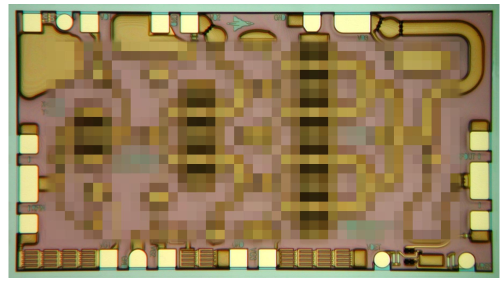
12.0-16.0 GHz GaAs MMIC Power Amplifier

January 2009 - Rev 23-Jan-09

XP1043-BD
RoHS

Features

- 32 dBm Saturated RF Power
- 41 dBm Output IP3 Linearity
- 17 dB Gain Control
- On-Chip Power Detector
- 100% RF Testing



General Description

The XP1043-BD is a linear power amplifier that operates over the 12.0-16.0 GHz frequency band. The device provides 21.5 dB gain and 41 dBm Output Third Order Intercept Point (OIP3) across the band. The amplifier is comprised of a three stage power amplifier with an integrated, temperature compensated on-chip power detector. The device includes on-chip ESD protection structures and DC by-pass capacitors to ease the implementation and volume assembly of the part. The device is manufactured in GaAs PHEMT device technology with BCB wafer coating to enhance ruggedness and repeatability of performance. XP1043-BD is well suited for Point-to-Point Radio, LMDS, SATCOM and VSAT applications.

Absolute Maximum Ratings[1,4]

Supply Voltage (Vd1,2,3)	+10.0V
Supply Current (Id1,2,3)	1500 mA
Gate Bias Voltage (Vg1,2,3)	-3V
Max Power Dissipation (Pdiss)	5.5W
RF Input Power	+19 dBm
Operating Temperature (Ta)	-55 to +85 ºC
Storage Temperature (Tstg)	-65 to +150 ºC
Channel Temperature (Tch)	-40 to MTTF Graph[2]

(1) Note: Minimum specifications are set under nominal (typ.) bias conditions. Bias can be adjusted higher to achieve greater linearity and power; however, maximum total power dissipated is specified at 5.5 W.
(2) Channel temperature directly affects a device's MTTF. Channel temperature should be kept as low as possible to maximize lifetime.

Electrical Characteristics (Ambient Temperature T = 25 ºC)[4]

Parameter	Units	Min.[3]	Typ.	Max.
Frequency Range (f)	GHz	12.0	-	16.0
Small Signal Gain (S21)	dB	19.0	21.5	
Input Return Loss (S11)	dB	10.0	15.0	
Output Return Loss (S22)	dB	10.0	10.0	
Reverse Isolation (S12)	dB		55.0	
P1dB	dBm		30.0	
Psat	dBm	31.0	32.0	
OIP3 at Pout = 18 dBm per Tone	dBm	40.0	41.0	
Power Detector Range	dB	-	37.0	-
Drain Bias Voltage (Vd1,2,3)	VDC		7.0	9.0
Detector Bias Voltage (Vdet,ref)	VDC		5.0	
Gate Bias Voltage (Vg1,2,3)	VDC	-2	-1.0	0.0
Supply Current (Id1)	mA		100	200
Supply Current (Id2)	mA		200	400
Supply Current (Id3)	mA		400	800

(3) Minimum specifications are set under nominal (typ.) bias conditions. Bias can be adjusted higher to achieve greater linearity and power.
(4) All specifications and data relate to packaged version, XP1043-QH, of the amplifier.

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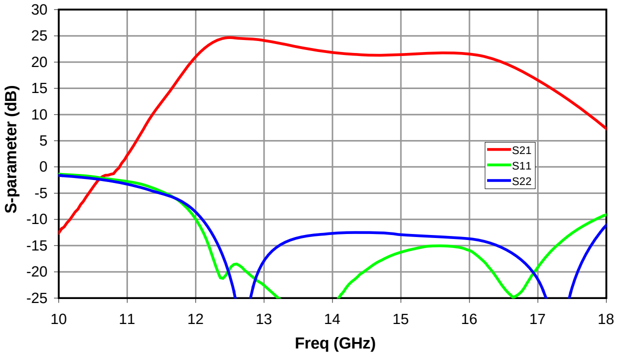
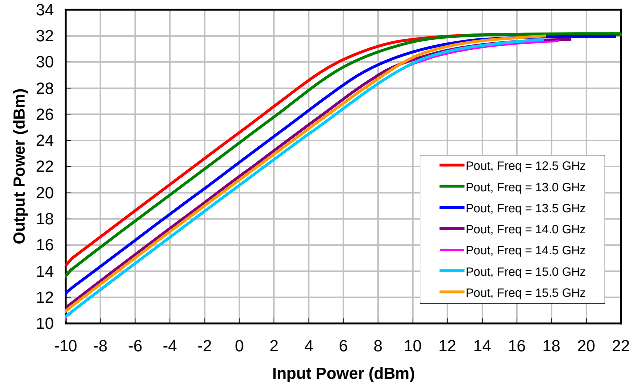
Power Amplifier Measurements (Packaged Version, XP1043-QH)

