Dual-band CDMA Low Noise Amplifier

Features

- IBM's integrated SiGe BiCMOS technology
- CDMA / AMPS operation in the Cellular and PCS receive bands
- Low noise figure:
  - 1.7B over Cellular band
  - 1.9dB over PCS band
- Low power supply current drain:
  - 10mA High linearity mode
  - 5mA Low linearity mode
  - <0.3mA Bypass mode
  - <1µA Standby mode
- High input IP3: + 8dBm
- 22dB reverse isolation
- Integrated logic and bias control network
- Single-ended RF interface
- Requires Single 2.75-volt power supply

Applications

- Single and dual mode CDMA and AMPS handsets receiving in the Cellular 869-894MHz, and PCS 1930-1990MHz bands
- Low noise/high linearity subsystems


QFN 16L Package
3.0mm x 3.0mm x 0.90mm

Description

The IBM3604012Q016 Low Noise Amplifier (LNA) is a monolithic device intended for CDMA and AMPS wireless handsets operating in the Cellular and PCS bands. The LNA is fabricated using IBM's Silicon Germanium (SiGe) BiCMOS technology for low noise, high gain and high linearity performance.

The monolithic LNA device consists of the following, as shown in figure 1:
- Two high gain blocks with medium gain and bypass switching options
- Logic and bias control network to support switching options and operating modes

Figure 1. Block Diagram
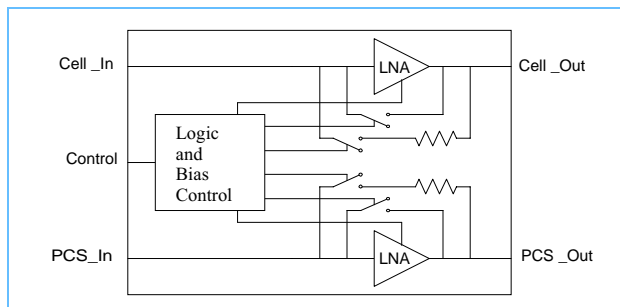
Note: The LNA is susceptible to damage from electrostatic discharge (ESD). Observe normal ESD precautions at all times when handling or using the device.

Each gain block is optimized for a single (cellular or PCS) band of operation. The integrated logic and bias control network facilitate band and gain selection. In addition, the device can operate in a high or low linearity mode. The low linearity mode reduces operating current and enables long battery life.

A bypass mode enables the device to handle strong incoming signals with low current drain. A Standby mode for power saving is also available.

The device is housed in a QFN 16 lead chip scale package and requires off-chip passive components for RF matching.

Ordering information:

To order samples of the product or the Evaluation board, please visit:

www.ibm.com/chips/support/howtobuy.html

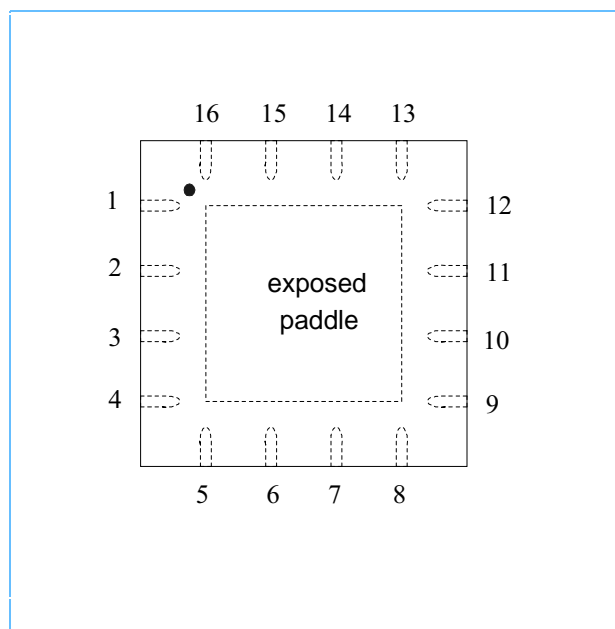| Part Number	Description
IBM3604012Q016	CDMA Dual Band Low Noise Amplifier
IBM3604012EVBA	Evaluation Board Assembly

Input and Output

Figure 2. Pinout

Table 1. Pin Assignments

Pin	Signal	Type	Description
1	Cell_In	Input	Cellular band LNA input
2	Band Select	Input	Band select logic input
3	Gain Select	Input	High/Mid gain logic input
4	PCS_ In	Input	PCS band LNA input
5	PCS_GND1	Ground	PCS signal ground
6	PCS_GND2	Ground	PCS signal ground
7	PCS_GND3	Ground	PCS signal ground
8	Ref_I_Set	DC	Current setting pin
9	PCS_Out	Output	PCS band LNA output
10	Vcc_GND	Ground	Bias circuit Ground
11	Vcc	Power	Bias circuit positive supply
12	Cell_out	Output	Cellular band LNA output
13	I_Select	Input	High/low linearity logic input
14	Bypass	Input	bypass switch logic input
15	Cell_GND1	Ground	Cellular signal ground
16	Cell_GND2	Ground	Cellular signal ground
ep	IC Ground	Ground	RF ground (exposed paddle)

