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FMA3011

12.7GHZ TO 16GHZ MMIC POWER AMPLIFIER

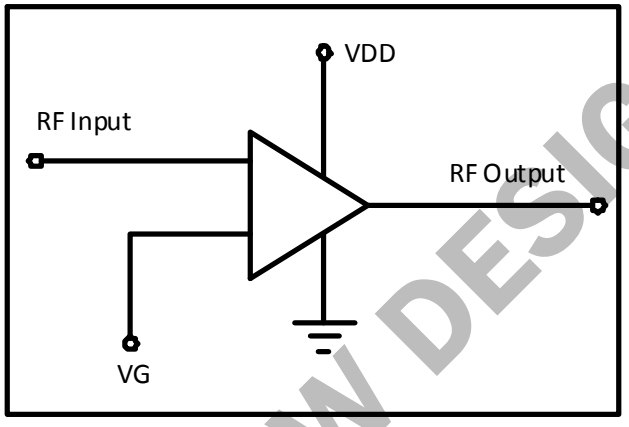
Package Style: Bare Die

Product Description

The FMA3011 is a high performance 12.7GHz to 16GHz Gallium Arsenide monolithic power amplifier with sufficiently high gain to ensure that IMD products from preceding stages can be kept to an absolute minimum. Coupled with the low IMD of this device, highly linear system performance can be achieved, while preserving the overall system gain requirements. It is suitable for use in digital microwave radios and electronic warfare applications. Balanced configuration using Lange couplers ensures excellent return losses and tolerance to external. The input stage is self-biased.

Optimum Technology Matching® Applied

- ☐ GaAs HBT
- ☐ GaAs MESFET
- ☐ InGaP HBT
- ☐ SiGe BiCMOS
- ☐ Si BiCMOS
- ☐ SiGe HBT
- ✓ GaAs pHEMT
- ☐ Si CMOS
- ☐ Si BJT
- ☐ GaN HEMT
- ☐ InP HBT
- ☐ RF MEMS
- ☐ LDMOS



Features

- Balanced Topology
- 37dBm OIP_3
- 30dB Gain
- Input Return Loss<-15dB
- Output Return Loss<-15dB

Applications

- Electronic Warfare
- Broadband Communication Infrastructure
- Cellular Backhaul
- Point-to-Point Radio

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Electrical Specifications					On wafer.
Small Signal Gain	27.7	30.5	32.3	dB	13GHz, pulsed
	25.2	28.5	31.7	dB	15GHz, pulsed
Input Return Loss		-13	-10.7	dB	12.5GHz to 15.5GHz, V_{DD}=5V, V_G=-0.5V
Output Return Loss		-14	-13.7	dB	12.5GHz to 15.5GHz, V_{DD}=5V, V_G=-0.5V
P1dB	26	29.2	32	dBm	13GHz to 15GHz, pulsed
OIP_3	35.5	37		dBm	13GHz, measured at 22dBm total output power
	35.5	37		dBm	15GHz, measured at 22dBm total output power
Noise Figure		4.1	4.5	dB	13GHz
		4.7	5.3	dB	15GHz
Self-bias Current	40	60	100	mA	Total for both input stages.

Note: $T_{AMBIENT}$=+25°C, Z_0=50Ω

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Absolute Maximum Ratings

Parameter	Rating	Unit
Max Input Power (P_{IN})	+25	dBm
Gate Voltage (V_{G1})	-2	V
Drain Voltage (V_{DD})	+10	V
Power Dissipation (P_{DISS})	3.5	W
Operating Temperature (T_{OPER})	-40 to 85	°C
Storage Temperature (T_{STG})	-55 to 150	°C

Caution! ESD sensitive device.

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

RoHS status based on EU Directive 2002/95/EC (at time of this document revision).

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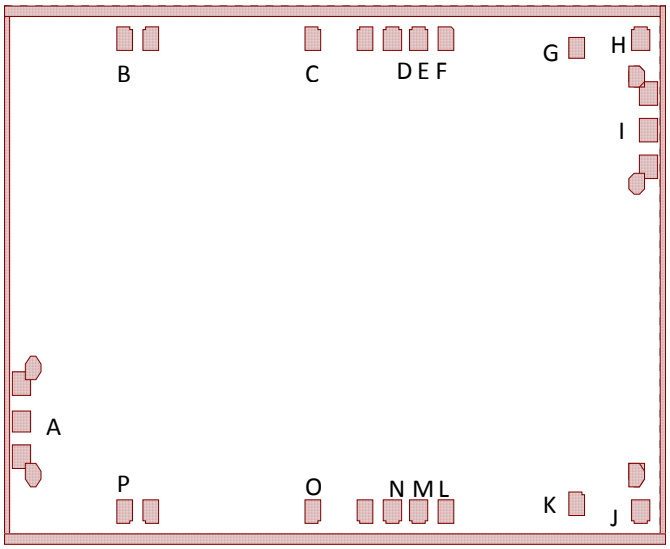
Pad Layout



