

# DATA SHEET

## **SA5223**

Wide dynamic range AGC  
transimpedance amplifier (150MHz)

Product specification  
IC19 Data Handbook

1995 Oct 24

## Wide dynamic range AGC transimpedance amplifier(150MHz)

SA5223

## DESCRIPTION

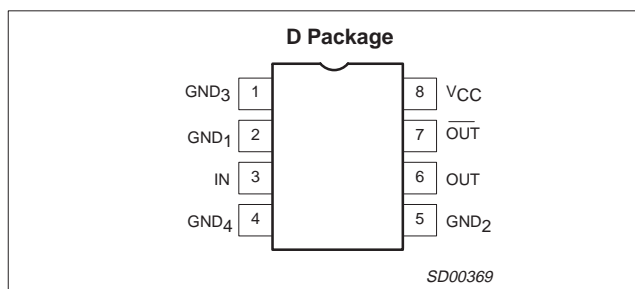
The SA5223 is a wide-band, low-noise transimpedance amplifier with differential outputs, incorporating AGC and optimized for signal recovery in wide-dynamic-range fiber optic receivers, such as SONET. The part is also suited for many other RF and fiber optic applications as a general purpose gain block.

The SA5223 is the first AGC amplifier to incorporate internal AGC loop hold capacitor, therefore, no external components are required. The internal AGC loop enables the SA5223 to effortlessly handle bursty data over a range of nA to mA of signal current, positive direction (sinking) only.

## FEATURES

- Extremely low noise:  $1.17\text{pA}/\sqrt{\text{Hz}}$
- Single 5V supply
- Low supply current: 22mA
- Large bandwidth: 150MHz
- Differential outputs
- Internal hold capacitor
- Low input/output impedances
- High power-supply-rejection ratio: 55dB
- Tight transresistance control
- High input overload: 4mA
- 2000V HBM ESD protection

## PIN DESCRIPTION



## APPLICATIONS

- OC3 SONET preamp (see AN1431 for detailed analysis)
- Current-to-voltage converters
- Wide-band gain block
- Medical and scientific instrumentation
- Sensor preamplifiers
- Single-ended to differential conversion
- Low noise RF amplifiers
- RF signal processing

## ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
8-Pin Plastic Small Outline	-40 to +85°C	SA5223D	SOT96-1

For unpackaged die please contact factory.

## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNITS
$V_{CC}$	Power supply voltage	6	V
$T_A$	Ambient temperature range	-40 to +85	°C
$T_J$	Junction temperature range	-55 to +150	°C
$T_{STG}$	Storage temperature range	-65 to +150	°C
$P_D$	Power dissipation $T_A = 25^\circ\text{C}$ (still air) <sup>1</sup>	0.78	W
$I_{INMAX}$	Maximum input current	5	mA

## NOTE:

1. Maximum power dissipation is determined by the operating ambient temperature and the thermal resistance  $\theta_{JA} = 158^\circ\text{C}/\text{W}$ . Derate  $6.2\text{mW}/^\circ\text{C}$  above  $25^\circ\text{C}$ .

## RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	RATING	UNITS
$V_{CC}$	Power supply voltage	4.5 to 5.5	V
$T_A$	Ambient temperature range: SA grade	-40 to +85	°C
$T_J$	Junction temperature range: SA grade	-40 to +105	°C

## Wide dynamic range AGC transimpedance amplifier(150MHz)

SA5223

**DC ELECTRICAL CHARACTERISTICS**Typical data and Min and Max limits apply at  $T_A = 25^\circ\text{C}$ , and  $V_{CC} = +5\text{V}$ , unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SA5223			UNIT
			Min	Typ	Max	
$V_{IN}$	Input bias voltage		1.3	1.55	1.8	V
$V_{O\pm}$	Output bias voltage		2.9	3.2	3.5	V
$V_{OS}$	Output offset voltage ( $V_{PIN6} - V_{PIN7}$ )		-200	80	+200	mV
$I_{CC}$	Supply current		15	22	29	mA
$I_{OMAX}$	Output sink/source current		1.5	2		mA

**NOTE:** Standard deviations are estimated from design simulations to represent manufacturing variations over the life of the product.**AC ELECTRICAL CHARACTERISTICS**Typical data and Min and Max limits apply at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = +5\text{V}$ , unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SA5223			UNIT
			Min	Typ	Max	
$R_T$	Transresistance (differential output)	DC tested, $R_L = \infty$ , $I_{IN} = 0-1\mu\text{A}$	90	125	160	k $\Omega$
$R_T$	Transresistance (single-ended output)	DC tested, $R_L = \infty$ , $I_{IN} = 0-1\mu\text{A}$	45	62.5	80	k $\Omega$
$R_O$	Output resistance (differential output)	DC tested		140		$\Omega$
$R_O$	Output resistance (single-ended output)	DC tested		70		$\Omega$
$f_{3dB}$	Bandwidth (-3dB)	Test Circuit 1	110	150		MHz
$R_{IN}$	Input resistance	DC tested		250		$\Omega$
$C_{IN}$	Input capacitance <sup>1</sup>			0.7		pF
$C_{INT}$	Input capacitance including Miller multiplied capacitance			4.0		pF
$\Delta R/\Delta V$	Transresistance power supply sensitivity	$V_{CC1} = V_{CC2} = 5 \pm 0.5\text{V}$		3		%/V
$\Delta R/\Delta T$	Transresistance ambient temperature sensitivity	$\Delta T_A = T_{A\text{ MAX}} - T_{A\text{ MIN}}$		0.09		%/°C
$I_{IN}$	RMS noise current spectral density (referred to input) <sup>2</sup>	Test Circuit 2, $f = 10\text{MHz}$		1.17		pA/ $\sqrt{\text{Hz}}$
$I_T$	Integrated RMS noise current over the bandwidth (referred to input) $C_S = 0.1\text{pF}$	Test circuit 2, $\Delta f = 50\text{MHz}$		7		nA
		$\Delta f = 100\text{MHz}$		12		
		$\Delta f = 150\text{MHz}$		16		
	$C_S = 0.4\text{pF}$	$\Delta f = 50\text{MHz}$		8		
		$\Delta f = 100\text{MHz}$		13		
		$\Delta f = 150\text{MHz}$		18		
PSRR	Power supply rejection ratio (change in $V_{OS}$ )	DC Tested, $\Delta V_{CC} = \pm 0.5\text{V}$		-55		dB
PSRR	Power supply rejection ratio <sup>3</sup>	$f = 1.0\text{MHz}$ , Test Circuit 3		-20		dB
$V_{OLMAX}$	Maximum differential output AC voltage	$I_i = 0-2\text{mA}$ peak AC		800		mV
$\frac{dR_T}{dt}$	AGC loop time constant parameter <sup>4</sup>	10 $\mu\text{A}$ to 20 $\mu\text{A}$ steps		1		dB/ms
$I_{INMAX}$	Maximum input amplitude for output duty cycle of 50 $\pm$ 5%	Test circuit 4		+2		mA
$t_r, t_f$	Output rise and fall times	10 – 90%		2.2		ns
$t_D$	Group delay	$f = 10\text{MHz}$		2.2		ns

