

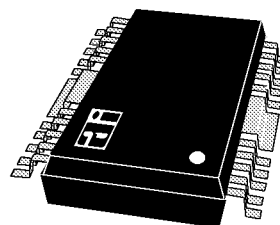
GaAs MMIC Saturated Power Amplifier in QSOP-28 Plastic Package



AP104-69

Features

- Output Power Up to 30 dBm
- 4.8 Volt Operation
- Efficiency Greater Than 55%
- High Power QSOP-28 Batwing Package
- Single Supply Operation



Description

The AP104-69 is a low cost MMIC power amplifier designed for the 824-849 MHz frequency band. It features 4 cell battery operation, and high efficiency. An on-chip DC/DC converter supplies -3 volts to the power amplifier and can supply 1.5 mA to an external circuit. The amplifier is designed to be stable over a temperature range of -30 to 100°C and over 7:1 VSWR loads.

Operating Specifications at 25°C

| Characteristic | Condition | Min. | Typ. | Max. | Unit |
|---|---|------|------|-------|------|
| Frequency | 824-849 MHz | | | | |
| Output Power (Referenced at Output Pin) | $0 < P_{IN} < 5$ | | 30 | | dBm |
| Efficiency | $P_{OUT} = 29.5$ dBm | | 60 | | % |
| Small Signal Gain | $P_{IN} = -20$ dBm | | 25 | | dB |
| Idle Current | $P_{IN} = -60$ dBm | | 75 | | mA |
| Noise in the Receive Band | $P_{OUT} = 29.5$ dBm R_X band = 869-894 MHz R_X band- width = 30KHz | | -100 | -95 | dBm |
| Reference Current | $P_{OUT} = 29.5$ dBm | | 1 | 5 | mA |
| Input VSWR | $P_{IN} = -30$ to $+7$ dBm | | | 2.5:1 | |
| Harmonic Power | 2fo 3fo | | -25 | -35 | dBc |
| Input Impedance | | | 50 | | Ohms |

Output Matching Circuit

The output match for the AP104-69 is provided externally in order to improve performance, reduce cost, and add flexibility. By making use of ceramic surface mount components with better Q's than GaAs matching elements, a lower loss matching network can be made. This lower loss results in higher power and efficiency for the amplifier. Also, by keeping these elements external the GaAs die size is reduced and the overall cost is less. This approach also permits the flexibility to tweak the amplifier for optimum performance at different powers, and/or frequencies.

The board schematic demonstrates one way to present the optimum load match while providing a path for the DC bias.

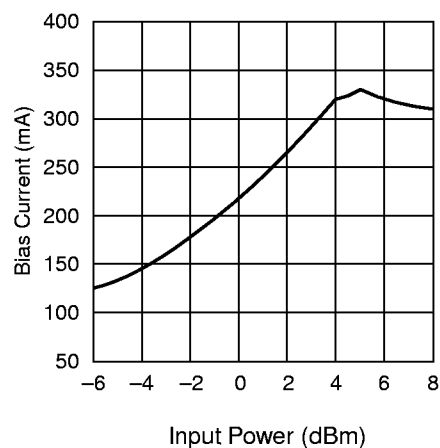
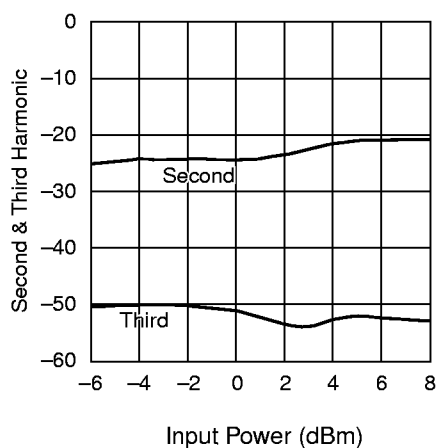
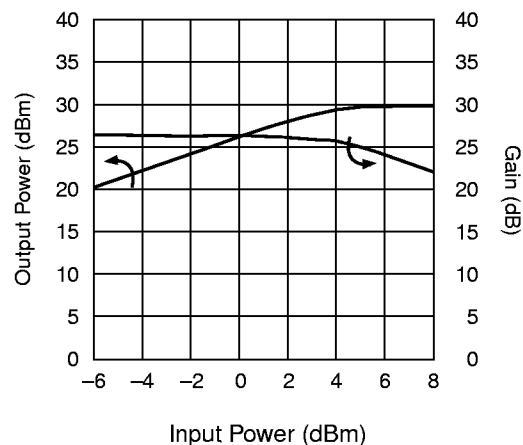
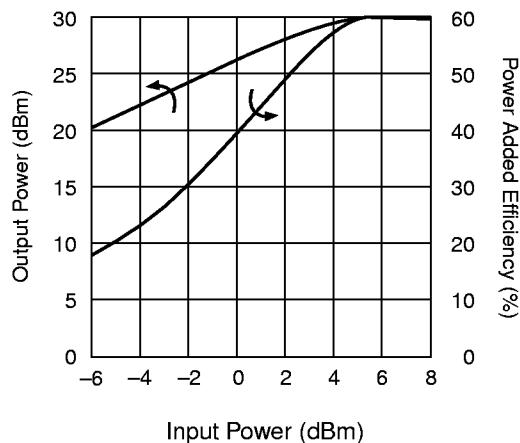
Bias Controller Circuit

