DATA SHEET

SA5223

Wide dynamic range AGC
transimpedance amplifier (150MHz)

Product specification

IC19 Data Handbook

1995 Oct 24

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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: $1.17pA/\sqrt{Hz}$
- 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

D Package

GND_3	1		8	V_{CC}
GND_1	2		7	$\overline{OUT}$
IN	3		6	OUT
GND_4	4		5	GND_2

SD00369
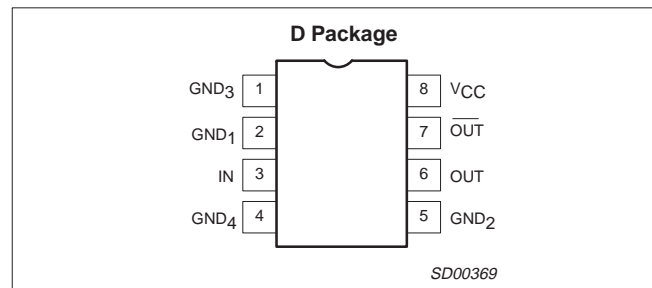
APPLICATIONS

- 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	$^\circ$C
T_J	Junction temperature range	-55 to +150	$^\circ$C
T_{STG}	Storage temperature range	-65 to +150	$^\circ$C
P_D	Power dissipation T_A = 25°C (still air)[1]	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 θ_{JA} = 158°C/W. Derate 6.2mW/$^\circ$C above 25°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	$^\circ$C
T_J	Junction temperature range: SA grade	-40 to +105	$^\circ$C

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DC ELECTRICAL CHARACTERISTICS

