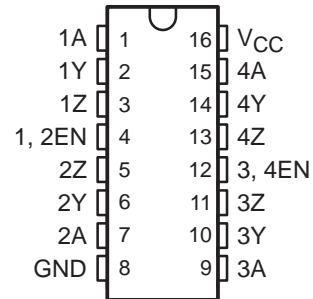


# SN55ALS194, SN75ALS194 QUADRUPLE DIFFERENTIAL LINE DRIVERS

SLLS009D – OCTOBER 1985 – REVISED MAY 1995

- Meet or Exceed the Requirements of ANSI Standard EIA/TIA-422-B and ITU Recommendation V.11
- Designed to Operate Up to 20 Mbaud
- 3-State TTL-Compatible Outputs
- Single 5-V Supply Operation
- High Output Impedance in Power-Off Condition
- Two Pairs of Drivers, Independently Enabled
- Designed as Improved Replacements for the MC3487

SN55ALS194 . . . J OR W PACKAGE  
SN75ALS194 . . . D OR N PACKAGE  
(TOP VIEW)



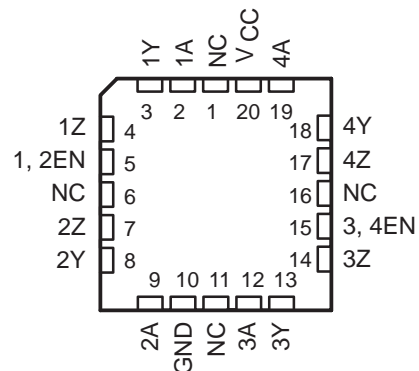
## description

These four differential line drivers are designed for data transmission over twisted-pair or parallel-wire transmission lines. They meet the requirements of ANSI Standard EIA/TIA-422-B and ITU Recommendation V.11 and are compatible with 3-state TTL circuits. Advanced low-power Schottky technology provides high speed without the usual power penalty. Standby supply current is typically only 26 mA. Typical propagation delay time is less than 10 ns, and enable/disable times are typically less than 16 ns.

High-impedance inputs keep input currents low: less than 1  $\mu$ A for a high level and less than 100  $\mu$ A for a low level. The driver circuits can be enabled in pairs by separate active-high enable inputs. The SN55ALS194 and SN75ALS194 are capable of data rates in excess of 20 megabits per second and are designed to operate with the SN55ALS195 and SN75ALS195 quadruple line receivers.

The SN55ALS194 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN75ALS194 is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

SN55ALS194 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection

FUNCTION TABLE  
(each driver)

INPUTS A	OUTPUT EN	OUTPUTS	
		Y	Z
H	H	H	L
L	H	L	H
X	L	Z	Z

H = high level, L = low level, X = irrelevant,  
Z = high impedance



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

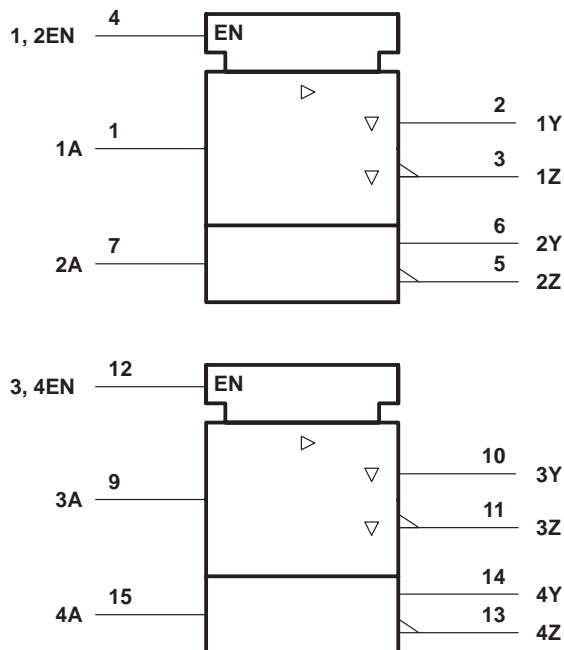
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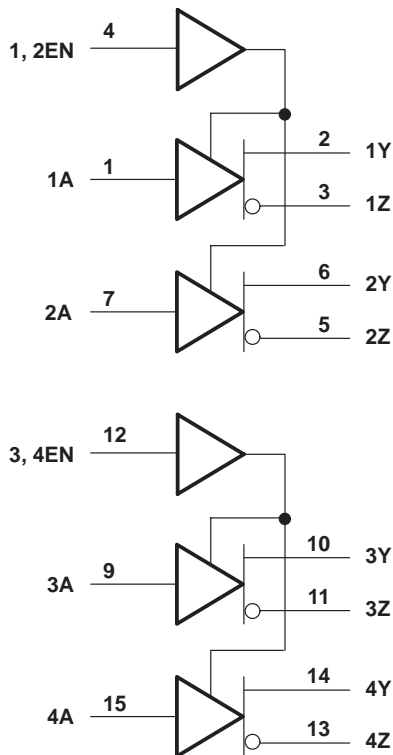
# SN55ALS194, SN75ALS194 QUADRUPLE DIFFERENTIAL LINE DRIVERS