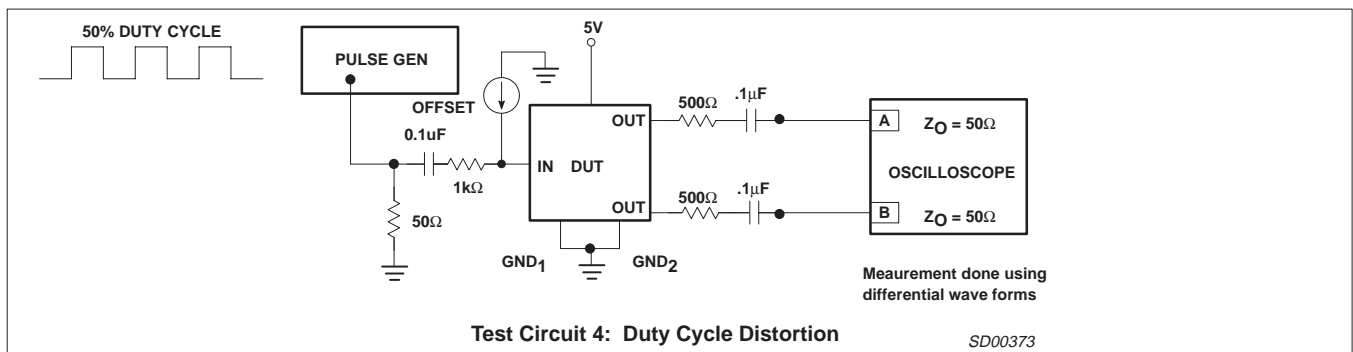
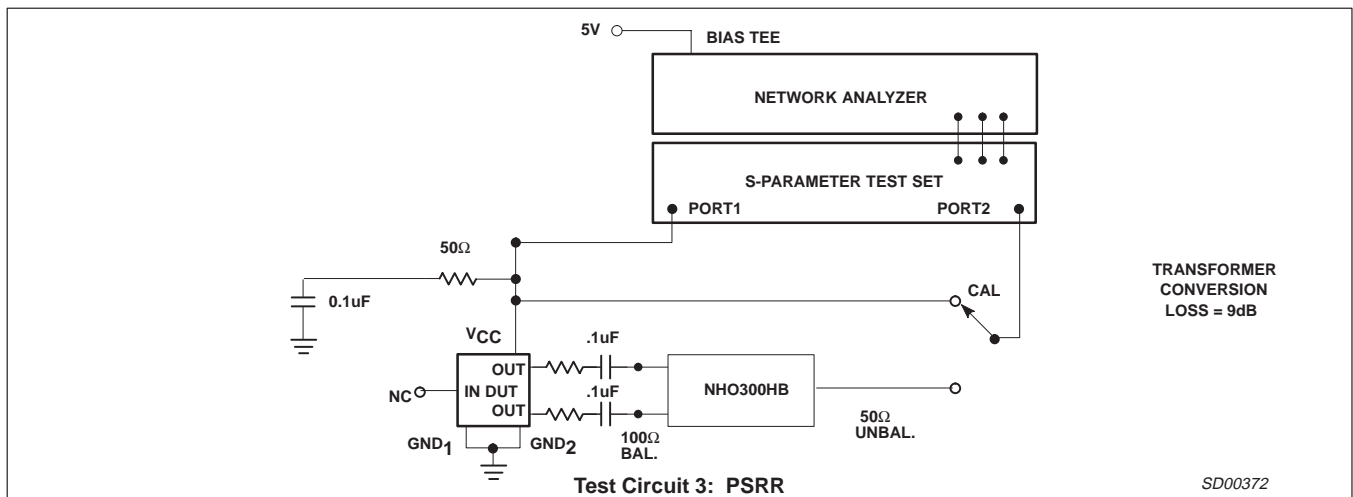
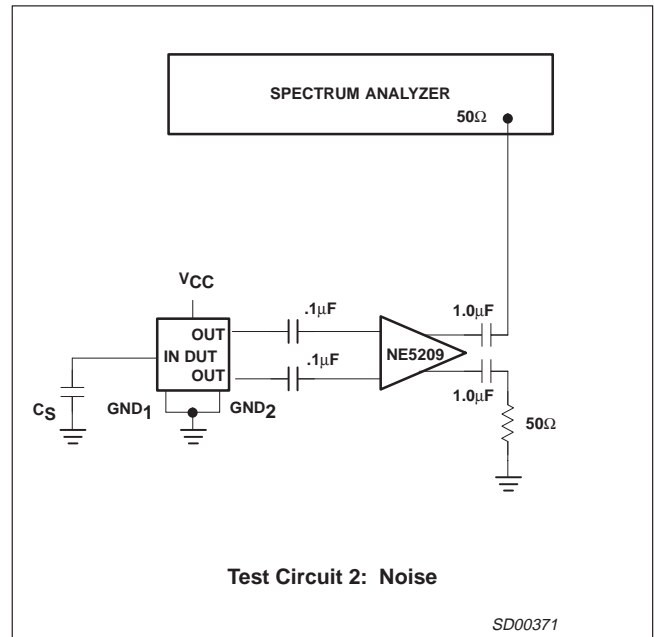
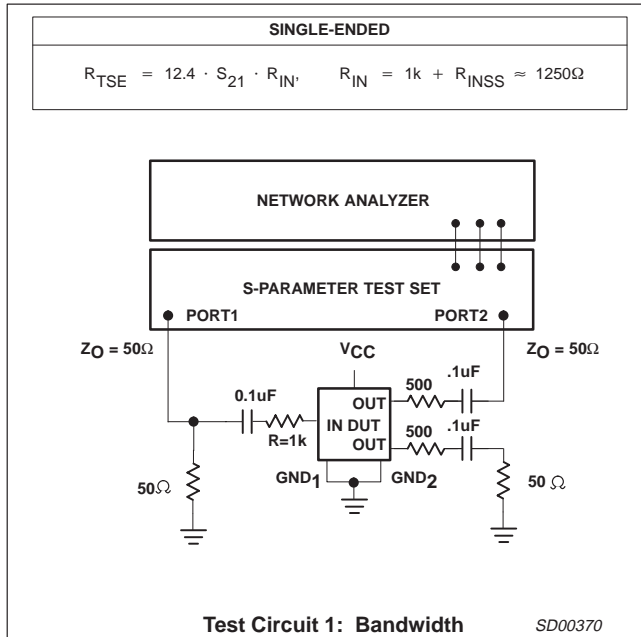
**NOTES:**