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

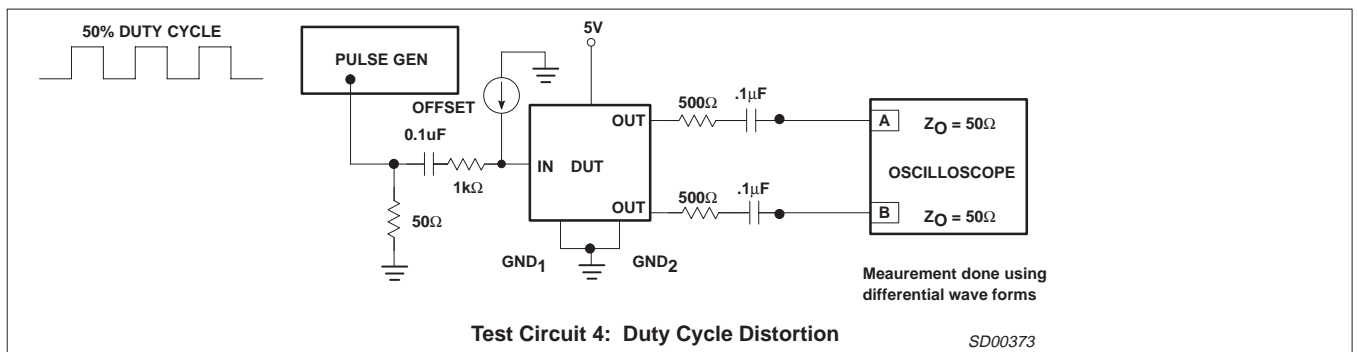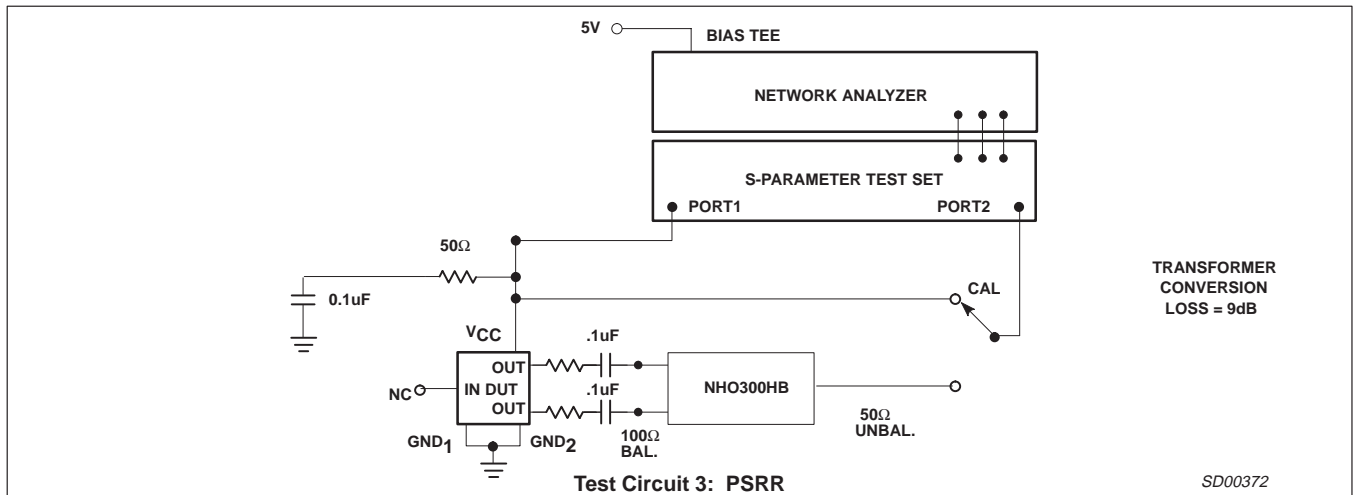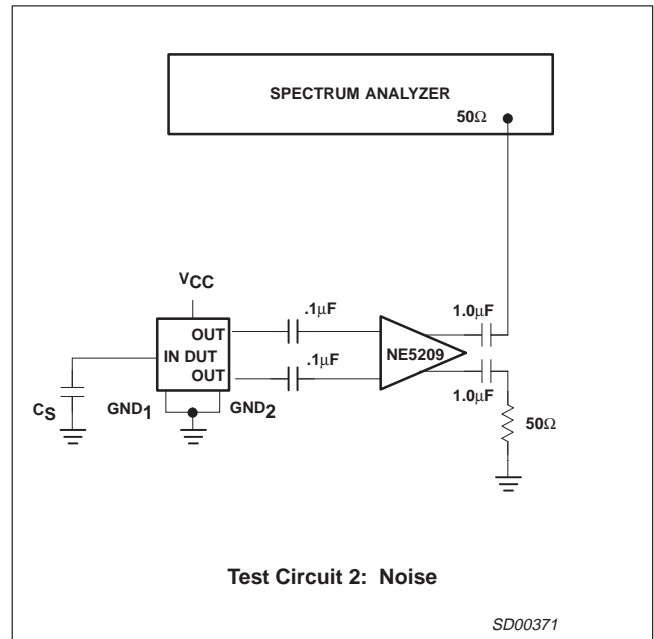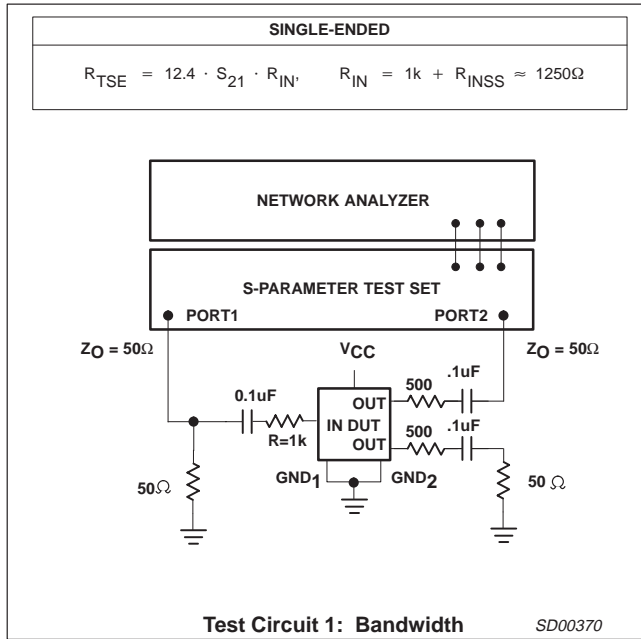| SYMBOL	PARAMETER	TEST CONDITIONS	SA5223			UNIT
			Min	Typ	Max	
R_T	Transresistance (differential output)	DC tested, $R_L = \infty$, $I_{IN} = 0\text{-}1\mu A$	90	125	160	kΩ
R_T	Transresistance (single-ended output)	DC tested, $R_L = \infty$, $I_{IN} = 0\text{-}1\mu A$	45	62.5	80	kΩ
R_O	Output resistance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

NOTES:
1. Does not include Miller-multiplied capacitance of input device.
2. Noise performance measured differential. Single-ended output noise is higher due to CM noise.
3. PSRR is output referenced and is circuit board layout dependent at higher frequencies. For best performance use a RF filter in V_{CC} line.
4. 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).