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## logic symbol†



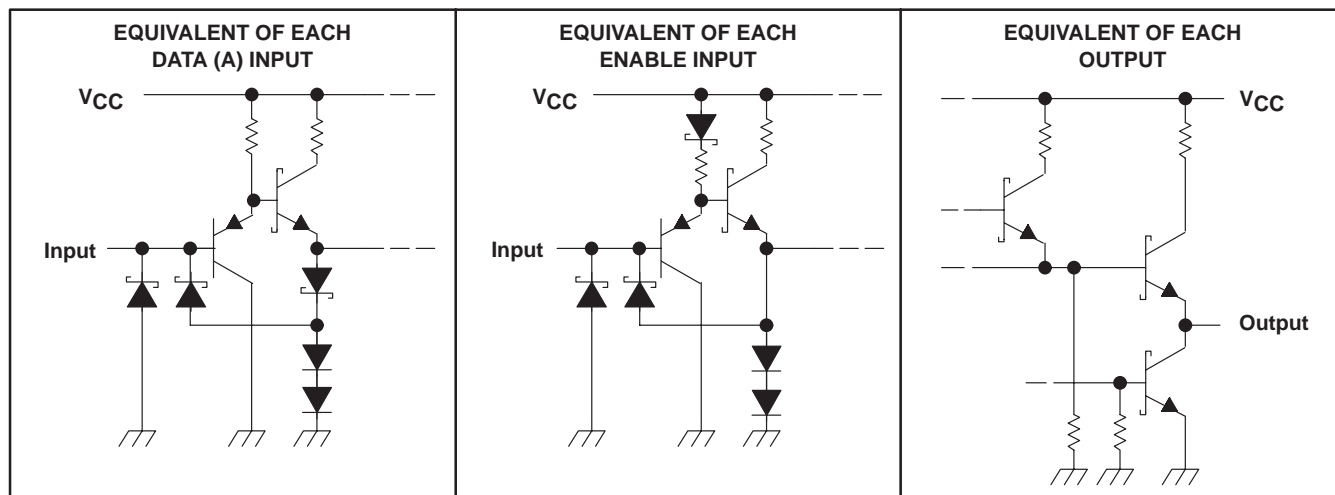
## logic diagram (positive logic)



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

Pin numbers shown are for the D, J, N, and W packages.

## schematics of inputs and outputs



# SN55ALS194, SN75ALS194 QUADRUPLE DIFFERENTIAL LINE DRIVERS

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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage, $V_I$	5.5 V
Output voltage, $V_O$	7 V
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : SN55ALS194	– 55°C to 125°C
SN75ALS194	0°C to 70°C
Storage temperature range, $T_{stg}$	– 65°C to 150°C
Case temperature for 60 seconds, $T_C$ : FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, or W package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J package	300°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to network ground terminal

**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$	$T_A = 125^\circ\text{C}$
	POWER RATING		POWER RATING	POWER RATING
D	950 mW	7.6 mW/°C	608 mW	N/A
FK	1375 mW	11.0 mW/°C	880 mW	275 mW
J	1375 mW	11.0 mW/°C	880 mW	275 mW
N	1150 mW	9.2 mW/°C	736 mW	N/A
W	1000 mW	8.0 mW/°C	640 mW	200 mW

## recommended operating conditions‡

	SN55ALS194			SN75ALS194			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, $V_{CC}$	4.5	5	5.5	4.75	5	5.25	V
High-level input voltage, $V_{IH}$	All inputs, $T_A = 25^\circ\text{C}$		2	2		V	
	A inputs, $T_A = \text{Full range}$		2	2			
	EN inputs, $T_A = \text{Full range}$		2.1	2			
Low-level input voltage, $V_{IL}$	0.8			0.8			V
High-level output current, $I_{OH}$	– 20			– 20			mA
Low-level output current, $I_{OL}$	$T_A = 25^\circ\text{C}$		48	48		mA	
	$T_A = \text{Full range}$		20	48			
Operating free-air temperature, $T_A$	– 55	125		0	70		°C

‡ Full range is  $T_A = -55^\circ\text{C}$  to  $125^\circ\text{C}$  for SN55ALS194 and  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$  for SN75ALS194.



