DATA SHEET

LM124/224/324/324A/ SA534/LM2902

Low power quad op amps

Product data
Supersedes data of 2002 Jul 12

2003 Sep 19

Philips
Semiconductors

Low power quad op amps

LM124/224/324/324A/ SA534/LM2902

DESCRIPTION

The LM124/SA534/LM2902 series consists of four independent, high-gain, internally frequency-compensated operational amplifiers designed specifically to operate from a single power supply over a wide range of voltages.

UNIQUE FEATURES

In the linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

The unity gain crossover frequency and the input bias current are temperature-compensated.

FEATURES

- Internally frequency-compensated for unity gain
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1 MHz (temperature-compensated)
- Wide power supply range Single supply: 3 V_{DC} to 30 V_{DC} or dual supplies: ±1.5 V_{DC} to ±15 V_{DC}
- Very low supply current drain: essentially independent of supply voltage (1 mW/op amp at +5 V_{DC})
- Low input biasing current: 45 nA_{DC} (temperature-compensated)
- Low input offset voltage: 2 mV_{DC} and offset current: 5 nA_{DC}
- Differential input voltage range equal to the power supply voltage
- Large output voltage: 0V_{DC} to V_{CC}–1.5 V_{DC} swing

PIN CONFIGURATION

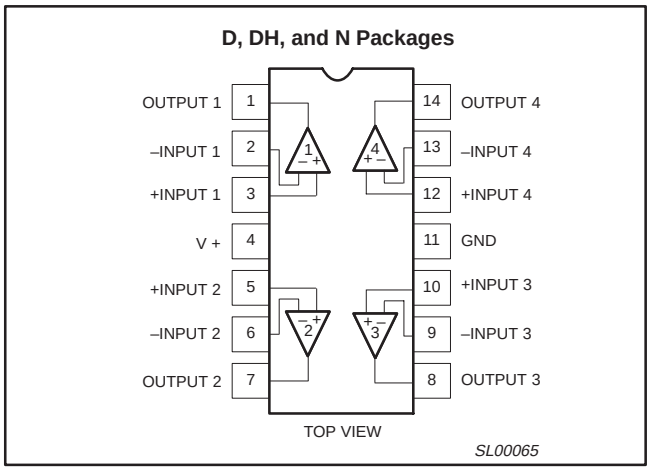


Figure 1. Pin configuration.

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
14-Pin Plastic Dual In-Line Package (DIP)	–55° C to +125 °C	LM124N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	–25 °C to +85 °C	LM224D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	–25 °C to +85 °C	LM224N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	0 °C to +70 °C	LM324AD	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	0 °C to +70 °C	LM324AN	SOT27-1
14-Pin Plastic Small Outline (SO) Package	0 °C to +70 °C	LM324D	SOT108-1
14-Pin Plastic Thin Shrink Small Outline Package (TSSOP)	0 °C to +70 °C	LM324DH	SOT402-1
14-Pin Plastic Dual In-Line Package (DIP)	0 °C to +70 °C	LM324N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	–40 °C to +85 °C	SA534D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	–40 °C to +85 °C	SA534N	SOT27-1
14-Pin Plastic Small Outline (SO) Package	–40 °C to +125 °C	LM2902D	SOT108-1
14-Pin Plastic Thin Shrink Small Outline Package (TSSOP)	–40 °C to +125 °C	LM2902DH	SOT402-1
14-Pin Plastic Dual In-Line Package (DIP)	–40 °C to +125 °C	LM2902N	SOT27-1

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply voltage	32 or ±16	V_{DC}
V_{IN}	Differential input voltage	32	V_{DC}
V_{IN}	Input voltage	–0.3 to +32	V_{DC}
P_D	Maximum power dissipation, T_{amb} = 25 °C (still-air) [1]		
	N package	1420	mW
	D package	1040	mW
	DH package	762	mW
	Output short-circuit to GND one amplifier[2] V_{CC} < 15 V_{DC} and T_{amb} = 25 °C	Continuous	
I_{IN}	Input current (V_{IN} < –0.3 V) [3]	50	mA
T_{amb}	Operating ambient temperature range		
	LM324/324A	0 to +70	°C
	LM224	–25 to +85	°C
	SA534	–40 to +85	°C
	LM2902	–40 to +125	°C
	LM124	–55 to +125	°C
T_{stg}	Storage temperature range	–65 to +150	°C
T_{sld}	Lead soldering temperature (10 sec max)	230	°C

