EiC Corp.
Excellence in Communications

PRELIMINARY DATA SHEET

ECM011

Dual Mode Cellular Band CDMA 3.5V POWER AMPLIFIER MODULE

Features

- Cellular Band CDMA/AMPS
- Quiescent Current Control
- Single 3.5V Supply for 3-Cell Ni or Li-Ion Battery
- 31.5dBm AMPS Power with 48% Efficiency
- 28dBm CDMA Power with 35% Efficiency
- 16dBm CDMA Power with 9% Efficiency

Features

- Power-Down Capability
- Temperature Compensation Circuit for Icq

Applications

- 3.5V CDMA/AMPS Cellular Handsets

Description

The ECM011 is a power amplifier module at 3.5V Vcc with high efficiency. This device was developed using EiC's own InGaP Heterojunction Bipolar Transistor (HBT) process. It is optimized for cellular CDMA (digital) in the 824MHz to 849MHz band. It operates from a positive voltage (3.2 - 4.2V Vcc) and includes a power-down feature. The input and output are both matched to 50Ω. It is housed in a 6 X 6 mm Land Grid Array package. A proprietary temperature compensated bias circuit provides nearly a constant Icq from -40°C to +85°C in the low power mode. A Q control pin switches the quiescent current to 50mA for low output power range.

Electrical Specifications

Test Conditions: Ta = 25°C, V_{CC} = +3.5 V, $V_{REF/PD}$ (reference / power-down voltage) = +2.9 V, F = 824 to 849MHz

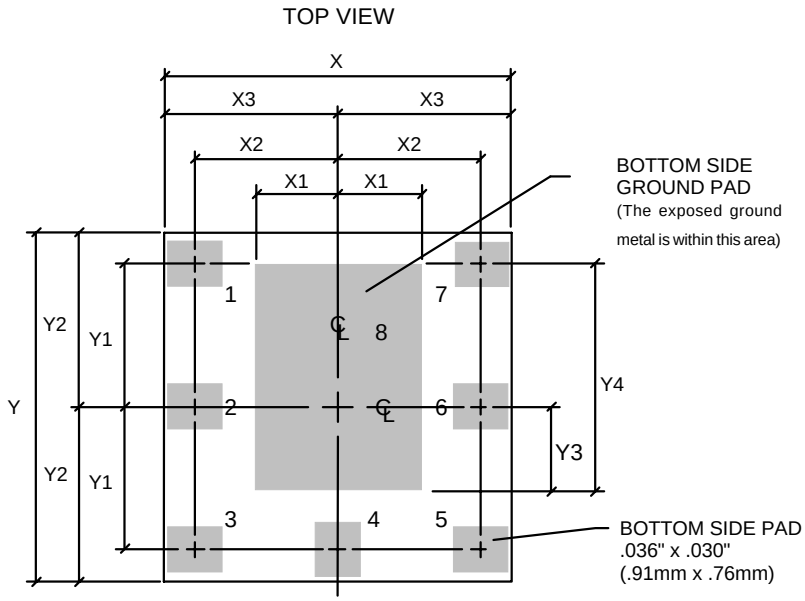
SYMBOL	PARAMETER	LIMITS			UNIT	TEST CONDITION
		MIN.	TYP.	MAX.		
F	Frequency	824		849	MHz	
G	Gain (CDMA Modulation)	26	29		dB	
P	Output Power (CDMA)	28			dBm	NOTE 1
ACPR	Adjacent Channel Power Rejection		-48	-46	dBc	NOTE 2
Alt CPR	Alternate Channel Power Rejection		-60	-56	dBc	NOTE 3
PAE	Power Added Efficiency (CDMA) @ 28.0dBm	30	35		%	High Power Mode
PAE1	Power Added Efficiency (CDMA) @ 16.0dBm		9		%	Low Power Mode
P_{SAT}	Output Power (AMPS)		31.5		dBm	
PAE	Power Added Efficiency (AMPS)		48		%	
	Output Load Stability 6:1 All Phase Angles			-60	dBc	
	Tolerance for output VSWR Mismatch		10:1			No Damage
I_{CQ}	Quiescent Current (No RF)		50	65	mA	Low Power Mode
I_{CQ}	Quiescent Current (No RF)		100	140	mA	High Power Mode
	Leakage Current Vcc = 3.5V, Vref = 0V		3	10	uA	
Ipd	Vref/pd Supply Current		1		mA	
$V_{ref/pd}$	Supply Voltage		2.9		V	
V_{cc}	Supply Voltage	3.2	3.5	4.2	V	
Vq	Vq Voltage (High Power Mode)	0.0		0.8	V	
Vq	Vq Voltage (Low Power Mode)	2.0	2.8		V	
IRL	Input Return Loss		10		dB	
NF	Noise Figure		4.5	6.0	dB	
	Noise Power		-135		dBm/Hz	
	Harmonics, 2f, 3f, 4f			-40	dBc	
$T_{ON/OFF}$	Power Down On/Off Time		<100		ns	
$T_{hi/Low}$	Switching time between output power levels		6		usec	
NOTE 1: Using Application Schematic. Tuned for CDMA.						
NOTE 2: @ 885KHz offset from band center, Pout ≤ 28dBm, High/Low mode						
NOTE 3: @ 1980KHz offset from band center, Pout ≤ 28dBm, High/Low mode						