# SN55ALS194, SN75ALS194 QUADRUPLE DIFFERENTIAL LINE DRIVERS

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**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (unless otherwise noted)**

PARAMETER		TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
V <sub>IK</sub>	Input clamp voltage	V <sub>CC</sub> = MIN,	I <sub>I</sub> = -18 mA			-1.5	V
V <sub>OH</sub>	High-level output voltage	V <sub>CC</sub> = MIN, I <sub>OH</sub> = -20 mA	SN55ALS194	2.4			V
			SN75ALS194	2.5			
V <sub>OL</sub>	Low-level output voltage	V <sub>CC</sub> = MIN,	I <sub>OL</sub> = MAX			0.5	V
V <sub>O</sub>	Output voltage	I <sub>O</sub> = 0		0		6	V
V <sub>OD1</sub>	Differential output voltage	I <sub>O</sub> = 0		1.5		6	V
V <sub>OD2</sub>	Differential output voltage	R <sub>L</sub> = 100 Ω, See Figure 1		1/2 V <sub>OD1</sub> or 2§			V
Δ V <sub>OD</sub>	Change in magnitude of differential output voltage¶					±0.4	V
V <sub>OC</sub>	Common-mode output voltage					±3	V
Δ V <sub>OC</sub>	Change in magnitude of common-mode output voltage¶					±0.4	V
I <sub>O</sub>	Output current with power off	V <sub>CC</sub> = 0	V <sub>O</sub> = 6 V			100	μA
			V <sub>O</sub> = -0.25 V			-100	
I <sub>OZ</sub>	High-impedance-state output current	V <sub>CC</sub> = MAX, Output enables at 0.8 V	V <sub>O</sub> = 2.7 V			100	μA
			V <sub>O</sub> = 0.5 V			-100	
I <sub>I</sub>	Input current at maximum input voltage	V <sub>CC</sub> = MAX,	V <sub>I</sub> = 5.5 V			100	μA
I <sub>IH</sub>	High-level input current	V <sub>CC</sub> = MAX,	V <sub>I</sub> = 2.7 V			50	μA
I <sub>IL</sub>	Low-level input current	V <sub>CC</sub> = MAX,	V <sub>I</sub> = 0.5 V			-200	μA
I <sub>OS</sub>	Short-circuit output current#	V <sub>CC</sub> = MAX,	V <sub>I</sub> = 2 V	-40		-140	mA
I <sub>CC</sub>	Supply current (all drivers)	V <sub>CC</sub> = MAX,	All outputs disabled		26	45	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

§ The minimum V<sub>OD2</sub> with a 100-Ω load is either 1/2 V<sub>OD1</sub> or 2 V, whichever is greater.

¶ Δ|V<sub>OD</sub>| and Δ|V<sub>OC</sub>| are the changes in magnitude of V<sub>OD</sub> and V<sub>OC</sub>, respectively, that occur when the input is changed from a high level to a low level.

# Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.

## switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C

PARAMETER	TEST CONDITIONS	SN55ALS194			SN75ALS194			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
t <sub>PLH</sub>	Propagation delay time, low- to high-level output		6	13		6	13	ns
t <sub>PHL</sub>	Propagation delay time, high- to low-level output		9	14		9	14	ns
	Output-to-output skew		3.5	6		3.5	6	ns
t <sub>t(OD)</sub>	Differential output transition time		8	14		8	14	ns
t <sub>PZH</sub>	Output enable time to high level		9	12		9	12	ns
t <sub>PZL</sub>	Output enable time to low level		12	20		12	20	ns
t <sub>PHZ</sub>	Output disable time from high level		9	15		9	14	ns
t <sub>PLZ</sub>	Output disable time from low level		12	15		12	15	ns