Pad	Name	Description	Pin Coordinates (μm)
A	I	RF input	96, 503
B	D1A	1st stage drain	671, 2068
C	G23A	2nd and 3rd gate	1721, 2068
D	D2AA	2nd drain direct	2171, 2068
E	D2AB	2nd drain with resistor	2321, 2068
F	D3AB	3rd drain with resistor	2471, 2068
G	D3AC	Alt 3rd drain direct	3198, 2040
H	D3AA	3rd stage drain direct	3560, 2068
I	O	RF output	3604, 1698
J	D3BA	3rd stage drain direct	3560, 132
K	D3BC	Alt 3rd drain direct	3198, 160
L	D3BB	3rd drain with resistor	2471, 132
M	D2BB	2nd drain with resistor	2321, 132
N	D2BA	2nd drain direct	2171, 132
O	G23B	2nd and 3rd gate	1721, 132
P	D1B	1st stage drain	671, 132

Note: Coordinates are referenced from the bottom left corner of the die to the center of bond pad opening. pads without identifiers are ground connections used in wafer testing.

Die Size (μm)	Die Thickness (μm)	Min. Bond Pad Pitch (μm)	Min. Bond Pad Opening (μmxμm)
3700x2200	100	150	88x88

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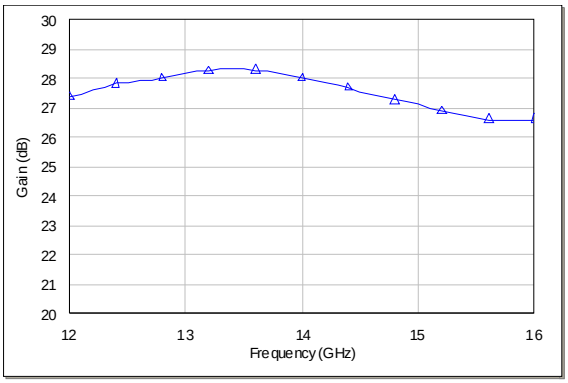
Typical Measured Performance On Wafer

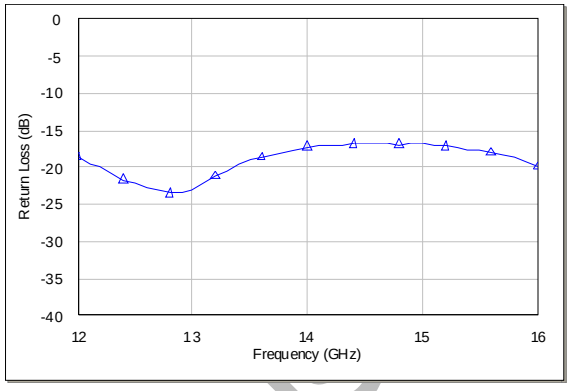
Conducted at lower bias point. Gain increases to the typical value at full bias.

