REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
-	As Drawn	6/10/99	STR
A	Update using Metelics Data	6/10/04	HK

Stress Analysis and Reliability Prediction

for the

Marki Microwave RF Mixer

Dual-Quad (Triple-Balanced) Housing Assembly

Ground Fixed Environment

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APPROVALS		DATE
Drawn	STR	6/10/99
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Stress Analysis and Reliability Prediction
Dual-Quad Housing, Ground Fixed Environment

SIZE	CAGE CODE	DWG. NO.	REV.
A	0UC32	051-03085	A

SCALE		SHEET
NONE		1 of 5

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1.0 Purpose and Scope

This report presents the results of stress analysis and reliability prediction performed on the Marki Microwave dual-quad (triple-balanced) mixer assembly in a sealed housing. It was performed to the requirements of MIL-HDBK-217F, Notice #2, with an environment of Ground, Fixed (G_F), and an ambient temperature of 40°C.

2.0 Reference Documents

2.1 Military

MIL-HDBK-217, Rev. F Notice #2	Reliability Prediction of Electronic Equipment
2.2 Marki Microwave	P1085WC Top Assembly
2.3 Metelics	Diode Test Data

3.0 Assumptions

The standard assumptions of MIL-HDBK-217 were used in addition to those specifically listed herein. The mounting surface to ambient thermal path resistance used for temperature rise calculations was 10°C/W for the components mounted on the hybrid assembly substrate.

4.0 Models

Discreet component failure rate calculations were used for all components in the mixer. The factors use are shown at the bottom of the sheet. The failure rates shown are for single components unless otherwise specified.

The stress factor used for arriving at the operating failure rate used the methods of –217. The stress factor shown on the prediction worksheets is the fully derated stress factor. The attached worksheets summarize all calculations.

The assembly consists of two packaged quad schottky diodes mounted on a microwave circuit board. This is mounted in a housing with SMA connectors. The quad diode is modeled using data from Metelics.

4.0 Models (continued)

A detailed calculation for a diode quad (A1) is show below as a typical calculation example:

Total input power (RF)	+15 dBm
Split between 2 quads, 2 diodes	-12 dB
Coupling loss, per diode (est.)	-1 dB
Dissipation (+6 dBm)	2 mW
Thermal Resistance for A1	300°C/W
Thermal Resistance, mount to housing	10°C/W
A1 temperature rise	0.6°C+0.1°C=1°C

Since the diode quad rating is 0.250W at 75°C ambient, it is necessary to determine the mounting surface temperature for the stress calculation required for MIL-HDBK-217. From the calculation above, the mounting surface temperature is 40°C (ambient) plus 0.2°C rise for a total of 40°C. Because the operating temperature is below the full rated temperature, the stress is:

$$\text{Stress} = \frac{\text{P applied}}{\text{P rated}}$$

$$\text{Stress} = \frac{4 * .002\text{W}}{.250\text{W}}$$

Stress = .03 The minimum stress used for –217 calculations is 0.10

5.0 Summary

The results of the component stress analysis included with this report demonstrate that with the present design, no component exceeds 3% of the temperature derated maximum values. The MTBF is 9,718,200 hours in a Ground, Fixed (G_F) environment at 40°C.

6.0 Worksheet

See page 5

DESIGN ANALYSIS PARTS LIST

UNIT DESIG. TOP ASSEMBLY ASS'Y NO. _____ PREPARED BY RICHARD L. MAYEUR

ASS'Y NAME RF MIXER SCHEMATIC _____

					APPLICATION DATA						FAILURE DATA		
					RATED			OPERATING					217 F#2 REMARKS 40°C
REFERENCE DESIGNAT.	PART NUMBER	NAME OR MANUFACTURER'S PART NAME & NUMBER			WATTS	VOLTS/ AMPS	AMBIENT TEMP. °C	WATTS	VOLTS/ AMPS	TEMP. RISE	STRESS FACTOR	FAILURE RATE	G_F
A1,2		DIODE, QUAD MIXER		4 SCHOTTKY DIODES	.250	6.0/.025	75°	.008	1.0/.005	1°	.03	0.0012	FOR 2
E1-3		FEEDTHRU, RF				100/5.0	125°		1.0/.005	1°	.01	0.0009	FOR 3
J1-3		CONNECTOR, RF	SMA		50	(RF)	25°	.010	(RF)	1°	.01	0.1008	FOR 3
													$\Sigma\lambda = 0.1029 / 10^6$ HRS.
													MTBF = 9,718,200 HRS.
	DIODE FACTORS (USE METELICS DATA)			FEEDTHRU FACTORS (USE 17.1, WELD + CLIP)				CONNECTOR FACTORS (USE 15.1)					
	$\Pi_E = 2.0$, $\lambda_b = .00028$			$\Pi_E = 2.0$, $\Pi_Q = 1.0$, $\lambda_b = .00017$				$\Pi_E = 5.0$, $\Pi_K = 1.0$, $\Pi_F = 1.4$					
	A1 $\lambda_p = .0006$ (EACH)			E1-3 $\lambda_p = .0003$ (EACH)				J1-3	$\lambda_b = .0048$, $\lambda_p = .0336$ (EACH)				

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DWG. NO. 051-03085

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CAGE CODE 0UC32

SIZE A

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