NOTES:

1. Derate above 25 °C at the following rates:
   N package at 11.4 mW/°C
   D package at 8.3 mW/°C
   DH package at 6.1mW/°C
2. Short-circuits from the output to V_{CC}+ can cause excessive heating and eventual destruction. The maximum output current is approximately 40 mA, independent of the magnitude of V_{CC}. At values of supply voltage in excess of +15 V_{DC} continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction.
3. This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input bias clamps. In addition, there is also lateral NPN parasitic transistor action on the IC chip. This action can cause the output voltages of the op amps to go to the V+ rail (or to ground for a large overdrive) during the time that the input is driven negative.

DC ELECTRICAL CHARACTERISTICS

V_{CC} = 5 V; T_{amb} = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM124/LM224			LM324/SA534/LM2902			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Offset voltage[1]	R_S = 0 Ω		±2	±5		±2	±7	mV
		R_S = 0 Ω, over temp.			±7			±9	
$\Delta V_{OS}/\Delta T$	Temperature drift	R_S = 0 Ω, over temp.		7			7		µV/°C
I_{BIAS}	Input current[2]	$I_{IN}(+)$ or $I_{IN}(-)$		45	150		45	250	nA
		$I_{IN}(+)$ or $I_{IN}(-)$, over temp.		40	300		40	500	
$\Delta I_{BIAS}/\Delta T$	Temperature drift	Over temp.		50			50		pA/°C
I_{OS}	Offset current	$I_{IN}(+)-I_{IN}(-)$		±3	±30		±5	±50	nA
		$I_{IN}(+)-I_{IN}(-)$, over temp.			±100			±150	
$\Delta I_{OS}/\Delta T$	Temperature drift	Over temp.		10			10		pA/°C
V_{CM}	Common-mode voltage range[3]	V_{CC} ≤ 30 V	0		V_{CC}–1.5	0		V_{CC}–1.5	V
		V_{CC} ≤ 30 V; over temp.	0		V_{CC}–2	0		V_{CC}–2	
CMRR	Common-mode rejection ratio	V_{CC} = 30 V	70	85		65	70		dB
V_{OUT}	Output voltage swing	R_L = 2 kΩ, V_{CC} = 30 V, over temp.	26			26			V
V_{OH}	Output voltage high	R_L ≤ 10 kΩ, V_{CC} = 30 V, over temp.	27	28		27	28		V
V_{OL}	Output voltage low	R_L ≤ 10 kΩ; over temp.		5	20		5	20	mV
I_{CC}	Supply current	R_L = ∞, V_{CC} = 30 V; over temp.		1.5	3		1.5	3	mA
		R_L = ∞; over temp.		0.7	1.2		0.7	1.2	
A_{VOL}	Large-signal voltage gain	V_{CC} = 15 V (for large V_O swing); R_L ≥ 2 kΩ	50	100		25	100		V/mV
		V_{CC} = 15 V (for large V_O swing); R_L ≥ 2k Ω; over temp.	25			15			
	Amplifier-to-amplifier coupling[5]	f = 1 kHz to 20 kHz, input referred		–120			–120		dB
PSRR	Power supply rejection ratio	R_S ≤ 0 Ω	65	100		65	100		dB
I_{OUT}	Output current source	V_{IN}+ = +1 V, V_{IN}– = 0 V, V_{CC} = 15 V	20	40		20	40		mA
		V_{IN}+ = +1 V, V_{IN}– = 0 V, V_{CC} = 15 V, over temp.	10	20		10	20		
	Output current sink	V_{IN}– = +1 V, V_{IN}+ = 0 V, V_{CC} = 15 V	10	20		10	20		
		V_{IN}– = +1 V, V_{IN}+ = 0 V, V_{CC} = 15 V, over temp.	5	8		5	8		
		V_{IN}– = +1 V, V_{IN}+ = 0 V, V_O = 200 mV	12	50		12	50		µA
I_{SC}	Short-circuit current[4]		10	40	60	10	40	60	mA
GBW	Unity gain bandwidth			1			1		MHz
SR	Slew rate			0.3			0.3		V/µs
V_{NOISE}	Input noise voltage	f = 1 kHz		40			40		nV/√Hz
V_{DIFF}	Differential input voltage[3]				V_{CC}			V_{CC}	V

