PRELIMINARY DATA SHEET

ECG015

BROADBAND HIGH OIP3 AMPLIFIER

1800 - 2500 MHz

Features

- 1800 to 2500 MHz
- Highly Reliable InGaP HBT
- Excellent Stability

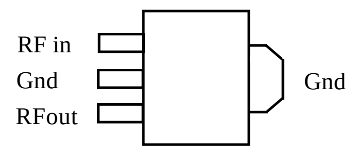
Applications

- Multi-carrier Systems
- High Linearity Amplifiers
- Cellular, PCS, WLL

Package Available

(-B) SOT-89

Package



SOT-89 (Top View)

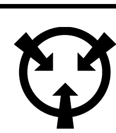
Description

The ECG015 is a high reliability, high OIP3 amplifier in a low cost SOT-89 package, optimized for the commercial communications market. The device is manufactured using advanced Indium Gallium Phosphide Heterojunction Bipolar Transistor (InGaP HBT) technology. The amplifier can be matched to achieve low VSWR and high OIP3 over the 1800 to 2500 MHz range. Typical OIP3 at 2140 MHz is +41 dBm. The ECG015 operates from a single 5 volt power supply.

Electrical Specifications

Test Conditions: Ta = 25°C, Vd = 5.0 V

SYMBOL	PARAMETER		LIMITS			UNIT	TEST CONDITION
			MIN.	TYP.	MAX.		
F	Frequency		1800		2500	MHz	
G	Gain (Small Signal)	f = 2140 MHz f = 2450 MHz	13.5 .	15.0 14.0		dB	
P_{1dB}	Output Power @ 1 dB Compression	f = 2140 MHz f = 2450 MHz		24.0 23.0		dBm	
OIP3	Output Third Order Intercept	f = 2140 MHz f = 2450 MHz	37.5 .	41 42		dBm	Note 1
RL_{IN}	Input Return Loss, 50 Ohm	1800 to 2500 MHz		15.0		dB	
RL_{OUT}	Output Return Loss, 50 Ohm	1800 to 2500 MHz		10.0		dB	
NF	Noise Figure	f = 2140 MHz f = 2450 MHz		5.0 5.0		dB	
I_c	Supply Current		85	110	135	mA	Note 2
	Output Mismatch without Spurs			10:1			
R_{th}, j-l	Thermal Resistance	Junction to Lead		85		°C/W	
Note 1: OIP3 = Pout (by power meter, total 2-tone power) + (IM3 (dBc)) / 2 - 3 dB							
Note 2: Tested at Vcc= 8.0V RS= 30 ohms							

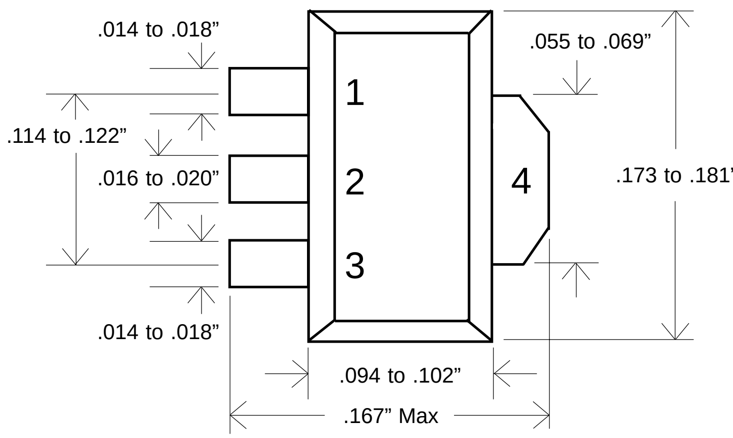


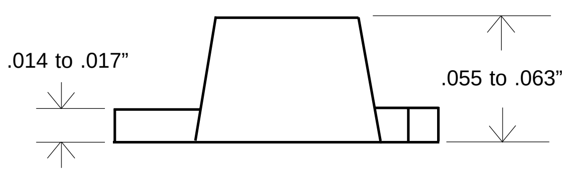
CAUTION!

