

Product Description

The TQ5132 is a 3V, RFA/Mixer IC designed specifically for Cellular band CDMA/AMPS applications. Its RF performance meets the requirements of products designed to the IS-95 and AMPS standards. The TQ5132 is designed to be used with the TQ3131 or TQ3132 (CDMA/AMPS LNA) which provides a complete CDMA receiver for 800MHz dual-mode phones.

The RFA/Mixer incorporates on-chip switches which determine CDMA, AMPS and bypass mode select. When used with the TQ3131 or TQ3132 (CDMA/AMPS LNA), four gain steps are available. The RF input port is internally matched to 50 Ω , greatly simplifying the design and keeping the number of external components to a minimum. The TQ5132 achieves good RF performance with low current consumption, supporting long standby times in portable applications. Coupled with the very small SOT23-8 package, the part is ideally suited for Cellular band mobile phones.

Electrical Specifications¹

Parameter	Min	Typ	Max	Units
Frequency		881		MHz
Gain		15.0		dB
Noise Figure		4.5		dB
Input 3 rd Order Intercept		2.5		dBm
DC supply Current		15.0		mA

Note 1: Test Conditions: Vdd=2.8V, RF=881MHz, LO=966MHz, IF=85MHz, Ta=25C, CDMA High Gain state.

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3V Cellular Band CDMA/AMPS RFA/Mixer IC

Features

- Small size: SOT23-8
- Single 3V operation
- Low-current operation
- Gain Select
- Mode Select
- High IP3 performance
- Few external components

Applications

- IS-95 CDMA Mobile Phones
- AMPS Mobile Phones
- Dual Mode CDMA Cellular application

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Electrical Characteristics

Parameter	Conditions	Min.	Typ/Nom	Max.	Units
RF Frequency	Cellular band	869	881	894	MHz
IF Frequency Range	High side LO	85		130	MHz
CDMA Mode-High Gain					
Gain		12.6	16.0	18.2	dB
Noise Figure			4.5	7.2	dB
Input IP3		-2.2	2.5		dBm
Supply Current (T _A = 25°C)			18.0	21.0	mA
CDMA Mode-High Gain Low Linearity					
Gain			18.5		dB
Noise Figure			4.0		dB
Input IP3			-0.3		dBm
Supply Current (T _A = 25°C)			18.0		mA
CDMA Mode-Mid Gain					
Gain			5.0		dB
Noise Figure			11.0		dB
Input IP3			14.0		dBm
Supply Current (T _A = 25°C)			13.5		mA
CDMA Mode-Low Gain					
Gain		5.2	8.0	10.2	dB
Noise Figure			10.0	12.8	dB
Input IP3		7.4	11.0		dBm
Supply Current (T _A = 25°C)			14.0	17.5	mA
AMPS Mode					
Gain		7.7	12.0	12.6	dB
Noise Figure			5.0	7.7	dB
Input IP3		-4.9	-1.0		dBm
Supply Current (T _A = 25°C)			9.0	10.3	mA
Supply Voltage		2.8		3.15	V