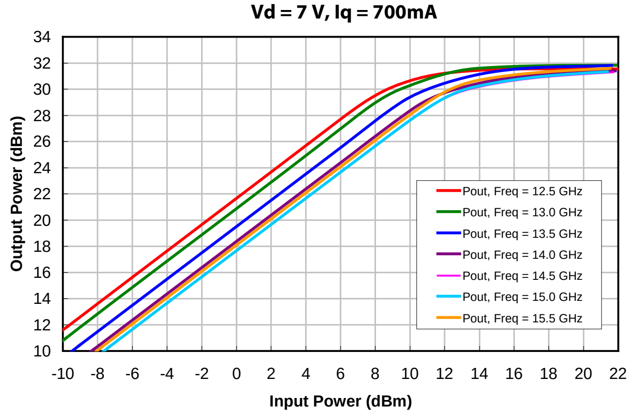
XP1043-QH: S-parameters (dB) vs. Freq (GHz), (VDD=7V, ID1=100mA, ID2=200mA, ID3=400mA)



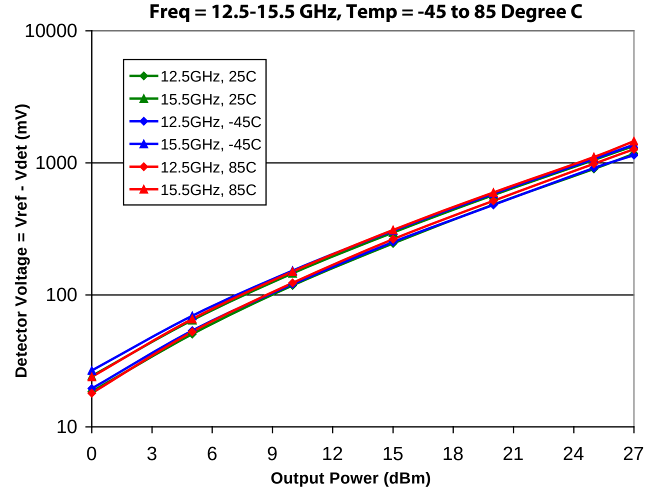
XP1043-QH: Pout (dBm) vs Pin (dBm) at Room Temp. Vd = 7 V, Iq = 700mA



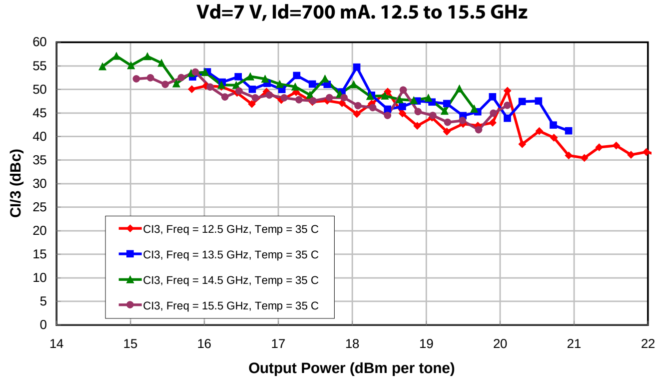
XP1043-QH: Pout (dBm) vs Pin (dBm) at +85 °C. Vd = 7 V, Iq = 700mA



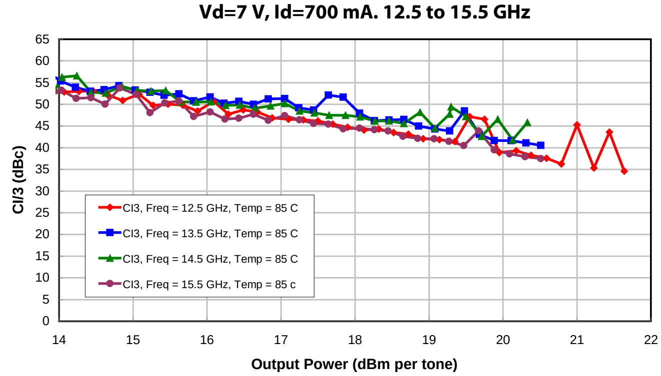
XP1043-QH: V_Detect (mV) vs Output Power (dBm) Freq = 12.5-15.5 GHz, Temp = -45 to 85 Degree C



