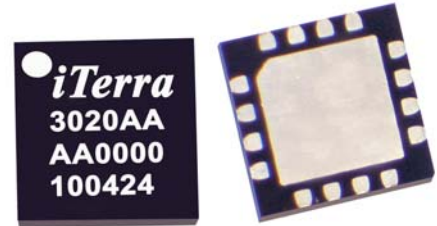


Description

The iT3020 is a highly linear low noise differential variable gain amplifier with a bandwidth of DC to 10 GHz. It is suitable for Automatic Gain Control (AGC) in high bandwidth applications such as a 10/12.5 Gb/s STM-64/OC-192 receiver front end. Offset correction and shutoff control are provided. Both AC and DC coupling are allowed at the input and output. High sensitivity allows the device to be used at the output of a transimpedance amplifier.

Features

- ❖ 3-dB bandwidth: 10 GHz
- ❖ Differential gain: 29 dB
- ❖ Bias supply: -5 V, 156 mA, and +5 V, 74 mA
- ❖ Power consumption: 1150 mW
- ❖ Gain control: 30 dB
- ❖ CMRR: Better than 25 dB
- ❖ DC offset correction
- ❖ Low RMS jitter
- ❖ Low-cost JEDEC QFP-N (MO-220) package



Absolute Maximum Ratings

Symbol	Parameters/conditions	Min.	Max.	Units
V _{ee}	Power supply voltage negative	-6	0	V
V _{cc}	Power supply voltage positive	0	6	V
V _d	Applied voltage at data input (differential)		3	V
V _m	Applied voltage at data input (single ended)		1.5	V
I _{offset(+),(-)}	Offset control current		5	mA
T _{ch}	Maximum channel temperature		150	°C
T _{stg}	Storage temperature	-65	150	°C

Recommended Operating Conditions

Symbol	Parameters/conditions	Min.	Typ.	Max.	Units
T _c	Operating temperature range (T _{case})	0		85	°C
V _{ee}	Power supply voltage	-5.25	-5	-4.75	V
V _{cc}	Power supply voltage	4.75	5	5.25	V
I _{ee}	Negative bias supply current	146	156	167	mA
I _{cc}	Positive bias supply current	65	74	82	mA
BR	Bit rate			12.5	Gb/s
V _{imn}	Offset control voltage	-5		5	V
V _{gc}	Gain control voltage	-3.2		0	V
V _{sh}	Shut-off control voltage	-5		0	V
	Input/output interface	AC and DC coupled			
V _{in_DC}	Input DC voltage (DC coupling)		0		V
V _{d_max}	Maximum differential input signal for linear mode			40	mV _{pp}
V _{m_max}	Maximum single-ended input signal for linear mode			40	mV _{pp}



iT3020 10 GHz Variable Gain Amplifier

Electrical Characteristics

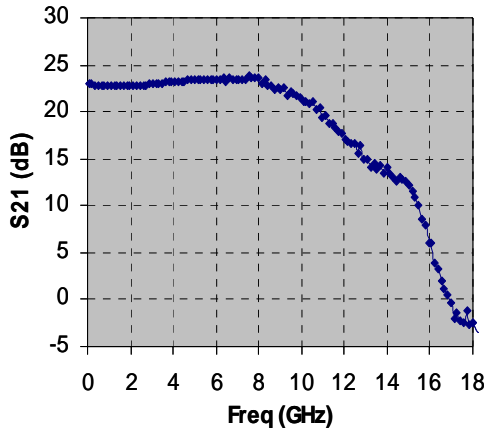
Symbol	Parameters/conditions	Min.	Typ.	Max.	Units
P	Power consumption	1030	1150	1260	mW
G	Single-ended small signal gain	22	23		dB
	Gain control dynamic range		20		dB
B3dB	3 dB bandwidth	9	10		GHz
RLin	Input return loss (up to 10 GHz)	12	20		dB
RLout	Output return loss (up to 10 GHz)	10	15		dB
Voutdc	Output DC voltage (DC coupled to 50 ohm load)		0		mV
P1dB	Output power at 1-dB gain compression Frequency 2 GHz, maximum gain setting	4.5	5.5		dBm
Psat	Saturated output power Frequency 2 GHz, maximum gain setting	6	7		dBm
IP3O	3rd-order output intercept point Frequency 2 GHz, maximum gain setting	15	16		dBm
THD	Total harmonic distortion (up to 10 GHz, Pout = 0 dBm) Single-ended output			-34	dBm
	Differential output			-42	dBm
Trse	Rise time (20% - 80%)		36	39	ps
Tfse	Fall time (20% - 80%)		37	39	ps
Jrms	Jitter degradation		0.7	1	ps
	Overshoot (Bit rate = 10 Gb/s, maximum gain setting)			6	%
CMRR	Common-mode rejection ratio (up to 10 GHz)	25			dB

S-Parameter Data

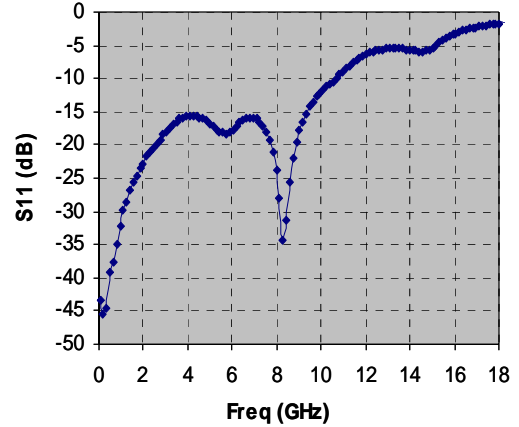
(Measured on connectorized evaluation board)

V_{ee} = -5 V, V_{cc} = 5 V
 I_{ee} = 156 mA, I_{cc} = 74 mA
 V_{gc} = 0 V, 10.2 mA
 V_{sh} = 0 V, 21.8 mA

