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DATA SHEET

NE/SA/AU5232

Matched dual high-performance low-voltage operational amplifier

Product data

2002 May 21

Philips
Semiconductors

PHILIPS

Matched dual high-performance low-voltage operational amplifier

NE/SA/AU5232

DESCRIPTION

The NE/SA/AU5232 is a matched, low voltage, high performance dual operational amplifier. Among its unique input and output characteristics is the capability for both input and output rail-to-rail operation, particularly critical in low voltage applications. The output swings to less than 50 mV of both rails across the entire power supply range. The NE/SA/AU5232 is capable of delivering 5.5 V peak-to-peak across a 600 Ω load and will typically draw only 700 μA per amplifier. The bandwidth is 2.5 MHz and the 1% settling time is 1.4 μs.

FEATURES

- Wide common-mode input voltage range: 250 mV beyond both rails
- Output swing within 50 mV of both rails
- Functionality to 1.8 V typical
- Low current consumption: 700 μA per amplifier
- ±15 mA output current capability
- Unity gain bandwidth: 2.5 MHz
- Slew rate: 0.8 V/μs
- Low noise: 33 nV/√Hz
- Electrostatic discharge protection
- Short-circuit protection
- Output inversion prevention

PIN CONFIGURATION

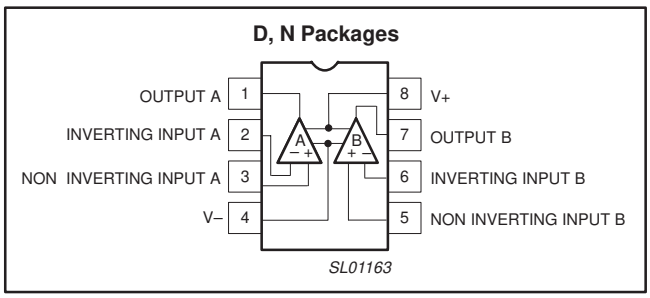


Figure 1. Pin configuration.

APPLICATIONS

- Automotive electronics
- Signal conditioning and sensing amplification
- Portable instrumentation
  - Test and measurement
  - Medical monitors and diagnostics
  - Remote meters
- Audio equipment
- Security systems
- Communications
  - Pagers
  - Cellular telephone
  - LAN
  - 5 V Datacom bus
- Error amplifier in motor drives
- Transducer buffer amplifier

ORDERING INFORMATION

ORDER CODE	DESCRIPTION	TEMPERATURE RANGE	DWG #
NE5232D	8-Pin Plastic Small Outline (SO) package	0 °C to +70 °C	SOT96-1
NE5232N	8-Pin Plastic Dual In-Line Package (DIP)	0 °C to +70 °C	SOT97-1
SA5232D	8-Pin Plastic Small Outline (SO) package	–40 °C to +85 °C	SOT96-1
SA5232N	8-Pin Plastic Dual In-Line Package (DIP)	–40 °C to +85 °C	SOT97-1
AU5232N	8-Pin Plastic Dual In-Line Package (DIP)	–40 °C to +125 °C	SOT97-1
AU5232D	8-Pin Plastic Small Outline (SO) package	–40 °C to +125 °C	SOT96-1

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Single supply voltage	7	V
V_{ESD}	ESD protection voltage at any pin[5] human body model robot model	 2000 200	 V V
V_S	Dual supply voltage	±3.5	V
V_{DP}	Voltage at any device pin[1]	$V_S \pm 0.5$	V
I_{DP}	Current into any device pin[1]	±50	mA
$V_{i(dif)}$	Differential input voltage[2]	0.5	V
$V_{i(CM)}$	Common-mode input voltage (positive)	$V_{CC} + 0.5$	V
$V_{i(CM)}$	Common-mode input voltage (negative)	$V_{EE} – 0.5$	V
P_D	Power dissipation[3]	500	mW
T_j	Operating junction temperature[3]	+150	°C
V_{SC}	Supply voltage allowing indefinite output short circuit to either rail[3,4]	7	V
T_{stg}	Storage temperature range	–65 to +150	°C
T_{sld}	Lead soldering temperature (10 sec max)	+230	°C
θ_{JA}	Thermal impedance 8-pin plastic DIP 8-pin plastic SO	 	 °C/W °C/W

NOTES:
1. Each pin is protected by ESD diodes. The voltage at any pin is limited by the ESD diodes.
2. The differential input of each amplifier is limited by two internal diodes, connected in parallel and opposite to each other. For more differential input range, use differential resistors in series with the input pins.
3. The maximum operating junction temperature is +150 °C. At elevated temperatures, devices must be derated according to the package thermal resistance and device mounting conditions. Derates above +25 °C: N package at 9.5 mW/°C; D package at 6.25 mW/°C.
4. Simultaneous short circuits of two amplifiers to the positive or negative rail can exceed the power dissipation ratings and cause eventual destruction of the device.
5. Guaranteed by design.