XP1043-QH: C/I3 (dBc) vs Pout per Tone (dBm) at Room Temp. Vd=7 V, Id=700 mA. 12.5 to 15.5 GHz

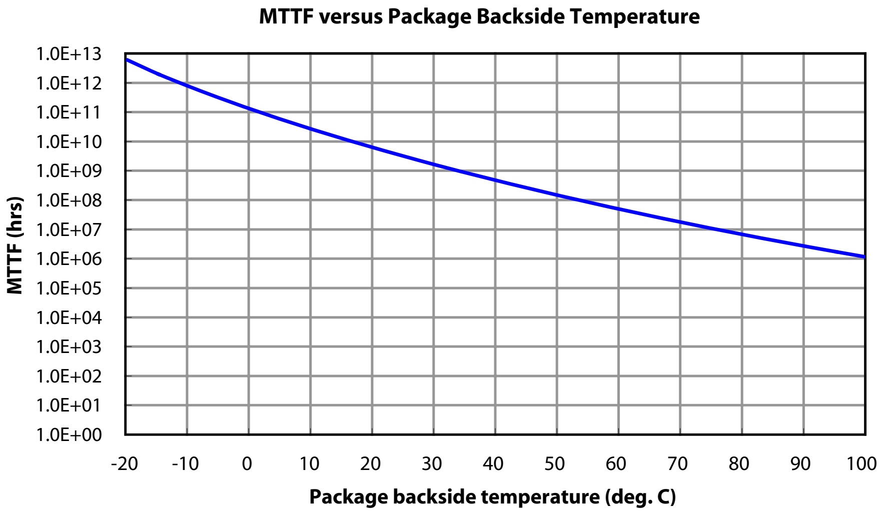


XP1043-QH: C/I3 (dBc) vs Pout per Tone (dBm) at at +85 °C. Vd=7 V, Id=700 mA. 12.5 to 15.5 GHz

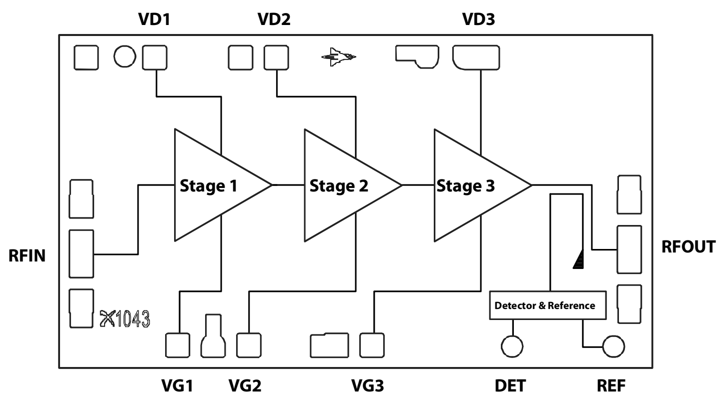


MTTF (Packaged Version, XP1043-QH)