Absolute Maximum Ratings

Device Voltage	6.0	V
Device Current	220	mA
RF Power Input	12	dBm
Operating Temperature	-40 to +85	°C
Storage Temperature	-65 to +150	°C
Junction Temperature	200	°C

Package Outline

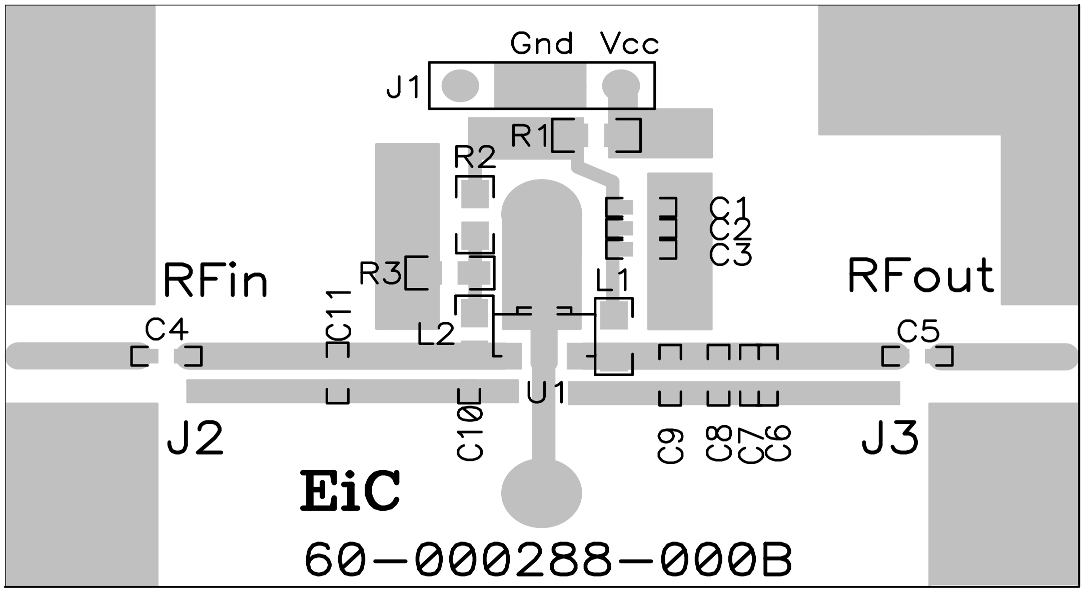




Pin Definitions

Pin #	Pin	Definition
1	RFin	This pin has a non-zero DC potential, requiring a DC blocking capacitor. Input matching is required to achieve a low VSWR.
2, 4	Gnd	The two ground connections should be directly connected together to the ground plane on the PCB. The ground connection also serves as a heatsink.
3	RFout	DC bias is applied to this pin through a RF choke. A bypass capacitor (1.0 micro farad) on the DC side of the choke is recommended for low frequency modulation signal.