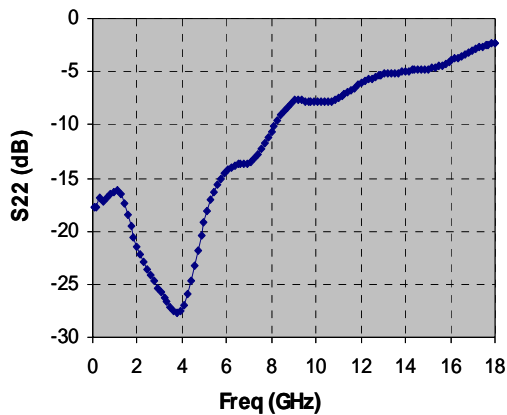
iT3020 Single Ended Gain



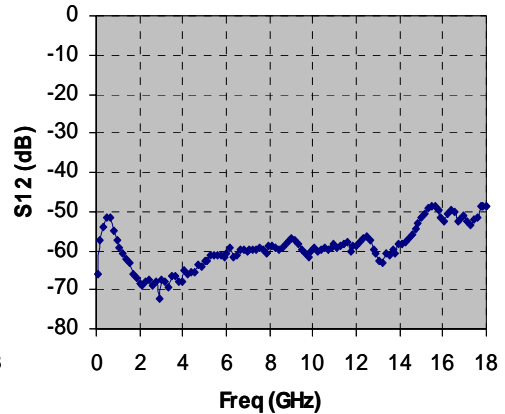
iT3020 Input Return Loss



iT3020 Output Return Loss



iT3020 Isolation

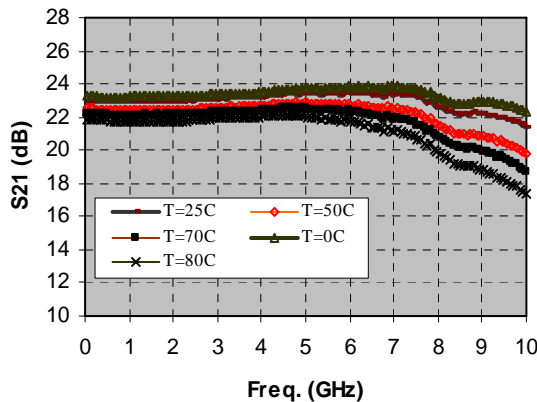


S21 Versus Temperature 0 to 80 °C

(Measured on connectorized evaluation board)

V_{ee} = -5 V, V_{cc} = 5 V
 I_{ee} = 156 mA, I_{cc} = 74 mA
 V_{gc} = 0 V, 10.2 mA
 V_{sh} = 0 V, 21.8 mA

S21 vs. Temperature

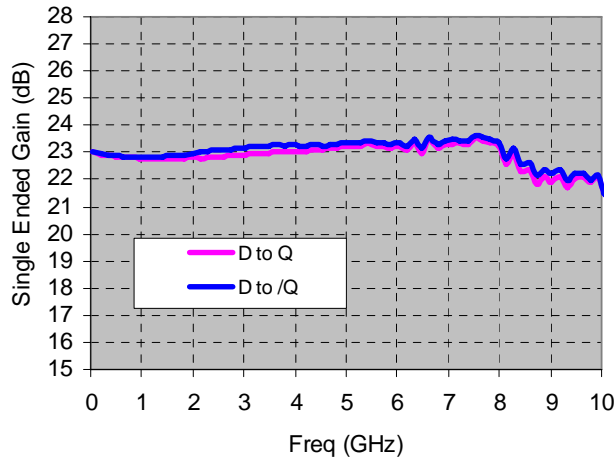


Single-Ended Gain in Direct and Cross Port Configurations

(Measured on connectorized Evaluation board)

V_{ee} = -5 V, V_{cc} = 5 V
 I_{ee} = 156 mA, I_{cc} = 74 mA
 V_{gc} = 0 V, 10.2 mA
 V_{sh} = 0 V, 21.8 mA

Single Ended Gain Direct and Cross Port Configurations

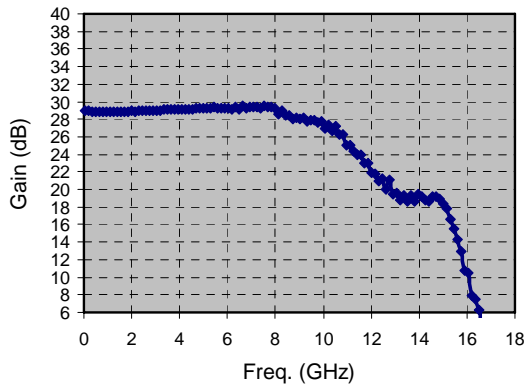


Differential Gain and CMRR

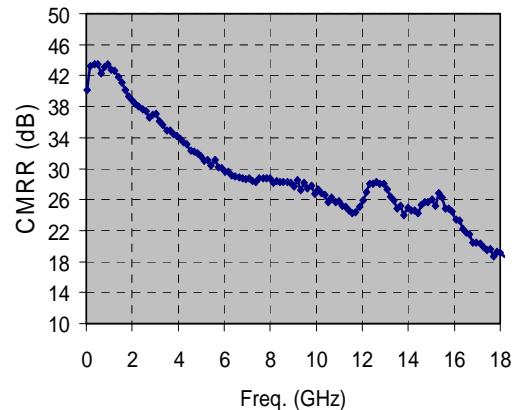
Measured on connectorized Evaluation board)

V_{ee} = -5 V, V_{cc} = 5 V
 I_{ee} = 156 mA, I_{cc} = 74 mA
 V_{gc} = 0 V, 10.2 mA
 V_{sh} = 0 V, 21.8 mA

Differential Gain



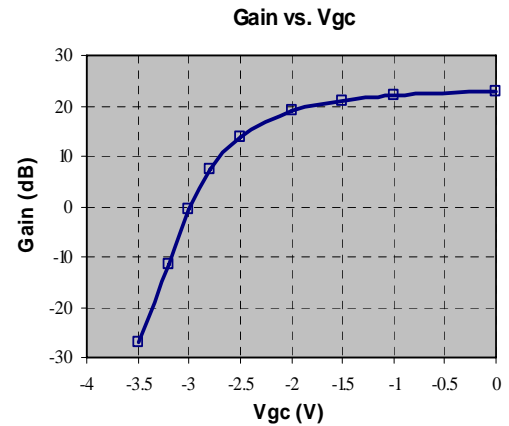
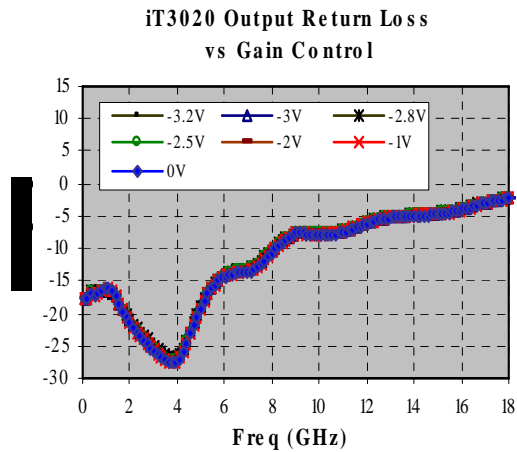
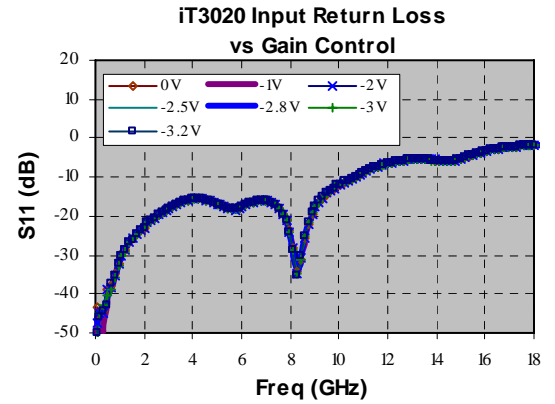
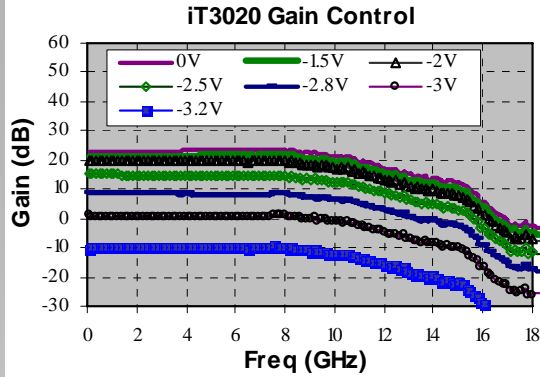
CMRR



