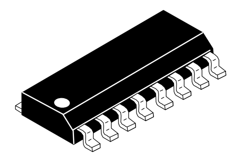
# MRFIC1803

## The MRFIC Line
# 1.8 GHz Upconverter

**1.8 GHz UPMIXER, EXCITER AND LO AMP GaAs MONOLITHIC INTEGRATED CIRCUIT**



**CASE 751B-05**
**(SO–16)**

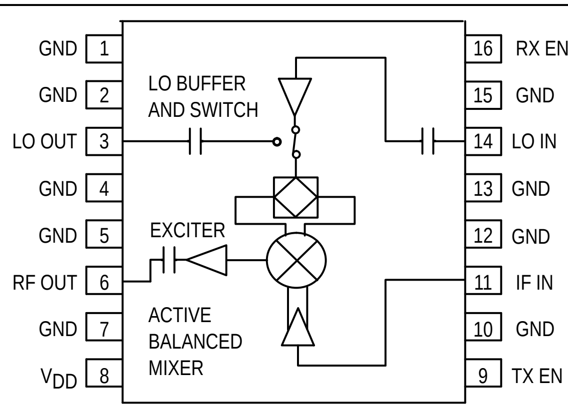
Designed primarily for use in DECT, Japan's Personal Handy System (PHS), and other wireless Personal Communication Systems (PCS) applications at 1.8 GHz, but also applicable to Industrial, Scientific and Medical (ISM) applications at 2.5 GHz. The MRFIC1803 is a complete active upmixer, exciter amplifier, and LO buffer amplifier in a low-cost SOIC-16 package. The low power consumption design includes a single balanced active mixer, CMOS compatible receive and transmit enable inputs, a buffer/exciter amplifier, and a buffered LO output capable of driving the MRFIC1804 downconverter. IF, LO and RF ports are matched to 50 Ω and no off-chip baluns are required. With both TX and RX enable pins low, the device is in standby mode and draws less than 0.3 mA.

Together with the rest of the MRFIC180X series, this GaAs IC family offers the complete transmit and receive functions, less LO and filters, needed for a typical 1.8 GHz cordless telephone.

- 10 dB IF to RF Conversion Gain
- Usable Frequency Range = 1.7 to 2.5 GHz
- Low Power Consumption = 80 mW (Typ)
- Single Bias Supply = 2.7 to 3.3 V
- No External Baluns Required
- IF, LO and RF Ports Matched to 50 Ω
- Low LO Power Requirement = –10 dBm (Typ)
- Low Cost Surface Mount Plastic Package
- Order MRFIC1803R2 for Tape and Reel.
  R2 Suffix = 2,500 Units per 16 mm, 13 inch Reel.
- Device Marking = M1803

**MAXIMUM RATINGS** ($T_A$ = 25°C unless otherwise noted)

| Ratings | Symbol | Value | Unit |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | 5.5 | Vdc |
| IF Input Power | $P_{IF}$ | 3 | dBm |
| LO Input Power | $P_{LO}$ | 3 | dBm |
| Transmit and Receive Enable Voltage | TX EN, RX EN | 5.5 | Vdc |
| Storage Temperature Range | $T_{stg}$ | – 65 to +150 | °C |
| Operating Ambient Temperature | $T_A$ | – 30 to + 85 | °C |