An on-chip bias controller circuit eliminates the need to individually adjust the gate bias voltages. This circuit uses +3.55 volts and the negative voltage from the DC converter (-2.7 V to -3.75 V) to set the gate voltages on each stage for the proper bias current.

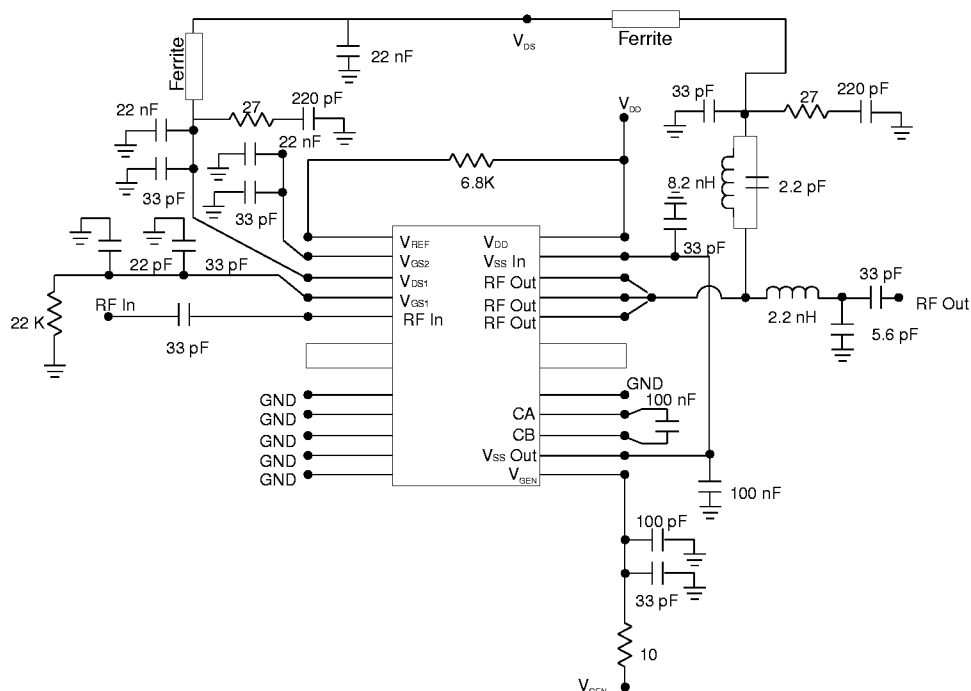
Standby Mode

The power amplifier should be turned off whenever possible in order to reduce the overall power consumption. The AP104 can be turned off in several ways. The simplest is to switch the bias controller supply voltage (Pin 28) open. The gate bias voltages are in turn reduced from their nominal voltages to V_{SS} , resulting in a PA bias current of less than 1 mA. Additional PMOS switches in the drain lines drop the bias-off currents to a few μA .

Typical Performance Data



Circuit Layout



Pin Out Assignments

Pin 1: V_{REF}

Reference voltage for bias control circuitry. 6.8K resistor between this pin and Pin 28 needed to set nominal drain currents.

