REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A1	ORIGINAL RELEASE	05/10/17	S. PALACIO

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

	NAME:	DATE:
CONTRACT NO:		
DRAWN:	M. Berry	05/10/17
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PROJ ENGR:	S. Palacio	05/10/17
PROG MGR:		
MFG.ENGR:		
QA ENGR:	J. Peacher	05/10/17
RELIABILITY:		

QUALIFICATION TEST PROCEDURE

MODEL: PMTO-8R8G9R56G-CD-1
PART NO: 27331550

PMI	SIZE **A**	CAGE CODE **05XQ0**	DWG. NO. **28131550**	REVISION A1
	SCALE	N/A		SHEET 1 OF 20

TABLE OF REVISIONS

DESCRIPTION	DATE	PMI
ORIGINAL RELEASE	05/10/17	M. BERRY

TABLE OF CONTENTS

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	SILICON CERTS	4-5 DAYS
VIBRATION	4.2	PMI	4-5 DAYS
SHOCK RESISTANCE	4.3	SILICON CERTS	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 APPENDIX E

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

SHIPBOARD (NAVAL SHELTERED) 50 °C PART TEMPERATURE

APPENDIX E

MECHANICALLY TUNED OSCILLATOR ENVIRONMENTAL REPORTS

SHIPBOARD (NAVAL SHELTERED) 50 °C PART TEMPERATURE

APPENDIX F

MECHANICALLY TUNED OSCILLATOR INSPECTION REPORT

SHIPBOARD (NAVAL SHELTERED) 50 °C PART TEMPERATURE