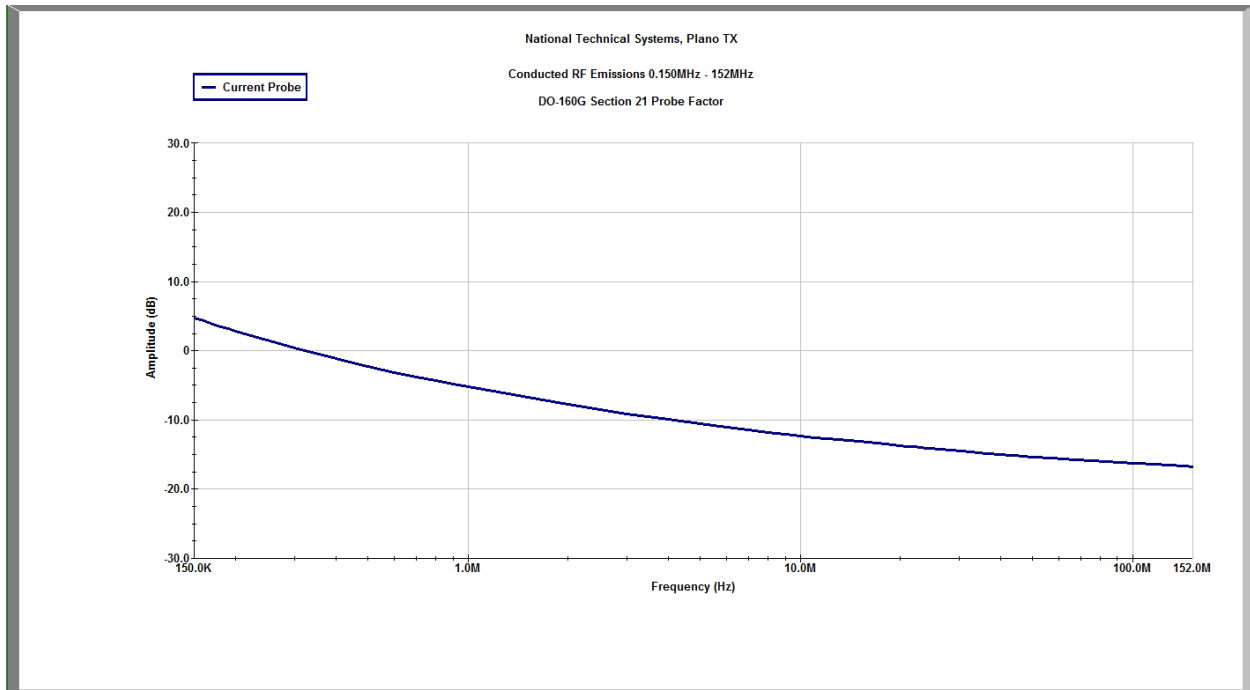
Company: SHOTOVER Systems

Contact: Ken Haan

CE - J8

5.4.3.4 Factors for Conducted Emissions

Current Probe Factor WC059781 for Conducted Emissions

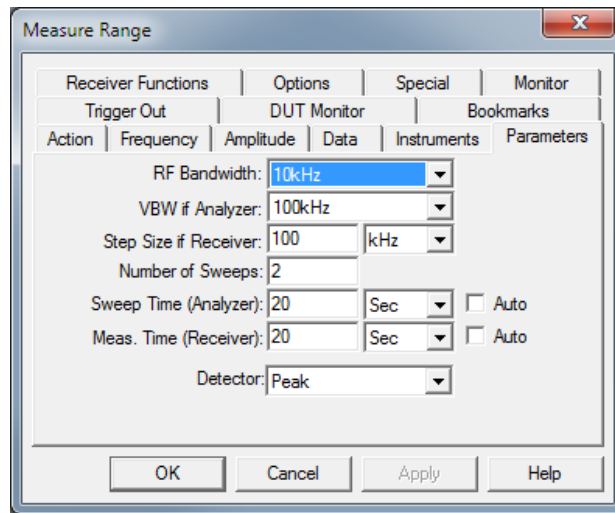


5.4.3.5 Test Data for Radio Frequency Radiated Emissions and Factors

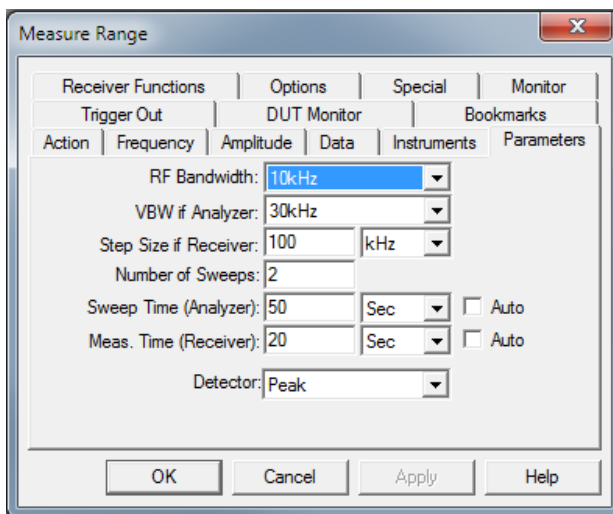
Measure Radiated Emissions from 100MHz to 6GHz.

- Radiated interference fields generated by the equipment within the frequency range.
- The arrangement of equipment for conducting the radiated RF emission test is shown in Section 5.7.3.7.
- Field strength units are obtained by using any appropriated antenna and adding the appropriate antenna factor to the measured voltage in dB micro-volts. Appropriated correction factor for cable losses and matching networks must also be applied
- Linearly polarized antennas are required for radiated tests. Measure radiated emissions using both vertically and horizontally polarized orientations.
- Directly expose aperture in the EUT (e.g., displays, CRTs, connectors) to the receiving antenna, which may require additional EUT orientations or receive antenna positions. If all EUT apertures are not exposed to the receive antenna, justification must be documented in the test report.
- Consider EUT realistic operating modes which produce maximum emission.
- Radiated ambient data (EUT “off” and test support equipment “om”) is required only if EUT emissions are greater than 3 dB below the selected category limit.
- It is good engineering practice to check ambient emissions prior to a radiated emissions test, and it is desirable that the ambient emissions be at least 6 dB below the selected limit line.
- Measure and record the EUT emissions conditions and apply the appropriate limit for the selected category.

5.4.3.6 Radiated Emissions Bandwidths Range



Radiated Emissions Bandwidth from 100MHz – 200MHz



Measure Range

Receiver Functions	Options	Special	Monitor
Trigger Out	DUT Monitor		Bookmarks
Action	Frequency	Amplitude	Data
	Instruments	Parameters	

RF Bandwidth: 10kHz

VBW if Analyzer: 30kHz

Step Size if Receiver: 100 kHz

Number of Sweeps: 2

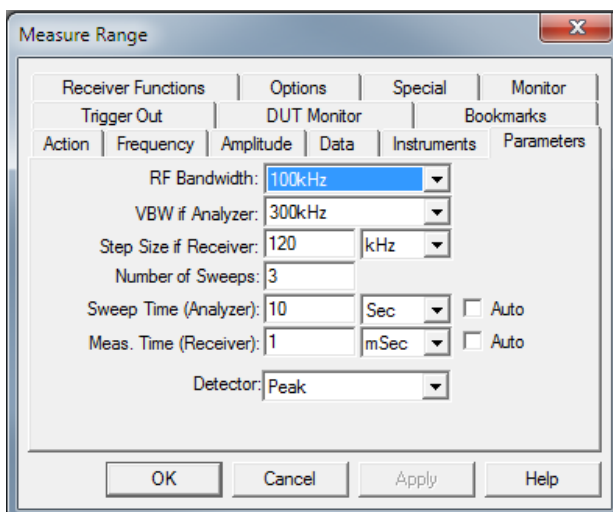
Sweep Time (Analyzer): 50 Sec ☐ Auto

Meas. Time (Receiver): 20 Sec ☐ Auto

Detector: Peak

OK Cancel Apply Help

Radiated Emissions Bandwidth from 200MHz – 400MHz



Measure Range

Receiver Functions	Options	Special	Monitor
Trigger Out	DUT Monitor		Bookmarks
Action	Frequency	Amplitude	Data
	Instruments	Parameters	

