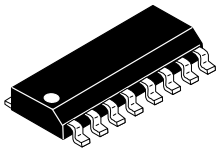
MRFIC1807

The MRFIC Line
1.8 GHz Power Amp/Switch

1.8 GHz POWER AMPLIFIER AND TRANSMIT/RECEIVE SWITCH GaAs MONOLITHIC INTEGRATED CIRCUIT



CASE 751B–05
(SO–16)

Designed primarily for use in DECT, Japan Personal Handy System (PHS) and other wireless Personal Communication Systems (PCS) applications. The MRFIC1807 includes a single–stage power amplifier and transmit/receive switch in a low–cost SOIC–16 package. The amplifier portion employs a depletion mode power GaAs MESFET and produces up to +27 dBm output with +19 dBm input. On–chip power control circuitry allows bias adjustment for optimum performance. The T/R switch is capable of handling up to +28 dBm through the transmit path without significant increase in insertion loss. The switch is controlled by CMOS logic level signals — no negative control voltage required. The MRFIC1807 is sized to be driven by the MRFIC1806 Driver/Ramp IC.

Together with the rest of the MRFIC1800 GaAs ICs, this family offers the complete transmit and receive functions, less LO and filters, needed for a typical 1.8 GHz cordless telephone.

- Usable 1500 – 2200 MHz
- 8.0 dB Gain Including Switch
- +26 dBm Minimum Output Power at Antenna Port
- 1.0 dB Typ RX Path Insertion Loss
- Simple Off–Chip Matching for Maximum Flexibility
- 3.0 to 5.0 V Supply
- No Spurious Outputs for Load VSWR up to 8:1
- CMOS Level Switching Signal for T/R Switch
- Order MRFIC1807R2 for Tape and Reel.
  R2 Suffix = 2,500 Units per 16 mm, 13 inch Reel.
- Device Marking = M1807

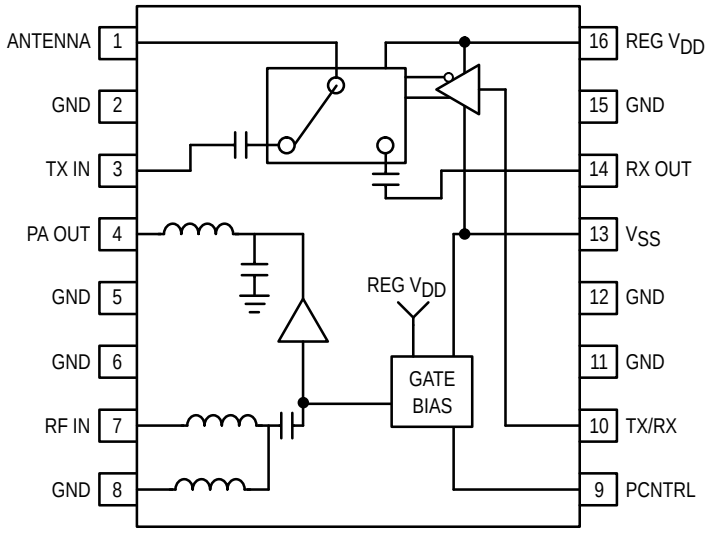


Figure 1. Pin Connection and Functional Block Diagram

REV 2

© Motorola, Inc. 1997

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C Unless Otherwise noted)

Rating	Symbol	Limit	Unit
PA Supply Voltage	V_{DD}	6.0	Vdc
Supply Voltage	REG V_{DD}	4.5	Vdc
Supply Voltage	V_{SS}	–4.0	Vdc
RF Input Power	P_{in}	+25	dBm
Switch Control Voltage	TX/RX	6.0	Vdc
PA Control Voltage	PCNTRL	3.0	Vdc
Ambient Operating Temperature	T_A	–10 to +70	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Thermal Resistance, Junction to Case	θ_{JC}	24	°C/W

