SiGe Semiconductor

SE1050W

LightCharger™ 10 Gb/s Transimpedance Amplifier
Final

Applications

- SONET/SDH-based transmission systems, test equipment and modules
- OC-192 fibre optic modules and line termination
- 10 Gigabit Ethernet
- Fibre Channel
- Serial data systems up to 10.7 Gb/s

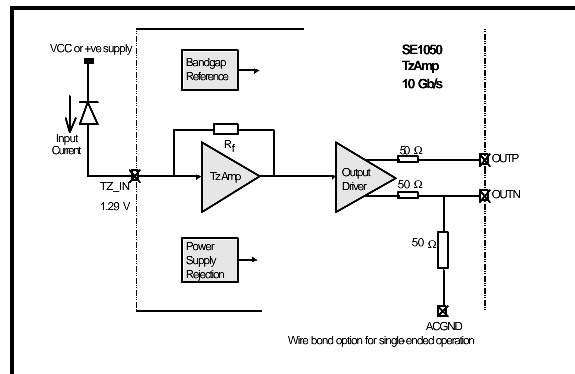
Features

- Single +5 V power supply
- Power dissipation = 430 mW (typ)
- Input noise current = 1.4 µA rms when used with a 0.2 pF detector
- Transimpedance gain = 1.2 kΩ into a 50 Ω load (differential)
- Input current overload = 2.3 mA pk (+1.1 dBm for 0.9 A/W responsivity - meets 10 Gigabit Ethernet specification)
- Wide linear dynamic range of 17 dB (typ)
- 50 Ω single-ended or 100 Ω differential wire bond selectable outputs
- Bandwidth (-3 dB) = 9.8 GHz
- Operates at OC-192 / STM-64 up to 10.7 Gb/s NRZ rates
- Power supply rejection for both single ended and differential modes of operation
- Optimized for PIN photodetectors
- Minimal external components, supply decoupling only
- Operating junction temperature range = -40°C to +100°C
- Equivalent to Nortel Networks AE99

Ordering Information

Type	Package	Remark
SE1050W	Bare Die	Shipped in Waffle Pack

Functional Block Diagram



Product Description

SiGe Semiconductor offers a portfolio of optical networking ICs for use in high-performance optical transmitter and receiver functions, from 155 Mb/s up to 12.5 Gb/s.

SiGe Semiconductor's SE1050W is a fully integrated silicon bipolar transimpedance amplifier, providing wideband, low noise preamplication of signal current from a PIN photodetector. It features differential outputs. A decoupling capacitor on the supply is the only external component required. A system block diagram is shown after the functional description, on page 3.

Noise performance is optimized for 10 Gb/s operation, with a calculated rms noise based sensitivity of –20 dBm for 10^{-10} bit error rate, using a detector with 0.20 pF capacitance and a responsivity of 0.9 A/W, with an infinite extinction ratio source.

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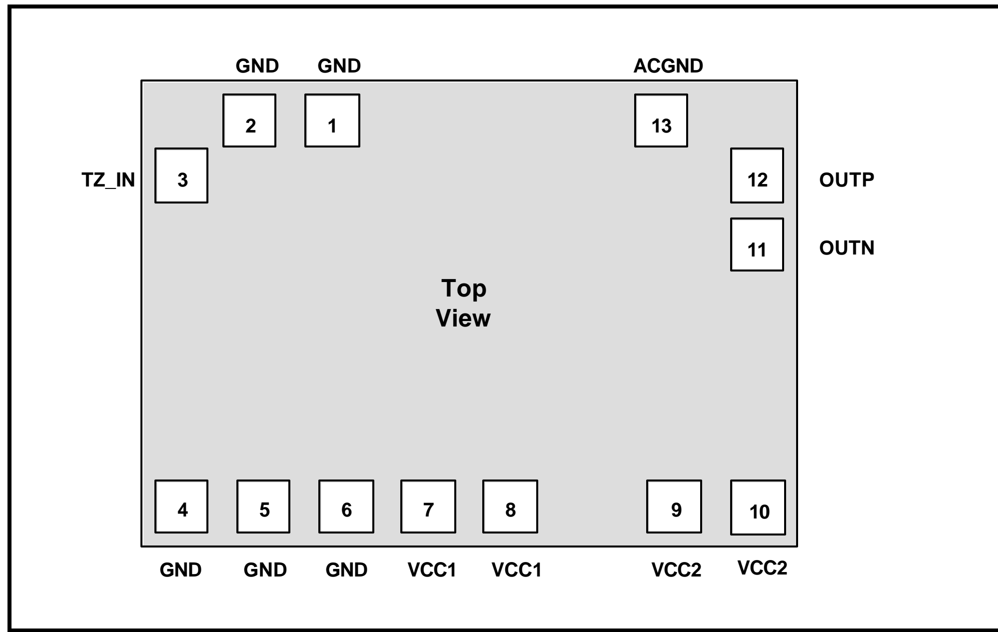
Bondpad Diagram



