REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A1	ORIGINAL RELEASE	02/28/20	S. PALACIO

Planar Monolithics Industries, Inc.
7311-F GROVE ROAD
FREDERICK, MD 21704

	NAME:	DATE:
CONTRACT NO:		
DRAWN:	J. Peacher	02/28/20
CHECKED:		
PROJ ENGR:	S. Palacio	02/28/20
PROG MGR:		
MFG.ENGR:		
QA ENGR:	J. Peacher	02/28/20
INSPECTOR:	T. Leland	02/28/20

QUALIFICATION TEST REPORT

MODEL: PMTO-8R8G9R56G-CD-1
PART NO: 27331551

PMI	SIZE **A**	CAGE CODE **05XQ0**	DWG. NO. **28131551**	REVISION A1
	SCALE	N/A		SHEET 1 OF 44

TABLE OF REVISIONS

DESCRIPTION	DATE	PMI
ORIGINAL RELEASE	02/28/20	J. PEACHER

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APPENDIX

1.0 SUMMARY

Planar Monolithics Industries, Inc. (PMI) has prepared this Qualification Test Procedure Report for the Mechanically Tuned Oscillator: PMTO-8R8G9R56G-CD-1.

1.1 SCOPE

This report describes the Qualification Tests, Reliability Prediction, and Part Derating created for the design of the Mechanically Tuned Oscillator: PMTO-8R8G9R56G-CD-1. The analysis includes a part level operational stress analysis in accordance with MIL-HDBK-217.

TABLE 1 – QUALIFICATION TESTS

TEST	DETAILS & RESULTS	PERFORMED BY	ESTIMATED DURATION
HUMIDITY	4.1	WASHINGTON LABS	4-5 DAYS
VIBRATION	4.2	WASHINGTON LABS	4-5 DAYS
SHOCK RESISTANCE	4.3	WASHINGTON LABS	4-5 DAYS
		TOTAL	~13.5 DAYS (12 – 15 DAYS)

2.0 GENERAL REQUIREMENTS

Evidence supporting successful completion of in-process testing (ESS Testing) and acceptance testing ***shall*** be verified prior to formal qualification testing. The Device Under Test, or DUT, ***shall*** be closed prior to formal acceptance test to provide a tamper proof seal. At any point during testing a unit does not meet the required specifications, testing ***shall*** be manually or automatically (dependent on availability of automated setup) stopped.

2.1 TEST CONDITIONS

Unless specified otherwise, testing ***shall*** be performed at an ambient temperature of 25(+10, -5)°C, a relative humidity of 55%, and pressure levels between 28 to 32 inches of mercury. The DUT ***shall*** be conductively cooled in a manner that maintains the DUT case temperature within the specified ambient temperature window. PMI will test the DUT on a thermal platform to ensure temperature is regulated. Initial characterization to include all Section 4.0 test parameters listed on the Acceptance Test Procedure (PMI Document 28031550); the measured values may vary but will meet specifications over the operating temperature range.

2.2 TEST FAILURE

If test failure is indicated, the test program for the DUT ***shall*** be stopped by the technician. The cognizant engineering and quality representatives ***shall*** be notified. The engineering and quality representatives ***shall*** assess the failure to assign cause. A written course of action ***shall*** be developed by engineering and quality to determine the root cause of the failure.

3.0 ELECTRICAL TEST PROCEDURES

All electrical testing procedure details can be found in PMI Document: 28031550.

4.0 QUALIFICATION TEST PROCEDURES – RESULTS FOUND IN APPENDICES

4.1 HUMIDITY

Requirements are in accordance with MIL-F-18870 (OS) for Class 4 Equipment.

4.2 VIBRATION

The unit ***shall*** withstand the Type 1 Vibration requirements of MIL-STD-167 except that the half amplitude of vibration ***shall*** be limited to 0.007±0.001 inch. The lower frequency ***shall*** be limited to 7 CPS and endurance test ***shall*** be limited to one hour maximum for each resonant point with a maximum time for test of three hours.

4.3 SHOCK RESISTANCE

The unit will exhibit a maximum frequency shift of ±1 MHz as a result of being subjected, while operating, to 30G, 11 millisecond half-sine shocks, 3 shocks, on each of the three axes.

5.0 MTBF INTRODUCTION

The following analysis consists of the basic reliability prediction performed on the Mechanically Tuned Oscillator, to establish analytically the quantitative reliability of the unit's design.

5.1 DOCUMENT PRECEDENCE

In the event of a conflict between the contents of this report and the referenced Military Standards and Specifications, the contents of this report ***shall*** take precedence.

5.2 MILITARY STANDARDS

MIL-STD-785B	Reliability Program for Systems and Equipment Development and Production	15 SEP 1980 Revision B
MIL-HDBK-217F	Reliability Prediction of Electronic Equipment (Notice 2)	10 NOV 2010 Revision F

6.0 EQUIPMENT DESCRIPTION AND OPERATING ENVIRONMENT

6.1 EQUIPMENT DESCRIPTION

Mechanically Tuned Oscillator: PMTO-8R8G9R56G-CD-1 is a temperature stabilized output medium power X-band Gunn-effect oscillator for use as an RF simulator signal generator. The oscillator unit contains a precision voltage regulator, a low-noise Gunn-effect oscillator mounted on a thermal platform with integral load isolators for each of the RF outputs and a solid state proportional temperature controller along with associated heaters and temperature sensor.

6.2 OPERATING ENVIRONMENT

The anticipated operating environment for the Mechanically Tuned Oscillator is a shipboard environment with a temperature range of 0°C to 50 °C. The reliability prediction and component derating analysis is performed at a baseplate temperature of 50 °C.

6.3 STORAGE ENVIRONMENT & MAINTAINABILITY

There are no deleterious effects from storage due to the nature of the design and the Mechanically Tuned Oscillator will exceed a 20-year storage life. The features that contribute to this characteristic are the nickel-plated finish of the housing and design for exposure to MIL-F-18870 (OS) humidity. Additionally, the service life of the Mechanically Tuned Oscillator will exceed 20 years due to the high MTBF and components selected (or equivalents) are projected to be available well into the service time frame. Both storage life and service life benefit from no limited life items as part of the design and there is no need for scheduled maintenance. While in storage, the unit should remain in an Electrostatic Discharge (ESD) safe and humidity controlled environment at room temperature. The module should remain sealed in the original packaging until operation. The unit's GPO/SMP connectors should be covered to prevent dust or damage while not in use. To increase ease of testing, see PMI document number 28031550 for details.

For any QA related issues or RMA requests, contact quality@pmi-rf.com.

7.0 RELIABILITY PREDICTION PROCESS

7.1 RELIABILITY METHODOLOGY

The Reliability Prediction of the Mechanically Tuned Oscillator in the shipboard environment using part stress method and part failure rate models of MIL-HDBK-217F Notice 2. Each part type failure rate was calculated using the calculated stresses provided by engineering and a computerized Reliability Prediction Program (Windchill Quality Solutions V10.1) then was added to arrive at the unit's serial failure rate. The result of the reliability prediction process is to obtain the equipment failure rate (λ) in failures per million hours (FPMH) and then calculate the equipment Mean Time Between Failures (MTBF) by reciprocating and converting to hours from million hours.

7.2 GROUND RULES/ASSUMPTIONS

The reliability prediction was performed under the following ground rules/assumptions:

Reliability Model:	Serial
Environment:	Shipboard (Naval Sheltered)
Part Temperature:	50 °C
Thermal/part stresses:	Capacitors: Voltage Stress
	Resistors: Voltage Stress
	Semiconductors: Tj Rise
Quality Levels:	Capacitors: Pi Q = 0.1
	Resistors: Pi Q = 0.1
	Diode Semiconductors: PiQ = 0.5
	Inductors: Pi Q = 0.1
	Connectors: Pi Q = 1.0

8.0 RELIABILITY REQUIREMENT

The Reliability Requirement for the Mean Time Between Failure (MTBF) of the Mechanically Tuned Oscillator is 50,000 operating hours in a shipboard environment at 50 °C.

9.0 RELIABILITY PREDICTION RESULTS

9.1 MTBF CALCULATIONS

Using the parts lists, calculated stress data and part temperatures for the Environmental Conditions, the MTBF was calculated and is reflected in Table 2.

TABLE 2 – RELIABILITY PREDICTION SUMMARY

Environment	Temperature	Required Failure Rate (FPMH, Max)	Required MTBF (Hours, Min)	Predicted Failure Rate (FPMH)	Predicted MTBF (Hours)
NS	50 °C	**20**	**50,000**	**2.740712**	**364,869**

9.2 RELIABILITY PREDICTION WORKSHEETS

The Reliability Prediction Worksheets are contained in **Appendix A**. The worksheets provide the details of the part stress method reliability prediction. The operating stress factor estimates, including the estimated increase in internal component temperatures, can be found in **Appendix B**.

10.0 PART DERATING

Semiconductor devices ***shall*** not exceed a power stress level of 50%, however, electrical component junction temperatures ***shall*** not exceed the following designated temperatures:

SILICON: ····· 125°C
MICROWAVE GERMANIUM DETECTORS AND MIXERS: ····· 60°C
MICROWAVE SILICON DETECTORS AND MIXERS: ····· 125°C
OPTO-ELECTRONIC LEDS, ISOLATORS, AND DISPLAYS: ··· 100°C

Microcircuits, integrated circuits and hybrid circuits ***shall*** be used in compliance with manufacturer's nominal operating specifications. Resistors ***shall*** not exceed a stress level of 50%. Capacitors (non-electrolytic), ***shall*** not exceed a stress level of 50% while capacitors (electrolytic), ***shall*** not exceed a stress level of 70%.

11.0 CONCLUSIONS

Based on the results of the parts count reliability prediction, the reliability of the Mechanically Tuned Oscillator is predicted to have a MTBF of **364,869 hours** when calculated per MIL-HDBK-217F Notice 2 in a shipboard environment at a 50 °C temperature which meets the reliability requirement of 50,000 hours.

12.0 LIST OF ABBREVIATIONS AND ACRONYMS

FPMH	Failures Per Million Hours
MTBF	Mean Time Between Failure
PMI	Planar Monolithics Industries
QTP	Qualification Test Procedure
ESD	Electrostatic Discharge
RAM	Reliability And Maintainability
PCB	Printed Circuit Board
RF	Radio Frequency
NS	Naval Sheltered

APPENDIX A

MECHANICALLY TUNED OSCILLATOR RELIABILITY PREDICTION DETAILS

SHIPBOARD (NAVAL SHELTERED) 50 °C PART TEMPERATURE

Windchill
Quality Solutions

Reliability Prediction Summary

File Name: PMTO-8R8G9R56G-CD-1.rfp
System: PMTO-8R8G9R56G-CD-1
Ref Des:
Description:

Failure Rate: 2.740712
MTBF (hrs): 364,869
Temperature: 50
Environment: NS - Naval Sheltered

Assembly Name	Part Number	Ref Des	Quantity	Failure Rate	MTBF
Gunn Oscillator	PMTO-8R8G9R56G-CD-1		1	2.740712	364,869
Gunn Oscillator DC PCB	FD-300-302-00-RA		1	1.042128	959,575
Gunn Oscillator RF PCB	FD-300-303-00-RA		1	0.210625	4,747,772

Windchill
Quality Solutions

Reliability Prediction Summary

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: PMTO-8R8G9R56G-CD-1
Ref Des:
Description:

Failure Rate: 2.740712
MTBF (hrs): 364,869
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Category	Subcategory	Ref Des	Quantity	Total Failure Rate
07-79-058	Semiconductor	Microwave Diode		1	1.484832
1321-000-K820-3	Connection	General		2	0.003127

Windchill
Quality Solutions

Reliability Prediction Summary

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: FD-300-302-00-RA
Ref Des:
Description:

Failure Rate: 1.042128
MTBF (hrs): 959,575
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Category	Subcategory	Ref Des	Quantity	Total Failure Rate
T491A104K050AT	Capacitor	Chip, Elec (CWR)	C2	1	0.000339
T491A475K050AT	Capacitor	Chip, Elec (CWR)	C4, 8	2	0.001641
T491A106K050AT7280	Capacitor	Chip, Elec (CWR)	C7	1	0.000976
MBRS540T3G	Semiconductor	Diode	D1, 2	2	0.006703
RC1206JR-07240RL	Resistor	Film (RL, RLR, RN, RNR, RM)	R7	1	0.010625
RC1206FR-0702RL	Resistor	Film (RL, RLR, RN, RNR, RM)	R8	1	0.010625
LM317	Integrated Circuit	Linear	U1	1	0.011219
PCB	Connection	SMT Interconnect Assy	PCB	1	0.000000
DN515-1528	Miscellaneous	Heater	Heater	1	1.000000

Windchill
Quality Solutions

Reliability Prediction Summary

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: FD-300-303-00-RA
Ref Des:
Description:

Failure Rate: 0.210625
MTBF (hrs): 4,747,772
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Category	Subcategory	Ref Des	Quantity	Total Failure Rate
X925D-IT-CW	Miscellaneous	RF or Microwave Passive Device	IS1, IS2	2	0.200000
RCD603-MOD	Resistor	Film (RL, RLR, RN, RNR, RM)	R1	1	0.010625
PCB	Connection	SMT Interconnect Assy	PCB	1	0.000000

APPENDIX B

MECHANICALLY TUNED OSCILLATOR OPERATING STRESS FACTOR DETAILS

SHIPBOARD (NAVAL SHELTERED) 50 °C PART TEMPERATURE

Windchill
Quality Solutions

Reliability Prediction
Operating Stress

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: PMTO-8R8G9R56G-CD-1
Ref Des:
Description:

Failure Rate: 2.740712
MTBF (hrs): 364,869
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Current Ratio	Voltage Ratio	Power Ratio	Temperature Rise	Temperature Actual	Failure Rate
07-79-058				50.0	100.0	1.484832
1321-000-K820-3				0.0	50.0	0.003127

Windchill
Quality Solutions

Reliability Prediction
Operating Stress

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: FD-300-302-00-RA
Ref Des:
Description:

Failure Rate: 1.042128
MTBF (hrs): 959,575
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Current Ratio	Voltage Ratio	Power Ratio	Temperature Rise	Temperature Actual	Failure Rate
T491A104K050AT		50.0			50.0	0.000339
T491A475K050AT		50.0			50.0	0.001641
T491A106K050AT7280		50.0			50.0	0.000976
MBRS540T3G		12.5		1.0	51.0	0.006703
RC1206JR-07240RL			10.0		50.0	0.010625
RC1206FR-0702RL			10.0		50.0	0.010625
LM317				5.0	55.0	0.011219
PCB					50.0	0.000000
DN515-1528					50.0	1.000000

Windchill
Quality Solutions

Reliability Prediction
Operating Stress

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: FD-300-303-00-RA
Ref Des:
Description:

Failure Rate: 0.210625
MTBF (hrs): 4,747,772
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Current Ratio	Voltage Ratio	Power Ratio	Temperature Rise	Temperature Actual	Failure Rate
X925D-IT-CW					50.0	0.200000
RCD603-MOD			10.0		50.0	0.010625
PCB					50.0	0.000000

APPENDIX C

MECHANICALLY TUNED OSCILLATOR RELIABILITY PREDICTION PI FACTORS

SHIPBOARD (NAVAL SHELTERED) 50 °C PART TEMPERATURE

Windchill
Quality Solutions

Reliability Prediction
Pi Factors

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: PMTO-8R8G9R56G-CD-1
Ref Des:
Description:

Failure Rate: 2.740712
MTBF (hrs): 364,869
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Ref Des	Pi Q	Pi E	Pi T	Pi S	All Pi Factors	Failure Rate
07-79-058		0.500000	4.000000	4.124534		π A: 1.000000, π E: 4.000000, π Q: 0.500000, π R: 1.000000, π T: 4.124534, λ B: 0.180000, Model Failure Rate: 1.484832	1.484832
1321-000-K820-3		1.000000	5.000000	1.525194		π E: 5.000000, π K: 1.000000, π Q: 1.000000, π T: 1.525194, λ B: 0.000410, Model Failure Rate: 0.001563	0.003127

Windchill
Quality Solutions

Reliability Prediction
Pi Factors

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: FD-300-303-00-RA
Ref Des:
Description:

Failure Rate: 0.210625
MTBF (hrs): 4,747,772
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Ref Des	Pi Q	Pi E	Pi T	Pi S	All Pi Factors	Failure Rate
X925D-IT-CW	IS1, IS2					Model Failure Rate: 0.100000	0.200000
RCD603-MOD	R1	1.000000	12.00000	1.272689	0.792557	π E: 12.000000, π P: 0.237245, π Q: 1.000000, π S: 0.792557, π T: 1.272689, λ B: 0.003700, Model Failure Rate: 0.010625	0.010625
PCB	PCB					π LC: 1.000000, α CC: 7.000000, α S: 18.000000, α SMT: 2.807149e+014, CRSMT: 0.030000, ECF: 0.130000, Nf: 8.421448e+012, Model Failure Rate: 4.631033e-010	0.000000

Windchill
Quality Solutions

Reliability Prediction
Pi Factors

File Name: PMTO-8R8G9R56G-CD-1.rfp
Assembly: FD-300-302-00-RA
Ref Des:
Description:

Failure Rate: 1.042128
MTBF (hrs): 959,575
Temperature: 50
Environment: NS - Naval Sheltered

Part Number	Ref Des	Pi Q	Pi E	Pi T	Pi S	All Pi Factors	Failure Rate
T491A104K050AT	C2	1.000000	7.000000	1.571645		π C: 0.588844, π E: 7.000000, π Q: 1.000000, π SR: 1.000000, π T: 1.571645, π V: 1.045073, λ B: 0.000050, Model Failure Rate: 0.000339	0.000339
T491A475K050AT	C4, 8	1.000000	7.000000	1.571645		π C: 1.427521, π E: 7.000000, π Q: 1.000000, π SR: 1.000000, π T: 1.571645, π V: 1.045073, λ B: 0.000050, Model Failure Rate: 0.000821	0.001641
T491A106K050AT 7280	C7	1.000000	7.000000	1.571645		π C: 1.698244, π E: 7.000000, π Q: 1.000000, π SR: 1.000000, π T: 1.571645, π V: 1.045073, λ B: 0.000050, Model Failure Rate: 0.000976	0.000976
MBRS540T3G	D1, 2	1.000000	9.000000	2.298737	0.054000	π C: 1.000000, π E: 9.000000, π Q: 1.000000, π S: 0.054000, π T: 2.298737, λ B: 0.003000, Model Failure Rate: 0.003352	0.006703
RC1206JR-07240RL	R7	1.000000	12.00000	1.272689	0.792557	π E: 12.000000, π P: 0.237245, π Q: 1.000000, π S: 0.792557, π T: 1.272689, λ B: 0.003700, Model Failure Rate: 0.010625	0.010625
RC1206FR-0702RL	R8	1.000000	12.00000	1.272689	0.792557	π E: 12.000000, π P: 0.237245, π Q: 1.000000, π S: 0.792557, π T: 1.272689, λ B: 0.003700, Model Failure Rate: 0.010625	0.010625
LM317	U1	1.000000	4.000000	1.012694		π E: 4.000000, π L: 1.000000, π Q: 1.000000, π T: 1.012694, C1: 0.010000, C2: 0.000273, Model Failure Rate: 0.011219	0.011219
PCB	PCB					π LC: 1.000000, α CC: 7.000000, α S: 18.000000, α SMT: 2.807149e+014, CRSMT: 0.030000, ECF: 0.130000, Nf: 8.421448e+012, Model Failure Rate: 4.631033e-010	0.000000
DN515-1528	Heater					Model Failure Rate: 1.000000	1.000000

APPENDIX D

MECHANICALLY TUNED OSCILLATOR ELECTRICAL PERFORMANCE DATA

PRE-QUALIFICATION TEST ATP TEST DATA

SUMMARY TEST DATA ON PMTO-8R8G9R56G-CD-1

Customer:
SO No:
Model No: PMTO-8R8G9R56G-CD-1
Serial No: PL25587/1920

Tested By: Garrett Radtke
Temperature: +25°C
Date: 8/28/2019
Drawing No: 27631550 Rev: A2