TEST CIRCUITS

SINGLE-ENDED

$$R_{TSE} = 12.4 \cdot S_{21} \cdot R_{IN}, \qquad R_{IN} = 1k + R_{INSS} \approx 1250\Omega$$

NETWORK ANALYZER

S-PARAMETER TEST SET

PORT1   PORT2

$Z_O = 50\Omega$ $Z_O = 50\Omega$

V_{CC}

0.1uF   500   .1uF

OUT

IN DUT

R=1k   OUT   500   .1uF

50Ω GND_1 GND_2 50Ω

Test Circuit 1: Bandwidth   SD00370

SPECTRUM ANALYZER

50Ω

V_{CC}

.1µF   1.0µF

OUT

IN DUT

OUT   .1µF   NE5209

C_S GND_1 GND_2 1.0µF

50Ω

Test Circuit 2: Noise   SD00371

5V   BIAS TEE

NETWORK ANALYZER

S-PARAMETER TEST SET

PORT1   PORT2

50Ω

0.1uF   CAL

TRANSFORMER
CONVERSION
LOSS = 9dB

V_{CC} .1uF

OUT

NC   IN DUT   NHO300HB

OUT   .1uF

GND_1 GND_2 100Ω 50Ω
BAL.   UNBAL.

Test Circuit 3: PSRR   SD00372

50% DUTY CYCLE   5V

PULSE GEN

OFFSET

0.1uF 500Ω .1µF   A $Z_O = 50\Omega$

OUT

IN   DUT   OSCILLOSCOPE

$1k\Omega$ OUT 500Ω .1µF   B $Z_O = 50\Omega$

50Ω

GND_1 GND_2

Meaurement done using
differential wave forms

Test Circuit 4: Duty Cycle Distortion   SD00373

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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)
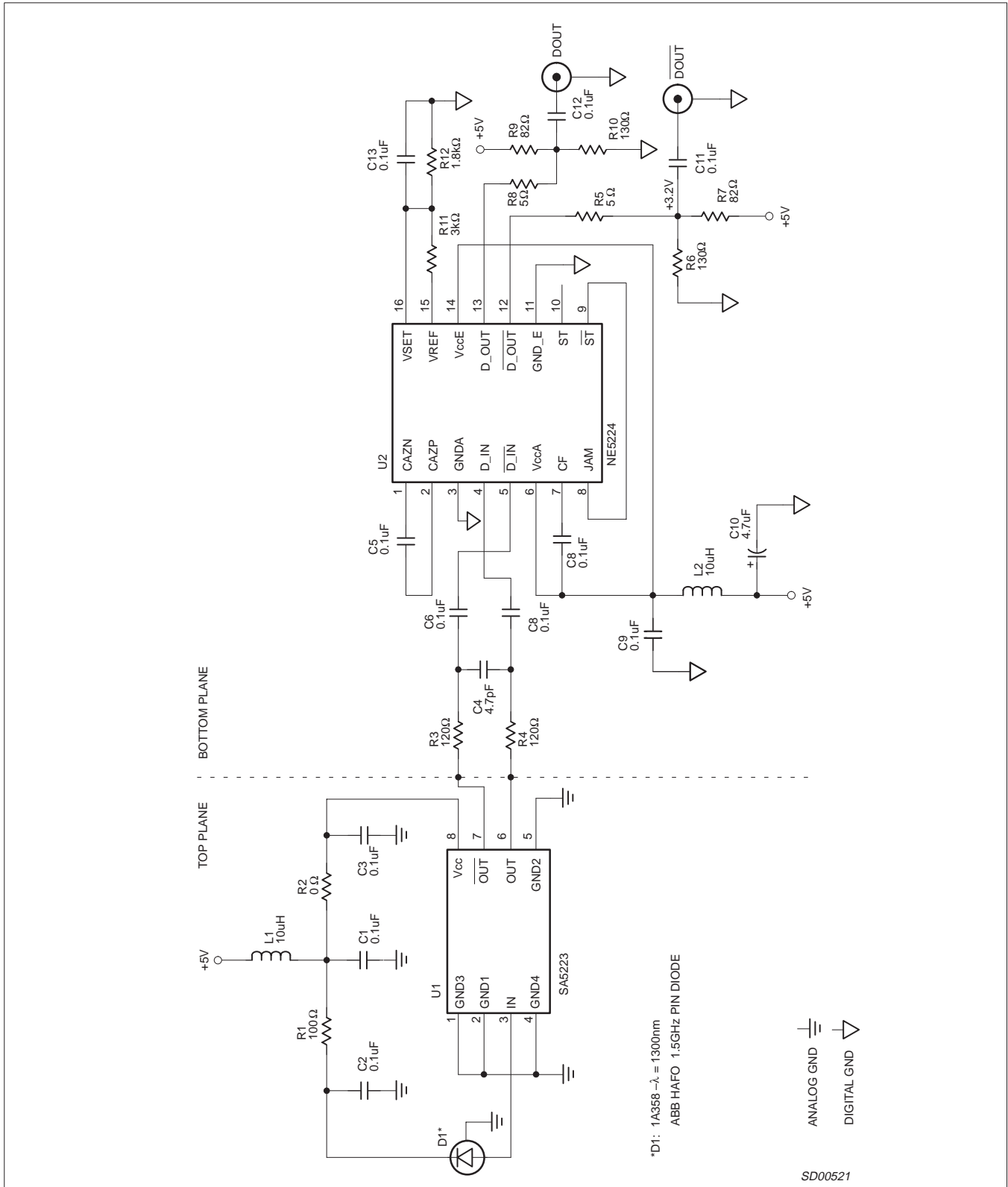
SA5223

