



**MONOLITHIC MICROWAVE INTEGRATED  
CIRCUIT (MMIC) GaAs PHEMT PPH15X-10**

**PROCESS FROM UMS,**

**BASED ON TYPE CHA5350-99F BARE DIE  
(K-BAND POWER AMPLIFIER)**

**ESCC Detail Specification No. 9012/002**

Issue 1	July 2015
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## 1 GENERAL

### 1.1 SCOPE

This specification details the ratings, physical and electrical characteristics, test and inspection data for the Microwave Monolithic Integrated Circuit (MMIC), in die form, K-Band Power Amplifier, based on type CHA5350-99F. The CHA5350-99F, based on the GaAs PHEMT PPH15X-10 process from UMS, covers the frequency range from 17 GHz to 24 GHz. This document is based on, and should be read in conjunction with ESCC Generic Specification No. 9010, the requirements of which are supplemented herein.

### 1.2 TYPE VARIANTS

MMIC Variants of the basic type components specified herein, which are also covered by this specification, are given in Table 1(a).

### 1.3 MAXIMUM RATINGS

The maximum ratings, which shall not be exceeded at any time during use or storage, applicable to the component specified herein, are scheduled in Table 1(b).

### 1.4 PARAMETER DERATING INFORMATION

The power dissipation de-rating curve is shown in Figure 1.

### 1.5 PHYSICAL DIMENSIONS

The physical dimensions of the die and mechanical drawing specified herein are shown in Figure 2.

### 1.6 FUNCTIONAL DIAGRAM

The functional diagram, showing pad identification of the component specified herein, is shown in Figure 3.

### 1.7 HANDLING PRECAUTIONS

These devices are susceptible to damage by electrostatic discharge. Therefore suitable precautions shall be employed for protection during all phases of manufacture test, packaging, shipping and handling.

These chips are categorized as Class 0 with a Minimum Critical Path Failure Voltage of 50V for this Variant.

## 2 APPLICABLE DOCUMENTS

The following documents form part of this specification and shall be read in conjunction with it:

- (a) ESCC Generic Specification No. 9010 for Monolithic Microwave Integrated Circuits (MMICs)
- (b) MIL STD 883 Test Methods and Procedures for Microelectronics
- (c) ESCC20600 Preservation, Packaging and Despatch of ESCC Components
- (d) ESCC21300 Terms Definition, Abbreviations, Symbols and Units
- (e) ESCC23800 Electrostatic Discharge Sensitivity Test method

**3 TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS**

For the purpose of this specification, the terms, definitions, abbreviations, symbols and units specified in ESCC Basic Specification No. 21300 shall apply. In addition, the following abbreviations are used:

RTH (J-C)= Thermal Resistance, Junction to Case.

Vd= Supply drain voltage.

Vg= Supply gate voltage.

**TABLE 1(a) – TYPE VARIANTS**

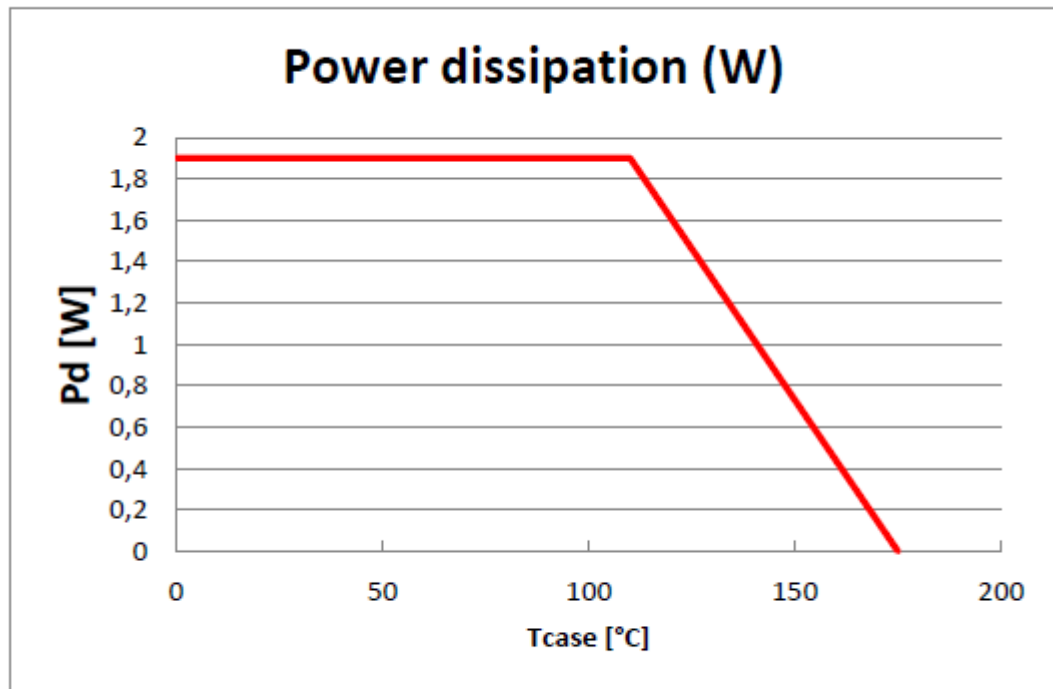
(1) VARIANT	(2) TYPE	(3) CASE	(4) FIGURE	(5) PAD METALLISATION AND THICKNESS OF TOP LAYER	(6) BACKSIDE FINISH (METALLISATION AND THICKNESS)
01	CHA5350-99F	CHIP	2	Au , 3.3µm	Au, 4.5µm