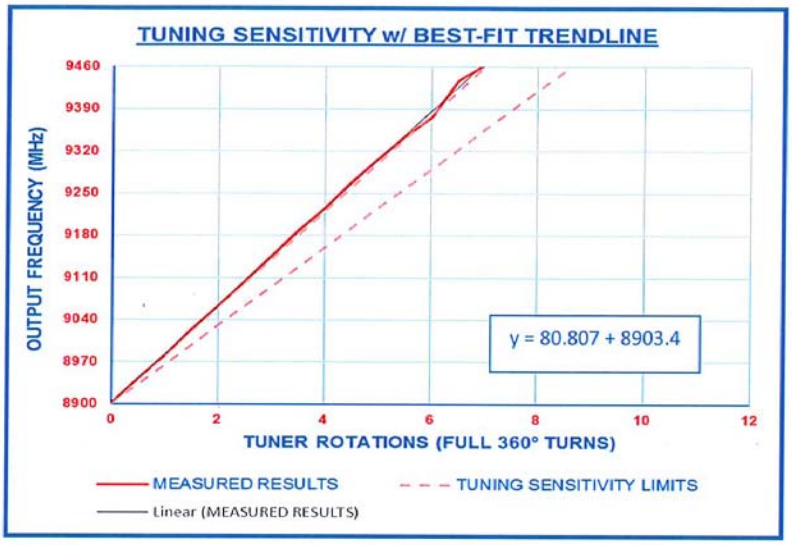
TEST ITEM	PARAMETERS	SPECIFIED VALUE	TEST RESULTS	QA QC
1	Frequency Range	8.8 to 9.56 GHz (Tuning) 8.9 to 9.46 GHz (Specifications)	8.8 TO 9.56 GHz (Tuning @ +25 Deg C) 8.8 TO 9.56 GHz (Tuning @ +50 Deg C) 8.9 TO 9.46 GHz (Specifications)	No Action Needed APPROVED
2	Tuning Sensitivity	65 MHz/360° MIN 80 MHz/360° MAX	80.807 MHz/360° 81.119 MHz/360° (Set Intercept) See Graphs	No Action Needed APPROVED
3	Output Frequency vs Tuner Rotation	±10 MHz (8.90 to 8.93 GHz) ±5 MHz (8.93 to 9.43 GHz) ±10 MHz (9.43 to 9.46 GHz)	-3.4 MHz (8.90 to 8.93 GHz) -6.3 MHz (8.93 to 9.43 GHz) +15.8 MHz (9.43 to 9.46 GHz) See Graphs	No Action Needed APPROVED
4	Power Output (Any Frequency)	J1: +10 (+3, -0) dBm J2: 0 (+3, -0) dBm	@ +25 Deg C 11.81 to 13.48 dBm 0.55 to 2.48 dBm @ +50 Deg C 11.61 to 13.41 dBm 2.06 to 3.23 dBm See Graphs	
5	Tuning Element	Starting Torque: 25 inch-oz MAX Withstanding Torque: 100 inch-oz MIN	PASS	APPROVED
6	Spurious Harmonic Signals	60 dBc MIN (IN BAND) 45 dBc MIN (OUT OF BAND) 30 dBc MIN (HARMONICS)	> 66.94 dBc > 60.57 dBc > 44.51 dBc	APPROVED
7	Noise	See Plots Below	PASS	APPROVED
8	Temperature Coefficient	15 kHz/°C MAX from 0°C to +50°C	55 kHz/°C FROM 0 °C TO 40 °C 800 kHz/°C FROM 40 °C TO 50 °C	No Action Needed APPROVED
9	Long Term Frequency Drift	50 kHz/hr MAX @ any constant temperature from 0°C to +50°C	PASS	APPROVED
10	Pulling Factor	<50 kHz	PASS	APPROVED
11	Regulator/Oscillator Power Supply	+24±1 VDC @ 1.5 A MAX 2% Regulation, Ripple = 2 mVrms	+24±1 @ 0.172 A	APPROVED
12	Heater Power Supply	+24±1 VDC @ 1.5 A MAX 2% Regulation, Ripple = 50 mVrms	+24±1 @ 1.16 A	APPROVED
13	Weight	2.4 lbs MAX	3 lbs	No Action Needed APPROVED

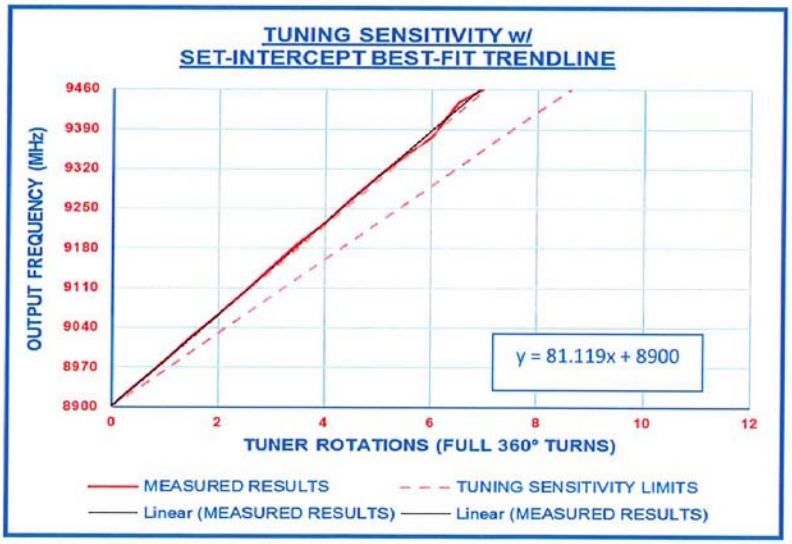
QA/QC Approval: PMI QA1 Date: 8/28/19

7311-F Grove Road Frederick, MD 21704 USA Phone: (301)662-5019 Fax: (301)662-1731
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

TUNING SENSITIVITY

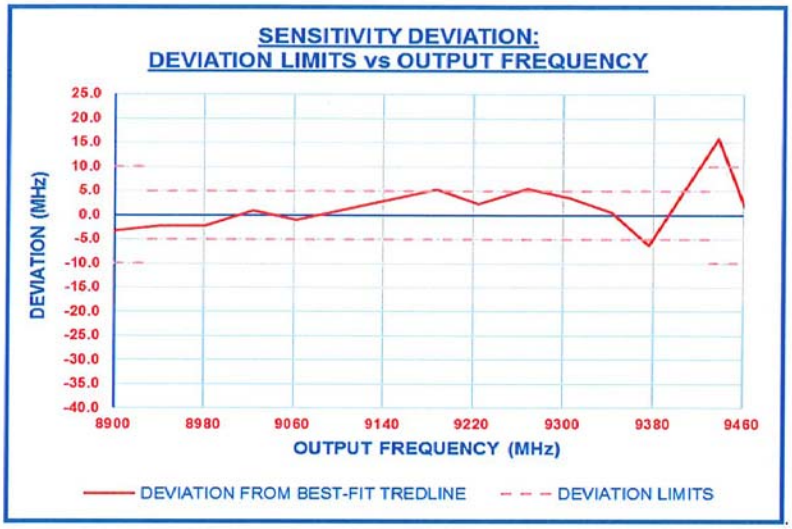


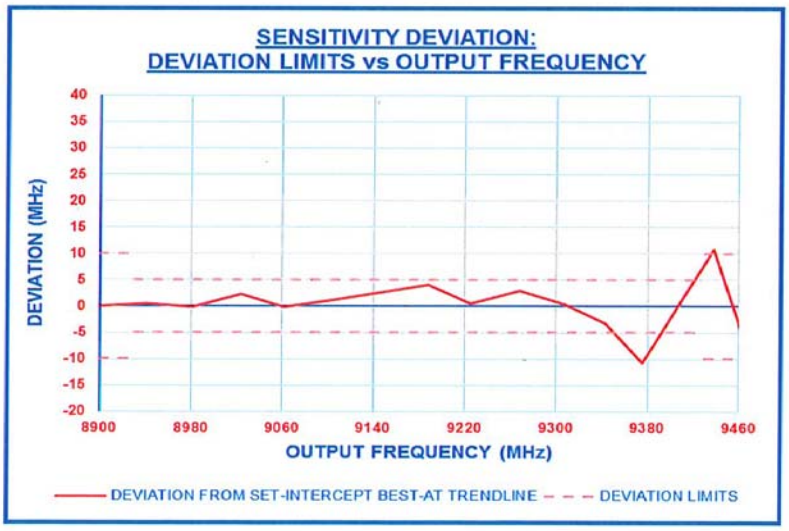


7311-F Grove Road Frederick, MD 21704 USA Phone: (301)662-5019 Fax: (301)662-1731
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

SENSITIVITY DEVIATION

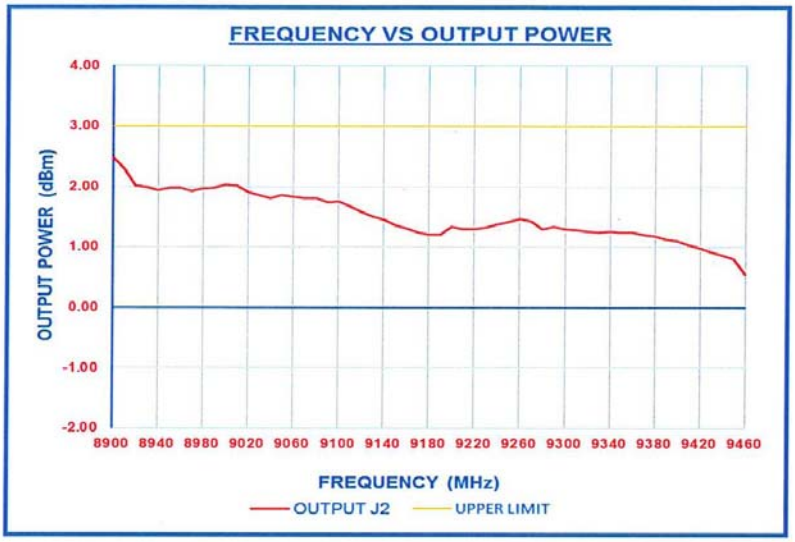


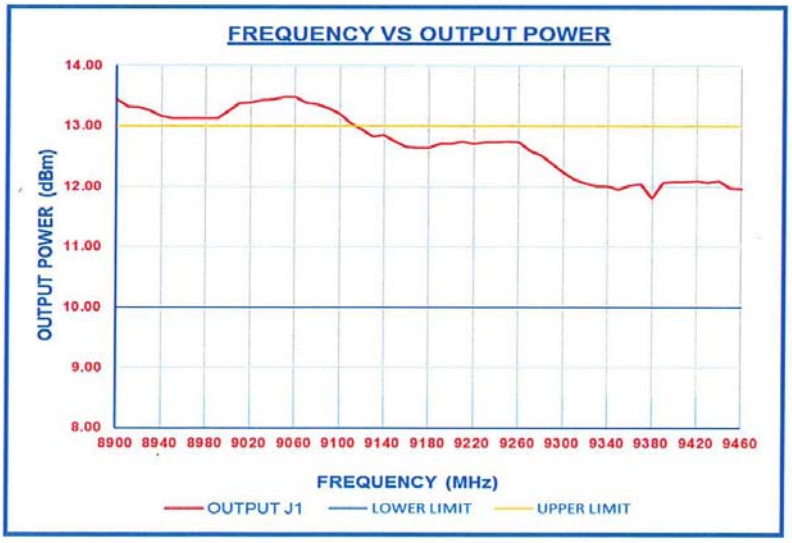


7311-F Grove Road Frederick, MD 21704 USA Phone: (301)662-5019 Fax: (301)662-1731
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

OUTPUT POWER @ +25 DEGREES C

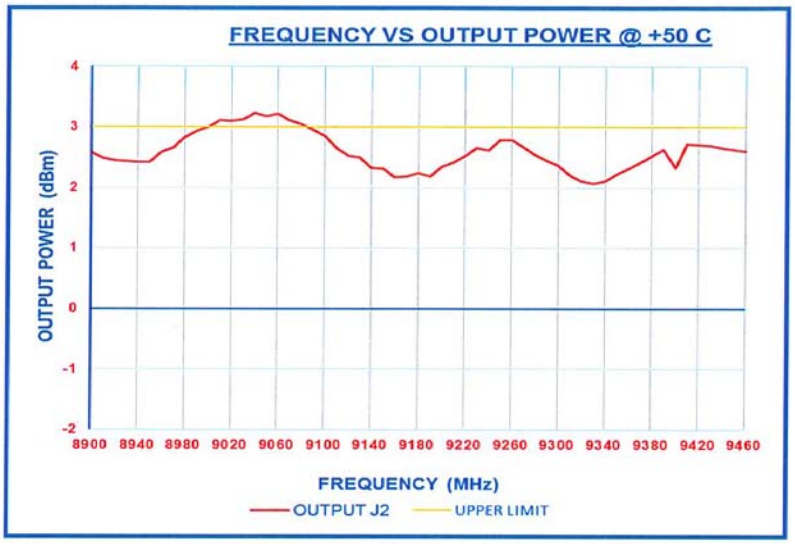


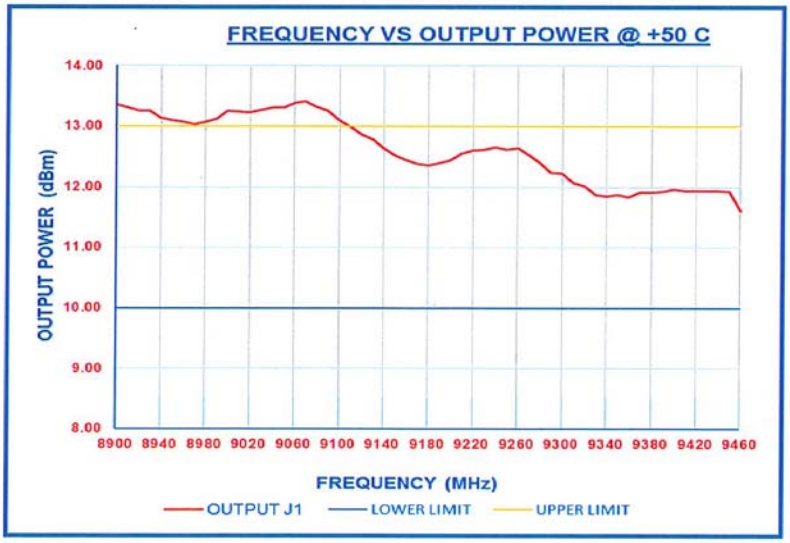


7311-F Grove Road Frederick, MD 21704 USA Phone: (301)662-5019 Fax: (301)662-1731
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

OUTPUT POWER @ +50 DEGREES C





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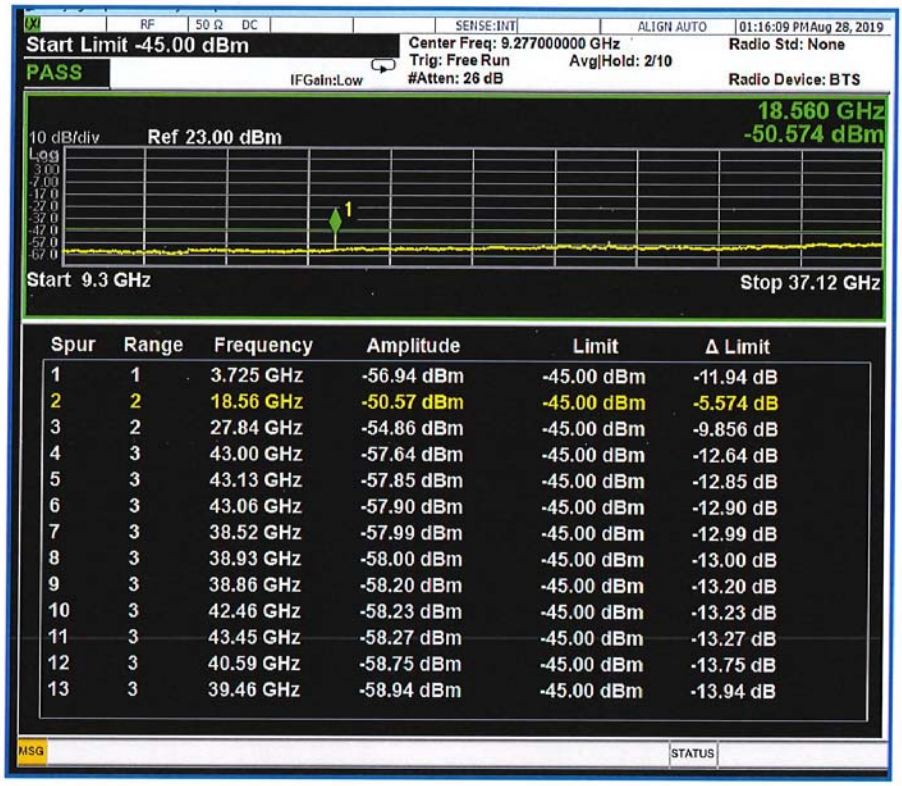
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

SPURIOUS SIGNALS @ 10 dB OUTPUT



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	3.725 GHz	-56.94 dBm	-45.00 dBm	-11.94 dB
2	2	18.56 GHz	-50.57 dBm	-45.00 dBm	-5.574 dB
3	2	27.84 GHz	-54.86 dBm	-45.00 dBm	-9.856 dB
4	3	43.00 GHz	-57.64 dBm	-45.00 dBm	-12.64 dB
5	3	43.13 GHz	-57.85 dBm	-45.00 dBm	-12.85 dB
6	3	43.06 GHz	-57.90 dBm	-45.00 dBm	-12.90 dB
7	3	38.52 GHz	-57.99 dBm	-45.00 dBm	-12.99 dB
8	3	38.93 GHz	-58.00 dBm	-45.00 dBm	-13.00 dB
9	3	38.86 GHz	-58.20 dBm	-45.00 dBm	-13.20 dB
10	3	42.46 GHz	-58.23 dBm	-45.00 dBm	-13.23 dB
11	3	43.45 GHz	-58.27 dBm	-45.00 dBm	-13.27 dB
12	3	40.59 GHz	-58.75 dBm	-45.00 dBm	-13.75 dB
13	3	39.46 GHz	-58.94 dBm	-45.00 dBm	-13.94 dB

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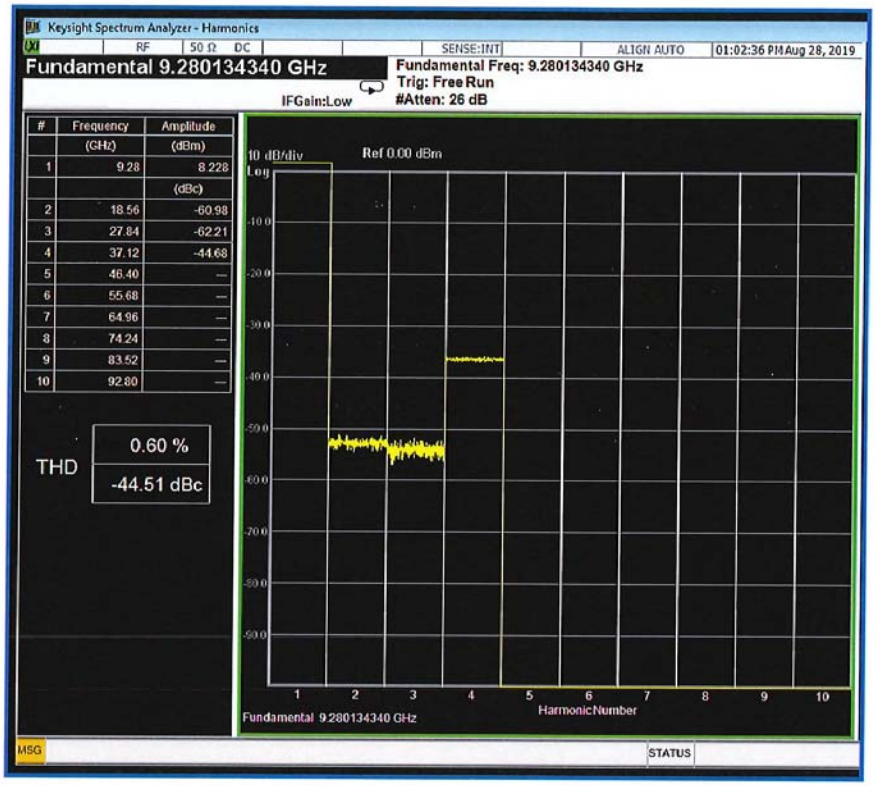
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