$T_{AMBIENT}$=25°C, I_D=180mA, V_{DD}=5V, V_{G1}=-0.5V

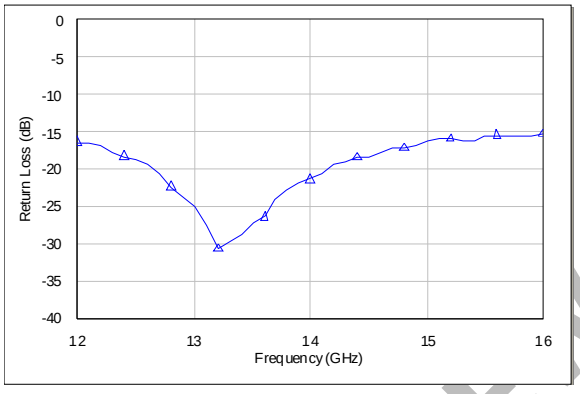
Gain



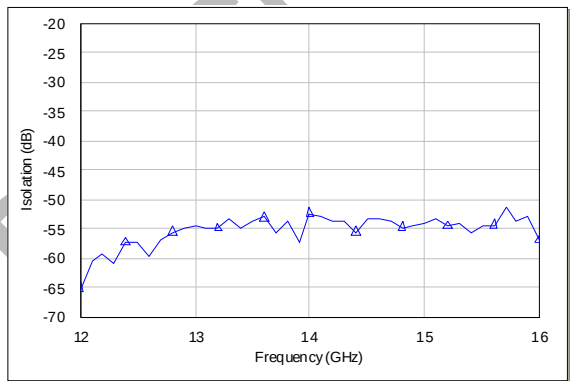
Input Return Loss



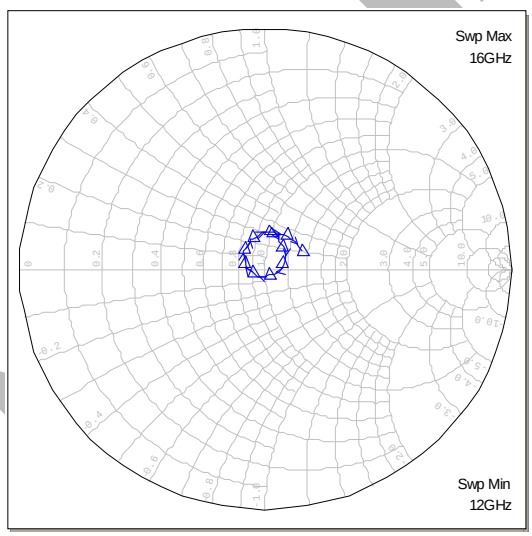
Output Return Loss



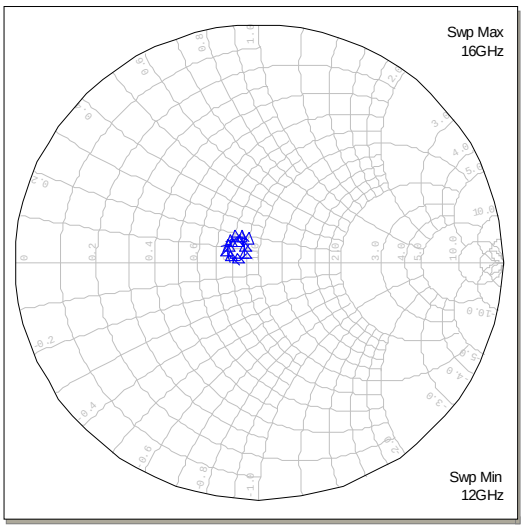
Reverse Isolation



Input Impedance



Output Impedance



Typical Measured Performance On Wafer

Conducted at lower bias point. Gain increases to the typical value at full bias.