S-Parameter Data, Varying Vgc (Gain Control)

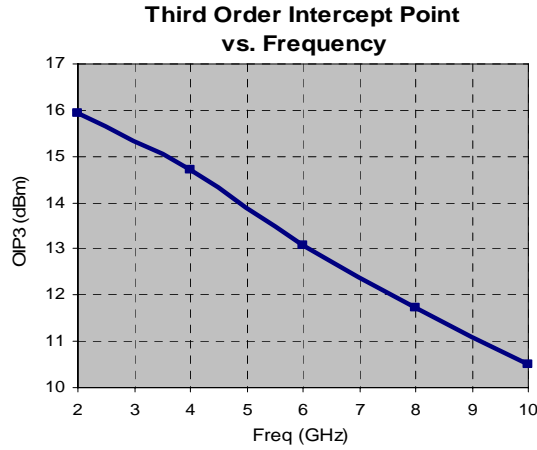
(Measured on connectorized
Evaluation board)

V_{ee} = -5 V, V_{cc} = 5 V
I_{ee} = 156 mA, I_{cc} = 74 mA



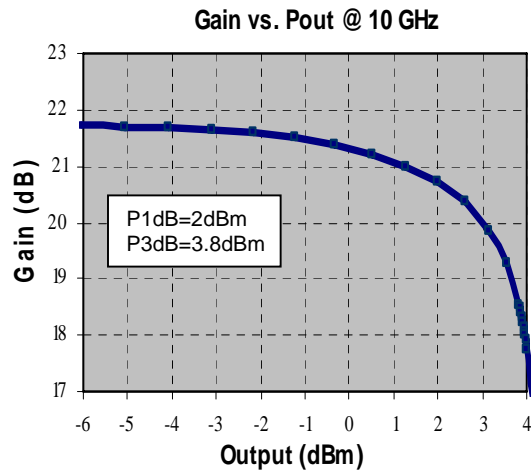
Third Order Intercept Point Versus Frequency

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA



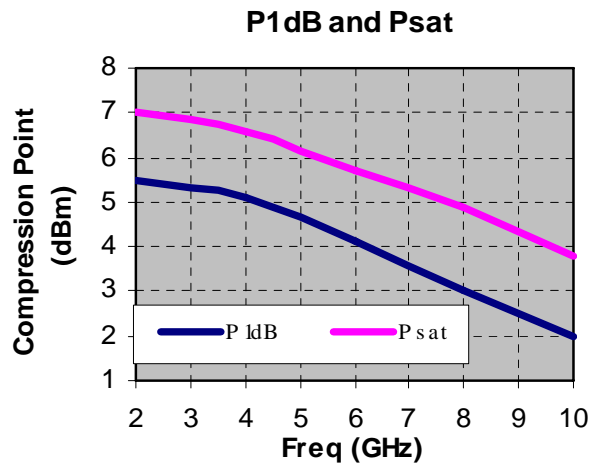
Gain Versus Output power At 10 GHz

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA



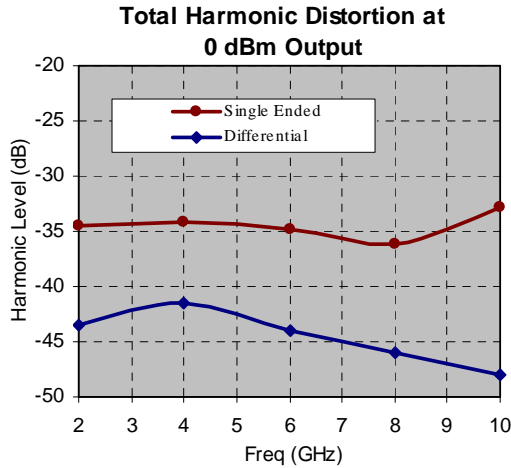
P1dB and Psat

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA



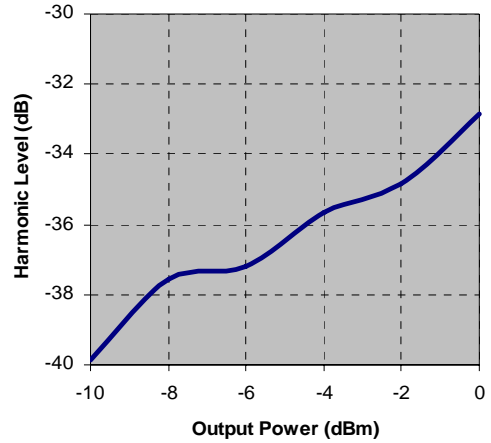
(a) Total Harmonic Distortion at 0 dBm Single-Ended/Differential

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA



(a)

Total Harmonic Distortion Vs. Output Power at 10 GHz



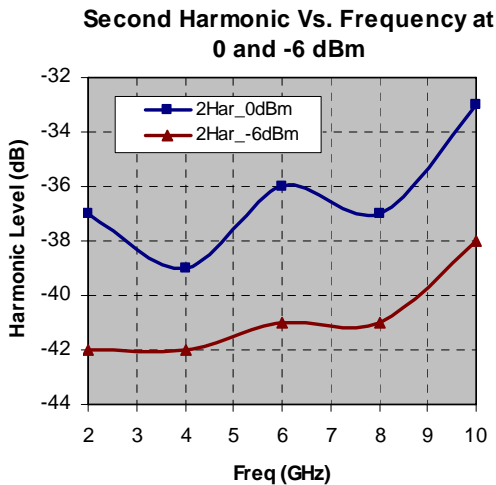
(b)