HARMONIC PERFORMANCE



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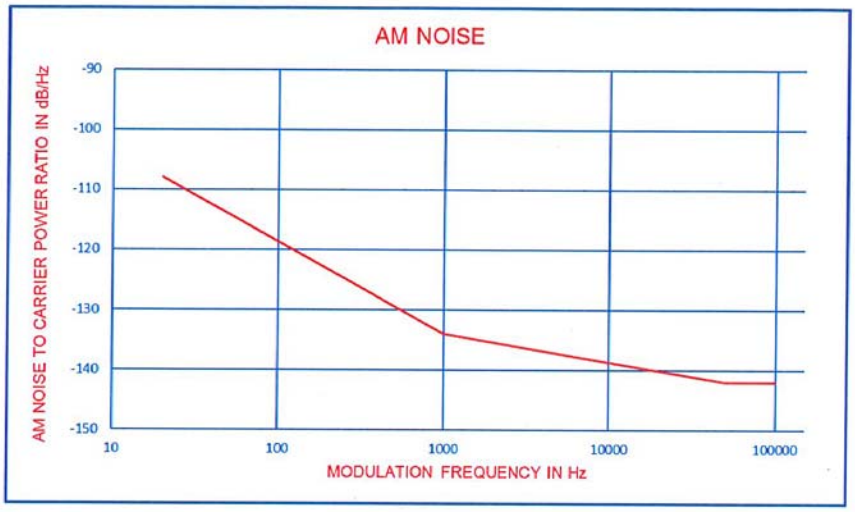
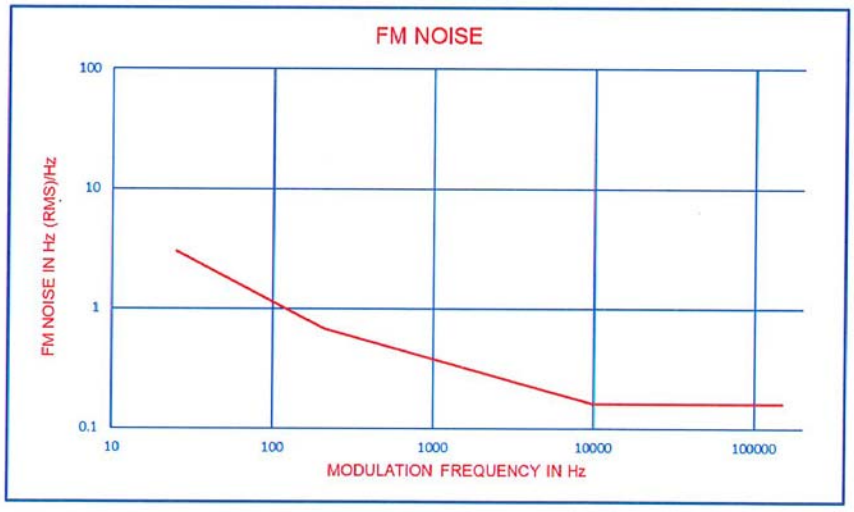
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1





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APPENDIX E

MECHANICALLY TUNED OSCILLATOR ENVIRONMENTAL REPORT

TEMPERATURE CYCLING (SECTION 3.2.1)

CERTIFICATE OF COMPLIANCE

THERMAL CYCLING

Customer:
SO No:
Model No: PMTO-8R8G9R56G-CD-1
Serial No: PL25587/1920

Tested By: J. Peacher
Date: 2/25/20

Test Started: 1/24/2020 - 6:22 PM
Test Ended: 1/26/2020 - 12:06 PM

Thermal Cycling Temp: +75°C (+/- 3°C)
-62°C (+0 / -5°C)
Cycles: 10 Cycles

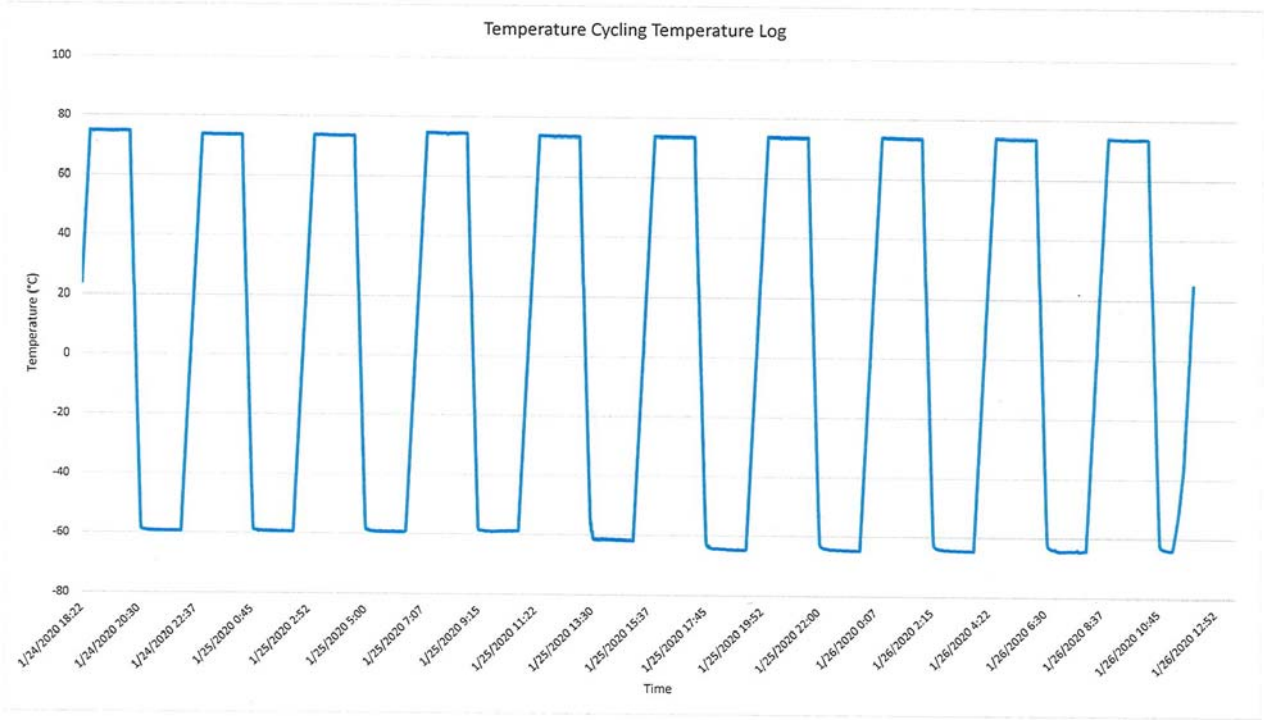
Test Type: Temperature Cycling

Thermal Plate programmed per Lockheed Martin Drawing 5399619, Section 3.2.1

Test Equipment: Asset 682 - ESS Thermal Plate - S/N: 19112603 - Calibration Due 1/28/21
Asset 677 - Keysight Digital Multimeter - S/N: MY47025886 - Calibration Due 12/20/20
Asset 681 - Keysight Thermal Sensor - Calibration Due 5/2/21

QA/QC Approval: T Leland Date: 2/25/20

7311-F Grove Road Frederick, MD 21704 USA Phone: (301)662-5019 Fax: (301)662-1731
Email: sales@pmi-rf.com


Temperature Cycling Temperature Log
Temperature (°C)
100
80
60
40
20
0
-20
-40
-60
-80
1/24/2020 18:22
1/24/2020 20:30
1/24/2020 22:37
1/25/2020 0:45
1/25/2020 2:52
1/25/2020 5:00
1/25/2020 7:07
1/25/2020 9:15
1/25/2020 11:22
1/25/2020 13:30
1/25/2020 15:37
1/25/2020 17:45
1/25/2020 19:52
1/25/2020 22:00
1/26/2020 0:07
1/26/2020 2:15
1/26/2020 4:22
1/26/2020 6:30
1/26/2020 8:37
1/26/2020 10:45
1/26/2020 12:52
Time

APPENDIX F

MECHANICALLY TUNED OSCILLATOR ENVIRONMENTAL REPORT

BURN-IN TESTING (SECTION 3.2.2)

CERTIFICATE OF COMPLIANCE

OPERATIONAL BURN-IN
THERMAL CYCLING

Customer:
SO No:
Model No: PMTO-8R8G9R56G-CD-1
Serial No: PL25587/1920

Tested By: J. Peacher
Date: 2/25/20

Test Started: 1/20/2020 - 6:20 PM
Test Ended: 1/22/2020 - 10:20 AM

Burn-In Temp: +50°C

Test Type: Operational Burn-In

Thermal Plate programmed per Lockheed Martin Drawing 5399619, Section 3.2.2
Voltage Controlled using Keysight Vee Program

Test Equipment: Asset 682 - ESS Thermal Plate - S/N: 19112603 - Calibration Due 1/28/21
Asset 647 - Keysight Power Supply - S/N: MY40009943 - Calibration Due 1/15/21
Asset 677 - Keysight Digital Multimeter - S/N: MY47025886 - Calibration Due 12/20/20
Asset 681 - Keysight Thermal Sensor - Calibration Due 5/2/21

QA/QC Approval: T Leland **Date:** 2/25/20

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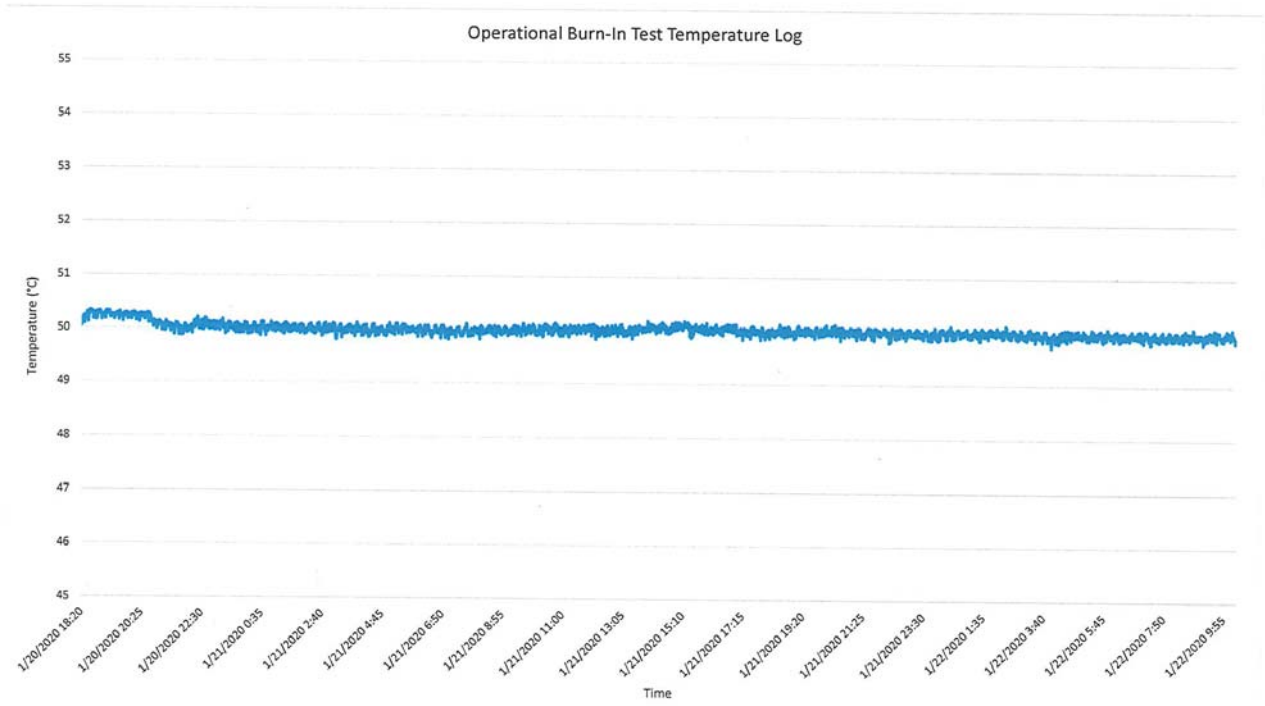
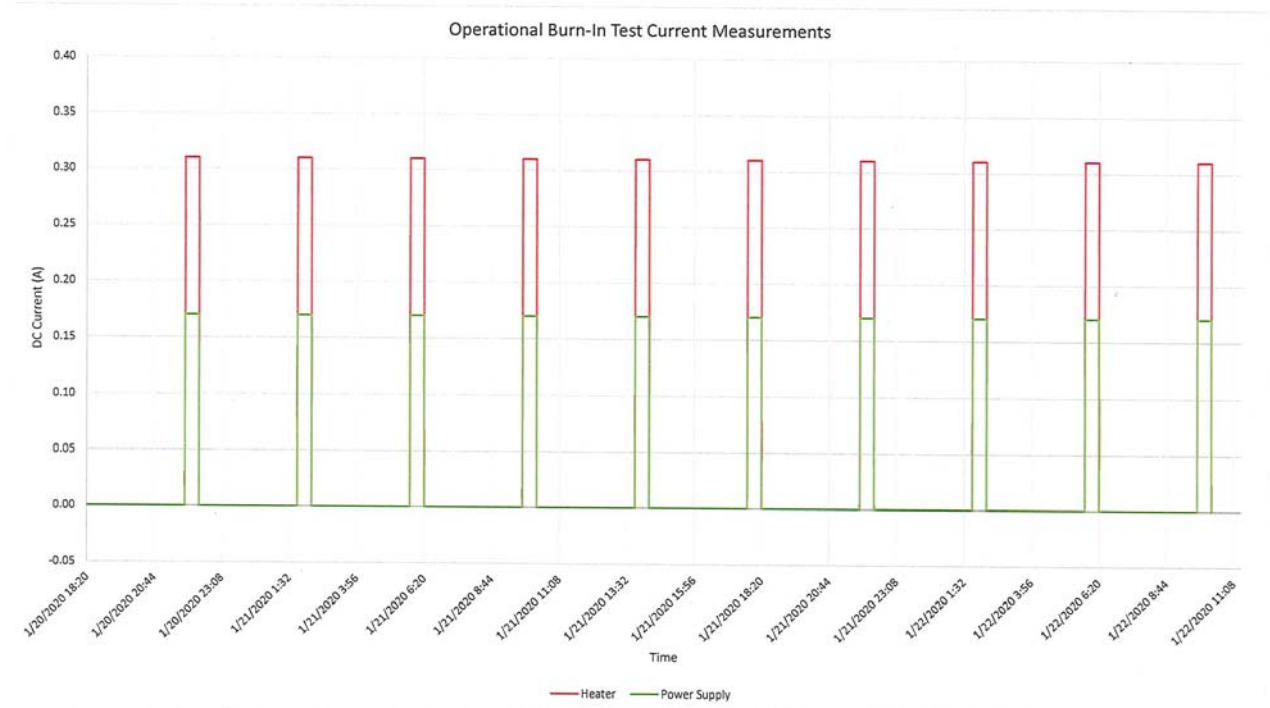
Email: sales@pmi-rf.com


Operational Burn-In Test Temperature Log
Temperature (°C)
55
54
53
52
51
50
49
48
47
46
45
1/20/2020 18:20
1/20/2020 20:25
1/20/2020 22:30
1/21/2020 0:35
1/21/2020 2:40
1/21/2020 4:45
1/21/2020 6:50
1/21/2020 8:55
1/21/2020 11:00
1/21/2020 13:05
1/21/2020 15:10
1/21/2020 17:15
1/21/2020 19:20
1/21/2020 21:25
1/21/2020 23:30
1/22/2020 1:35
1/22/2020 3:40
1/22/2020 5:45
1/22/2020 7:50
1/22/2020 9:55
Time


Operational Burn-In Test Current Measurements
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
DC Current (A)
1/20/2020 18:20
1/20/2020 20:44
1/20/2020 23:08
1/21/2020 1:32
1/21/2020 3:56
1/21/2020 6:20
1/21/2020 8:44
1/21/2020 11:08
1/21/2020 13:32
1/21/2020 15:56
1/21/2020 18:20
1/21/2020 20:44
1/21/2020 23:08
1/22/2020 1:32
1/22/2020 3:56
1/22/2020 6:20
1/22/2020 8:44
1/22/2020 11:08
Time
Heater
Power Supply

APPENDIX F

MECHANICALLY TUNED OSCILLATOR QUALIFICATION REPORT

POST QUALIFICATION TEST ATP DATA

SUMMARY TEST DATA ON PMTO-8R8G9R56G-CD-1

Customer:		**Tested By:**	Sebastian Palacio
SO No:		**Temperature:**	+25°C
Model No:	PMTO-8R8G9R56G-CD-1	**Date:**	2/25/2020
Serial No:	PL25587/1920	**Drawing No:**	27631550 Rev: A2

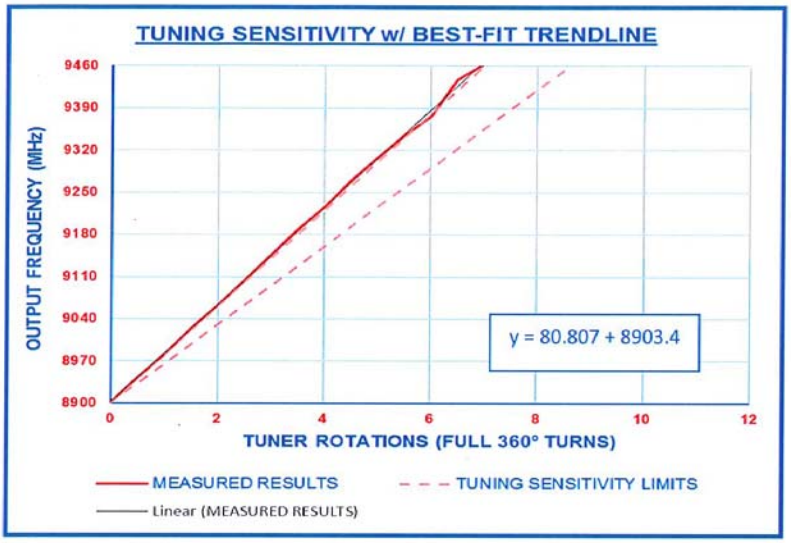
TEST ITEM	PARAMETERS	SPECIFIED VALUE	TEST RESULTS	QA QC
1	Frequency Range	8.8 to 9.56 GHz (Tuning) 8.9 to 9.46 GHz (Specifications)	8.8 TO 9.56 GHz (Tuning @ +25 Deg C) 8.8 TO 9.56 GHz (Tuning @ +50 Deg C) 8.9 TO 9.46 GHz (Specifications)	
2	Tuning Sensitivity	65 MHz/360° MIN 80 MHz/360° MAX	80.807 MHz/360° 81.119 MHz/360° (Set Intercept) See Graphs	
3	Output Frequency vs Tuner Rotation	±10 MHz (8.90 to 8.93 GHz) ±5 MHz (8.93 to 9.43 GHz) ±10 MHz (9.43 to 9.46 GHz)	-3.4 MHz (8.90 to 8.93 GHz) -6.3 MHz (8.93 to 9.43 GHz) +15.8 MHz (9.43 to 9.46 GHz) See Graphs	
4	Power Output (Any Frequency)	J1: +10 (+3, -0) dBm J2: 0 (+3, -0) dBm	@ +25 Deg C 11.81 to 13.48 dBm 0.55 to 2.48 dBm @ +50 Deg C 11.61 to 13.41 dBm 2.06 to 3.23 dBm See Graphs	
5	Tuning Element	Starting Torque: 25 inch-oz MAX Withstanding Torque: 100 inch-oz MIN	PASS	PMI QA 1
6	Spurious Harmonic Signals	60 dBc MIN (IN BAND) 45 dBc MIN (OUT OF BAND) 30 dBc MIN (HARMONICS)	> 66.94 dBc > 60.57 dBc > 44.51 dBc	PMI QA 1
7	Noise	See Plots Below	PASS	PMI QA 1
8	Temperature Coefficient	15 kHz/°C MAX from 0°C to +50°C	55 kHz/°C FROM 0 °C TO 40 °C 800 kHz/°C FROM 40 °C TO 50 °C	
9	Long Term Frequency Drift	50 kHz/hr MAX @ any constant temperature from 0°C to +50°C	PASS	PMI QA 1
10	Pulling Factor	<50 kHz	PASS	PMI QA 1
11	Regulator/Oscillator Power Supply	+24±1 VDC @ 1.5 A MAX 2% Regulation, Ripple = 2 mVrms	+24±1 @ 0.172 A	PMI QA 1
12	Heater Power Supply	+24±1 VDC @ 1.5 A MAX 2% Regulation, Ripple = 50 mVrms	+24±1 @ 1.16 A	PMI QA 1
13	Weight	2.4 lbs MAX	3 lbs	