RF Bandwidth: 100kHz

VBW if Analyzer: 300kHz

Step Size if Receiver: 120 kHz

Number of Sweeps: 3

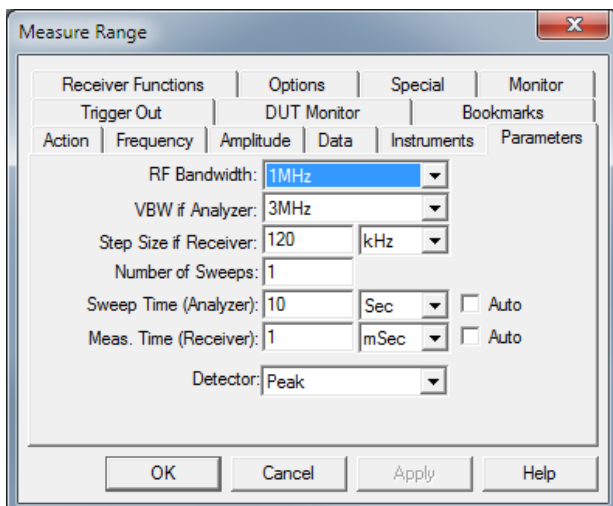
Sweep Time (Analyzer): 10 Sec ☐ Auto

Meas. Time (Receiver): 1 mSec ☐ Auto

Detector: Peak

OK Cancel Apply Help

Radiated Emissions Bandwidth from 400MHz – 960MHz



Measure Range

Receiver Functions	Options	Special	Monitor
Trigger Out	DUT Monitor		Bookmarks
Action	Frequency	Amplitude	Data
	Instruments	Parameters	

RF Bandwidth: 1MHz

VBW if Analyzer: 3MHz

Step Size if Receiver: 120 kHz

Number of Sweeps: 1

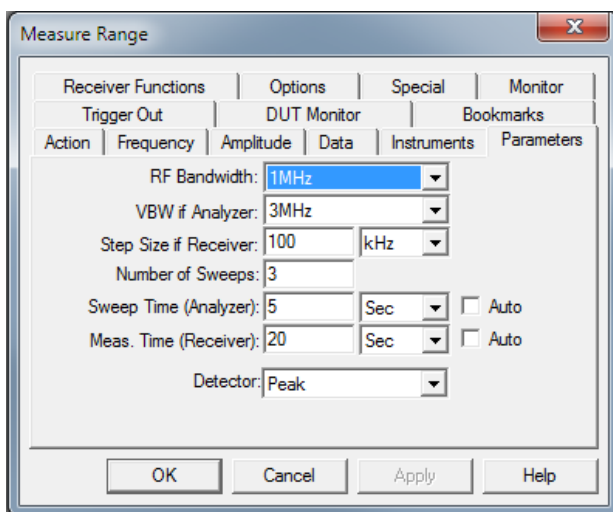
Sweep Time (Analyzer): 10 Sec ☐ Auto

Meas. Time (Receiver): 1 mSec ☐ Auto

Detector: Peak

OK Cancel Apply Help

Radiated Emissions Bandwidth from 960MHz – 1000MHz



Measure Range

Receiver Functions | Options | Special | Monitor

Trigger Out | DUT Monitor | Bookmarks

Action | Frequency | Amplitude | Data | Instruments | Parameters

RF Bandwidth: 1MHz

VBW if Analyzer: 3MHz

Step Size if Receiver: 100 kHz

Number of Sweeps: 3

Sweep Time (Analyzer): 5 Sec ☐ Auto

Meas. Time (Receiver): 20 Sec ☐ Auto

Detector: Peak

OK Cancel Apply Help

Radiated Emissions Bandwidth from 1GHz – 6GHz

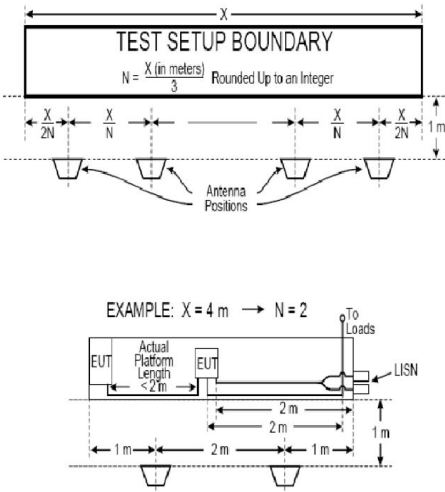
5.4.3.7 Test Data for Radiated Emissions

Date of Test: 01/19/2023

Operator: Eugene DeVito, EMC Test Technician

National Technical Systems Section 21 Radiated Emissions Log							
Temp:	19.6	° C	Humidity:	17.6	% RH		
Date	Time	Log Entries					Initials
1/19/23	0800	Setup EUT in SR2 for Section 21 RE Cat M					EDD
	0915	Run Sys Ver - Passed					EDD
	0943	Start RE					EDD
	1019	Finished with Bicon V & H					EDD
	1120	Finished with LDRG V & H					EDD
	1200	Back from lunch					EDD
	1214	Finished with SDRG V & H					EDD
	1245	Finished RE - EUT Passed					EDD
Witnessed By:		Ken Haan					
Test Performed By:		Eugene DeVito					
Program Manager:		John Hill					

National Technical Systems						
Radiated Emissions Data Sheet						
Remarks: None						
Service Branch: Aerospace				Test Level: Category M		
Tile Software Version:		Tile7				
Start Frequency (MHz)	Stop Frequency (MHz)	6dB Bandwidth (kHz)	Limit	Mode of Operation	Pass / Fail	Remarks
100	200	10	Category M	EUT Fully Operational	Pass	None
200	1000	10	Category M	EUT Fully Operational	Pass	None
1000	6000	100	Category M	EUT Fully Operational	Pass	None
Test Performed By:		Eugene DeVito				

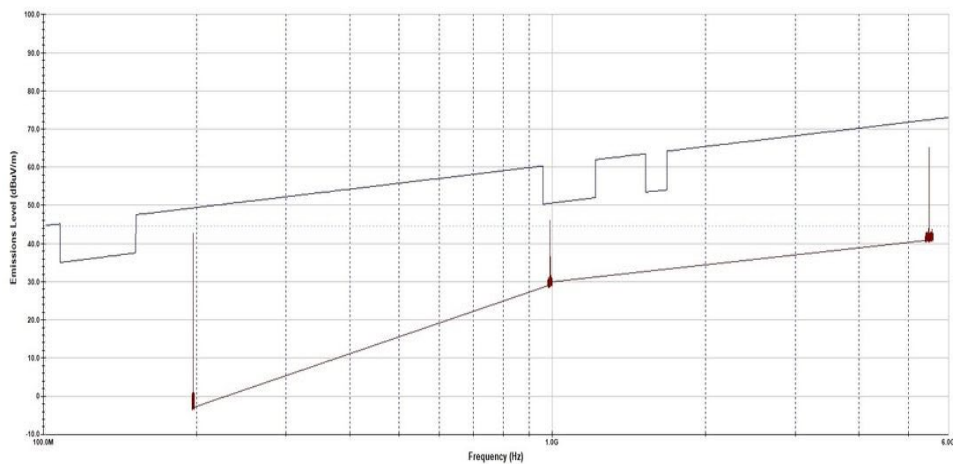
National Technical Systems					
Radiated Emissions Antenna Positions Below 200MHz					
Remarks: The purpose of this sheet is to meet the requirements of DO-160G Section 21. "When the beamwidth of the antenna does not totally cover the system under test, multiple area scans shall be performed. However, it is required that each EUT within the system and at least one-half wavelength of wiring of that EUT shall be exposed in its entirety during the test. In shielded enclosure tests, the antenna shall be at least 0.3 m away from the shielded enclosure walls or shelves."					
Test setup boundary edge to edge distance (cm):				110.0	cm
Choose the end of the test setup on which the EUT is mounted:	Number of Lateral Positions Required	Position 1 Location (cm from the left edge)	Position 2 Location (cm from the right edge)	Position 3 Location (cm from the left edge)	Position 4 Location (cm from the right edge)
Left	1	55.0	N/A	N/A	N/A
 The diagram illustrates the test setup boundary and an example configuration. The top part shows a rectangular boundary of width X and height 1m. The number of lateral positions N is calculated as $N = \frac{X \text{ (in meters)}}{3}$ rounded up to an integer. The boundary is divided into segments of width $\frac{X}{2N}$ and $\frac{X}{N}$. Antenna positions are indicated by arrows pointing to the boundary. The bottom part shows an example setup with X = 4m and N = 2. It includes two EUTs on an actual platform length of 2m, with distances of 1m, 2m, 2m, and 1m between them. A LISN is connected to the loads.					
Test Performed By:		Eugene DeVito			

National Technical Systems						
Radiated Emissions Antenna Positions Above 200MHz						
Remarks: The purpose of this sheet is to meet the requirements of DO-160G Section 21. " When the beamwidth of the antenna does not totally cover the system under test, multiple area scans shall be performed. However it is required that each EUT within the system and at least one-half wavelength of wiring of that EUT shall be exposed in its entirety during the test. In shielded enclosure tests, the antenna shall be at least 0.3 m away from the shielded enclosure wall or absorber.						
EUT width on the edge facing the transmit antenna:						15.0 cm
Choose the end of the test setup on which the EUT is mounted:						Left
EUT Testing 200MHz to 1GHz						
Receive Antenna Asset Number, Model, and Frequency Range			Most Narrow Beam width (degrees)	Test Distance (meters)	Lateral Antenna coverage (cm)	Required Number of Antenna Positions
1075	3106	0.2 -1GHz	28	1	49.9	1
Antenna Position 1 Location, cm Measured from the Left Edge of the EUT		Antenna Position 2 Location, cm Measured from the Left Edge of the EUT		Antenna Position 3 Location, cm Measured from the Left Edge of the EUT		Antenna Position 4 Location, cm Measured from the Left Edge of the EUT
7.5		Not Applicable		Not Applicable		Not Applicable
EUT Testing 1GHz to 6GHz						
Receive Antenna Asset Number, Model, and Frequency Range			Most Narrow Beam width (degrees)	Test Distance (meters)	Lateral Antenna coverage (cm)	Required Number of Antenna Positions
1392	3115	1-6GHz	25	1	44.0	1
Antenna Position 1 Location, cm Measured from the Left Edge of the EUT		Antenna Position 2 Location, cm Measured from the Left Edge of the EUT		Antenna Position 3 Location, cm Measured from the Left Edge of the EUT		Antenna Position 4 Location, cm Measured from the Left Edge of the EUT
7.5		Not Applicable		Not Applicable		Not Applicable
Test Performed By:			Eugene DeVito			