Bondpad Description

Pad No.	Name	Description
1	GND	Negative supply (0V).
2	GND	Negative supply (0V).
3	TZ_IN	Input pad (connect to photodetector anode).
4	GND	Negative supply (0V).
5	GND	Negative supply (0V).
6	GND	Negative supply (0V).
7	VCC1	Positive supply (+5 V).
8	VCC1	Positive supply (+5 V).
9	VCC2	Positive supply (+5 V) – Note: This is a separate supply for the output driver stage only.
10	VCC2	Positive supply (+5 V) – Note: This is a separate supply for the output driver stage only.
11	OUTN	Negative differential voltage output; leave unconnected for single-ended operation.
12	OUTP	Positive differential or single-ended voltage output.
13	ACGND	Bond option: Connected to external capacitor to ground for single-ended operation (recommended 1 nF); unconnected for differential operation.

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Functional Description

Amplifier Front-End

The transimpedance front-end amplifies the current from a PIN photodetector, anode connected to pad TZ_IN, to produce a differential output voltage with the feedback resistor Rf determining the level of amplification (see the functional block diagram on page 1).

The input pad TZ_IN is biased at nominally 1.29 V above ground, allowing the photodetector to have a wide reverse-bias by connecting the cathode to VCC. This enables single rail operation and normally ensures that the PIN operates in its constant, low-capacitance region.

The output stage has its own supply connection VCC2 (+5 V) to maintain integrity of the high-speed signal path. The output stage shares the GND (0 V) connection with the remainder of the circuitry, which has a separate supply connection VCC1 (+5 V).

Output Driver Stage

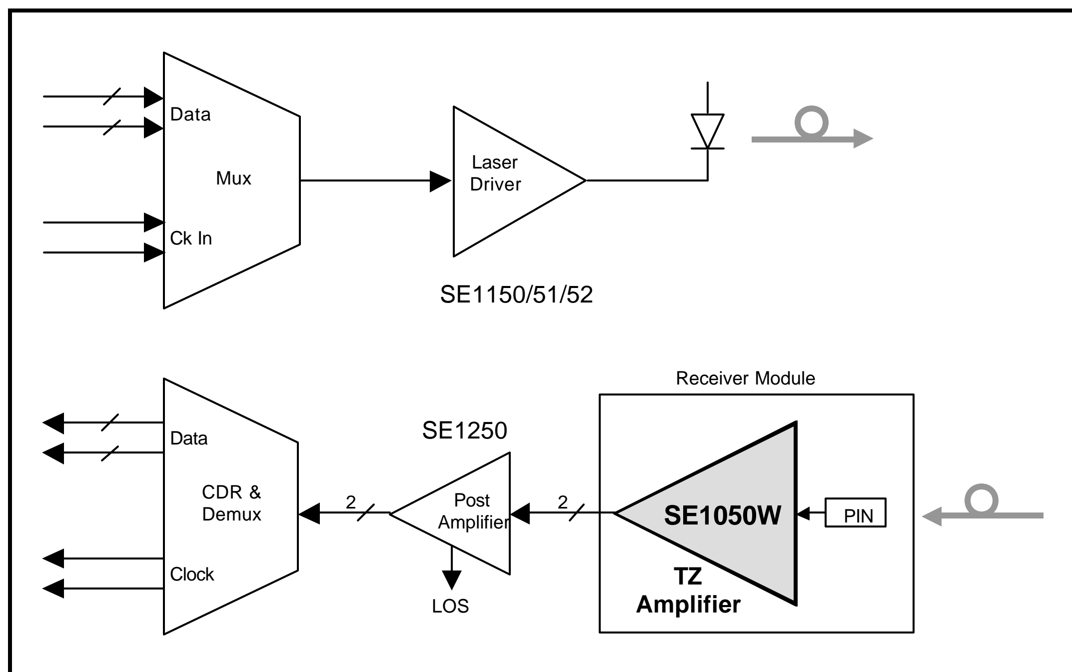
The output driver acts as a buffer stage, capable of swinging up to 1.1 V pk-pk differential into a 100 Ω load.