Figure 3. Functional Block Diagram

Note: Package base is an exposed paddle conductor.
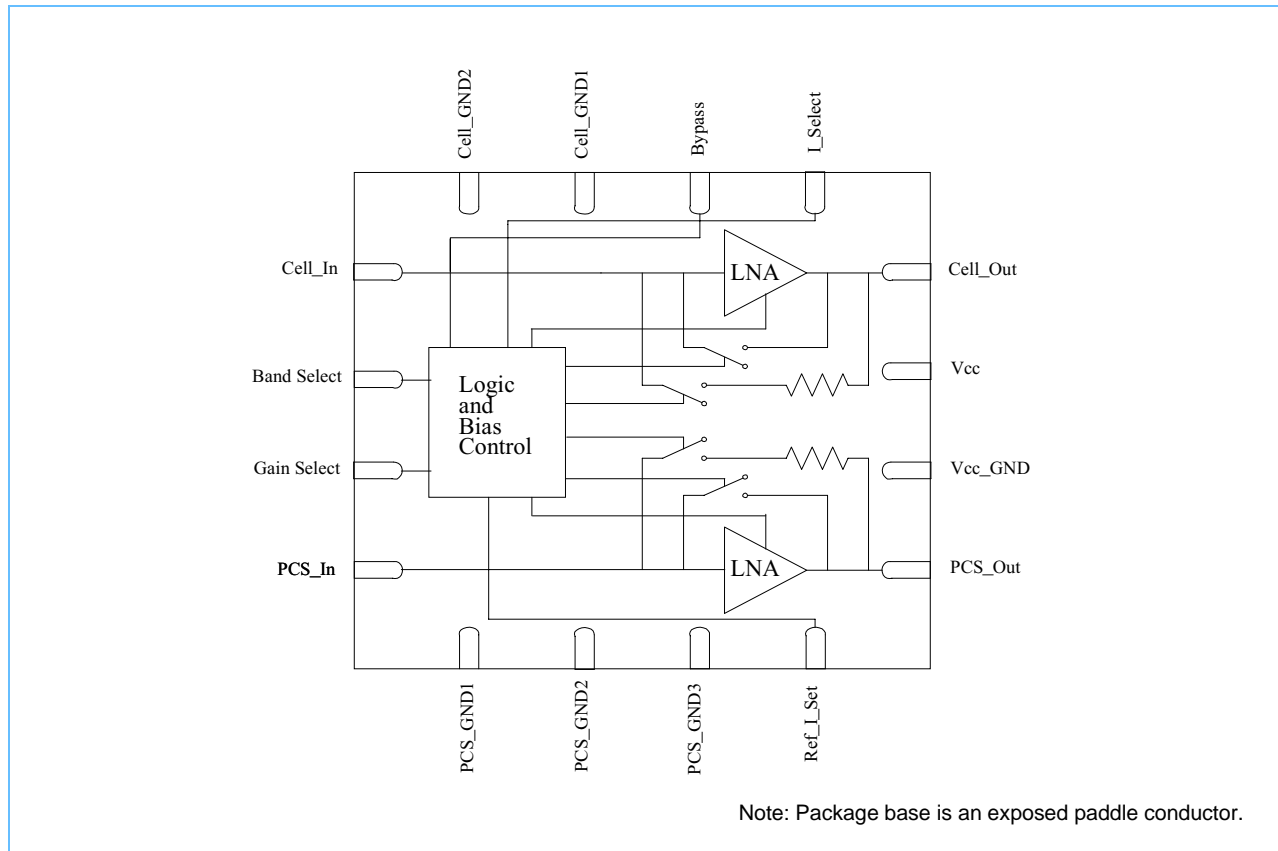
Electrical and Thermal Characteristics

Table 2. Absolute Maximum and Minimum Ratings

Parameter	Symbol	Min	Max	Units	Notes
Supply Voltage	V_{CC}	--	3.6	volts	
Continuous Power Dissipation		--	30	mW	
RF Input Level	Cell_In, PCS_In	--	+10	dBm	Vcc applied
Operating Temperature		-40	+85	°C	
Storage Temperature		-65	+150	°C	
Lead Temperature		--	240	°C	Soldering for 10 seconds

Table 3. DC Electrical Characteristics (25 °C)

Parameter	Symbol	Min	Typ	Max	Units	Notes
Supply Voltage	V_{CC}	2.65	2.75	2.85	volts	
Supply Current	Icc		10	12.5	mA	High Linearity mode
			5	7	mA	Low Linearity mode
			<0.3	1	mA	Bypass mode
			<1.0	10	µA	Standby mode
Logic Input Low Voltage Level	V_{IL}	0.0	--	0.54	volts	
Logic Input High Voltage Level	V_{IH}	2.4	--	Vcc	volts	
Logic Input Low Current	I_{IL}	--	--	-1.5	nA	$V_{IL} = 0.0$
Logic Input High Current	I_{IH}	--	--	1.5	nA	$V_{IH} = V_{CC}$