$T_{AMBIENT}$=25°C, I_D=180mA, V_{DD}=5V, V_{G1}=-0.5V

Frequency	S11		S21		S12		S22	
	Re	Im	Re	Im	Re	Im	Re	Im
12.000000	0.02862	0.14634	-6.67930	22.40440	-0.00002	-0.00055	-0.08042	0.08541
12.100000	0.04739	0.14199	-3.50866	23.34877	0.00065	-0.00070	-0.06926	0.08047
12.200000	0.05071	0.13091	-0.24776	23.97320	0.00030	-0.00104	-0.06486	0.07525
12.300000	0.05901	0.11523	3.18014	24.08470	0.00038	-0.00081	-0.05980	0.06616
12.400000	0.07374	0.09515	6.72798	23.70643	0.00028	-0.00133	-0.05717	0.05895
12.500000	0.08162	0.07863	10.21719	22.56068	0.00054	-0.00128	-0.05739	0.05220
12.600000	0.08652	0.06465	13.39561	21.06022	0.00018	-0.00102	-0.05660	0.04683
12.700000	0.08131	0.04328	16.42668	18.92982	0.00102	-0.00101	-0.05818	0.03881
12.800000	0.07224	0.02250	19.08678	16.47102	0.00107	-0.00128	-0.05909	0.03077
12.900000	0.06434	-0.00163	21.43423	13.71294	0.00135	-0.00114	-0.06285	0.02316
13.000000	0.05353	-0.01339	23.36681	10.66305	0.00138	-0.00131	-0.06789	0.01570
13.100000	0.03684	-0.02027	24.87215	7.07652	0.00152	-0.00090	-0.07716	0.01088
13.200000	0.01690	-0.02392	25.72424	3.35031	0.00157	-0.00083	-0.08625	0.00932
13.300000	-0.00248	-0.03228	26.09245	-0.53323	0.00209	-0.00036	-0.09435	0.00948
13.400000	-0.01801	-0.03173	25.70407	-4.42088	0.00170	-0.00056	-0.10434	0.01258
13.500000	-0.03347	-0.02676	24.80453	-8.34490	0.00205	-0.00013	-0.11028	0.01474
13.600000	-0.04619	-0.01233	23.09648	-11.90000	0.00219	-0.00038	-0.11522	0.01902
13.700000	-0.06234	-0.00087	21.00504	-15.11085	0.00164	0.00006	-0.12067	0.02500
13.800000	-0.07110	0.00140	18.32389	-17.87180	0.00200	0.00062	-0.12163	0.02956
13.900000	-0.07895	0.01599	15.46391	-20.31469	0.00136	0.00027	-0.12588	0.03534
14.000000	-0.08032	0.02743	12.11258	-22.07279	0.00233	0.00054	-0.13015	0.04070
14.100000	-0.08049	0.04620	8.78339	-23.44850	0.00222	0.00064	-0.13013	0.04824
14.200000	-0.08831	0.06197	5.16222	-24.30297	0.00178	0.00106	-0.12897	0.05541
14.300000	-0.08713	0.07151	1.55327	-24.54886	0.00197	0.00069	-0.12704	0.06067
14.400000	-0.08305	0.08453	-2.05811	-24.14934	0.00129	0.00105	-0.12680	0.06672
14.500000	-0.07201	0.09639	-5.39476	-23.34800	0.00180	0.00118	-0.12620	0.07174
14.600000	-0.06335	0.11361	-8.61700	-22.07628	0.00192	0.00099	-0.12231	0.07730
14.700000	-0.06197	0.12273	-11.48291	-20.37179	0.00166	0.00126	-0.11860	0.08131
14.800000	-0.04812	0.12781	-14.12595	-18.29621	0.00163	0.00080	-0.11485	0.08523
14.900000	-0.03018	0.13962	-16.44033	-15.96085	0.00146	0.00120	-0.11173	0.09098
15.000000	-0.00996	0.15195	-18.40505	-13.31864	0.00124	0.00156	-0.10638	0.09579
15.100000	0.00530	0.15823	-19.86278	-10.37735	0.00121	0.00175	-0.10103	0.09968
15.200000	0.01873	0.15667	-20.88333	-7.40515	0.00121	0.00143	-0.09553	0.10018
15.300000	0.03561	0.15014	-21.43556	-4.37013	0.00093	0.00176	-0.08894	0.10282
15.400000	0.05833	0.14512	-21.67941	-1.27367	0.00029	0.00159	-0.08270	0.10265
15.500000	0.07723	0.14294	-21.46588	1.79864	0.00053	0.00179	-0.07516	0.10419
15.600000	0.09221	0.13881	-20.88945	4.79123	0.00064	0.00179	-0.06926	0.10464
15.700000	0.10365	0.12732	-19.93439	7.75941	0.00080	0.00255	-0.06143	0.10268
15.800000	0.12069	0.11209	-18.55769	10.59434	-0.00001	0.00210	-0.05579	0.10057
15.900000	0.13756	0.08919	-16.75654	13.19331	0.00010	0.00229	-0.04917	0.09557
16.000000	0.15418	0.07345	-14.71157	15.56911	-0.00011	0.00142	-0.04345	0.09163

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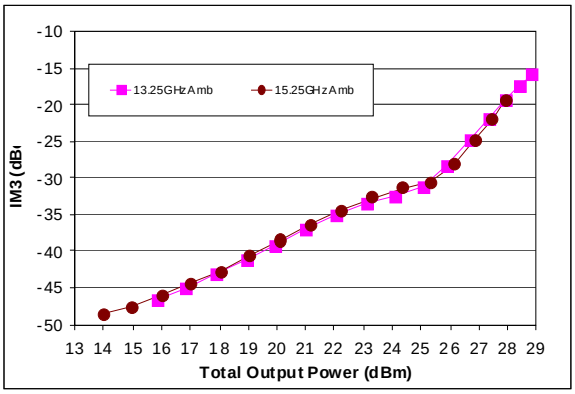
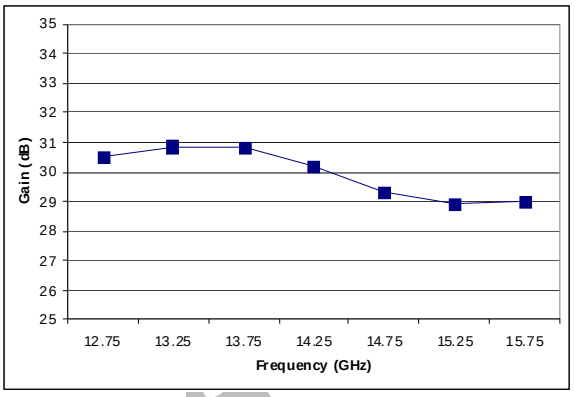
Typical Performance for Full Bias Jig-Based Measurements