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Single supply voltage	+2 to +5.5	V
V_S	Dual supply voltage	±1 to ±2.75	V
$V_{i(CM)}$	Common-mode input voltage (positive)	$V_{CC} + 0.25$	V
$V_{i(CM)}$	Common-mode input voltage (negative)	$V_{EE} – 0.25$	V
T_{amb}	Temperature NE SA AU	 0 to +70 –40 to +85 –40 to +125	 °C °C °C

DC ELECTRICAL CHARACTERISTICS

V_{CC} = 2 V to 5.5 V, V_{EE} = 0 V, T_{amb} = 25 °C; $V_{EE} < V_{i(CM)} < V_{CC}$; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS						UNIT
			NE5232			SA5232			
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{CC}	Supply current	V_{CC} = 5.5V		1.4	2.0		1.4	2.0	mA
		V_{CC} = 5.5 V; over full temp. range		1.5	2.3		1.6	2.4	
V_{OS}	Offset voltage			±0.2	±4		±0.2	±4	mV
		Over full temp. range		±0.4	±5		±0.6	±5	
$\Delta V_{OS}/\Delta T$	Offset voltage drift with temperature			4			4		µV/°C
ΔV_{OS}	Offset voltage difference between any amplifiers in the same package at the same common mode level[1]			0.4	3		0.4	3	mV
		Over full temp. range		0.8	4		1.2	4	
I_{OS}	Offset current			±3	±20		±3	±30	nA
		Over full temp. range		±4	±30		±6	±60	
$\Delta I_{OS}/\Delta T$	Offset current drift with temperature			0.02	±.3		0.03	±.3	nA/°C
I_B	Input bias current[1]	$V_{EE} < V_{i(CM)} < V_{EE}$ +0.5 V	–200	–90		–200	–90		nA
		Over full temp. range	–225	–100		–250	–150		
		V_{EE} +1 V < $V_{i(CM)} < V_{CC}$		25	70		25	75	
		Over full temp. range		35	100		35	120	
$\Delta I_B/\Delta T$	Input bias current drift with temperature			0.5			0.5		nA/°C
ΔI_B	Input bias current difference between any amplifier in the same package at the same common mode level.	$V_{EE} < V_{i(CM)} < V_{EE}$ +0.5 V		10	30		10	30	nA
		Over full temp. range		25	50		50	70	
		V_{EE} +1 V < $V_{i(CM)} < V_{CC}$		5	20		5	20	
		Over full temp. range		15	30		25	50	
$V_{i(CM)}$	Common-mode input range	$V_{OS} \leq$ 6 mV	V_{EE}–0.25		V_{CC}+0.25	V_{EE}–0.25		V_{CC}+0.25	V
		$V_{OS} \leq$ 6 mV; Over full temp. range	V_{EE}–0.1		V_{CC}+0.1	V_{EE}–0.1		V_{CC}+0.1	
CMRR	Common-mode rejection ratio, small signal	$V_{EE} < V_{i(CM)} < V_{EE}$+0.5V; V_{EE}+1V < $V_{i(CM)} < V_{CC}$	80	100		80	100		dB
		Over full temp. range	75	100		75			
	Common-mode rejection ratio, large signal	$V_{EE} < V_{i(CM)} < V_{CC}$	65	90		65	90		
		Over full temp. range	60	80		60			
PSRR	Power supply rejection ratio	$V_{EE} < V_{i(CM)} < V_{CC}$	80	100		80	100		dB
		Over full temp. range	80	90		80	90		
I_L	Peak load current, sink and source		10	12		10	12		mA
		Over full temp. range	5	8		5	8		
A_{VOL}	Open-loop voltage gain		90	110		90	110		dB
		Over full temp. range		90			90		
V_{OUT}	Output voltage swing	I_{PEAK} = 0.1 mA	V_{EE}+0.05		V_{CC}–0.05	V_{EE}+0.1		V_{CC}–0.1	V
		I_{PEAK} = 10 mA	V_{EE}+0.25		V_{CC}–0.25	V_{EE}+0.25		V_{CC}–0.25	
		I_{PEAK} = 5 mA; over full temp. range	V_{EE}+0.22		V_{CC}–0.22	V_{EE}+0.2		V_{CC}–0.2	
	Output voltage swing for V_{CC} = 2.75 V, V_{EE} = –2.75 V	R_L = 2 kΩ	V_{EE}+0.2		V_{CC}–0.2	V_{EE}+0.2		V_{CC}–0.2	V
		R_L = 600 Ω	V_{EE}+0.25		V_{CC}–0.25	V_{EE}+0.25		V_{CC}–0.25	

