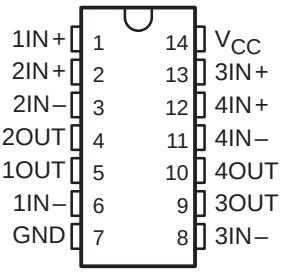
SLOS059 – JULY 1979 – REVISED SEPTEMBER 1990

- **Wide Range of Supply Voltages, Single or Dual Supplies**
- **Wide Bandwidth**
- **Large Output Voltage Swing**
- **Output Short-Circuit Protection**
- **Internal Frequency Compensation**
- **Low Input Bias Current**
- **Designed to Be Interchangeable With National Semiconductor LM2900 and LM3900, Respectively**

N PACKAGE
(TOP VIEW)

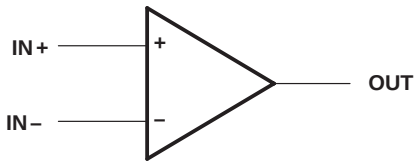


description

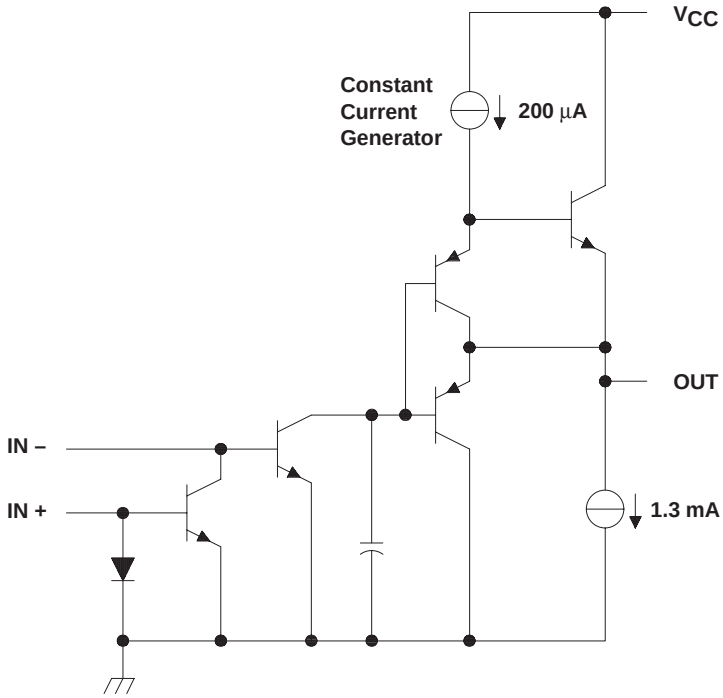
These devices consist of four independent, high-gain frequency-compensated Norton operational amplifiers that were designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies is also possible. The low supply current drain is essentially independent of the magnitude of the supply voltage. These devices provide wide bandwidth and large output voltage swing.

The LM2900 is characterized for operation from –40°C to 85°C, and the LM3900 is characterized for operation from 0°C to 70°C.

symbol (each amplifier)



schematic (each amplifier)



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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

	LM2900	LM3900	UNIT
Supply voltage, V_{CC} (see Note 1)	36	36	V
Input current	20	20	mA
Duration of output short circuit (one amplifier) to ground at (or below) 25°C free-air temperature (see Note 2)	unlimited	unlimited	
Continuous total dissipation	See Dissipation Rating Table		
Operating free-air temperature range	–40 to 85	0 to 70	°C
Storage temperature range	–65 to 150	–65 to 150	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260	260	°C

NOTES: 1. All voltage values, except differential voltages, are with respect to the network ground terminal.
2. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
N	1150 mW	9.2 mW/°C	736 mW	598 mW

recommended operating conditions

	LM2900		LM3900		UNIT
	MIN	MAX	MIN	MAX	
Supply voltage, V_{CC} (single supply)	4.5	32	4.5	32	V
Supply voltage, V_{CC+} (dual supply)	2.2	16	2.2	16	V
Supply voltage, V_{CC-} (dual supply)	–2.2	–16	–2.2	–16	V
Input current (see Note 3)		–1		–1	mA
Operating free-air temperature, T_A	–40	85	0	70	°C

NOTE 3: Clamp transistors are included that prevent the input voltages from swinging below ground more than approximately –0.3 V. The negative input currents that may result from large signal overdrive with capacitive input coupling must be limited externally to values of approximately –1 mA. Negative input currents in excess of –4 mA causes the output voltage to drop to a low voltage. These values apply for any one of the input terminals. If more than one of the input terminals are simultaneously driven negative, maximum currents are reduced. Common-mode current biasing can be used to prevent negative input voltages.

electrical characteristics, V_{CC} = 15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		LM2900			LM3900			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{IB}	Input bias current (inverting input)	I_{I+} = 0	T_A = 25°C		30	200		30	200	nA
			T_A = Full range		300			300		
	Mirror gain	I_{I+} = 20 µA to 200 µA, T_A = Full range, See Note 4		0.9		1.1	0.9		1.1	µA/µA
	Change in mirror gain				2%	5%		2%	5%	
	Mirror current	$V_{I+} = V_{I-}$, See Note 4	T_A = Full range,		10	500		10	500	µA
A_{VD}	Large-signal differential voltage amplification	V_O = 10 V, f = 100 Hz	R_L = 10 kΩ,	1.2	2.8		1.2	2.8		V/mV
r_i	Input resistance (inverting input)				1			1		MΩ
r_o	Output resistance				8			8		kΩ
B_1	Unity-gain bandwidth (inverting input)				2.5			2.5		MHz
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)				70			70		dB
V_{OH}	High-level output voltage	I_{I+} = 0, I_{I-} = 0	R_L = 2 kΩ	13.5			13.5			V
			V_{CC} = 30 V, No load		29.5			29.5		
V_{OL}	Low-level output voltage	I_{I+} = 0, R_L = 2 kΩ	I_{I-} = 10 µA,		0.09	0.2		0.09	0.2	V
I_{OS}	Short-circuit output current (output internally high)	I_{I+} = 0, V_O = 0	I_{I-} = 0,	–6	–18		–6	–10		mA
	Pulldown current			0.5	1.3		0.5	1.3		mA
I_{OL}	Low-level output current‡	I_{I-} = 5 µA	V_{OL} = 1 V		5			5		mA
I_{CC}	Supply current (four amplifiers)	No load			6.2	10		6.2	10	mA