RECOMMENDED OPERATING RANGES

Parameter	Symbol	Value	Unit
RF Input Frequency	f_{RF}	1.5 to 2.2	GHz
PA Supply Voltage	V_{DD}	3.0 to 5.0	Vdc
Supply Voltage	REG V_{DD}	2.9 to 3.1	Vdc
Supply Voltage	V_{SS}	–2.75 to –2.25	Vdc
RF Input Power	P_{IN}	+5.0 to +23	dBm
Switch Control Voltage, High (TX Mode)	TX/RX	2.8 to 3.5	Vdc
Switch Control Voltage, Low (RX Mode)	TX/RX	–0.2 to 0.2	Vdc
PA Control Voltage	PCNTRL	0.0 to 2.5	Vdc

ELECTRICAL CHARACTERISTICS (1)

Transmit Mode (V_{DD} = 3.5 V, REG V_{DD} = 3.0 V, T_A = 25°C, V_{SS} = –2.5 V, PCNTRL 0 V to 2.5 V, P_{IN} = 20 dBm @ 1.9 GHz, TX/RX = 3 V, P_{OUT} Measured at ANT Port)

Characteristic	Min	Typ	Max	Unit
Small Signal Gain (P_{IN} = 0 dBm, PCNTRL set for I_{DDQ} = 180 mA)	7.0	8.0	—	dB
Output Power (PCNTRL adjusted for efficiency ≥ 35%)	26	26.8	—	dBm
Output 1.0 dB Compression (PCNTRL set for I_{DDQ} = 180 mA)	—	25	—	dBm
Harmonic Output (PCNTRL set for P_{OUT} = 26 dBm)	—	–40	—	dBc
Switch RX to TX Switching Time	—	0.1	—	µsec
TX/RX Control Input Current, Pin 10	—	0.2	—	mA
Drain Efficiency (P_{out} = 26 dBm) (2)	—	40	—	%
Supply Current, I_{SS}	—	0.8	1.2	mA
Supply Current, REG I_{DD}	—	0.8	1.2	mA
PCNTRL Control Input Current (Pin 9)	—	15	—	µA
Leakage Power at RX Port	—	–1	+ 6	dBm

Receive Mode (V_{DD} = 0 V, REG V_{DD} = 3.0 V, V_{SS} = –2.5 V, TX/RX = 0 V, T_A = 25°C, Freq = 1.9 GHz)

Characteristic	Min	Typ	Max	Unit
ANT to RX Insertion Loss	—	1.0	1.3	dB
Switch TX to RX Switching Time	—	1.0	—	µsec
Supply Current, REG I_{DD}	—	60	250	µA
Supply Current, I_{SS}	—	60	250	µA

NOTES:
1. Measured with circuit configuration shown in Figure 2.
2. Includes switch loss.