DC ELECTRICAL CHARACTERISTICS (Continued)

V_{CC} = 5 V, T_{amb} = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM324A			UNIT
			Min	Typ	Max	
V_{OS}	Offset voltage[1]	R_S = 0 Ω		±2	±3	mV
		R_S = 0 Ω, over temp.			±5	
$\Delta V_{OS}/\Delta T$	Temperature drift	R_S = 0 Ω, over temp.		7	30	µV/°C
I_{BIAS}	Input current[2]	$I_{IN}(+)$ or $I_{IN}(-)$		45	100	nA
		$I_{IN}(+)$ or $I_{IN}(-)$, over temp.		40	200	
$\Delta I_{BIAS}/\Delta T$	Temperature drift	Over temp.		50		pA/°C
I_{OS}	Offset current	$I_{IN}(+)-I_{IN}(-)$		±5	±30	nA
		$I_{IN}(+)-I_{IN}(-)$, over temp.			±75	
$\Delta I_{OS}/\Delta T$	Temperature drift	Over temp.		10	300	pA/°C
V_{CM}	Common-mode voltage range[3]	V_{CC} ≤ 30 V	0		V_{CC}–1.5	V
		V_{CC} ≤ 30 V, over temp.	0		V_{CC}–2	V
CMRR	Common-mode rejection ratio	V_{CC} = 30 V	65	85		dB
V_{OUT}	Output voltage swing	R_L = 2 kΩ, V_{CC} = 30 V; over temp.	26			V
V_{OH}	Output voltage high	R_L ≤ 10 kΩ, V_{CC} = 30 V; over temp.	27	28		V
V_{OL}	Output voltage low	R_L ≤ 10 kΩ, over temp.		5	20	mV
I_{CC}	Supply current	R_L = ∞, V_{CC} = 30 V, over temp.		1.5	3	mA
		R_L = ∞, over temp.		0.7	1.2	mA
A_{VOL}	Large-signal voltage gain	V_{CC} = 15 V (for large V_O swing), R_L ≥ 2 kΩ	25	100		V/mV
		V_{CC} = 15 V (for large V_O swing), R_L ≥ 2k Ω, over temp.	15			V/mV
	Amplifier-to-amplifier coupling[5]	f = 1 kHz to 20 kHz, input referred		–120		dB
PSRR	Power supply rejection ratio	R_S ≤ 0 Ω	65	100		dB
I_{OUT}	Output current source	$V_{IN}+$ = +1 V, $V_{IN}-$ = 0 V, V_{CC} = 15 V	20	40		mA
		$V_{IN}+$ = +1 V, $V_{IN}-$ = 0 V, V_{CC} = 15 V, over temp.	10	20		mA
	Output current sink	$V_{IN}-$ = +1 V, $V_{IN}+$ = 0 V, V_{CC} = 15 V	10	20		mA
		$V_{IN}-$ = +1 V, $V_{IN}+$ = 0 V, V_{CC} = 15 V, over temp.	5	8		mA
		$V_{IN}-$ = +1 V, $V_{IN}+$ = 0 V, V_O = 200 mV	12	50		µA
I_{SC}	Short-circuit current[4]		10	40	60	mA
V_{DIFF}	Differential input voltage[3]				V_{CC}	V
GBW	Unity gain bandwidth			1		MHz
SR	Slew rate			0.3		V/µs
V_{NOISE}	Input noise voltage	f = 1 kHz		40		nV/√Hz

NOTES:

1. $V_O \approx 1.4\ V_{DC}$, R_S = 0 Ω with V_{CC} from 5 V to 30 V and over full input common-mode range (0 V_{DC}+ to V_{CC} –1.5 V).
2. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
3. The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC} –1.5, but either or both inputs can go to +32 V without damage.
4. Short-circuits from the output to V_{CC} can cause excessive heating and eventual destruction. The maximum output current is approximately 40 mA independent of the magnitude of V_{CC}. At values of supply voltage in excess of +15 V_{DC}, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.
5. Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of coupling increases at higher frequencies.