CAUTION!
SENSITIVE ELECTRONIC DEVICE

PACKAGE DIMENSIONS AND MARKINGS

The ECM011 is a laminate base, overmold encapsulated modular package designed for surface-mounted solder attachment to a printed circuit board.

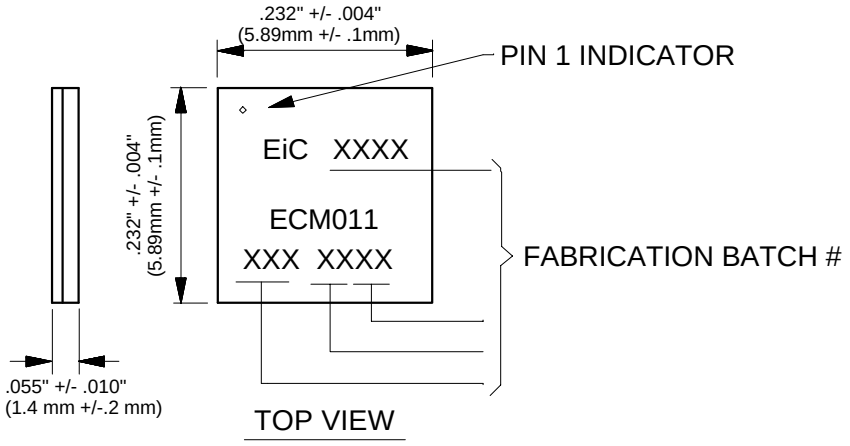
Package Dimensions



SYMBOL	ENGLISH inch ± .004	METRIC mm± 0.1
X	.232	5.89
X1	.055	1.40
X2	.095	2.41
X3	.116	2.95
Y	.232	5.89
Y1	.095	2.41
Y2	.116	2.95
Y3	.055	1.40
Y4	.150	3.81

PINOUT
PIN 1 Vcc1
PIN 2 RFin
PIN 3 Vpd
PIN 4 Vq
PIN 5 Vcc2
PIN 6 RFout
PIN 7 Gnd
PIN 8 Gnd

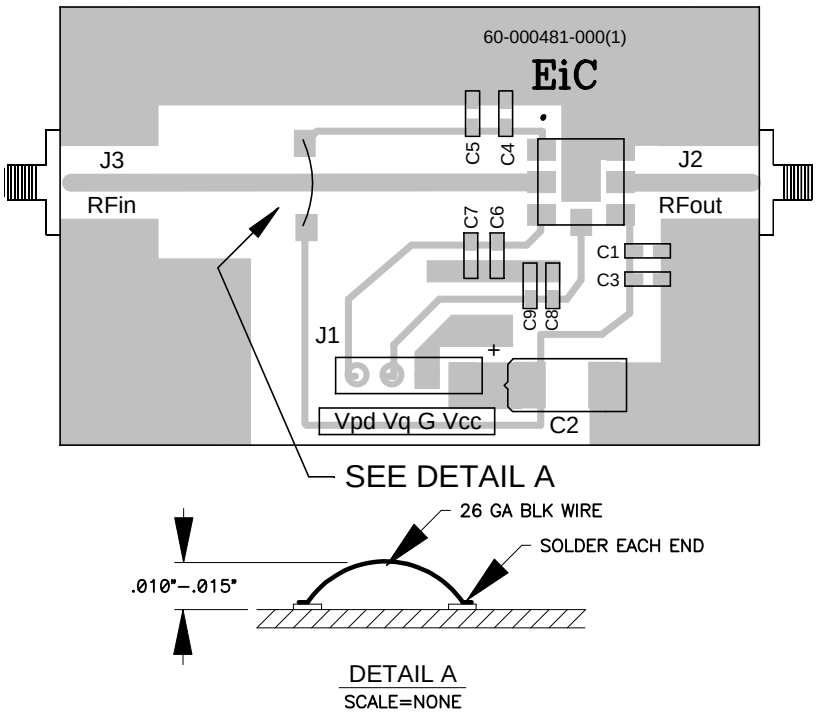
Device Marking



PCB LAYOUT

1. The front side of the pcb ground area under the PAM requires the use of multiple vias to provide low thermal resistance to the backside of the pcb ground.