**TABLE 1(b) – MAXIMUM RATINGS(1)**

No.	CHARACTERISTICS	SYMBOL	MAXIMUM RATINGS	UNIT	REMARKS
1	RF input power	$P_{RF}$	+15	dBm	CW mode
2	Drain bias voltage	$V_{d1,2,3,4}$	8	V	
3	Gate bias voltage	$V_g$	$-2.5 < V_g < -0.3$	V	
4	Junction temperature	$T_j$	175	°C	
5	Drain bias current	$I_d$	650	mA	Total current of the circuit
6	Operating temperature range	$T_a$	-55 to +110	°C	With respect to max $T_j = 175^\circ\text{C}$
7	Storage Temperature Range	$T_{stg}$	-55 to +175	°C	
8	Soldering Temperature	$T_{s01}$	+300	°C	AuSn 80/20 (see AN001 UMS application note)
9	Thermal resistance (2)	$R_{th}$	35	°C/W	$R_{th}$ (J-C) @ 110°C
10	Dissipated power (3),(4)	$P_{diss}$	5.2	W	Maximum DC power

**NOTES**

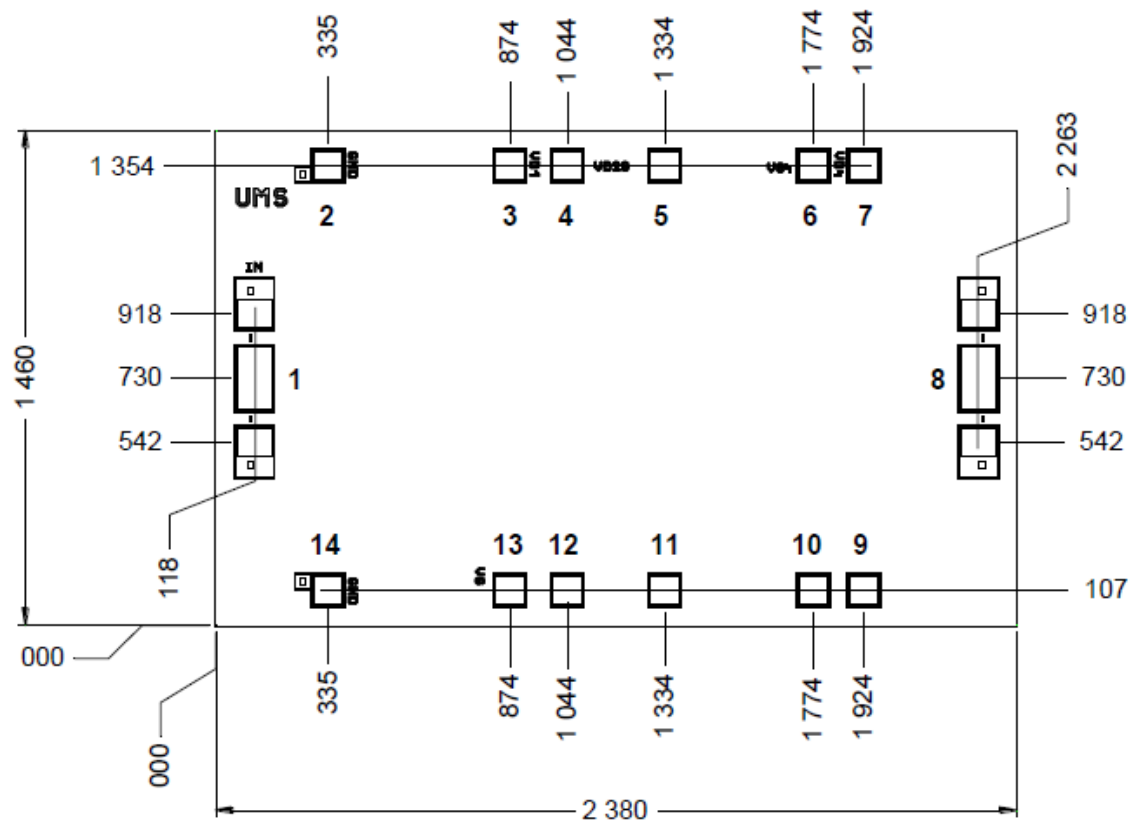
1. Operation of this device above anyone of these parameters may cause permanent damage.
2. For bare die mounted in appropriate package. Not a true maximum rating – for information only.
3. For the assembled chip the relevant substrate or package should be taken into account.
4. For chip mounted in appropriate package. Not a true maximum rating – for information only.