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

SD00521

TOP VIEW

BOTTOM VIEW

SD00522
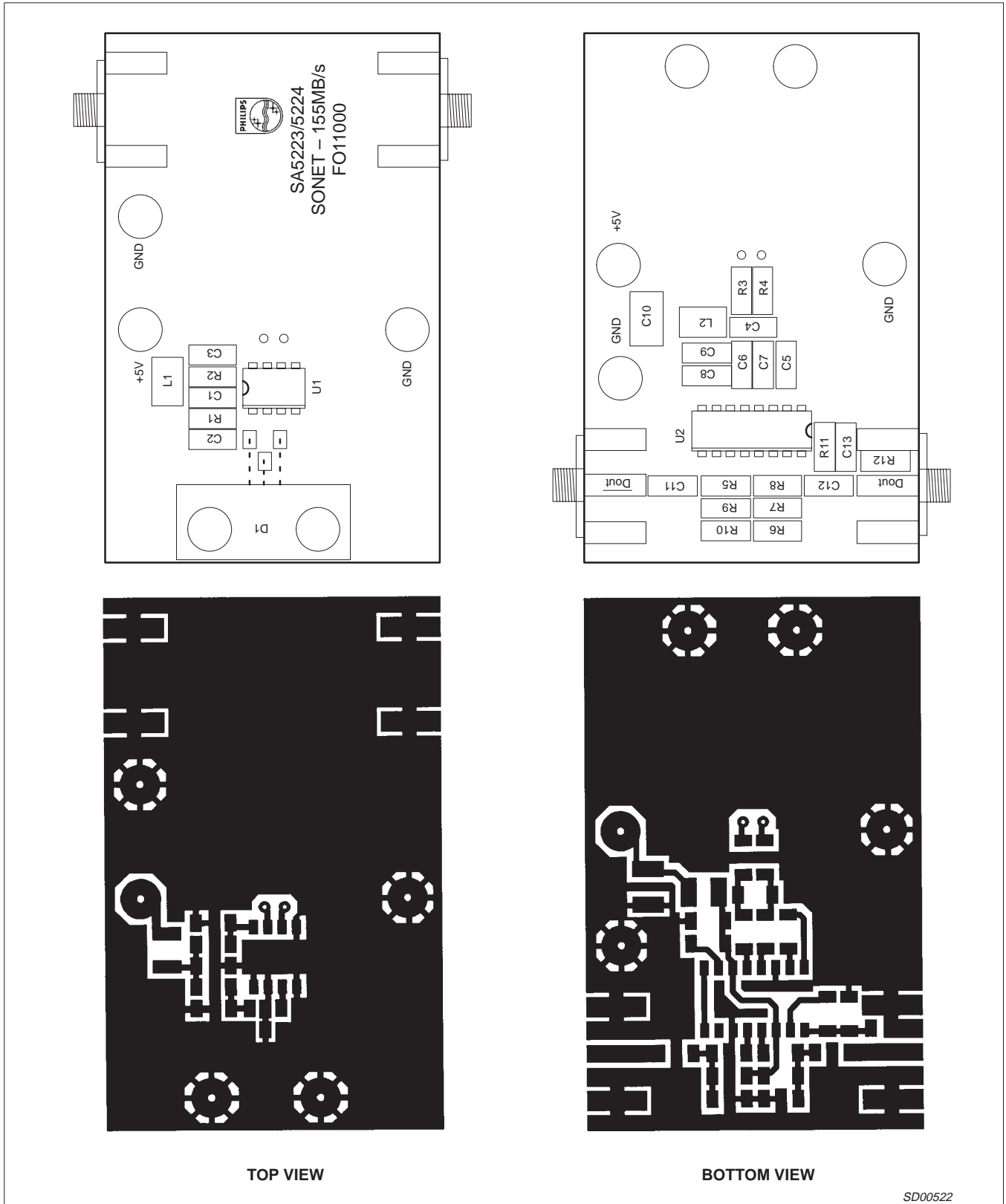
Figure 3. SA5223 Board Layout (NOT ACTUAL SIZE)