- Does not include Miller-multiplied capacitance of input device.
- Noise performance measured differential. Single-ended output noise is higher due to CM noise.
- PSRR is output referenced and is circuit board layout dependent at higher frequencies. For best performance use a RF filter in  $V_{CC}$  line.
- This implies that the SA5223 gain will change 1dB (10%) in the absence of data for 1ms (i.e., can handle bursty data without degrading Bit Error Rate (BER) for 100,000 cycles at 100MHz).

# Wide dynamic range AGC transimpedance amplifier(150MHz)

SA5223

## TEST CIRCUITS



Wide dynamic range AGC transimpedance amplifier(150MHz)

SA5223

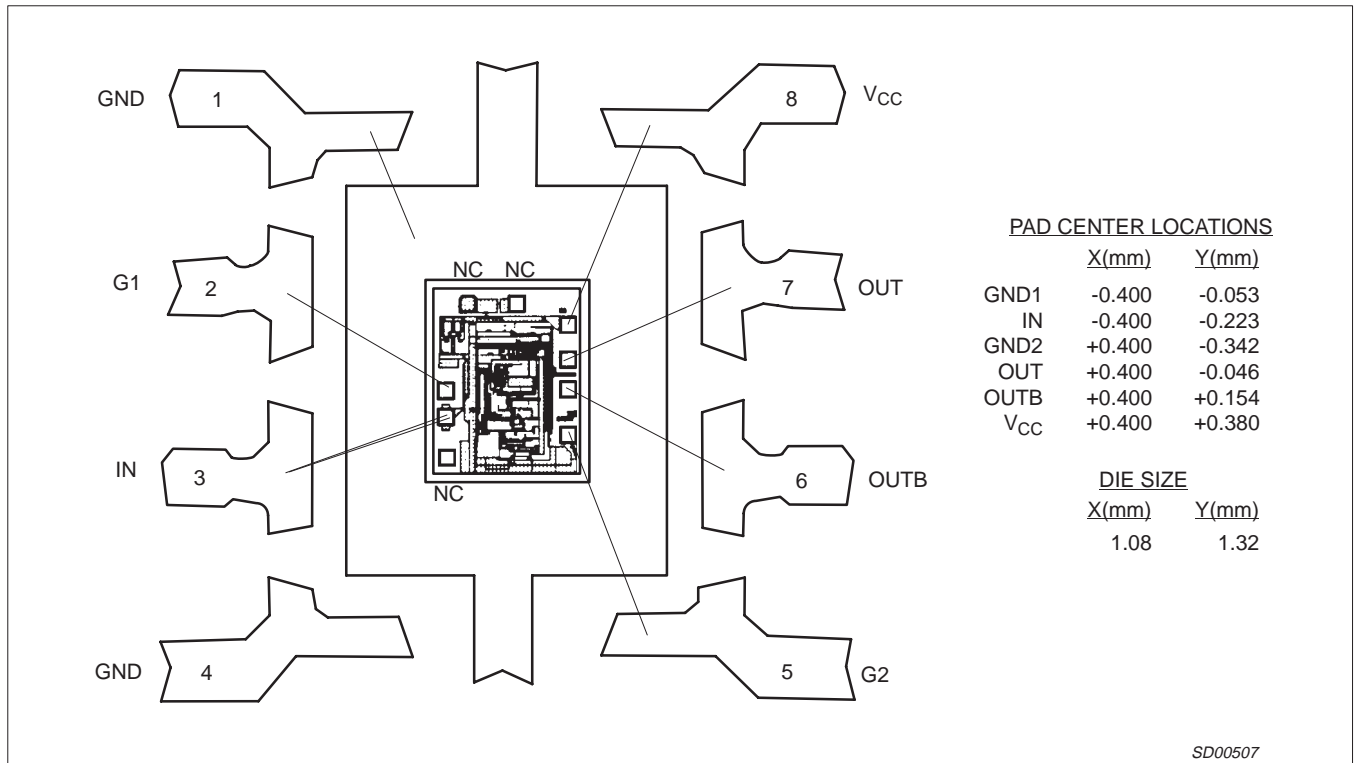


Figure 1. SA5223 Bonding Diagram

**Die Sales Disclaimer**

Due to the limitations in testing high frequency and other parameters at the die level, and the fact that die electrical characteristics may shift after packaging, die electrical parameters are not specified and die are not guaranteed to meet electrical characteristics (including temperature range) as noted in this data sheet which is intended only to specify electrical characteristics for a packaged device.