**Pin Connections and Functional Block Diagram**





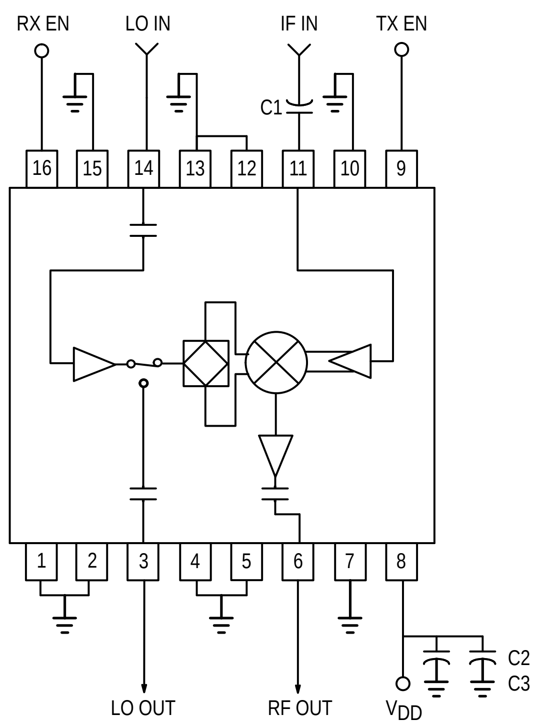
MOTOROLA

## RECOMMENDED OPERATING RANGES

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| LO Input Frequency | $f_{LO}$ | 1.5 to 2.4 | GHz |
| LO Input Power | $P_{LO}$ | –10 | dBm |
| IF Input Frequency | $f_{IF}$ | 70 to 350 | MHz |
| RF Output Frequency | $f_{RF}$ | 1.7 to 2.5 | GHz |
| Transmit and Receive Enable Voltage | TX EN, RX EN | 2.7 to $V_{DD}$ | Vdc |
| Supply Voltage | $V_{DD}$ | 2.7 to 5 | Vdc |

**ELECTRICAL CHARACTERISTICS** ($V_{DD}$ = 3 V, $T_A$ = 25°C, LO = 1790 MHz @ –10 dBm, IF = 110 MHz @ –15 dBm, TX EN = 3.0 V, RX EN = 0 V, unless otherwise noted)

| Characteristic | Min | Typ | Max | Unit |
|---|---|---|---|---|
| IF to RF Conversion Gain | 8 | 10 | — | dB |
| RF Output 1 dB Compression | — | – 2 | — | dBm |
| RF Output 3rd Order Intercept | — | 9 | — | dBm |
| LO Feed Through to RF Port | — | –19 | — | dBm |
| Auxiliary LO Output Power (TX EN = 0 V, RX EN = 3 Vdc) | — | – 4 | — | dBm |
| Supply Current, TX Mode | — | 28 | 50 | mA |
| Supply Current, RX Mode (TX EN = 0 V, RX EN = 3 Vdc) | — | 3 | — | mA |
| Standby Mode Current (TX EN = 0 V, RX EN = 0 Vdc) | — | 0.1 | 0.3 | mA |




C1 470 pF
C2 100 pF
C3 0.1 µF (optional)