I_D=450mA, V_{DD}=7V, V_G=-0.35V

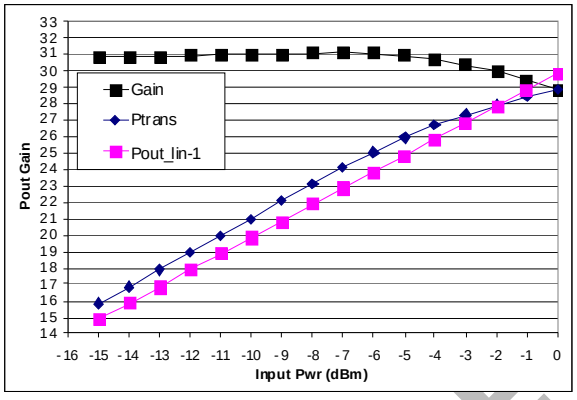
IM3 Level (dBc) versus Total Output Power (dBm)



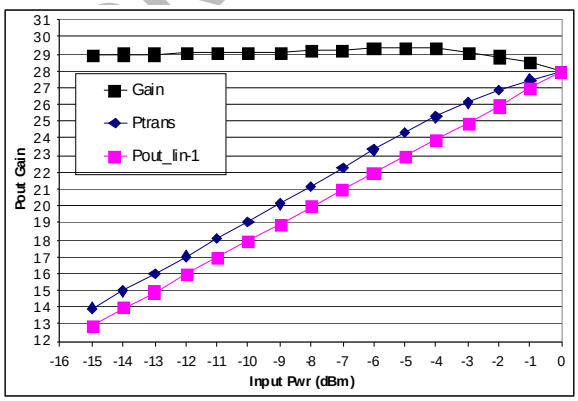
Gain



Power Transfer Characteristic 13GHz P1dB



Power Transfer Characteristic 15GHz P1dB



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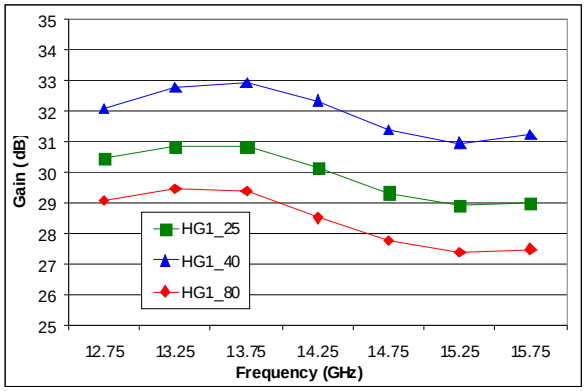
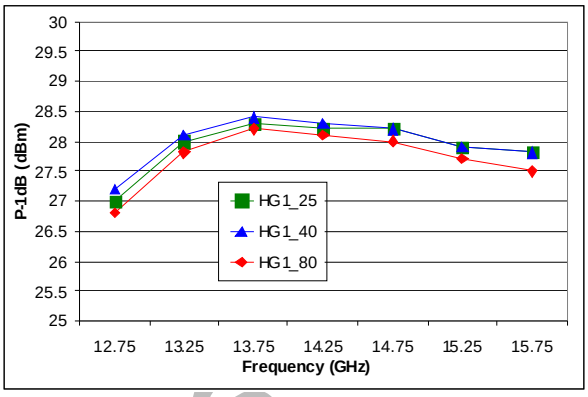
Typical Performance for Full Bias Jig-Based Measurements