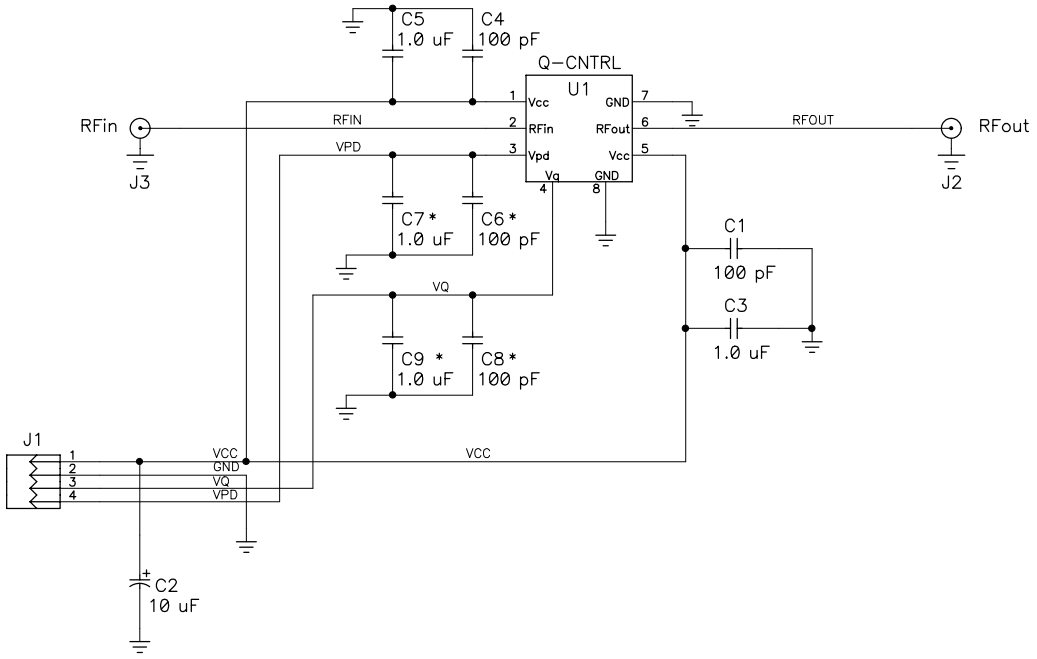
EVAL BOARD



QTY	DESIGNATOR	VALUE	DESCRIPTION	MANUFACTURER &P/N	
4	C1, C4, C6, C8	100pF	CAPACITOR, 0603	ROHM MCH185A101JK	NOTE 1
4	C3, C5, C7, C9	1.0uF	CAPACITOR, 0603	ROHM MCH182F105ZK	NOTE 1
1	C2	10 uF	CAPACITOR, 6032	PANASONIC ECS-HICC106R	NOTE 1
2	J2, J3		SMA CONNECTOR	CDI 5260CC	NOTE 1
1	U1	ECM011	IC	EiC Corp	
1	---	---	26 GA, WIRE .5”	ANY	
1	J1	---	CONNECTOR, RT. ANG	SULLINS PZC04SGAN	
		---	PCB	EiC Corp 60-000481-000(1)	

1. EiC RECOMMENDED COMPONENTS ARE SHOW. EQUIVALENT COMPONENTS MAY BE USED.
NOTES: UNLESS OTHERWISE SPECIFIED

SCHEMATIC



* C6,C7 and C9,C10 WERE ADDED ON THE Vpd and Vq LINES ON THE EVALUATION BOARD AS PROTECTION AGAINST POWER SUPPLY VOLTAGE OVERSHOOT TRANSIENT.
WHEN DOING THE SWITCHING SPEED TEST ON THOSE PINS, THE CAPACITORS SHOULD BE DISCONNECTED.