**Figure 1. Applications Circuit Configuration**

## Typical Characteristics

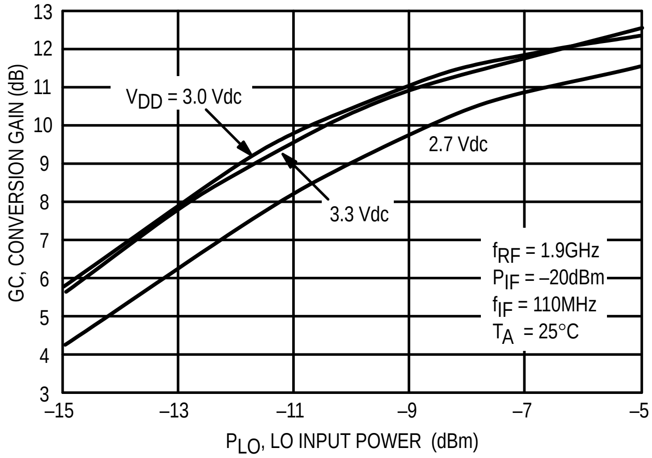



**Figure 2. Conversion Gain versus LO Power**

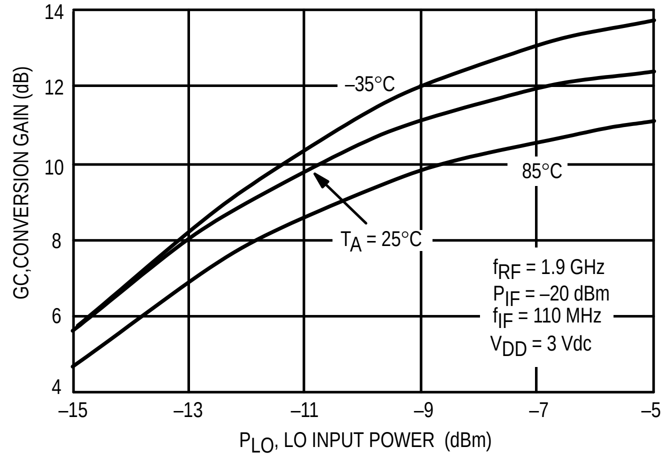



**Figure 3. Conversion Gain versus LO Power**

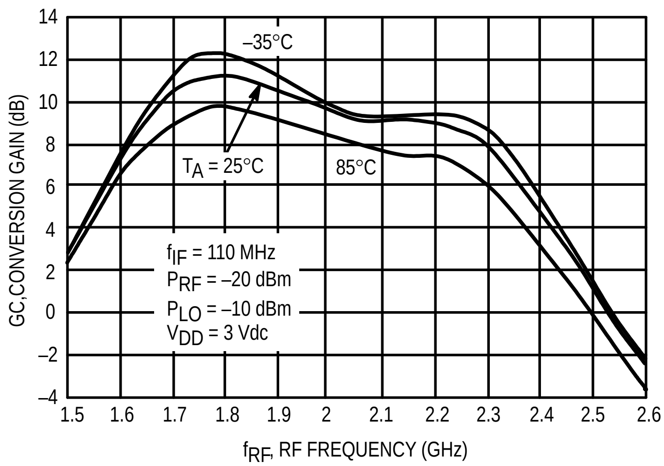



**Figure 4. Conversion Gain versus RF Frequency**

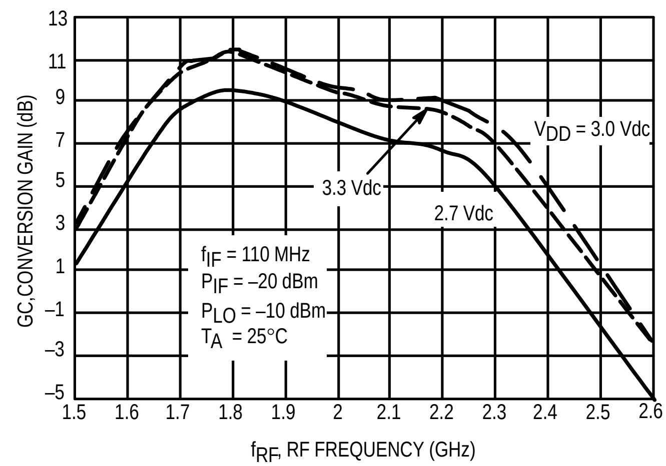



**Figure 5. Conversion Gain versus RF Frequency**

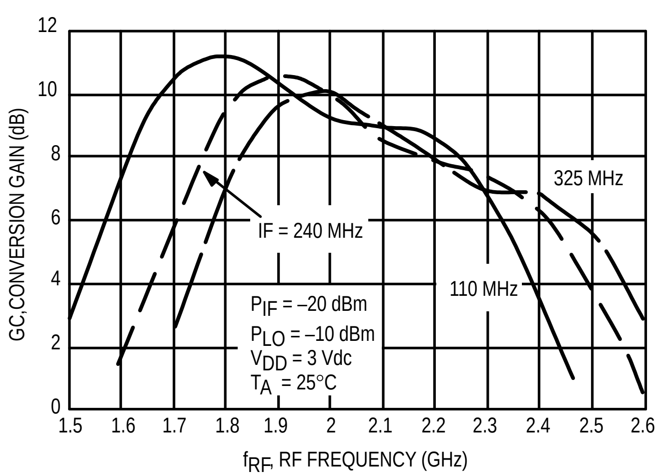



**Figure 6. Conversion Gain versus RF Frequency**

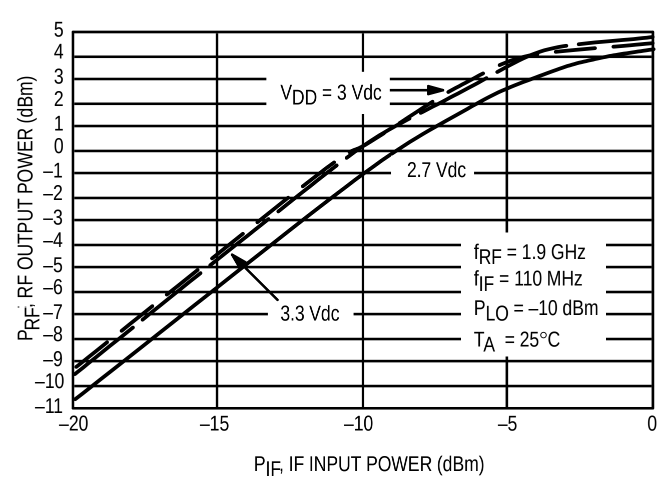



**Figure 7. RF Output Power versus IF Input Power**

## Typical Characteristics

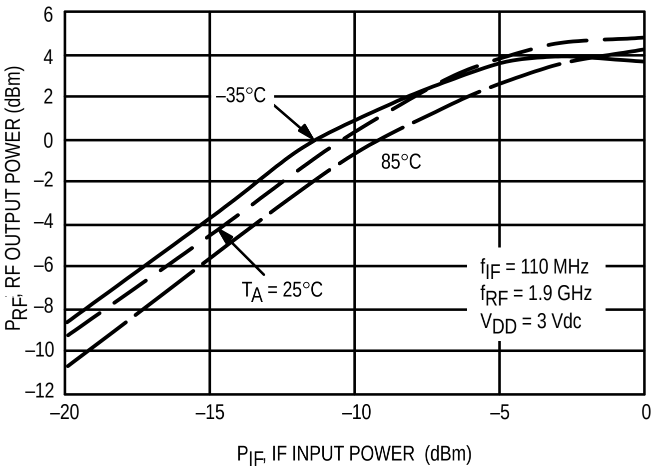



**Figure 8. RF Output Power versus IF Input Power**

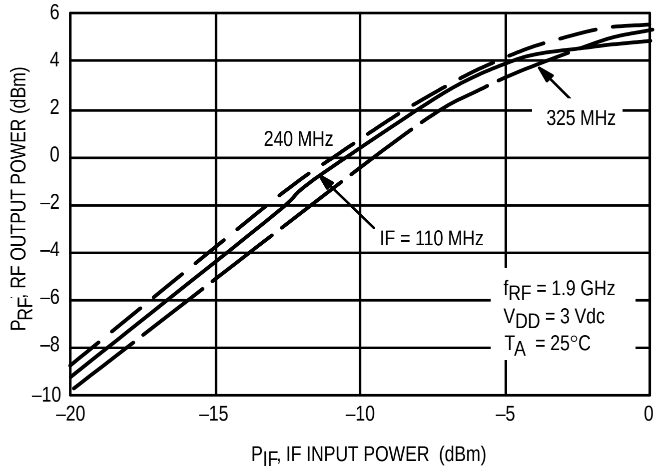