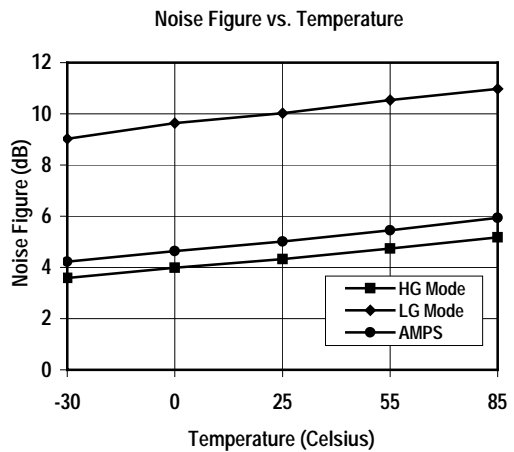
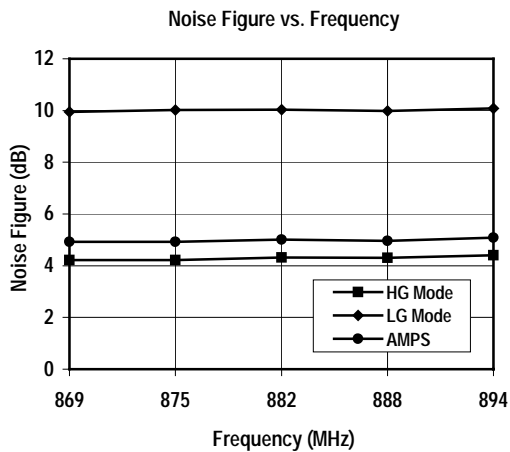
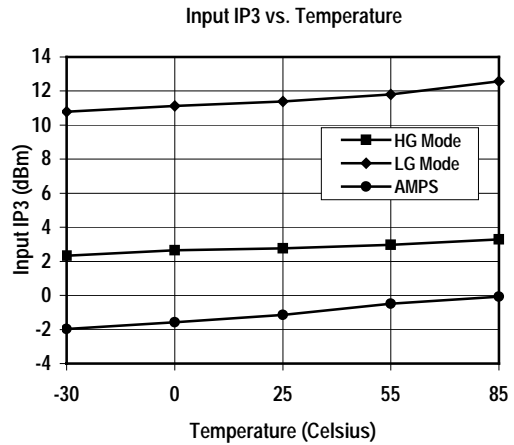
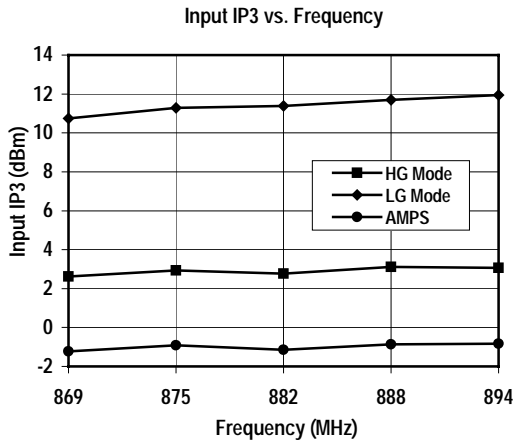
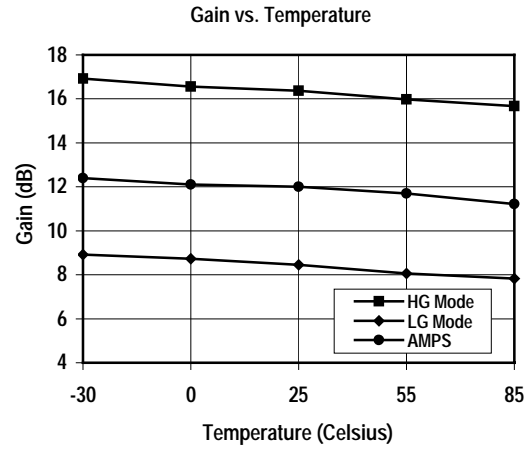
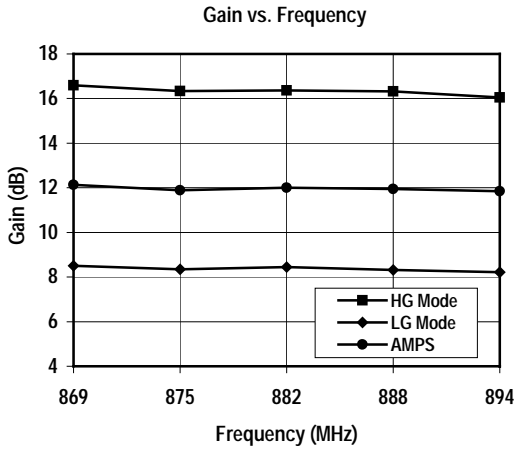
Note 1: Test Conditions: V_{dd}=2.8 to 3.15V, RF=869-894MHz, LO=High side -6 to -2dBm, IF=85MHz, T_A= -30 to 85° C, unless otherwise specified.

Absolute Maximum Ratings

Parameter	Value	Units
DC Power Supply	5.0	V
Power Dissipation	500	mW
Operating Temperature	-30 to 85	C
Storage Temperature	-60 to 150	C
Signal level on inputs/outputs	+20	dBm
Voltage to any non supply pin	+0.3	V