NOTE:

1. These parameters are measured for $V_{EE} < V_{CM} < V_{EE}$+0.5 V and for V_{EE}+1 V < $V_{CM} < V_{CC}$. By design these parameters are intermediate for common mode ranges between the measured regions.

DC ELECTRICAL CHARACTERISTICS

V_{CC} = 2 V to 5.5 V, V_{EE} = 0 V, T_{amb} = 25 °C; $V_{EE} < V_{i(CM)} < V_{CC}$; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			AU5232			
			MIN	TYP	MAX	
I_{CC}	Supply current	V_{CC} = 5.5V		1.4	2.0	mA
		V_{CC} = 5.5 V; over full temp. range		1.6	2.4	
V_{OS}	Offset voltage			±0.2	±4	mV
		Over full temp. range		±0.6	±5	
$\Delta V_{OS}/\Delta T$	Offset voltage drift with temperature			4		µV/°C
ΔV_{OS}	Offset voltage difference between any amplifiers in the same package at the same common mode level[1]			0.4	3	mV
		Over full temp. range		1.2	4	
I_{OS}	Offset current			±3	±30	nA
		Over full temp. range		±6	±60	
$\Delta I_{OS}/\Delta T$	Offset current drift with temperature			0.03	±.3	nA/°C
I_B	Input bias current[1]	$V_{EE} < V_{i(CM)} < V_{EE}$ +0.5 V	–200	–90		nA
		Over full temp. range	–250	–150		
		V_{EE} +1 V < $V_{i(CM)} < V_{CC}$		25	75	
		Over full temp. range		35	120	
$\Delta I_B/\Delta T$	Input bias current drift with temperature			0.5		nA/°C
ΔI_B	Input bias current difference between any amplifier in the same package at the same common mode level.	$V_{EE} < V_{i(CM)} < V_{EE}$ +0.5 V		10	30	nA
		Over full temp. range		50	70	
		V_{EE} +1 V < $V_{i(CM)} < V_{CC}$		5	20	
		Over full temp. range		25	50	
$V_{i(CM)}$	Common-mode input range	$V_{OS} \leq$ 6 mV	V_{EE}–0.25		V_{CC}+0.25	V
		$V_{OS} \leq$ 6 mV; Over full temp. range	V_{EE}–0.1		V_{CC}+0.1	
CMRR	Common-mode rejection ratio, small signal	$V_{EE} < V_{i(CM)} < V_{EE}$+0.5V; V_{EE}+1V < $V_{i(CM)} < V_{CC}$	80	100		dB
		Over full temp. range	70			
	Common-mode rejection ratio, large signal	$V_{EE} < V_{i(CM)} < V_{CC}$	65	90		
		Over full temp. range	55			
PSRR	Power supply rejection ratio	$V_{EE} < V_{i(CM)} < V_{CC}$	80	100		dB
		Over full temp. range	75	90		
I_L	Peak load current, sink and source		10	12		mA
		Over full temp. range	5	8		
A_{VOL}	Open-loop voltage gain		90	110		dB
		Over full temp. range		90		
V_{OUT}	Output voltage swing	I_{PEAK} = 0.1 mA	V_{EE}+0.1		V_{CC}–0.1	V
		I_{PEAK} = 10 mA	V_{EE}+0.25		V_{CC}–0.25	
		I_{PEAK} = 5 mA; over full temp. range	V_{EE}+0.2		V_{CC}–0.2	
	Output voltage swing for V_{CC} = 2.75 V, V_{EE} = –2.75 V	R_L = 2 kΩ	V_{EE}+0.2		V_{CC}–0.2	V
		R_L = 600 Ω	V_{EE}+0.25		V_{CC}–0.25	

NOTE:

1. These parameters are measured for $V_{EE} < V_{CM} < V_{EE}$+0.5 V and for V_{EE}+1 V < $V_{CM} < V_{CC}$. By design these parameters are intermediate for common mode ranges between the measured regions.