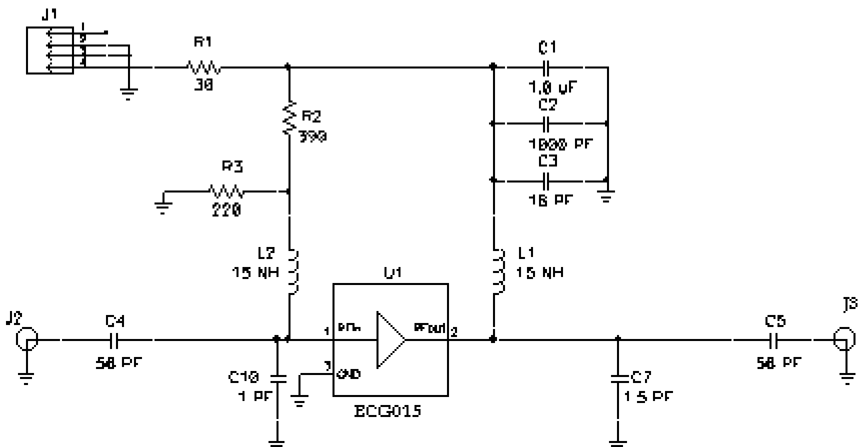
Evaluation Board Layout



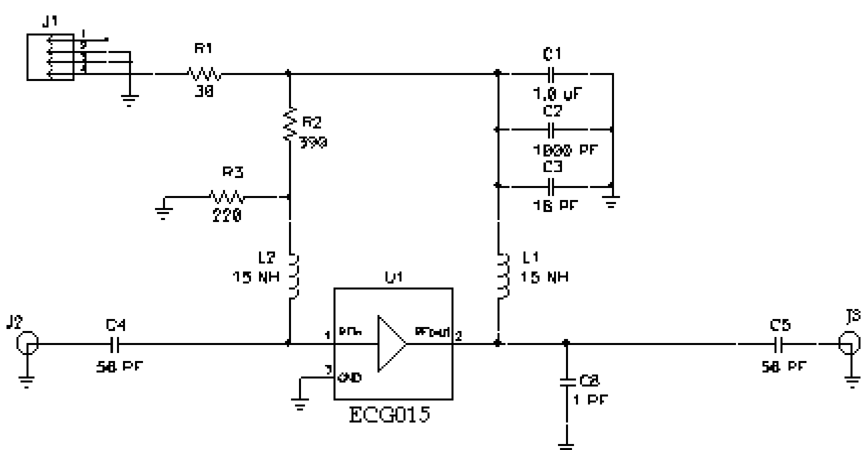
ECG015						
1.9 GHz	**2.14 GHz**	**2.45 GHz**	**VALUE**	**DESCRIPTION**	**MANUFACTURER AND P/N**	
R1	R1	R1	30 Ω	RESISTOR, 0805	ROHM MCR10JW300	Note 1
R2	R2	R2	390 Ω	RESISTOR, 0805	ROHM MCR10JW391	Note 1
R3	R3	R3	220 Ω	RESISTOR, 0805	ROHM MCR10JW221	Note 1
L1,L2	L1,L2	L1,L2	15 nH	INDUCTOR, 0805	TOKO LL1608-F15NK	Note 1
C1	C1	C1	1.0 uF	CAPACITOR, 0603	PANASONIC ECJ-1VF1A105Z	Note 1
C2	C2	C2	1000pF	CAPACITOR, 0603	ROHM MCH185A102KK	Note 1
C3	C3	C3	18 Pf	CAPACITOR, 0603	ROHM MCH185A180JK	Note 1
C4,C5	---	---	56 pF	CAPACITOR, 0603	ROHM MCH185A560JK	Note 1
C7	---	---	1.5 pF	CAPACITOR, 0603	ROHM MCH185A1R5CK	Note 1
C10	C8	C9	1.0 pF	CAPACITOR, 0603	ROHM MCH185A010CK	Note 1
U1	U1	U1	---	IC, ECG015	EiC Corp ECG015	
1	1	1	---	HEATSINK	EiC Corp MD-000290-000	
6	6	6	---	SCR,#2-56x1/4 SOC HD CAP	ANY	
J1	J1	J1	---	CONN, 4 POS	SULLINS ELEC PZC04SGAN	
J2,J3	J2,J3	J2,J3	---	CONN, SMA	CKI 5260CC	
1	1	1	---	PCB	EiC Corp 60-000288-000	

NOTE 1. EiC RECOMMENDED COMPONENTS ARE SHOWN.
EQUIVALENT COMPONENTS MAY BE USED.
NOTE UNLESS OTHERWISE SPECIFIED

1.9GHz Schematic



2.14GHz Schematic



Recommended Bias Resistor Values

R = (Vcc-Vde)/Icc = (Vcc-5.0)/0.10

Approximate Supply Voltage (V_{cc}) based on standard values for R1	5	6	7	8	10	12
R1 (Ohms)	0	10	20	30	51	68