All die are 100% functional with various parametrics tested at the wafer level, at room temperature only (25°C), and are guaranteed to be 100% functional as a result of electrical testing to the point of wafer sawing only. Although the most modern processes are utilized for wafer sawing and die pick and place into waffle pack

carriers, it is impossible to guarantee 100% functionality through this process. There is no post waffle pack testing performed on individual die.

Since Philips Semiconductors has no control of third party procedures in the handling or packaging of die, Philips Semiconductors assumes no liability for device functionality or performance of the die or systems on any die sales.

Although Philips Semiconductors typically realizes a yield of 85% after assembling die into their respective packages, with care customers should achieve a similar yield. However, for the reasons stated above, Philips Semiconductors cannot guarantee this or any other yield on any die sales.

Wide dynamic range AGC transimpedance amplifier(150MHz)

SA5223

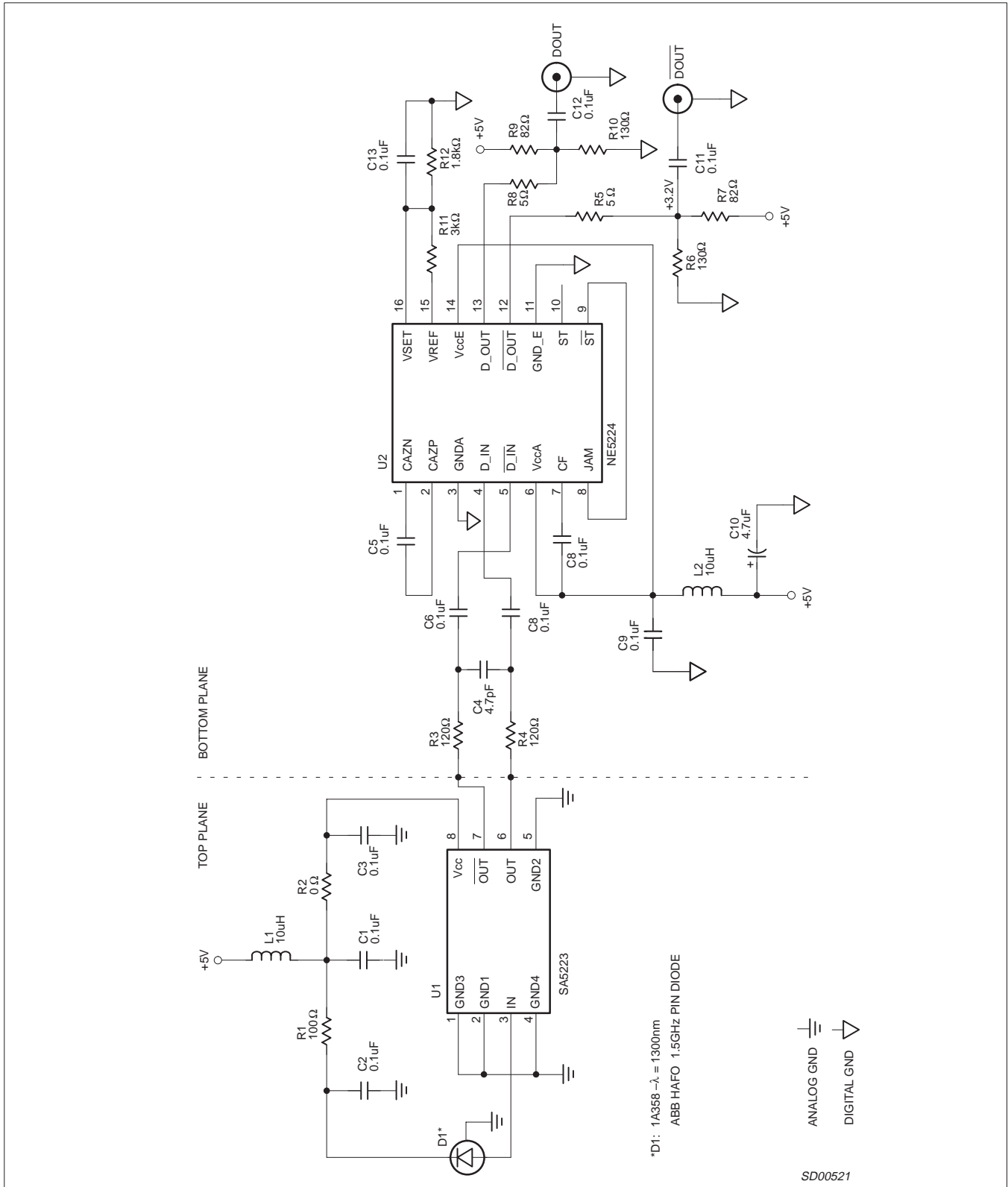


Figure 2. SONET Test Board — 155Mb/s (1300nm)