RTCA/DO-160G

Section 21 (RE)

System Verification



Operator: Eugene DeVito

Project No.: PR163195

PR163195 DO-160G Sec21 RE System Verification.ill

Company: SHOTOVER Systems

Last Data Update 09:38:16 AM, Thursday, January 19, 2023

Contact: Ken Haan

RE Cat M a System Verification Graph

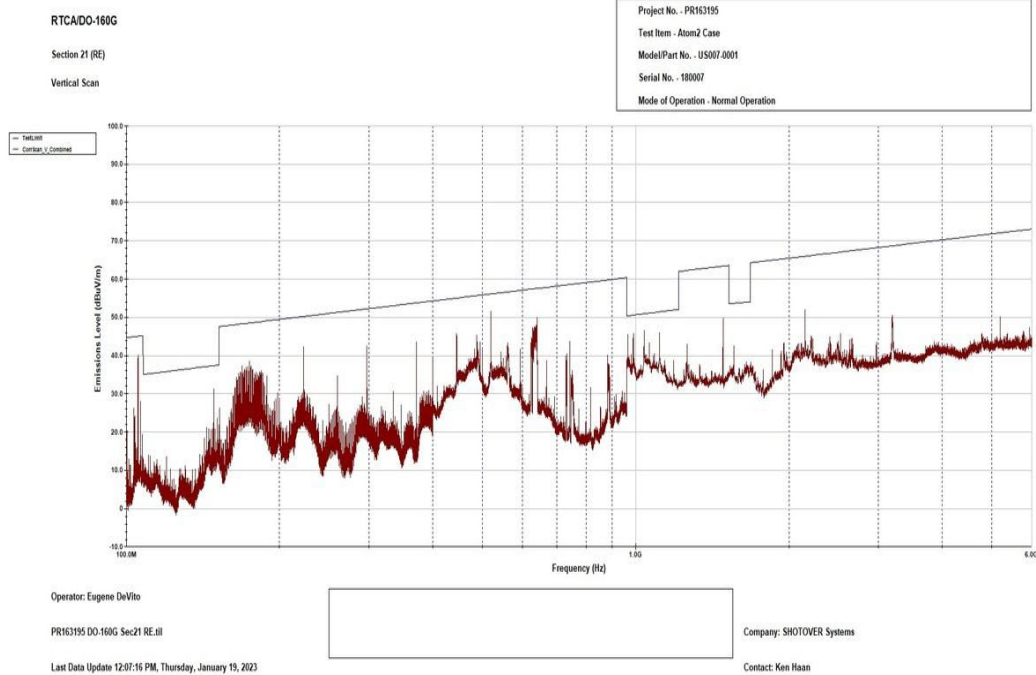
RTCA/DO-160G
Section 21 (RE)
System Verification

Operator: Eugene DeVito
PR163195 DO-160G Sec21 RE System Verification.til
09:38:16 AM, Thursday, January 19, 2023

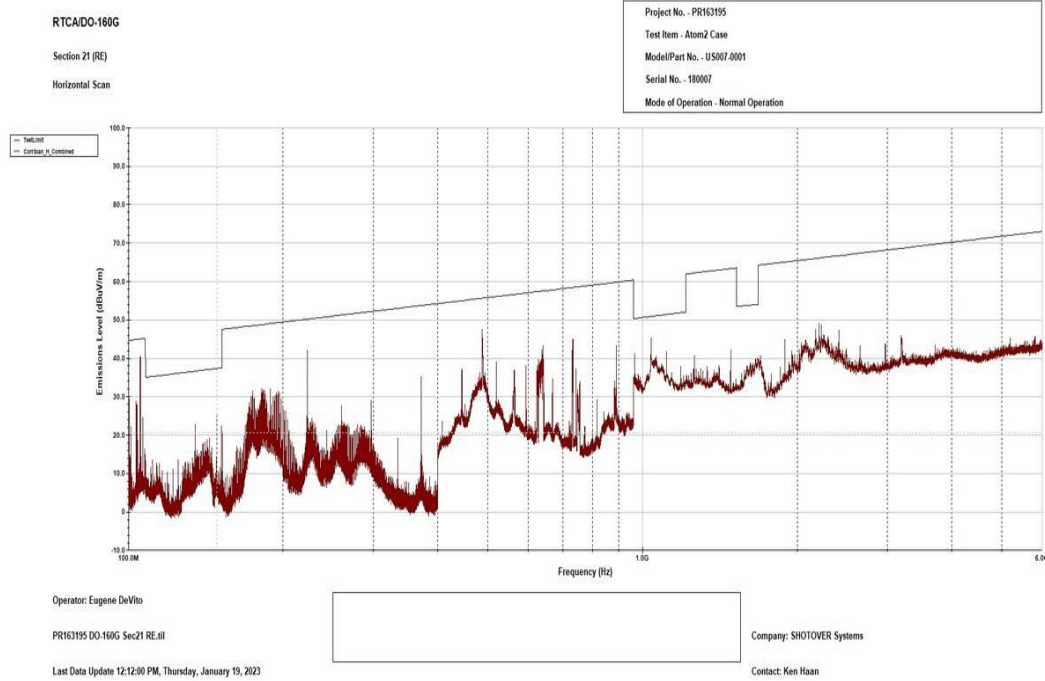
Project No.: PR163195
Contact: Ken Haan
Company: SHOTOVER Systems

Frequency (MHz)	Limit (dBuV/m)	Peaks (dBuV/m)	Delta (dB)
197.000 MHz	49.303	42.643	-6.660
990.000 MHz	50.522	45.978	-4.544
5.500 GHz	72.396	65.204	-7.193