I_D=450mA; V_{DD}=7V; V_G=-0.35V; $T_{AMBIENT}$=-40°C, +25°C, +80°C

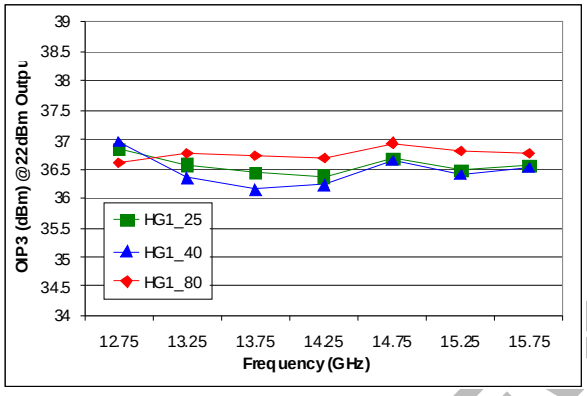
Gain



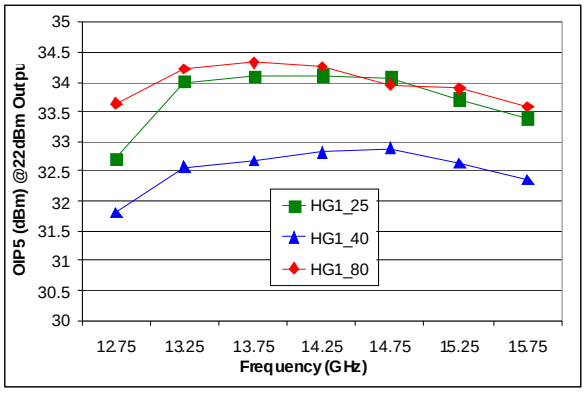
1dB Compression Point



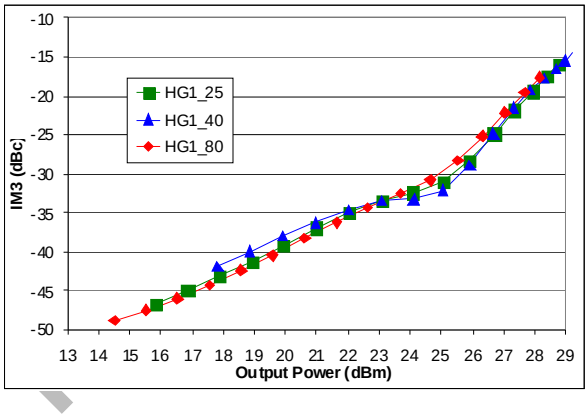
Third Order Output Intercept Point (OIP_3)



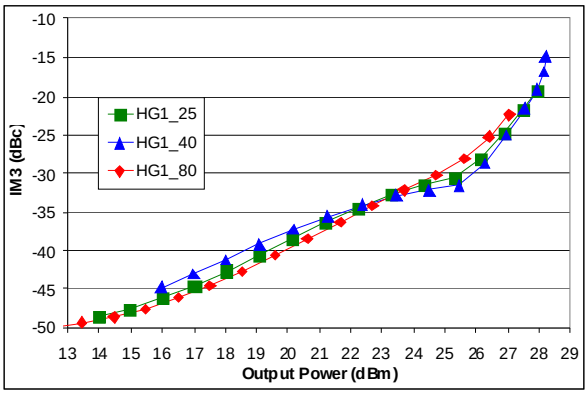
Third Order Output Intercept Point (OIP_5)