(b) Total Harmonic Distortion Versus Output Power At 10 GHz

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA

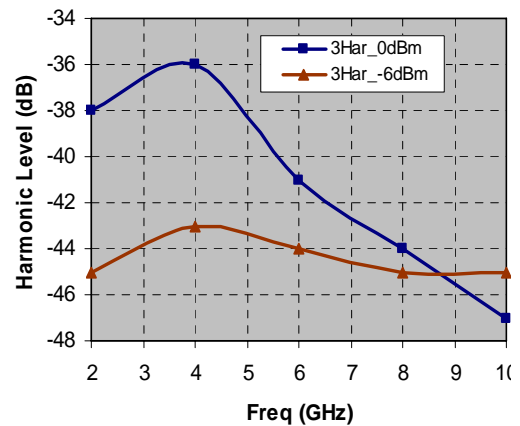
(a) Second Harmonic Versus Frequency At 0 and -6 dBm

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA



(a)

Third Harmonic Vs. Frequency at 0 and -6 dBm



(b)

(b) Third Harmonic Versus Frequency At 0 and -6 dBm

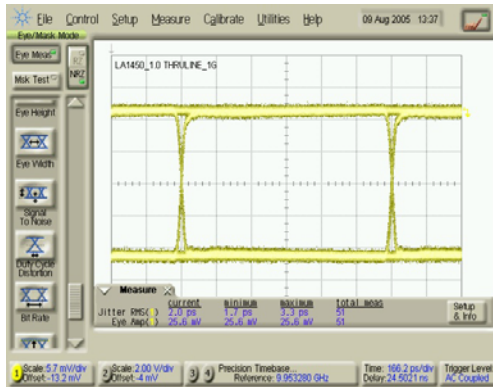
V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA

*Differential THD is estimated from single-ended measurement. It is assumed to be equal to the third harmonic level at -3 dBm power output

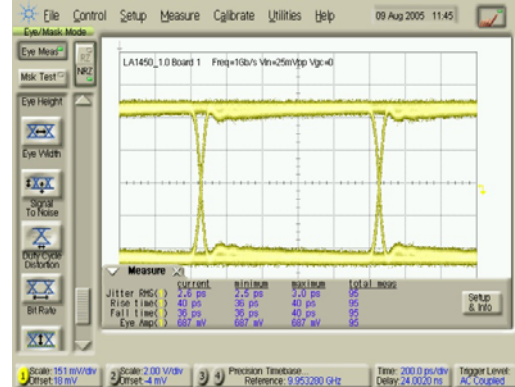
Eye Diagram Performance Versus Bit Rates

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA
V_{in} = 25 mV pp, V_{gc} = 0 V

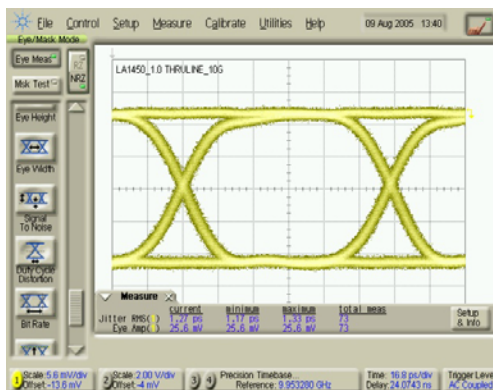
Differential input and DC coupled



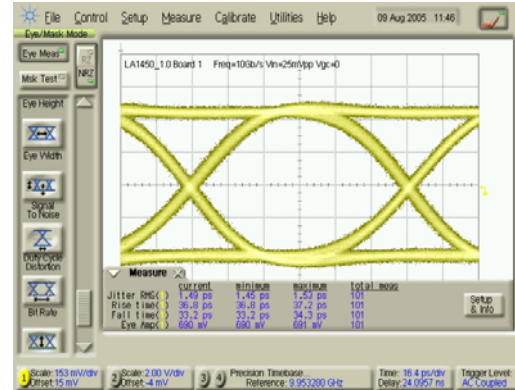
Bit rate: 1 Gb/s
Through Line



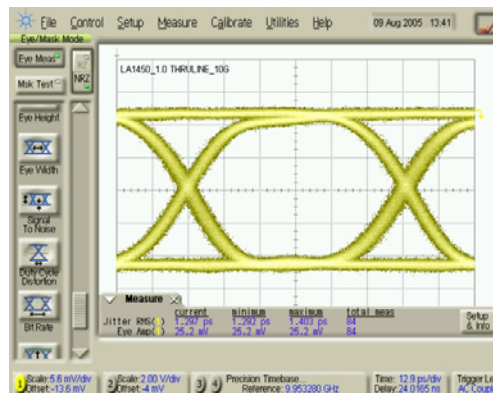
Bit rate: 1 Gb/s
V_{out} = 687 mVpp, tr = 40 ps, tf = 40 ps



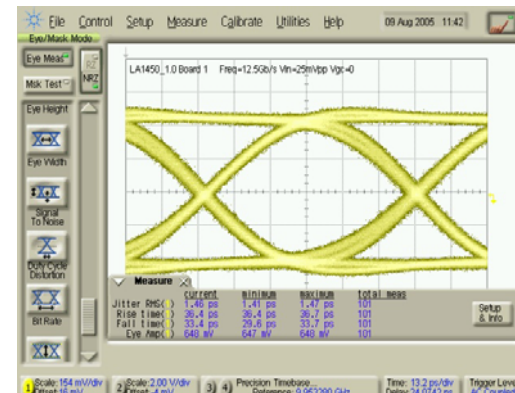
Bit rate: 10 Gb/s
Through Line



Bit rate: 10 Gb/s
V_{out} = 690 mVpp, tr = 37.2 ps, tf = 34.3 ps



Bit rate: 12.5 Gb/s
Through Line

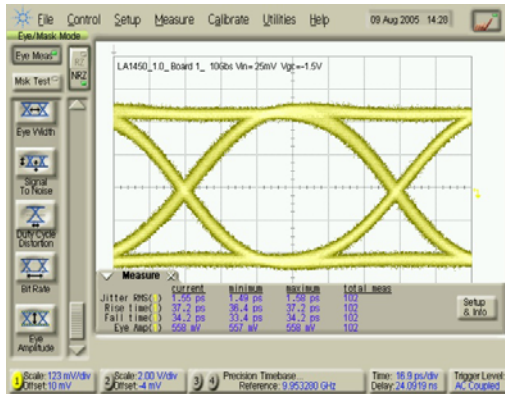


Bit rate: 12.5 Gb/s
V_{out} = 648 mVpp, tr = 36.7 ps, tf = 33.7 ps

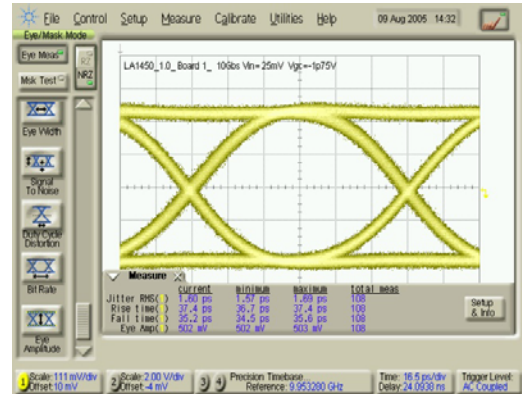
Eye Diagram Performance Versus Vgc

V_{ee} = -5 V, I_{ee} = 156 mA
 V_{cc} = 5 V, I_{cc} = 74 mA
 V_{in} = 25 mV pp,
 BR = 10 Gb/s