# Wide dynamic range AGC transimpedance amplifier(150MHz)

## SA5223

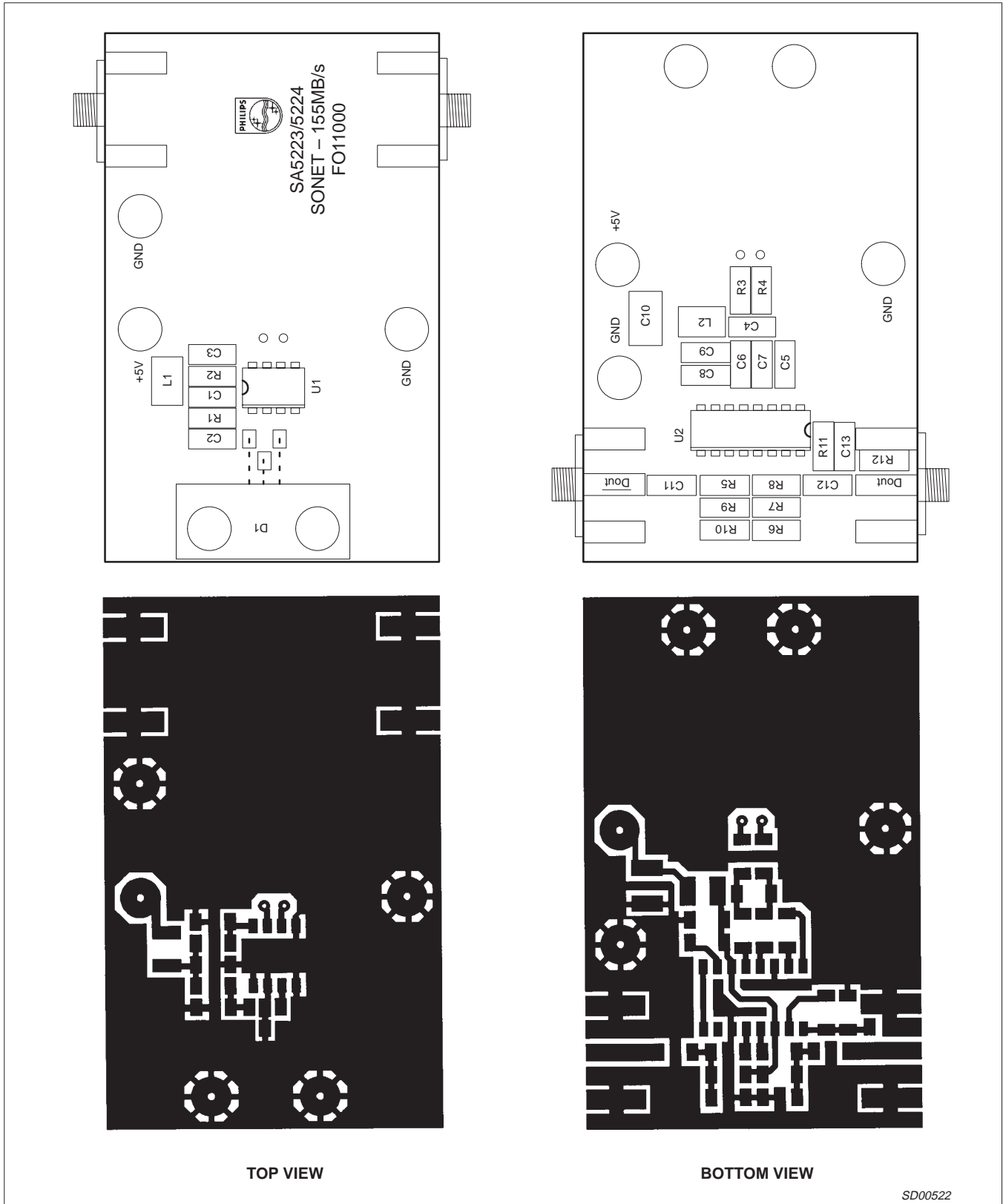


Figure 3. SA5223 Board Layout (NOT ACTUAL SIZE)

Wide dynamic range AGC transimpedance amplifier(150MHz)