Table 4. Mode Control Truth Table

Modes of Operation			Control Pin Logic			
Band	Gain	Linearity	Band Select	Gain Select	I_Select	Bypass
Cellular	High	High	0	1	1	0
	Mid	High	0	0	1	0
	High	Low	0	1	0	0
	Mid	Low	0	0	0	0
	Bypass	--	0	0	0	1
PCS	High	High	1	1	1	0
	Mid	High	1	0	1	0
	High	Low	1	1	0	0
	Mid	Low	1	0	0	0
	Bypass	--	1	0	0	1
Standby Mode			1	1	1	1

Table 5. AC Electrical Characteristics, Cellular Band 869-894MHz, High Linearity mode (Current 10mA)

Parameter	Min	Typ	Max	Units	Notes
Power Gain	14.5	15.0	15.5	dB	High gain selected
	10.0	10.5	11.0	dB	Medium gain selected
	-3.5	-4	-4.5	dB	Bypass mode
Gain Flatness (869-894 MHz)	--	+/-0.3	--	dB	High gain selected
	--	+/-0.2	--	dB	Medium gain selected
	--	+/-0.3	--	dB	Bypass mode
Noise Figure	--	1.7	1.9	dB	High gain selected
	--	2.4	2.8	dB	Medium gain selected
	--	6.0	6.5	dB	Bypass mode
Input Third Order Intercept Point (IIP3)	+7.5	+8.5	--	dBm	High gain selected
	+14.5	+15.5	--	dBm	Medium gain selected
	+20.0	+20.5	--	dBm	Bypass mode
Input 1dB Compression	-4.5	-4	--	dBm	High gain selected
	-0.5	+0.5	--	dBm	Medium gain selected
	+4.5	+5.0	--	dBm	Bypass mode
Input Return Loss	7	8	--	dB	High gain selected
	12	15	--	dB	Medium gain selected
	6	7	--	dB	Bypass mode
Output Return Loss	10	12	--	dB	High gain selected
	6	7	--	dB	Medium gain selected
	10	12	--	dB	Bypass mode
Reverse Isolation	20	22	--	dB	High gain selected
	16	18	--	dB	Medium gain selected
	3	4	--	dB	Bypass mode

Note: Device characteristics measured with IBM3604012EVBA Evaluation Board Assembly. Optimum external input and output matching to 50 ohm terminations. Input power =-30dBm (-15dBm: Bypass mode); V_{CC} = 2.75 volts, ambient temperature = 25 °C, and frequency = 880 MHz. Max, Min and Typ values are based on statistical samples from several non-consecutive wafer lots.

Table 6. AC Electrical Characteristics, Cellular Band 869-894MHz, Low Linearity mode (Current 5mA)

Parameter	Min	Typ	Max	Units	Notes
Power Gain	14.0	14.5	15.0	dB	High gain selected
	9.5	10.0	10.5	dB	Medium gain selected
	-3.5	-4	-4.5	dB	Bypass mode
Gain Flatness (869-894 MHz)	--	+/-0.3	--	dB	High gain selected
	--	+/-0.2	--	dB	Medium gain selected
	--	+/-0.2	--	dB	Bypass mode
Noise Figure	--	1.6	1.8	dB	High gain selected
	--	2.4	2.6	dB	Medium gain selected
	--	6	6.5	dB	Bypass mode
Input Third Order Intercept Point (IIP3)	6.5	+8.0	--	dBm	High gain selected
	9.5	+10.5	--	dBm	Medium gain selected
	+20.0	+20.5	--	dBm	Bypass mode
Input 1dB Compression	-4.5	-3.5	--	dBm	High gain selected
	-1.0	+1.2	--	dBm	Medium gain selected
	+4.5	+5.0	--	dBm	Bypass mode
Input Return Loss	6	8	--	dB	High gain selected
	10	14	--	dB	Medium gain selected
	6	7	--	dB	Bypass mode
Output Return Loss	10	12	--	dB	High gain selected
	6	7	--	dB	Medium gain selected
	10	12	--	dB	Bypass mode
Reverse Isolation	20	22	--	dB	High gain selected
	16	18	--	dB	Medium gain selected
	3	4	--	dB	Bypass mode

Note: Device characteristics measured with IBM3604012EVBA Evaluation Board Assembly. Optimum external input and output matching to 50 ohm terminations. Input power =-30dBm (-15dBm: Bypass mode); V_{CC} = 2.75 volts, ambient temperature = 25 °C, and frequency = 880 MHz. Max, Min and Typ values are based on statistical samples from several non-consecutive wafer lots.