Pin 2: V_{GS2}

Second stage gate voltage tap. Should be bypassed as shown.

Pin 3: V_{DS1}

First stage drain bias feed. Requires a matching inductor with good RF bypassing and the +4.8 volt nominal supply voltage.

Pin 4: V_{GS1}

First stage gate voltage tap. Requires similar RF bypassing as Pin 2 and an 22K resistor to properly bias the first stage.

Pin 5: RF In

RF input with a 33 pF series input matching capacitor.

Pin 6-14: GND

Connect to ground.

Pin 15: V_{GEN}

Supply voltage to DC/DC converter. Requires +3.7 volts with 100 nF of bypassing.

Pin 16: V_{SS_out}

Negative output voltage from DC/DC converter. Two bypassing capacitors, a 100 nF and a 33 pF capacitor, are required. This voltage should be supplied to the bias controller network at Pin 27. External circuitry (LCD display, driver amplifiers, etc.) can tap off the negative voltage at this point. A maximum of 2 mA can be supplied.

Pin 17: CB

Switched capacitor for DC/DC converter. A 100 nF capacitor must be connected between Pin 17 and Pin 18 with a minimal distance between the capacitor and the chip.

Pin 18: CA

Switched capacitor for DC/DC converter, shared with Pin 17.

Pin 19-23: GND

Connect to ground.

Pin 24-26: RF Out/ V_{DD2}

RF output and bias injection for the second stage drain. Output matching circuitry is required to transform the optimum load impedance to 50 ohms. The circuit must also provide a path for the +4.8 volt DC bias and have good RF bypassing.

Pin 27: V_{SS_in}

Negative voltage for the bias controller circuit. The negative voltage from the DC/DC converter, Pin 16, should be fed to this pin.

Pin 28: V_{DD}

Bias controller supply voltage. The regulated +3.75 volt supply must be connected to this pin. Disconnecting this voltage will turn the PA bias off. A switch at this pin can turn the PA on or off while leaving V_{GEN} connected and the negative supply unchanged. A 6.8K resistor must be connected between this pin and Pin 1.

Pin Out Table

| Terminal | Symbol | Positive Bias Function |
|----------|------------------|----------------------------|
| 1 | V_{REF} | Reference Voltage |
| 2 | V_{GS2} | Gate Voltage 2 |
| 3 | V_{DS1} | Drain Supply Voltage 1 |
| 4 | V_{GS1} | Gate Voltage 1 |
| 5 | RF IN | RF Input |
| 6 | GND | Ground |
| 7 | GND | Ground |
| 8 | GND | Ground |
| 9 | GND | Ground |
| 10 | GND | Ground |
| 11 | GND | Ground |
| 12 | GND | Ground |
| 13 | GND | Ground |
| 14 | V_{REF} | Voltage Generator Ground |
| 15 | V_{GEN} | Generator Voltage |
| 16 | V_{SSOUT} | Neg. Bias Voltage Out |
| 17 | CB | Generator Flying Cap |
| 18 | CA | Generator Flying Cap |
| 19 | GND | Ground |
| 20 | GND | Ground |
| 21 | GND | Ground |
| 22 | GND | Ground |
| 23 | GND | Ground |
| 24 | RFOUT/ V_{DS2} | RF Output/Supply Voltage 2 |
| 25 | RFOUT/ V_{DS2} | RF Output/Supply Voltage 2 |
| 26 | RFOUT/ V_{DS2} | RF Output/Supply Voltage 2 |
| 27 | V_{SSIN} | Neg. Bias Voltage In |
| 28 | V_{DD} | Positive Bias Voltage In |

Absolute Maximum Ratings

| Characteristics | Symbol | Value |
|-----------------------|-----------|--------------|
| Drain Voltage | V_{DD} | 10 V |
| Bias Voltage | V_{SS} | -6 V |
| Reference Voltage | V_{REF} | 6 V |
| Power Input | P_{IN} | 12 dBm |
| Operating Temperature | T_{OPT} | -30 to 100°C |
| Storage Temperature | T_{STG} | -35 to 120°C |

Outline Drawing QSOP-28