EQUIVALENT CIRCUIT

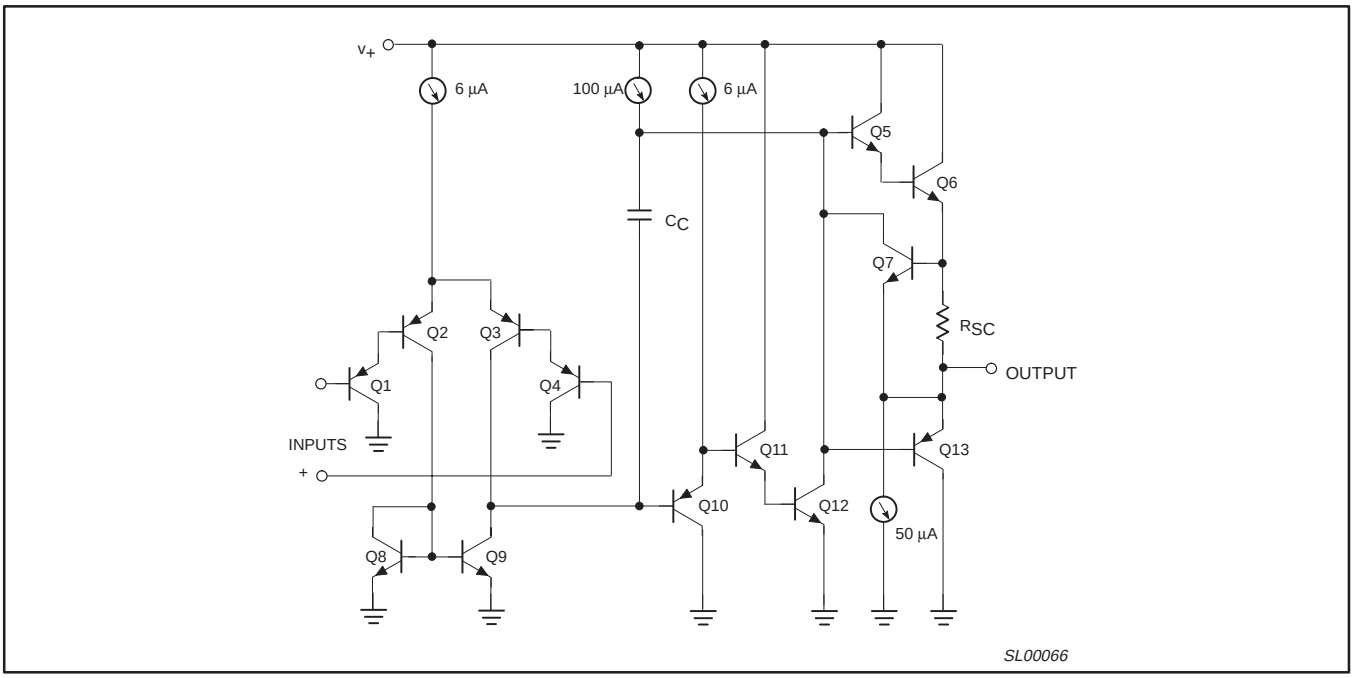
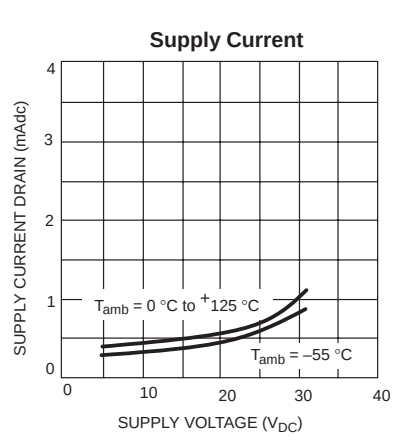
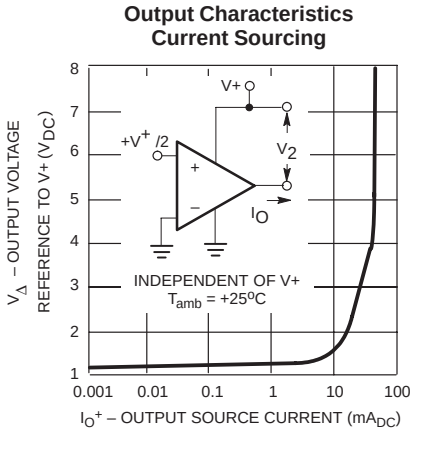
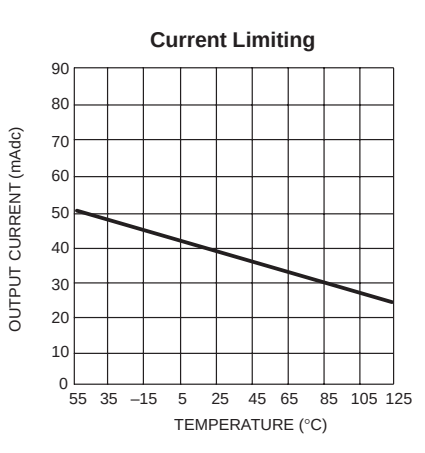