Figure 1

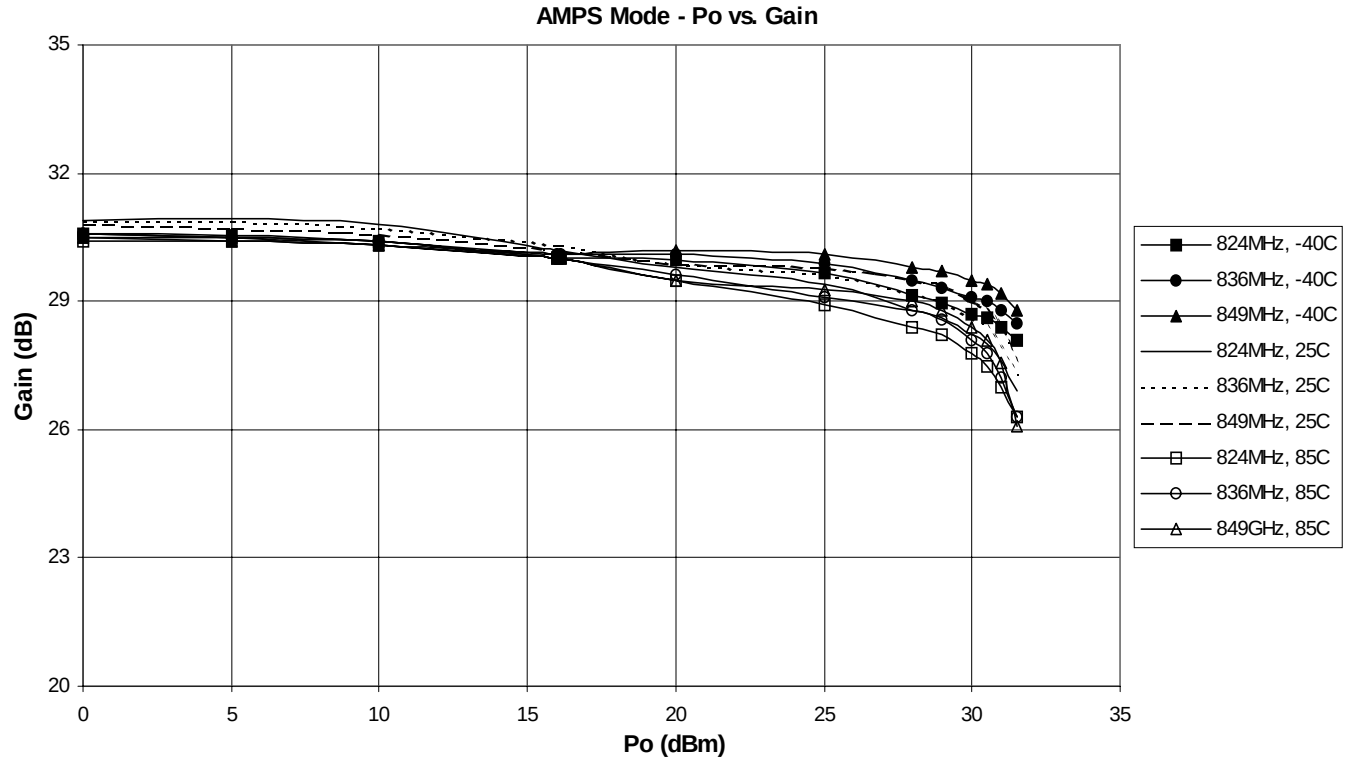


Figure 2

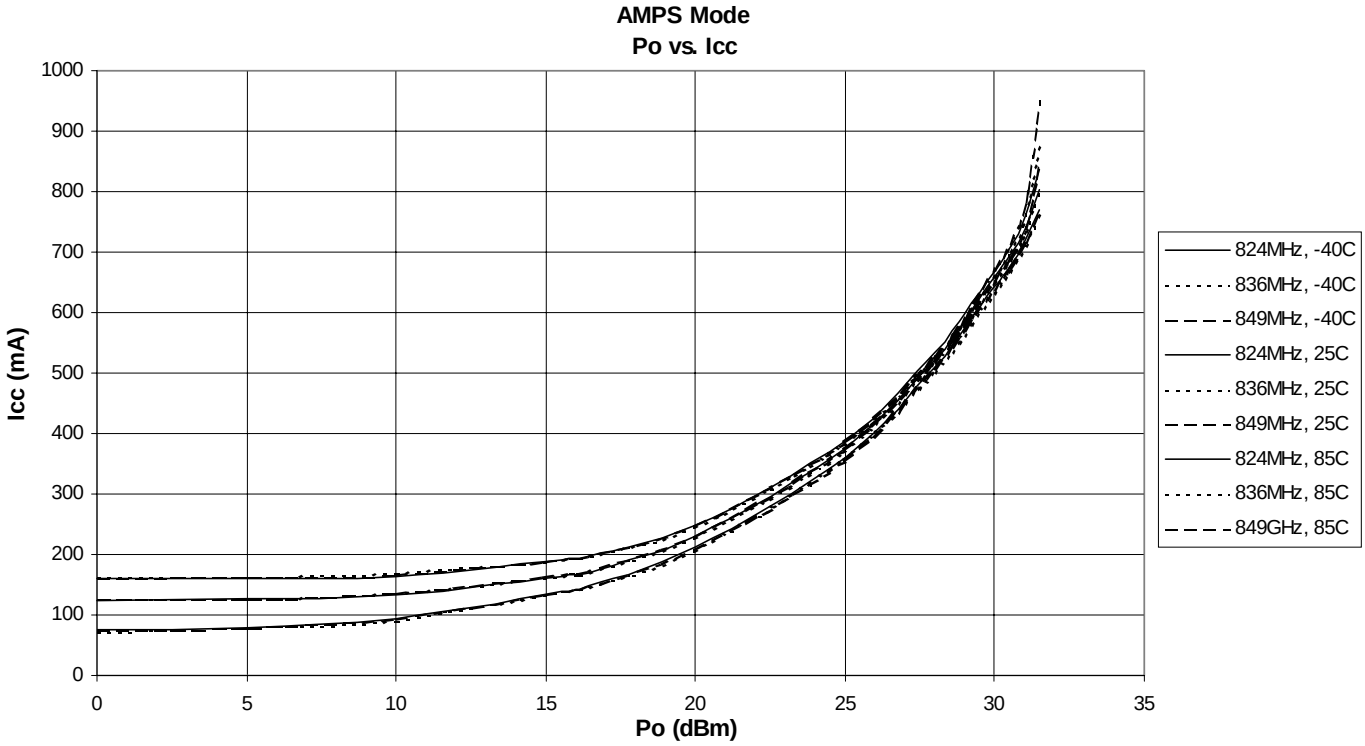


Figure 3

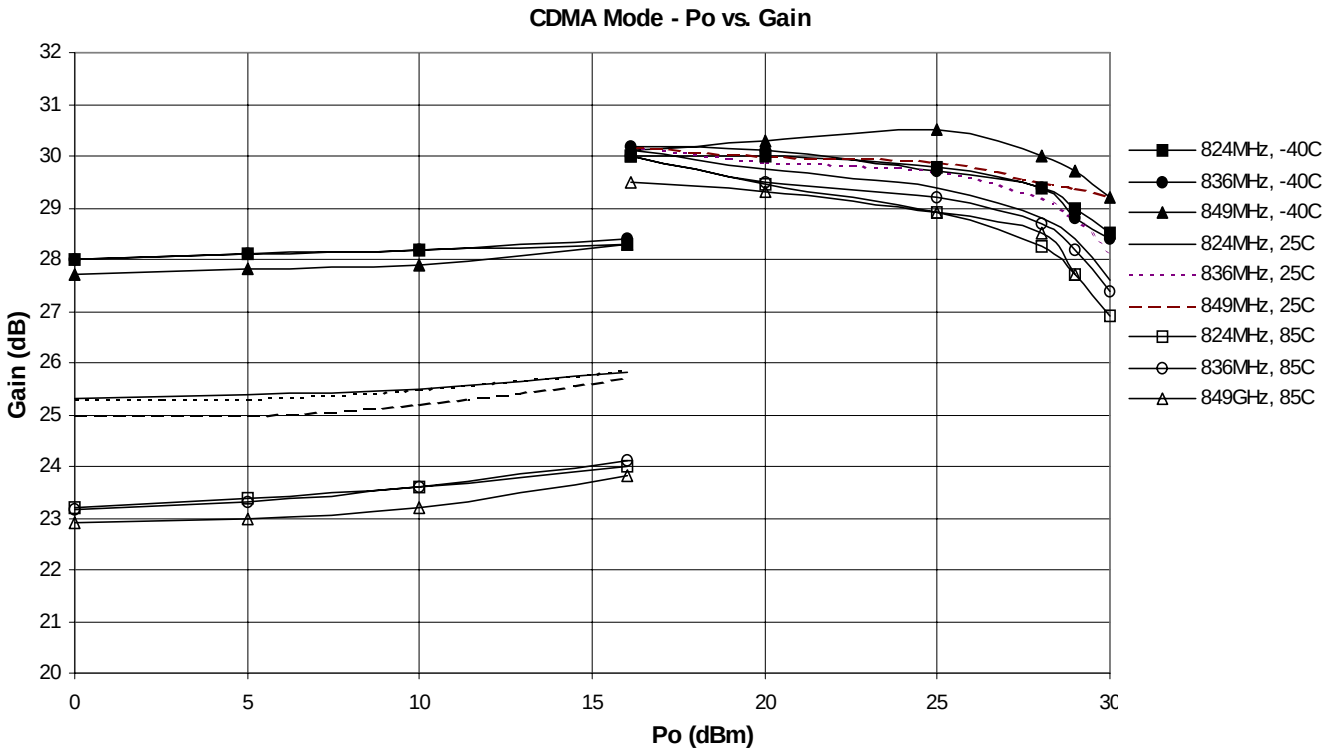


