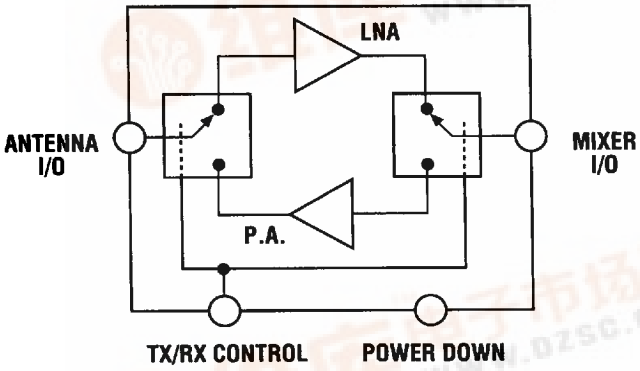


TQ9205

2.4 - 2.5 GHz Amplifier/Switch

The TQ9205 is a monolithic transmit/receive amplifier function designed specifically for spread-spectrum applications in the 2.4 - 2.5 GHz ISM band. The receive path contains a high-gain, low-noise amplifier, internally matched to 50 Ω at both ports. The transmit path incorporates an internally matched, class-A, medium-power (150 mW) transmit amplifier suitable for modulation schemes which require linear operation. The TQ9205 also features fully integrated T/R switches at both the antenna and the mixer ports, providing half-duplex operation. Transmit or receive is controlled by a CMOS-logic-compatible T/R control pin in which only one mode is active. Power down is accomplished with an external PMOS switch in series with the V_{DD} line. The small-sized, SSOP 24-pin package is ideal for reduced board space applications such as PCMCIA cards. The monolithic, internally matched design of the TQ9205 reduces development time, cost, and level of RF expertise required to achieve a high-value 2.4 GHz RF subsystem solution.

Electrical Specifications

Test Conditions: RF = 2442 MHz, T_A = 25 °C, V_{DD} = +5 V

Parameter[1]	Min	Typ	Max	Units
Rx Noise Figure		3.5	4.5	dB
Rx Gain	17	18		dB
Rx Input 3rd Order Intercept[2]		-10		dBm
Rx Supply Current		32	40	mA
Tx Power Gain	12	14		dB
Tx 1dB Compression Point	20	21		dBm
Tx Supply Current		190	250	mA
Positive Supply Voltage	4.5	5.0	5.5	V

Notes: 1. Min/max values listed are 100% production-tested.
2. Frequency separation of the two signals is 1 MHz.

Features

- *Single-supply operation with power-down mode. No supply sequencing required.*
- *+21 dBm power output*
- *Integrated T/R switches and digital control logic*
- *24-pin SSOP compatible with PCMCIA card formats*
- *50 Ω antenna and mixer ports*

Applications

- *General ISM-Band spread-spectrum wireless communications*
- *Wireless Local Area Networks*
- *Portable Data Terminals*
- *Remote Monitoring*

Electrical Specifications

Test Conditions: RF = 2.4 to 2.5 GHz, T_A = 25 °C, V_{DD} = +5 V, unless otherwise specified

Receive Mode (TX/$\overline{RX}$ = LOW)

Parameter	Conditions	Min	Typ	Max	Units
Gain		17	18		dB
Noise Figure	SSB		3.5	4.5	dB
Input 3rd Order Intercept	1 MHz frequency separation		-10		dBm
Input Return Loss	Rx input = ANTENNA pin, TX/$\overline{RX}$ = LOW	8	10		dB
Output Return Loss	Rx output = MXR I/O pin, TX/$\overline{RX}$ = LOW	10	12		dB

Transmit Mode (TX/$\overline{RX}$ = HIGH)

Parameter	Conditions	Min	Typ	Max	Units
Gain		12	14		dB
Output 1 dB Compression		20	21		dBm
Output 3rd Order Intercept	1 MHz frequency separation		30		dBm
Input Return Loss	Tx input = MXR I/O pin	10	12		dB
Output Return Loss	Tx output = ANTENNA pin	6	8		dB
2nd Harmonic Distortion	P_{OUT} = 20 dBm		-27		dBc
3rd Harmonic Distortion	P_{OUT} = 20 dBm		-37		dBc