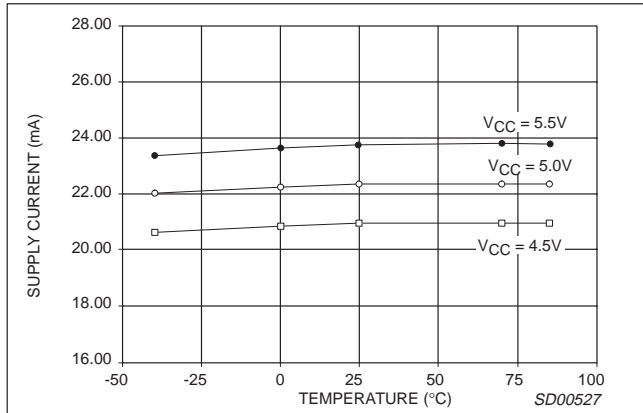# Wide dynamic range AGC transimpedance amplifier(150MHz)　　　SA5223
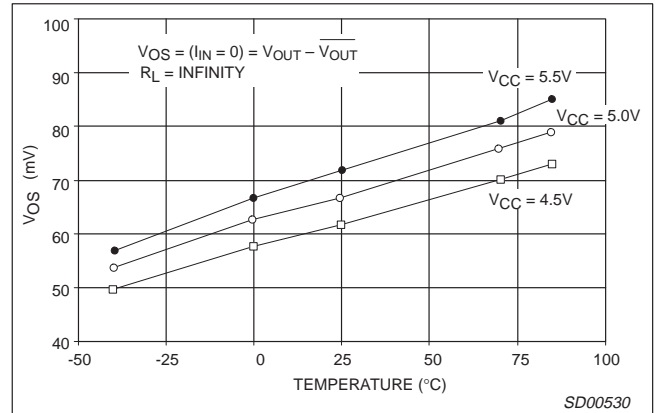
Figure 4. SA5223 I$_{CC}$ vs Temperature
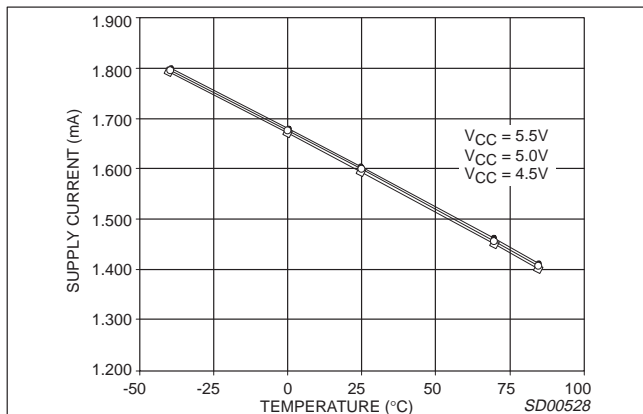
Figure 7. SA5223 Output V$_{OS}$ vs Temperature