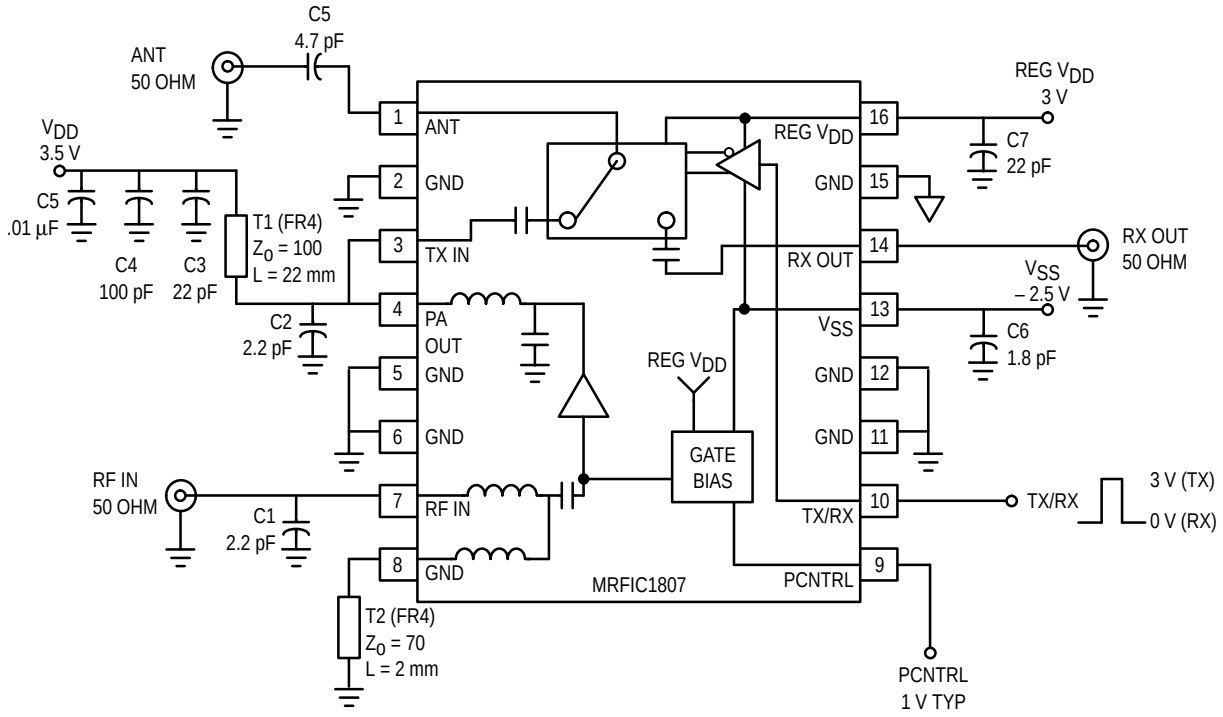


Figure 2. 1.9 GHz Applications Circuit Configuration

Table 1. Small Signal S – Parameters

(V_{DD} = 3.5 V, I_{DDQ} = 180 mA, T_A = 25°C, no input or output matching)

	S_{11}		S_{21}		S_{12}		S_{22}	
Freq (GHz)	**Mag**	**Angle**	**Mag**	**Angle**	**Mag**	**Angle**	**Mag**	**Angle**
1.5	0.614	–171.5	2.203	82.6	0.104	74.5	0.741	175.4
1.6	0.695	175.7	1.871	71.7	0.110	69.2	0.746	171.5
1.7	0.747	167.3	1.647	63.4	0.108	64.0	0.745	167.4
1.8	0.777	160.3	1.473	56.2	0.106	58.7	0.746	163.0
1.9	0.799	154.2	1.341	49.2	0.120	54.0	0.753	158.9
2.0	0.814	148.3	1.230	43.0	0.118	49.6	0.758	154.8
2.1	0.826	142.5	1.128	36.8	0.114	45.2	0.764	150.6
2.2	0.835	137.0	1.041	31.2	0.120	40.6	0.767	146.7
2.3	0.842	131.4	0.959	26.4	0.127	37.0	0.780	143.4
2.4	0.856	126.6	0.895	21.1	0.124	33.8	0.796	139.8
2.5	0.870	121.7	0.840	16.0	0.126	30.4	0.808	136.4