Table 7. AC Electrical Characteristics, PCS Band 1930-1990MHz, High Linearity mode (Current 10mA)

| Parameter	Min	Typ	Max	Units	Notes
Power Gain	13.0	13.5	14.0	dB	High gain selected
	12.0	12.5	13.0	dB	Medium gain selected
	6.0	-6.5	7.0	dB	Bypass mode
Gain Flatness (1930-1990 MHz)	--	+/-0.5	--	dB	High gain selected
	--	+/-0.4	--	dB	Medium gain selected
	--	+/-0.3	--	dB	Bypass mode
Noise Figure	--	1.9	2.1	dB	High gain selected
	--	2.2	2.4	dB	Medium gain selected
	--	6.5	7.0	dB	Bypass mode
Input Third Order Intercept Point (IIP3)	+5.5	+6.5	--	dBm	High gain selected
	+6.0	+7.0	--	dBm	Medium gain selected
	+27	+28	--	dBm	Bypass mode
Input 1dB Compression	-4.0	-3.5	--	dBm	High gain selected
	-3.5	-3.0	--	dBm	Medium gain selected
	6.0	+6.5	--	dBm	Bypass mode
Input Return Loss	10	12	--	dB	High gain selected
	10	13	--	dB	Medium gain selected
	8	10	--	dB	Bypass mode
Output Return Loss	10	12	--	dB	High gain selected
	10	14	--	dB	Medium gain selected
	8	10	--	dB	Bypass mode
Reverse Isolation	20	22	--	dB	High gain selected
	20	22	--	dB	Medium gain selected
	6	6.5	--	dB	Bypass mode

Note: Device characteristics measured with IBM3604012EVBA Evaluation Board Assembly. Optimum external input and output matching to 50 ohm terminations. Input power =-30dBm (-10dBm: Bypass mode); V_{CC} = 2.75 volts, ambient temperature = 25 °C, and frequency = 1960 MHz. Max, Min and Typ values are based on statistical samples from several non-consecutive wafer lots.

Table 8. AC Electrical Characteristics, PCS Band 1930-1990MHz, Low Linearity mode (Current 5mA)

Parameter	Min	Typ	Max	Units	Notes
Power Gain	12.5	13.0	13.5	dB	High gain selected
	11.5	12.0	12.5	dB	Medium gain selected
	6.0	-6.5	7.0	dB	Bypass mode
Gain Flatness (1930-1990MHz)	--	+/-0.6	--	dB	High gain selected
	--	+/-0.4	--	dB	Medium gain selected
	--	+/-0.2	--	dB	Bypass mode
Noise Figure	--	1.9	2.2	dB	High gain selected
	--	2.3	2.5	dB	Medium gain selected
	--	6.5	7.0	dB	Bypass mode
Input Third Order Intercept Point (IIP3)	-2.5	-1.5	--	dBm	High gain selected
	-2.0	-1.0	--	dBm	Medium gain selected
	+27	+28	--	dBm	Bypass mode
Input 1dB Compression	-4.5	-3.5	--	dBm	High gain selected
	-3.0	-2.0	--	dBm	Medium gain selected
	6.0	+6.5	--	dBm	Bypass mode
Input Return Loss	7	9	--	dB	High gain selected
	10	12	--	dB	Medium gain selected
	8	10	--	dB	Bypass mode
Output Return Loss	10	12	--	dB	High gain selected
	10	12	--	dB	Medium gain selected
	8	10	--	dB	Bypass mode
Reverse Isolation	18	20	--	dB	High gain selected
	20	23	--	dB	Medium gain selected
	6	6.5	--	dB	Bypass mode

Note: Device characteristics measured with IBM3604012EVBA Evaluation Board Assembly. Optimum external input and output matching to 50 ohm terminations. Input power =-30dBm (-10dBm: Bypass mode); V_{CC} = 2.75 volts, ambient temperature = 25 °C, and frequency = 1960 MHz. Max, Min and Typ values are based on statistical samples from several non-consecutive wafer lots.