**Figure 9. RF Output Pwer versus IF Input Power**

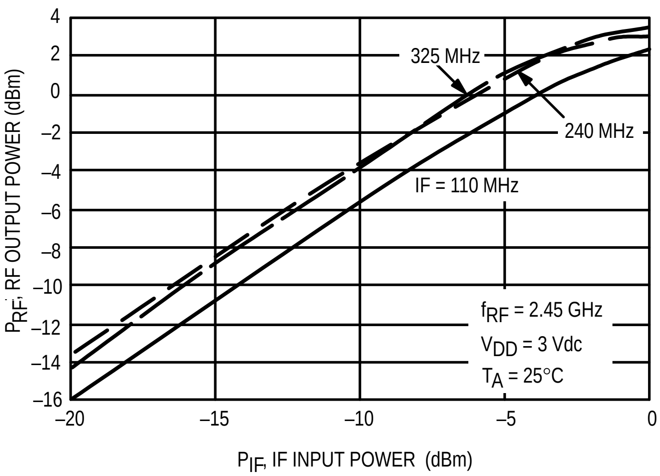



**Figure 10. RF Output Power versus IF Input Power at 2.45GHz**

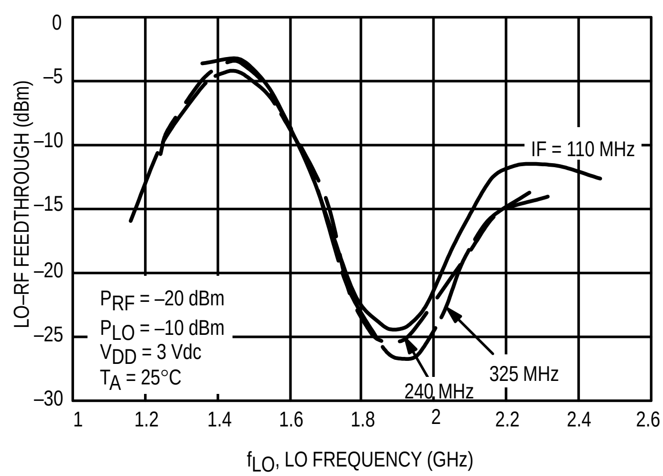



**Figure 11. LO to RF Feedthrough versus LO Frequency**

| Frequency (MHz) | RF Output | LO Input | LO Output |
|---|---|---|---|
| 1500 | 22.07 –j11.36 | 41.98 +j22.31 | 20.09 +j31.15 |
| 1550 | 21.74 –j4.69 | 50.60 +j9.80 | 26.39 +j40.79 |
| 1600 | 22.28 +j2.16 | 41.93 –j0.07 | 37.63 +j52.47 |
| 1650 | 24.01 +j8.25 | 32.74 +j3.32 | 56.16 +j63.47 |
| 1700 | 26.64 +J14.13 | 28.78 +j11.39 | 87.97 +j67.31 |
| 1750 | 30.83 +j20.11 | 28.98 +j21.04 | 131.33 +j40.34 |
| 1800 | 36.39 +j25.30 | 32.13 +j30.26 | 137.85 –j16.48 |