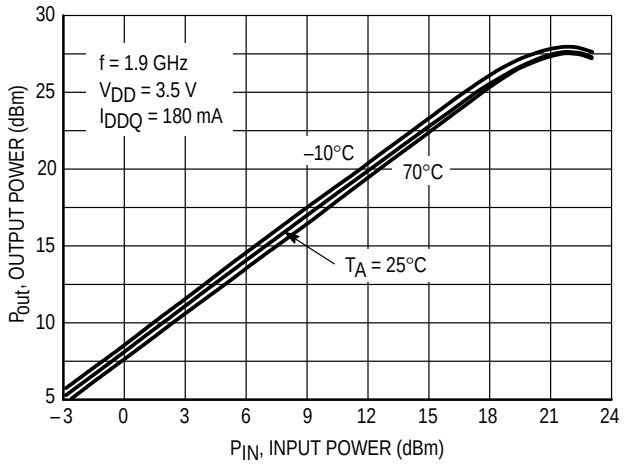


Figure 3. Output Power versus Input Power

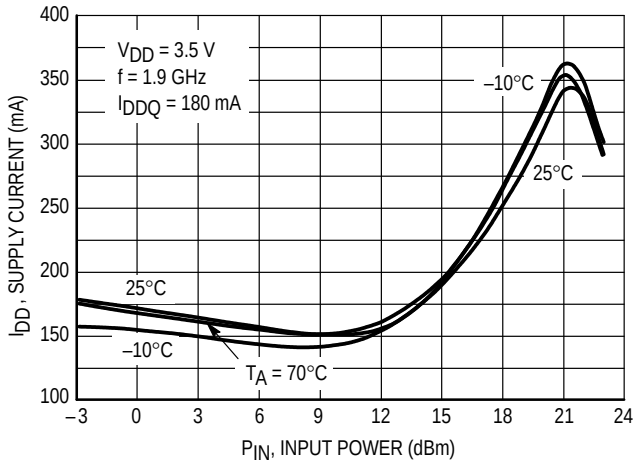


Figure 4. Supply Current versus Input Power

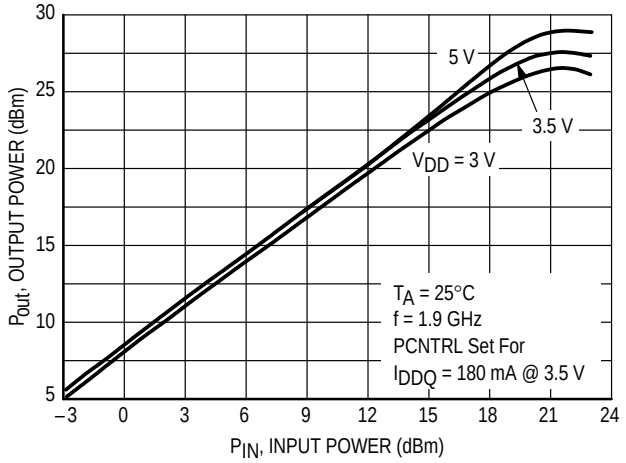


Figure 5. Output Power versus Input Power

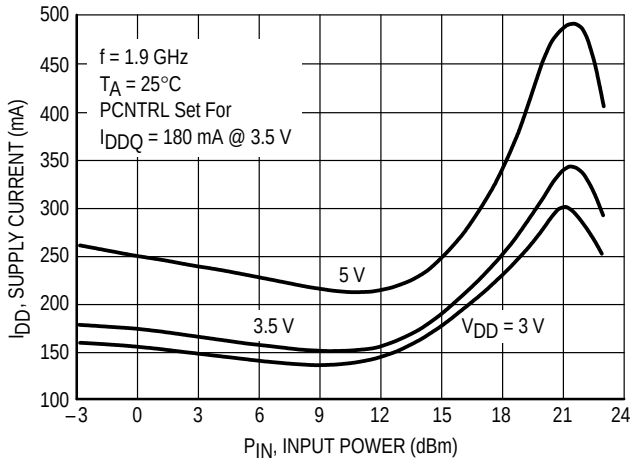


Figure 6. Supply Current versus Input Power

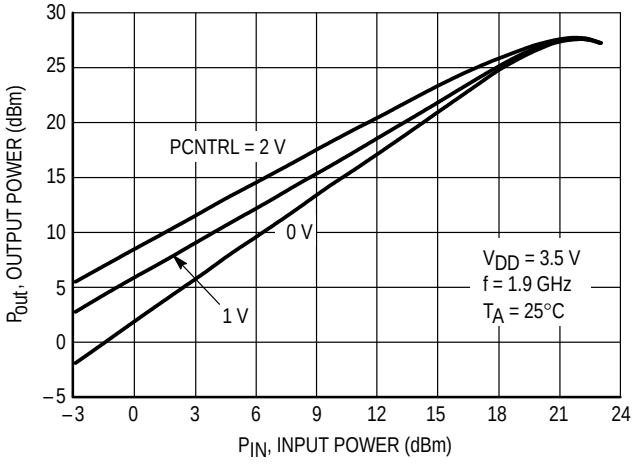


Figure 7. Output Power versus Input Power

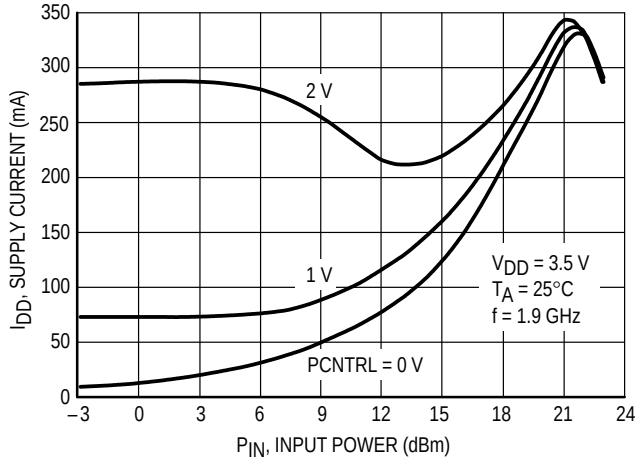


Figure 8. Supply Current versus Input Power

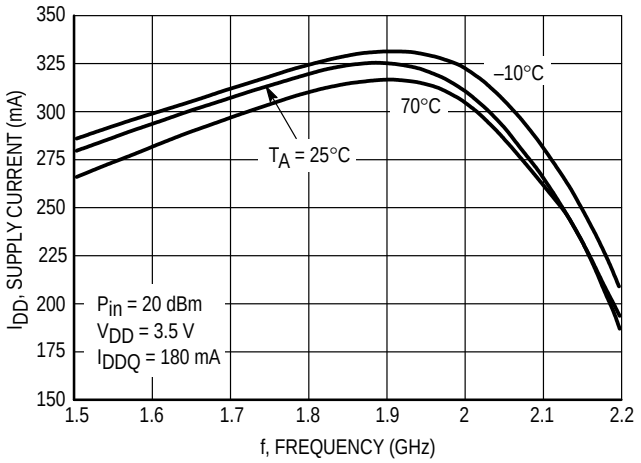


Figure 9. Supply Current versus Frequency

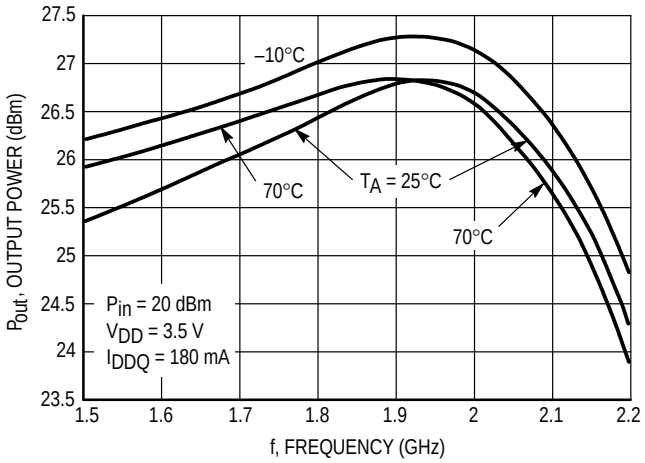


Figure 10. Output Power versus Frequency

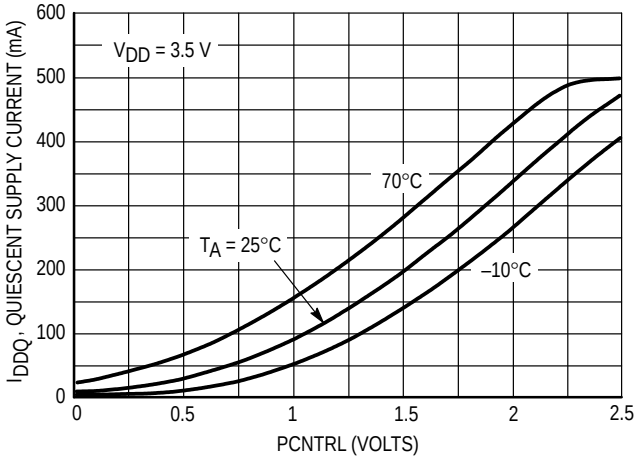


Figure 11. Quiescent Supply Current versus PCNTRL

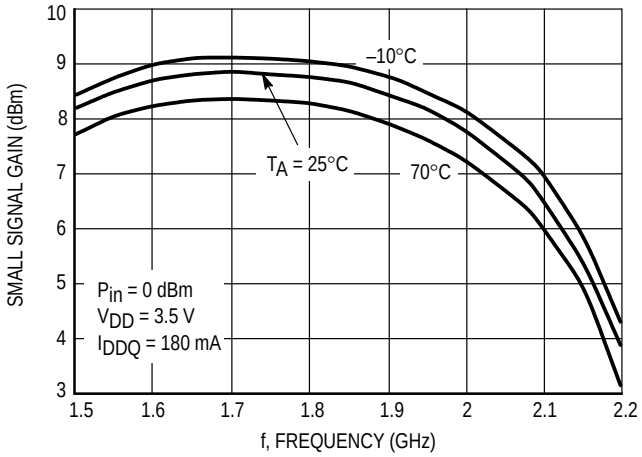


Figure 12. Small Signal Gain versus Frequency

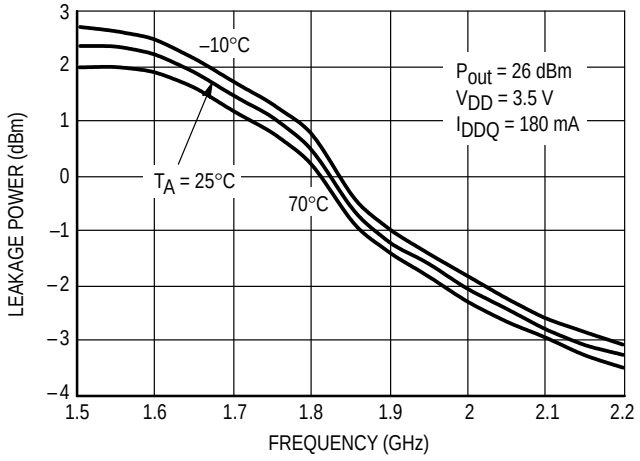


Figure 13. Leakage Power at RX Port in TX Mode versus Frequency

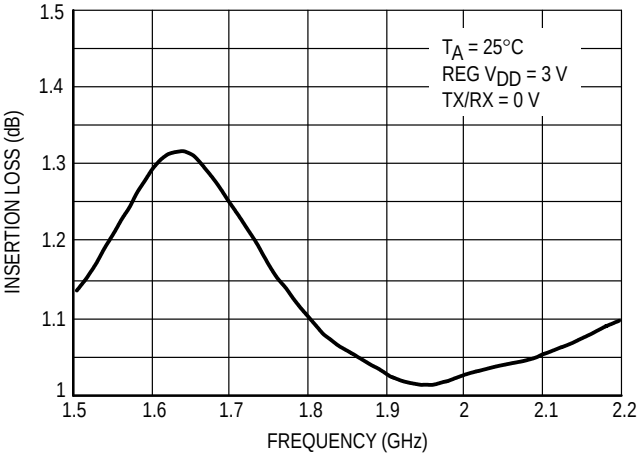