**FIGURE 1 – PARAMETER DERATING INFORMATION**

Power dissipation de-rating curve



**FIGURE 2 – PHYSICAL DIMENSIONS**



**NOTES**

All dimensions are in micrometers Chip size

=2380x1460 ±35μm Chip

thickness = 70μm ±10μm

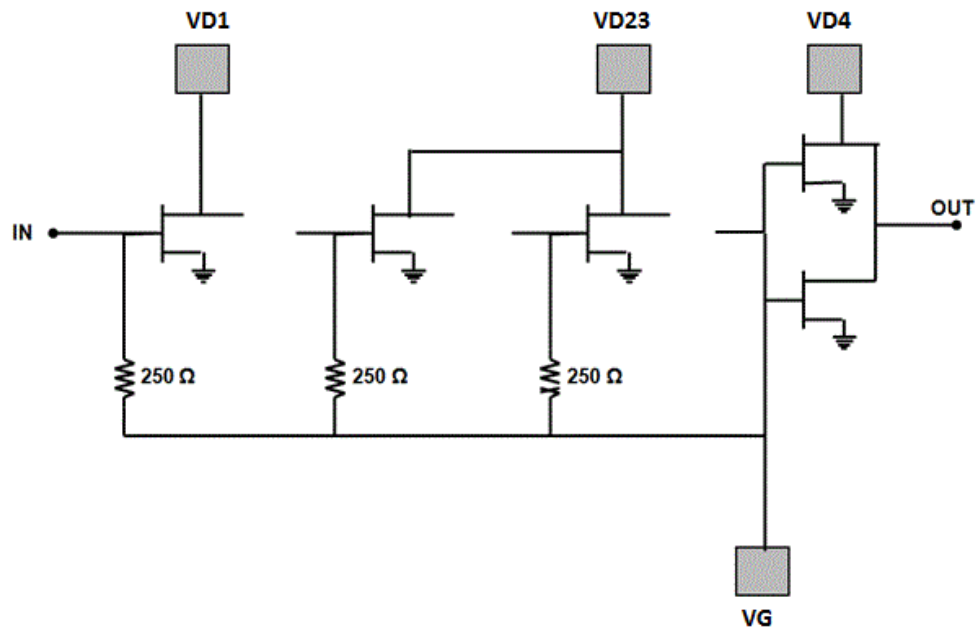
RF pads (1, 8) = 110 x 200μm<sup>2</sup>

DC pads= 100 x 100μm<sup>2</sup>

Chip width and length are given with a tolerance of ±35μm

Pin number	Pin name	Description
1	IN	Input RF
2, 14	Gnd	Gnd (NC)
3	Vd1	1 <sup>st</sup> stage drain voltage
5	Vd2, Vd3	2 <sup>nd</sup> and 3 <sup>rd</sup> drain voltage
7	Vd4	4 <sup>th</sup> drain voltage
8	OUT	Output RF
10	Vg	Gate voltage
4, 6, 9, 11, 12, 13	/	NC

**FIGURE 3 – FUNCTIONAL DIAGRAM**



## 4 REQUIREMENTS

### 4.1 GENERAL

The complete requirements for procurement of the naked MMIC die specified herein shall be as stated in this specification and ESCC Generic Specification No. 9010 for Monolithic Microwave Integrated Circuits (MMIC).