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# SN55ALS194, SN75ALS194 QUADRUPLE DIFFERENTIAL LINE DRIVERS

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## SYMBOL EQUIVALENTS

DATA SHEET PARAMETER	EIA/TIA-422-B
$V_O$	$V_{oa}, V_{ob}$
$ V_{OD1} $	$V_o$
$ V_{OD2} $	$V_t (R_L = 100 \Omega)$
$\Delta  V_{OD} $	$  V_t  -  \bar{V}_t  $
$V_{OC}$	$ V_{os} $
$\Delta  V_{OC} $	$ V_{os} - \bar{V}_{os} $
$I_{OS}$	$ I_{sa} ,  I_{sb} $
$I_O$	$ I_{xa} ,  I_{xb} $

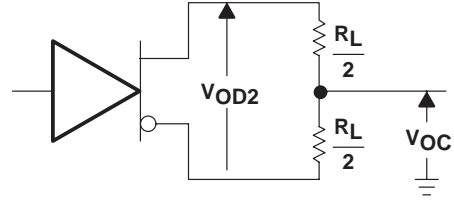
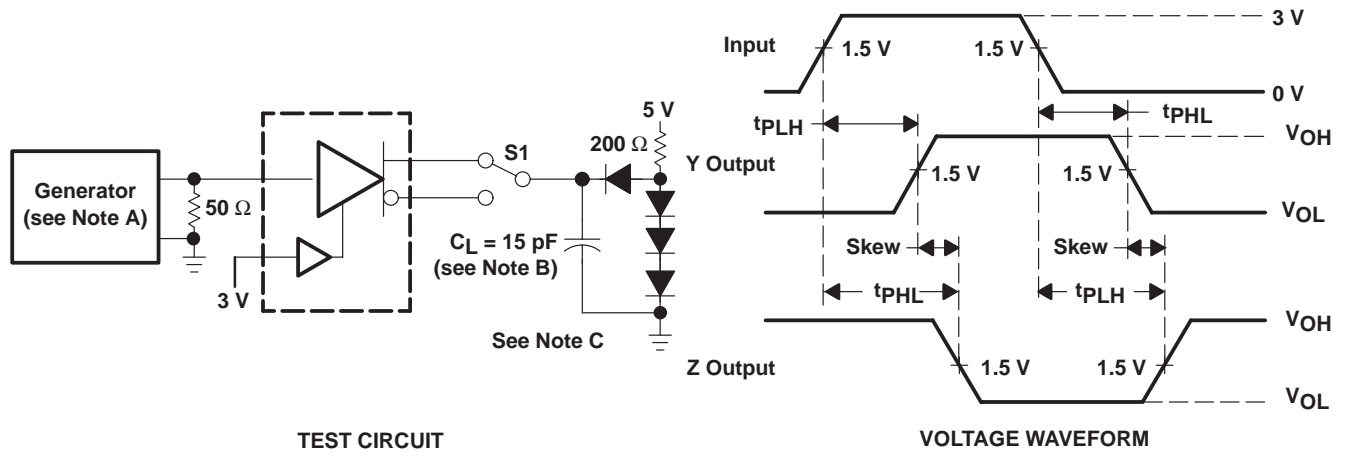


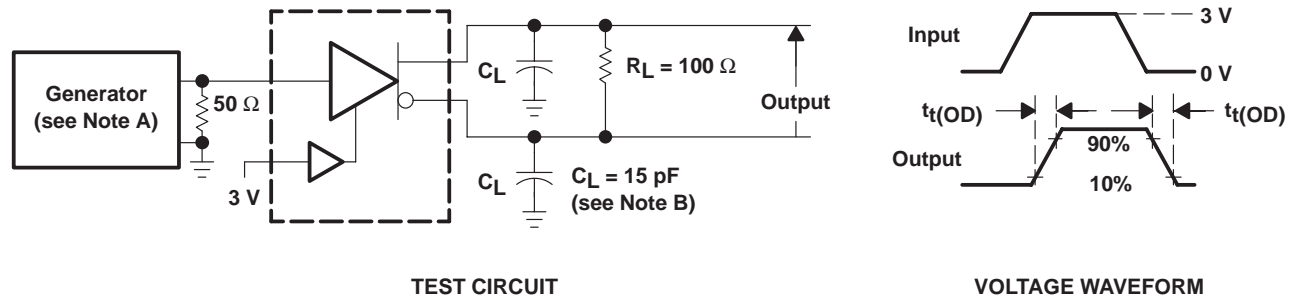
Figure 1. Driver  $V_{OD}$  and  $V_{OC}$

## PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $t_r \leq 5$  ns,  $t_f \leq 5$  ns,  $PRR \leq 1$  MHz, duty cycle  $\leq 50\%$ ,  $Z_O \approx 50 \Omega$ .  
 B.  $C_L$  includes probe and stray capacitance.  
 C. All diodes are 1N916 or 1N3064.