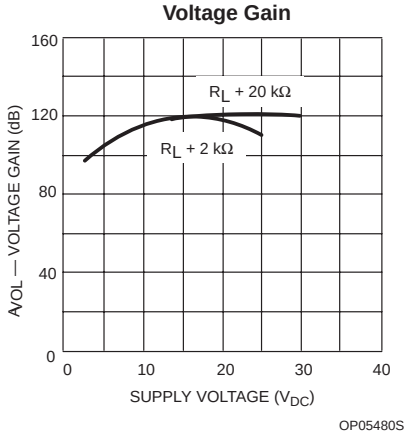
Figure 2. Equivalent circuit.

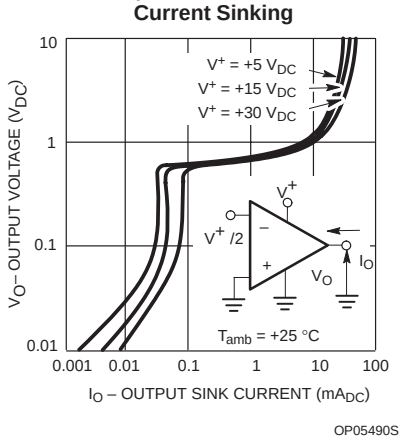
TYPICAL PERFORMANCE CHARACTERISTICS

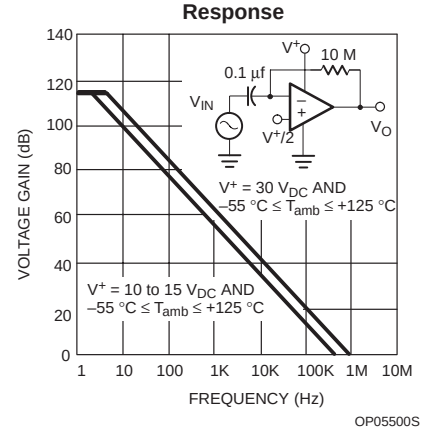












SL00067

Figure 3. Typical Performance Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