The output can be configured in a differential or single-ended mode. For differential operation, the pad ACGND is not wire bonded and the circuit provides a fully balanced 100 Ω output, on the pins OUTP and OUTN. For single-ended operation, the ACGND pad is required to be wire bonded to an external capacitor to ground (recommend 1 nF). Under these circumstances, OUTP operates as a single-ended 50 Ω output. In both cases, increasing optical input level gives a positive-going output signal on the OUTP pin.

Power Supply Rejection

An on-chip power supply rejection circuit is used to achieve both single-ended and differential rejection from the +5 V VCC rail. This rejection ensures that performance is not degraded by noise on the power supply. The circuit achieves a power supply rejection on the outputs of 38 dB for single-ended and 24 dB for differential operation, up to 100 kHz. The use of external decoupling will help to remove any unwanted signals at higher frequencies.

System Block Diagram



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Absolute Maximum Ratings

These are stress ratings only. Exposure to stresses beyond these maximum ratings may cause permanent damage to, or affect the reliability of the device. Avoid operating the device outside the recommended operating conditions defined below.

Symbol	Parameter	Min	Max	Unit
VCC	Supply Voltage	–0.7	6.0	V
V_{IO}	Voltage at any input or output	–0.5	VCC+0.5	V
I_{IO}	Current sourced into any input or output except TZ_IN	–20	20	mA
I_{IO}	Current sourced into pin TZ_IN	–5	5	mA
V_{ESD}	Electrostatic Discharge (100 pF, 1.5 kΩ) except TZ_IN and ACGND	–2	2	kV
V_{ESD}	Electrostatic Discharge (100 pF, 1.5 kΩ) pins TZ_IN and ACGND	–0.25	0.25	kV
Tstg	Storage Temperature	–65	150	°C

Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
VCC	Supply Voltage	4.7	5.0	5.3	V
Tj	Operating Junction Temperature	–40		100	°C

DC Electrical Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
ICC	Supply Current		86	130	mA
Vin	Input Bias Voltage	1.28	1.29	1.34	V
Vout	Output Bias Voltage		3.0		V
Rout	Output Resistance	38	50	62	Ω

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AC Electrical Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
BW (3dB)	Small Signal Bandwidth at –3dB point	8	9.8	13	GHz
Tz	Differential Transimpedance (50 Ω on each output, f = 100 MHz)	0.75	1.2	1.8	kΩ
Dri	Input Data Rate			10.7	Gb/s
Voutmax	Maximum Differential Output Voltage			1.1	V pk-pk
Flf	Low Frequency Cut-off		37	47	kHz
PSRR	Power Supply Rejection Ratio (differential) up to 100 kHz	16	24		dB
PSRR	Power Supply Rejection Ratio (single-ended) up to 100 kHz	30	38		dB
Olim	Onset of Limiting (mean input current from photodetector)	290	460		µA mean
DR	Linear Dynamic Range (sensitivity to onset of limiting)		17		dB
I_{OL}	Input Current before overload (10 Gb/s NRZ data)	2300			µA pk-pk
Pol	Optical Overload	+1.1			dBm
Nrms	Input Noise Current (in 10 GHz)		1.4	2.0	µA rms

DC and AC electrical characteristics are specified under the following conditions:

Supply Voltage (VCC)..4.7 V to 5.3 V
Junction Temperature (Tj).................................–40°C to 100°C
Load Resistor (R_L)...50 Ω AC coupled via 100 nF, for each output
Photodetector Capacitance (Cd)......................0.2 pF
Input bond wire inductance (Li) ....1.1 nH
(Must comply with recommended bonding arrangement that will be provided as an application note)
Photodetector responsivity ....0.9 A/W
Photodetector series resistance.......................10 Ω max
Transimpedance (Tz) measured with 0 > Iin < 580 µA pk-pk, at 100 MHz

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Bondpad Configuration

The bondpad center coordinates are referenced to the center of the lower left pad (pad 4). All dimensions are in microns (µm).