Figure 4

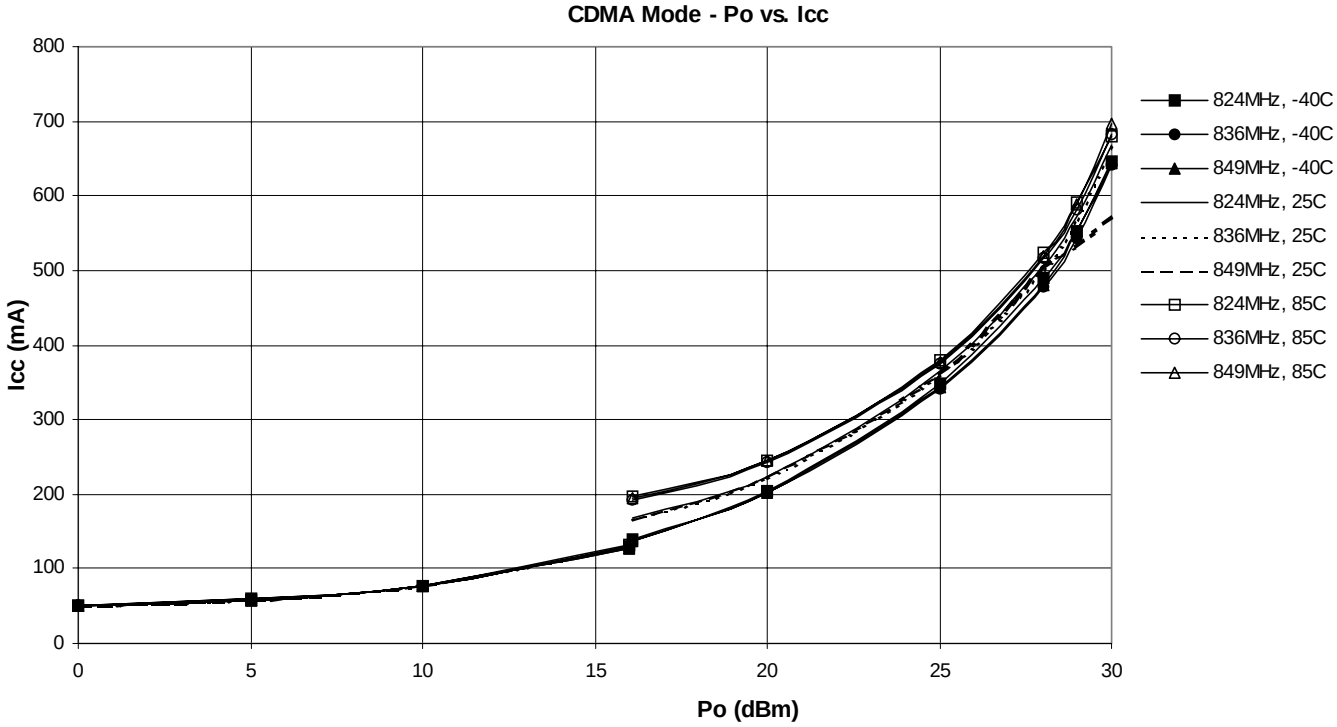


Figure 5

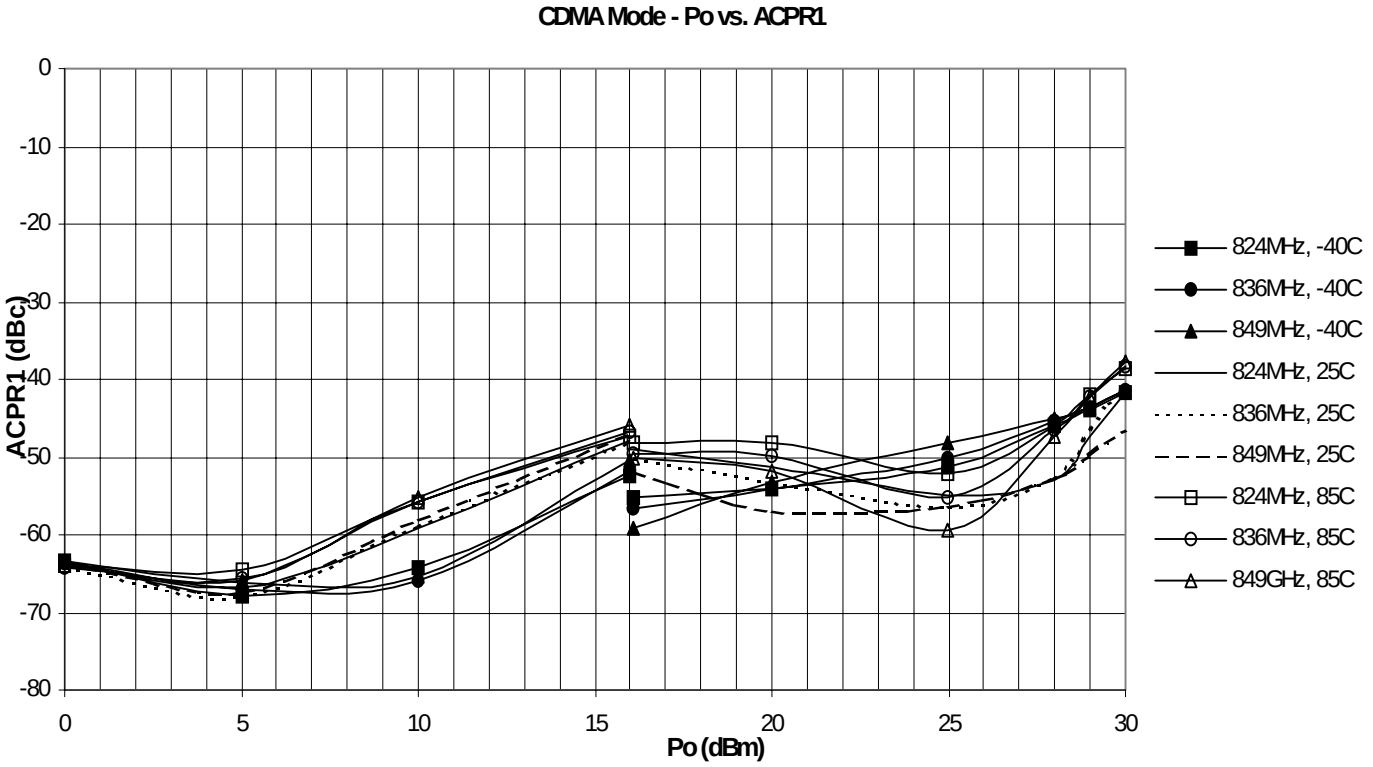
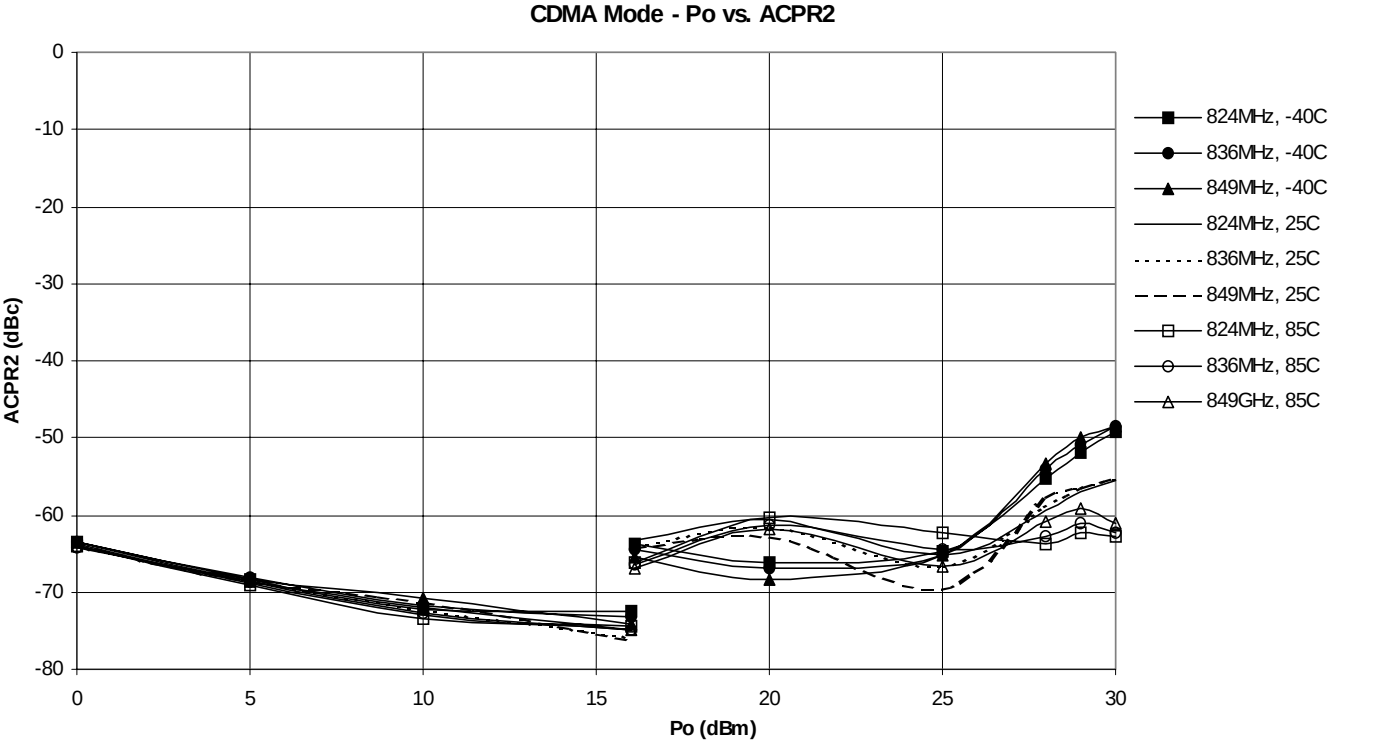


Figure 6



ECM011 Operating Principles and Key Features

ECM011 is a 6x6mm size Power Amplifier Module (PAM) for cellular band CDMA (digital) and AMPS (analog) handset market..
The PAM utilizes InGaP HBT technology and a multi layer laminate base, over molded modular package with a LGA signal pad.