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range for T_A is –40°C to 85°C for LM2900 and 0°C to 70°C for LM3900.

‡ The output current-sink capability can be increased for large-signal conditions by overdriving the inverting input.

NOTE 4: These parameters are measured with the output balanced midway between V_{CC} and GND.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	Low-to-high output	V_O = 10 V, C_L = 100 pF, R_L = 2 kΩ		0.5		V/µs
		High-to-low output			20		

TYPICAL CHARACTERISTICS†

INPUT BIAS CURRENT (INVERTING INPUT) vs FREE-AIR TEMPERATURE

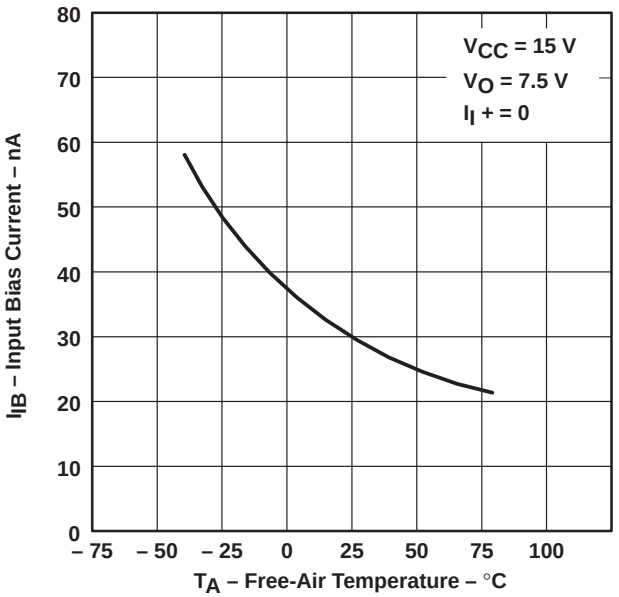


Figure 1

MIRROR GAIN vs FREE-AIR TEMPERATURE

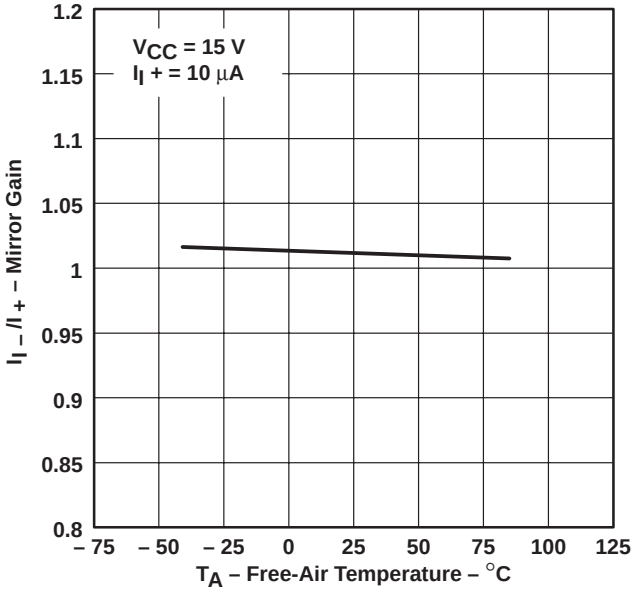


Figure 2

LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREQUENCY

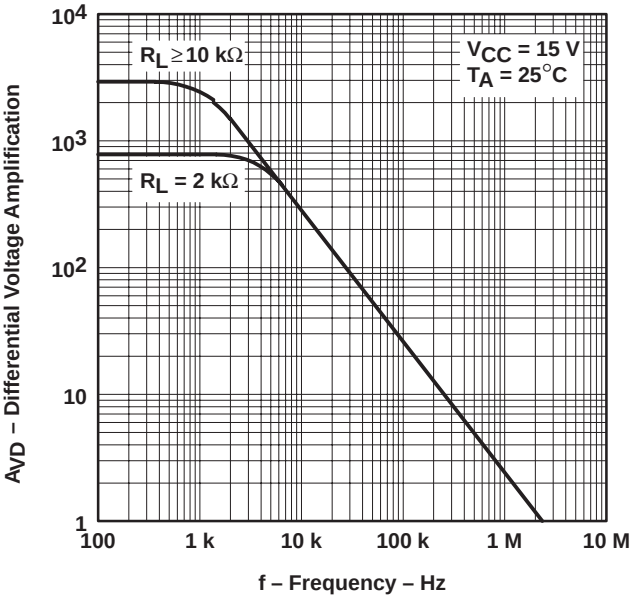


Figure 3

LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs SUPPLY VOLTAGE

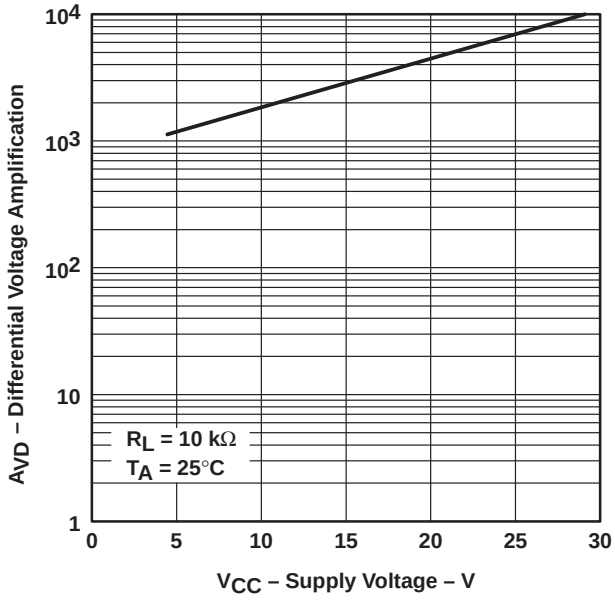


Figure 4

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

LARGE SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

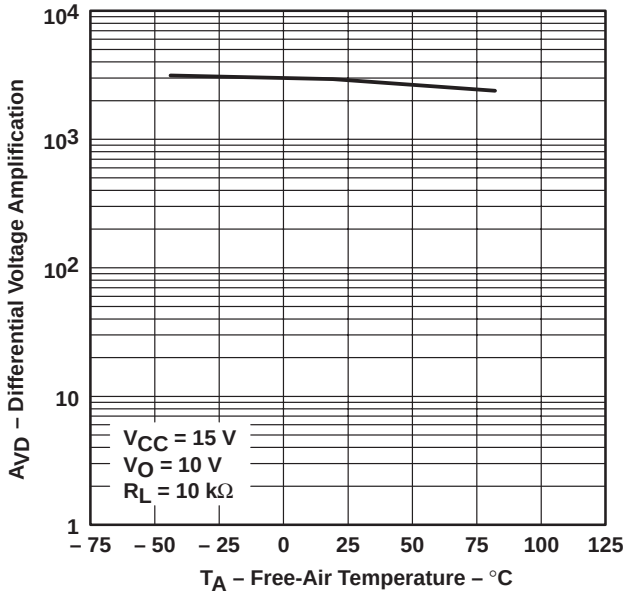


Figure 5

SUPPLY VOLTAGE REJECTION RATIO vs FREQUENCY

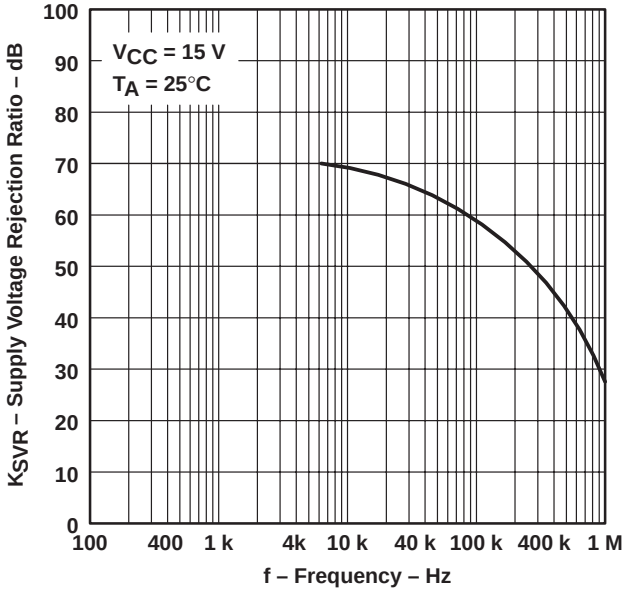


Figure 6

PEAK-TO-PEAK OUTPUT VOLTAGE vs FREQUENCY

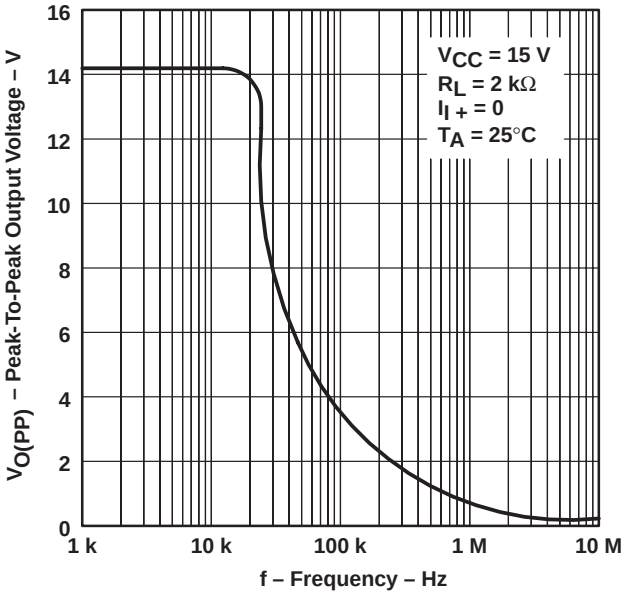