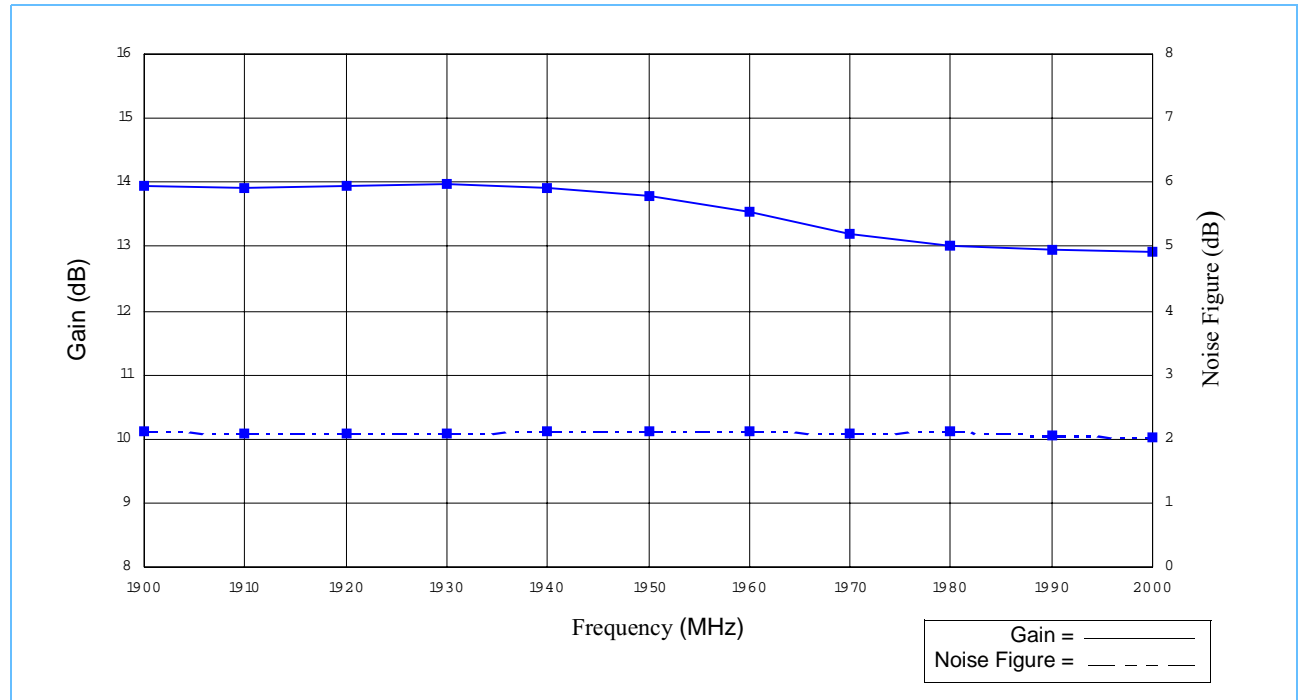# Gain and Noise Figure Plots $(V_{CC} = 2.75V, T=25 \text{ deg.C})$