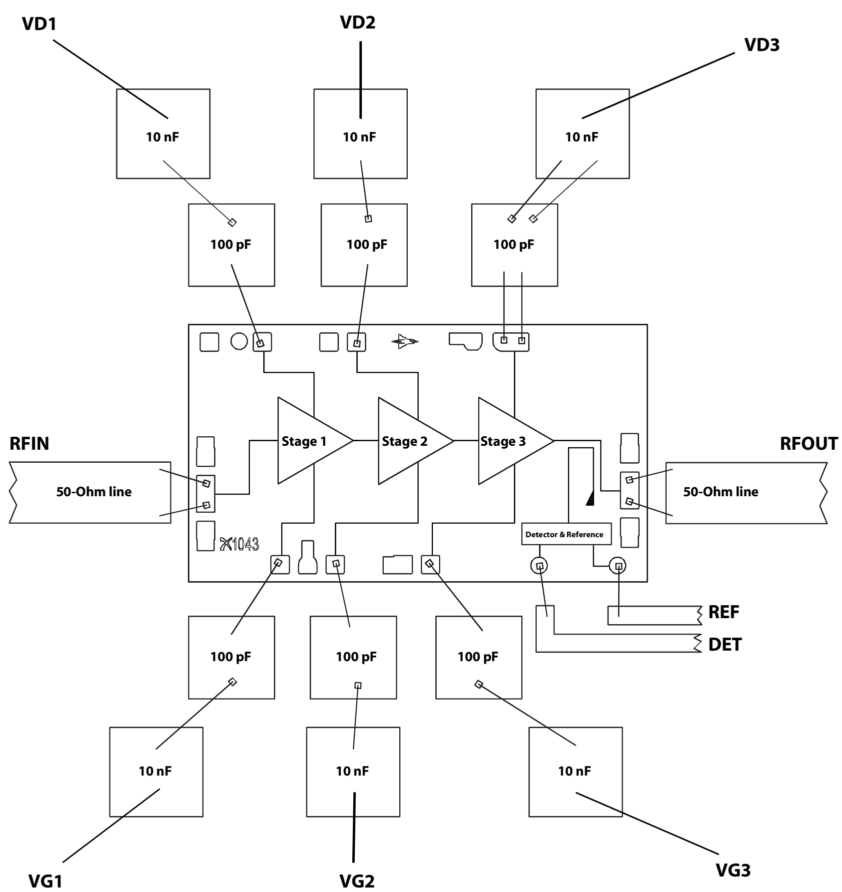
These numbers were calculated based on accelerated life test information and thermal model analysis received from the fabricating foundry.



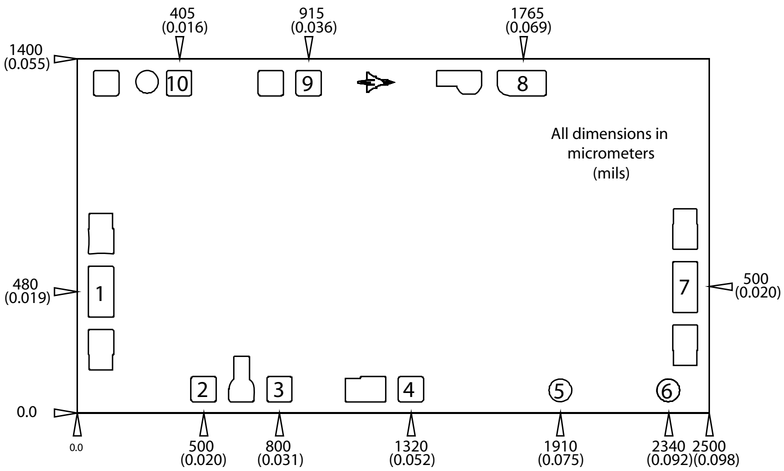
Functional Schematic



Recommended Board Layout & Bonding Diagram



Die Mechanical Drawing

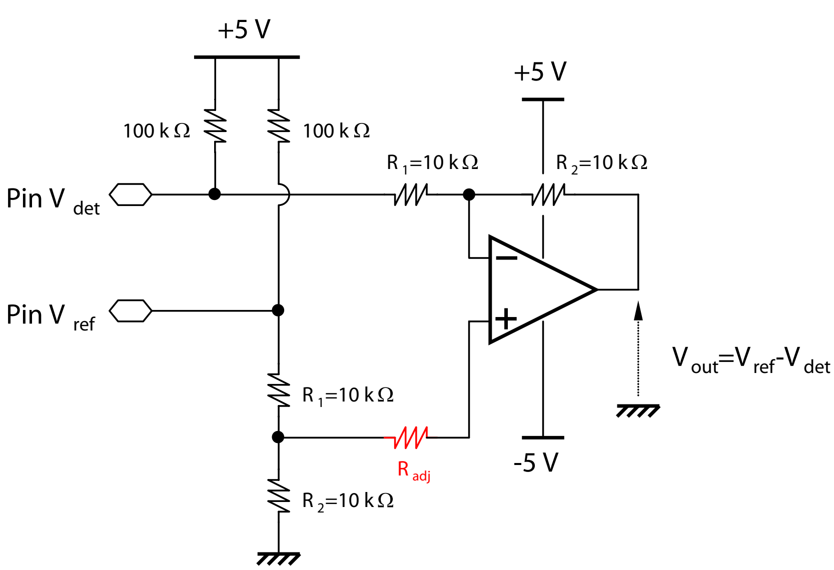


Pad Designations

Pin Number	Pin Name	Pin Function	Nominal Value
1	RF In	RF Input	-
2	VG1	Gate 1 Bias	-1.0V
3	VG2	Gate 2 Bias	-1.0V
4	VG3	Gate 3 Bias	-1.0V
5	DET	Detector Output	+5.0V Bias through 100 kOhm resistor
6	REF	Reference Output	+5.0V Bias through 100 kOhm resistor
7	RF Out	RF Output	-
8	VD3	Drain 3 Bias	7.0V, 100 mA
9	VD2	Drain 2 Bias	7.0V, 200 mA
10	VD1	Drain 1 Bias	7.0V, 400 mA