Figure 1

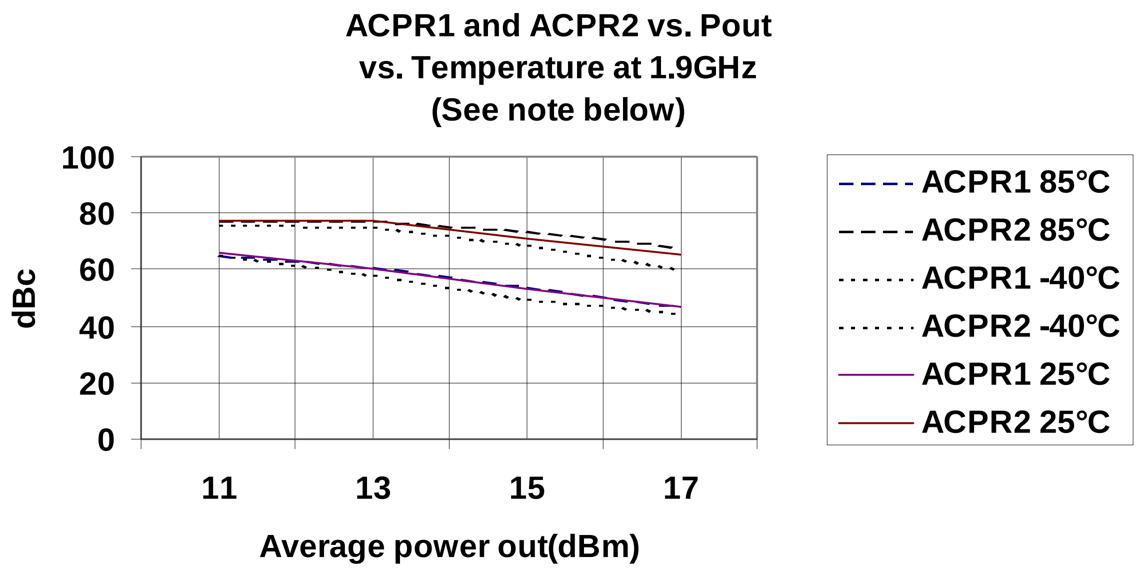
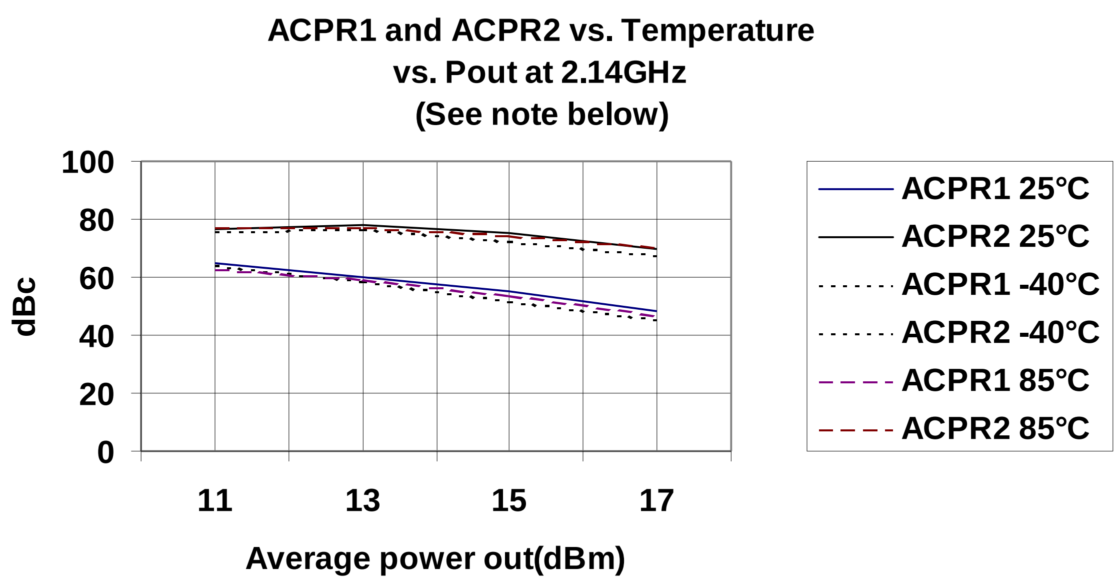
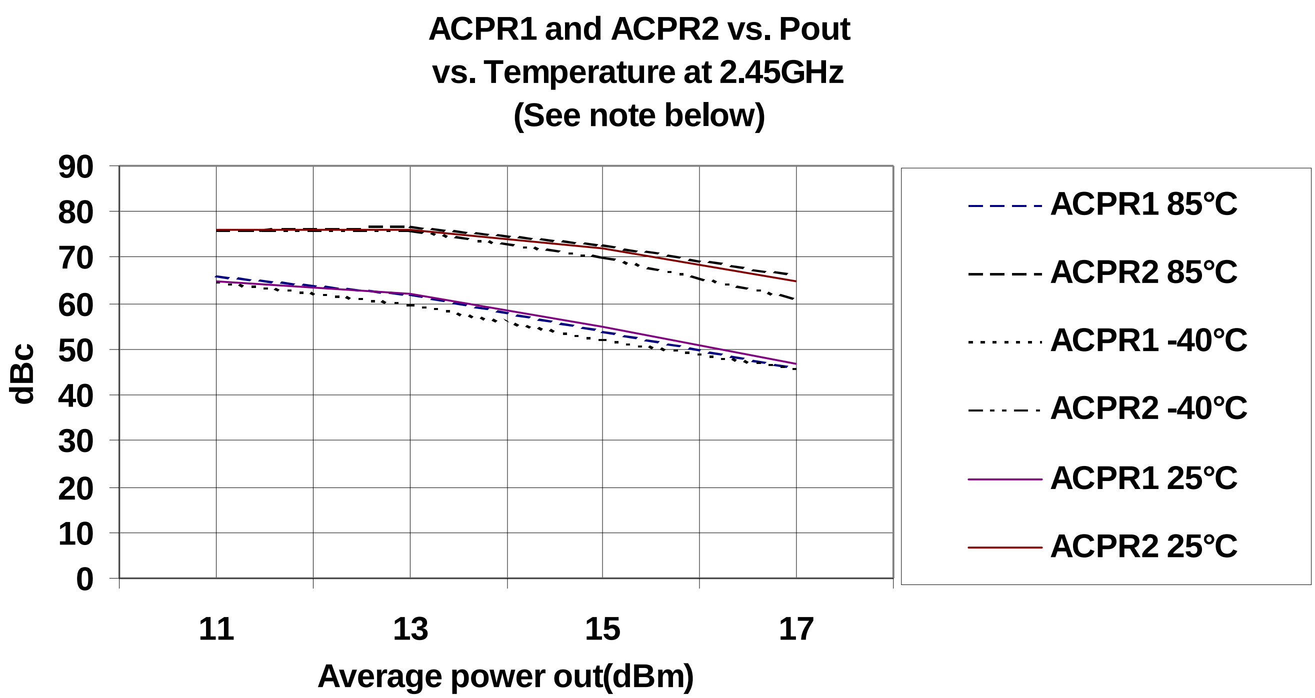