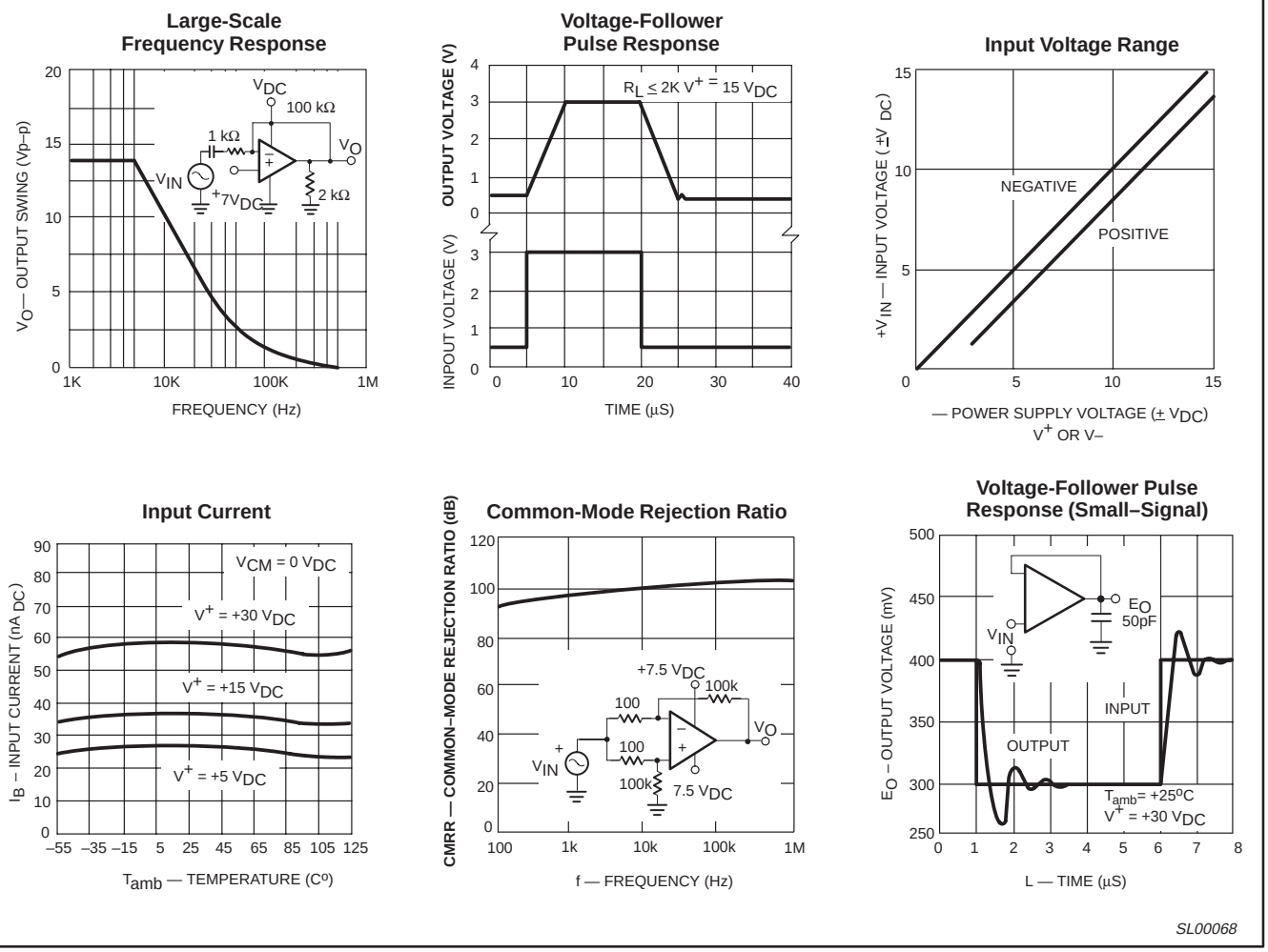


Figure 4. Typical Performance Characteristics (cont.)