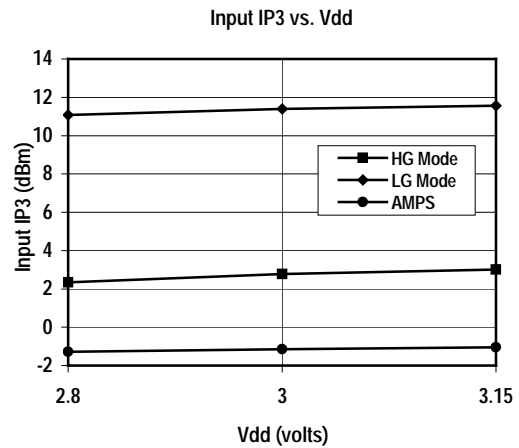
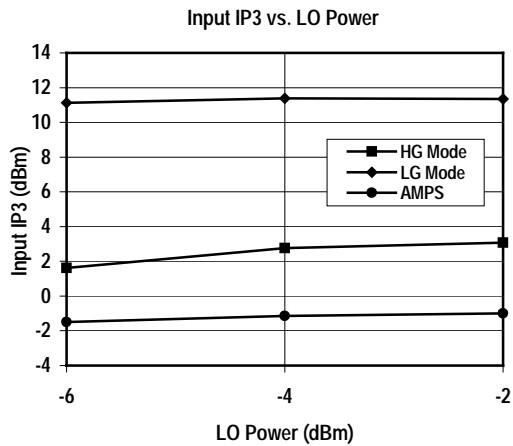
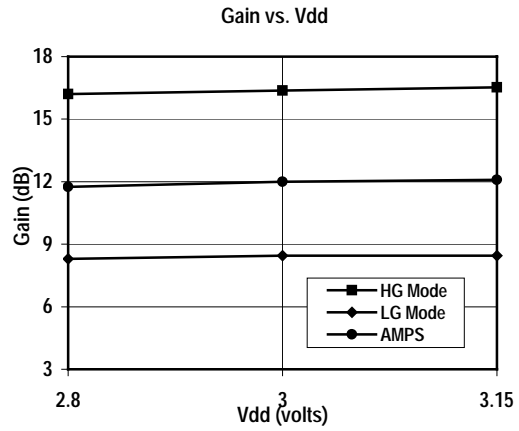
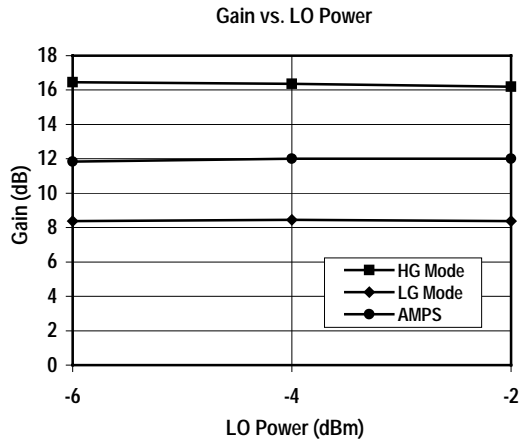
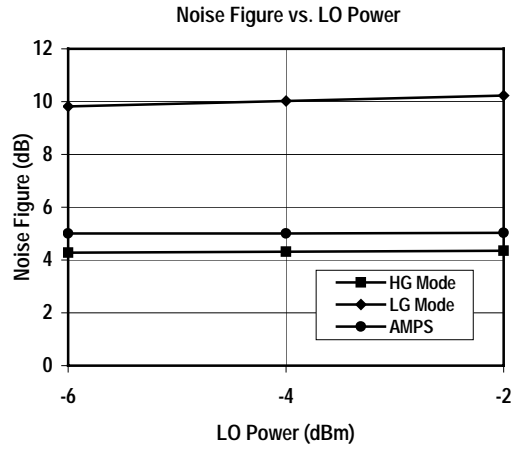
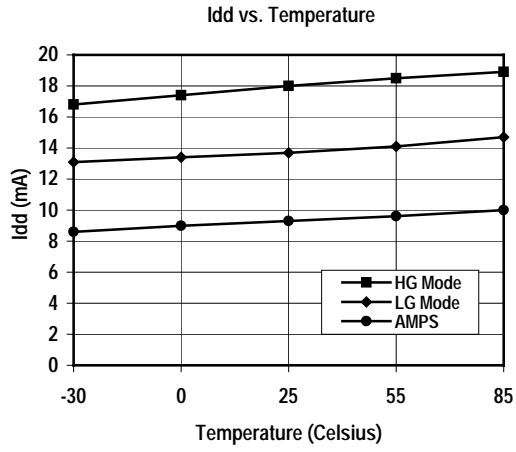
Typical Performance, Note: HG Mode=CDMA High Gain, LG Mode=CDMA Low Gain