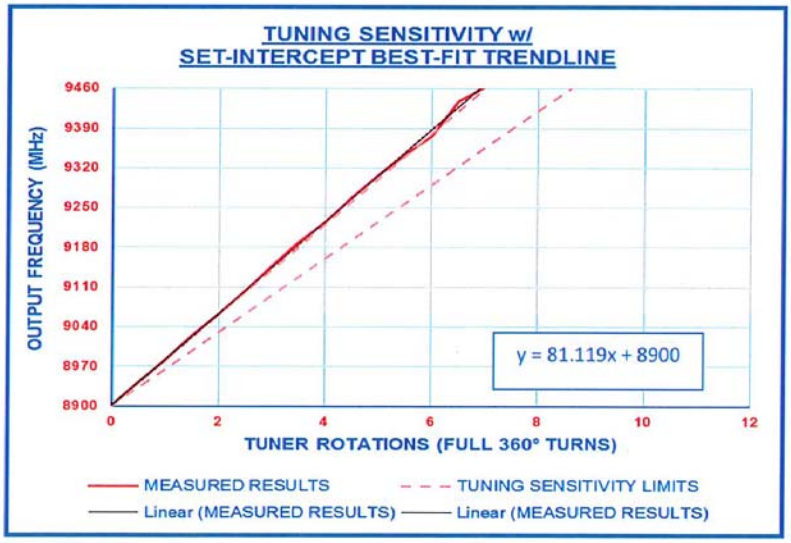
QA/QC Approval: PMI QA 1 **Date:** 2/26/20

7311-F Grove Road Frederick, MD 21704 USA Phone: (301)662-5019 Fax: (301)662-1731
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

TUNING SENSITIVITY





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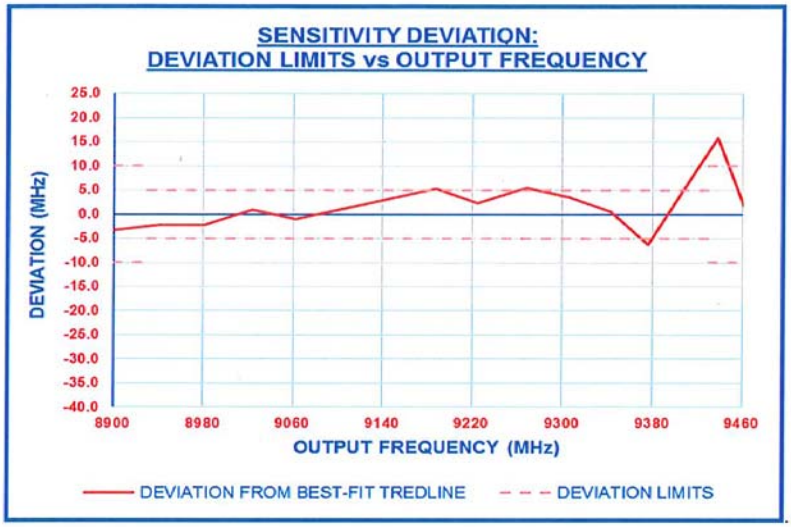
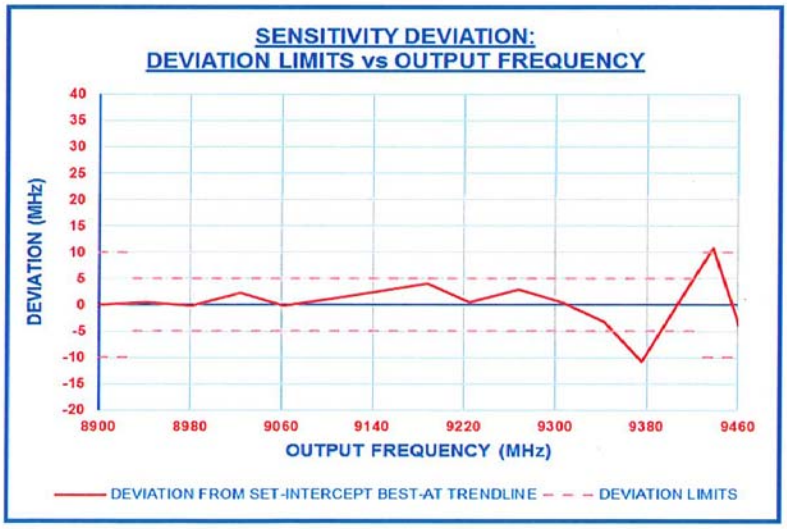
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

SENSITIVITY DEVIATION





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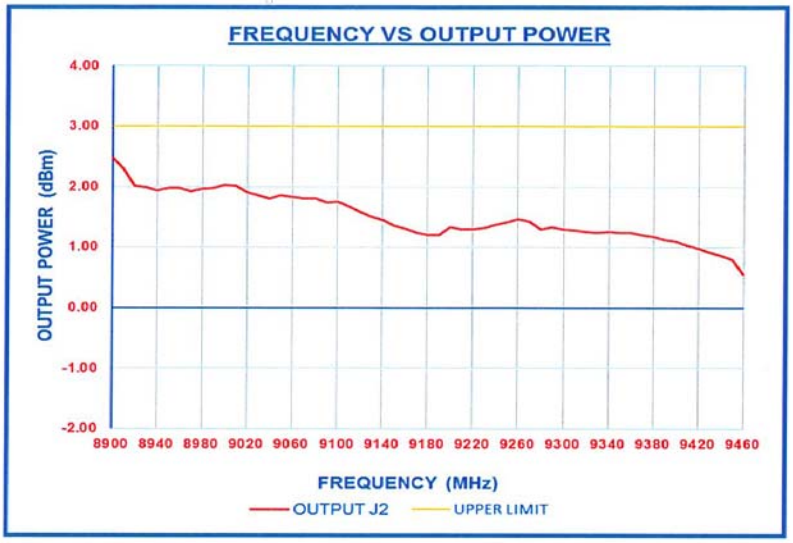
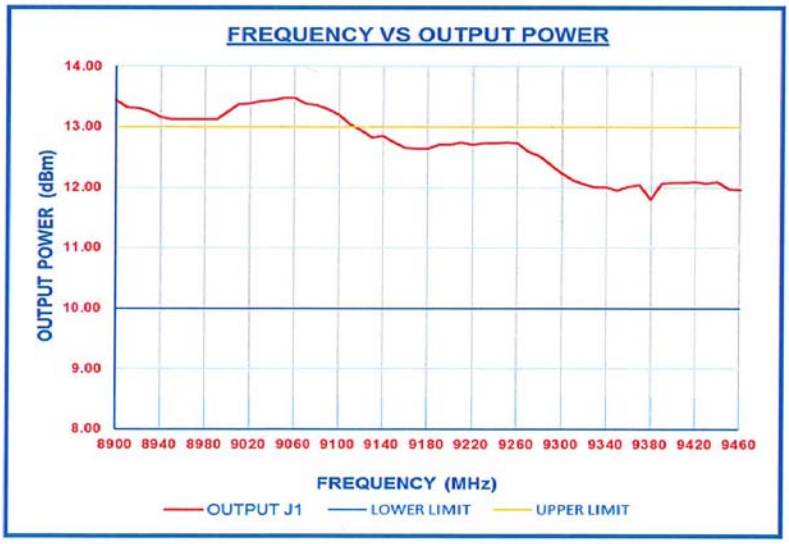
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

OUTPUT POWER @ +25 DEGREES C





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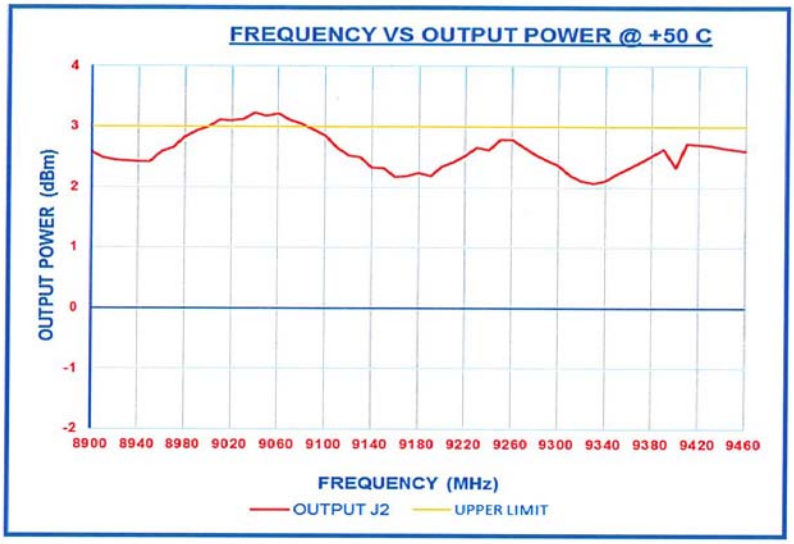
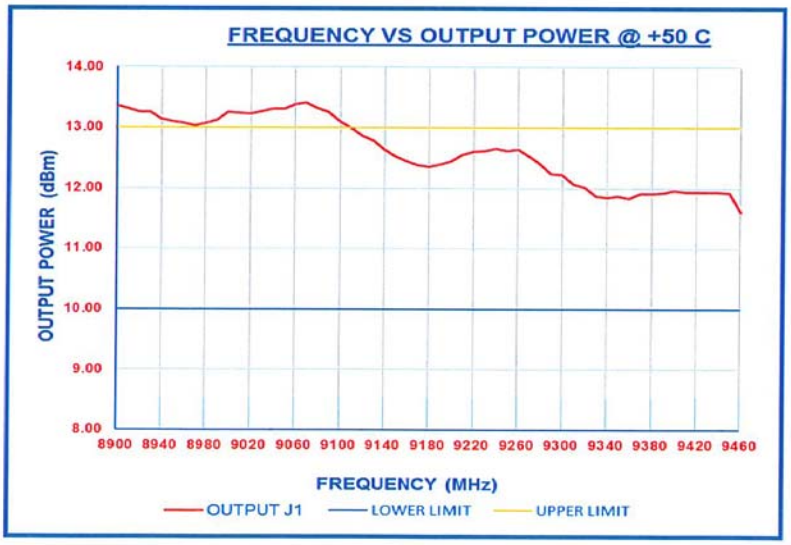
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

OUTPUT POWER @ +50 DEGREES C





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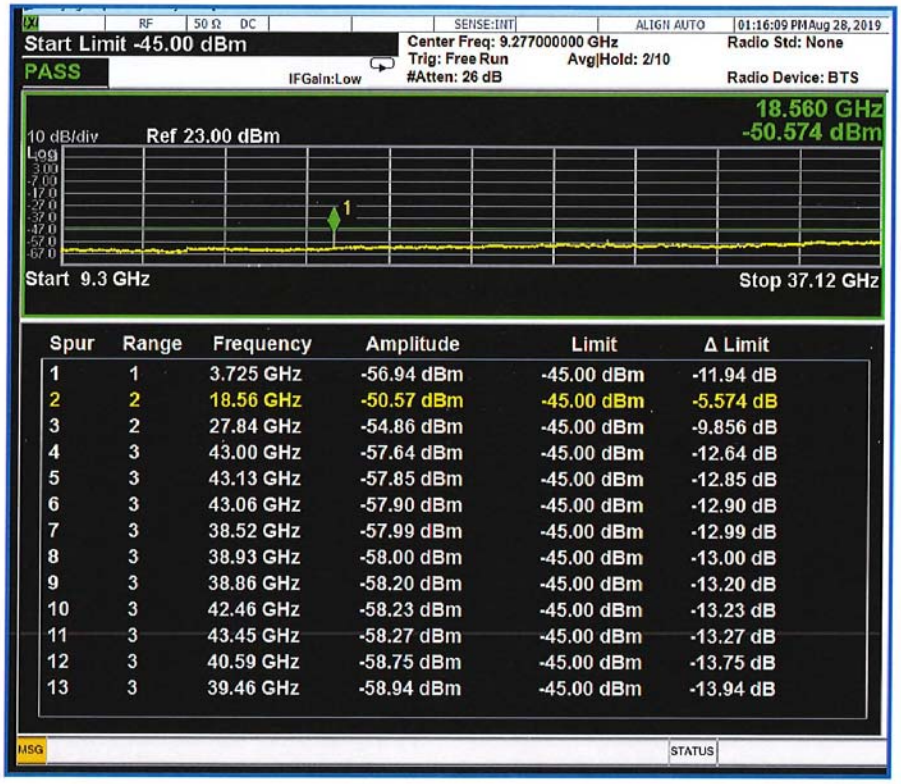
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

SPURIOUS SIGNALS @ 10 dB OUTPUT



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	3.725 GHz	-56.94 dBm	-45.00 dBm	-11.94 dB
2	2	18.56 GHz	-50.57 dBm	-45.00 dBm	-5.574 dB
3	2	27.84 GHz	-54.86 dBm	-45.00 dBm	-9.856 dB
4	3	43.00 GHz	-57.64 dBm	-45.00 dBm	-12.64 dB
5	3	43.13 GHz	-57.85 dBm	-45.00 dBm	-12.85 dB
6	3	43.06 GHz	-57.90 dBm	-45.00 dBm	-12.90 dB
7	3	38.52 GHz	-57.99 dBm	-45.00 dBm	-12.99 dB
8	3	38.93 GHz	-58.00 dBm	-45.00 dBm	-13.00 dB
9	3	38.86 GHz	-58.20 dBm	-45.00 dBm	-13.20 dB
10	3	42.46 GHz	-58.23 dBm	-45.00 dBm	-13.23 dB
11	3	43.45 GHz	-58.27 dBm	-45.00 dBm	-13.27 dB
12	3	40.59 GHz	-58.75 dBm	-45.00 dBm	-13.75 dB
13	3	39.46 GHz	-58.94 dBm	-45.00 dBm	-13.94 dB

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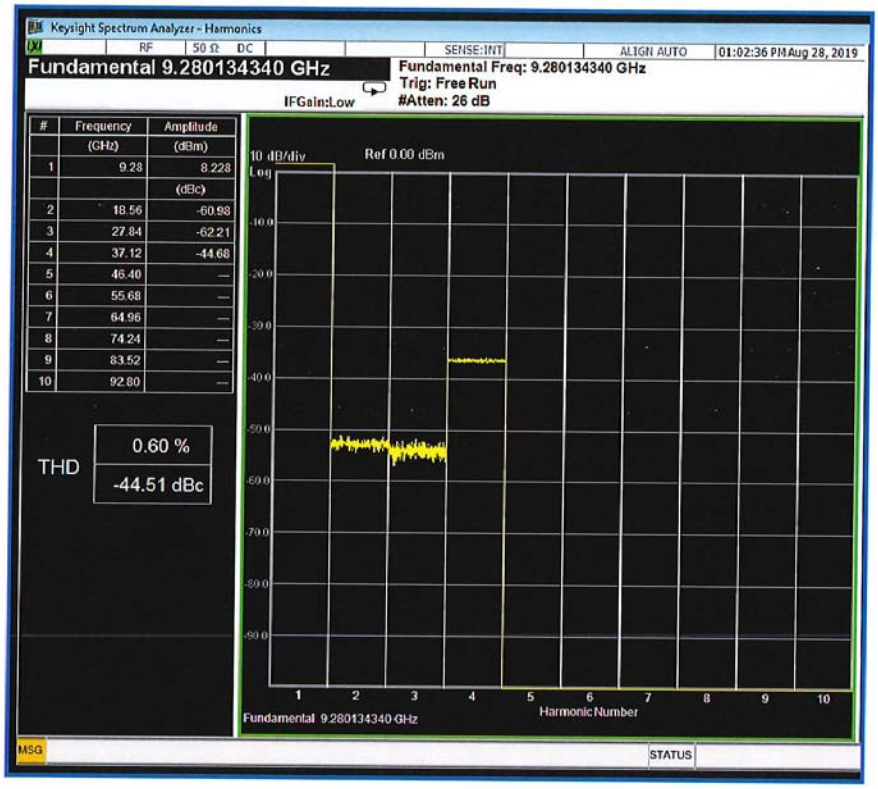
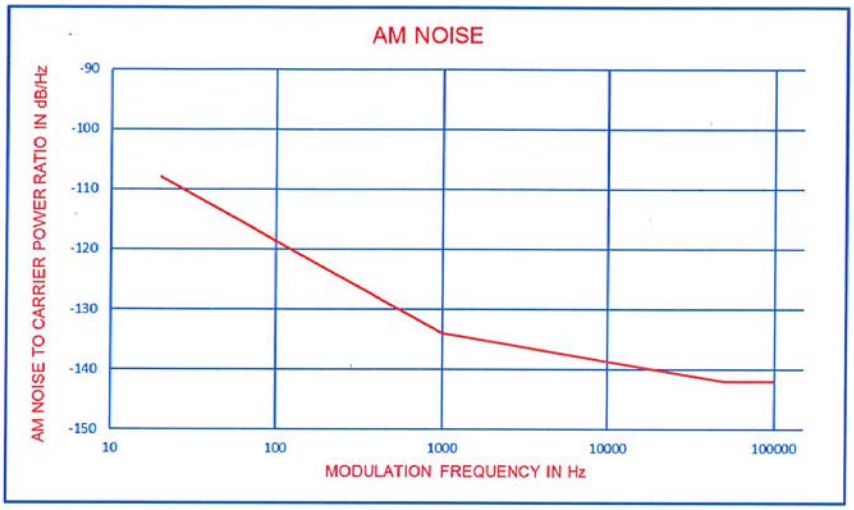
SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1

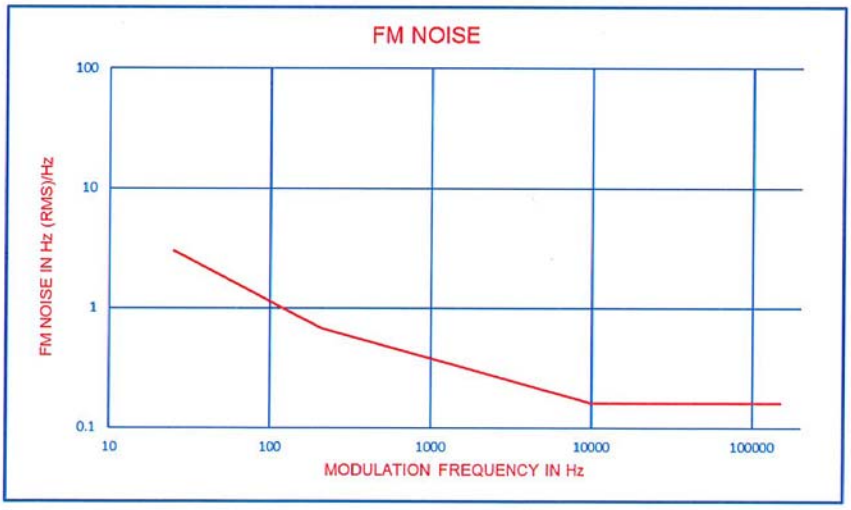
HARMONIC PERFORMANCE



7311-F Grove Road Frederick, MD 21704 USA Phone: (301)662-5019 Fax: (301)662-1731
Email: sales@pmi-rf.com

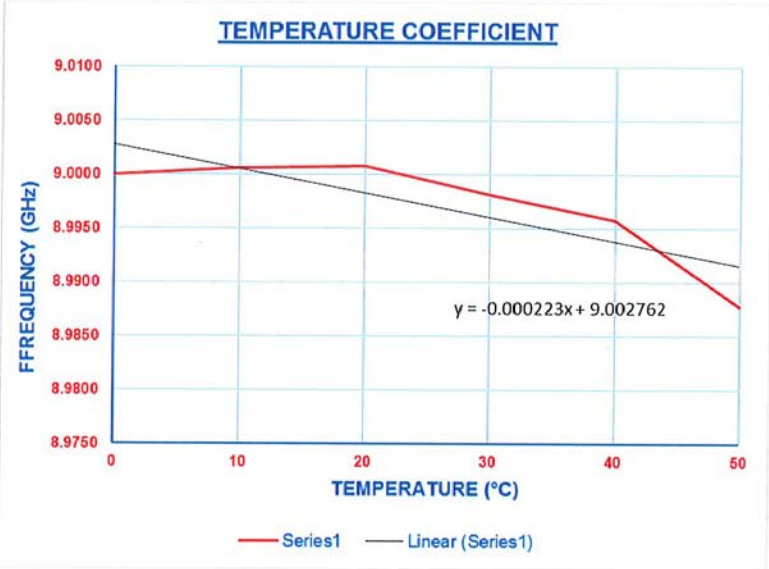
SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1





7311-F Grove Road Frederick, MD 21704 USA Phone: (301)662-5019 Fax: (301)662-1731
Email: sales@pmi-rf.com

SUMMARY TEST DATA
ON
PMTO-8R8G9R56G-CD-1



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Email: sales@pmi-rf.com

APPENDIX F

MECHANICALLY TUNED OSCILLATOR ENVIRONMENTAL REPORT

VIBRATION, SHOCK AND HUMIDITY RESISTANCE TEST REPORT

(SECTIONS 2.12.4 and 2.12.5)

Washington Laboratories, Ltd.