The test requirement for the MMIC lot validation shall be performed on mounted MMIC samples submitted to Burn-in and electrical measurements CHART III(b) and Lot Acceptance tests level 2 CHART V.

Deviations from the Generic Specification applicable to this specification only, are listed in Para. 4.2.

Deviations from the applicable Generic Specification and this Detail Specification, formally agreed with specific Manufacturers on the basis that the alternative requirements are equivalent to the ESCC requirements and do not affect the MMIC chip reliability, are listed in the appendices attached to this specification.

### 4.2 DEVIATIONS FROM GENERIC SPECIFICATION

#### 4.2.1 Deviations from Production Control – Wafer Lot Acceptance

(a) Total Dose Radiation Testing: not required

#### 4.2.2 Deviations from Production Control - Wafer screening (CHART II (a))

(a) Para. 9.5.2.1: applicable on 5 bare dies assembled on appropriate substrate

#### 4.2.3 Deviations from Production Control - Wafer acceptance testing (CHART III (a))

(a) Para. 9.7.1 and 9.7.2 only applicable

#### 4.2.4 Deviations from Final Production Tests (Chart II (b)) (a) ~~Chart II (b) shall not be performed.~~

#### 4.2.5 Deviations from Burn-in and Electrical Measurements (Chart III (b))

(a) Para. 9.15: shall not be performed

(b) Para. 9.16: shall apply as per condition MIL-STD-883, Test Method 1015, Test condition 'B'. Duration shall be 240 hrs, 110°C ambient ( $T_j=175^\circ\text{C}$ ).

(c) Para.9.5.2.2: shall not be performed.

#### 4.2.6 Deviations from Qualification Tests (Chart IV)

Chart IV shall not be performed.

#### 4.2.7 Deviations from Lot Acceptance Tests (Chart V)

Chart V Level 2 – Endurance Subgroup plus electrical Subgroup shall apply.

Environmental/Mechanical Subgroups shall not be performed.

Deviations from the applicable Chart V level 2 to this specification are listed herein.

- (a) Level 3: Electrical measurements at room and high and low temperatures (-40°C/+60°C) on 3 samples per qualification lot shall be performed. Components Assembly and Capability Tests shall not be performed.
- (b) Level 3 Special testing para. 9.27, shall not be performed.
- (c) Level 2 Endurance Subgroup shall be performed on 10 samples. The operating life test duration shall be 1,000 hours minimum at 110°C ambient (Tj=175°C) or equivalent as per table 1 of MIL-STD-883 Test method 1005.

#### 4.3 MECHANICAL REQUIREMENTS

##### 4.3.1 Dimension Check

The dimensions of the components specified herein shall be checked. They shall conform to those shown in Figure 2.

##### 4.3.2 Weight

The maximum weight of the components specified herein is negligible

##### 4.3.3 Terminal Strength

- (a) Shall not be performed

##### 4.3.4 Bond Strength

The requirements for bond strength are specified in Section 9 of ESCC Generic Specification No. 9010. The test conditions shall be as described in MIL STD 883, method 2011, cond. D.

- (a) Condition: 'D'.
- (b) Bond Strengths: 20 wires (5 dies, 4 wires per die, No defect allowed)

##### 4.3.5 Die Shear

The requirements for die shear are specified in Section 9 of ESCC Generic Specification No. 9010. The test conditions shall be as described in MIL STD 883, method 2019.

- (a) Minimum acceptable on die shear strengths: 2.5kg (on 5 parts, No defect allowed)

#### 4.4 MATERIALS AND FINISHES

The materials and finishes shall be as specified herein. Where a definite material is not specified, a material which will enable the components specified herein to meet the performance requirements of this specification shall be used. Acceptance or approval of any constituent material does not guarantee acceptance of the finished product.

Bond Pad Metallization and Back-side metallization is Au

#### 4.5 MARKING

##### 4.5.1 General

The marking of components delivered to this specification shall be in accordance with the requirements of ESCC Basic Specification No. 21700 and the following paragraphs. When the component is too small to accommodate all of the marking as specified, as much as space permits shall be marked and the marking information, in full, shall accompany the component in its primary package.

The information to be marked and the order of precedence shall be as follows:

- (a) The ESCC Component Number.
- (b) Manufacturer name or Symbol
- (c) Manufacturer Part Number
- (d) Traceability as defined in ESCC : Lot, Wafer, Date code ...