T/R Switch and Power Down Control

Parameter	Conditions	Min	Typ	Max	Units
Input Logic HIGH		2.4			V
Input Logic LOW				0.7	V
Input Current			10		µA
Switching Speed	10 pF load on RXSW or TXSW, 10% to 90%		1		µs
Power Down Mode Current	PWRDWN = HIGH		1		mA

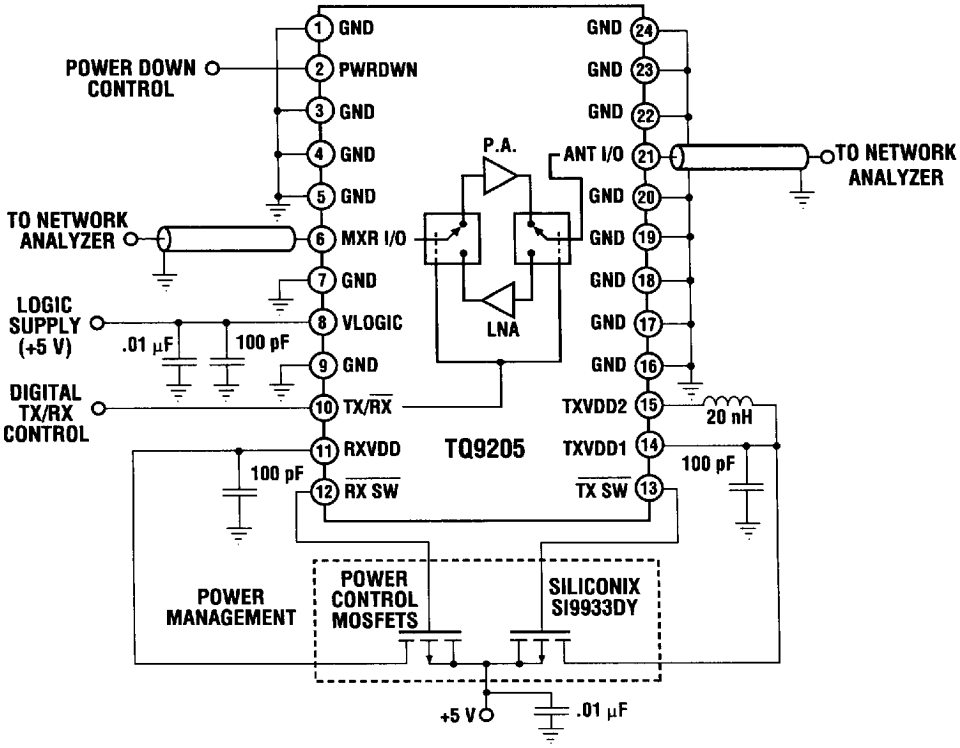
Power Supply

Parameter	Conditions	Min	Typ	Max	Units
Supply Voltage		4.5	5.0	5.5	V
Receive Mode Current	TX/$\overline{RX}$ = LOW, RXVDD		32	40	mA
Transmit Mode Current	TX/$\overline{RX}$ = HIGH, TXVDD1 + TXVDD2		190	250	mA
Power-Down Mode Current	PWRDWN = HIGH, total current		1.0		mA

T/R Switch and Sleep Mode Control Truth Table

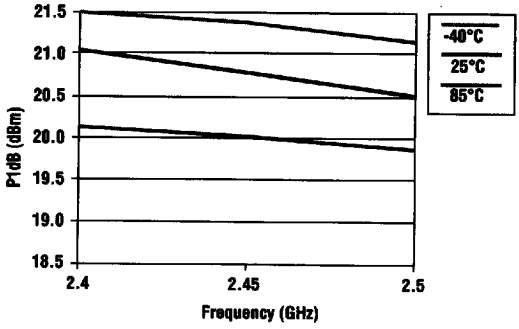
Mode	*Control Signals*	
Transmitter Section Active	TX/$\overline{RX}$ = HIGH	Power Down = LOW
Receiver Section Active	TX/$\overline{RX}$ = LOW	Power Down = LOW
Power Down Active	TX/$\overline{RX}$ = HIGH or LOW	Power Down = HIGH