I. In GaP HBT offers Reliability and Quality

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

The HBT life test of EiC InGaP HBT has gone through 315^{o}C junction temperature and 50kA/cm^{2} for over 6000 hours (8 ½ months), translating to multi-million hours lifetime or longer in the operation envelope [1]. This kind of robust performance is far superior to conventional AlGaAs HBT.

The InGaP HBT PAM goes through a product burn-in test as well. A large sample group, usually 100 pieces, goes through burn-in test at an ambient temperature of 125 to 145 ^{o}C for 1000 hours. The FIT number is than calculated based upon the data collected. The MTTF is simply 1/FIT, this MTTF should agree with the HBT life test results.

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 may be flawed.

Although handset applications do not have as stringent operating requirements as the infrastructure market, the high reliability of InGaP HBT offers an assurance to the user of a high quality product designed for high volume production.

II. InGaP HBT and Patent-pending Circuit Design Offers Low Temperature Variation

Current gain of InGaP HBT varies about 10% over –40 to +85^{o}C range, compared with 50% of AlGaAs HBT. This low gain variation over temperature, coupled with the patent-pending circuit design approach, provides for more stable electrical performance.

III. ECM011 Offers High Gain and Margin for Transmitter Chain Design

The typical gain of the ECM011 is 29dB. This high gain allows the driver amplifier to run very linear which results in reduced current. Taking into account the 3dB loss of the BPF in front of the PAM, the driver needs to deliver only 4dBm linear power. The P_{1dB} of the driver amplifier should be more than 10dBm.

If a lower gain PAM is used, the driver needs to provide more power, at the expense of more operation current and possible degradation in ACPR.

Therefore the ECM011 can replace a lower gain PAM, this allows the driver to work at a lower output power and provide better ACPR, this improved performance offers more design margin in the transmitter chain.

IV. Easy Shut Down and Low Leakage Current

The V_{cc} pin of the PAM is connected directly to the battery, therefore a shut down FET is not required. A voltage is applied to the V_{ref} pin, which then brings up the quiescent current. A Q control pin switches the quiescent current to 50mA for the low output power range. The low power range is below 16dBm; the high power range is from 16dBm to full power.

Removing the voltage applied to V_{ref} pin, the quiescent current will drop to a small leakage current, typically <10uA. The low leakage current of the PAM allows for a longer standby time for the phone.

V. General Application

The PAM requires a minimal number of external components. Both the input and output are dc-blocked within the PAM as shown in the function diagram. The input pin is connected to ground through a shunt inductor within the PAM.

ECM011 is designed with a low quiescent current of 50mA typical in the low power mode. At full CDMA power of 28dBm, the operation current will be greater than 500mA. Therefore it is a “quasi class B” or “deep class AB” amplifier. The operation current increases with output power.

CDMA signal has a time varying amplitude. The peak power is 4dB above the average RF power (it can be more accurately defined by PDF, power density function). As the peak power is clipped by the amplifier saturation power level, the distortion of the signal will cause the ACPR to deteriorate rapidly. Therefore the P_{1dB} (as tested by a SINE wave) of the amplifier should be over 31dBm to provide good ACPR at 28 dBm of output power.

A 100pF capacitor is required adjacent to the V_{cc2} pin. In addition, a large capacitor (>uF) is required. The CDMA signal has a time-varying amplitude; therefore the PAM draws on operation current corresponding to the instantaneous demand by the RF power. The large capacitor near-by is the electric charge reservoir, providing current on demand. The long electrical path from battery behaves as a large inductor; the instantaneous demand on current will cause a voltage drop, resulting in poor ACPR.

On the evaluation board, a large shunt capacitor is added to protect the V_{ref} pin from power supply over-voltage during ON/OFF. This is similar but different from the ESD. Therefore the rise and fall time test of the power down feature needs to be tested with the shunt capacitor on V_{ref} pin removed.

Conclusion

ECM011 offers high gain, low quiescent current, and a small footprint. The InGaP technology provides excellent reliability and quality, assuring the phone set manufacturer a high quality product designed for high volume production.

Reference

1. “InGaP HBTs offer Enhanced Reliability”, Barry Lin, Applied Microwave and Wireless. pp 115-116, Dec. 2000
2.” Interaction of Degradation Mechanisms in Be-Doped GaAs HBTs”, Darrell Hill and John Parsey, Digest GaAs IC Symposium, Oct., 2000. pp 241-244

APPLICATION NOTES

Please visit our website at www.eiccorp.com to view or download the following documents. You may also call our Customer Service to request a hardcopy.

Document #	Description
AP-000513-000	Tape and Reel Specifications: PAMS
AP-000516-000	Application Note Index