Figure 2. Test Circuit and Voltage Waveform



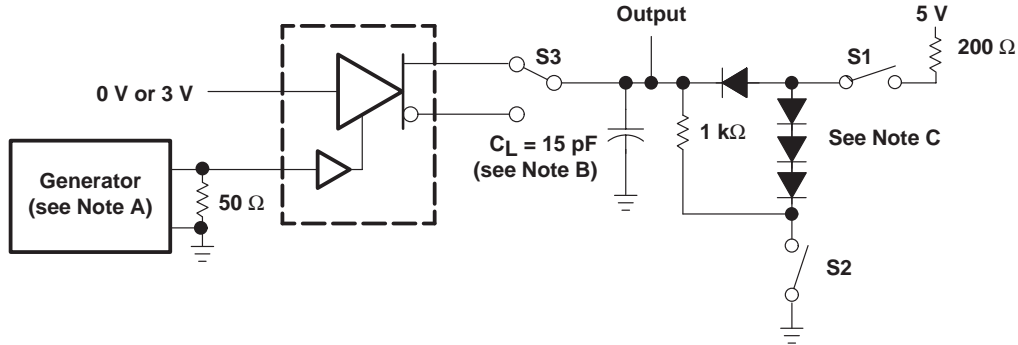
- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $t_r \leq 5$  ns,  $t_f \leq 5$  ns,  $PRR \leq 1$  MHz, duty cycle  $\leq 50\%$ ,  $Z_O \approx 50 \Omega$ .  
 B.  $C_L$  includes probe and stray capacitance.

Figure 3. Differential-Output Test Circuit and Voltage Waveform

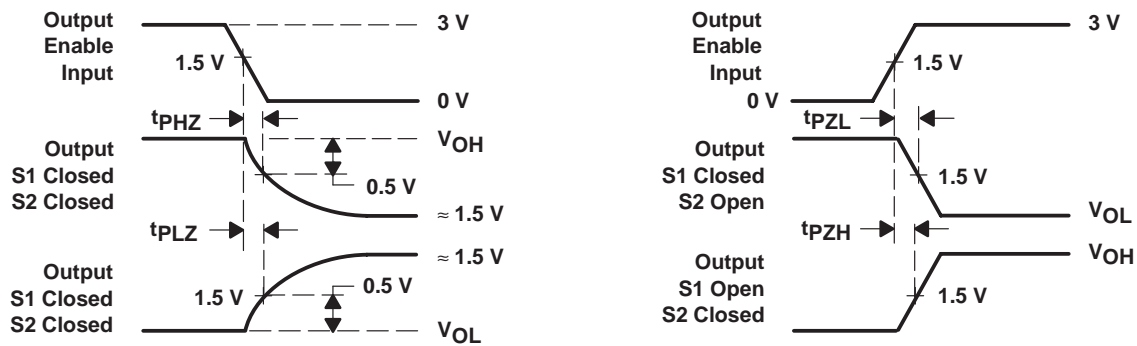
# SN55ALS194, SN75ALS194 QUADRUPLE DIFFERENTIAL LINE DRIVERS

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## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $t_r \leq 5 \text{ ns}$ ,  $t_f \leq 5 \text{ ns}$ ,  $\text{PRR} \leq 1 \text{ MHz}$ , duty cycle  $\leq 50\%$ ,  $Z_0 \approx 50 \Omega$ .  
 B.  $C_L$  includes probe and stray capacitance.  
 C. All diodes are 1N916 or 1N3064.