Figure 14. RX Path Insertion Loss in RX Mode versus Frequency

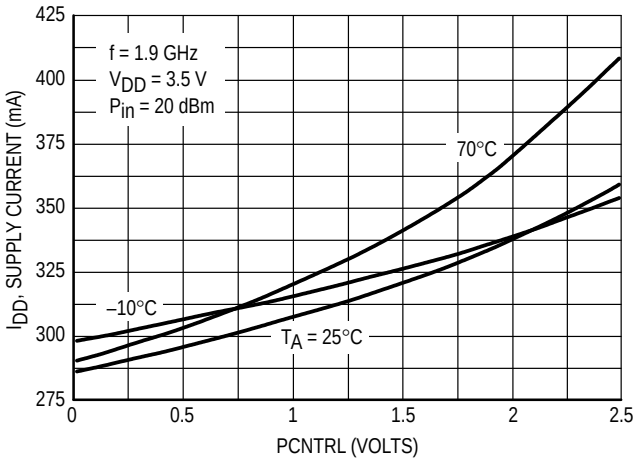


Figure 15. Supply Current versus PCNTRL

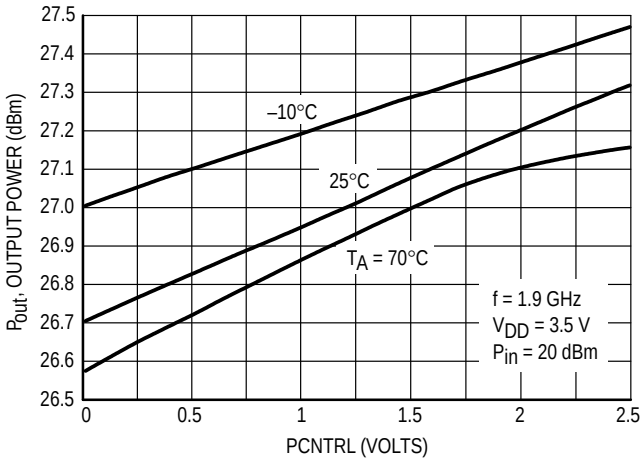


Figure 16. Output Power versus PCNTRL

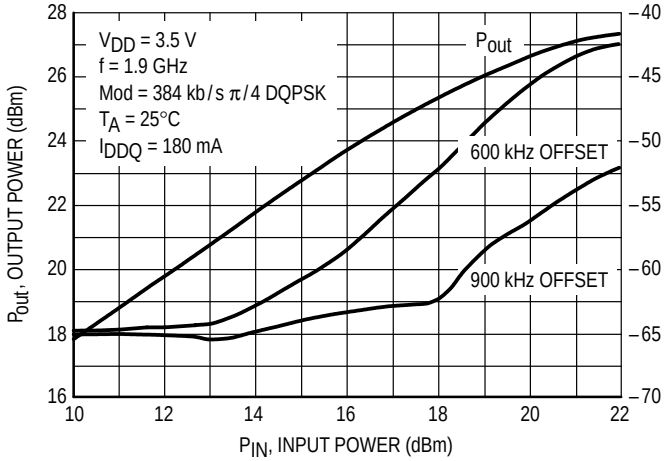


Figure 17. Output Power and Adjacent Channel Power Ratio versus Input Power

DESIGN AND APPLICATIONS INFORMATION

DESIGN PHILOSOPHY

The MRFIC1807 is designed to operate with the MRFIC1806 Driver/Ramp IC in 1.9 GHz Personal Communication System (PCS) applications such as Europe's DECT and Japan's PHS. The design incorporates a depletion mode GaAs power MESFET with a high–power transmit/receive switch and associated bias circuitry in one low–cost SOIC–16 package.

The power MESFET is sized to produce at least 27 dBm saturated output power, including switch loss, from a 3.5 V supply, but the output power can be controlled using the PCNTRL input. This control voltage also allows setting of the quiescent current of the FET. PCNTRL can be set to give best