Figure 7

SHORT-CIRCUIT OUTPUT CURRENT (OUTPUT INTERNALLY HIGH) vs SUPPLY VOLTAGE

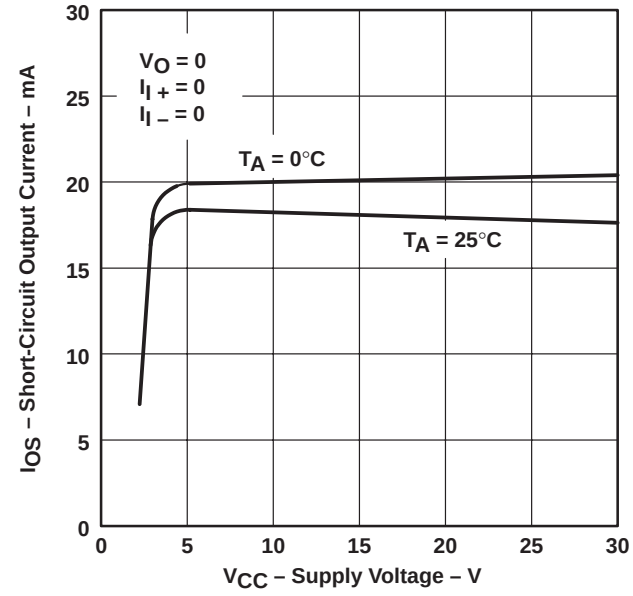


Figure 8

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

LOW-LEVEL OUTPUT CURRENT vs SUPPLY VOLTAGE

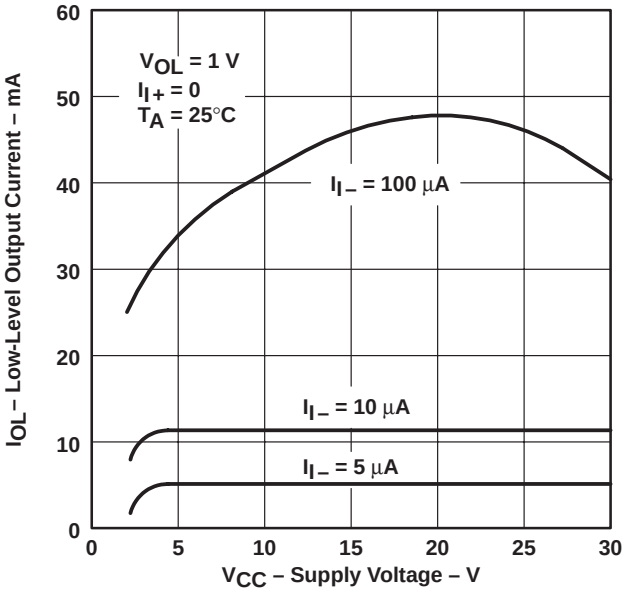


Figure 9

PULLDOWN CURRENT vs SUPPLY VOLTAGE

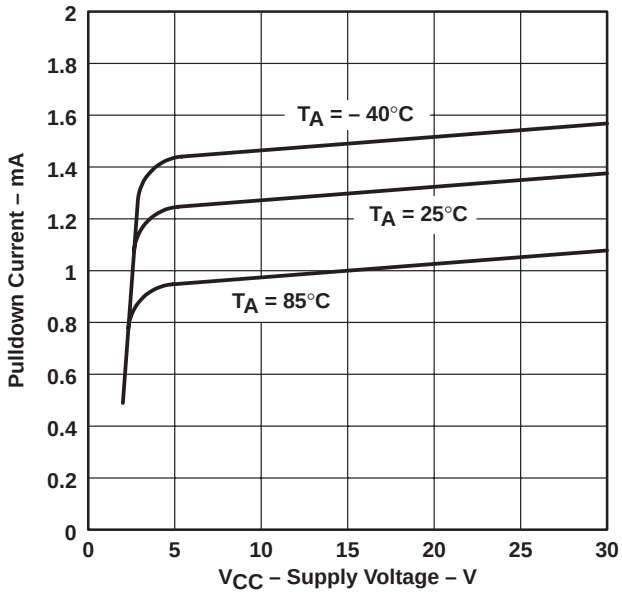


Figure 10

PULLDOWN CURRENT vs FREE-AIR TEMPERATURE

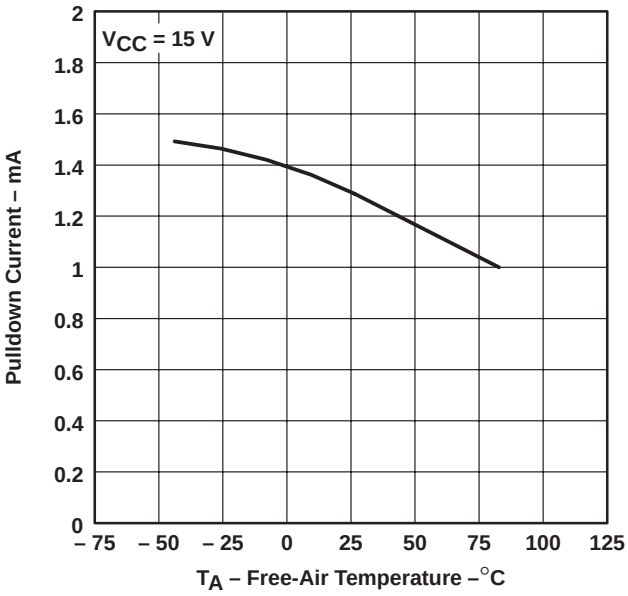


Figure 11

TOTAL SUPPLY CURRENT vs SUPPLY VOLTAGE

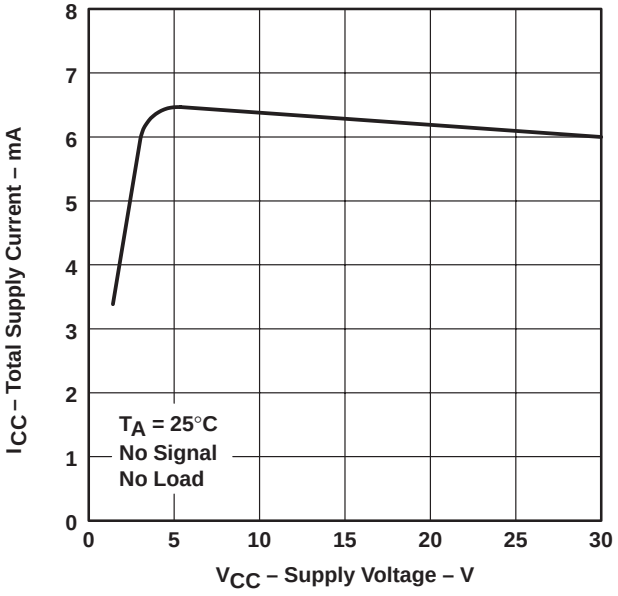


Figure 12

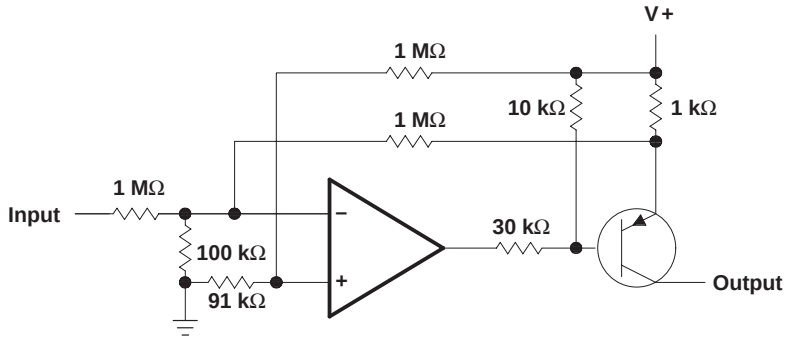
† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

APPLICATION INFORMATION

Norton (or current-differencing) amplifiers can be used in most standard general-purpose operational amplifier applications. Performance as a dc amplifier in a single-power-supply mode is not as precise as a standard integrated-circuit operational amplifier operating from dual supplies. Operation of the amplifier can best be understood by noting that input currents are differenced at the inverting input terminal and this current then flows through the external feedback resistor to produce the output voltage. Common-mode current biasing is generally useful to allow operating with signal levels near (or even below) ground.