SA5223

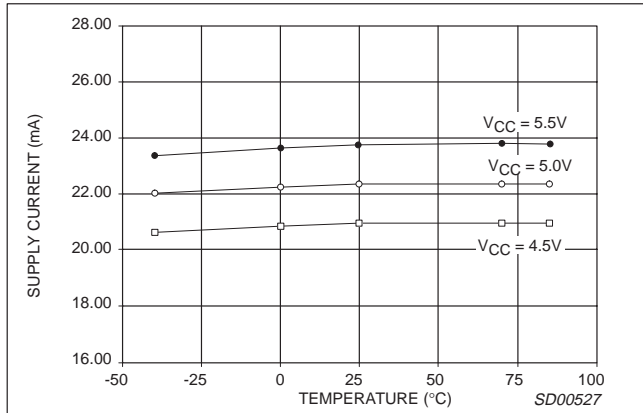


Figure 4. SA5223 I<sub>CC</sub> vs Temperature

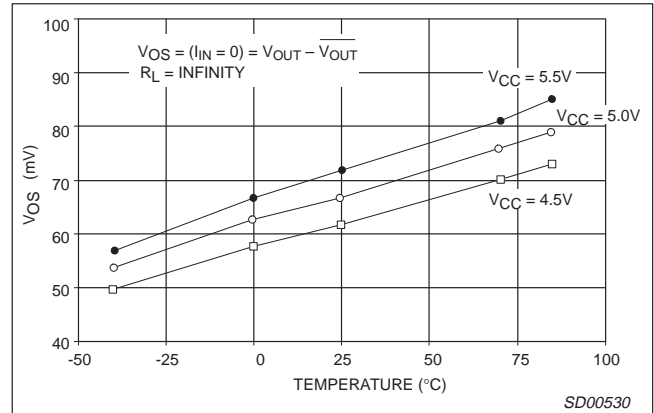


Figure 7. SA5223 Output V<sub>OS</sub> vs Temperature

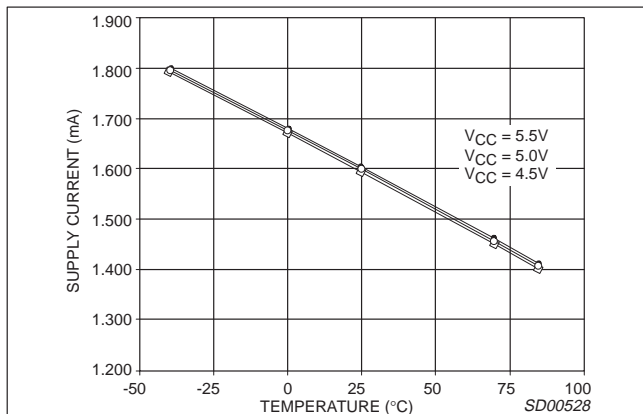


Figure 5. SA5223 Input V<sub>BIAS</sub> vs Temperature

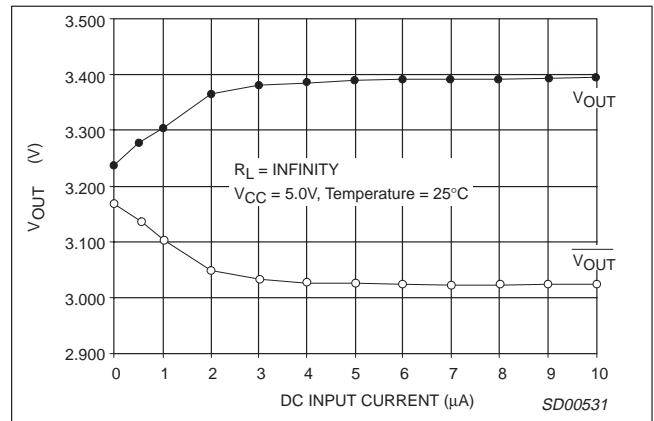


Figure 8. SA5223 Output Voltage vs DC Input Current (for small input current)

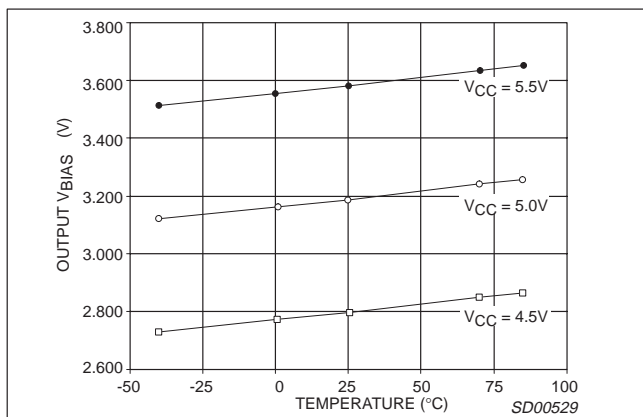


Figure 6. SA5223 Output V<sub>BIAS</sub> vs Temperature

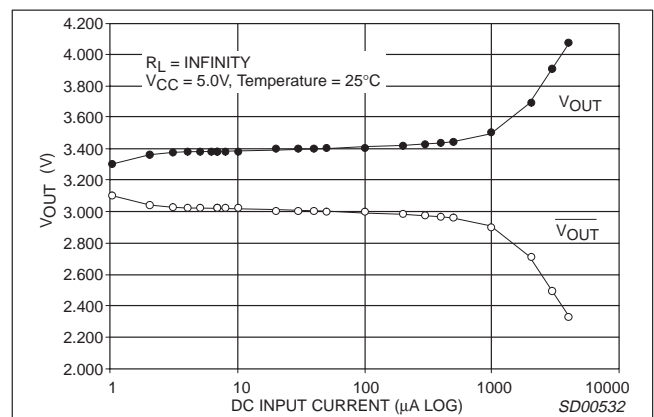


Figure 9. SA5223 Output Voltage vs DC Input Current (for large input current)



Wide dynamic range AGC transimpedance amplifier(150MHz)

SA5223

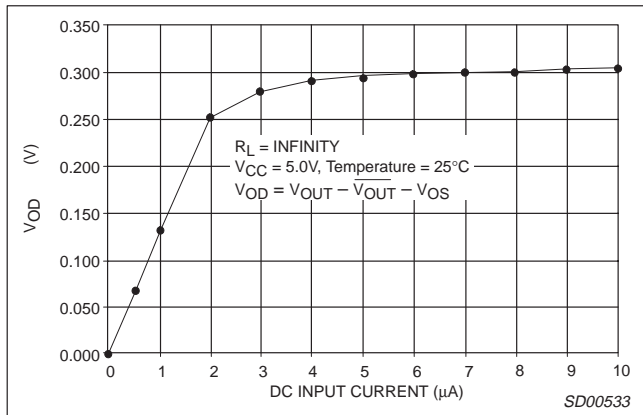


Figure 10. SA5223 Differential Output vs DC I<sub>IN</sub> (for small input current)

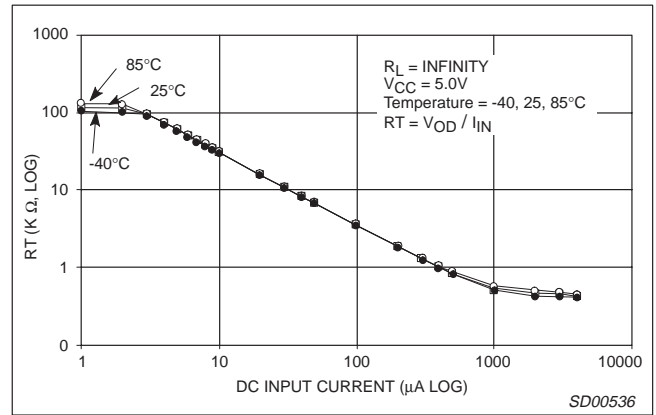


Figure 13. SA5223 Differential RT vs DC I<sub>IN</sub> (for large input current)