Figure 4. Driver Test Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS†

Y OUTPUT VOLTAGE  
 vs  
 DATA INPUT VOLTAGE

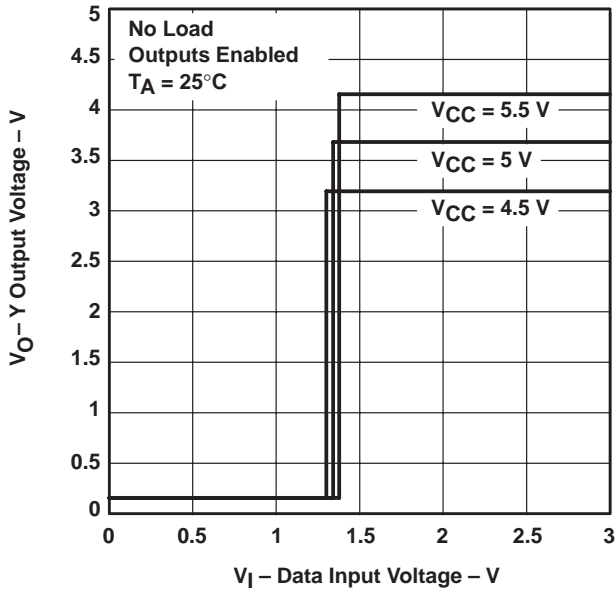


Figure 5

Y OUTPUT VOLTAGE  
 vs  
 DATA INPUT VOLTAGE

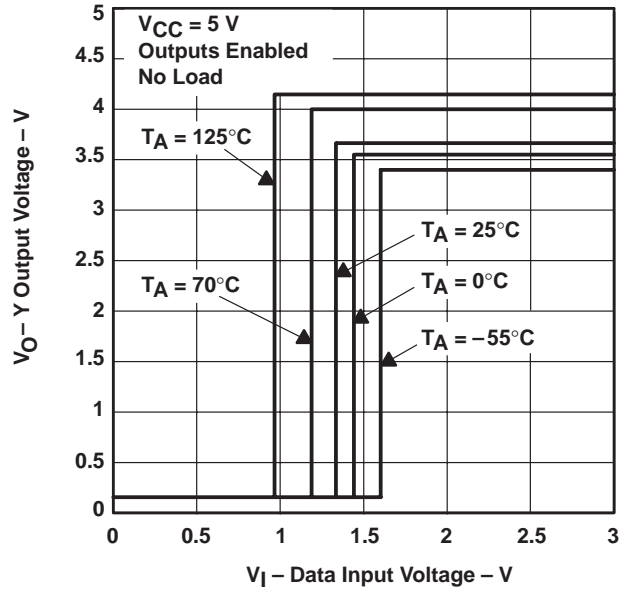


Figure 6

Y OUTPUT VOLTAGE  
 vs  
 ENABLE G INPUT VOLTAGE

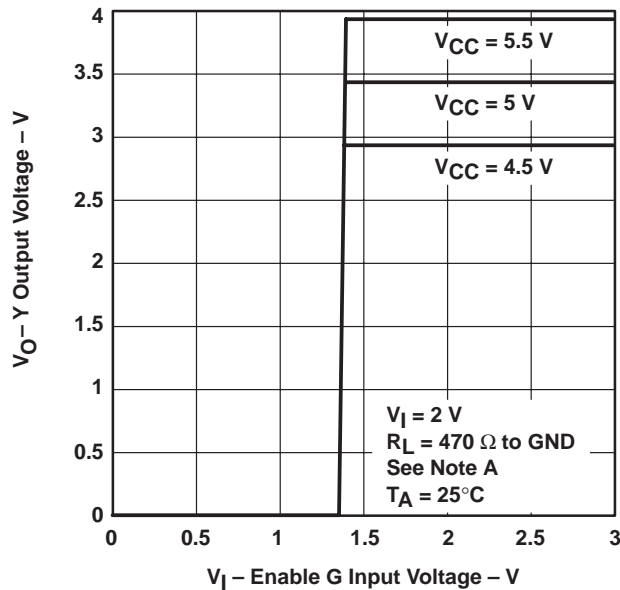


Figure 7

Y OUTPUT VOLTAGE  
 vs  
 ENABLE G INPUT VOLTAGE

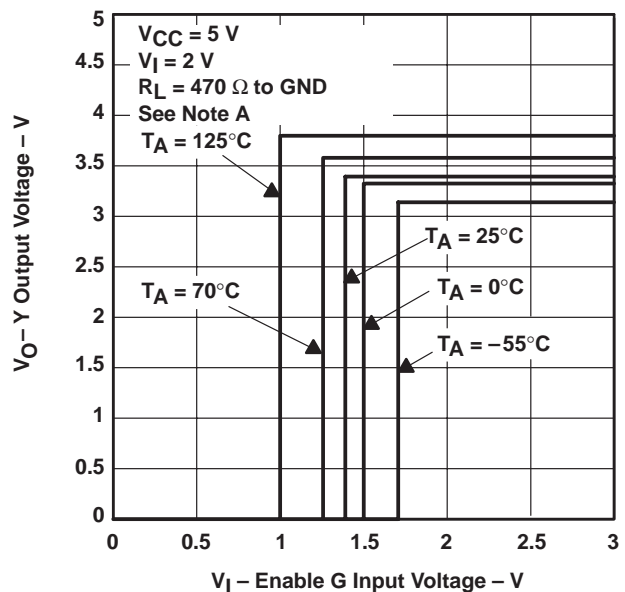


Figure 8

† Data for temperatures below 0°C and above 70°C are applicable to the SN55ALS194 circuits only.