Cellular Band: High Gain and High Linearity Mode
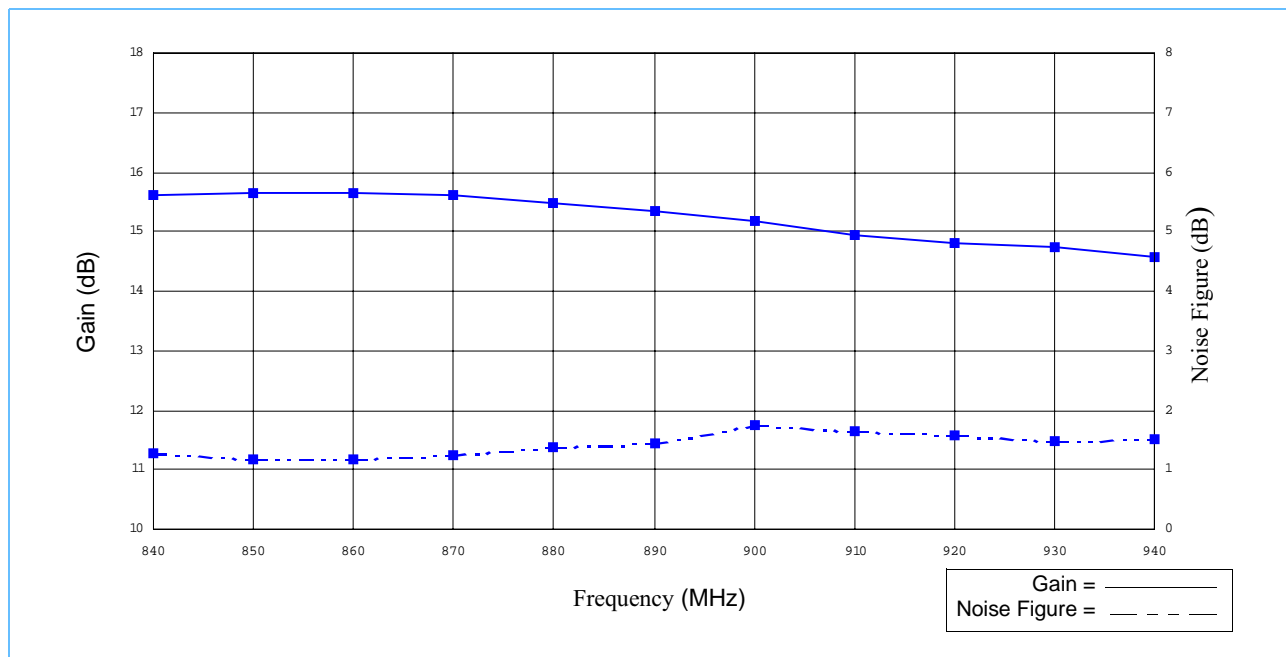
Cellular Band: High Gain and Low Linearity Mode
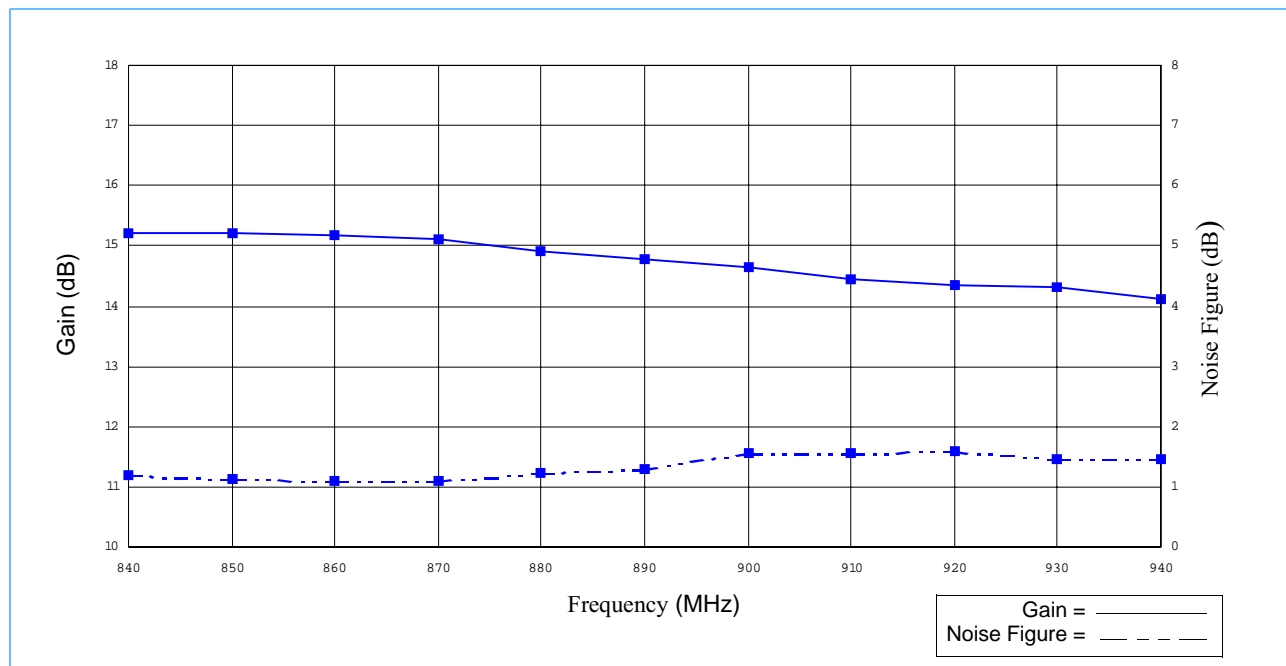
PCS Band: High Gain and High Linearity Mode
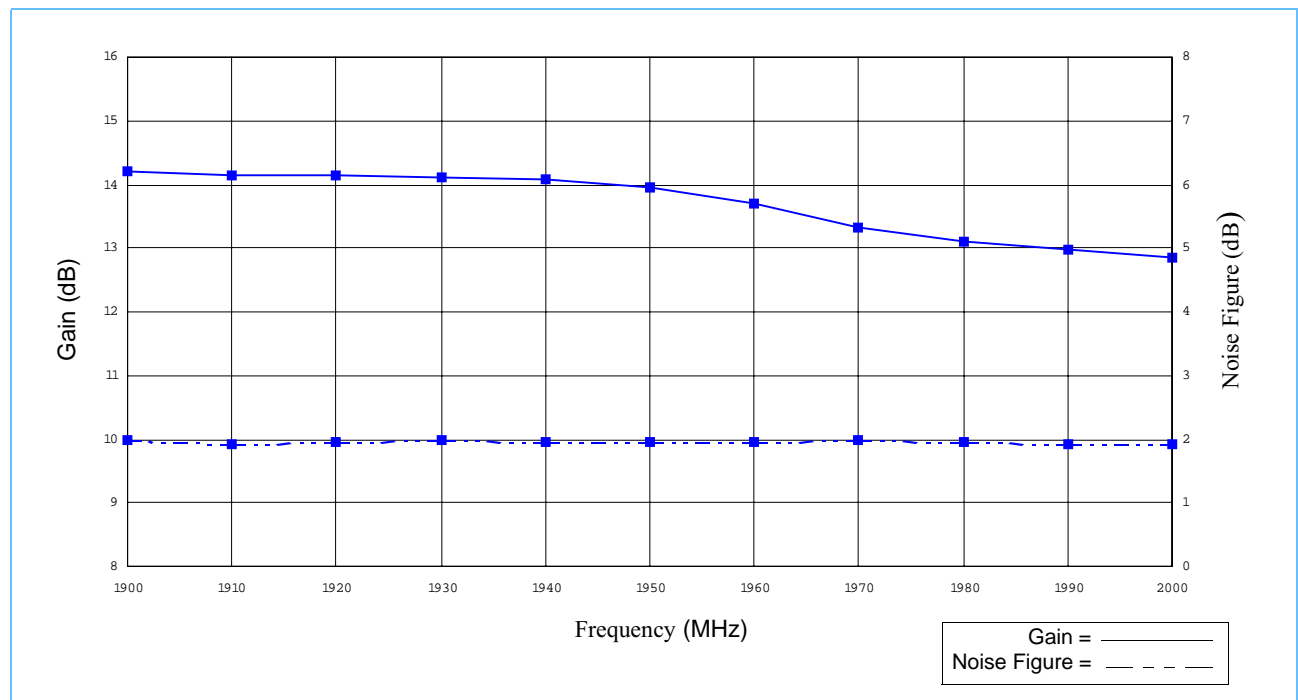