The primary package shall bear an "ESD Sensitive" label.

#### 4.5.2 ESCC Component Number

Each component shall bear the ESCC Component Number which shall be constituted and marked as follows:

Detail specification Number: 9012002

Type Variant (see Table 1(a))01

Testing Level (B or C, as applicable) B

#### 4.5.3 Pad Identification

Pad identification shall be as shown in Figure 2 of this specification.

#### 4.5.4 Traceability Information

Each component shall be marked in respect of traceability information in accordance with the requirements of ESCC Basic Specification No. 21700.

#### 4.5.5 Packaging

An appropriate Gel-pak of glass filled black conductive polycarbonate with appropriate retention level shall be used for delivery, so that for storage and shipment the parts are adequately safeguarded against mechanical or electrical injury during transportation to the ordered and:

- Protected against deterioration due to humidity
- Primary HS-shield metalized bag, partly filled with dry nitrogen and sealed
- Secondary DRY-SHIELD metalized humidity proof bag with desiccant and humidity indicator, partly filled with dry nitrogen and sealed
- Suitable for storage in their primary package for a period of several months,
- Easily identified after each stage of packaging

Furthermore the top side of the Gel-Pak shall be clearly identified. Appropriate Gel-Pak is VR76 CC 02 XL.

### 4.6 ELECTRICAL MEASUREMENTS

#### 4.6.1 Electrical Measurements at Room Temperature

The parameters to be measured at room temperature are scheduled in Table 2. Unless otherwise specified, the measurements shall be performed at  $T_{amb} = + 25 \pm 3$  °C.

#### 4.6.2 Electrical Measurements at High and Low Temperatures

The parameters to be measured at high and low temperatures are scheduled in Table 3. Unless otherwise specified, the measurements shall be performed at + 60°C and -40°C.

#### 4.6.3 Circuits for Electrical Measurements

Circuits for use in performing electrical measurements listed in Table 2 and Table 3 of this specification are shown in Figure 4.

#### 4.7 BURN-IN TESTS

Burn-in shall be done in accordance with Chart III(b) of ESCC Generic Specification N° 9010.

##### 4.7.1 Parameter Drift Values

The parameter and drift values applicable to Burn-In are specified in Table 4 of this specification. Unless otherwise stated, measurements shall be performed at  $T_{amb} = + 25 \pm 3$  °C. The parameter drift values applicable to the scheduled parameters shall not be exceeded. In addition to these drift value requirements, the appropriate limit value specified for a given parameter in Table 2 shall not be exceeded.

##### 4.7.2 Conditions for Burn-In

The requirements for Burn-In are specified in Section 9 of ESCC Generic Specification No. 9010. The conditions for Burn-In shall be as specified in Table 5 of this specification.

##### 4.7.3 Electrical Circuit for Burn-In

The circuit for use in performing the Burn-In test is shown in Figure 5 of this specification.

#### 4.8 ENDURANCE TESTS (CHART V OF ESCC GENERIC SPECIFICATION NO. 9010)

##### 4.8.1 Electrical Measurements at Intermediate Points and on Completion of Endurance Tests

The parameters to be measured at intermediate points and on completion of endurance testing are scheduled in Table 2 of this specification. Unless otherwise stated, the measurements shall be performed at  $T_a = + 25 \pm 3$  °C.

##### 4.8.2 Conditions for Operating Life Test (Part of Endurance Testing)

The requirements for operating life testing are specified in Section 9 of ESCC Generic Specification No. 9010. The conditions for operating life testing are specified in Table 5 of this specification.

##### 4.8.3 Electrical Circuit for Operating Life Test

The circuit for use in performing the operating life test shall be the same as shown in Figure 5 of this specification for burn-in.

#### 4.9 TOTAL DOSE IRRADIATION TESTING

Not applicable.

#### 4.10 SPECIAL TESTING

Not applicable.