NOTE A: The A input is connected to V<sub>CC</sub> during the testing of the Y outputs and to GND during the testing of the Z outputs.

# SN55ALS194, SN75ALS194 QUADRUPLE DIFFERENTIAL LINE DRIVERS

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## TYPICAL CHARACTERISTICS†

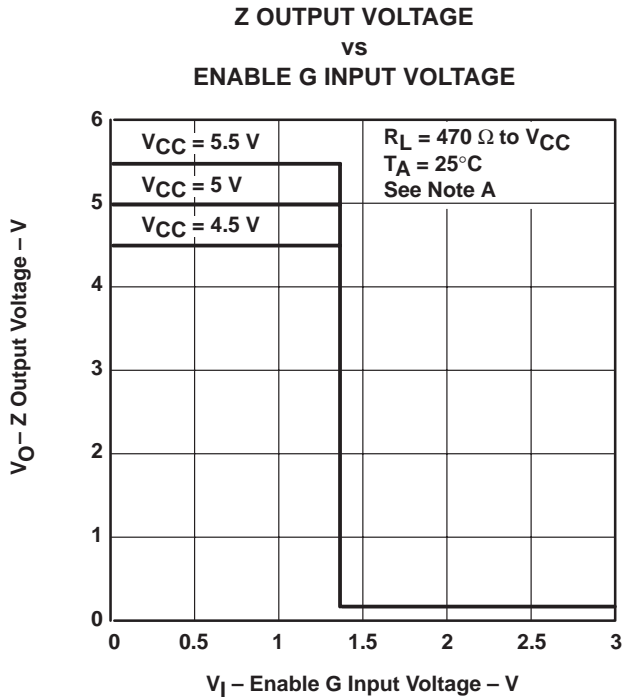


Figure 9

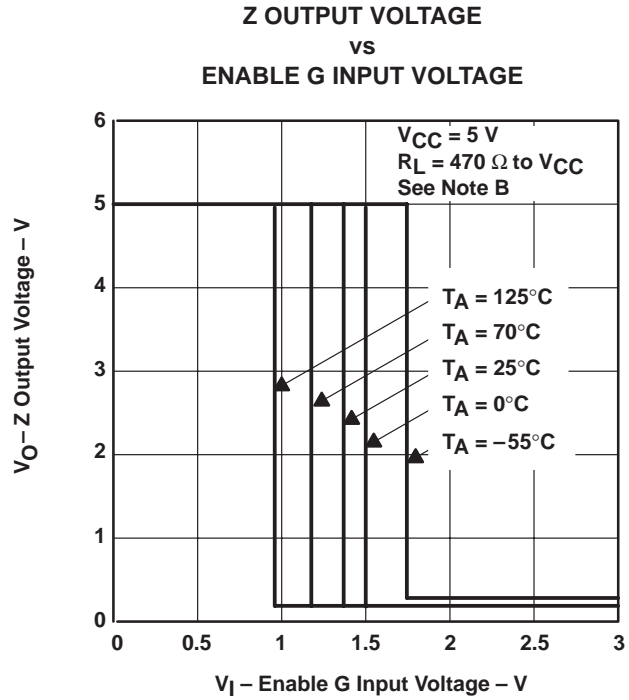


Figure 10

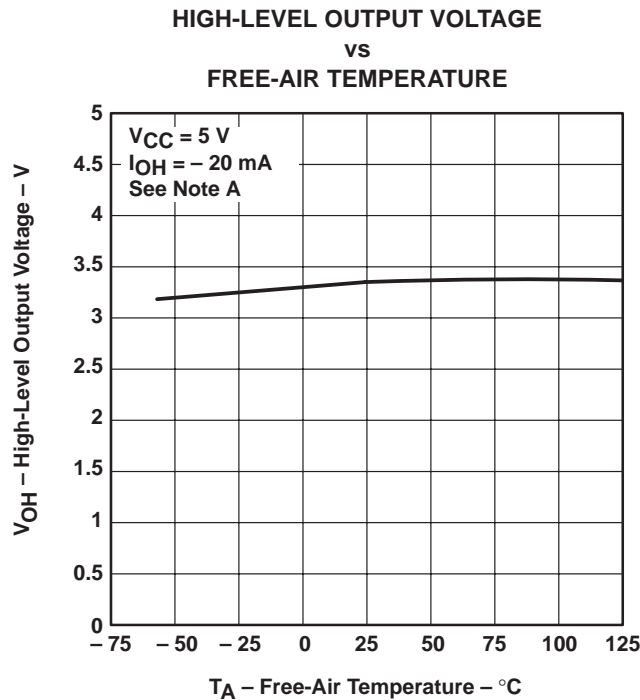


Figure 11

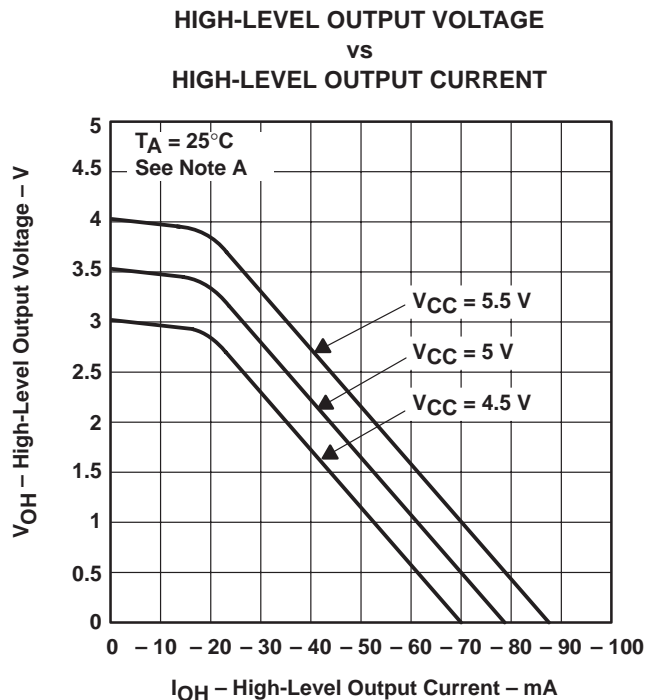


Figure 12