efficiency or linearity for the particular system application. The TX/RX control pin allows fast switching of the T/R switch for TDMA applications. When switching from transmit to receive, the battery supply voltage should be removed from the PA (Pin 4), to avoid excessive current drain. This is usually accomplished using an external pass transistor controlled by the TX/RX signal. Alternatively, if PCNTRL is reduced to 0 V during RX mode, the bias current is reduced to nearly zero.

The Transmit/Receive switch is a reflective MESFET design which is optimized for low loss and power handling in transmit mode. The design can handle 28 dBm of transmit power without significant increase in insertion loss. A regulated 3.0 Volt supply is required at pin 16 for the T/R switch and the bias and control circuitry.

DECT APPLICATIONS

Figure 2 shows the component values for a DECT implementation of the MRFIC1807. For use in equipment designed for DECT, the power amplifier is operated close to saturation to improve device efficiency. Maximum power output at the antenna connector is 24 dBm during a burst. The constant envelope characteristics of the GMSK modulation allow non–linear amplification without spectral regrowth. The transmit signal must be shaped or "ramped" to meet system transmit turn on time requirements of 10 μsec minimum while not splattering into adjacent channels. A turn on time on greater than 2.0 μsec has been shown to give adequate adjacent channel power performance. Most DECT realizations have the modulation applied to the transmit VCO so the most straight forward way of implementing this ramping function is at the power amplifier. The MRFIC1806 Driver/Ramp IC has an on–chip ramping circuit specifically designed for DECT. When ramped in this manner, the MRFIC1806 will supply the appropriately ramped RF signal to the MRFIC1807 which only has to be turned on and off with TX/RX. Alternate off–chip ramping can be implemented either with external components or at baseband. Consult the MRFIC1806 datasheet for more information.