PCS Band: High gain and Low Linearity Mode

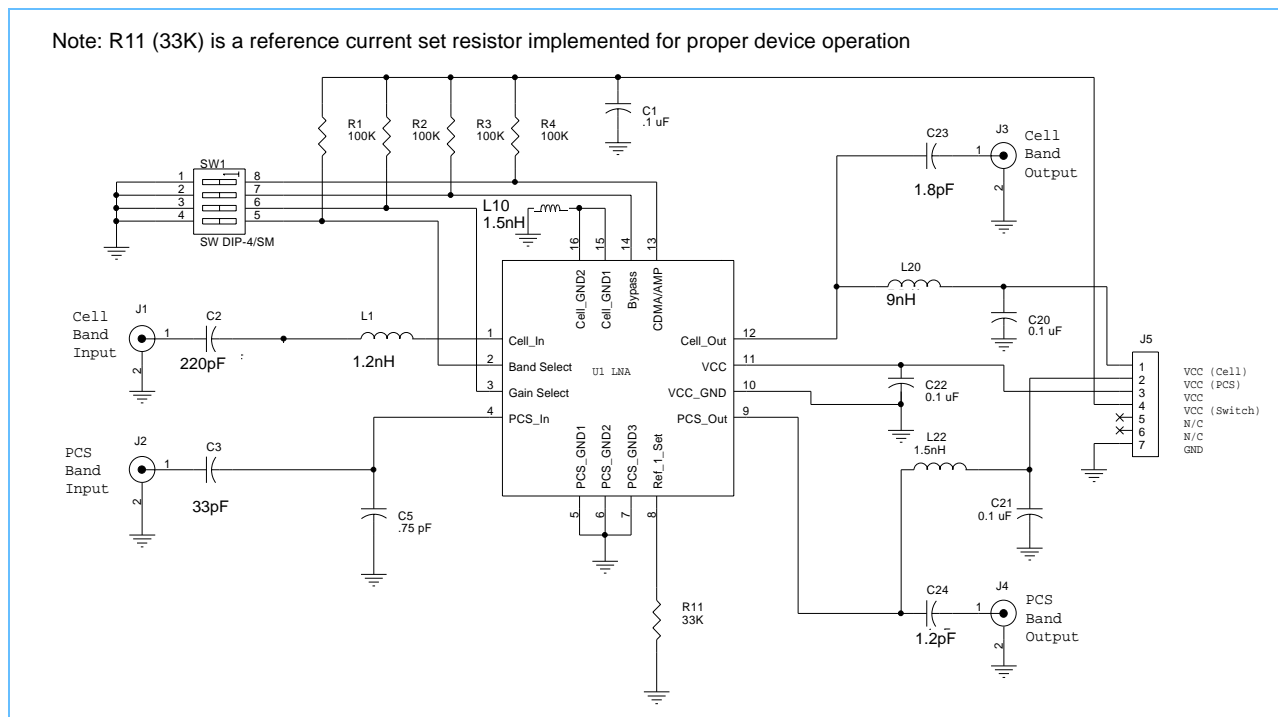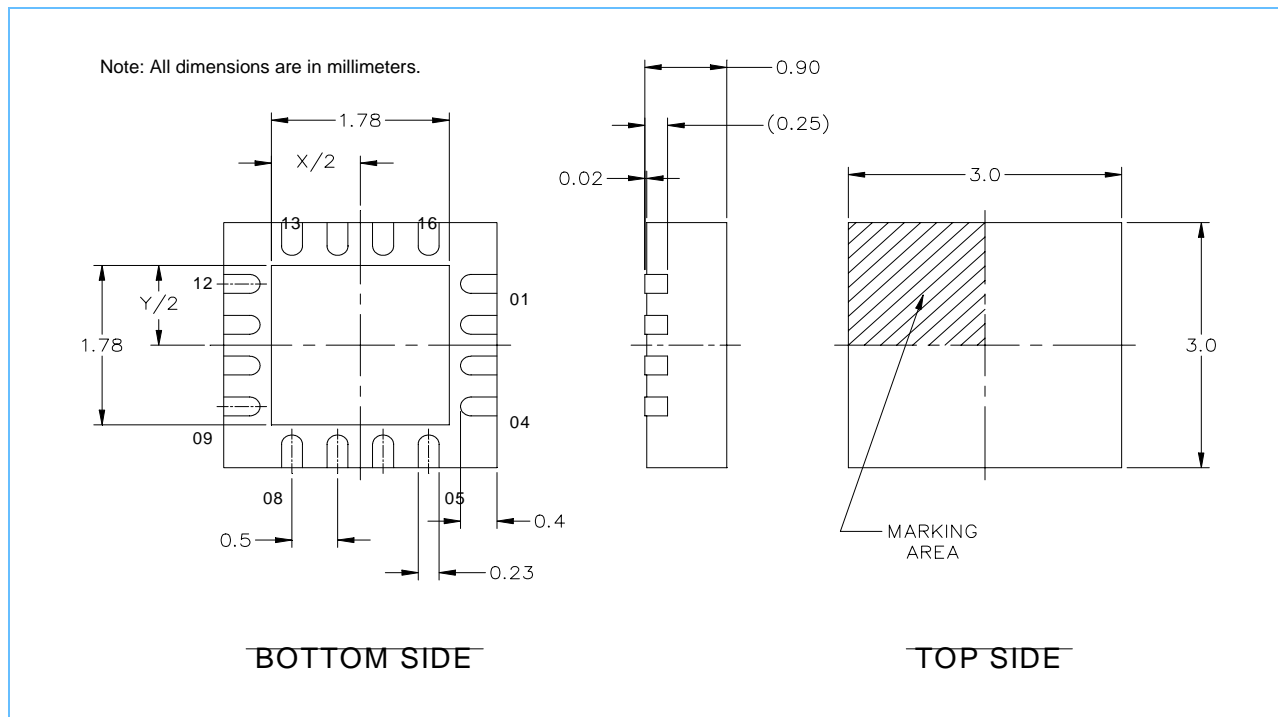*Figure 4. IBM3604012EVBA Evaluation Board Assembly Schematic*
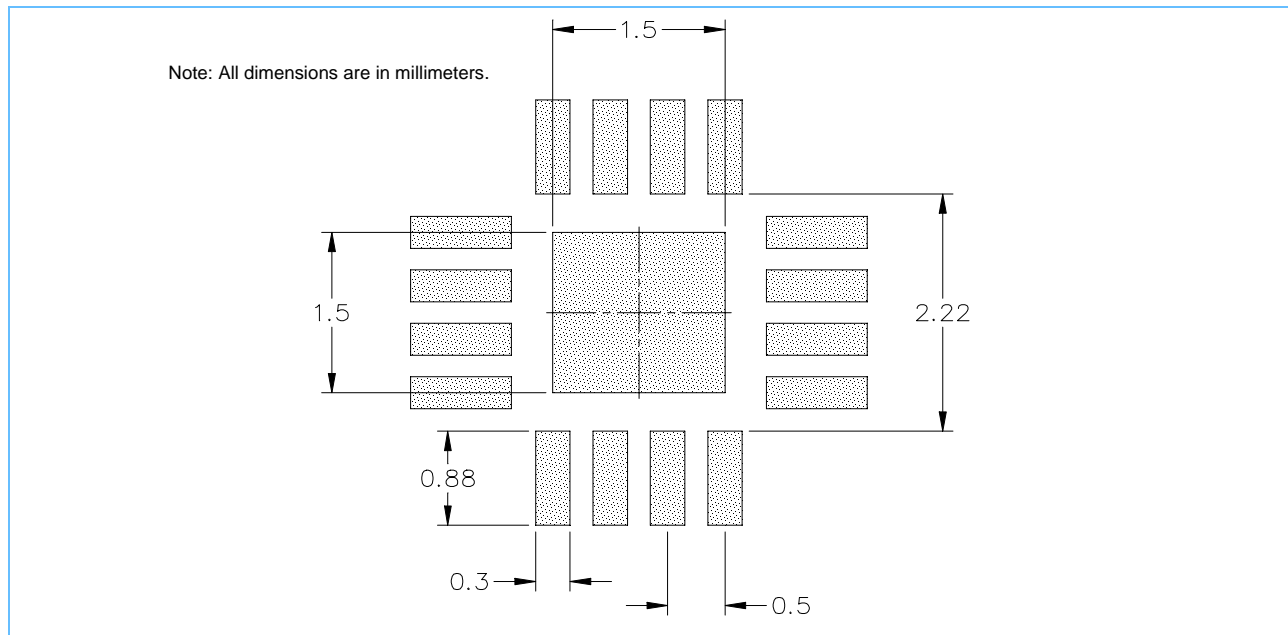

Figure 5. Package Diagram

Figure 6. PCB Pad Placement

Note: All dimensions are in millimeters.

1.5

1.5

2.22

0.88

0.3

0.5

Document Revision Log

Rev.	Contents of Modification
September 25, 2001	Initial release (00).
October 30, 2001	Data and board schematic per tests on tape out (01)
January 15, 2002	Data tables updated with split lot values (02)

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