13.25GHz IM3 Level versus Output Power



15.25GHz IM3 Level versus Output Power



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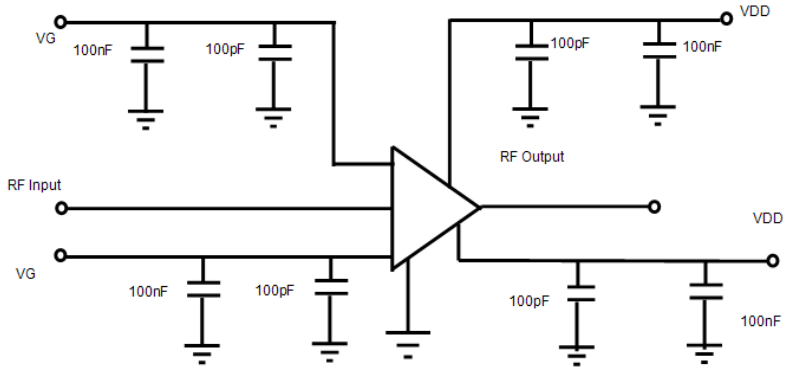
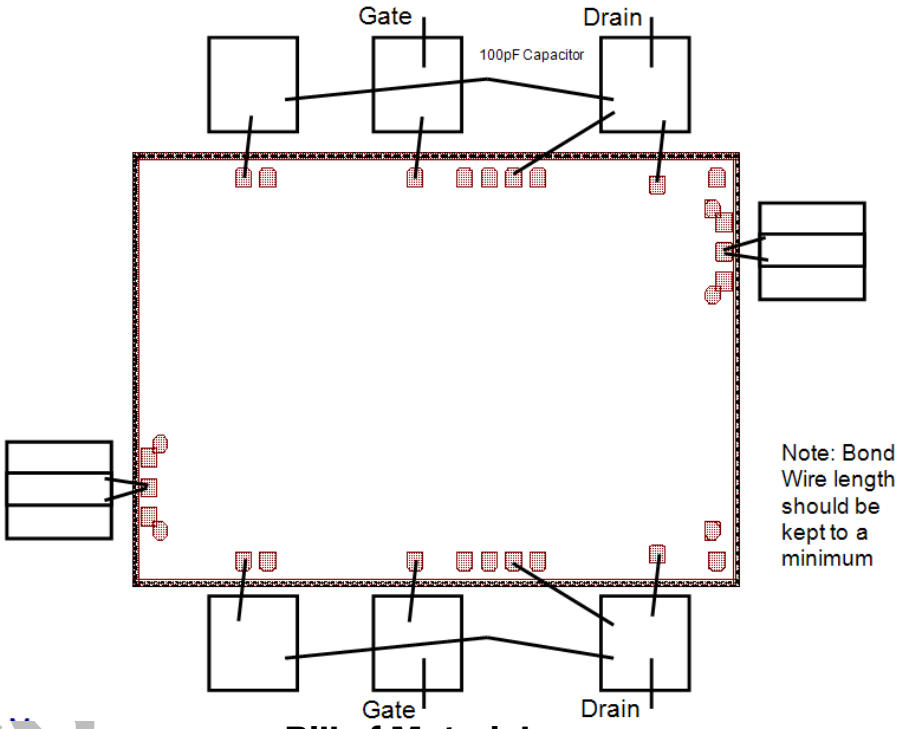
Biasing Circuit Schematic



Assembly Diagram

Dimensions in millimeters.



Bill of Materials

All RF tracks should be 50Ω characteristic material.		
C1 Capacitor	100pF	Chip Capacitor
C2 Capacitor	100nF	0402

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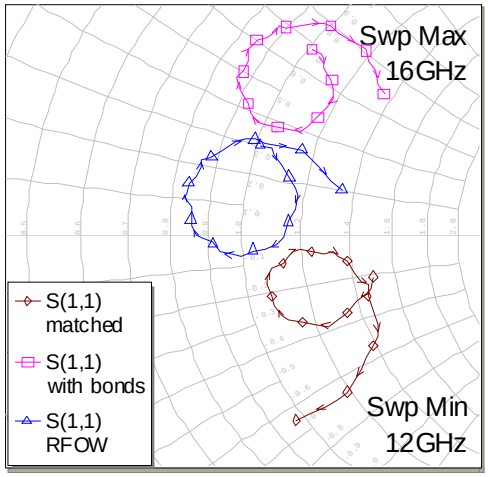
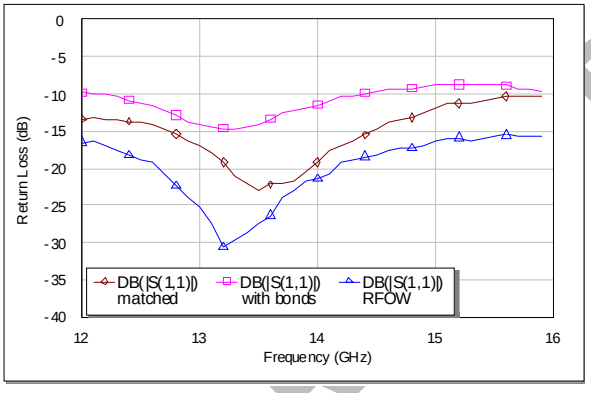
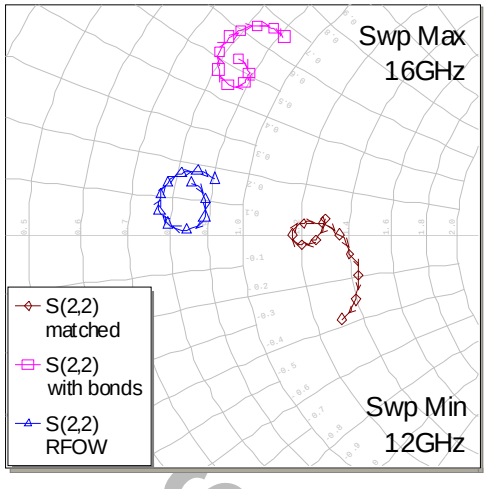
Effect of Bondwires and Bond Compensation