Figure 5. SA5223 Input V$_{BIAS}$ vs Temperature
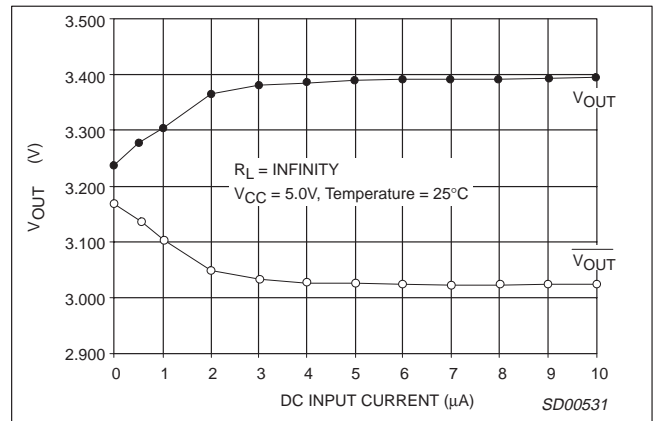
Figure 8. SA5223 Output Voltage vs DC Input Current (for small input current)
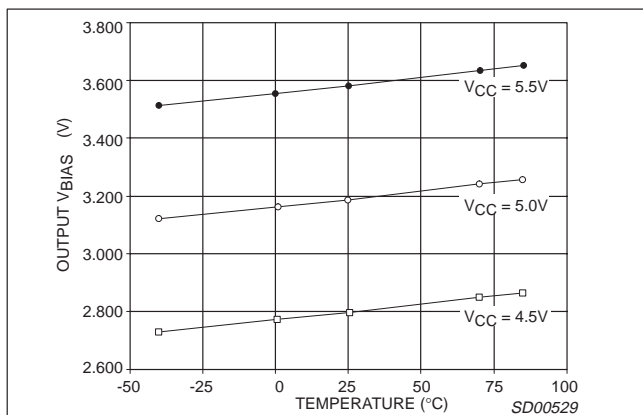
Figure 6. SA5223 Output V$_{BIAS}$ vs Temperature
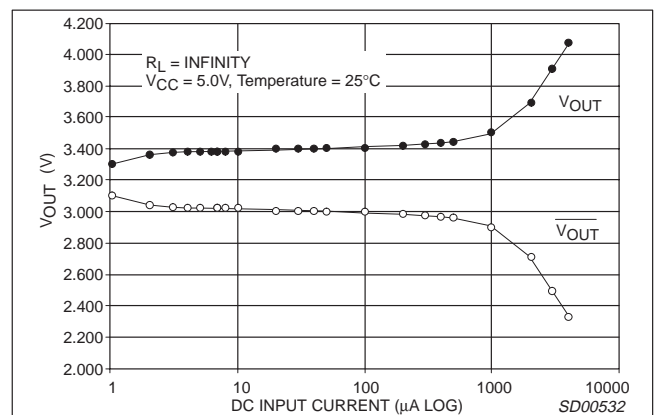
Figure 9. SA5223 Output Voltage vs DC Input Current (for large input current)

Wide dynamic range AGC transimpedance amplifier(150MHz)　　　SA5223
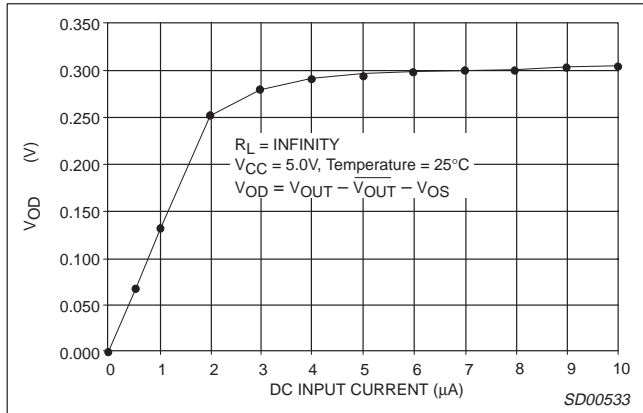
**Figure 10. SA5223 Differential Output vs DC I_IN
(for small input current)**