Figure 2



Note: ACPR1 measured at 750KHz
ACPR2 at 1.98MHz Forward 9 Channel
Signal Generator:HP E4432B

Figure 3



Note: ACPR1 measured at 750KHz
ACPR2 at 1.98MHz Forward 9 Channel
Signal Generator:HP E4432B

Figure 4

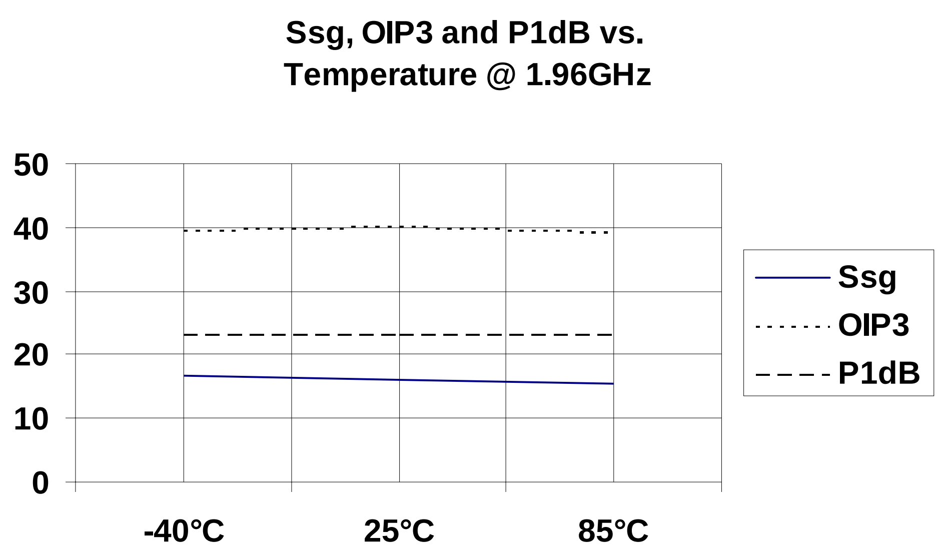


Figure 5

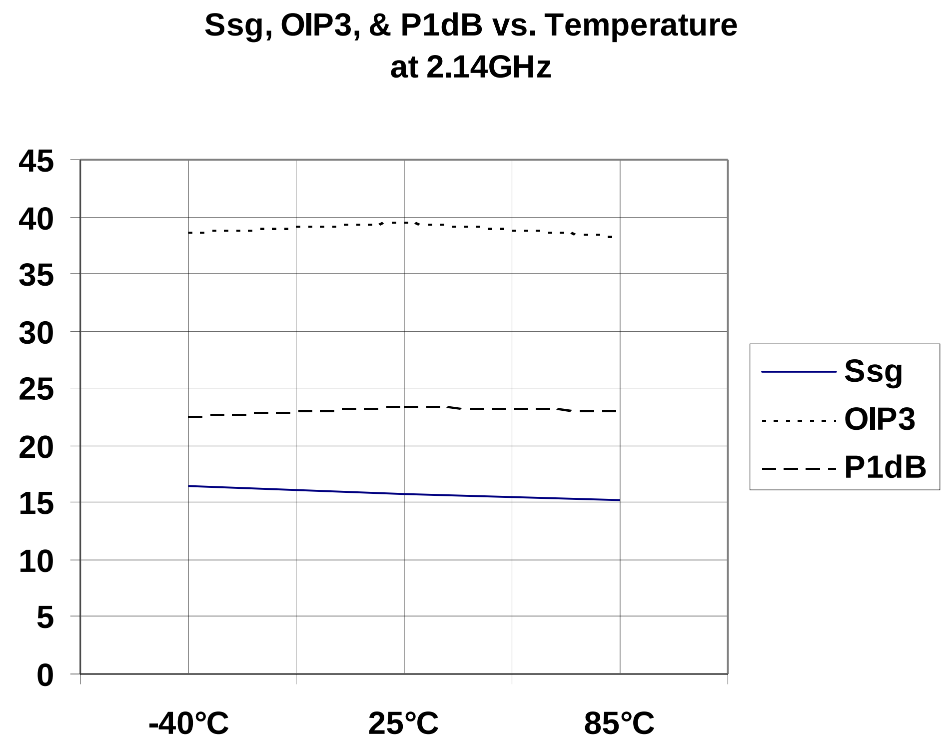
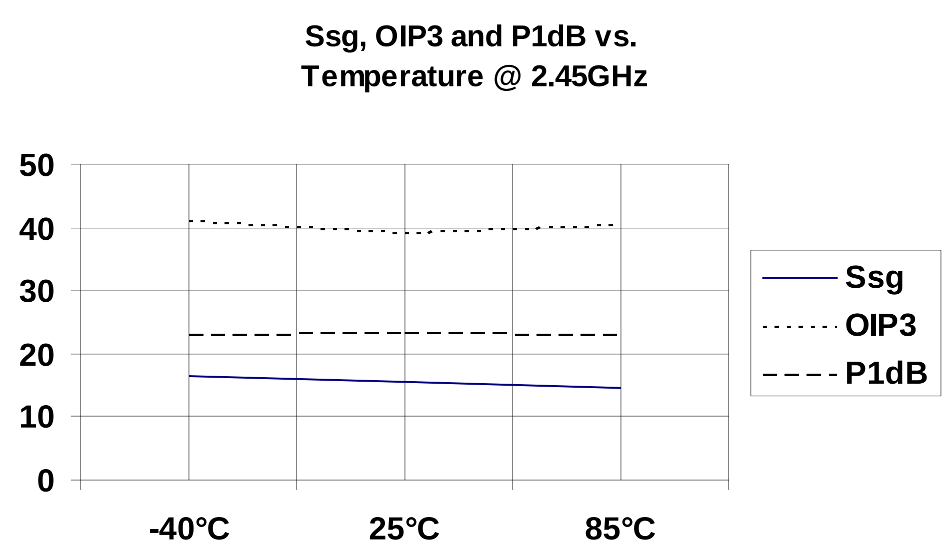