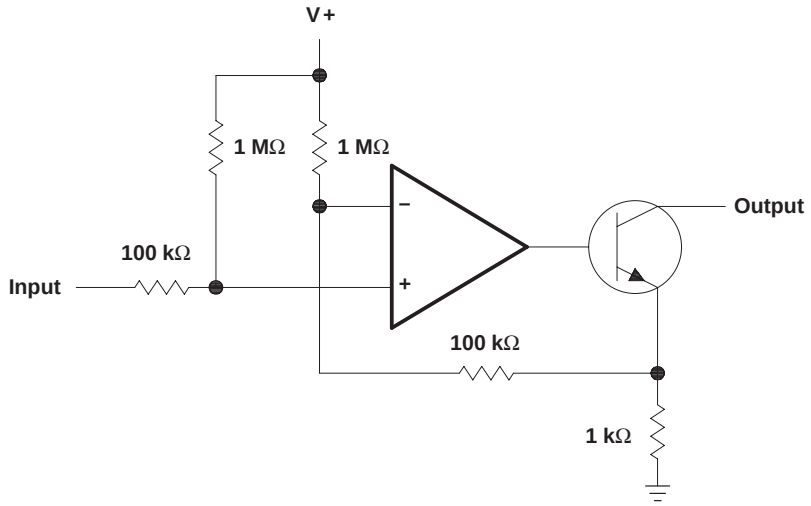
Internal transistors clamp negative input voltages at approximately –0.3 V but the magnitude of current flow has to be limited by the external input network. For operation at high temperature, this limit should be approximately –100 μA.

Noise immunity of a Norton amplifier is less than that of standard bipolar amplifiers. Circuit layout is more critical since coupling from the output to the noninverting input can cause oscillations. Care must also be exercised when driving either input from a low-impedance source. A limiting resistor should be placed in series with the input lead to limit the peak input current. Current up to 20 mA will not damage the device, but the current mirror on the noninverting input will saturate and cause a loss of mirror gain at higher current levels, especially at high operating temperatures.



$I_O \approx 1$ mA per input volt

Figure 13. Voltage-Controlled Current Source



$I_O \approx 1$ mA per input volt

Figure 14. Voltage-Controlled Current Sink

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM2900D	Active	Production	SOIC (D) | 14	50 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM2900
LM2900D.A	Active	Production	SOIC (D) | 14	50 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM2900