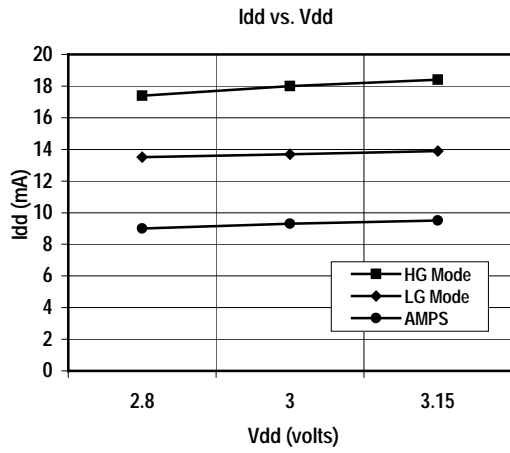
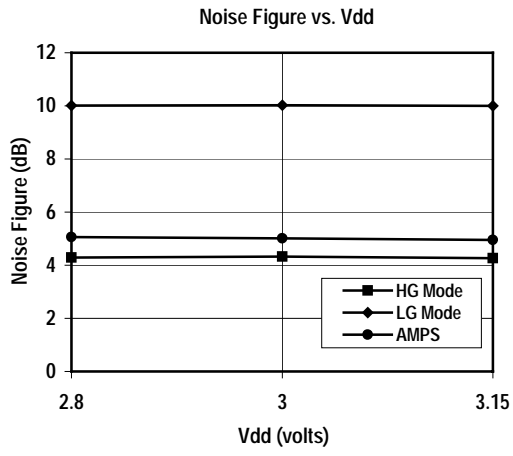
Test Conditions, unless otherwise specified: Vdd=2.8V, Ta=25C, RF=881MHz, LO=966MHz, LO input=-4dBm, IF=85MHz



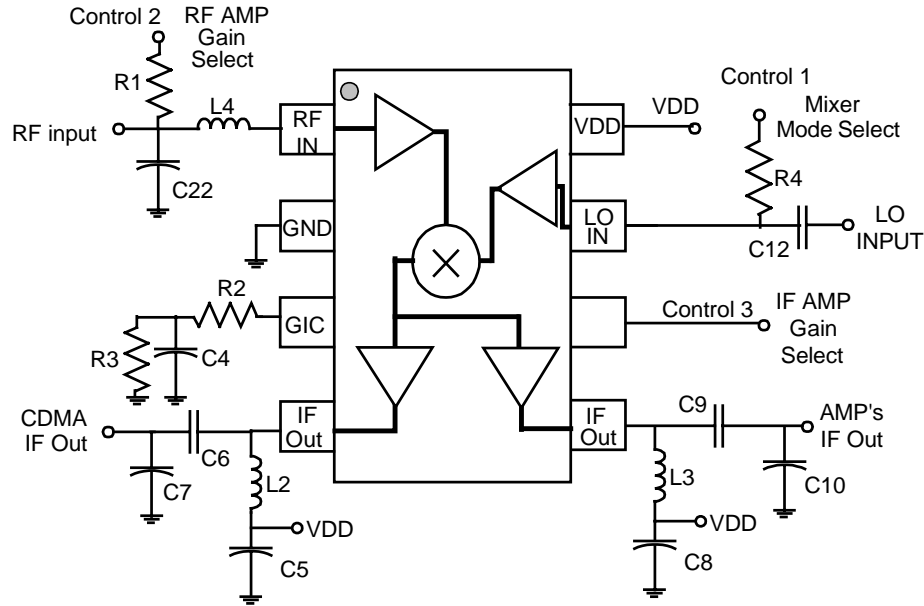
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Application/Test Circuit

Bill of Material for TQ5132 RF AMP/Mixer

Component	Reference Designator	Part Number	Value	Size	Manufacturer
Receiver IC	U1	TQ5132		SOT23-8	TriQuint Semiconductor
Capacitor	C4		.022 μ F	0402	
Capacitor	C10		18pF	0402	
Capacitor	C5,C8		1200pF	0402	
Capacitor	C6		27pF	0402	
Capacitor	C7		30pF	0402	
Capacitor	C9		15pF	0402	
Capacitor	C12		100pF	0402	
Capacitor	C22		2.7pF	0402	
Resistor	R1, R4		5.1K Ω	0402	
Resistor	R2		6.8 Ω	0402	
Resistor	R3		180 Ω	0402	
Inductor	L2		180nH	0805	
Inductor	L3		270nH	0805	
Inductor	L4		18nH	0402	

TQ5132 Product Description

The TQ5132 is a miniature low noise mixer (downconverter) in a small SOT-23-8 package (2.9X2.8X1.14 mm) with operation at 2.8v. The TQ5132 specs are designed to be compatible with IS-98 Interim Standard for Dual-Mode CDMA cellular systems. The low noise mixer features an AMPS control pin for *Gain*, *Intercept* and *Current* (*GIC* pin) and it has excellent intermodulation characteristics with high intercept point in all modes. For optimum performance the TQ5132 RF frequency of operation should be from 869 to 894 MHz. The IF range is from 85 to 130 MHz and its injection mode for the local oscillator is high side.