| 1850 | 43.92 +j29.26 | 37.68 +j40.38 | 103.88 –j50.81 |
| 1900 | 54.37 +j30.98 | 48.31 +j54.15 | 69.58 –j53.97 |
| 1950 | 65.34 +j28.57 | 68.80 +j70.87 | 50.13 –j46.24 |
| 2000 | 75.30 +j21.12 | 118.18 +j86.46 | 38.97 –j36.86 |
| 2050 | 81.19 +j8.43 | 220.83 +j17.19 | 32.08 –j27.58 |
| 2100 | 80.22 –j4.24 | 148.91 –j120.77 | 28.43 –j19.86 |
| 2150 | 74.20 –j14.00 | 58.50 –j105.11 | 26.56 –j12.82 |
| 2200 | 65.50 –j19.72 | 27.23 –j71.51 | 26.03 –j5.89 |
| 2250 | 57.40 –j21.38 | 17.22 –j50.26 | 26.73 –j0.03 |
| 2300 | 50.59 –j20.61 | 13.00 –j35.19 | 28.46 +j5.10 |
| 2350 | 44.53 –j18.16 | 10.95 –j22.96 | 30.88 +j9.86 |
| 2400 | 40.24 –j14.78 | 10.23 –j13.58 | 33.75 +j13.92 |
| 2450 | 37.73 –j10.54 | 10.20 –j5.32 | 37.50 +j17.32 |
| 2500 | 36.38 –j6.72 | 10.62 +j2.90 | 42.00 +j20.34 |