Figure 11. SA5223 Differential Output vs DC I_IN

**Figure 12. SA5223 Differential RT vs DC I_IN
(for small input current)**

**Figure 13. SA5223 Differential RT vs DC I_IN
(for large input current)**
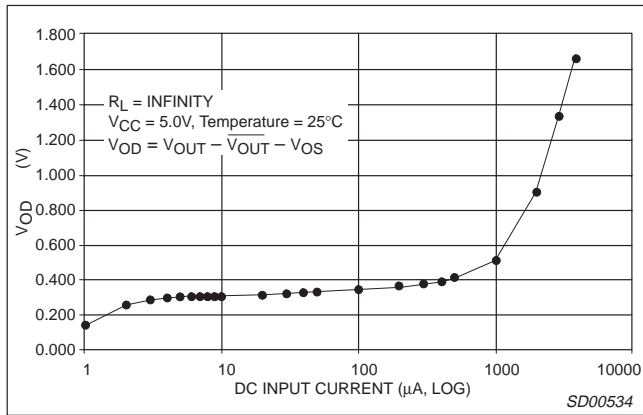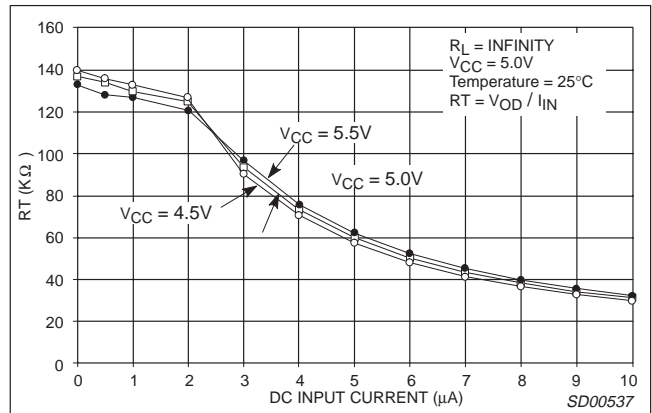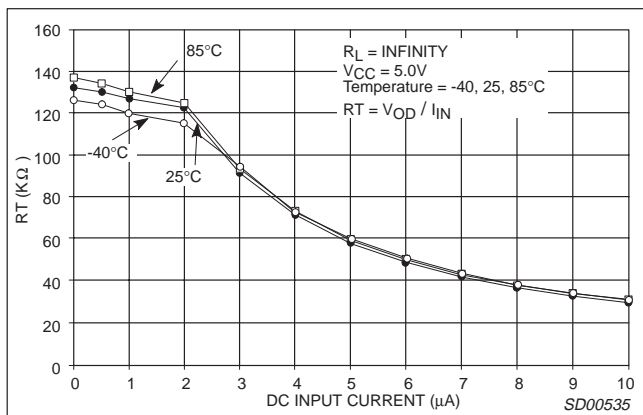

**Figure 14. SA5223 Differential RT vs DC I_IN
(for small input current)**

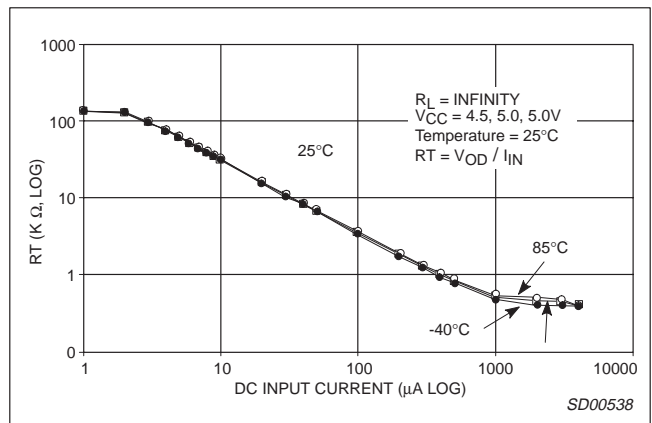**Figure 15. SA5223 Differential RT vs DC I_IN
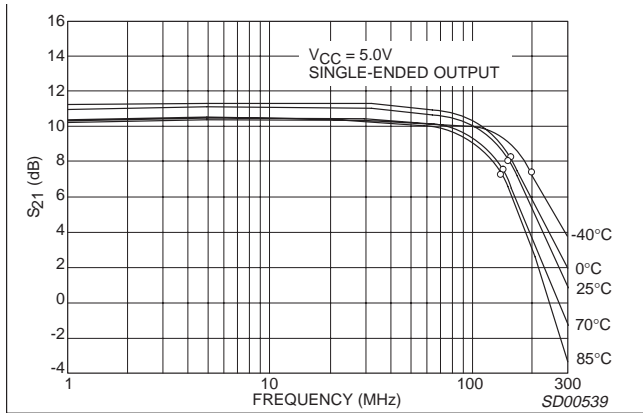(for large input current)**

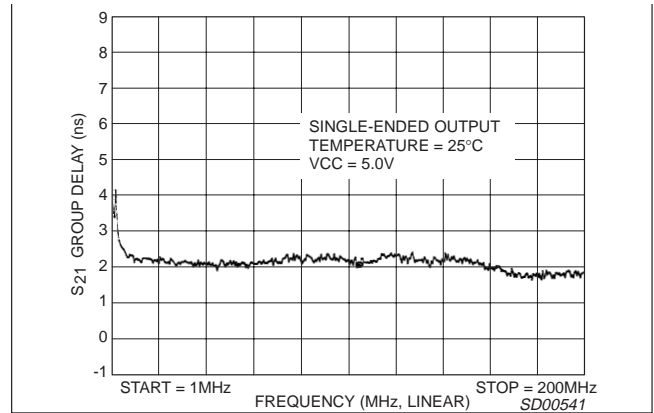**Figure 16. Insertion Gain vs Frequency**
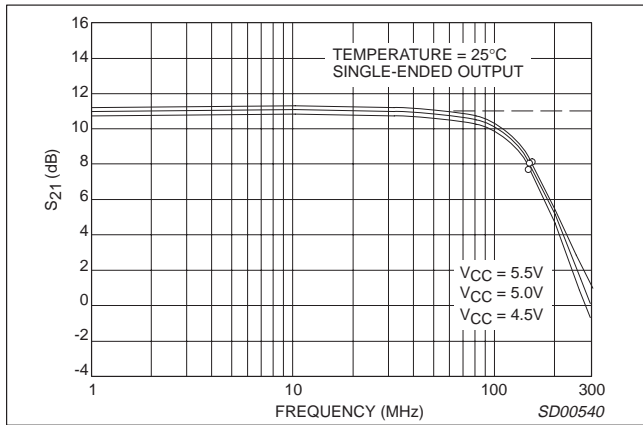