RE Cat M b System Verification Table



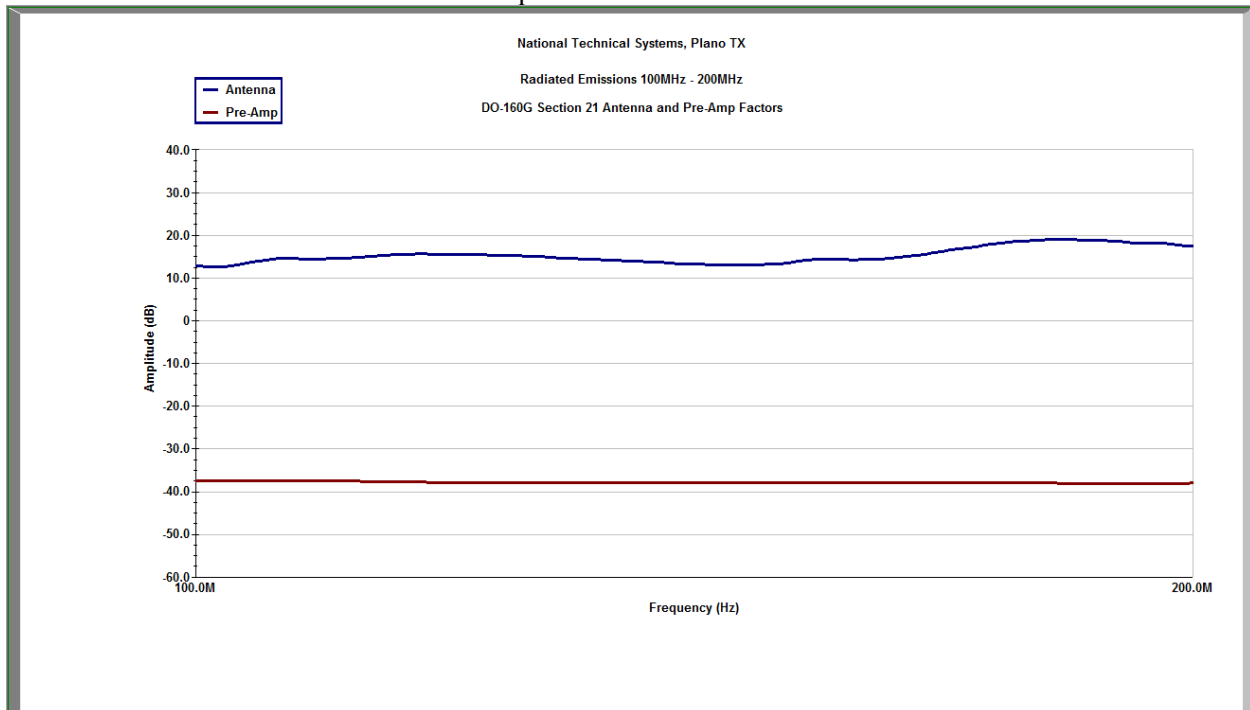
RE Cat M d Vertical



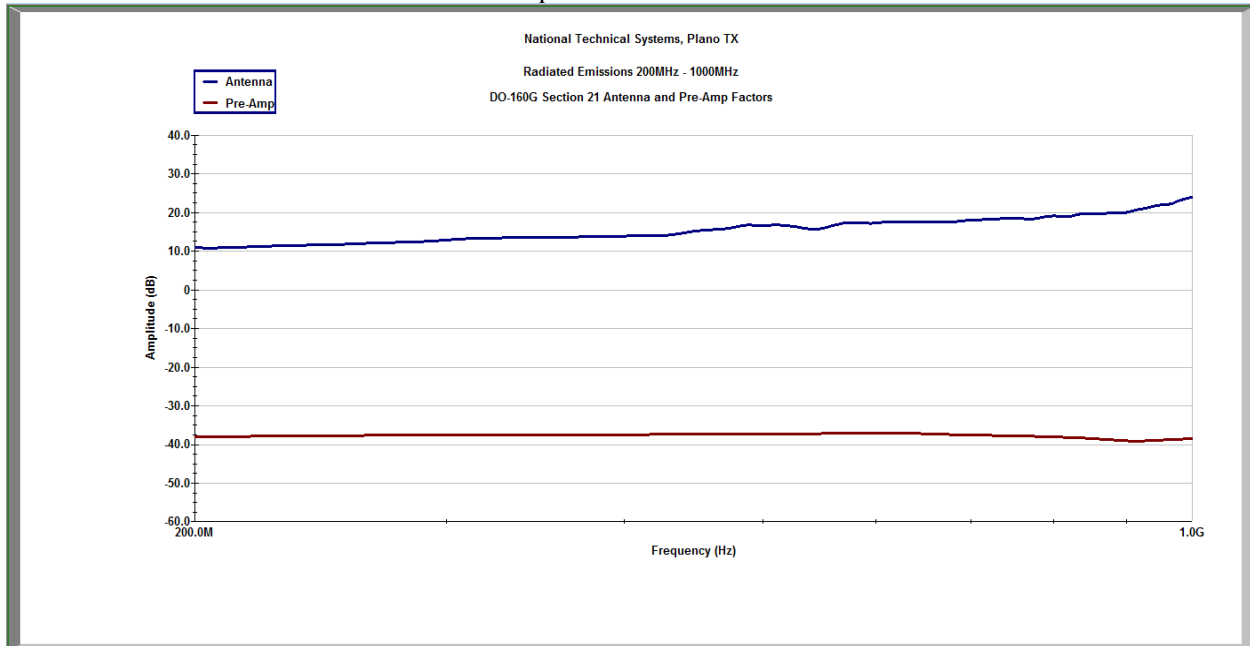
RE Cat M c Horizontal

5.4.3.8 Factors for Radiated Emissions

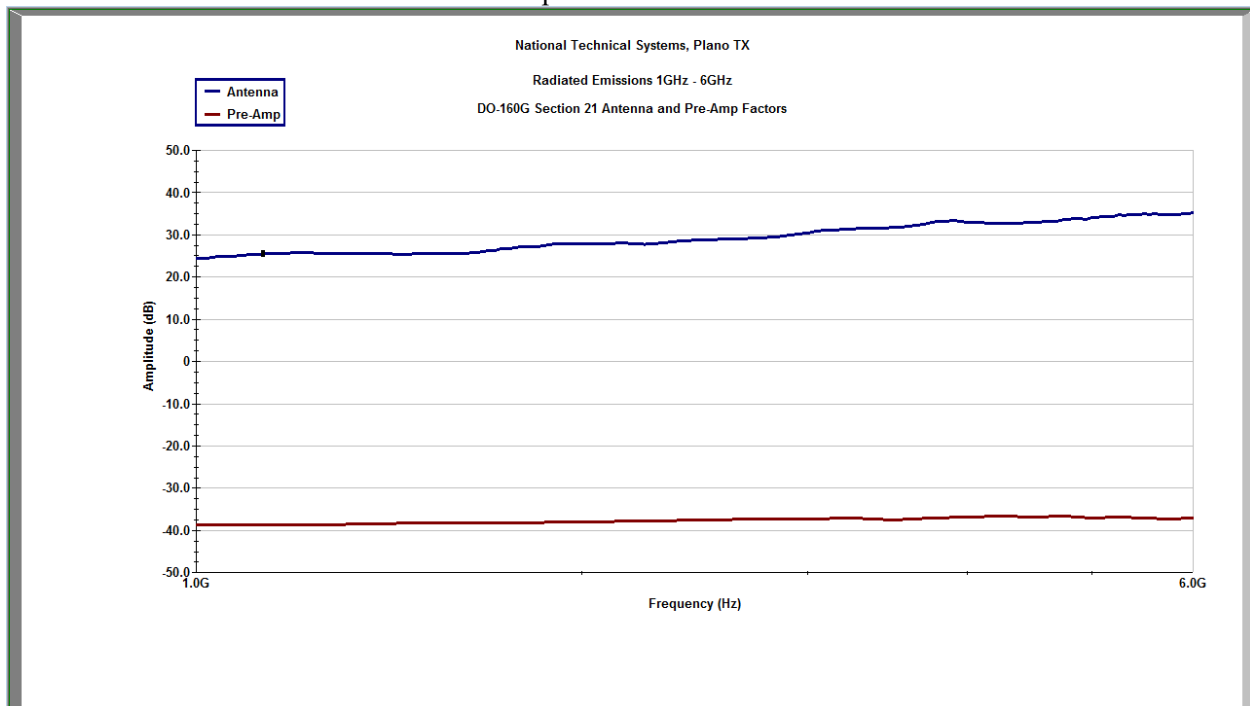
Biconical Antenna WC059574 and Pre-Amp WC078464 Factor for Radiated Emissions



Giant Horn Antenna WC059428 and Pre-Amp WC078464 Factor for Radiated Emissions



Small Horn Antenna WC059579 and Pre-Amp WC078464 Factor for Radiated Emissions



5.4.4 Test Equipment Lists

5.4.4.1 Conducted Emissions

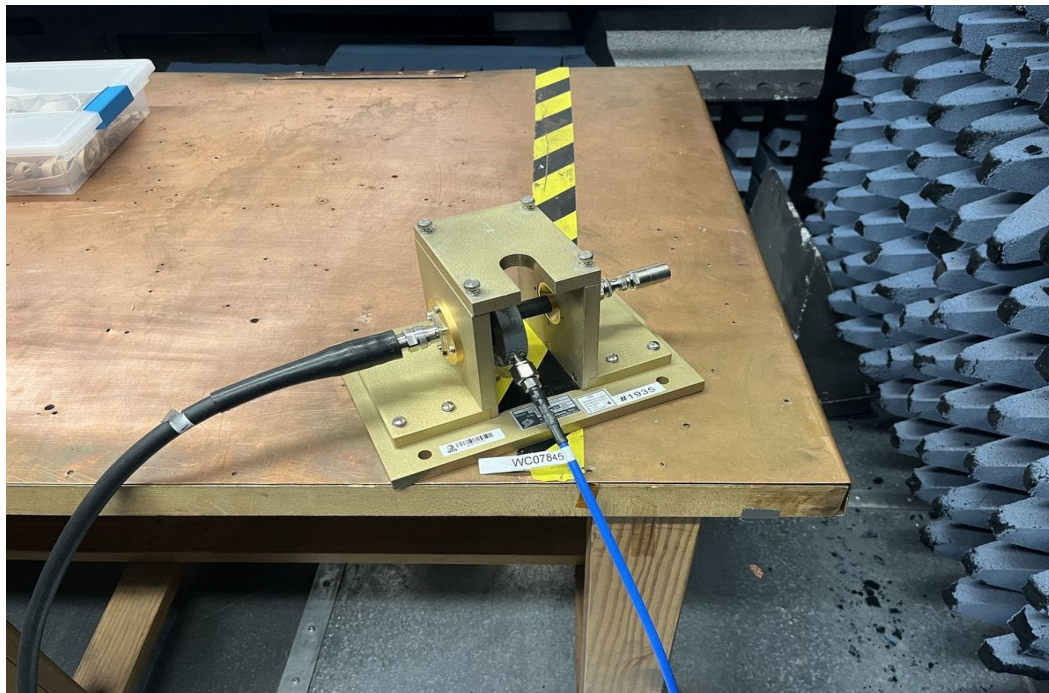
Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059715	Chamber (EMI, Anechoic)OTA	Rayproof	SR 1	07/13/2015	NCR
WC059623	Chamber (EMI, Semi-Anechoic)	Rayproof	SR 2	NCR	NCR
WC059609	Fixture (Calibration)	Fischer Custom Communications	FCC-BCICF-1	02/01/2022	02/01/2024
WC059781	Probe (Current)	Fischer Custom Communications	F-33-2 Current Probe	09/09/2022	09/30/2024
WC059822	Receiver	Keysight Technologies	N9038A	09/21/2022	09/21/2023
WC076927	Cable (Test)	Teledyne-taber	RF Coax Cable	09/15/2022	09/15/2023
WC078515	TBD	Megaphase	EMC3-N1N1-236	09/14/2022	09/20/2023