**Table 1. Selected Device Impedances**

## DESIGN AND APPLICATIONS INFORMATION

The MRFIC1803 combines a single–balanced FET mixer with an LO pre–amp and an exciter amplifier to form a self–contained upconverter. The device is usable from RF frequencies of 1.7 to 2.5 GHz and at IF frequencies of 70 to 325 MHz. The design is optimized for low side injection in hetrodyne transmitter applications. In the upconversion process, modulation is imparted to an IF carrier which is converted to the RF transmit frequency by a mixer. By DC coupling the IF input, the device can be used for simple on–off keying (OOK) or bi–phase shift keying (BPSK) applications with no IF.

The MRFIC1803 design minimizes the need for off–chip components. An active balun is employed at the IF input and provides an excellent broadband 50Ω match over the full range of IF frequencies. The LO quadrature divider is passive and internal to the device. The LO buffer amplifier is equipped with a diversity switch which switches the amplified LO signal to the LO output pin during RECEIVE mode. The –5 dBm LO output is the appropriate level to drive the MRFIC1804 for 1.8 GHz applications or the MRFIC2401 for 2.4 GHz applications.

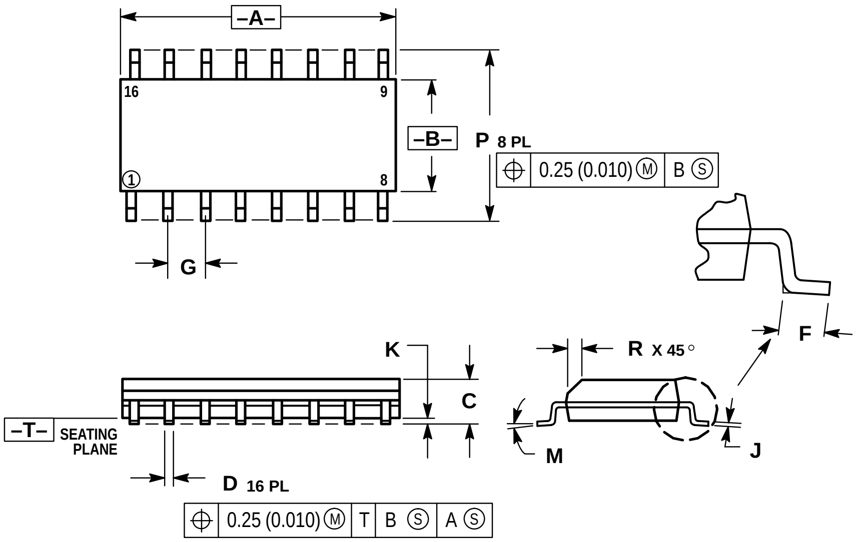
As shown in Figure 1, the device is easy to use with minimal off–chip components. More or less bypassing of the control and supply lines may be required depending on board layout and shielding. Careful layout of the RF frequency portions of the board is critical to successful implementation. Controlled impedance lines must be used and any off–chip components must be mounted as close to the IC as possible. The applications circuit was used to gather the information displayed in the typical characteristics curves. Since the MRFIC1803 design was optimized for the 1.7 to 1.9 GHz frequency range, improved performance can be had with some off–chip matching at frequencies outside this range. In particular, matching of the LO port will supply higher LO drive and improve conversion gain. At the RF output, either better gain or better 1dB compression can be had with external matching.

Filtering is generally required in the upconversion process to reduce image and LO radiation. To minimize pin count, this filtering is accomplished external to the device at the exciter output. For the frequency ranges of application, two and three pole ceramic surface filters are available at reasonable cost and with less than 2 dB of loss.

## 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**

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