App Note [1] Biasing - As shown in the Pin Designations table, the device is operated under the nominal bias conditions of VD1,2,3 at 7.0V with 100, 200, 400mA respectively. It is recommended to use active bias to keep the currents constant in order to maintain the best performance over temperature. Under heavy RF saturation the device will tend to self bias and pull the desired drain current. Depending on the supply voltage available and the power dissipation constraints, the bias circuit may be a single transistor or a low power operational amplifier, with a low value resistor in series with the drain supply used to sense the current. The gate of the PHEMT is controlled to maintain correct drain current and thus drain voltage. The typical gate voltage needed to do this is -1.0V. Make sure to sequence the applied voltage to ensure negative gate bias is available before applying the positive drain supply.

App Note [2] Power Detector - As shown in the schematic below, the power detector is implemented by providing +5V bias through 100 Ω resistors and measuring the difference in output voltage with standard op-amp in a differential mode configuration.



Handling and Assembly Information

CAUTION! - Mimix Broadband MMIC Products contain gallium arsenide (GaAs) which can be hazardous to the human body and the environment. For safety, observe the following procedures:

- *Do not ingest.*
- *Do not alter the form of this product into a gas, powder, or liquid through burning, crushing, or chemical processing as these by-products are dangerous to the human body if inhaled, ingested, or swallowed.*
- *Observe government laws and company regulations when discarding this product. This product must be discarded in accordance with methods specified by applicable hazardous waste procedures.*

Life Support Policy - Mimix Broadband's products are not authorized for use as critical components in life support devices or systems without the express written approval of the President and General Counsel of Mimix Broadband. As used herein: (1) Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user. (2) A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ESD - Gallium Arsenide (GaAs) devices are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic containers, which should be opened in cleanroom conditions at an appropriately grounded anti-static workstation. Devices need careful handling using correctly designed collets, vacuum pickups or, with care, sharp tweezers.

Die Attachment - GaAs Products from Mimix Broadband are 0.100 mm (0.004") thick and have vias through to the backside to enable grounding to the circuit. Microstrip substrates should be brought as close to the die as possible. The mounting surface should be clean and flat. If using conductive epoxy, recommended epoxies are Tanaka TS3332LD, Die Mat DM6030HK or DM6030HK-Pt cured in a nitrogen atmosphere per manufacturer's cure schedule. Apply epoxy sparingly to avoid getting any on to the top surface of the die. An epoxy fillet should be visible around the total die periphery. For additional information please see the Mimix "Epoxy Specifications for Bare Die" application note. If eutectic mounting is preferred, then a fluxless gold-tin (AuSn) preform, approximately 0.001^2 thick, placed between the die and the attachment surface should be used. A die bonder that utilizes a heated collet and provides scrubbing action to ensure total wetting to prevent void formation in a nitrogen atmosphere is recommended. The gold-tin eutectic (80% Au 20% Sn) has a melting point of approximately 280º C (Note: Gold Germanium should be avoided). The work station temperature should be 310º C +/- 10º C. Exposure to these extreme temperatures should be kept to minimum. The collet should be heated, and the die pre-heated to avoid excessive thermal shock. Avoidance of air bridges and force impact are critical during placement.

Wire Bonding - Windows in the surface passivation above the bond pads are provided to allow wire bonding to the die's gold bond pads. The recommended wire bonding procedure uses 0.076 mm x 0.013 mm (0.003" x 0.0005") 99.99% pure gold ribbon with 0.5-2% elongation to minimize RF port bond inductance. Gold 0.025 mm (0.001") diameter wedge or ball bonds are acceptable for DC Bias connections. Aluminum wire should be avoided. Thermo-compression bonding is recommended though thermosonic bonding may be used providing the ultrasonic content of the bond is minimized. Bond force, time and ultrasonics are all critical parameters. Bonds should be made from the bond pads on the die to the package or substrate. All bonds should be as short as possible.

Ordering Information

Part Number for Ordering	Description
XP1043-BD-000V	"V" - vacuum release gel paks
XP1043-BD-EV1	XP1043 die evaluation module

Caution: ESD Sensitive
Appropriate precautions in handling, packaging and testing devices must be observed.

Proper ESD procedures should be followed when handling this device.