**TABLE 2 – ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE OF NAKED DIE – DC & RF PARAMETERS**

No.	CHARACTERISTICS	SYMBOL	TEST CONDITIONS	LIMITS			UNIT
				MIN.	TYP.	MAX.	
1	Frequency range	Freq	Vd=6V & Idq=300mA	17		24	GHz
2	Linear Gain	Gain		20	26		dB
3	Input Return Loss	RLin			-17	-9	dB
4	Output Return Loss	Rlout			-12		dB
5	Output Power @ 1dB compression	P <sub>-1dB</sub>		24.5	26.5		dBm
6	Saturated output power	P <sub>sat</sub>		25	27		dBm
7	Power added efficiency @1dB gain comp	PAE <sub>-1dB</sub>			25		%
8	Output third order interception point on the frequency range 17-21 GHz	OIP3	Note (1)		35.5		dBm
9	Output third order interception point on the frequency range 21-24 GHz	OIP3	Note (1)		34		dBm
10	Drain supply voltage	Vd <sub>1,2,3,4</sub>				6	V
11	Drain quiescent current (Vd=6V)	Idq	Vg tuned to Idq=300mA		300		mA
12	Drain current @ 1dB gain compression	Id <sub>-1dB</sub>			350	450	mA
13	Drain current @ saturation	Id <sub>-P<sub>sat</sub></sub>			400	500	mA

**NOTES**

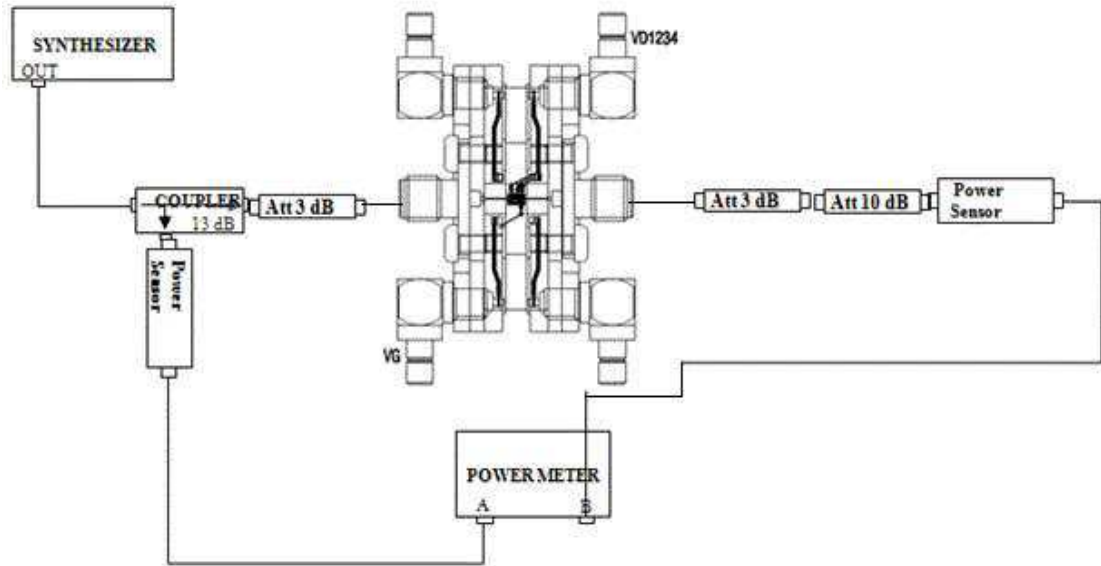
1. only by samples during on wafer tests.

**TABLE 3 – ELECTRICAL MEASUREMENTS AT LOW AND HIGH TEMPERATURE OF NAKED DIE - DC & RF PARAMETERS**

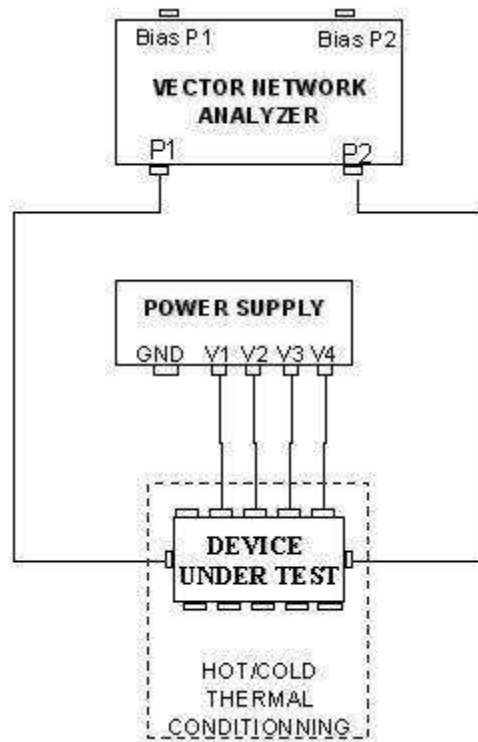
No.	CHARACTERISTICS	SYMBOL	TEST CONDITIONS	TYP		UNIT
				-40°C	+60°C.	
1	Frequency range	Freq	Vd=6V & Idq=300mA	17	24	GHz
2	Linear Gain	Gain		28	24	dB
3	Input Return Loss	Rlin		-17	-17	dB
4	Output Return Loss	Rlout		-12	-12	dB
5	Output Power @ 1dB compression	P <sub>-1dB</sub>		27	26	dBm
6	Saturated output power	P <sub>sat</sub>		27.5	26.5	dBm
10	Drain supply voltage	Vd <sub>1,2,3,4</sub>		6	6	V
11	Drain quiescent current (Vd=6V)	Idq	Vg tuned to Idq = 300mA	350	250	mA
12	Drain current @ 1dB gain compression	Id_ P <sub>-1dB</sub>		400	300	mA
13	Drain current @ saturation	Id_ P <sub>sat</sub>		450	350	mA