5.4.4.2 Radiated Emissions

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059715	Chamber (EMI, Anechoic)OTA	Rayproof	SR 1	07/13/2015	NCR
WC059428	Antenna (Double Ridge Guide)	Sunol Sciences	DRH-118	05/12/2021	05/12/2023
WC059574	Antenna (Biconical)	EMCO	3109	01/27/2021	NCR
WC059579	Antenna (Double Ridge Guide)	EMCO	3106	01/28/2021	02/28/2023
WC076927	Cable (Test)	Teledyne-taber	RF Coax Cable	09/15/2022	09/15/2023
WC078464	Amplifier (Pre/RF/Low Noise)	A. H. Systems	AHSY-PAM-0118P	07/27/2021	02/22/2023
WC078469	Software	ETS-Lindgren	C47213	NCR	NCR
WC078515	TBD	Megaphase	EMC3-N1N1-236	09/14/2022	09/20/2023
WC059623	Chamber (EMI, Semi-Anechoic)	Rayproof	SR 2	NCR	NCR

5.4.5 Test Pictures Setup

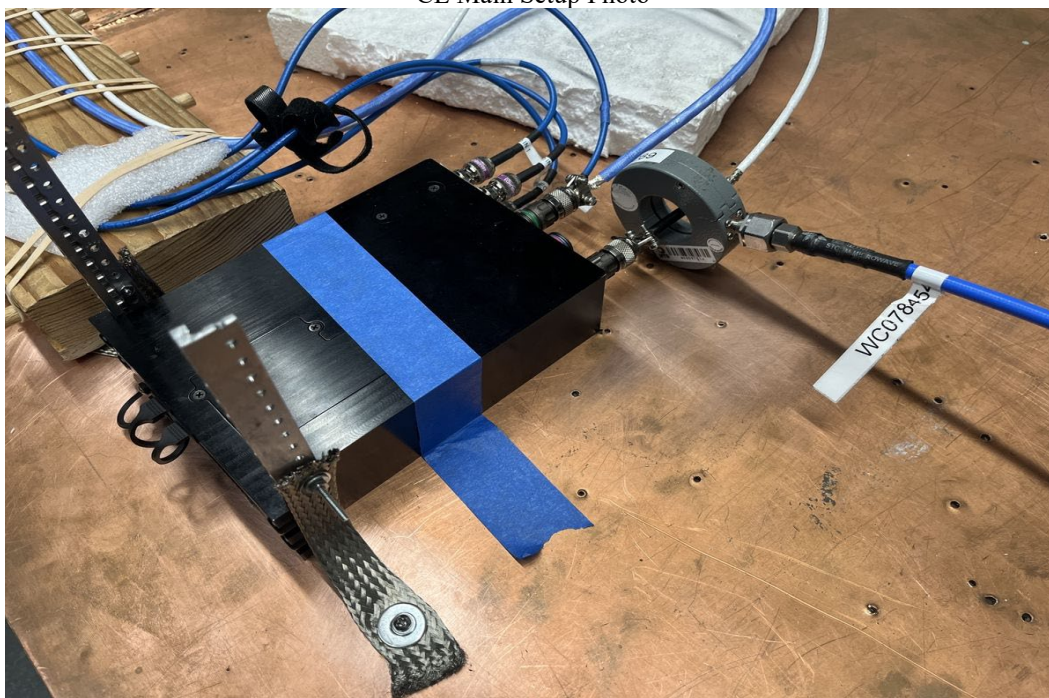
5.4.5.1 Conducted Emissions



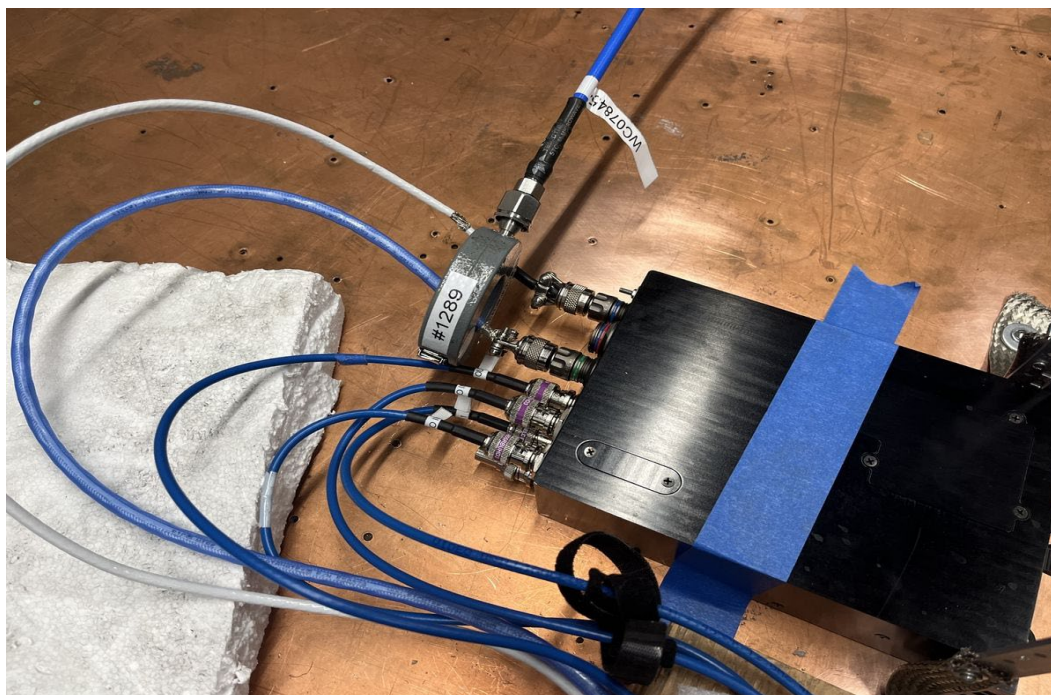
CE System Verification Photo



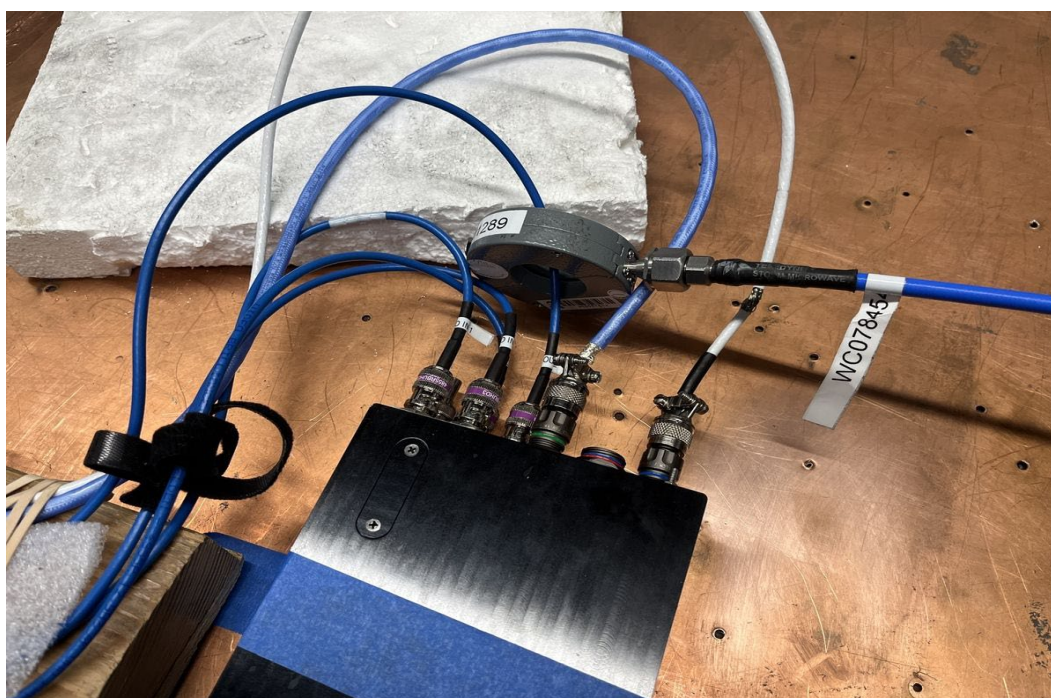
CE Main Setup Photo



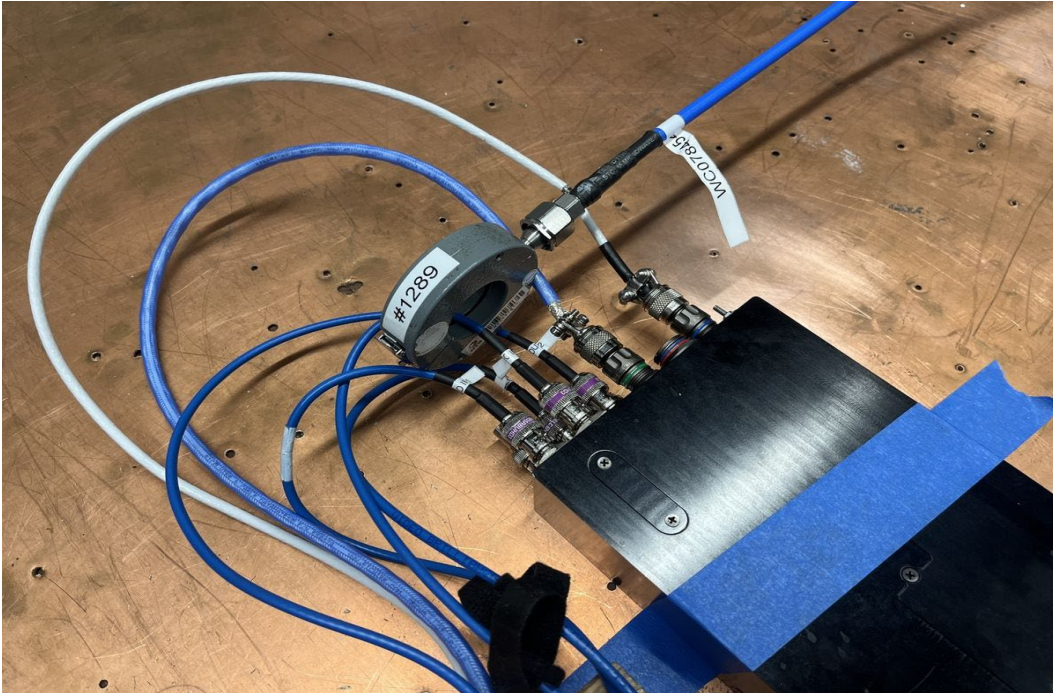
CE J1 Setup Photo



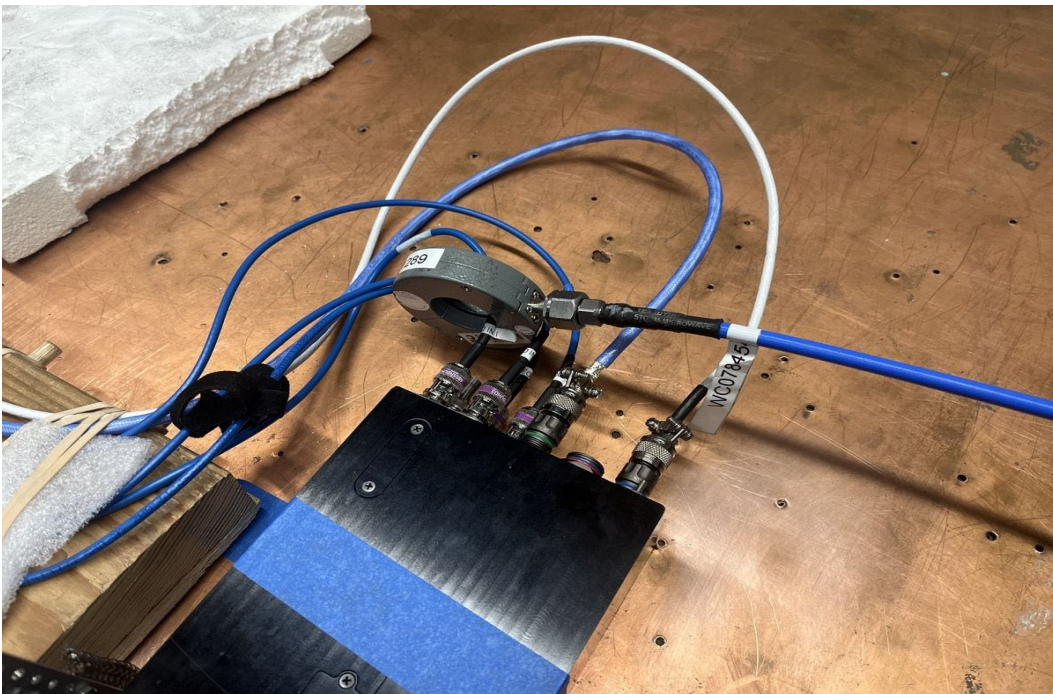
CE J2 Setup Photo



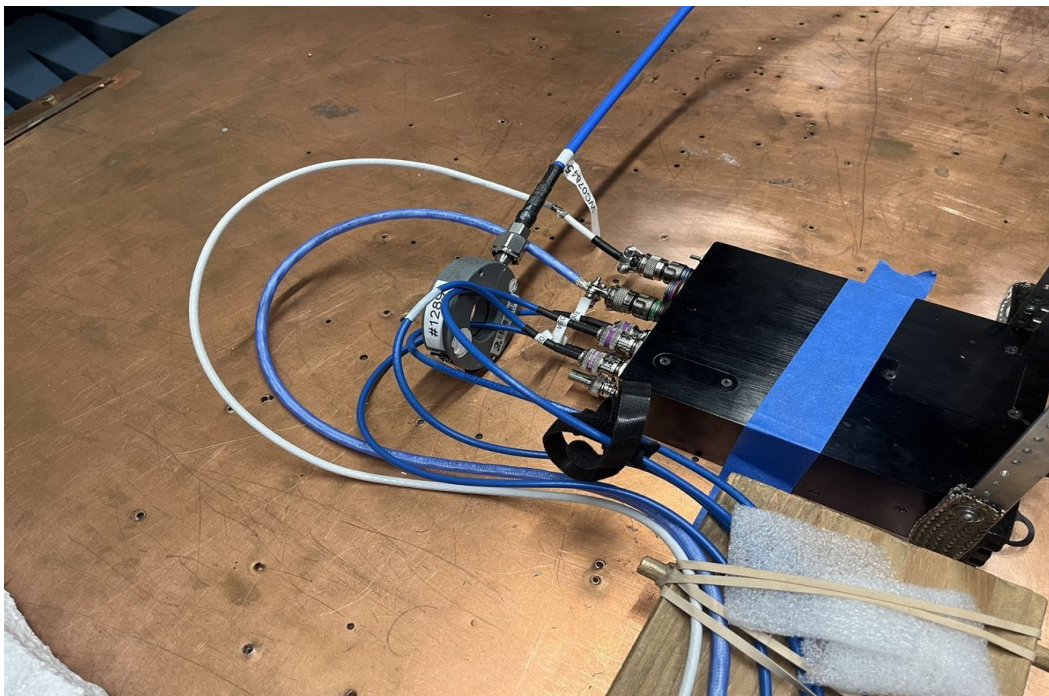
CE J5 Setup Photo



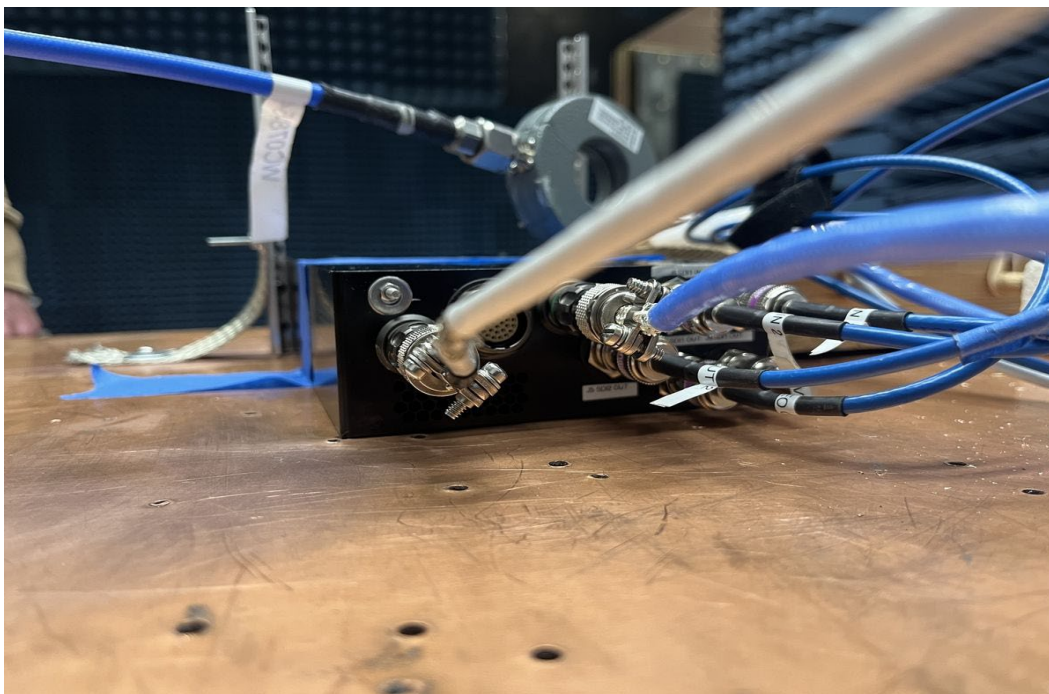
CE J6 Setup Photo



CE J7 Setup Photo



CE J8 Setup Photo



CE Rear Panel Photo 1

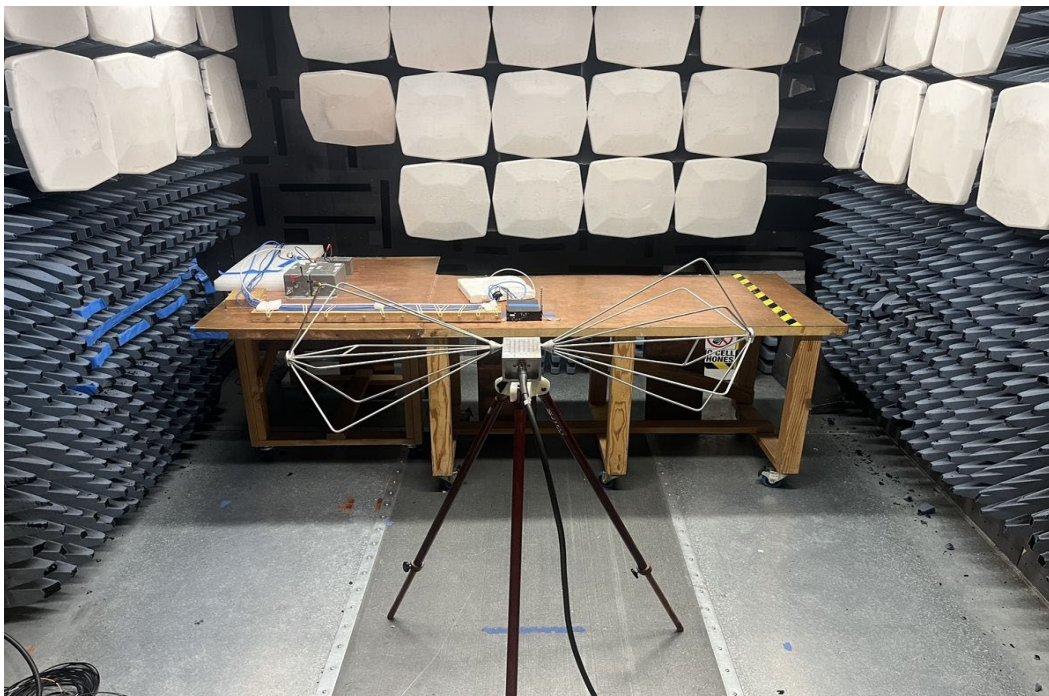