TQ9205 Test Circuit

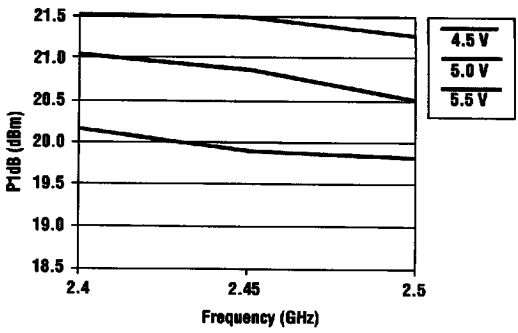


Typical Performance

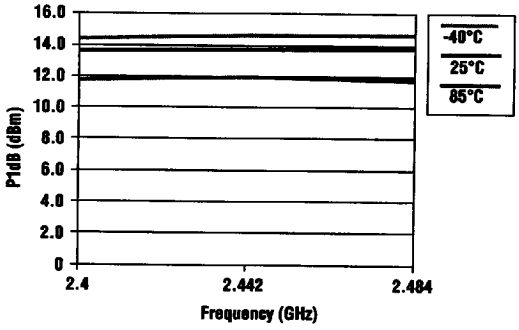
Tx P1dB vs. Frequency vs. Temperature



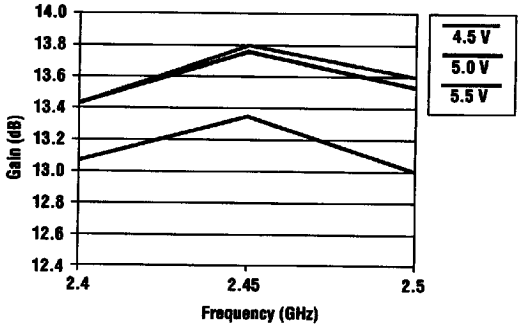
Tx P1dB vs. Frequency vs. V_{DD}



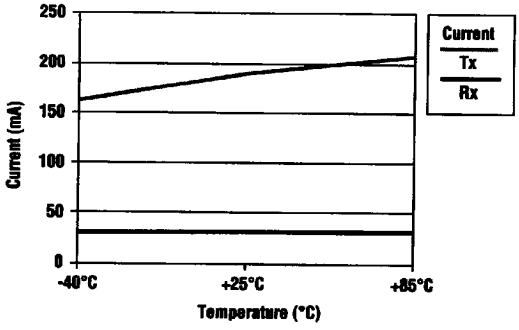
Tx Gain vs. Frequency vs. Temperature



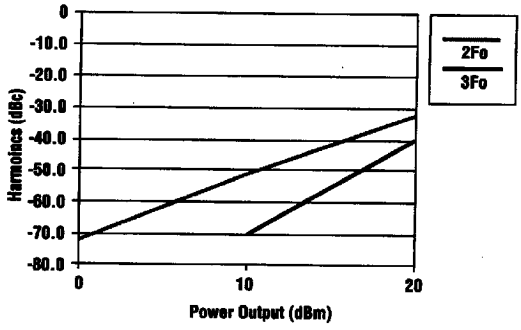
Tx Gain vs. Frequency vs. V_{DD}



Supply Current vs. Temperature

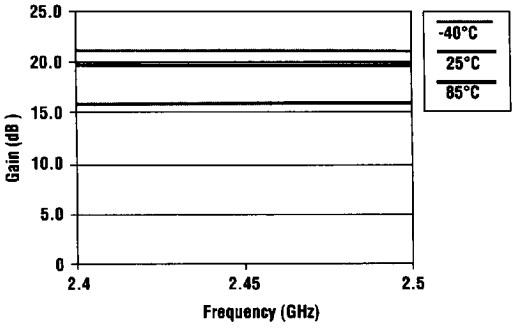


Transmit Harmonics vs. Power Output

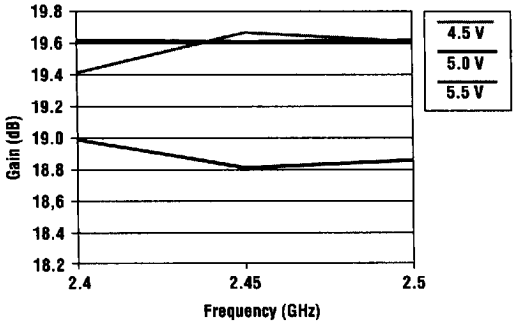