Pad No.	Name	X Coordinate (µm)	Y Coordinate (µm)
1	GND	234.9	658.0
2	GND	121.7	658.0
3	TZ_IN	0	510.3
4	GND	0	0
5	GND	116.5	0
6	GND	233.5	0
7	VCC1	365.2	0
8	VCC1	480.2	0
9	VCC2	693.0	0
10	VCC2	808.0	0
11	OUTN	808.0	418.9
12	OUTP	808.0	537.3
13	ACGND	619.9	658.0

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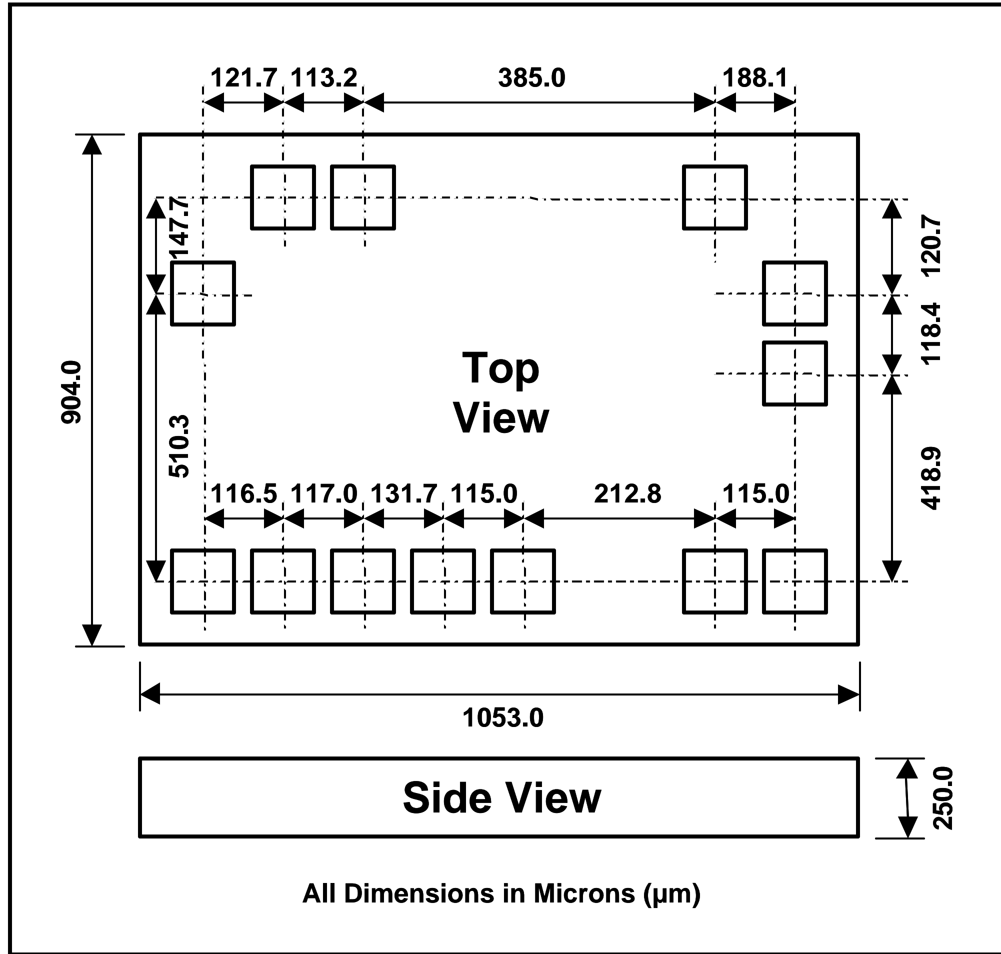
The diagram below shows the bondpad configuration of the SE1050W Transimpedance Amplifier. Note that the diagram is not to scale. All bondpads are 92 µm x 92 µm with a passivation opening of 82 µm x 82 µm. All VCC and GND pads must be bonded to minimize inductive effects.