Operation

The TQ5132 is a single-ended mixer with switching capabilities for the various signal levels found in CDMA applications. The TQ5132 combines a RF amplifier, a LO driver amplifier, and separate digitally controlled IF amplifiers for CDMA and AMPS outputs.

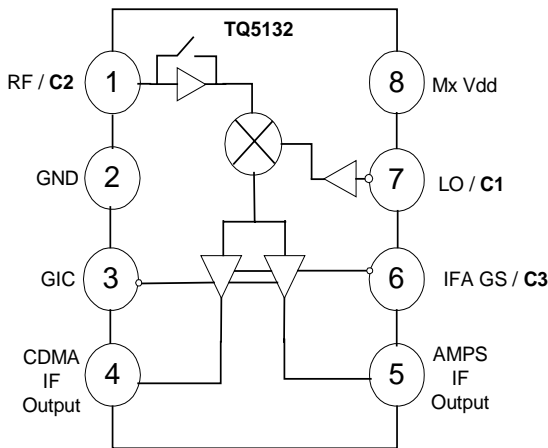


Figure 1. TQ5132 Block Diagram

Circuit Description

RF Amplifier

The TQ5132 has an integrated pre-amplifier stage in a cascode configuration. The output is internally matched to 50 ohms at 881MHz. Pin 1 requires an external match that is set to deliver a 2:1 VSWR in both the low and high gain modes (i.e. RFA is on or off). Figure 2 shows an approximated impedance at pin 1 (RFA input) to implement any desired match. Remember to apply the LO signal when tuning the RF match.

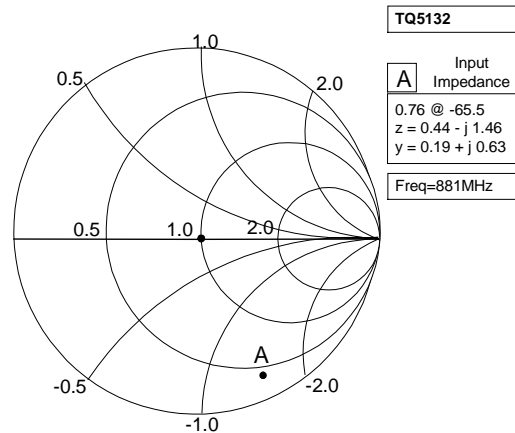


Figure 2. TQ5132 RF Amplifier Input Impedance

LO Buffer Amplifier

The LO buffer amplifier is a grounded gate FET with a broadband match to 50Ω. It has on-chip DC block and on-chip LO tuning circuit to shape the frequency response and drive it to a level suitable for the gate of the mixer FET. Thus the optimum LO frequency range is fixed and centered around 990mhz. The LO is limited to high-side injection mode and it operates from 950MHz to 1030MHz. The input to the LO buffer is through pin 7 which also feeds the control line (C1) that selects the mixer mode of operation, either CDMA or AMPS. Due to this logic control, the only external component required at the LO port is a series capacitor to prevent DC from traveling to other parts of the system. The LO drive level of operation should be between -7 and 0 dBm. Best performance is obtained between -6 and -2 dBm.

LO/filter/Mixer interaction

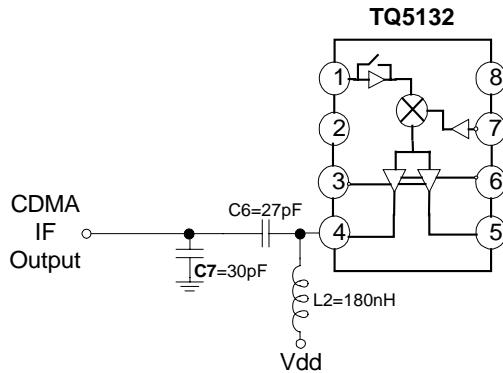
The physical position of the image reject filter is likely to have an effect on the performance of the mixer especially in the Low Gain mode where the RF amplifier is switched out. This is primarily due to self-mixing of the LO energy bouncing from the filter back into the mixer either out-of-phase or in-phase creating an offset in magnitude. To minimize this effect, TriQuint recommends placing the image-reject filter as close to the IC as possible. In TriQuint's demo board its position is 42 mils from the pad of the matching inductor and 126 mils from the IC pad. This location for the image-reject filter works well.