Typical Performance

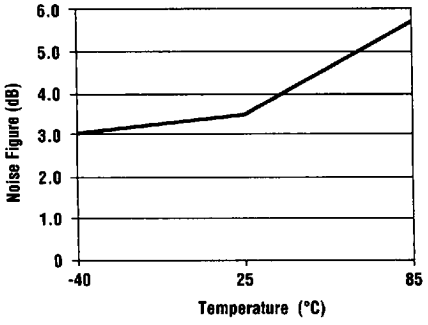
Rx Gain vs. Frequency vs. Temperature



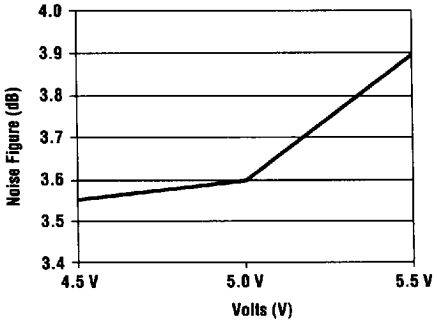
Rx Gain vs. Frequency vs. V_{DD}



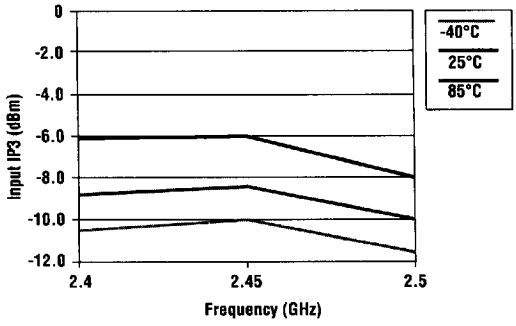
Rx Noise Figure vs. Temperature



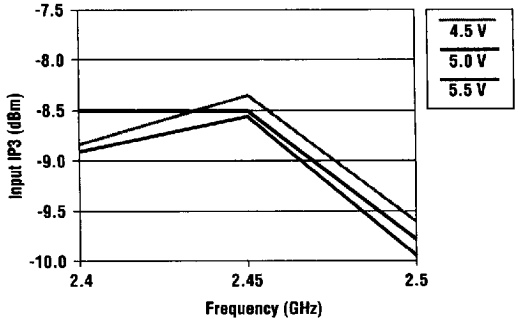
Rx Noise Figure vs. V_{DD}



Rx Input IP3 vs. Frequency vs. Temp.



Rx Input IP3 vs. Frequency vs. V_{DD}

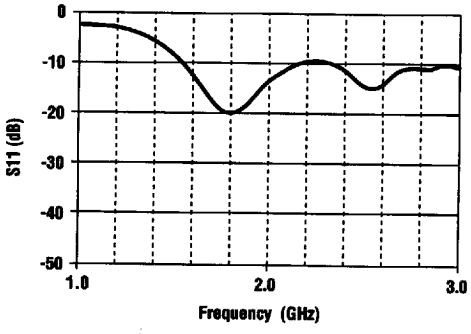


ICs

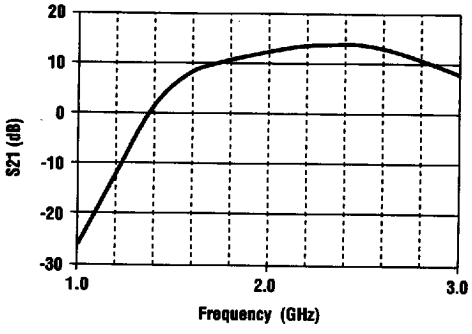
Typical Performance (Transmit Mode)