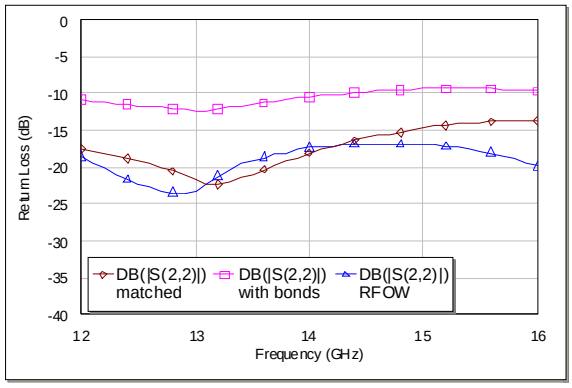
A pair of bondwires in the V formation as shown in the figure above should, if kept reasonably short, yield a combined inter-connect inductance of below 0.25nH. The FMA3011 has excellent return losses (blue triangles) and these are modified by the addition of a 0.25nH bondwire inductance (pink squares) as shown in the figures below.



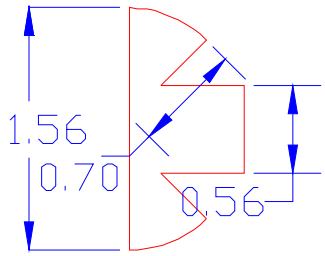


Once bonded the return losses are still at a reasonable level. They can be improved with a simple compensation network. The figures also show the effect of this bondwire compensation network (brown diamonds). The network is shown at the end of this section.





Dimensions in mm. Material is 10 thou 4350 Er=3.38.



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Preferred Assembly Instructions

GaAs devices are fragile and should be handled with great care. Specially designed collets should be used where possible.

The back of the die is metallized and the recommended mounting method is by the use of conductive epoxy or solder. If conductive epoxy is used it should be applied to the attachment surface uniformly and sparingly to avoid encroachment of epoxy on to the top face of the die and ideally should not exceed half the chip height. For automated and manual dispense Ablebond 8350M is recommended. Ablestick 84-1 can be used as an alternative. These should be cured at a temperature of 150°C for 1 hour in an oven especially set aside for epoxy curing only. If possible the curing oven should be flushed with dry nitrogen. The gold-tin (80% Au 20% Sn) eutectic die attach has a melting point of approximately 280 °C but the absolute temperature being used depends on the leadframe material used and the particular application. The maximum time at used should be kept to a minimum.

This part has gold (Au) bond pads requiring the use of gold (99.99% pure) bondwire. It is recommended that 25.4µm diameter gold wire is used. For thermosonic ball bonding a nominal stage temperature of 150°C and a bonding force of 40g has been shown to give effective results for 25µm wire. Ultrasonic energy shall be kept to a minimum. For this bonding technique, stage temperature should not be raised above 200 °C and bond force should not be raised above 60g. Thermosonic wedge bonding and thermocompression wedge bonding can also be used to achieve good wire bonds.

Bonds should be made from the die first and then to the mounting substrate or package. The physical length of the bondwires should be minimized especially when making RF or ground connections.

Handling Precautions

To avoid damage to the devices, care should be exercised during handling. Proper Electrostatic Discharge (ESD) precautions should be observed at all stages of storage, handling, assembly, and testing.

ESD/MSL Rating

These devices should be treated as Class 0 (0V to 250V) using the human body model as defined in JEDEC Standard No. 22-A114. Further information on ESD control measures can be found in MIL-STD-1686 and MIL-HDBK-263. This is an unpackaged part and therefore no MSL rating applies.

Application Notes and Design Data

Application Notes and design data including S-parameters, noise data, and large signal models are available on request at www.rfmd.com.

Reliability

An MTTF of 4.2 million hours at a channel temperature of 150 °C is achieved for the process used to manufacture this device.

Disclaimers

This product is not designed for use in any space-based or life-sustaining/supporting equipment.

Ordering Information

Quantity	Ordering Code
Standard order quantity (waffle pack)	FMA3011-000
Small quantity (25)	FMA3011-000SQ
Sample quantity (3)	FMA3011-000S3

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