AC ELECTRICAL CHARACTERISTICS

T_{amb} = +25 °C; V_{CC} = 2 V to 5.5 V; R_L = 10 kΩ; C_L = 100 pF; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS						UNIT
			NE5232			SA/AU5232			
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate	Over full temperature range	0.5	0.8		0.5	0.8		V/µs
BW	Unity gain bandwidth: –3 dB	Over full temperature range	2	2.5	4.0	2	2.5	4.0	MHz
θ_M	Phase Margin	C_L = 50 pF		55			55		deg
t_S	1% settling time	A_V = 1, 1 V step		1.4			1.4		µs
V_N	Input referred voltage noise	A_V = 1, R_S = 0 Ω, at 1 kHz		33			33		$nV/Hz^{1/2}$
THD	Total harmonic distortion	10 kHz, $1V_{P-P}$, A_V = 1		0.1			0.1		%

OUTPUT INVERSION PREVENTION

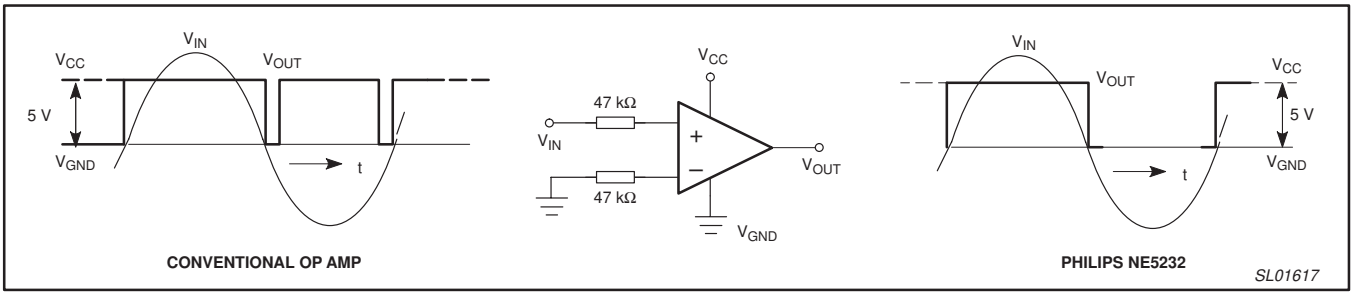
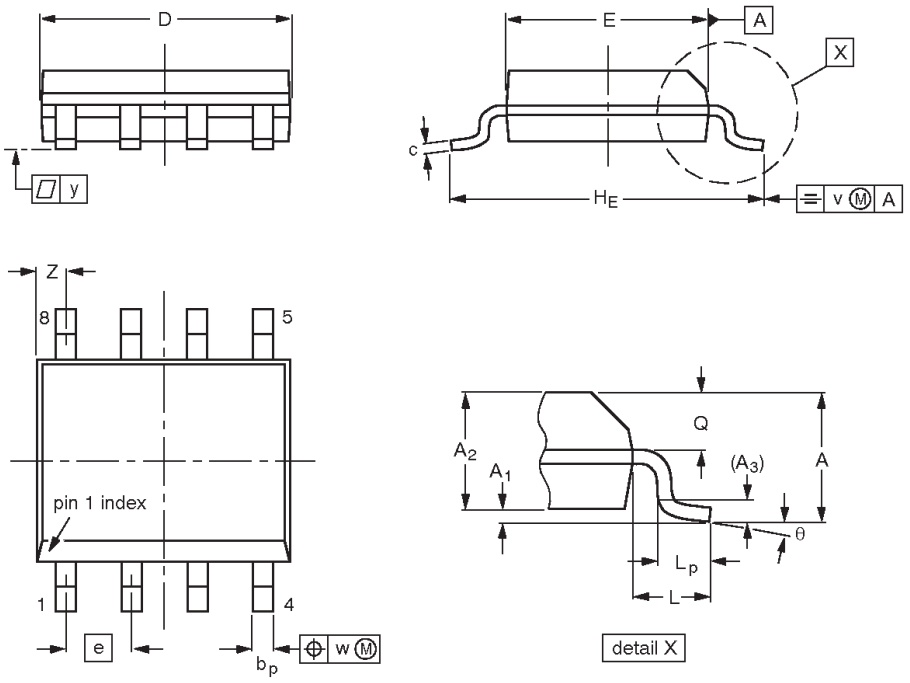
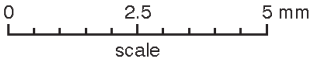