LM2900DR	Active	Production	SOIC (D) | 14	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM2900
LM2900DR.A	Active	Production	SOIC (D) | 14	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM2900
LM2900N	Active	Production	PDIP (N) | 14	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 85	LM2900N
LM2900N.A	Active	Production	PDIP (N) | 14	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 85	LM2900N
LM3900D	Active	Production	SOIC (D) | 14	50 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	LM3900
LM3900D.A	Active	Production	SOIC (D) | 14	50 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	LM3900
LM3900DR	Active	Production	SOIC (D) | 14	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	LM3900
LM3900DR.A	Active	Production	SOIC (D) | 14	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	LM3900
LM3900N	Active	Production	PDIP (N) | 14	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	LM3900N
LM3900N.A	Active	Production	PDIP (N) | 14	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	LM3900N

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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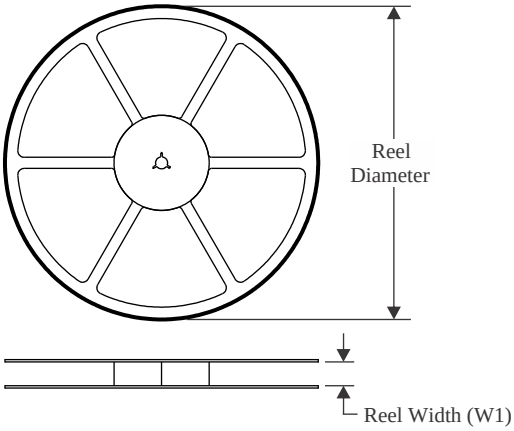
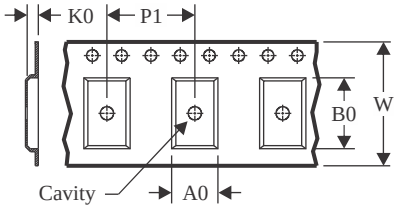
TAPE AND REEL INFORMATION