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CDMA IF Amplifier

The CDMA IF amplifier is an open drain stage with a gain step to adjust the output power levels according to the system requirement. No quiescent current adjustments are possible in this mode since the self-bias circuit is on-chip. While the IF output can be tuned for frequencies as high as 500 MHz, the downconverter performance is limited by the internal tuned circuit of the LO buffer amplifier. The highest IF that can be used without significant deviation from typical performance is 130 MHz. This output is a high impedance open drain FET $z = 5.47 - j 0.71 \Omega$ (normalized). The match requires a RF choke to Vdd for proper biasing (see figure 3). Typical CDMA IF output impedance is shown in figure 4. The gain of the CDMA IF amplifier can be adjusted according to the degeneration resistor value R2 (see figure 5).



Note: These values were optimized for TriQuint's 5131 Demo board. The discrepancy between these values and those of the customer's application may differ due to board and component parasitics.

Figure 3. TQ5132 CDMA IF Output Match (IF = 85MHz)

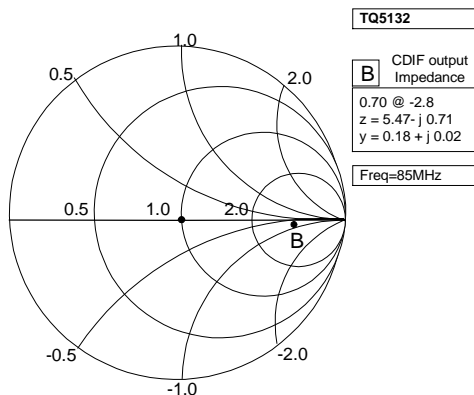
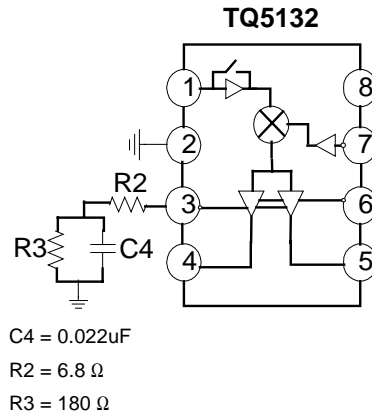


Figure 4. TQ5132 CDMA IF Output Impedance at Pin 4

AMPS IF Amplifier

The source of the AMPS IF amplifier is connected directly to pin 3. This allows the system designer to adjust Gain, output Intercept and Current (GIC) by adding an external self-bias circuit at this pin (see figure 5). A large bypass capacitor value in the self-bias circuit minimizes the effects of low frequency components present at this pin. TriQuint recommends 0.022uF or greater. The AMPS IF amplifier gain is only mildly affected by the value of R2.



Note: These values were optimized for TriQuint's 5131 Demo board. The discrepancy between these values and those of the customer's application may differ due to board and component parasitics.

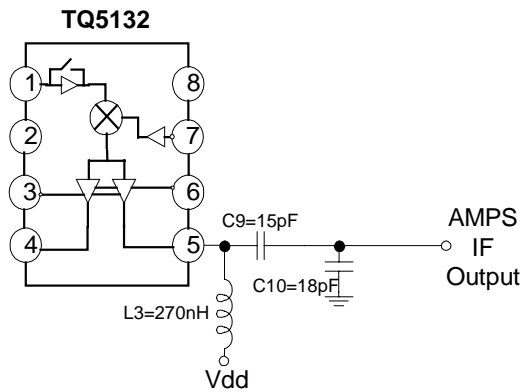
Figure 5. TQ5132 AMPS GIC pin

Once the operating point is chosen, the designer still has flexibility to adjust gain and intercept by varying the ratio of the DC bias resistors, R2/R3. Maximum gain is obtained when the total DC resistance ($R2 + R3$) at pin 3 is bypassed.

The normalized impedance of the AMPS IF output is $z = 15.4 - j 2.87 \Omega$. This particular measurement was taken on the 5132 demo board by lifting pin 5 of the PCB pad and soldering the center conductor of a semirigid probe next to it. The outer conductor was grounded close to the pin and its electrical length dialed as a port extension in order to move the calibration reference plane right at the tip of the probe. Keep in mind that the total DC bias resistance in the GIC pin must be selected before taking this measurement. When designing the PCB, it is recommended to place the self-bias circuit of the amplifier as close to the pin as possible to minimize possible loading effects that might cause oscillation. Similarly, the shunt capacitor C10

of the IF match should be grounded close to the IC (see figure 6).