Environmental Test Report

for the

PLANAR MONOLITHICS INDUSTRIES, INC.

PMTO-8R8G9R56G-CD-1

WLL Report # **16421-01 Rev 1**

February 20, 2020

Prepared for:

PLANAR MONOLITHICS INDUSTRIES, INC.

7311-F GROVE RD. #F

FREDERICK, MD 21704

Prepared by:

WASHINGTON LABORATORIES, LTD.

4840 WINCHESTER BLVD., SUITE 5

FREDERICK, MD 21703

Environmental Test Report

for the

PLANAR MONOLITHICS INDUSTRIES, INC.

PMTO-8R8G9R56G-CD-1

WLL Report # **16421-01 Rev 1**

February 20, 2020

Prepared by:

Corey Blackford
Senior Compliance Technician

Reviewed by:

Elmer Rodriguez
Product Safety Service, Manager

ABSTRACT

This report has been prepared on behalf of Planar Monolithics Industries, Inc. to document the findings of the environmental testing performed on the PMTO-8R8G9R56G-CD-1.

This Environmental Test Report provides the test results from testing of the Planar Monolithics Industries, Inc. PMTO-8R8G9R56G-CD-1. Monolithics Industries, Inc. instructions defined the test standards and procedures to be used. The report revision dates and test results are summarized below.

Report Revision	Revision Date	Revision Summary	Revised By	Reviewed By
Rev 1	February 20, 2020	Initial release	--	ER

Test Method	Test Date(s)	Results Summary
Test 1: MIL-F-18870E, Section 4.6.16, Humidity	2/10 – 2/16/2020	Customer verified pass
Test 2: MIL-STD-167A, Section 5.1.2.4, Vibration	2/18 – 2/19/2020	Customer verified pass
Test 3: Shock	2/18 – 2/19/2020	Customer verified pass

Table of Contents

List of Tables

List of Photographs

List of Figures

1 ADMINISTRATIVE

Washington Laboratories, Limited was contracted by Planar Monolithics Industries, Inc. to perform testing on the PMTO-8R8G9R56G-CD-1, under Planar Monolithics Industries, Inc. purchase order number 70200214.

This document describes the test procedures, methodology, equipment, and pass/fail criteria used to perform environmental testing of the Planar Monolithics Industries, Inc. PMTO-8R8G9R56G-CD-1.

1.1 Customer & Customer Representative

Planar Monolithics Industries, Inc.
Jason Peacher
7311-F Grove Rd. #F
Frederick, MD 21704

1.2 Test Specimen Identification

The Planar Monolithics Industries, Inc. PMTO-8R8G9R56G-CD-1 is a temperature stabilized output medium power x-band gunn-effect oscillator for use as an RF simulator signal generator. The unit will be referred to as the Equipment Under Test (EUT) for the remainder of this report.

1.3 Manufacturer

Planar Monolithics Industries, Inc.
7311-F Grove Rd. #F
Frederick, MD 21704

1.4 Requirements Summary

Planar Monolithics Industries, Inc. defined methods, procedures, and details to be used for testing documented in this report, unless otherwise defined in the detailed test results sections. Any deviations from these documents are detailed in Section 2.

1.5 References

- Washington Laboratories Quotation No. 71891A
- MIL-F-18870E, 05-1986, Fire Control Equipment, Naval Ship and Shore, General Specification, Military Specification
- MIL-STD-167A, 11-2005, Mechanical Vibrations of Shipboard Equipment, Department of Defense Standard
- Washington Laboratories Quality Assurance Manual
- ISO 10012-1, Quality Assurance Requirements for Measuring Equipment, dated 2003-04-15
- ISO 17025:2005, General requirements for the competence of testing and calibration laboratories, dated 2005-05-15

1.6 Test and Support Personnel

Washington Laboratories, Ltd: Corey Blackford
Client Representative: Jason Peacher

1.7 Primary Test Location

Unless otherwise noted, all testing carried out by Washington Labs, Ltd. occurred at:

Washington Laboratories, Ltd.
4840 Winchester Blvd., Ste. 5
Frederick, MD 21703

2 EQUIPMENT INFORMATION

2.1 Equipment Configuration

The EUT was comprised of the following equipment:

Table 1: Equipment Configuration

Manufacturer	Model	Description	Serial Number
Planar Monolithics Industries, Inc.	PMTO-8R8G9R56G-CD-1	EUT	PL25587/1920

2.2 Equipment Photograph

2.3 Support Equipment

No support equipment was used during testing.

2.4 PMTO-8R8G9R56G-CD-1 Modifications

No modifications were performed in order to meet the test requirements.

2.5 PMTO-8R8G9R56G-CD-1 Verification Procedure

Post-test EUT visual inspection was performed by Washington Laboratories, Ltd. personnel following each test. No operational checks or verification was performed by Washington Laboratories, Ltd.

Post-test EUT operational checks were performed by Planar Monolithics Industries, Inc. personnel at their site.

3 TEST REQUIREMENTS

3.1 Tests Performed

The test results summary provides a listing of the test performed for this program along with the compliance status. The test suite was defined in the scope of work with the test plan/procedure used to define the detailed test approach.

3.2 Test Instrumentation and Calibration

All test instrumentation required for the tests was furnished by the test laboratory and met the requirements of the test specification. Calibration records of the standards and test instruments are on file at the test location. All test instrumentation identification and calibration due dates, where applicable, used during testing are included in this report.

3.3 Environmental Testing

Environmental testing was carried out per test conditions, equipment, accuracy, tolerances, and levels in each detailed test method section. Specific tailoring, any deviations from, or modifications to the specified test standard is identified below.

4 DEVIATIONS TO THE TEST PLAN

The test procedure was based on the Planar Monolithics Industries, Inc. requirements for the selected test methods. Deviations were necessary during testing, and are detailed below.

4.1 MIL-F-18870E, Section 4.6.16.2, Humidity

MIL-F-18870E specifies the EUT to be operational during humidity testing; however, testing was performed with the EUT unpowered, and returned to Planar Monolithics Industries, Inc. for post-test inspection.

4.2 MIL-STD-167A, Section 5.1.2.4, Vibration

Vibration test parameters were modified from MIL-STD-167A requirements per Planar Monolithics Industries, Inc. instructions. Details are provided in the test section.

5 SUMMARY OF THE TEST RESULTS

Table 2 provides a summary of the test results.

Table 2: Test Results Summary

Test Method	Test Date(s)	Results Summary
Test 1: MIL-F-18870E, Section 4.6.16, Humidity	2/10 – 2/16/2020	Customer verified pass
Test 2: MIL-STD-167A, Section 5.1.2.4, Vibration	2/18 – 2/19/2020	Customer verified pass
Test 3: Shock	2/18 – 2/19/2020	Customer verified pass

6 ENVIRONMENTAL TESTING

6.1 Test 1, MIL-F-18870E, Section 4.6.16, Humidity

EUT Configuration: Configured for operation, unpowered

Test Procedure Reference: N/A

Compliance Requirements: The EUT shall meet internal requirements of Planar Monolithics Industries, Inc. following testing.

Test Engineer(s): C. Blackford

Test Date(s): 2/10 – 2/16/2020

Ambient Conditions: 15 - 22 °C, 21 - 49% RH

EUT S/N: See Section 2.1

Test History: None

Test Procedure

Prior to testing, the EUT was inspected for any visible physical damage. The EUT was then placed into a temperature and humidity chamber at ambient conditions, in its unpackaged configuration but unpowered and with no I/O connections.

The chamber was ramped to 45 °C at 30% RH, and the EUT exposed to these conditions for a minimum of 2 hours. The EUT was then subjected to a temperature and humidity cycle per Section 4.6.16.3, consisting of a 1.5-hour ramp to 60 °C at 95% RH, a 16-hour dwell at these conditions, followed by a 1.5-hour ramp to 30 °C at 95% RH, and an 8-hour dwell at these conditions. This cycle was then repeated 4 times, for a total of 5 24-hour cycles.

The chamber was then ramped to 50 °C over 1 hour. For the following 8-hour dwell, relative humidity was maintained at 50% for the first 2 hours, raised to 90% for the following four hours, and then reduced to 40% for the remainder of the dwell.

Following testing, the EUT was removed from the test chamber and a visual inspection performed.

Calibration Verification

See Table 3 for equipment calibration dates.

Results

At the completion of the test program, the EUT was returned to Planar Monolithics Industries, Inc. for inspection and verification.

Areas of Concern

None

Notes

Photograph 1 shows the test configuration, and Figure 1 shows the test profile.

Table 3: MIL-F-18770E Humidity Calibrated Equipment

Test: Humidity			Date(s): 2/10 – 2/17/2020
Asset #	**Manufacturer & Model**	**Description**	**Calibration Due**
00597	Tenney T10RS1-5	Temp. & Humidity Chamber	10/7/2020
00894	Kestrel 5000	Weather Meter	1/14/2021

Photograph 1: MIL-F-18770E Humidity Test Configuration

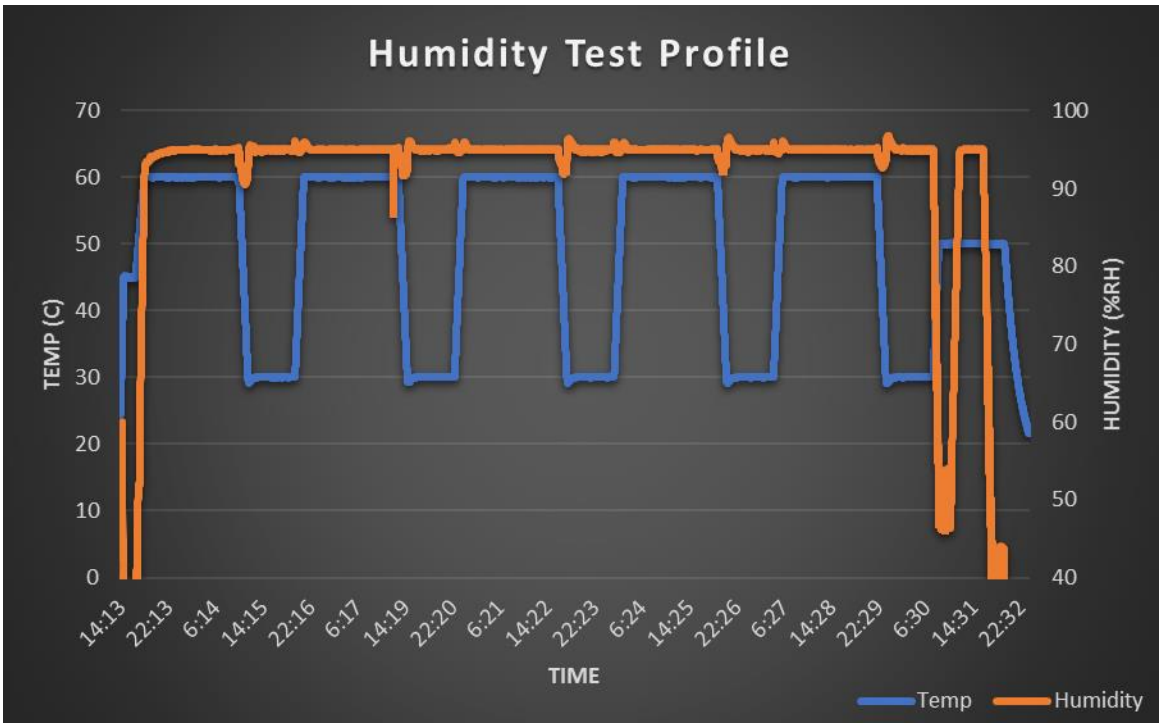


Figure 1: MIL-F-18770E Humidity Test Profile

6.2 Test 2, MIL-STD-167A, Section 5.1.2.4, Vibration

EUT Configuration: Configured for operation, unpowered

Test Procedure Reference: N/A

Compliance Requirements: The EUT shall meet internal requirements of Planar Monolithics Industries, Inc. following testing.

Test Engineer(s): C. Blackford

Test Date(s): 2/18 – 2/19/2020

Ambient Conditions: 13 - 16 °C, 38 - 42% RH

EUT S/N: See Section 2.1

Test History: Humidity

Test Procedure

Prior to testing, the EUT was inspected for any visible physical damage. The EUT, in its unpackaged configuration but unpowered and with no I/O connections, was rigidly affixed to the vibration table. A triaxial accelerometer was placed on the EUT to monitor vibration response, and two single-axis accelerometers were placed on the vibration table near the EUT to act as weighted-average controls. Testing was performed in each of three mutually perpendicular axes (X, Y, and Z; longitudinal, transverse, and vertical, respectively), and all testing was completed in each axis before testing in the following axis was started.

Test frequencies and levels were modified per Planar Monolithics Industries, Inc. request. For all tests, the low frequency was modified from 4 Hz to 7 Hz, and the double-amplitude displacement changed to 0.014" (±0.001") from 0.02". Due to mechanical limits of the vibration table in relation to the revised profile levels, the low frequency was changed to 8 Hz. Endurance level testing was limited to 1 hour total for up to three identified resonant frequencies in each axis.

A low-level sine sweep was performed per MIL-STD 167A, Section 5.1.4.2.4, Exploratory Vibration Test. This profile consisted of a sine sweep from 8 – 33 Hz, with a double-amplitude displacement of 0.014" and a sweep rate of 0.67 octaves/minute.

Following the low-level sine sweep, a second sine sweep was performed per MIL-STD 167A, Section 5.1.4.2.3, Variable Frequency Test. This profile consisted of a sine sweep per MIL-STD 167A, using profile amplitude data identical to the exploratory vibration test, and a dwell of 5 minutes at each discrete whole frequency between 8 – 33 Hz.

Following both sine sweep tests, response data was analyzed to determine the resonant frequency of the EUT. No resonant frequency was observed in any of the three axes tested; as such, per MIL-STD-167A requirements, 33 Hz was selected as the dwell frequency. The dwell time was 1 hour in each axis, per Planar Monolithics Industries, Inc. requirements.

Following testing in each axis, the EUT was removed from the vibration table and a visual inspection performed.

Calibration Verification

See

Table 4 for equipment calibration dates.

Results

At the completion of the test program, the EUT was returned to Planar Monolithics Industries, Inc. for inspection and verification.

Areas of Concern

None

Notes

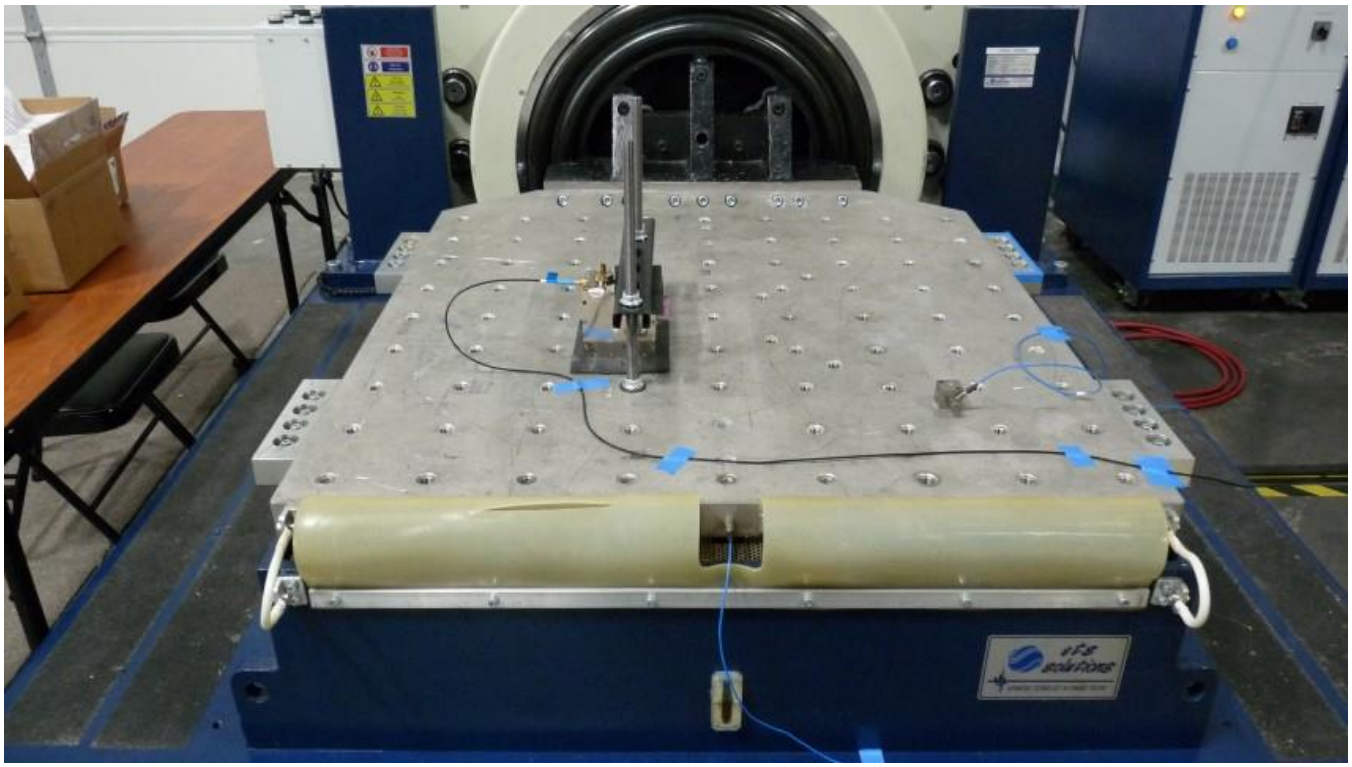
Photograph 2 - Photograph 4 show the test configurations, and Photograph 5 shows the response accelerometer location.

Figure 2 shows the vibration test profile, Figure 3 - Figure 5 show the exploratory vibration test EUT responses, and Figure 6 - Figure 8 show the variable vibration test EUT responses.