Mechanical die visual inspection criteria per MIL-STD-883 Method 2010.10 Condition B Class Level B.



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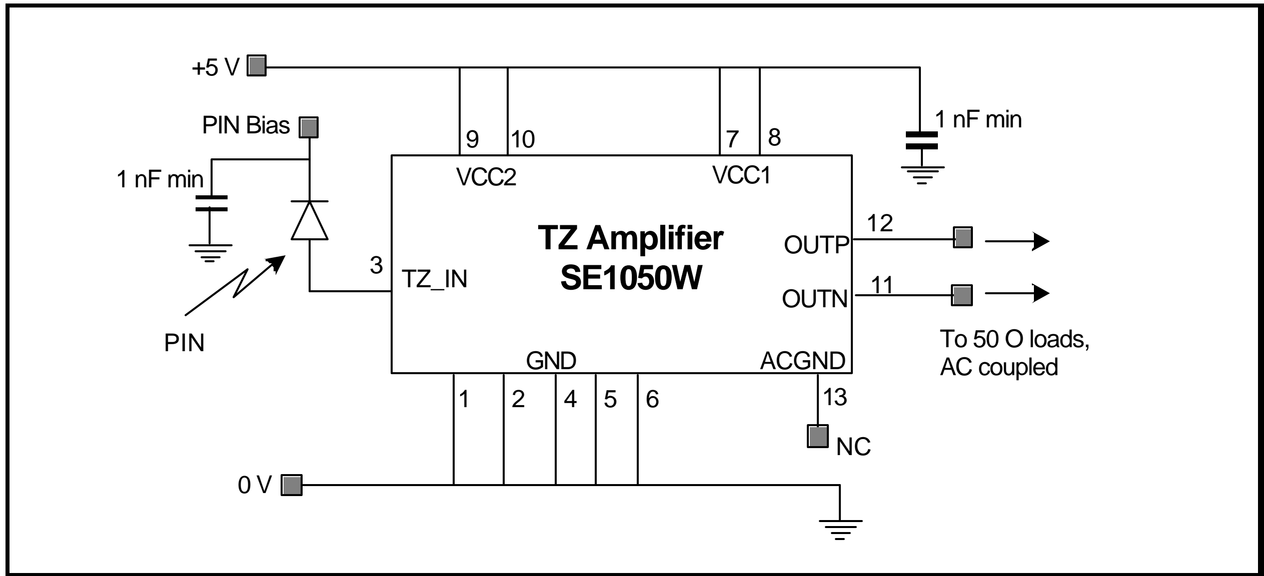
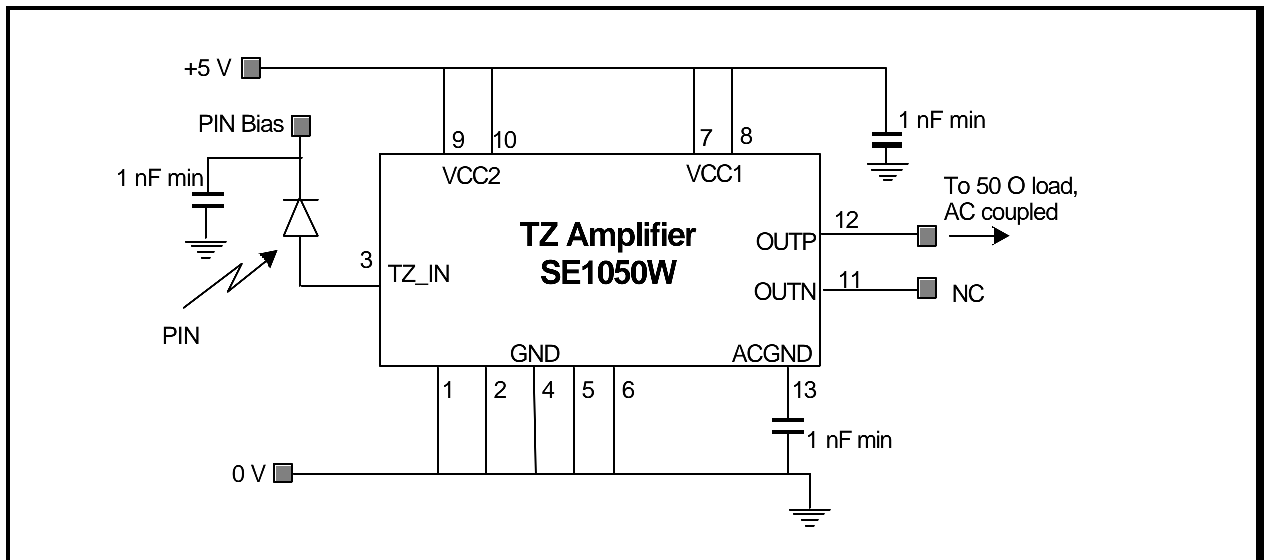
Applications Information