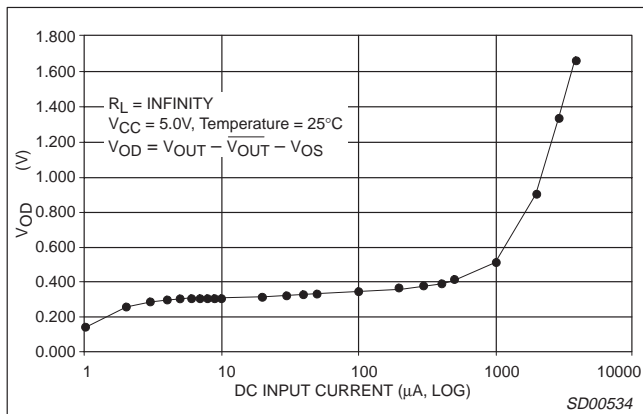


Figure 11. SA5223 Differential Output vs DC I<sub>IN</sub>

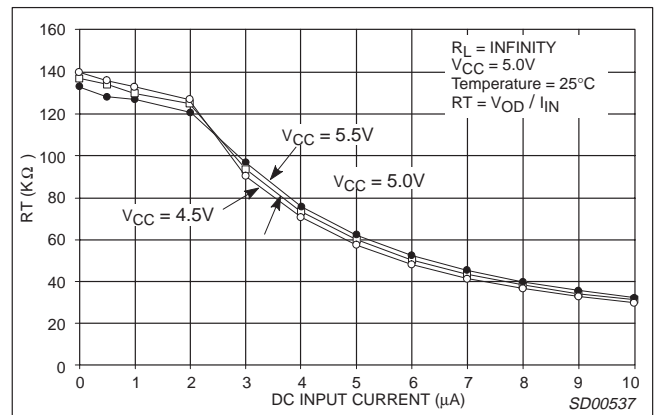


Figure 14. SA5223 Differential RT vs DC I<sub>IN</sub> (for small input current)

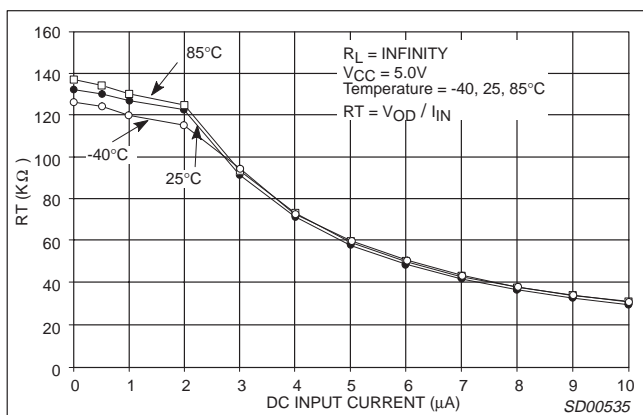


Figure 12. SA5223 Differential RT vs DC I<sub>IN</sub> (for small input current)

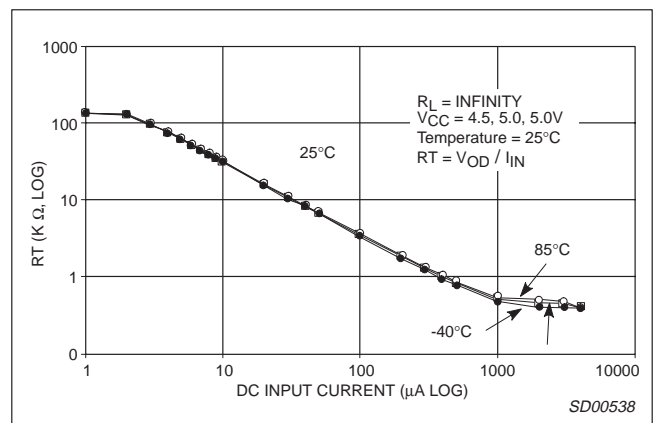


Figure 15. SA5223 Differential RT vs DC I<sub>IN</sub> (for large input current)