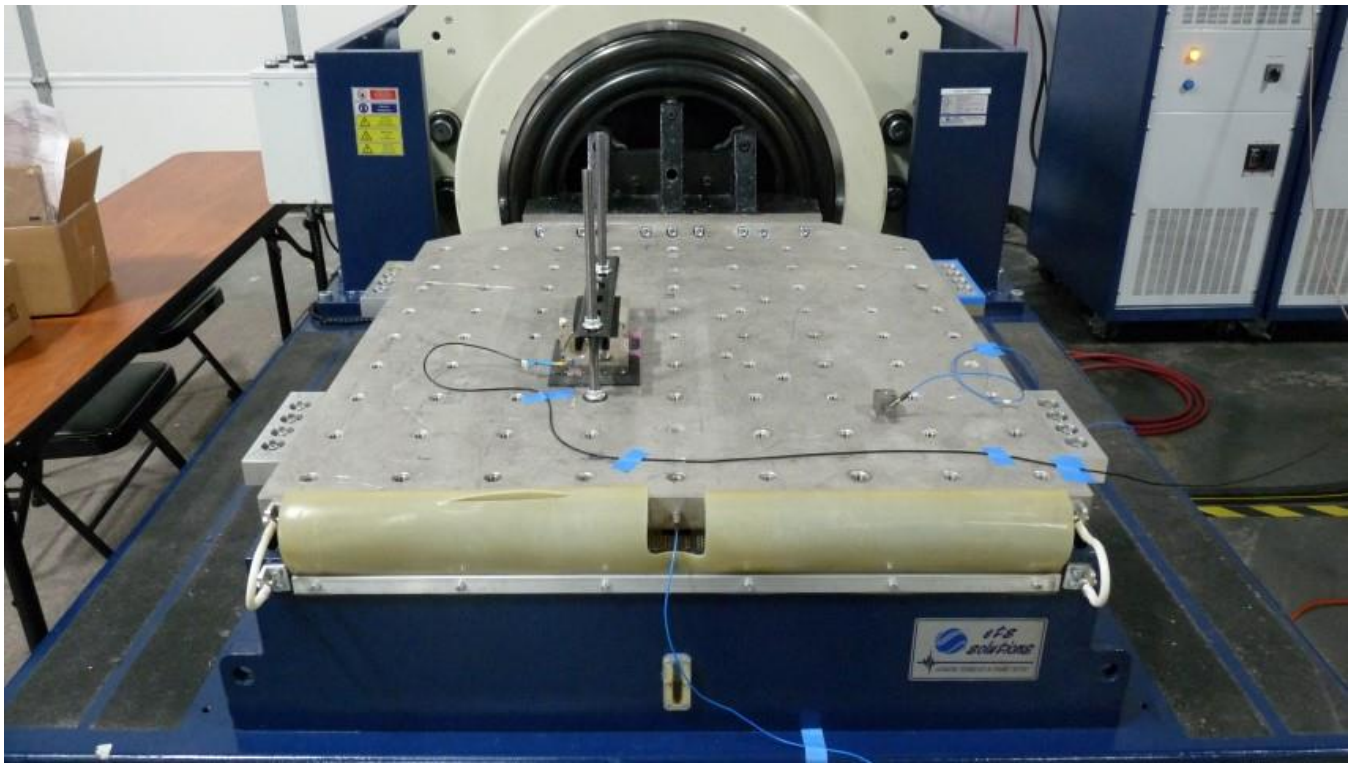
Table 4: MIL-STD-167A Vibration Calibrated Equipment

Test: Vibration			**Date(s): 2/18 – 2/19/2020**
Asset #	**Manufacturer & Model**	**Description**	**Calibration Due**
00908	ETS IPA 120H	Vibration Amplifier	CNR
00909	ETS LS748A/GT900M	Vibration Table	CNR
00672	Dactron LAS200	Vibration Controller	7/10/2020
00107	PCB Piezotronics 353B03	Single-axis Accelerometer	6/25/2020
00907	Dytran 3030B4	Single-axis Accelerometer	6/25/2020
00718	Dytran 3023A	Triaxial Accelerometer	6/25/2020
00894	Kestrel 5000	Weather Meter	1/14/2021

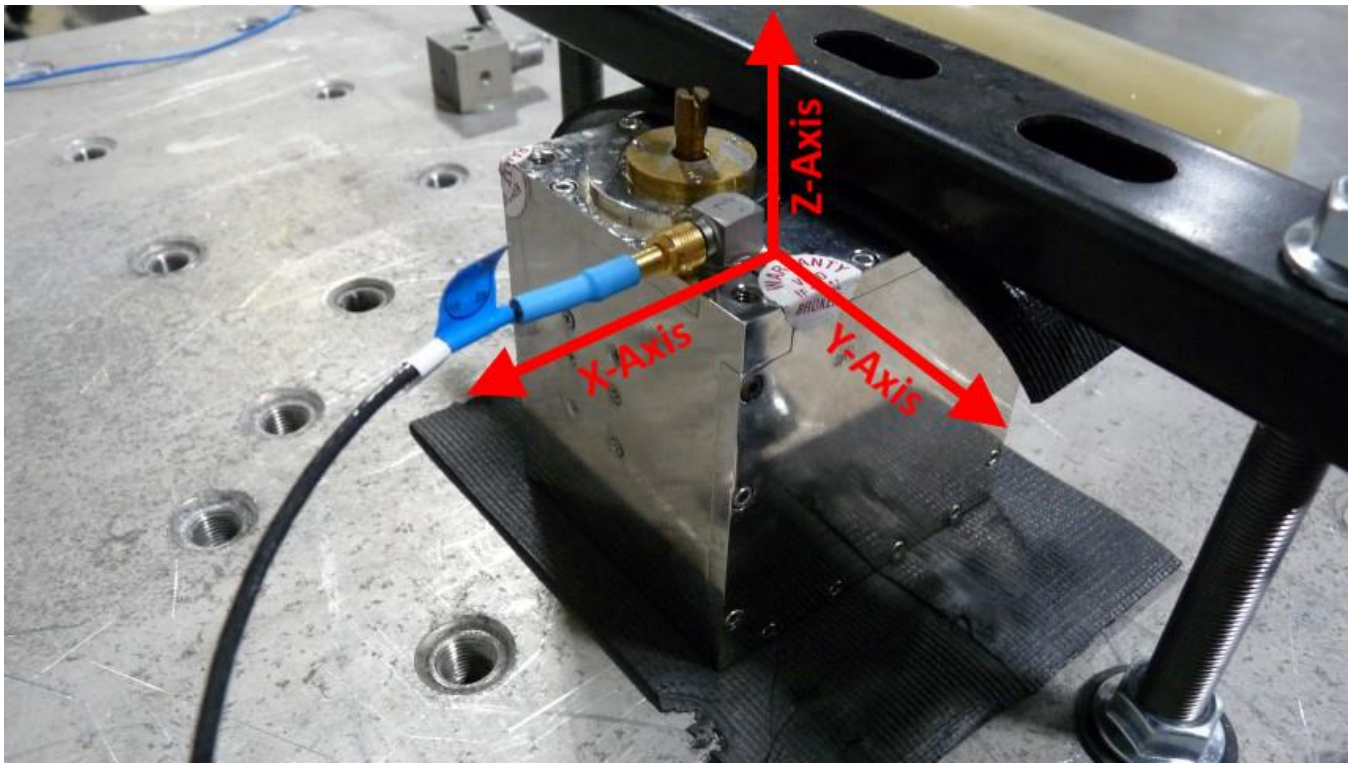
Photograph 2: MIL-STD-167A Vibration & Shock Test, X-Axis Configuration