Figure 6



Typical S-Parameters: Temperature 25 Degrees C

Frequency (MHz)	S11 (Mag)	S11 (Ang)	S21 (Mag)	S21 (Ang)	S12 (Mag)	S12 (Ang)	S22 (Mag)	S22 (Ang)
1800	0.0795	0.4539	5.7139	2.5459	0.0339	-0.0163	-0.4963	0.2198
1900	0.1519	0.3950	5.8909	1.8103	0.0310	-0.0181	-0.5165	0.2271
2000	0.2204	0.3004	6.0173	0.8354	0.0244	-0.0192	-0.5383	0.2442
2100	0.2643	0.1829	5.9736	-0.1421	0.0185	-0.0190	-0.5650	0.2631
2200	0.2730	0.0400	5.7473	-1.1704	0.0112	-0.0189	-0.5867	0.2946
2300	0.2463	-0.0882	5.3364	-1.9851	0.0044	-0.0156	-0.6073	0.3362
2400	0.1618	-0.2350	4.6155	-2.8457	-0.0025	-0.0089	-0.6105	0.3917
2500	0.0224	-0.3485	3.6779	-3.5100	-0.0075	0.0024	-0.5974	0.4629

EiC High Linearity Amplifier Series

Introduction

EiC's High Linearity Amplifier family is made up of a series of high reliability Amplifiers with high linearity. They can be matched for specific frequency band application from 50MHz or so to 3GHz.

The output P1dB is from 22 to 24dBm. The OIP3 is typically 40dBm for all versions.

They are packaged in SOT89 package for thermal dissipation. All the parts were designed with low thermal resistance to provide low junction temperatures and long lifetimes.

Unlike the Darlington amplifier family, the high linearity family maintains the high OIP3 over the usable frequency range while requiring external matching circuits for good S11 and S22 at various frequency bands (see the datasheet for the details of each commonly used frequency band), and in the parts with temperature compensation, no bias line temperature stabilizing resistor is needed.

I. EiC InGaP HBT offers Reliability and Quality

EiC proprietary InGaP HBT provides excellent reliability and is used in infrastructure industry. The InGaP HBT is inherently superior to AlGaAs HBT. The surface defect density in InGaP is much lower than AlGaAs.