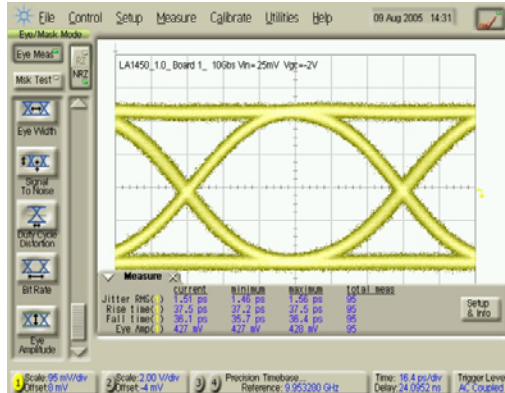
Differential input and DC coupled



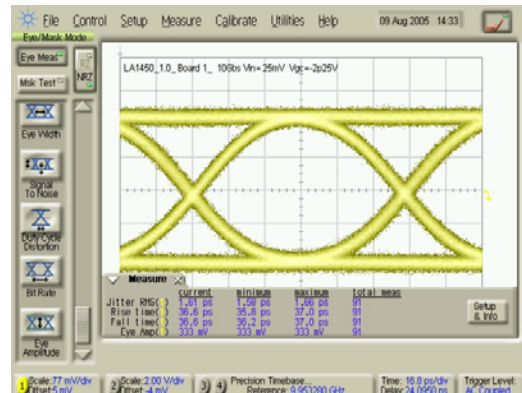
V_{gc} = -1.5 V
 V_{out} = 558 mV pp, tr = 37.2 ps, tf = 34.2 ps



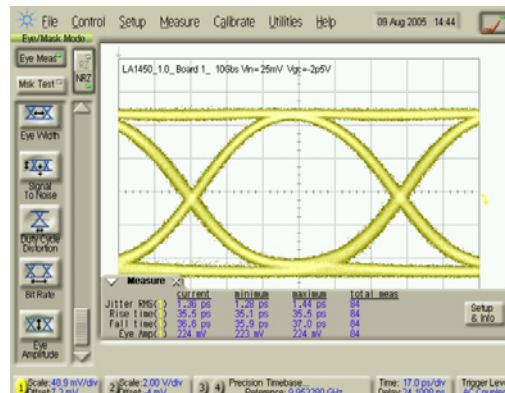
V_{gc} = -1.75 V
 V_{out} = 503 mVpp, tr = 37.4 ps, tf = 35.6 ps



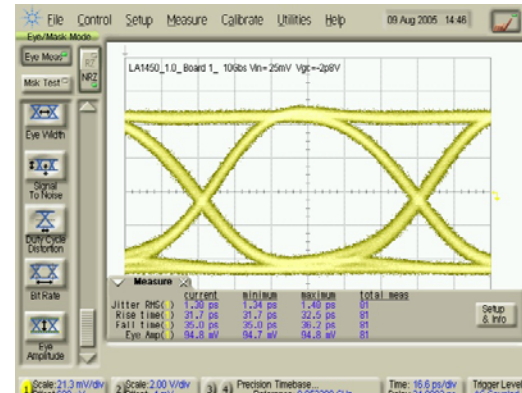
V_{gc} = -2 V
 V_{out} = 428 mV pp, tr = 37.5 ps, tf = 36.4 ps



V_{gc} = -2.25 V
 V_{out} = 333 mVpp, tr = 37 ps, tf = 37 ps



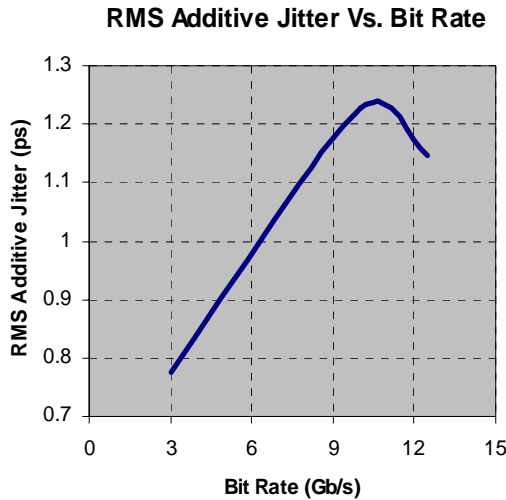
V_{gc} = -2.5 V
 V_{out} = 224 mV pp, tr = 35.5 ps, tf = 37 ps



V_{gc} = -2.8 V
 V_{out} = 94.8 mV pp, tr = 32.5 ps, tf = 36.2 ps

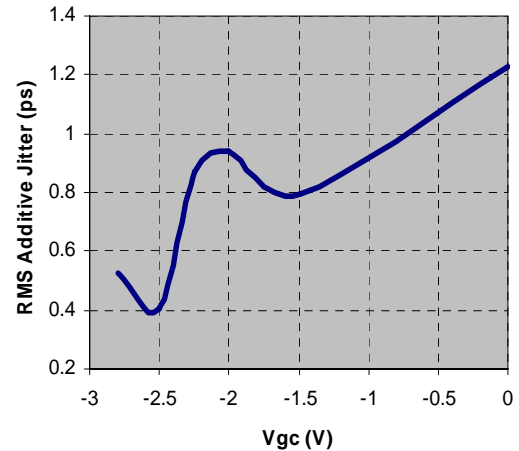
(a) RMS Additive Jitter Versus Bit Rate at Maximum Gain

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA
V_{in} = 25 mV pp, V_{gc} = 0 V



(a)

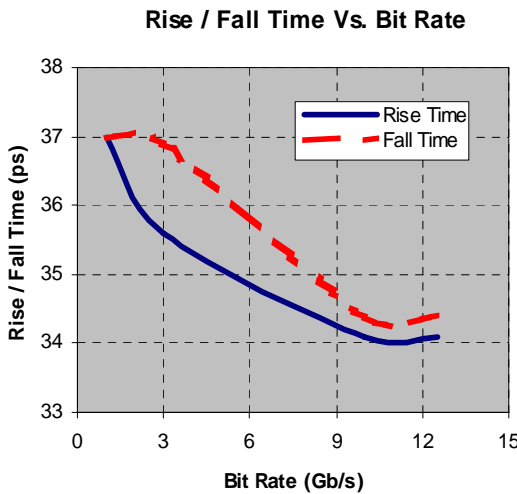
RMS Additive Jitter Vs. Gain Control



(b)