**FIGURE 4 – TEST CONFIGURATIONS FOR ELECTRICAL MEASUREMENTS [DUT IN JIG]**



Power test set-up



S parameter test set-up

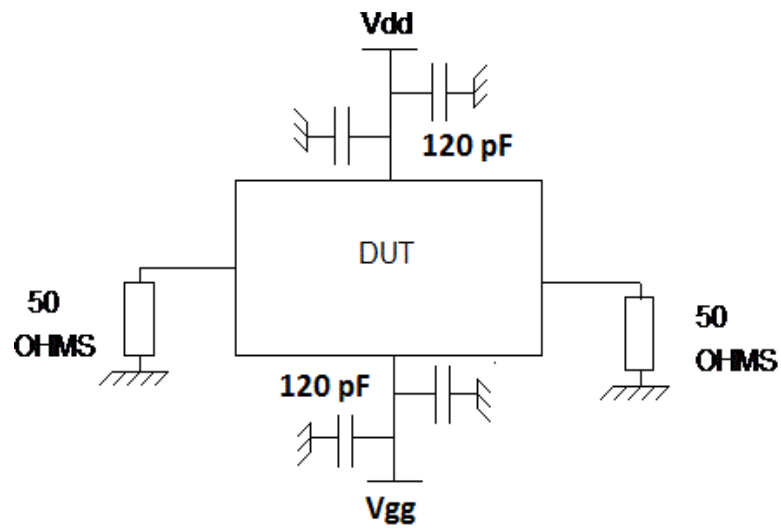
**TABLE 4 – PARAMETER DRIFT VALUES**

No.	CHARACTERISTICS	SYMBOL	SPEC. AND/OR TEST METHOD	TEST CONDITIONS	LIMITS	UNIT
2	Linear Gain	G	As per Table 2	As per Table 2	+/-1	dB
5	Output Power @ 1dB compression	P <sub>-1dB</sub>	As per Table 2	As per Table 2	+/-1	dBm
11	Drain quiescent current (V <sub>d</sub> =6V)	I <sub>dq</sub>	As per Table 2	As per Table 2	+/-20	%

**TABLE 5 – CONDITIONS FOR BURN IN AND OPERATING LIFE TESTS**

No.	CHARACTERISTICS	SYMBOL	VALUE	UNIT
1	Ambient Temperature	T <sub>amb</sub>	+110°C	°C
2	Junction Temperature	T <sub>j</sub>	+175°C	°C
3	Drain Current	I <sub>dq</sub>	V <sub>g</sub> tuned to I <sub>dq</sub> =300	mA
4	Drain Voltage	V <sub>d</sub>	6	V
5	Duration for Burn In		240	H
6	Duration for Life Test		1000	H

**FIGURE 5 – ELECTRICAL CIRCUIT FOR BURN IN AND LIFE TEST**



**APPENDIX A**  
**AGREED DEVIATIONS FOR UMS TECHNOLOGIES (D)**

ITEMS AFFECTED	DESCRIPTION OF DEVIATIONS
Visual inspection MIL STD 883, method 2010	SQ_10S_Visual inspection Specification for GaAs MMIC Level A (internal UMS specification for Visual inspection; based on Method 2010 condition A)
Recommended conditions for die attach and wire bonding	UMS application note : AN0001 User guide for bare dies GaAs MMIC storage, pick & place, die attach and wire bonding