# Wide dynamic range AGC transimpedance amplifier(150MHz)

## SA5223

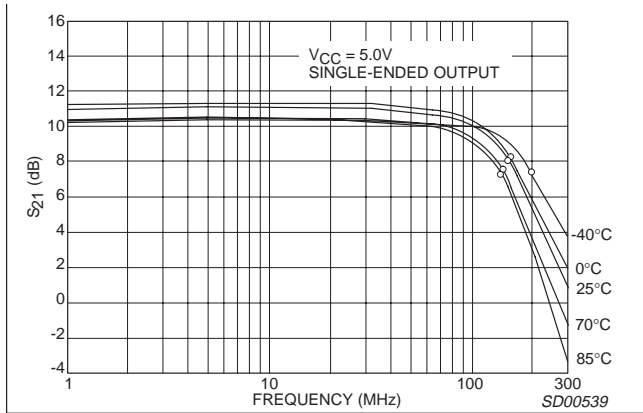


Figure 16. Insertion Gain vs Frequency

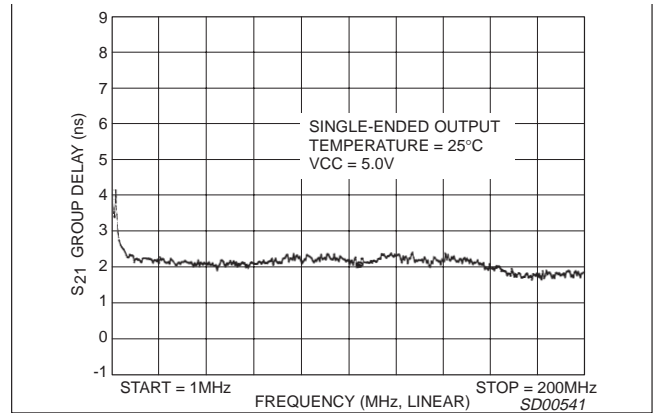


Figure 18. Group Delay vs Frequency

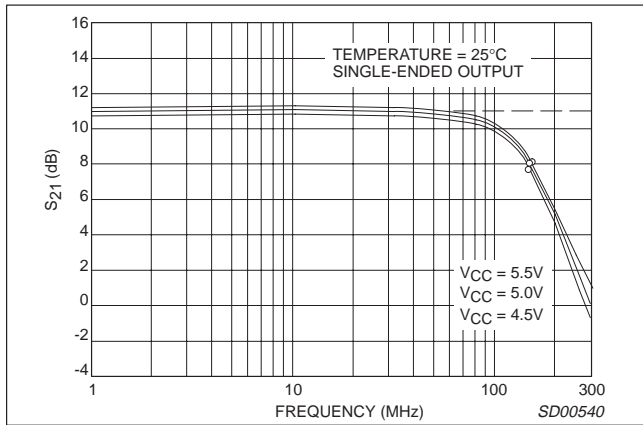


Figure 17. Insertion Gain vs Frequency

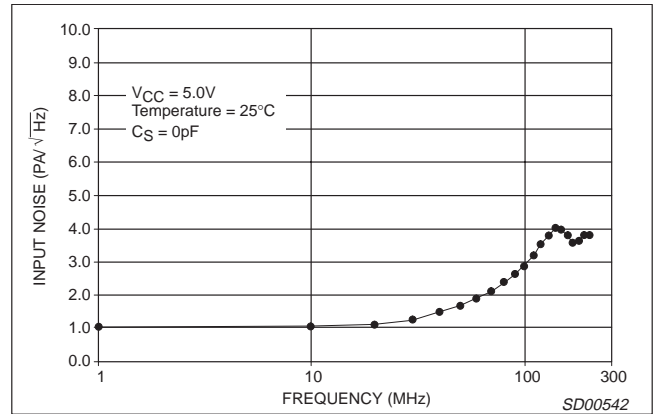


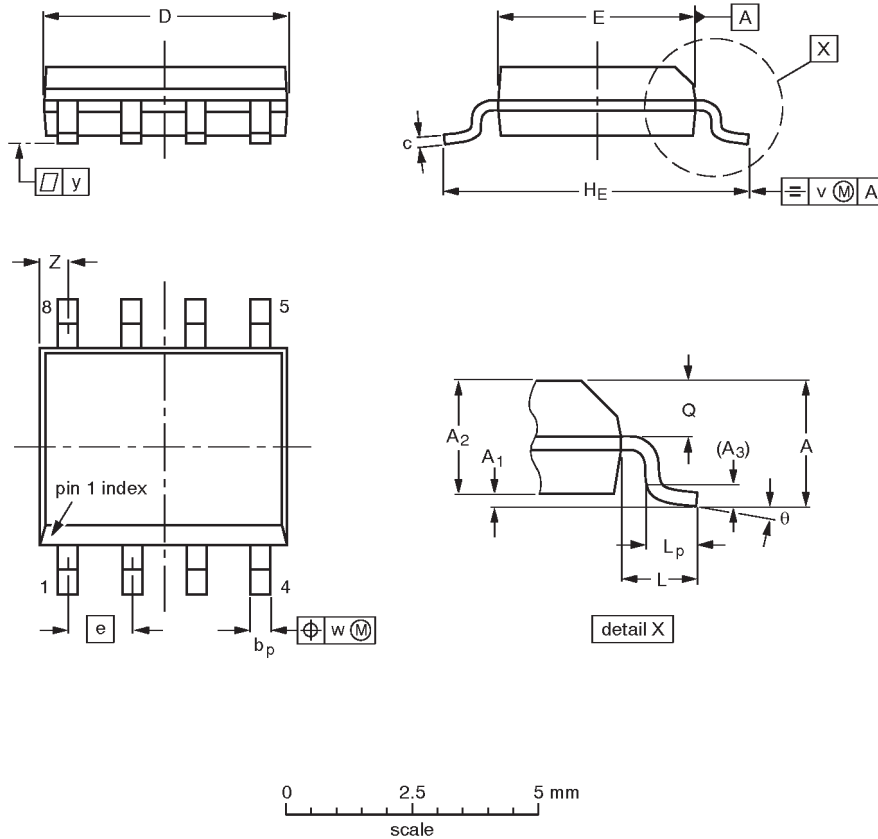
Figure 19. SA5223 Input Current RMS Noise Spectral Density

Wide dynamic range AGC transimpedance amplifier (150MHz)

SA5223

SO8: plastic small outline package; 8 leads; body width 3.9mm

SOT96-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.0098 0.0039	0.057 0.049	0.01	0.019 0.014	0.0098 0.0075	0.20 0.19	0.16 0.15	0.050	0.24 0.23	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT96-1	076E03S	MS-012AA				92-11-17 95-02-04

## Wide dynamic range AGC transimpedance amplifier (150MHz)

SA5223

**Data sheet status**

Data sheet status	Product status	Definition [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

[1] Please consult the most recently issued datasheet before initiating or completing a design.

**Definitions**

**Short-form specification** — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

**Application information** — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

**Disclaimers**

**Life support** — These products are not designed for use in life support appliances, devices or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips Semiconductors customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips Semiconductors for any damages resulting from such application.

**Right to make changes** — Philips Semiconductors reserves the right to make changes, without notice, in the products, including circuits, standard cells, and/or software, described or contained herein in order to improve design and/or performance. Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no license or title under any patent, copyright, or mask work right to these products, and makes no representations or warranties that these products are free from patent, copyright, or mask work right infringement, unless otherwise specified.

Philips Semiconductors  
811 East Arques Avenue  
P.O. Box 3409  
Sunnyvale, California 94088-3409  
Telephone 800-234-7381

© Copyright Philips Electronics North America Corporation 1998  
All rights reserved. Printed in U.S.A.

print code

Date of release: 08-98

Document order number:

*Let's make things better.*