After designing the IF match in simulation using the given S-parameters, some adjustment might be needed when implementing the match on the bench. At this point remember that the LO driver amplifier must be turned on since the IFA is directly coupled to the mixer FET. Figure 6 shows the circuit topology and component values designed for TriQuint's demo board. Figure 7 shows a typical AMPS IF output impedance.



Note: These values were optimized for TriQuint's 5131 Demo board. The discrepancy between these values and those of the customer's application may differ due to board and component parasitics.

Figure 6. TQ5132 AMPS IF Output Match (IF = 85 MHz)

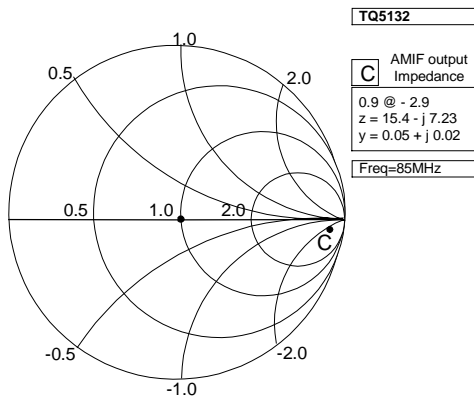


Figure 7. TQ5132 AMPS IF Output Impedance at Pin 5

Vdd Decoupling

External spurious signals at high and low frequencies can appear on the Vdd lines. Proper decoupling of these lines is required to eliminate unwanted noise. The recommended

decoupling network has a PI configuration. On the main Vdd node, a large capacitor of 0.022 uF is used, followed by a 3.3 or 10 ohm resistor in series with the supply line. Last, a bypass capacitor that presents a low impedance to ground at the RF frequency is normally placed very close to the pin. However, in the TQ5132 this bypass capacitor on the IC node is on-chip and the external one near the IC is not needed.

Board Layout Recommendations

All ground pins should be kept close to the IC and have its own via to the ground plane to minimize inductance.

Most PC boards for portable applications have thin dielectric layers and very narrow line width which increase the board parasitic capacitance and inductance. To minimize these effects when implementing a matching network, it is recommended to relieve the ground underneath pads carrying RF signals whenever possible.

Control Line Description

The control lines can be toggled between high and low levels using CMOS logic circuitry. Control line C1 is used to switch between CDMA and AMPS IF output. The other two control lines C2 and C3 set the various CDMA output levels required by the system.

Table 1. Downconverter Control Lines C1, C2, C3

Receiver State	C1	C2	C3
AMPS Mode	0	0	1
CDMA High Gain	1	0	0
CDMA HG, low lin	1	0	1
CDMA Mid Gain	1	1	0
CDMA Low Gain	1	1	1

C1 = Mixer Mode, C2 = RFA gain select and LNA gain select, C3 = IFA gain select and LNA mode select.

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Receiver State	RFA	IFA
AMPS Mode	HG, AMPS Idd	HG, AMPS Output
CDMA High Gain	HG, CDMA Idd	LG, CDMA Output
CDMA HG, low lin	HG, CDMA Idd	HG, CDMA Output
CDMA Mid Gain	Bypass	LG, CDMA Output
CDMA Low Gain	Bypass	HG, CDMA Output

Table 2. Electrical States of RFA and IFA

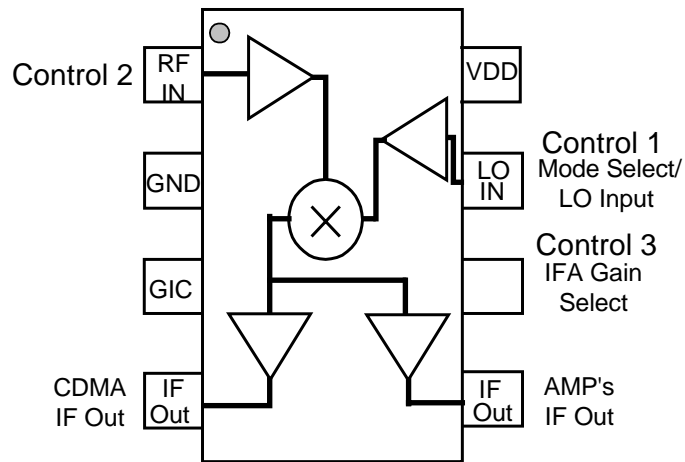
In the AMPS mode the TQ5132 switches the IF output to the AMPS pin and turns on the RF amplifier but at lower current than CDMA mode. Thus the system draws much less current in AMPS mode.