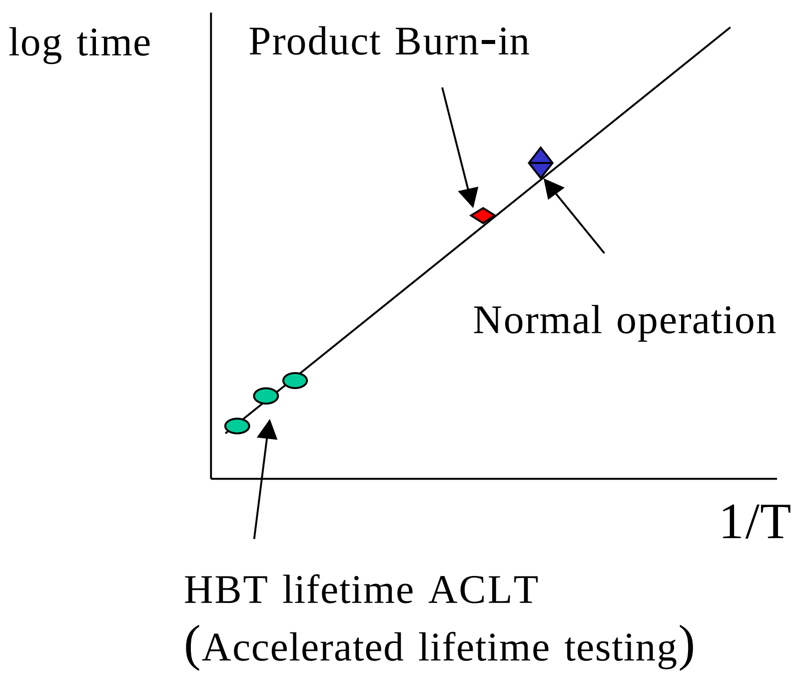


Figure 1. Drawings to show the consistency of the transistor life test and product burn-in

However, not all InGaP HBTs are equal. The HBT life test of EiC InGaP HBT has gone through 315^oC junction temperature and 50kA/cm^2 for over 6000 hours (8 ½ months), translating to multi-million hours lifetime or longer in the operation envelop [1]. **This kind of life test is far superior to the conventional AlGaAs HBT, and many other reported InGaP HBT**.

The InGaP HBT product would go through product burn-in test as well. A large sample group, usually 100 pieces, goes through burn-in test at ambient temperature of 125 to 145 ^oC for 1000 hours. The FIT can be calculated based on the number of failed devices, activation energy, etc. The MTTF is simply 1/FIT. This MTTF should agree with the HBT life test result when HBT is the dominant failure mechanism (not other IC components like resistor, inductor, capacitor, etc). This is shown in Fig. 1.

The agreement between the MTTF of HBT from life test and the FIT is essential: it validates both tests. If there is a large discrepancy [2], the quality claim can be flawed. Figure 1 describes the scenario. When a short life test result and high activation energy are derived, a really long operation time can be mistakenly claimed when another low activation energy mechanism is not identified.

II. Careful Thermal Design of the High Linearity Amplifier

Although the High Linearity Amplifier series only offers medium power level (<25dBm), the thermal design is still a key factor affecting the reliability. Even for a low power amplifier, if the HBT cells are closely spaced on the IC die, the transistor junction temperature can still be high, negatively affecting the reliability.

Utilizing EiC's experience on Power Amplifiers, each high linearity Amplifier is carefully designed and laid out to provide a low thermal resistance. The ballasting is also carefully crafted, which is a must for any bipolar transistor (Si BJT, SiGe BJT, AlGaAs/GaAs HBT, InGaP/GaAs HBT, HBT family on InP substrate).

III. High Linearity

HBT is known for its high linearity [3]. Applying this feature to the High Linearity Amplifier, a high OIP3 amplifier is made.

Compared with other transistor technology, InGaP HBT has easy process control which allows the OIP3 to be maintained in volume production.

IV. Broad Operation Frequency Range

The high linearity amplifier family requires external matching components to achieve good 50 ohm matching. They can be matched for any commonly used application to 3GHz. The datasheet covers the recommended matching circuits for each frequency band. No expensive high-Q capacitors are used to keep the cost minimal.

Since an external matching circuit is required, the PCB grounding inductance also requires attention. A high grounding inductance layout on PCB could cause gain reduction. The recommended layout is in the datasheet. Multiple via holes are recommended for both low electrical grounding inductance and low thermal resistance.

The amplifier is biased through an inductor as an RF choke. User can choose the value for each application frequency band. The choke inductor needs to be able to accommodate the bias current. DC blocking capacitors at both input and output are required as well.

V. Temperature Stabilization

All bipolar transistors have a negative temperature coefficient for V_{be}(temperature). For Si BJT, it is about –2mV/^{o}C, and for GaAs HBT -1mV/^{o}C. As a result, the I-V curve of the circuit will shift to lower voltage as temperature rises. This is more severe in Si BJT circuit with the twice as large temperature coefficient.

EC1089 and ECG009 in the high linearity amplifier family have a built in temperature compensation circuit. They can be biased from a 5V supply directly without using a temperature stabilizing resistor between the power supply and the RF choke.

ECG014 and ECG015 have no temperature compensation built inside the IC. Although they can operate from a 5V power supply, the temperature variation may exceed the application limit. A temperature stabilizing resistor inserted between the power supply and the RF choke can reduce the performance variation over temperature due to bias current change. However a temperature stabilizing resistor means the power supply voltage has to be higher than 5V.