For optimum performance it is recommended that the device be used in differential mode with the circuit shown in the first diagram below. All VCC and GND pads must be wire bonded to ensure correct high frequency performance.

Connections for differential operation:



Connections for single ended operation:



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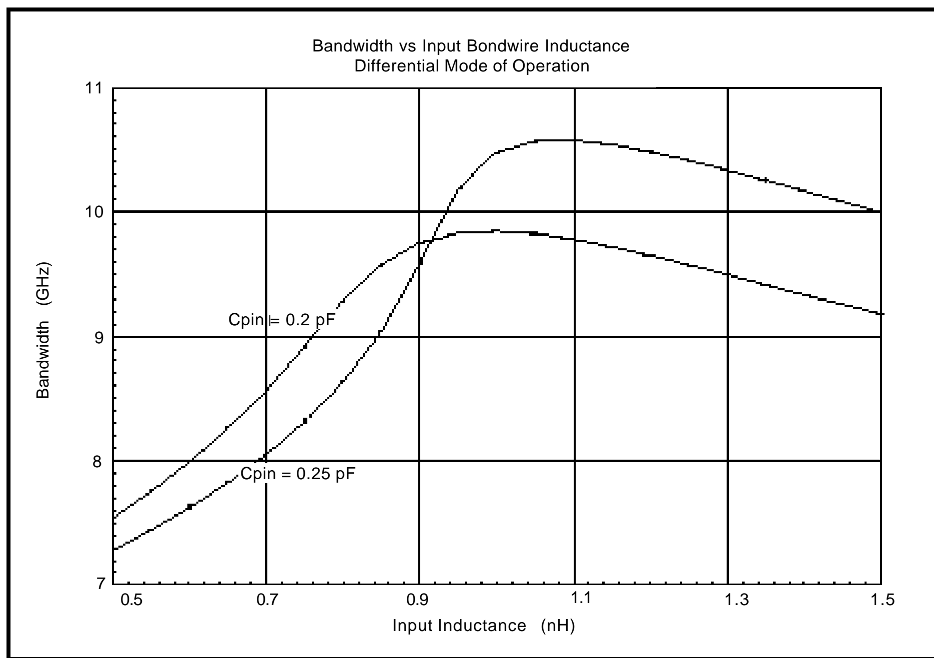
As a guide to the effect of bondwire length on inductance, the table below gives some examples of observed inductance per millimeter for popular gold bondwire diameters. The effect of input bondwire inductance on Bandwidth, Input Referred Noise and Gain Peak, is shown in the graphs below.