In the High Gain modes, a cascode amplifier is switched in before the mixer. Control for this function is made via a DC signal on the RF input pin 1. The IF amplifier gain can be stepped as well via a control line at pin 6.

The CDMA Mid Gain Mode provides an intermediate gain step. The mixer has the RF amplifier turned off and the IF stage at minimum gain.

In the low gain modes, the RF amplifier is disabled and the input signal is routed directly to the mixer.

Package Pinout



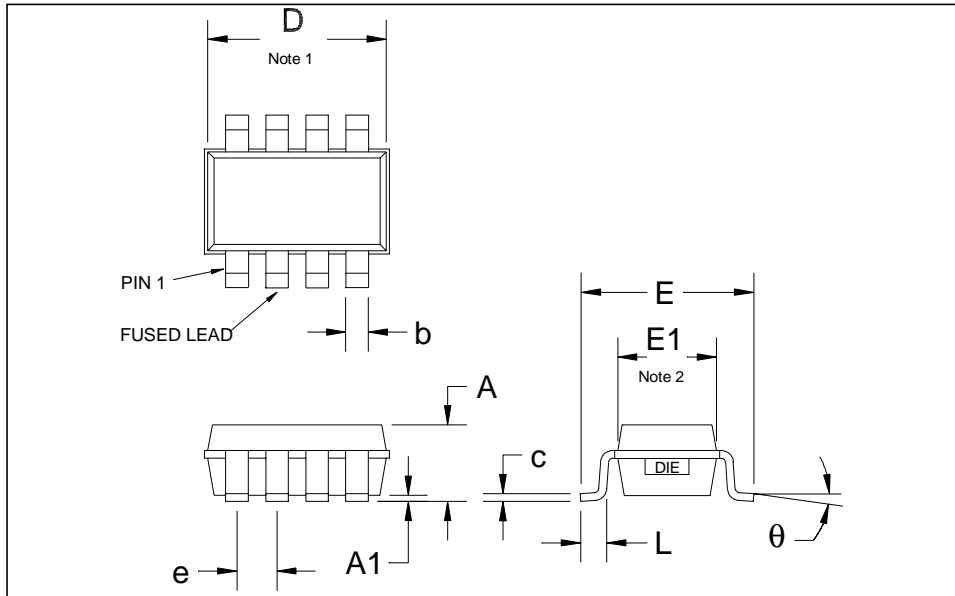
Pin Descriptions

Pin Name	Pin #	Description and Usage
RF IN	1	RF Input, RF amplifier gain select, Logic Control 2
GND	2	Ground, paddle
GIC	3	Off chip tuning for gain/IP3/current
IF OUT	4	CDMA IF Output
IF OUT	5	AMPS IF Output
IFA Gain	6	IF amplifier gain select, Logic Control 3
LO IN	7	LO Input, mode select (CDMA/AMPS), Logic Control 1
Vdd	8	LNA Vdd, typical 2.8V

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Package Type: SOT23-8 Plastic Package



DESIGNATION	DESCRIPTION	METRIC	ENGLISH	NOTE
A	OVERALL HEIGHT	1.20 +/- .25 mm	0.05 +/- .250 in	3
A1	STANDOFF	.100 +/- .05 mm	.004 +/- .002 in	3
b	LEAD WIDTH	.365 mm TYP	.014 in	3
c	LEAD THICKNESS	.127 mm TYP	.005 in	3
D	PACKAGE LENGTH	2.90 +/- .10 mm	.114 +/- .004 in	1,3
e	LEAD PITCH	.65 mm TYP	.026 in	3
E	LEAD TIP SPAN	2.80 +/- .20 mm	.110 +/- .008 in	3
E1	PACKAGE WIDTH	1.60 +/- .10 mm	.063 +/- .004 in	2,3
L	FOOT LENGTH	.45 +/- .10 mm	.018 +/- .004 in	3
Theta	FOOT ANGLE	1.5 +/- 1.5 DEG	1.5 +/- 1.5 DEG	

Notes

1. The package length dimension includes allowance for mold mismatch and flashing.
2. The package width dimension includes allowance for mold mismatch and flashing.
3. Primary dimensions are in metric millimeters. The English equivalents are calculated and subject to rounding error.

Additional Information

For latest specifications, additional product information, worldwide sales and distribution locations, and information about TriQuint:

Web: www.triquint.com Tel: (503) 615-9000
 Email: info_wireless@tqs.com Fax: (503) 615-8900

For technical questions and additional information on specific applications:

Email: info_wireless@tqs.com

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Revision A, April, 2000