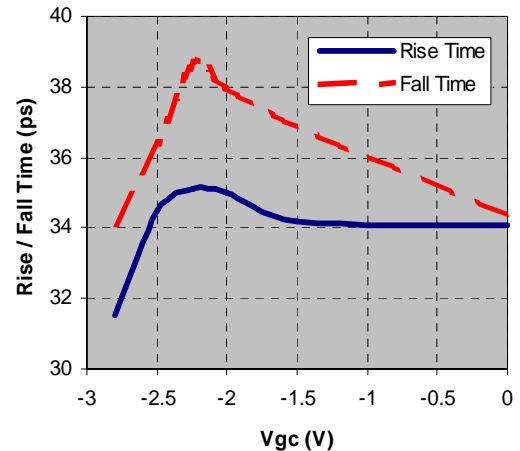
(a) Rise / Fall Time Versus Bit Rate at Maximum Gain

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA
V_{in} = 25 mV pp, V_{gc} = 0 V



(a)

Rise / Fall Time Vs. Gain Control



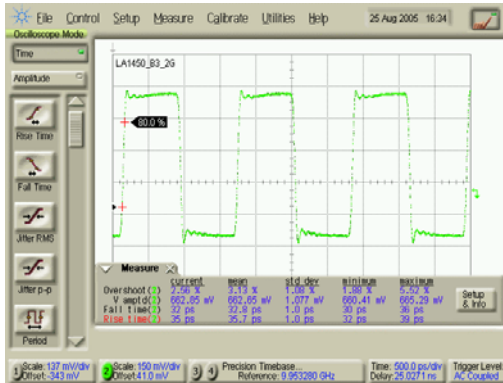
(b)

(b) Rise / Fall Time Versus Gain Control At 10 Gb/s

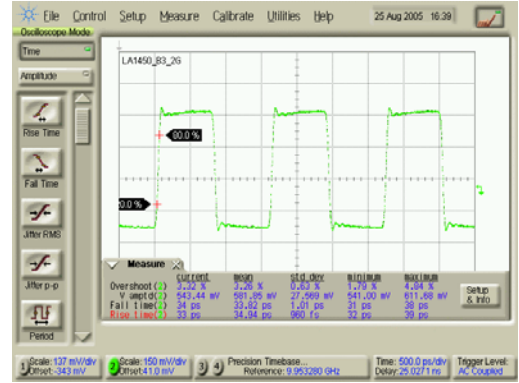
V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA
V_{in} = 25 mV pp

Square Wave Performance Varying Vgc At 5 Gb/s

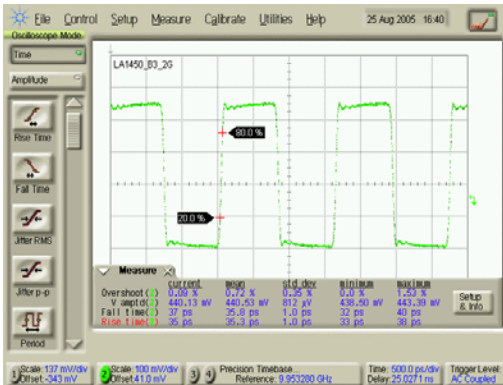
V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA
V_{in} = 25 mV pp



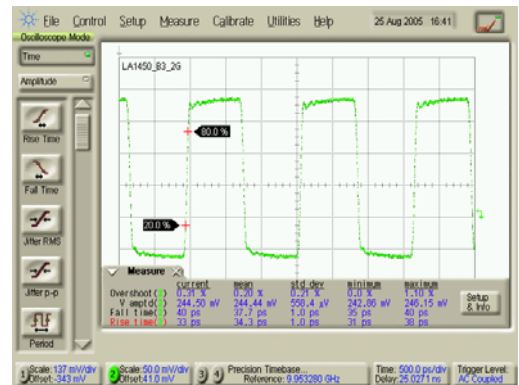
V_{gc} = 0 V
V_{out} = 662.7 mV pp, Overshoot = 3.1 %



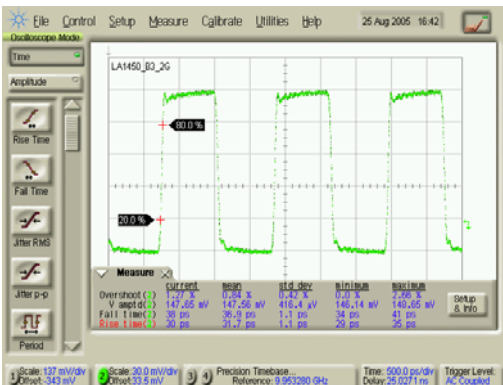
V_{gc} = -1.5 V
V_{out} = 581.9 mVpp, Overshoot = 3.26 %



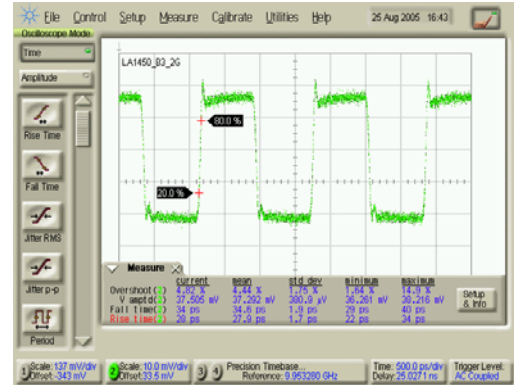
V_{gc} = -2 V
V_{out} = 440.5 mVpp, Overshoot = 0.72 %



V_{gc} = -2.5 V
V_{out} = 244.4 mVpp, Overshoot = 0.2 %



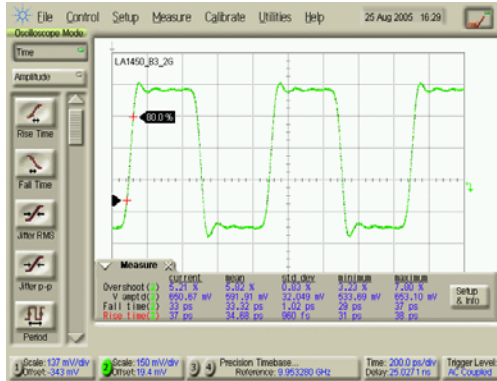
V_{gc} = -2.7 V
V_{out} = 147.6 mVpp, Overshoot = 0.84 %



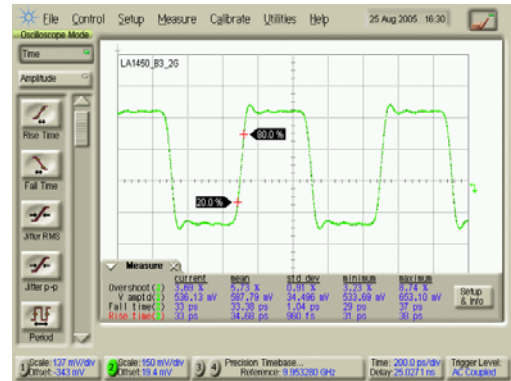
V_{gc} = -3 V
V_{out} = 37.3 mVpp, Overshoot = 4.44 %