REEL DIMENSIONS

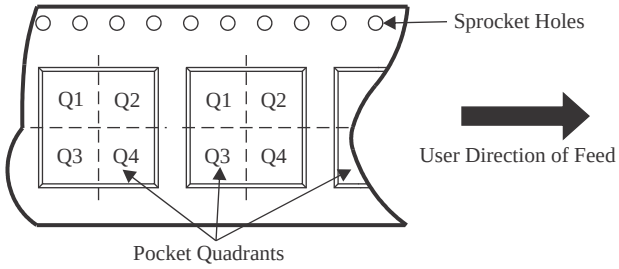


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

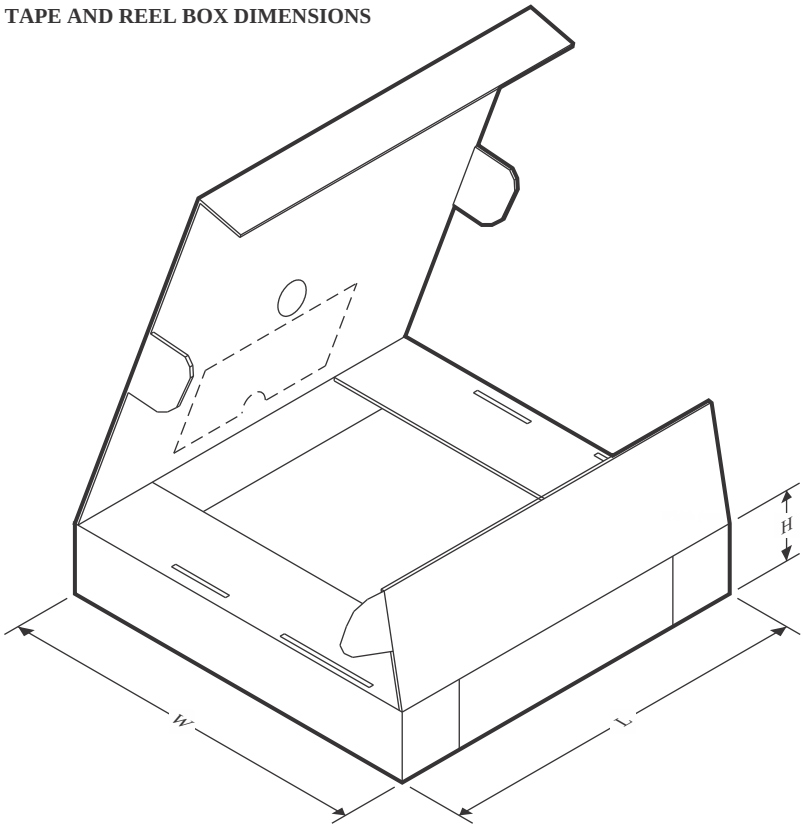
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM2900DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LM3900DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

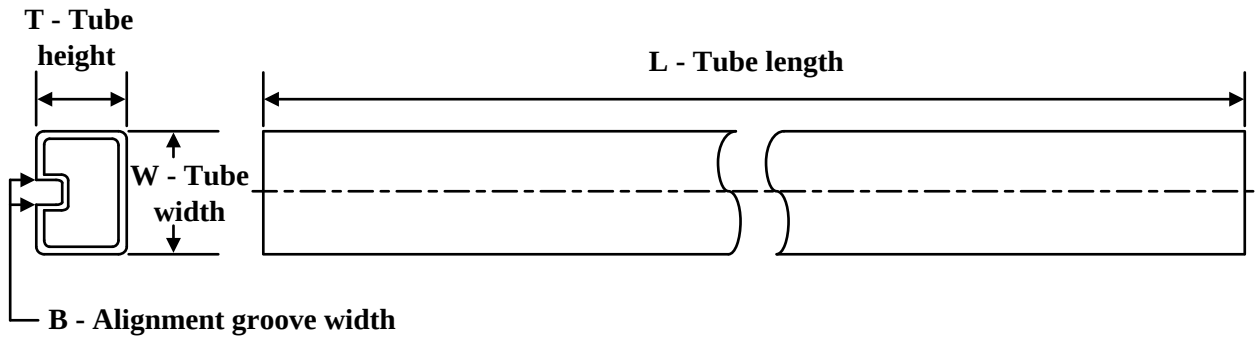
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2900DR	SOIC	D	14	2500	356.0	356.0	35.0
LM3900DR	SOIC	D	14	2500	356.0	356.0	35.0