Photograph 3: MIL-STD-167A Vibration & Shock Test, Y-Axis Configuration



Photograph 4: MIL-STD-167A Vibration & Shock Test, Z-Axis Configuration



Photograph 5: MIL-STD-167A Vibration & Shock Test, Response Accelerometer Detail

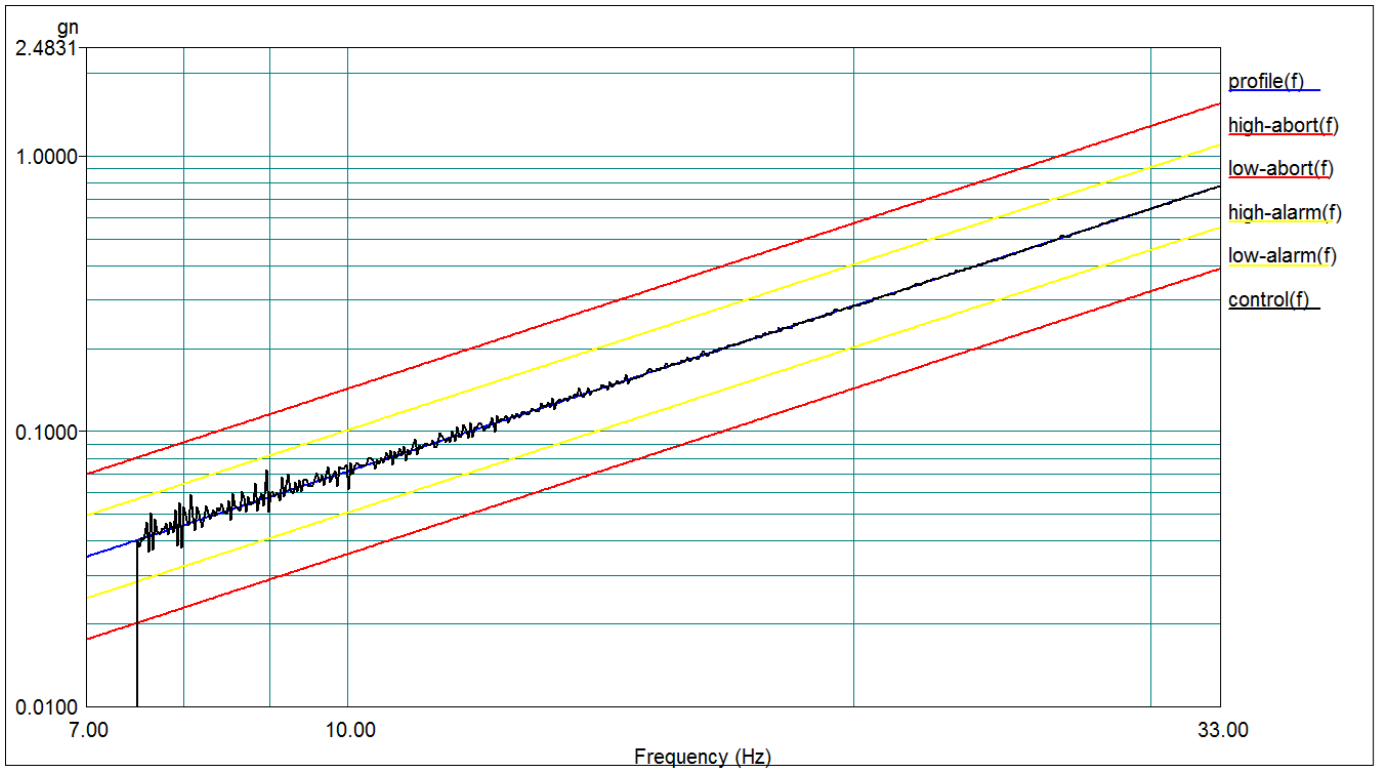


Figure 2: MIL-STD-167A Exploratory & Variable Vibration Test Profile

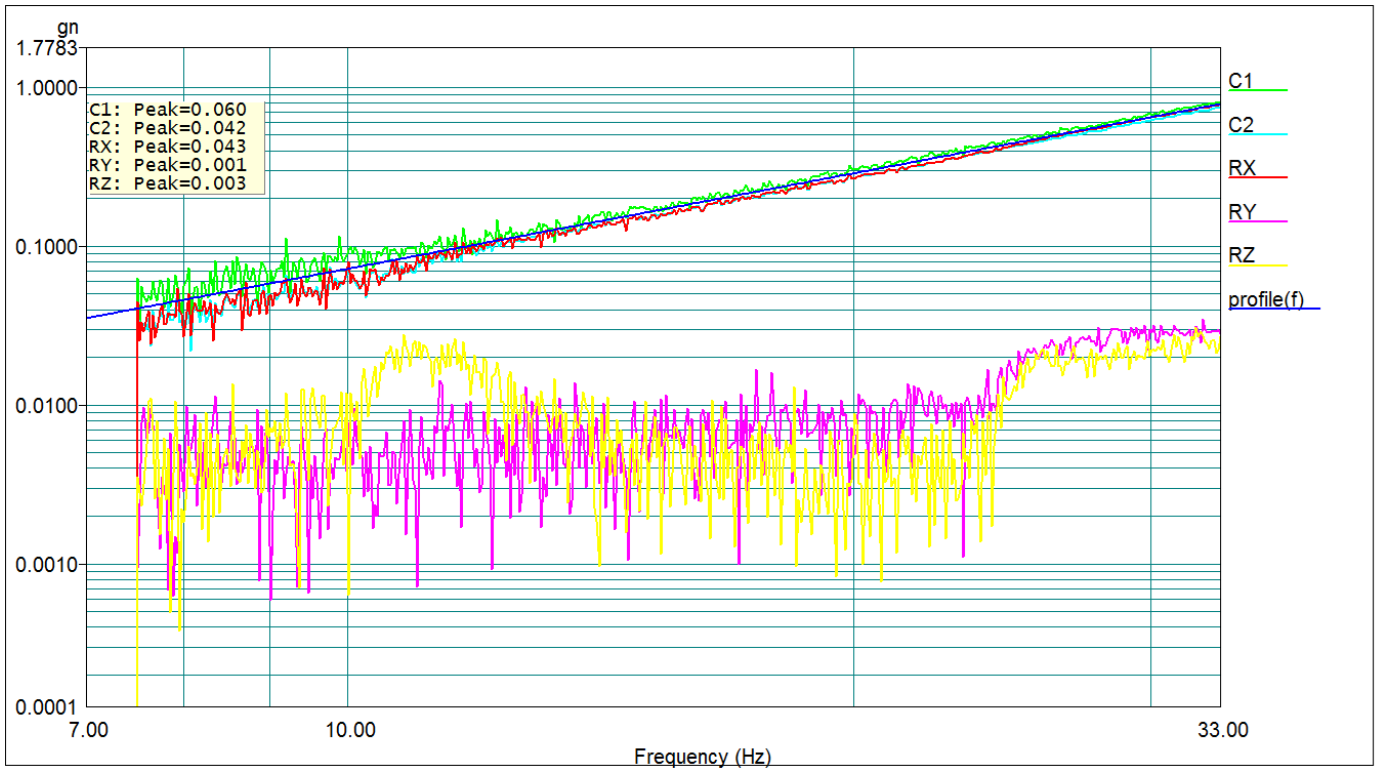


Figure 3: MIL-STD-167A Exploratory Vibration Test, X-Axis EUT Response

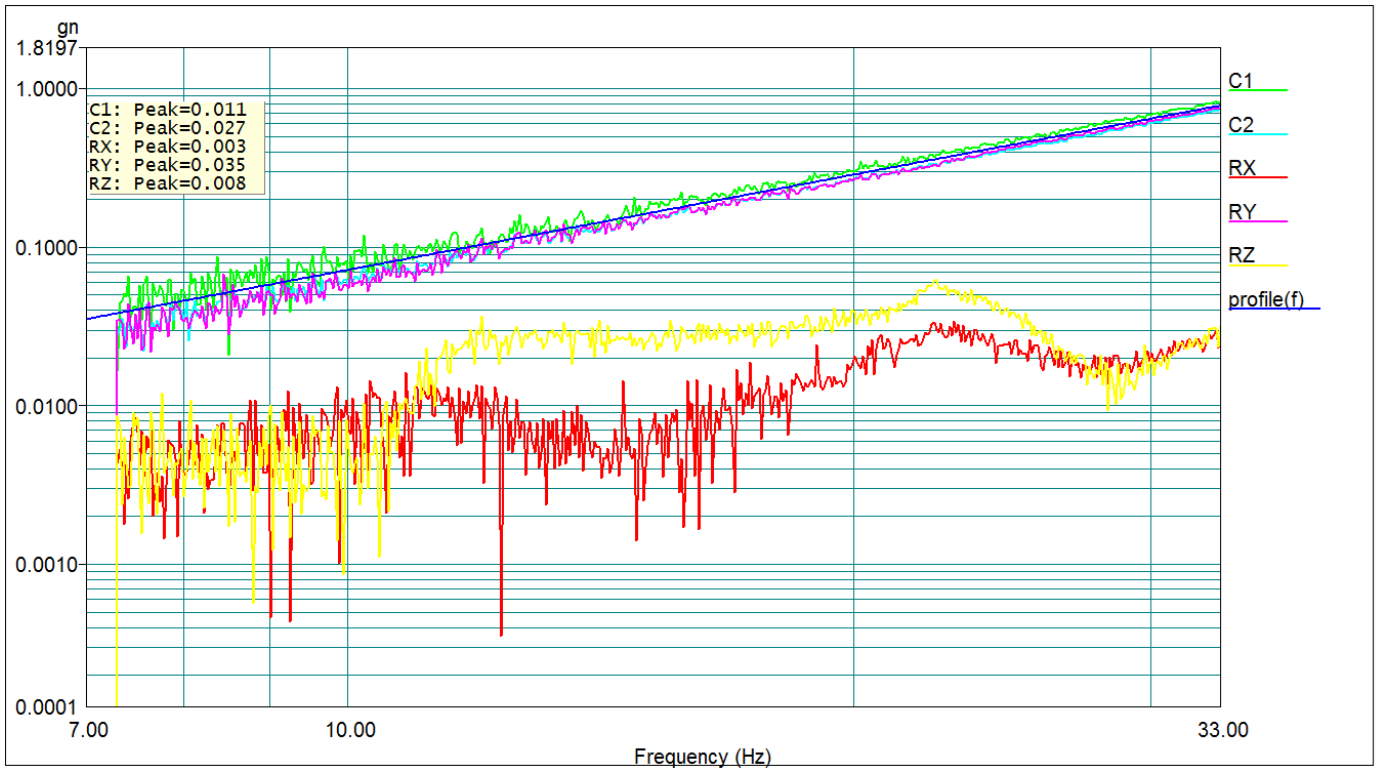


Figure 4: MIL-STD-167A Exploratory Vibration Test, Y-Axis EUT Response

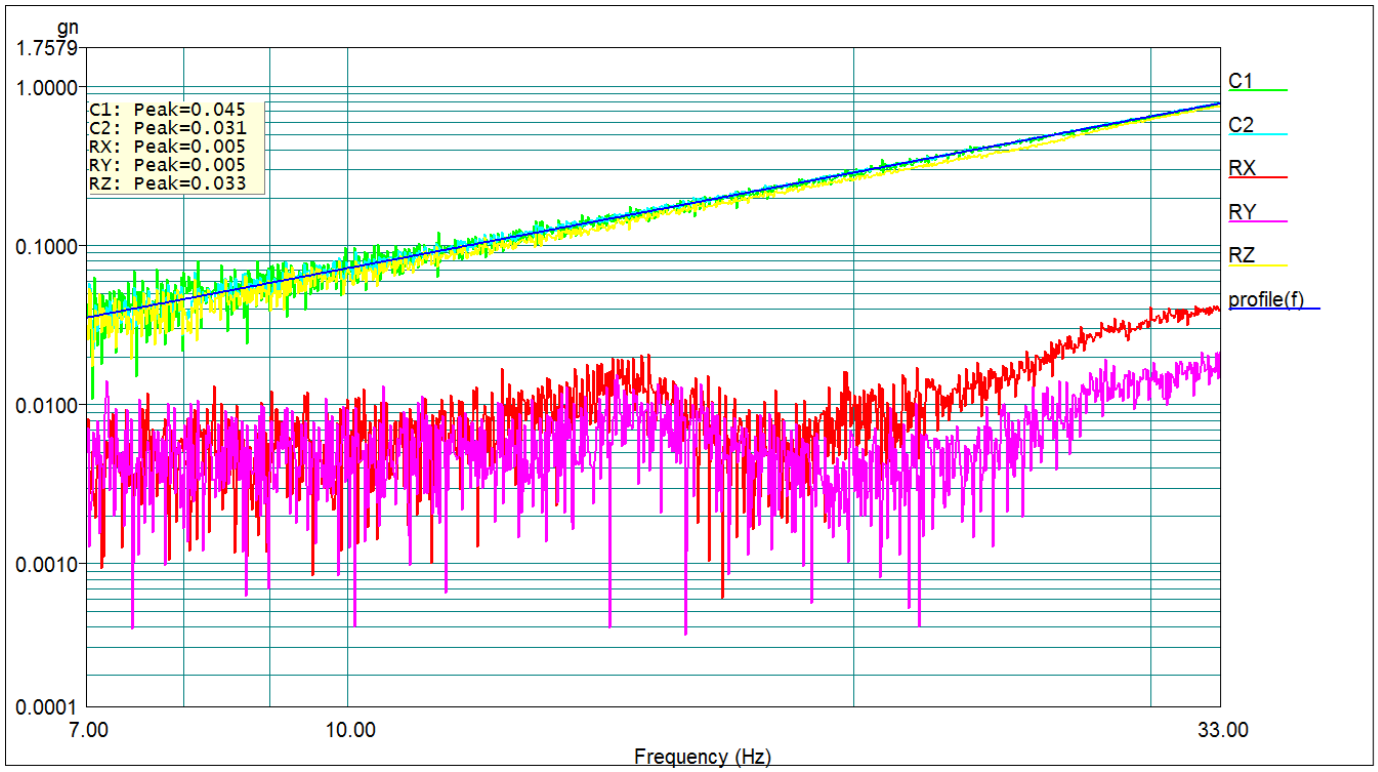


Figure 5: MIL-STD-167A Exploratory Vibration Test, Z-Axis EUT Response

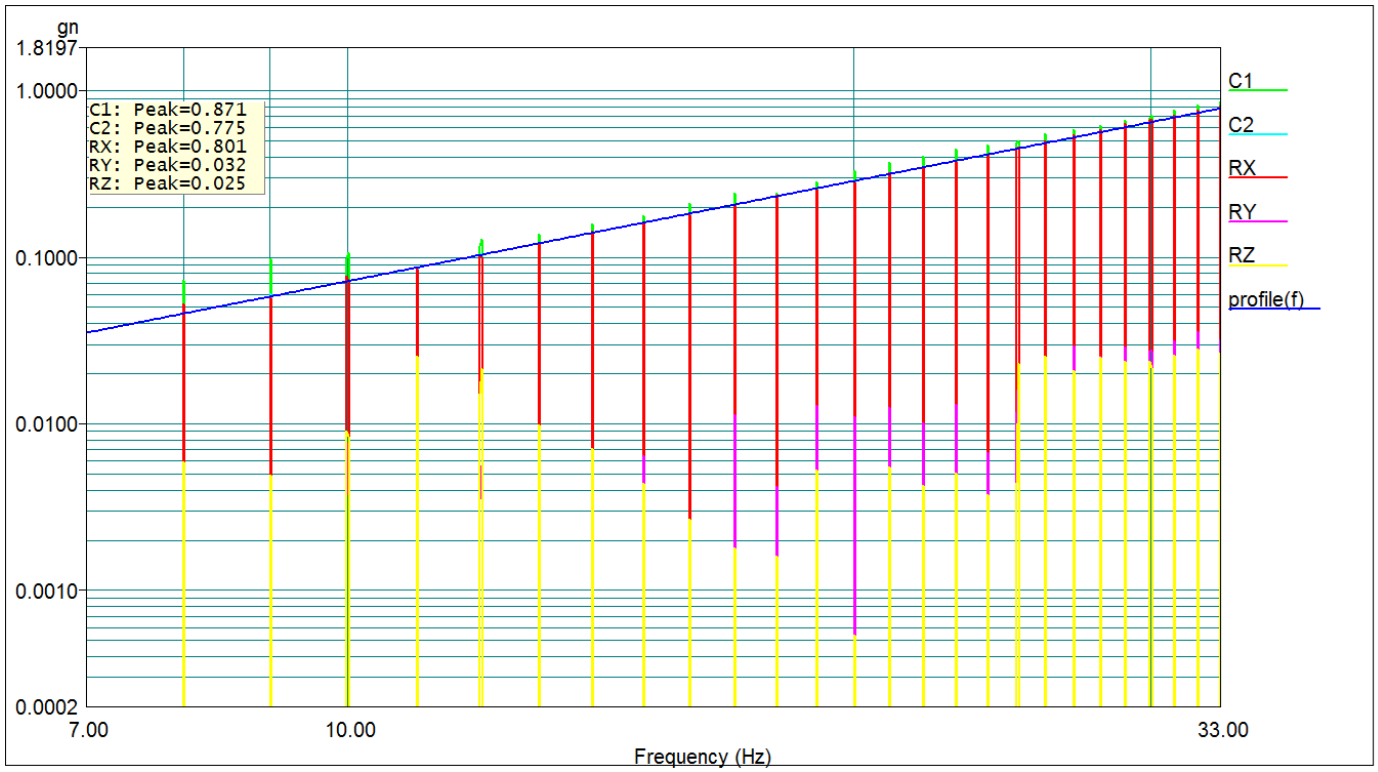


Figure 6: MIL-STD-167A Variable Vibration Test, X-Axis EUT Response

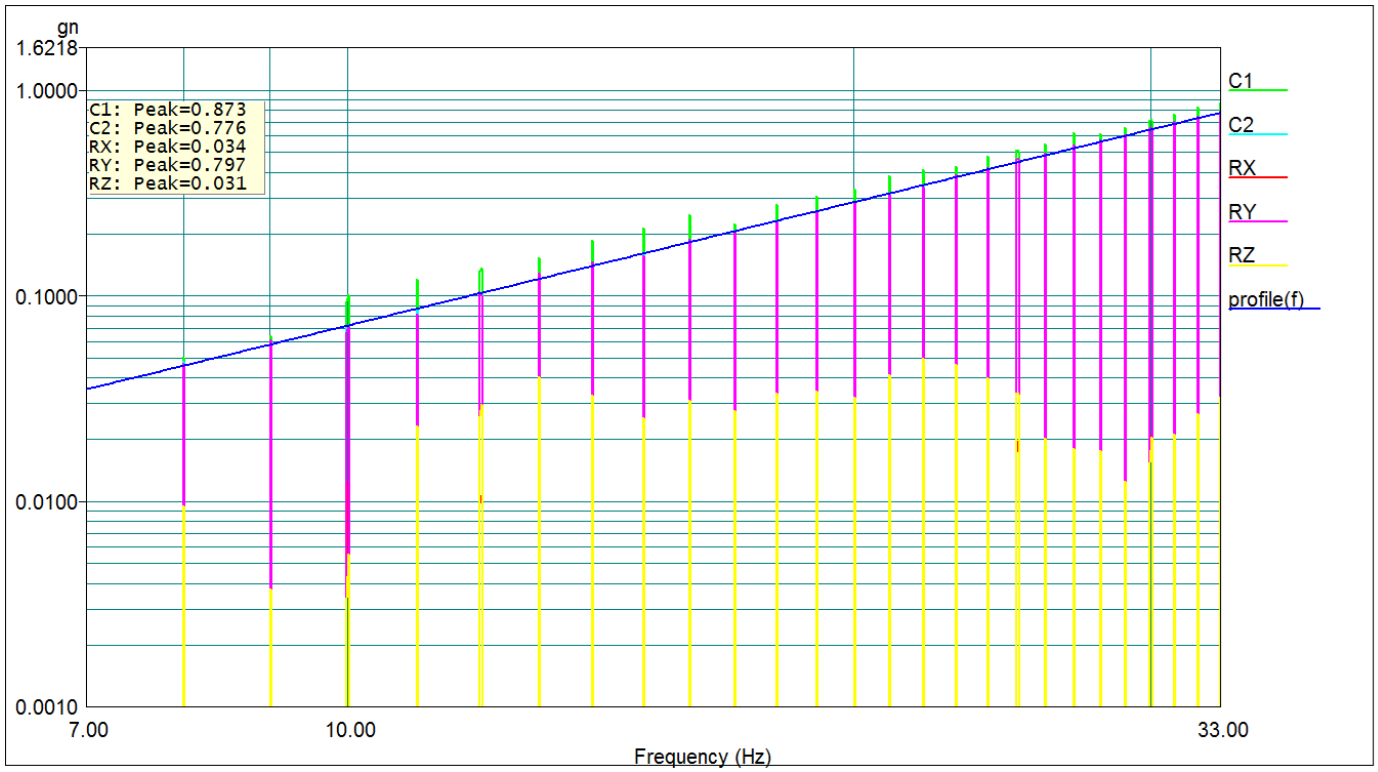


Figure 7: MIL-STD-167A Variable Vibration Test, Y-Axis EUT Response

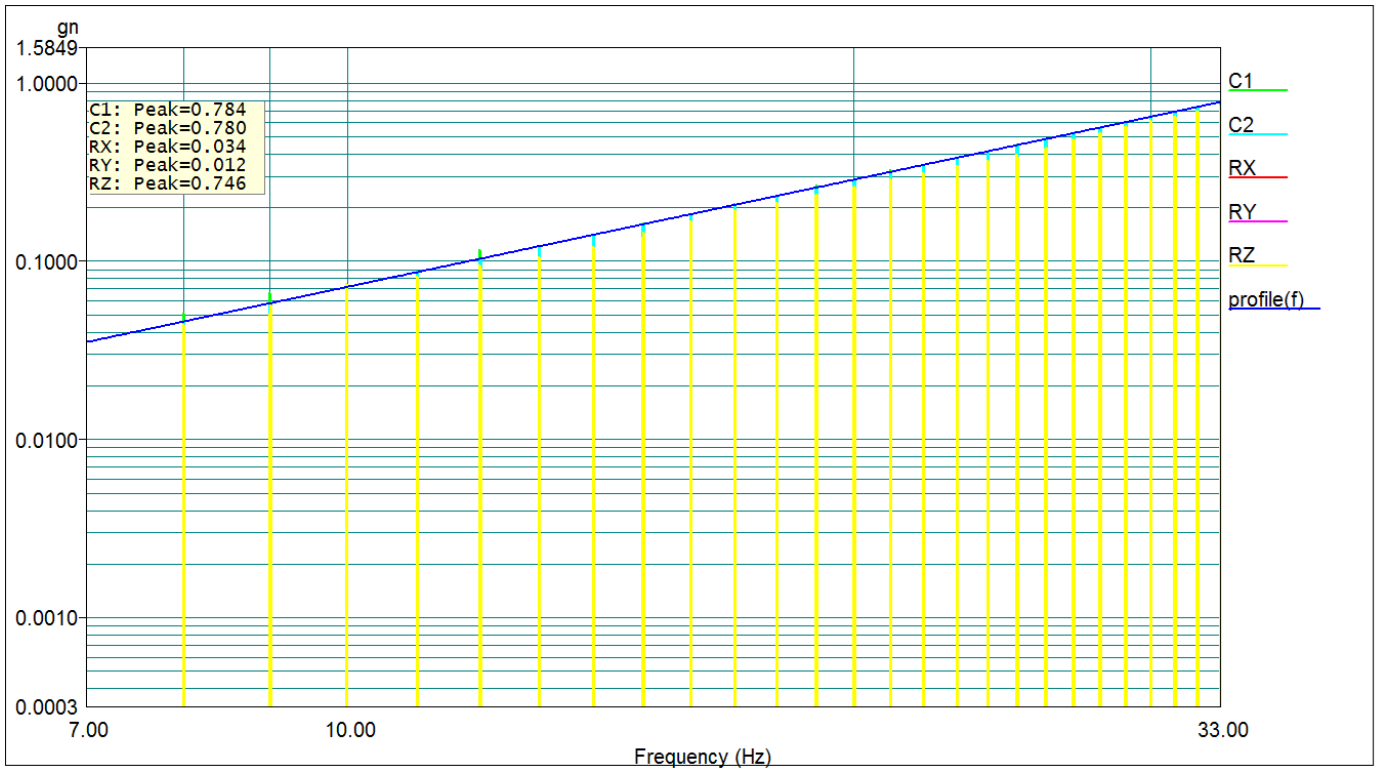


Figure 8: MIL-STD-167A Variable Vibration Test, Z-Axis EUT Response

6.3 Test 3, Shock

EUT Configuration: Configured for operation, unpowered

Test Procedure Reference: N/A

Compliance Requirements: The EUT shall meet internal requirements of Planar Monolithics Industries, Inc. following testing.

Test Engineer(s): C. Blackford

Test Date(s): 2/18 – 2/19/2020

Ambient Conditions: 13 - 16 °C, 38 - 42% RH

EUT S/N: See Section 2.1

Test History: Humidity, Vibration

Test Procedure

Prior to testing, the EUT was inspected for any visible physical damage. The EUT, in its unpackaged configuration but unpowered and with no I/O connections, was rigidly affixed to the vibration table. A triaxial accelerometer was placed on the EUT to monitor vibration response, and two single-axis accelerometers were placed on the vibration table near the EUT to act as weighted-average controls.

The EUT was subjected to a shock test consisting of a 30G, 11ms half-sine pulse, applied three times per direction in each axis (18 total shock pulses).

Following testing in each axis, the EUT was removed from the vibration table and a visual inspection performed.

Calibration Verification

See Table 5 for equipment calibration dates.

Results

At the completion of the test program, the EUT was returned to Planar Monolithics Industries, Inc. for inspection and verification.

Areas of Concern

None

Notes

Photograph 2 - Photograph 4 show the test configurations, and Photograph 5 shows the response accelerometer location.

Figure 9 & Figure 10 show the shock test profiles, and Figure 11 - Figure 16 show the shock test EUT responses.

Table 5: Shock Calibrated Equipment

Test: Shock			Date(s): 2/18 – 2/19/2020
Asset #	**Manufacturer & Model**	**Description**	**Calibration Due**
00908	ETS IPA 120H	Vibration Amplifier	CNR
00909	ETS LS748A/GT900M	Vibration Table	CNR
00672	Dactron LAS200	Vibration Controller	7/10/2020
00107	PCB Piezotronics 353B03	Single-axis Accelerometer	6/25/2020
00907	Dytran 3030B4	Single-axis Accelerometer	6/25/2020
00718	Dytran 3023A	Triaxial Accelerometer	6/25/2020
00894	Kestrel 5000	Weather Meter	1/14/2021