Conclusion

EiC's InGaP HBT High Linearity Amplifier Series offer high linearity, good gain, and high reliability. Careful thermal design assures a cool operation temperature. Cross-check between the product burn-in and the transistor life test result validates both tests. This series of products will best serve the infrastructure market.

Reference

[1]. "InGaP HBTs offer Enhanced Reliability", Barry Lin, Applied Microwave and Wireless. pp 115-116, Dec. 2000

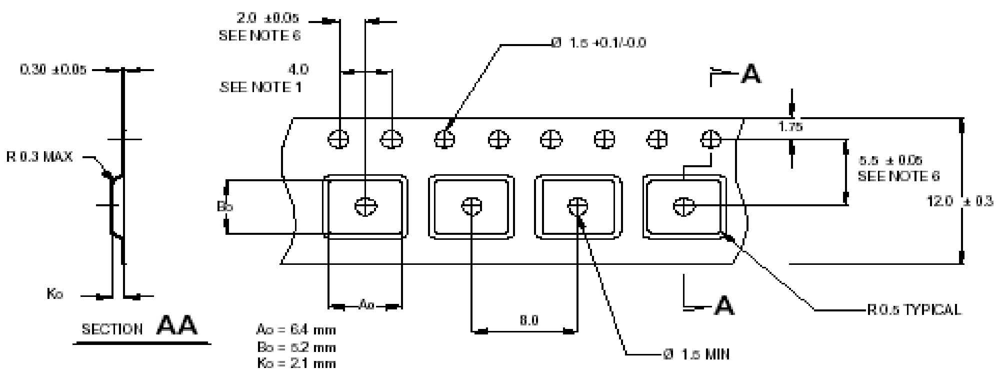
[2] Darrel Hill, John Parsey, "Motorola Digital DNA^{TM} Laboratory, 2100 E. Elliot Rd., Tempe, Arizona 85284

[3] N.L. Wang, W.J.Ho, J.A. Higgins, "AlGaAs/GaAs HBT Linearity Characteristics", IEEE Trans. Microwave Theory Tech., pp.1845-1850, vol. 42, no.10, Oct. 1994

TAPE AND REEL SPECIFICATION
SOT-89

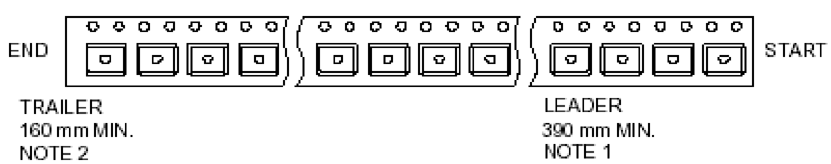
1. EMBOSSED TAPE.

2. TAPE DIMENSIONS. (ALL DIMENSIONS ARE IN MILLIMETERS)



1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ± 0.2.
2. CAMBER NOT TO EXCEED 1 mm IN 100 mm.
3. MATERIAL: BLACK CONDUCTIVE POLSTYRENE.
4. Ao AND Bo MEASURED ON A PLANE 0.3 mm ABOVE THE BOTTOM OF THE POCKET.
5. Ko MEASURED FROM A PLANE ON THE INSIDE BOTTOM OF THE POCKET TO THE TOP SURFACE OF THE CARRIER.
6. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE.

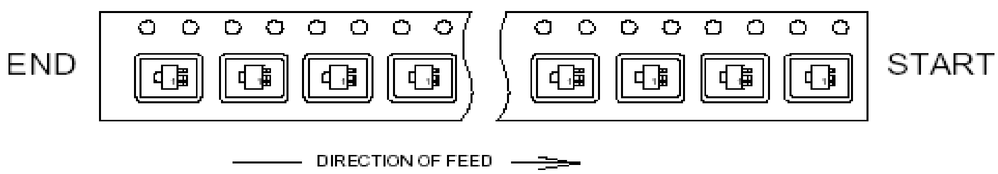
3. TAPE LEADER AND TRAILER DIMENSIONS



1. THERE SHALL BE A LEADER OF 230 mm MINIMUM WHICH MAY CONSIST OF CARRIER AND/OR COVER TAPE FOLLOWED BY A MINIMUM OF 160 mm OF EMPTY CARRIER TAPE SEALED WITH COVER TAPE.

2. THE TRAILER OF 160 mm MUST BE SEALED WITH COVER TAPE AND MUST RELEASE FROM THE REEL HUB UPON COMPLETION, WITHOUT DAMAGE.

4. COMPONENT ORIENTATION.



5. REEL DIMENSIONS