S-Parameter Magnitude – TX Mode, MXR I/O = Input, ANT I/O = Output

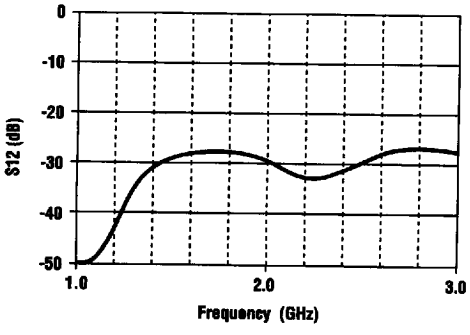
|S11| vs. Frequency



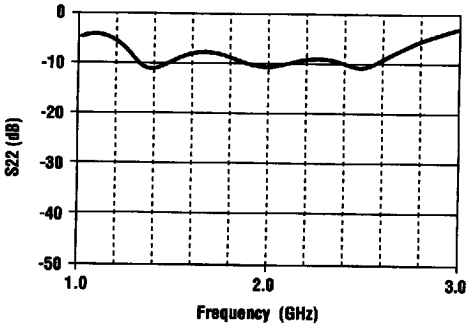
|S21| vs. Frequency



|S12| vs. Frequency



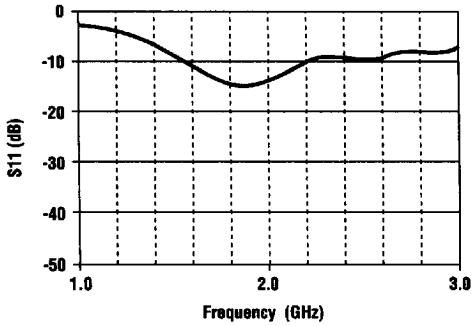
|S22| vs. Frequency



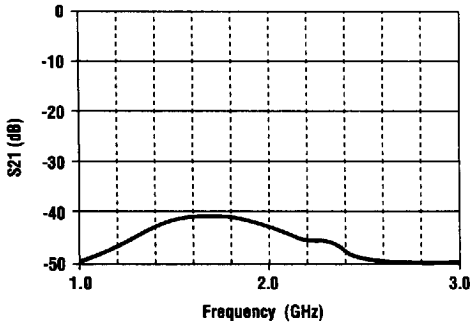
Typical Performance (Receive Mode)