CE Rear Panel Photo 2

5.4.5.2 Radiated Emissions



RE - Biconical Vertical



RE - Biconical Horizontal



RE - LDRG Vertical



RE - LDRG Horizontal



RE - SDRG Vertical



RE - SDRG Horizontal

5.4.6 Comments

The EUT met the requirement of RTCA/DO-160G, Section 21 Category M.

5.5 RTCA/DO-160G Section 25 Electrostatic Discharge (ESD)

5.5.1 Purpose of the Test

The Electrostatic Discharge test relates to airborne equipment which may be involved in static electricity discharges from human contact. Some factors contributing to an ESD event may be: low relative humidity, temperature, use of low conductivity (artificial fiber) carpets, vinyl seals and plastic structures which may exist in all locations within an aircraft. This test is applicable for all equipment and surfaces which are accessible during normal operation and/or maintenance of the aircraft. The electrostatic discharge test is designed to determine the immunity or the ability of equipment to perform its intended function without permanent degradation of performance as a result of an air discharged electrostatic pulse.

5.5.2 Test Description

The immunity to electrostatic discharge shall be determined by the ability of the equipment under test "EUT" to withstand a series of electrostatic pulses at a selected severity level of 15,000 volts, directed at specific human contact locations on the EUT. The quantity of pulses shall be ten (10) in each of the selected locations in both positive and negative voltage polarities. The test configuration is depicted in Figure 25-1

5.5.3 Categories

Category A – Electronic equipment that is installed, repaired or operated in ail aerospace environment

5.5.4 ESD Generator

The ESD generator shall have a general schematic as shown in Figure 25-2, with a discharge resistor of 330 ohms ($\pm 20\%$) and an energy storage capacitor of 150 pf ($\pm 20\%$), and shall be capable of generating a pulse of 15,000 volts, in both positive and negative polarities. The ESD generator shall also have an air discharge tip as shown in Figure 25-3. The ESD generator shall be calibrated to produce a positive and negative 15,000 volts (+10%, -0%) peak output pulse. The generator setting required to produce this output shall be recorded.

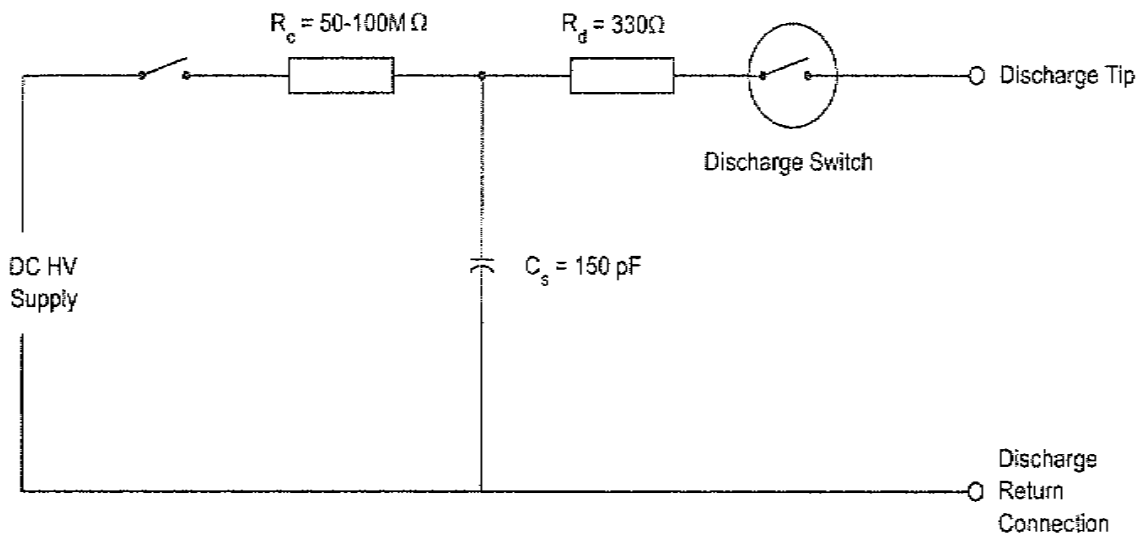
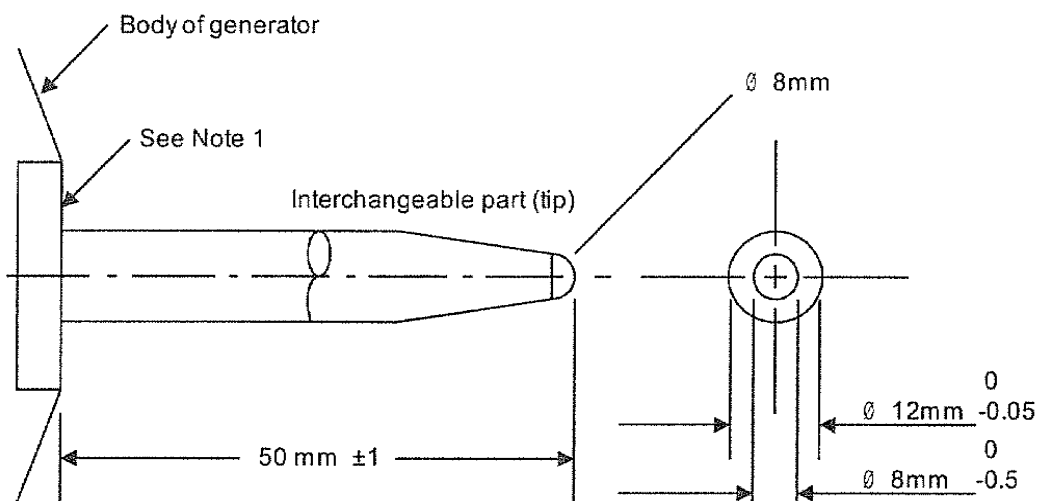


Figure 25-2: Simplified Diagram of the ESD generator



Note 1 - The discharge switch (e.g., vacuum relay) shall be mounted as close as possible to the tip of the discharge electrode.