TYPICAL APPLICATIONS

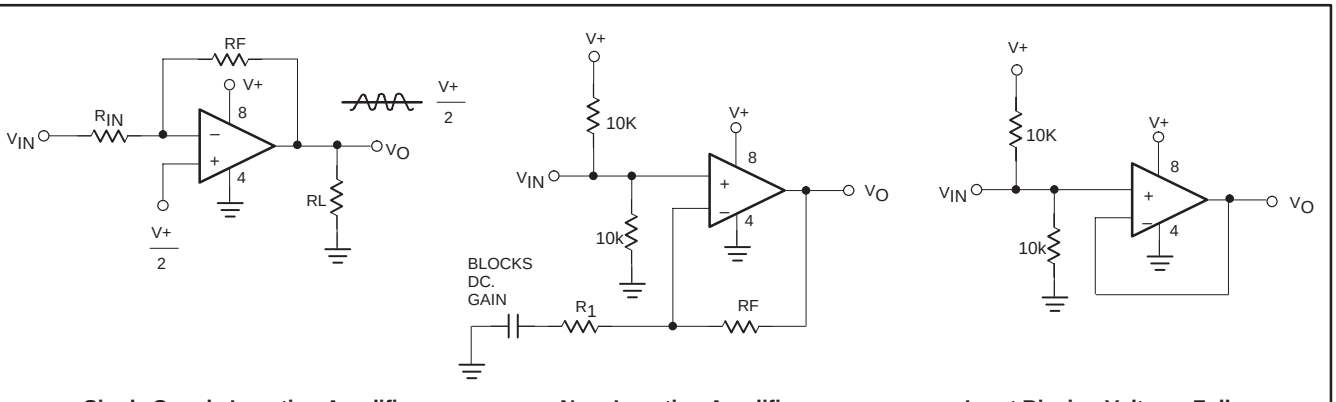
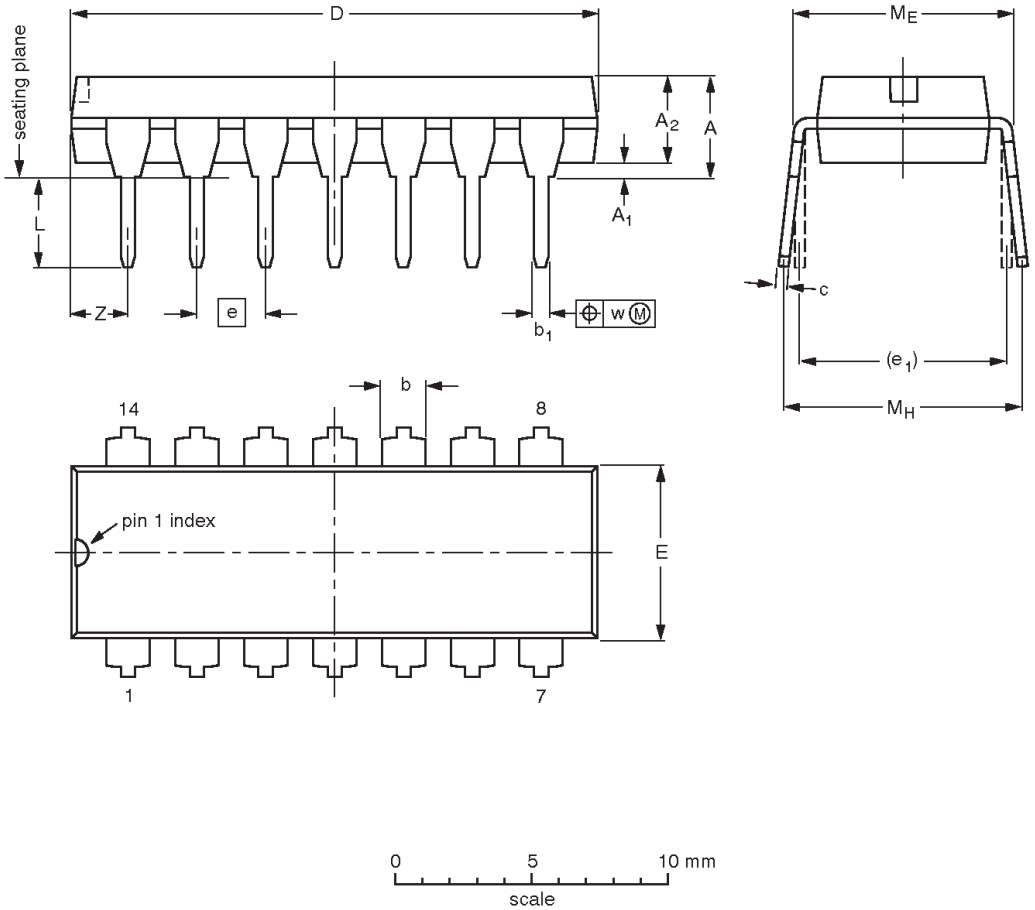


Figure 5. Typical Applications

DIP14: plastic dual in-line package; 14 leads (300 mil) **SOT27-1**



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

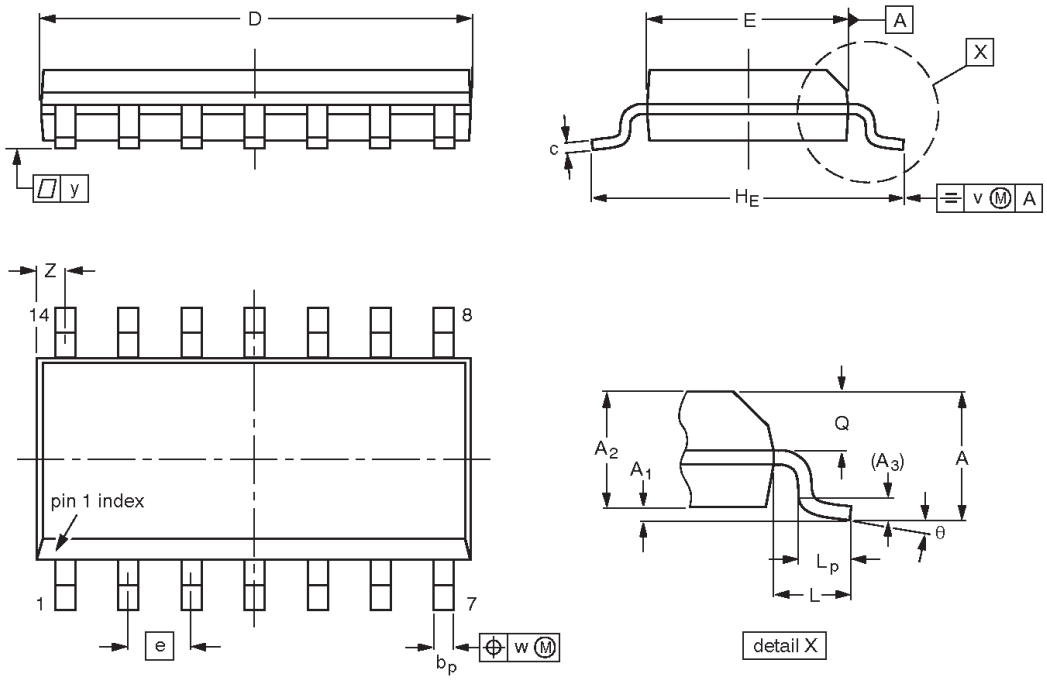
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.02	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.1	0.3	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.087