S-Parameter Magnitude – RX Mode, ANT I/O = Input, MXR I/O = Output

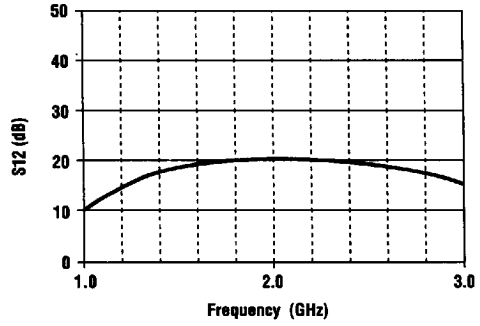
|S11| vs. Frequency



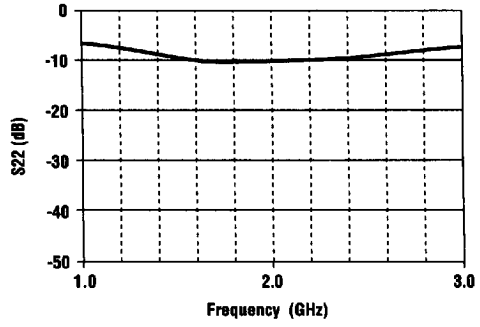
|S21| vs. Frequency



|S12| vs. Frequency



|S22| vs. Frequency

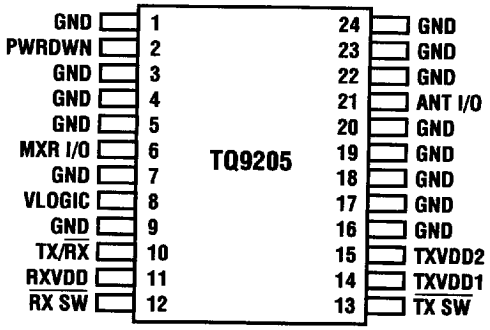


Pin Descriptions

Pin Name	Pin #	Description
PWRDWN	2	Power down control line; active HIGH. Pulls pins 12 and 13 HIGH to shut off the external PMOS switch.
MXR I/O	6	Transmit input and receive output. 50 Ω interface to filter or TQ9206. No blocking caps required.
VLOGIC	8	Supply voltage for T/R switch and power down. Local bypass caps required. Always draws current.
TX/$\overline{RX}$	10	Transmit/receive control line. CMOS logic compatible. Tx = HIGH. Rx = LOW.
RXVDD	11	Supply voltage for receive circuitry. Local bypass cap required. Permits power management.
$\overline{RXSW}$	12	Receive Mode power management switch drive. 0 to 5 V output for PMOS switch. $\overline{RXSW}$ = LOW for TX/$\overline{RX}$ = LOW.
$\overline{TXSW}$	13	Transmit Mode power management switch drive. 0 to 5 V output for PMOS switch. $\overline{TXSW}$ = LOW for TX/$\overline{RX}$ = HIGH
TXVDD1	14	Supply voltage for transmit amplifier 1st stage. Local bypass cap. required.
TXVDD2	15	Supply voltage for transmit amplifier output stage. Series inductance required (20 nH typ.)
ANT I/O	21	Transmit output and receive input. 50 Ω interface to filter or antenna. No blocking caps required.
GND	(1)	Ground connections. Keep lengths physically short for stability and best performance. Use multiple ground vias close to pins.

Note: 1. GND Pins are: 1, 3-5, 7, 9, 16-20, 22-24.

TQ9205 Pinout



DC Power and Ground Connections

The TQ9205 was designed to operate from a single +5 V supply. A range of 4.5 V to 5.5 V is permissible for normal operation. The TQ9205 uses separate V_{DD} pins for delivering the supply voltage to different sections of the circuit. This is done for isolation and power management. Each supply voltage pin should be bypassed with a high-frequency ceramic capacitor. The TXVDD2 (Pin 15) requires a series 20 nH bias injection inductor in addition to bypass capacitance. The TQ9205 application circuit shows the location and typical values for the bypass capacitors.

As with most RF circuits, a good local connection to ground is very important. The TQ9205 requires a top-surface ground with multiple via hole connections to the backside ground plane for best thermal and electrical performance. These via holes should be located beneath the package and adjacent to the package ground pins.

RF Connections

The TQ9205 operates at microwave frequencies. Controlled impedance transmission lines are required for connection to RF ports. Best results have been obtained with 50 Ω coplanar waveguide connections to the antenna and mixer I/O ports. Coplanar waveguide requires a top-surface ground which serves to orient the E-field component of the RF energy in the plane of the circuit board. This provides a ground-signal-ground connection to the TQ9205, yielding minimum discontinuities and best VSWR.

Control Signals

TX/RX

The TX/RX control line selects between the transmit and receive amplifier signal path and controls the power management drivers. On-chip logic controls the mode of operation through both internal T/R switches and external PMOS switches. The T/R switches establish the RF signal path by connecting the antenna and mixer ports to the appropriate transmit or receive amplifier. External PMOS switches are used in series with the RXVDD and TXVDD supply voltages to power down the unused amplifier function. The on-chip control logic of the TQ9205 provides two logic outputs, which enables gate control for the external PMOS switches.