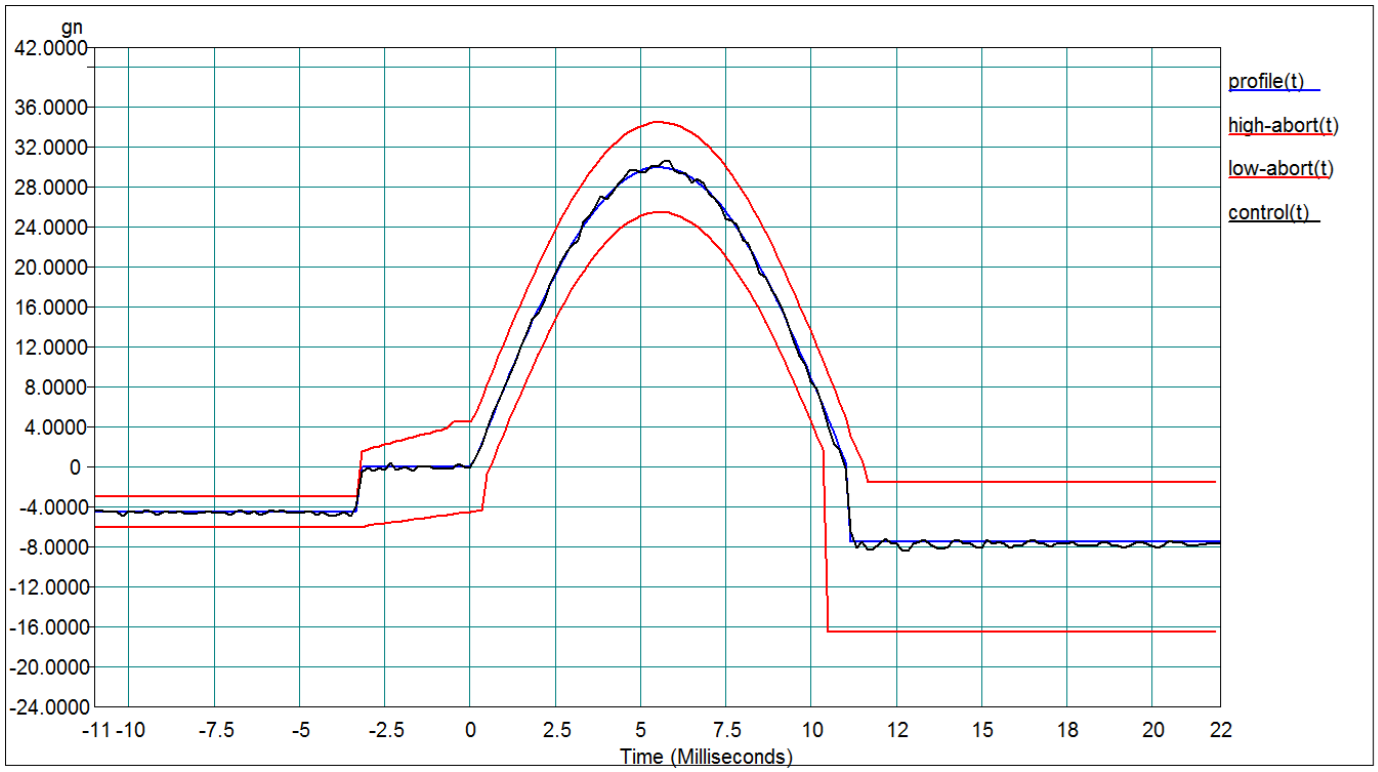


Figure 9: Shock Test Profile, Positive Pulse

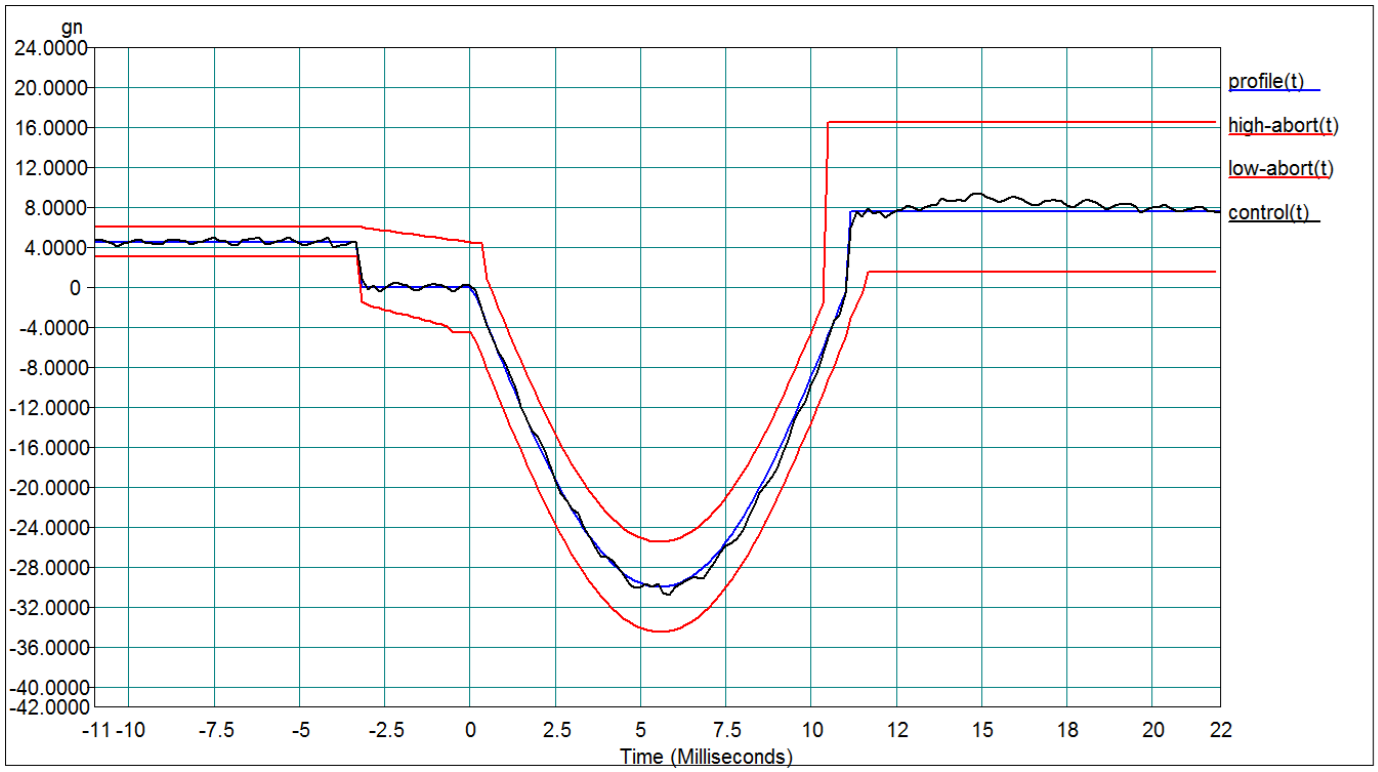


Figure 10: Shock Test Profile, Inverse Pulse

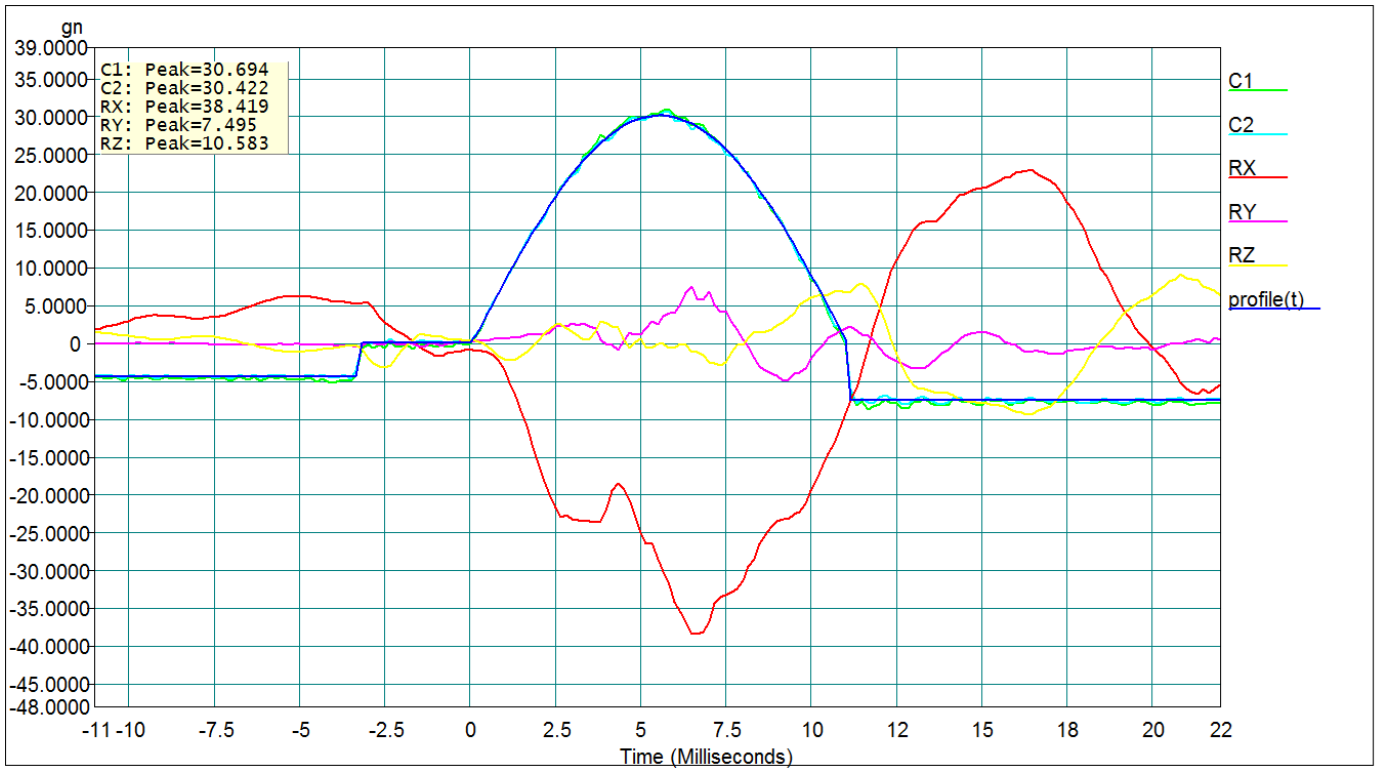


Figure 11: X-Axis Shock, Positive Pulse EUT Response

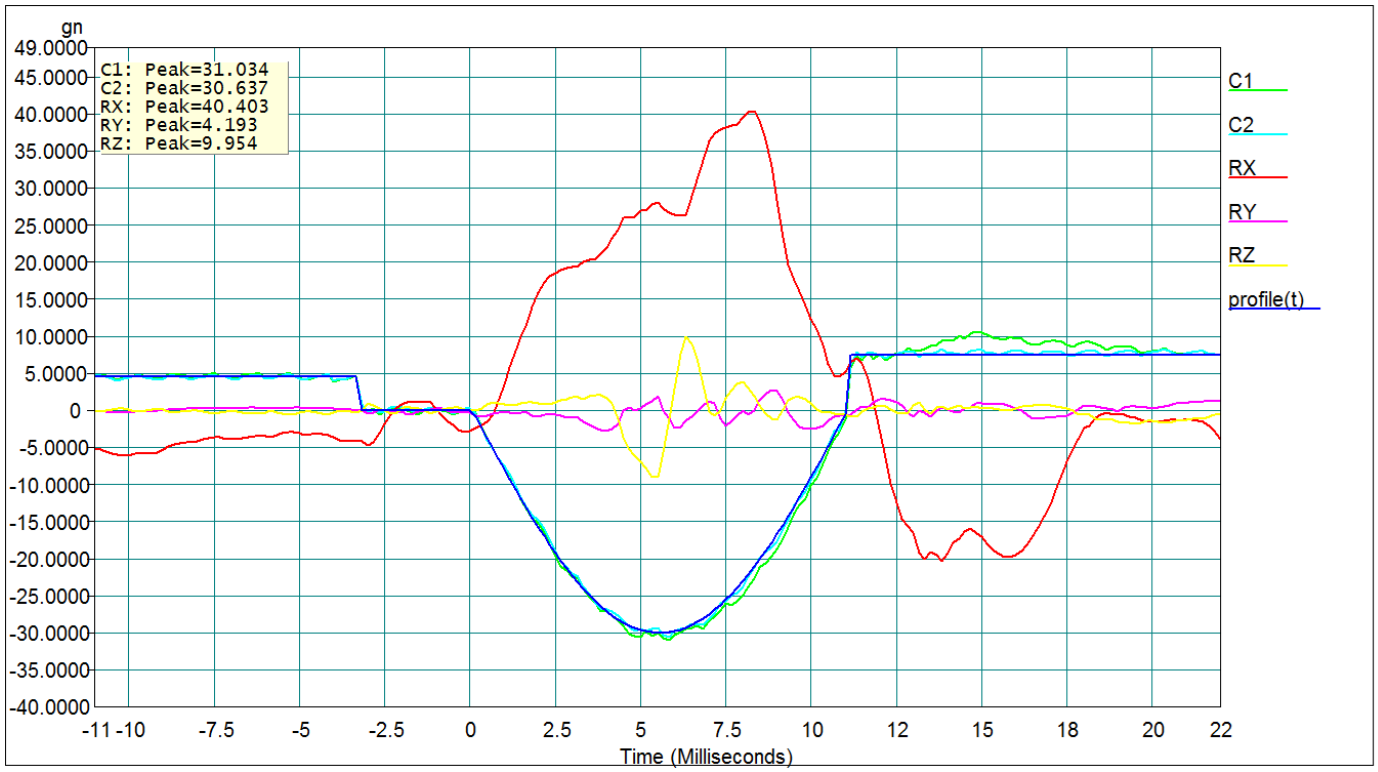


Figure 12: X-Axis Shock, Inverse Pulse EUT Response

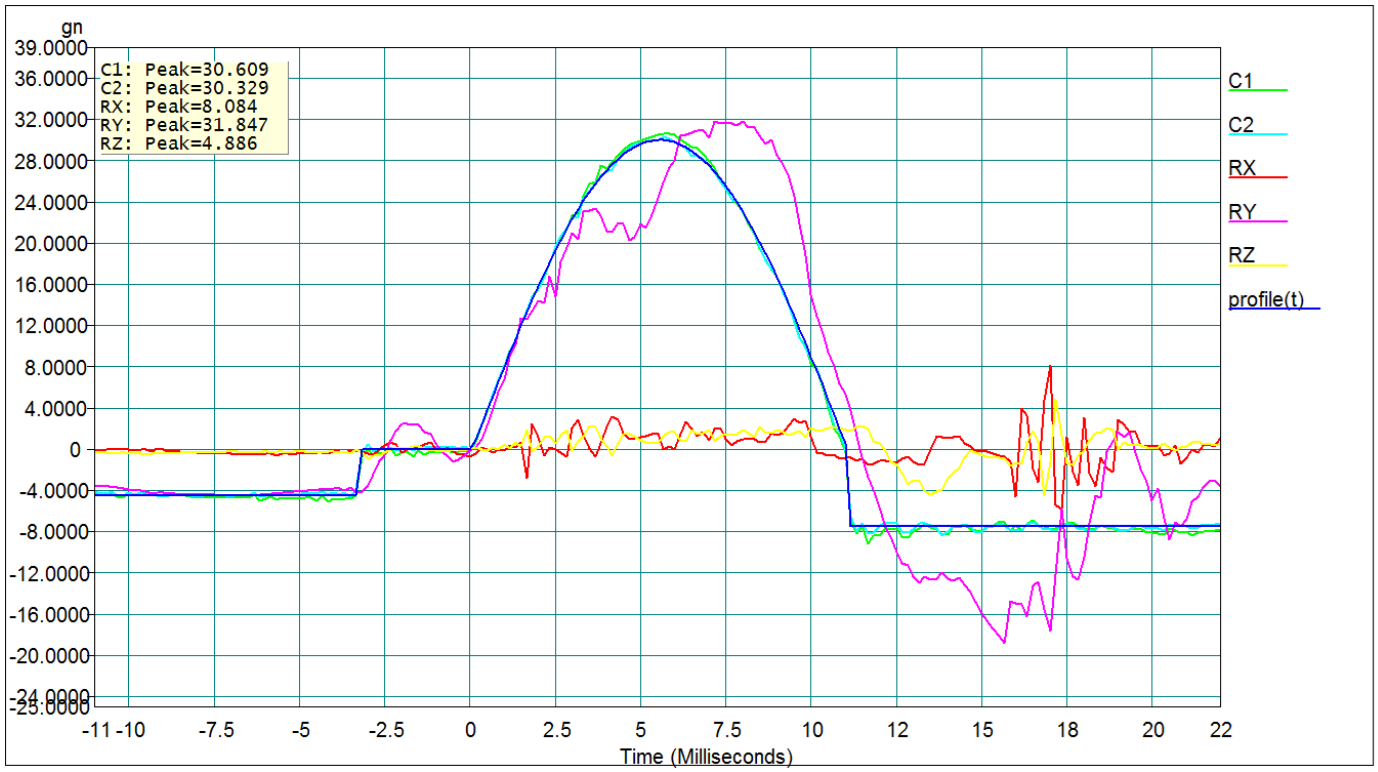


Figure 13: Y-Axis Shock, Positive Pulse EUT Response

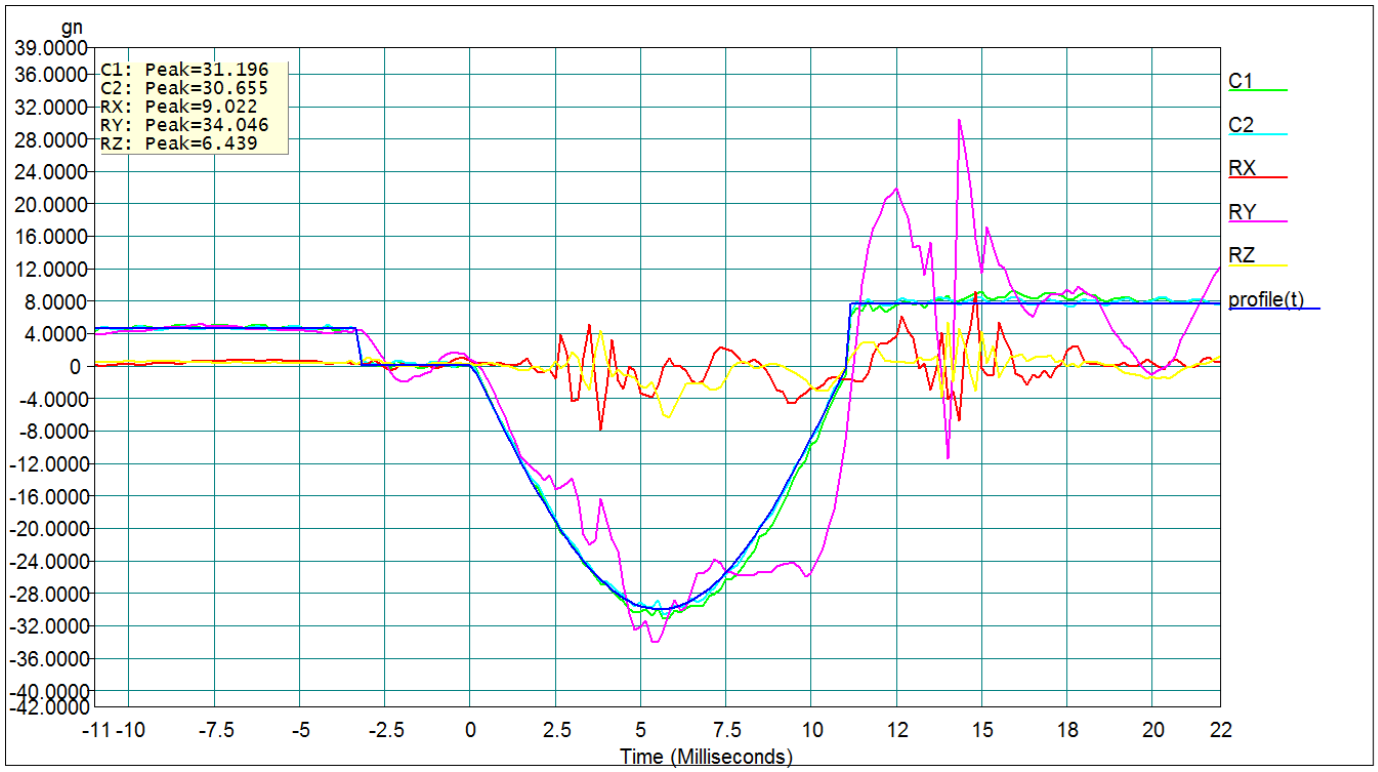


Figure 14: Y-Axis Shock, Inverse Pulse EUT Response

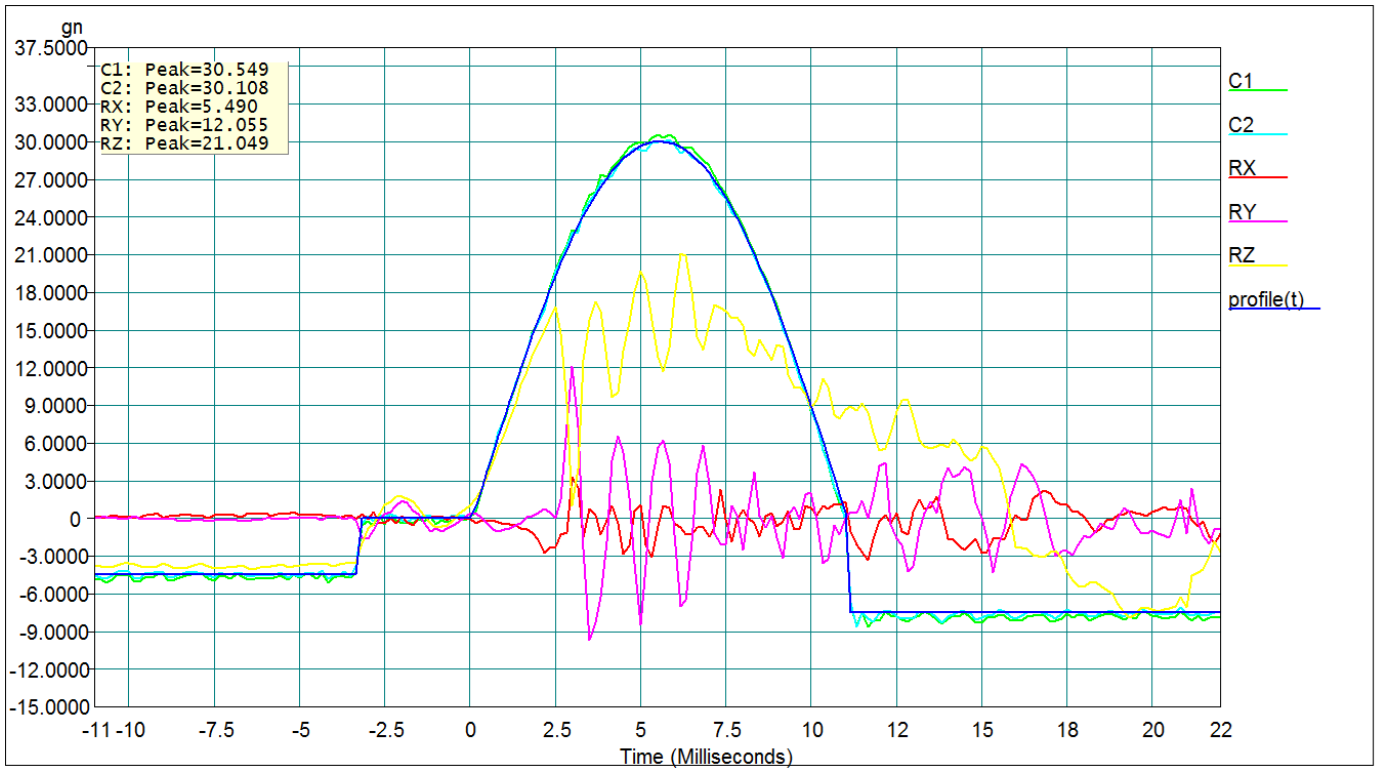


Figure 15: Z-Axis Shock, Positive Pulse EUT Response

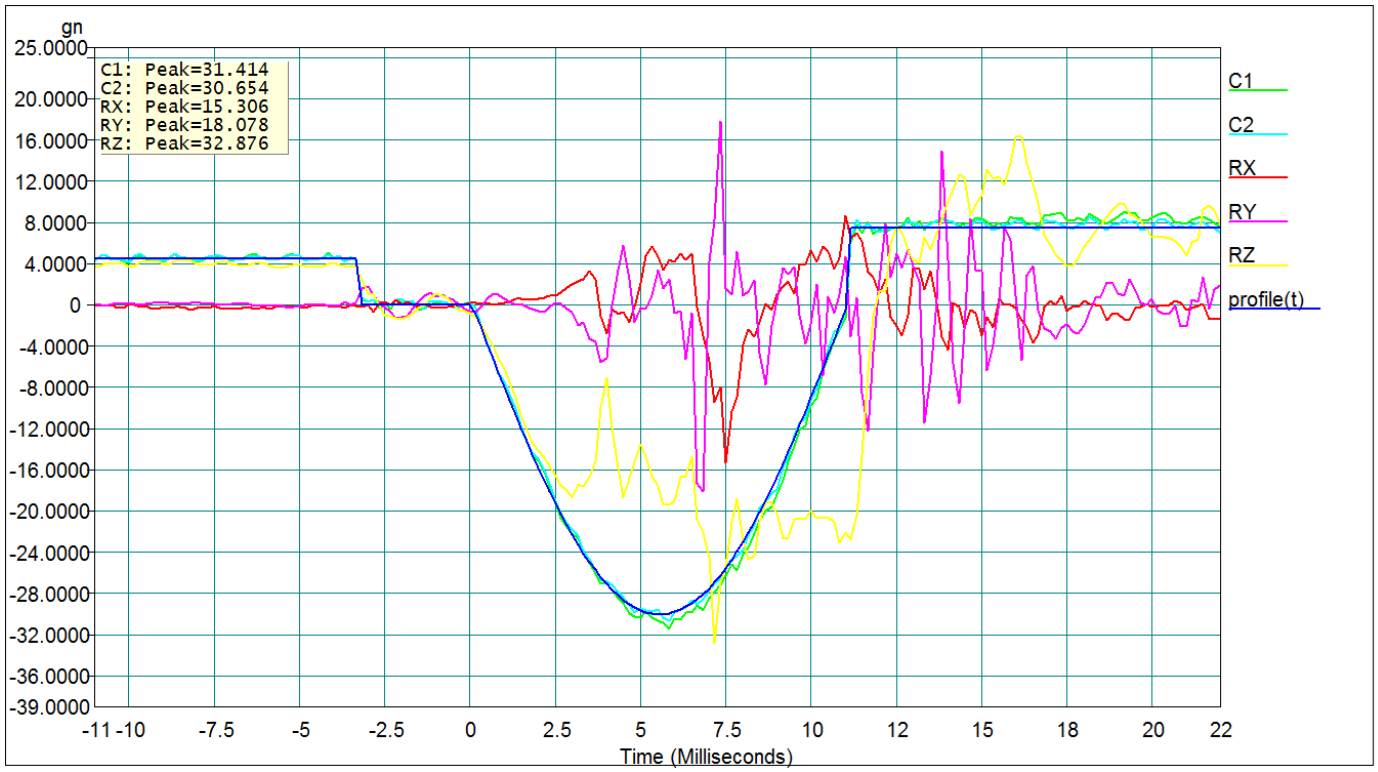


Figure 16: Z-Axis Shock, Inverse Pulse EUT Response

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