Bondwire diameter (μm)	Inductance per mm (nH)
25	0.81
30	0.77
32	0.76



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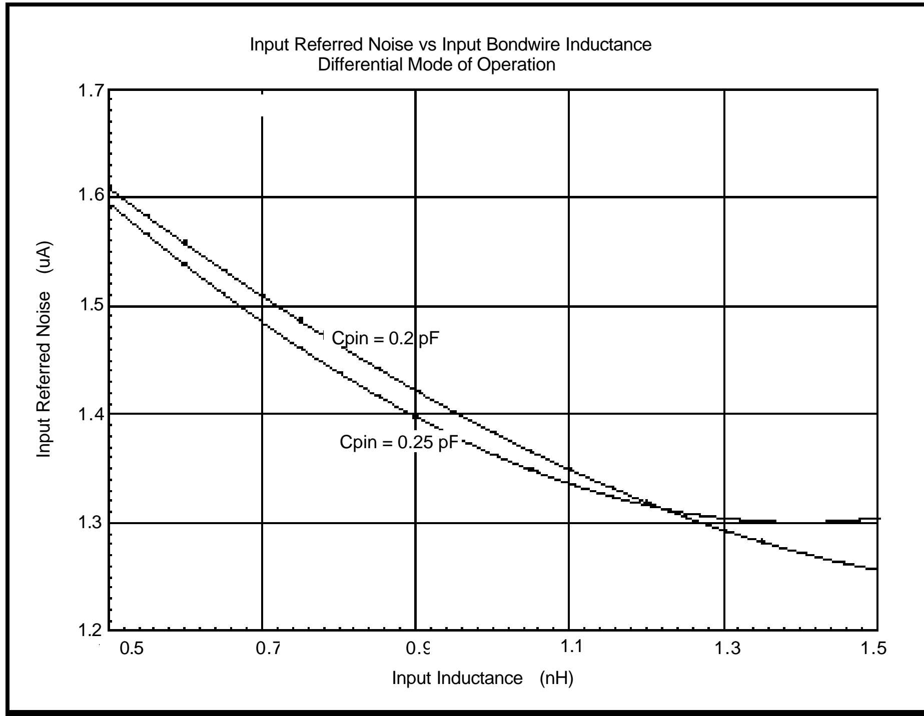

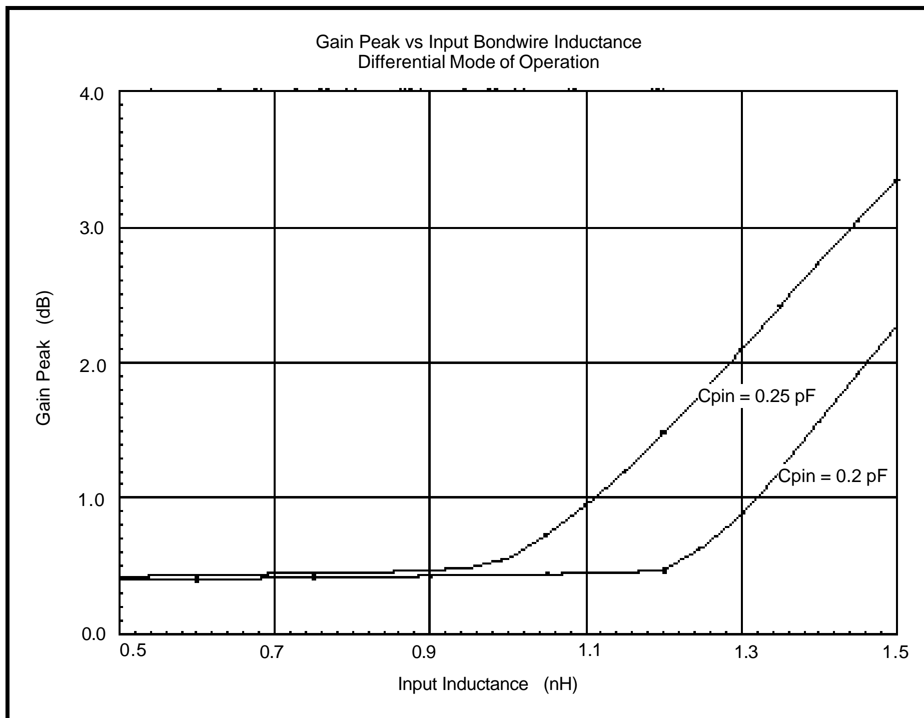

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Product Preview
The datasheet contains information from the product concept specification. SiGe Semiconductor reserves the right to change information at any time without notification.

Preliminary
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Final
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