Square Wave Performance Varying Vgc At 10 Gb/s

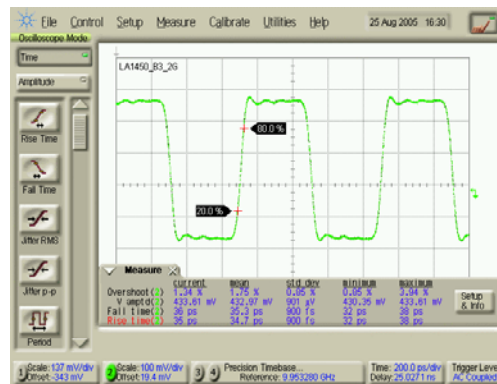
V_{ee} = -5 V, I_{ee} = 156 mA
 V_{cc} = 5 V, I_{cc} = 74 mA
 V_{in} = 25 mV pp



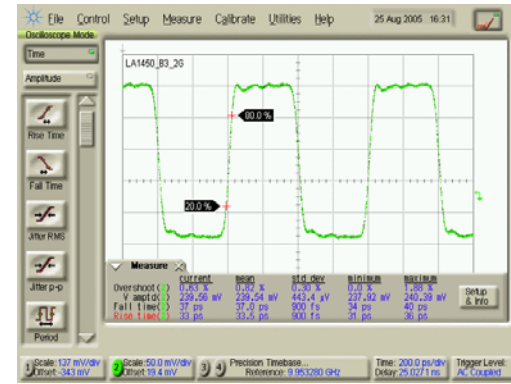
V_{gc} = 0 V
 V_{out} = 591.9 mV pp, Overshoot = 5.82 %



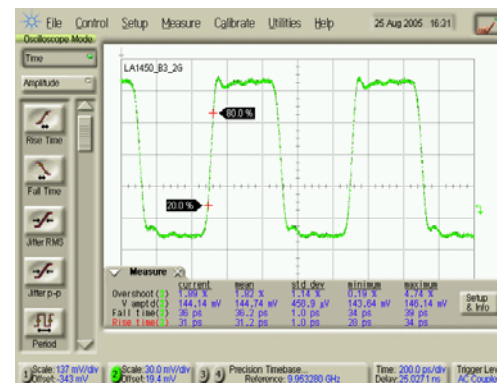
V_{gc} = -1.5 V
 V_{out} = 587.8 mVpp, Overshoot = 5.73 %



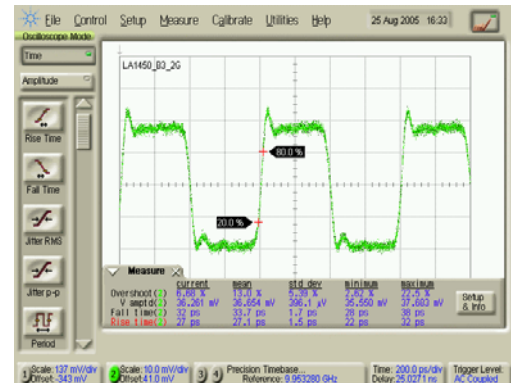
V_{gc} = -2 V
 V_{out} = 433 mVpp, Overshoot = 1.75 %



V_{gc} = -2.5 V
 V_{out} = 239.5 mVpp, Overshoot = 0.82 %



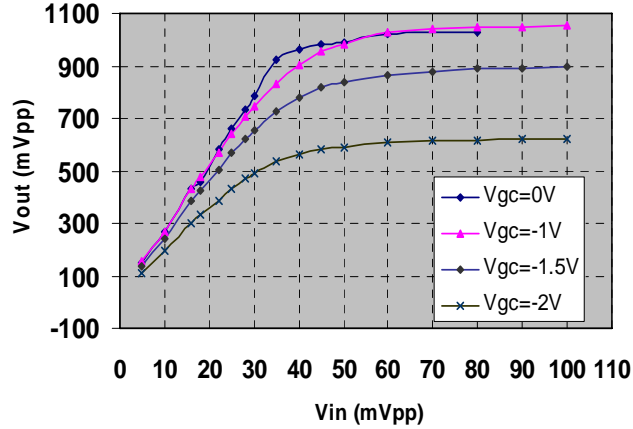
V_{gc} = -2.7 V
 V_{out} = 144.7 mVpp, Overshoot = 1.82 %



V_{gc} = -3 V
 V_{out} = 36.7 mVpp, Overshoot = 13.0 %

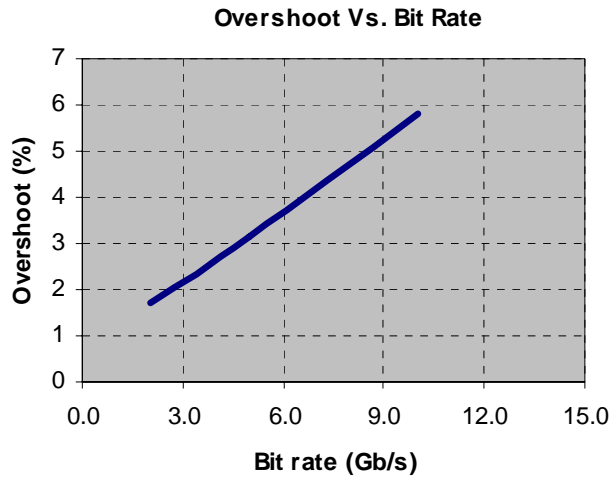
Performance as Function of Input Voltage

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA



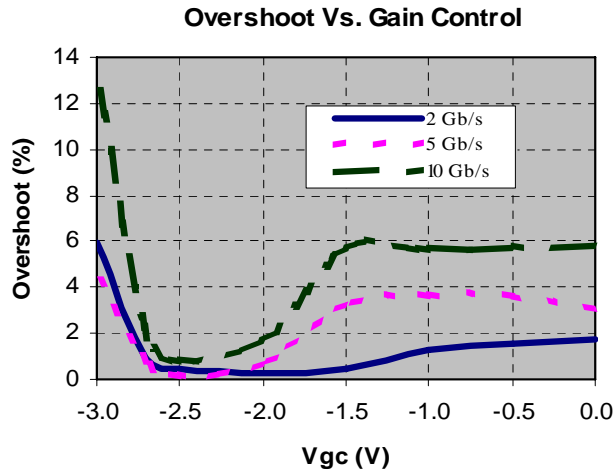
Overshoot Versus Bit Rate at Maximum Gain