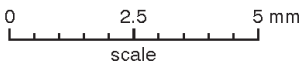
Note

1. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT27-1	050G04	MO-001	SC-501-14			~~99-12-27~~ 03-02-13

SO14: plastic small outline package; 14 leads; body width 3.9 mm **SOT108-1**





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

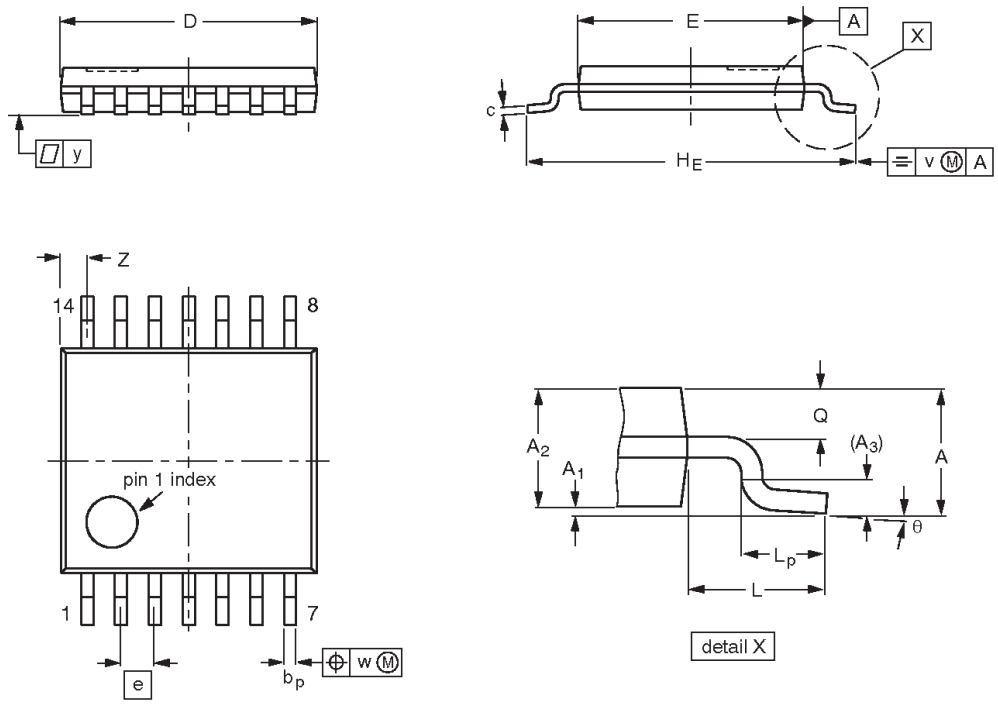
UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.35 0.34	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

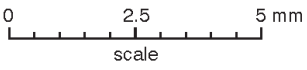
Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT108-1	076E06	MS-012				~~99-12-27~~ 03-02-19

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm **SOT402-1**





DIMENSIONS (mm are the original 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	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.72 0.38	8^o 0^o

Notes

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT402-1		MO-153				~~99-12-27~~ 03-02-18

REVISION HISTORY

Rev	Date	Description
_5	20030919	**Product data (9397 750 12078). ECN 853-0929 30369 of 19 September 2003.** Modifications: ● Modified Figure 2; Q10 and Q13 changed from NPN to PNP.
_4	20020712	**Product data (9397 750 10172). ECN 853-0929 28616 of 12 July 2002.**

Data sheet status

Level	Data sheet status [1]	Product status [2] [3]	Definitions
I	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.
II	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.
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[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.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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 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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