Figure 2. Output inversion prevention.

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





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

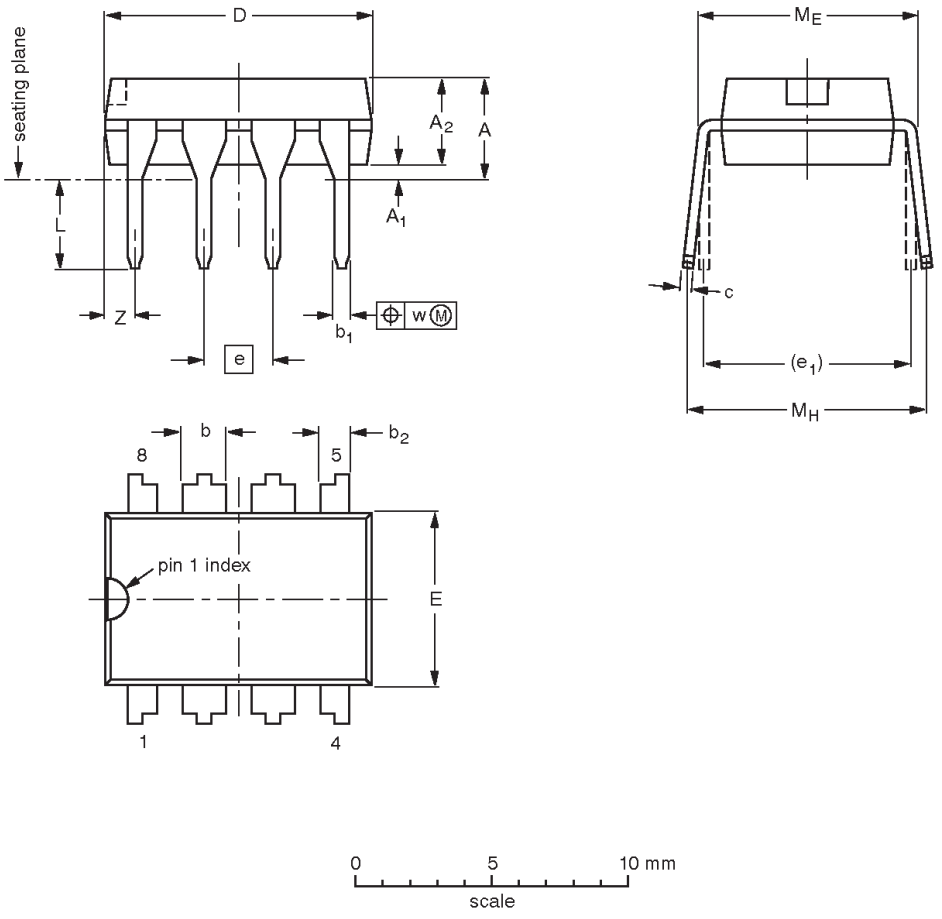
UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.050	0.244 0.228	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	076E03	MS-012				~~97-05-22~~ 99-12-27

DIP8: plastic dual in-line package; 8 leads (300 mil) **SOT97-1**



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

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.14	0.53 0.38	1.07 0.89	0.36 0.23	9.8 9.2	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	1.15
inches	0.17	0.020	0.13	0.068 0.045	0.021 0.015	0.042 0.035	0.014 0.009	0.39 0.36	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.045

Note

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT97-1	050G01	MO-001	SC-504-8			~~95-02-04~~ 99-12-27

NOTES

Matched dual high-performance low-voltage operational amplifier

NE/SA/AU5232

Data sheet status

Data sheet status [1]	Product status [2]	Definitions
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A.

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

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.

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Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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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