Figure 25-3: Discharge Electrode of the ESD Generator

5.5.5 Test Data

Date of Test: 01/30/2023

Operator: Thomas Wittig, EMC Test Technician

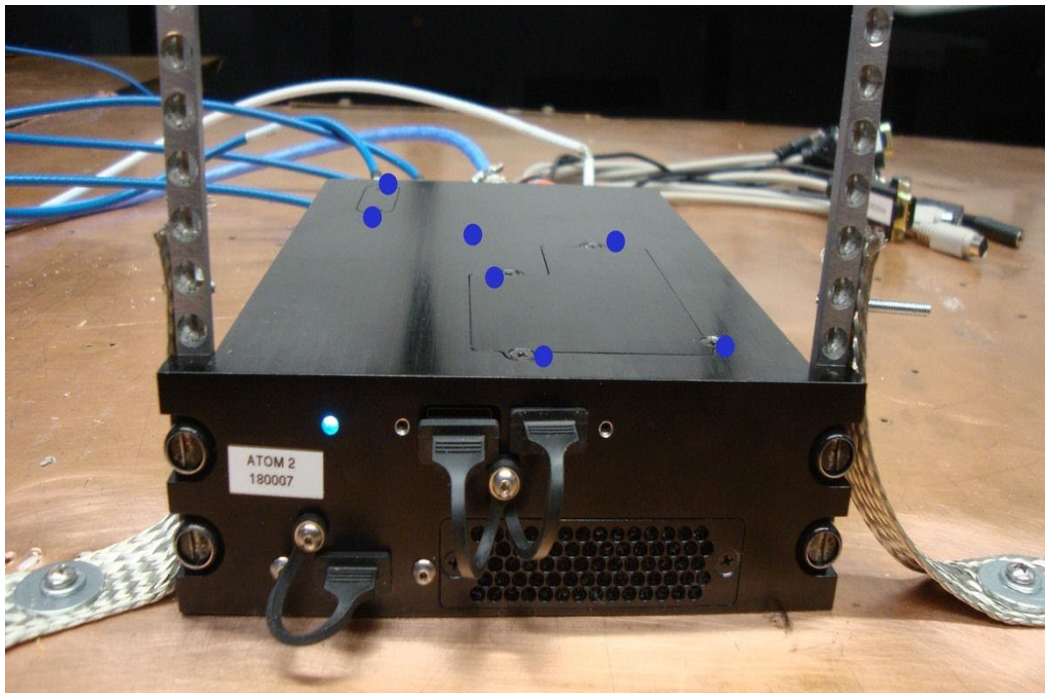
National Technical Systems Section 25 ESD Log							
Temp:	18	° C	Humidity:	39	% RH	Barometer:	836 mb
Date	Time	Log Entries					Initials
1/30/23	1000	Setup for section 25 ESD testing					TW
		Performed 4-2 pre-test verification					
	1100	Begin ESD testing on the Atom 2					TW
		Performed +/-15kV air discharges at multiple test points					TW
	1330	Completed ESD testing on all faces of EUT, including connectors, seams and screws.					TW
		No errors, upsets or degradation occurred during testing					TW
Witnessed By:		Ken Haan					
Test Performed By:		T. Wittig					
Program Engineer:		Ken Haan					

National Technical Systems					
ESD Data Sheet					
Remarks: The immunity to electrostatic discharge shall be determined by the ability of the equipment under test (EUT) to withstand a series of ESD pulses at a test level of 15,000 volts, directed at specific human contact locations on the EUT. the quantity of pulses shall be ten in each of teh selected locations in both positive and negative polarities.					
Bonding Measurement					
Test Point	Voltage Level	Type	Application of Discharge	Results	Comments
Test Setup Photo 1	15kV	Air	10 Positive / 10 Negative	Comply	N/A
Test Setup Photo 2	15kV	Air	10 Positive / 10 Negative	Comply	N/A
Test Setup Photo 3	15kV	Air	10 Positive / 10 Negative	Comply	N/A
Test Setup Photo 4	15kV	Air	10 Positive / 10 Negative	Comply	N/A
Test Performed By: T. Wittig					

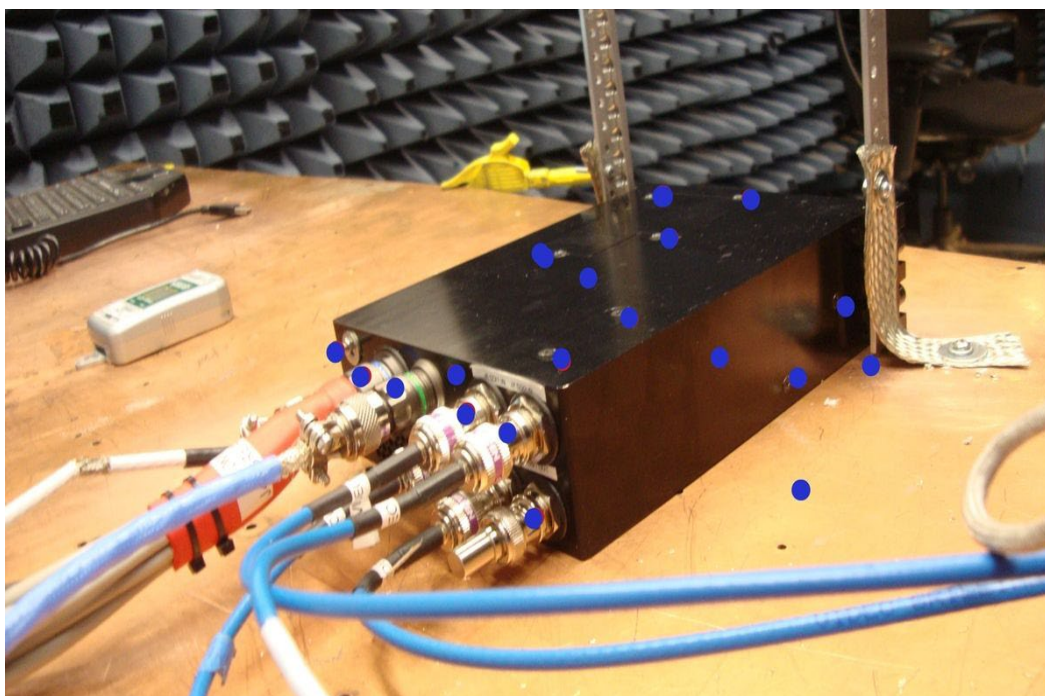
5.5.6 Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC059715	Chamber (EMI, Anechoic)OTA	Rayproof	SR 1	07/13/2015	NCR
WC059665	Gun (ESD Simulator)	EMC-Partner	ESD3000	05/31/2022	05/31/2023
WC059669	Meter (Digital Multimeter)	Fluke	83-3	09/12/2022	09/12/2023
WC078486	Meter (Hydrometer)	Extech Instruments	Datalogger 42270	06/22/2022	06/22/2023

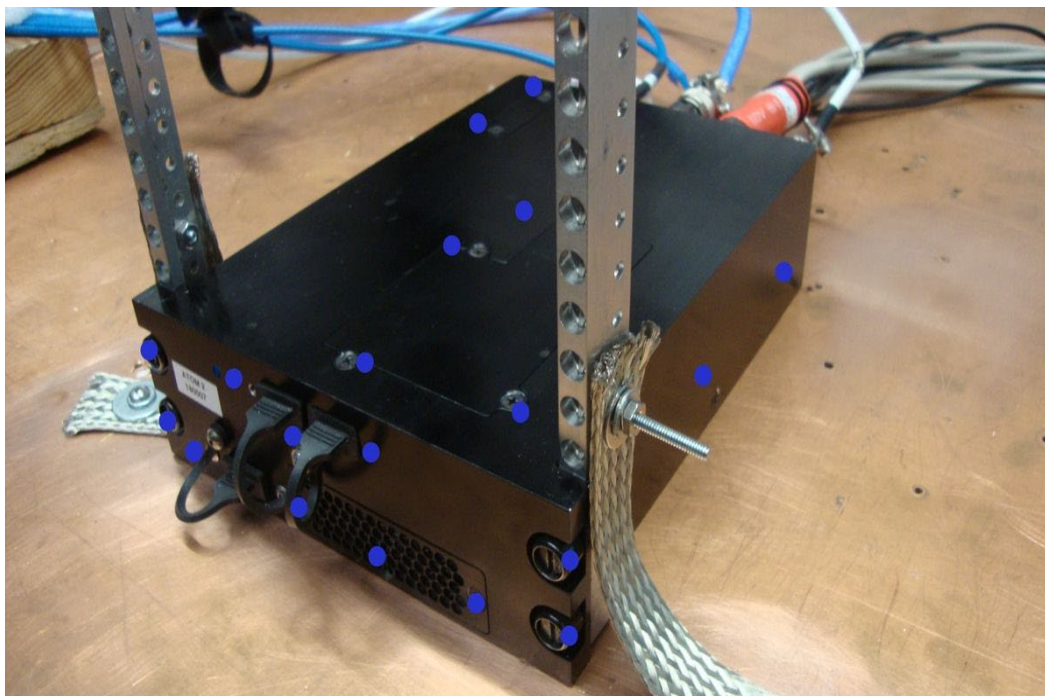
5.5.7 Test Pictures Setup



ESD Test Setup 1



ESD Test Setup 2



ESD Test Setup 3



ESD Test Setup 4

5.5.8 Comments

The EUT met the requirement of RTCA/DO-160G, Section 25 Category A.

End of Report