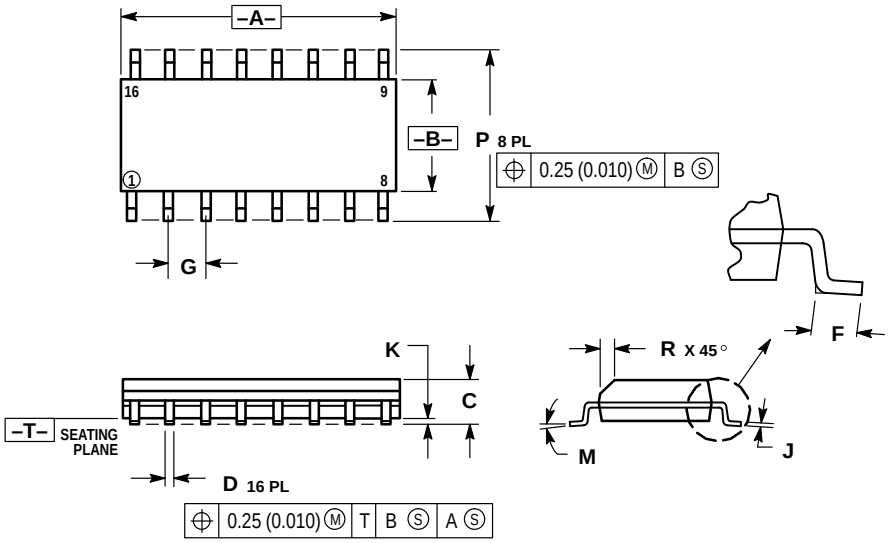
PHS APPLICATIONS

For Japan's Personal Handy System applications, the modulation is π/4 DQPSK. When amplified with a non–linear amplifier, the signal will regrow the sidebands which have been carefully filtered at baseband, resulting in adjacent channel interference. To avoid this spectral regrowth, the amplifier must be operated "backed off" from saturation. The amount of backoff required has been shown to be a function of amplifier saturated output capability and may be as high as 5.0 dB. The PHS specification calls for a maximum average power during a burst to be 19 dBm. This is consistent with 5.0 dB backoff from the DECT operating point so the same DECT operating condition could be used. Alternatively, PCNTRL can be adjusted for a lower bias point to improve efficiency or higher bias for better linearity. With π/4 DQPSK modulation, ramping can be accomplished in the encoder so no external ramp circuit is needed. See the MRFIC1806 data sheet for further details.

EVALUATION BOARDS

Evaluation boards are available for RF Monolithic Integrated Circuits by adding a "TF" suffix to the device type. For a complete list of currently available boards and ones in development for newly introduced product, please contact your local Motorola Distributor or Sales Office.

PACKAGE DIMENSIONS



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

CASE 751B–05
ISSUE J

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. “Typical” parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including “Typicals” must be validated for each customer application by customer’s technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and Ⓜ are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

Mfax is a trademark of Motorola, Inc.

How to reach us:
USA / EUROPE / Locations Not Listed: Motorola Literature Distribution; P.O. Box 5405, Denver, Colorado 80217. 303–675–2140 or 1–800–441–2447

Mfax™: RMFAX0@email.sps.mot.com – TOUCHTONE 602–244–6609
– US & Canada ONLY 1–800–774–1848

INTERNET: http://motorola.com/sps

JAPAN: Nippon Motorola Ltd.: SPD, Strategic Planning Office, 4–32–1, Nishi–Gotanda, Shinagawa–ku, Tokyo 141, Japan. 81–3–5487–8488

ASIA / PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park, 51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852–26629298