TUBE



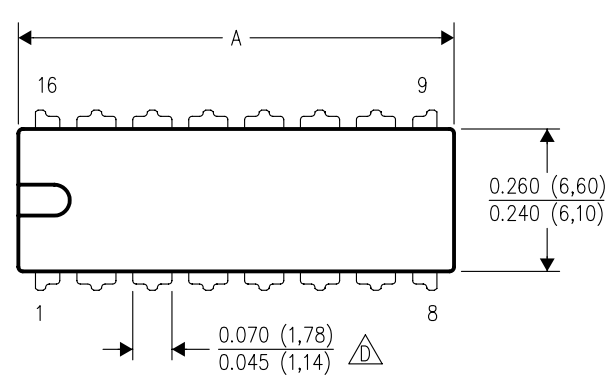
*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM2900D	D	SOIC	14	50	506.6	8	3940	4.32
LM2900D.A	D	SOIC	14	50	506.6	8	3940	4.32
LM2900N	N	PDIP	14	25	506	13.97	11230	4.32
LM2900N.A	N	PDIP	14	25	506	13.97	11230	4.32
LM3900D	D	SOIC	14	50	506.6	8	3940	4.32
LM3900D.A	D	SOIC	14	50	506.6	8	3940	4.32
LM3900N	N	PDIP	14	25	506	13.97	11230	4.32
LM3900N.A	N	PDIP	14	25	506	13.97	11230	4.32

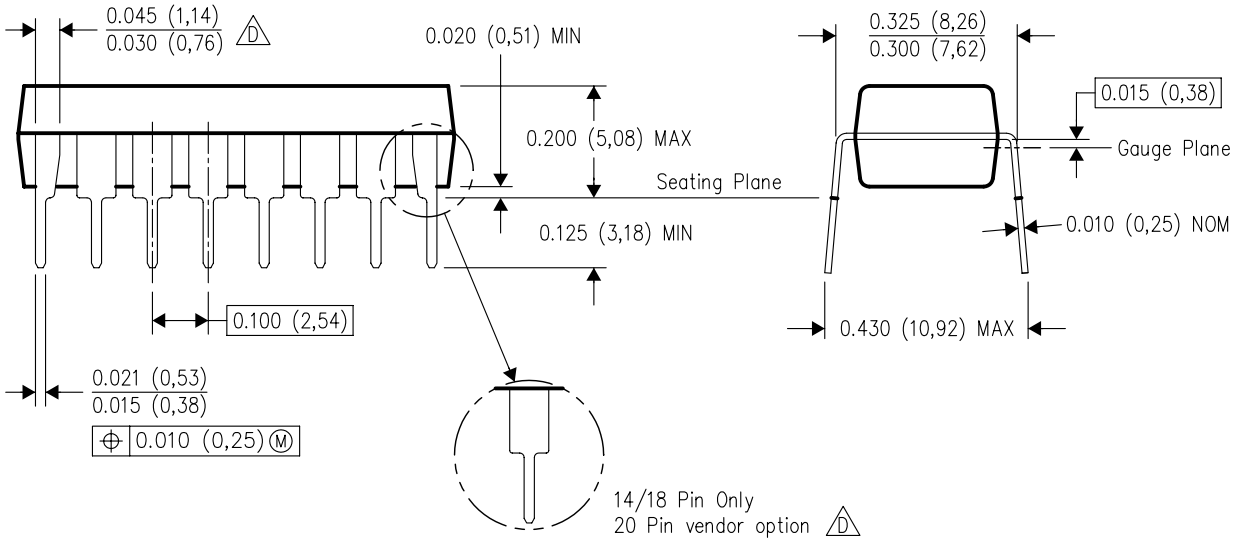
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN

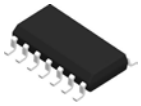


DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

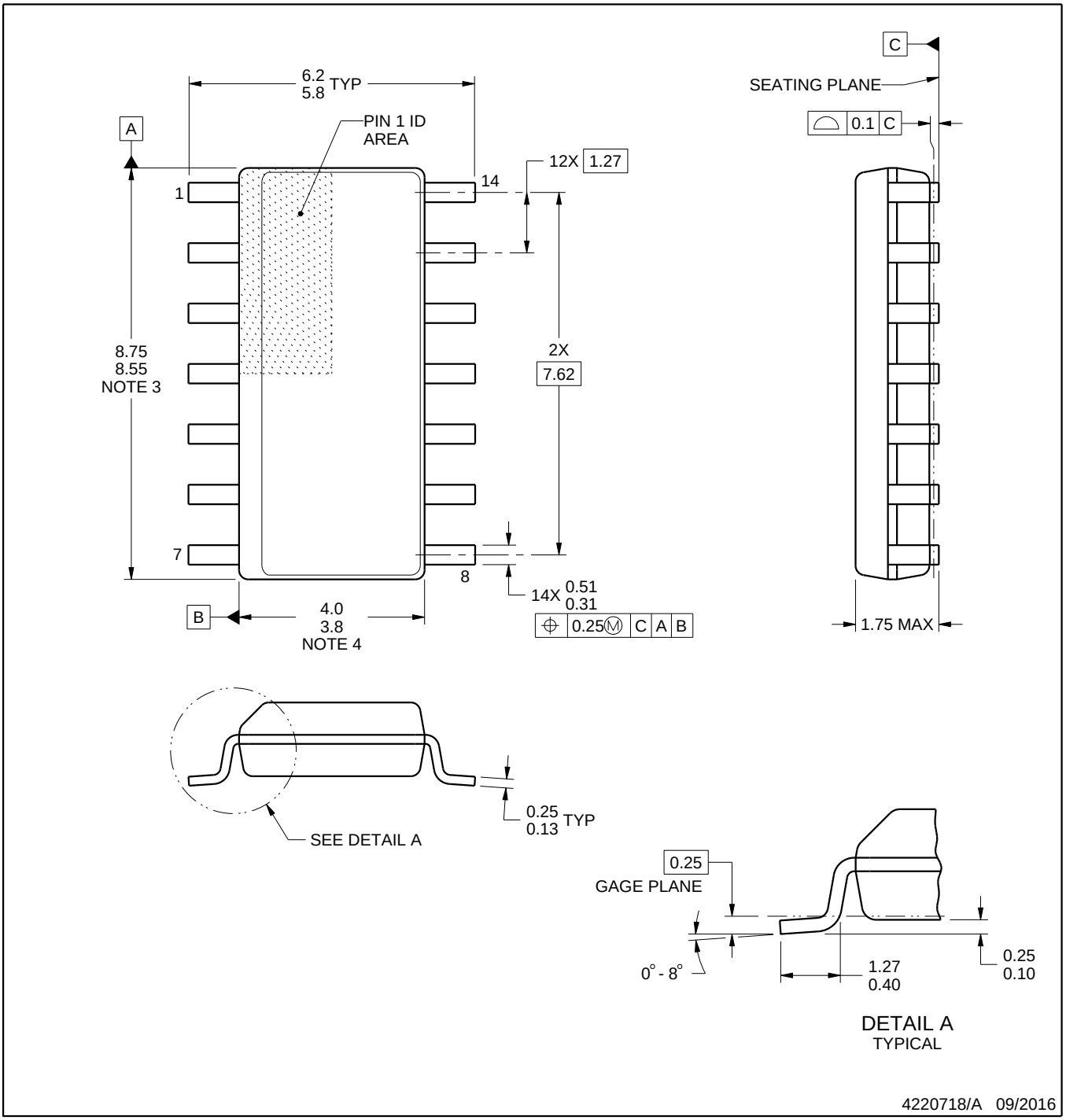


PACKAGE OUTLINE

D0014A

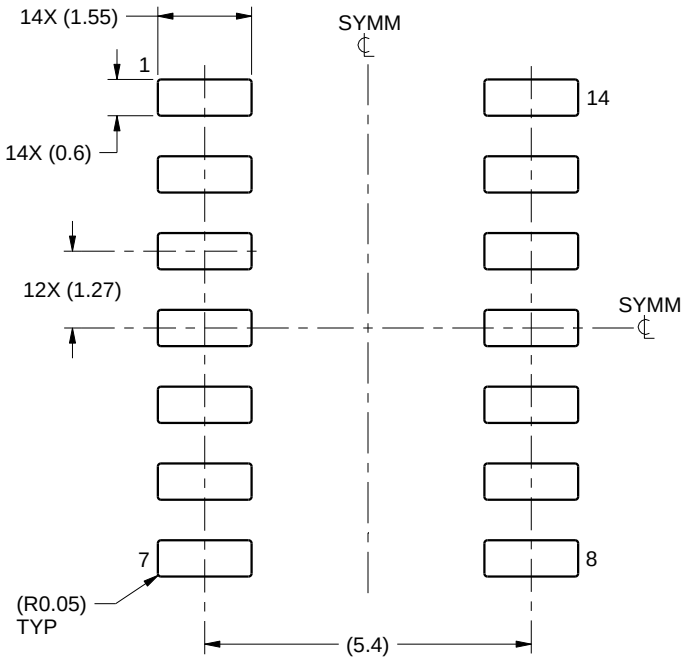
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

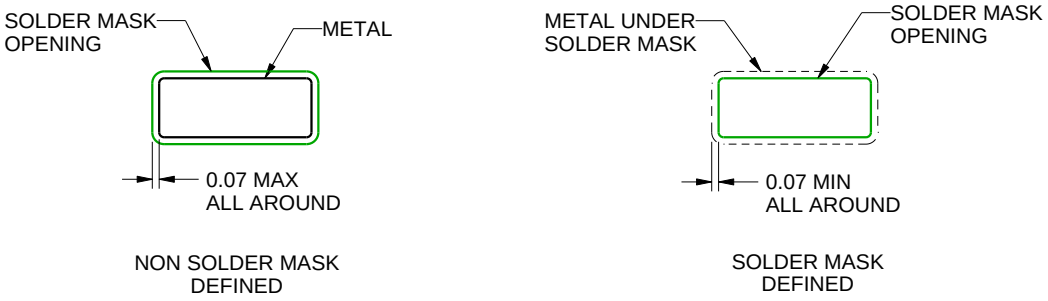


NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm, per side.
5. Reference JEDEC registration MS-012, variation AB.



LAND PATTERN EXAMPLE
SCALE:8X



SOLDER MASK DETAILS

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NOTES: (continued)

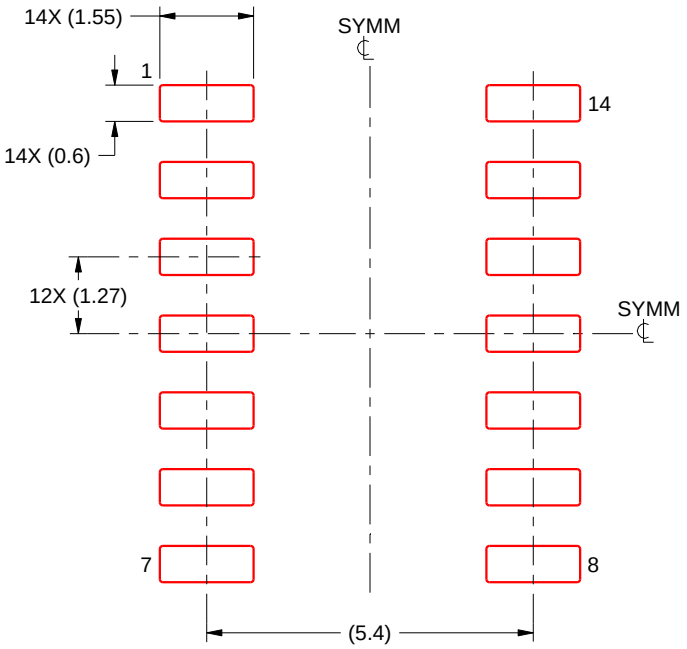
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0014A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:8X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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