Figure 18. Group Delay vs Frequency

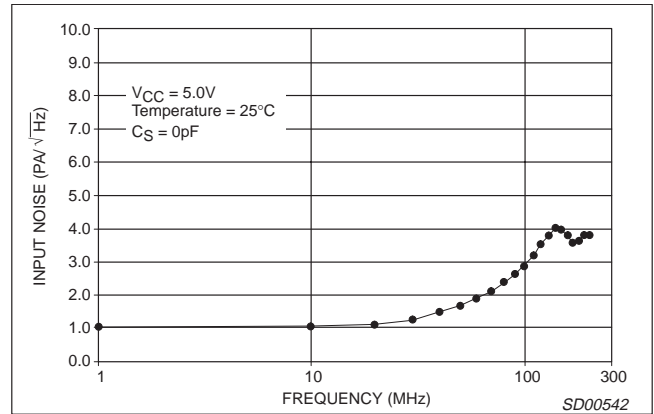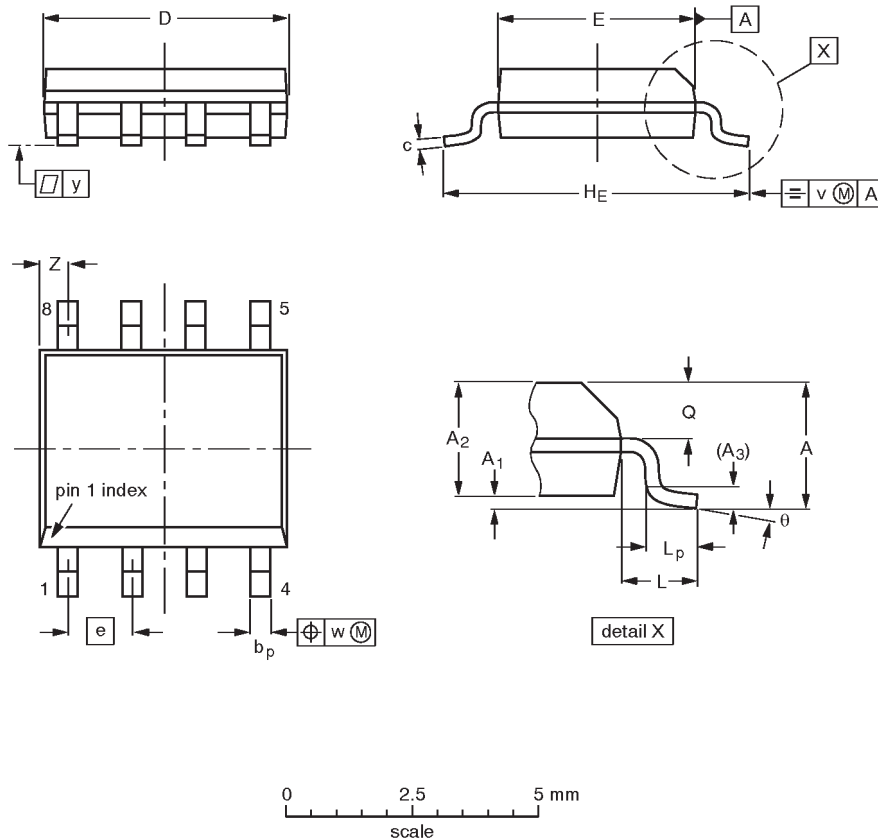**Figure 17. Insertion Gain vs Frequency**

Figure 19. SA5223 Input Current RMS Noise Spectral Density

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SA5223

SO8: plastic small outline package; 8 leads; body width 3.9mm   **SOT96-1**

pin 1 index

detail X

```
0        2.5        5 mm
scale
```

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

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	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 chages 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.

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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.

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