V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA
V_{in} = 25 mV pp, V_{gc} = 0 V



Overshoot Versus Gain Control At 2, 5 and 10 Gb/s

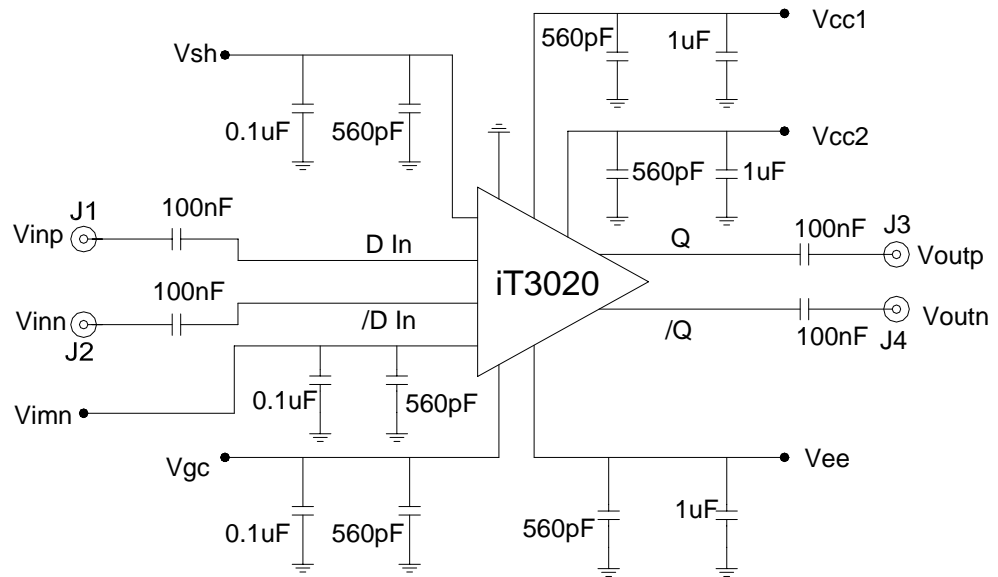
V_{ee} = -5 V, I_{ee} = 156 mA
V_{cc} = 5 V, I_{cc} = 74 mA
V_{in} = 25 mV pp



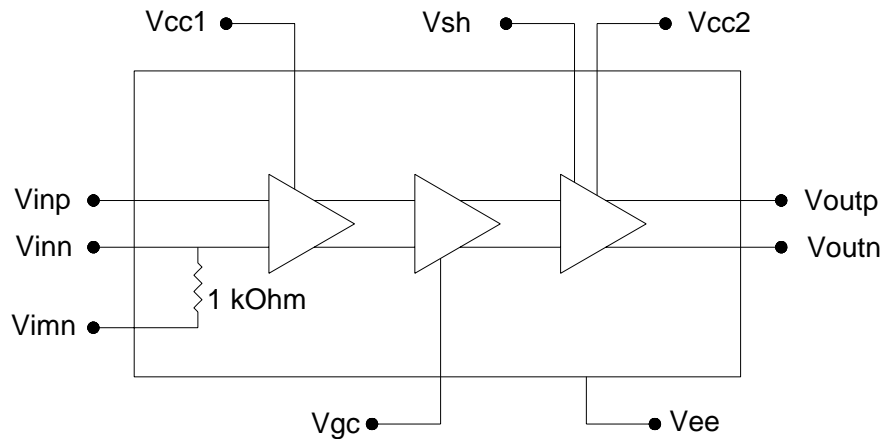
Recommended Operational Setup

Apply -5 V at Vee,
 $+5\text{ V}$ at Vcc
 Apply 0 V at Vsh
 and Vgc for
 maximum output

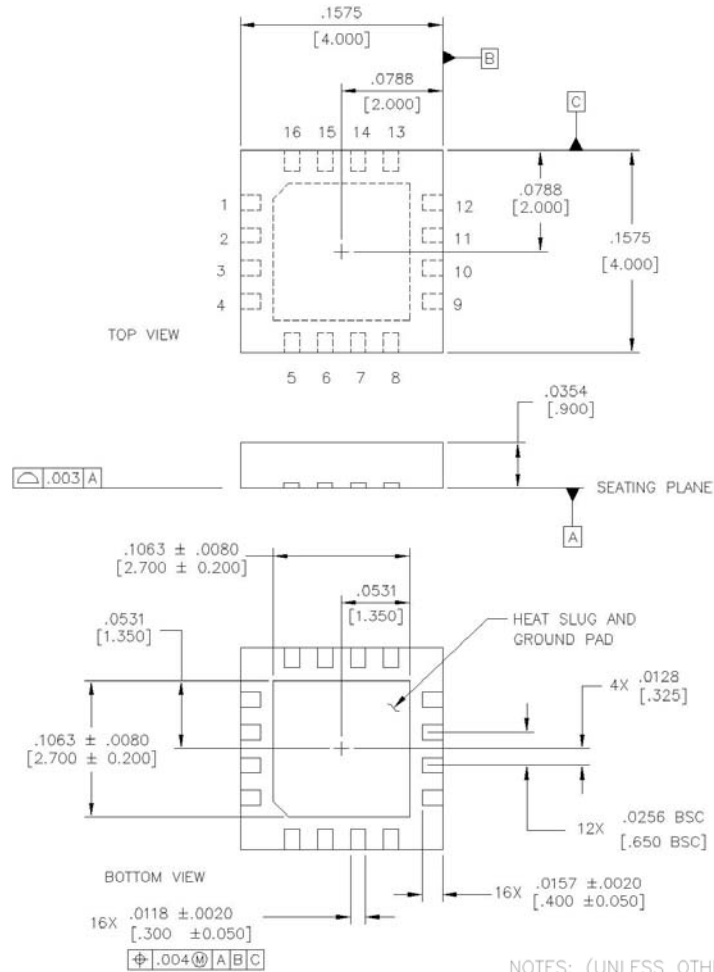
DC blocking
 capacitors optional



Device System Diagram



Package Drawings, Pinouts



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. DIMENSIONS: INCHES [mm]
2. EXCEPT WHERE NOTED, TOLERANCE ON DIMENSIONS ARE: $\pm \frac{.0039}{[0.100]}$

Pinouts:

P1: Gnd	P9: Gnd
P2: Vinp (RF input)	P10: Voutp (/RF out)
P3: Vinn (/RF input)	P11: Voutn (RF out)
P4: Gnd	P12: Gnd
P5: Vgc (Gain control)	P13: Vcc2 (positive supply)
P6: Vee (Negative supply)	P14: Vsh (shutoff control)
P7: N/C	P15: Vcc1 (positive supply)
P8: N/C	P16: Vimn (input offset control)

Biasing Procedures:

Apply power supply in the following order:

1. Vgc
2. Vsh
3. Vcc-1&2
4. Vee