Power Down

The power down function is an extension of the TX/$\overline{RX}$ control logic. Power down simultaneously shuts down both the transmit and receive amplifiers via external PMOS power switches in series with the TX and RX supply voltages. The $\overline{RXSW}$ and $\overline{TXSW}$ control pins go LOW when the power down pin is HIGH which completely powers down all the internal circuitry except for the logic drivers. Both T/R switches go to a high-impedance state in power down mode. Bias must be supplied to the logic V_{DD} at all times. Power consumption in the power down mode is on the order of 1 mA.

Power down can be eliminated if the TQ9205 is to be used exclusively in either transmit or receive mode. *However, the TQ9205 can oscillate if both the transmit and receive amplifiers are simultaneously powered, due to the internal feedback path created by the isolated arms of the T/R switches.*

External Power Management Switches

Silicon PMOS switches are recommended for supply voltage / power down control. PMOS has the current-handling capability and low on-resistance characteristics which provide maximum supply headroom for the TQ9205.

Transmit (TX) Operation

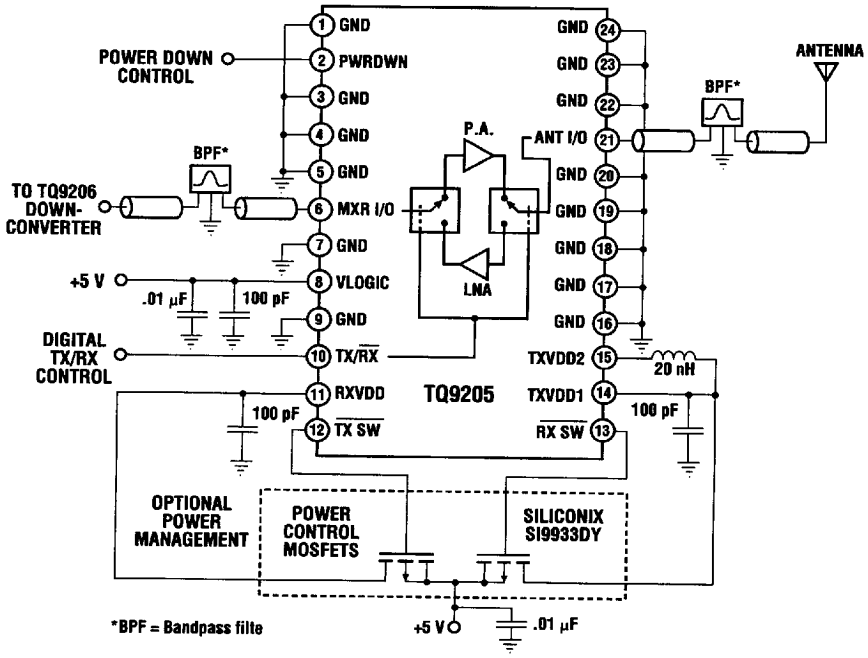
In the transmit mode, TX/$\overline{RX}$ is HIGH and PWRDWN is LOW. The signal path flows through the two switches and the transmit amplifier. The RF signal is applied to MXR I/O and is available at ANT I/O. The full +21 dBm output is produced with a drive level of +8 dBm applied at the MXR I/O port. Only the transmit side is active via external power control of TXVDD.

Receive (RX) Operation

In the receive mode, TX/$\overline{RX}$ is LOW and PWRDWN is LOW. The signal path flows through the two switches and the receive amplifier. The RF signal is applied to ANT I/O and is available at MXR I/O. The full gain and low noise figure is produced up to input levels of -20 dBm at the ANT I/O port. Only the receive side is active via external power control of RXVDD.

ICs

TQ9205 Basic Application Circuit



Absolute Maximum Ratings

Parameter	Min.	Typ.	Max	Units
+ DC Supply Voltage			8	V
Input Power			+27	dBm
Storage Temperature	-55		155	°C
Operating Temperature	0		70	°C

ESD-sensitive device - Class 1

24-Pin SSOP Package (all dimensions in millimeters)