† Data for temperatures below  $0^\circ\text{C}$  and above  $70^\circ\text{C}$  are applicable to the SN55ALS194 circuits only.

NOTES: A. The A input is connected to  $V_{CC}$  during the testing of the Y outputs and to GND during the testing of the Z outputs.

B. The A input is connected to ground during the testing of the Y outputs and to  $V_{CC}$  during the testing of the Z outputs.



TYPICAL CHARACTERISTICS†

LOW-LEVEL OUTPUT VOLTAGE  
 vs  
 FREE-AIR TEMPERATURE

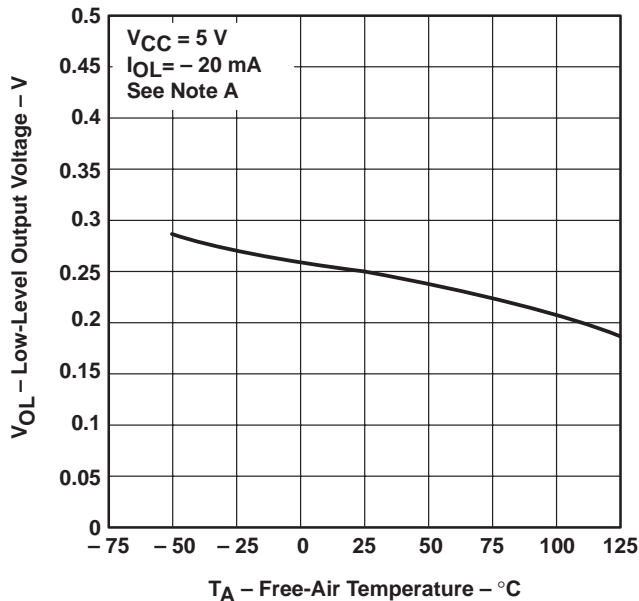


Figure 13

LOW-LEVEL OUTPUT VOLTAGE  
 vs  
 LOW-LEVEL OUTPUT CURRENT

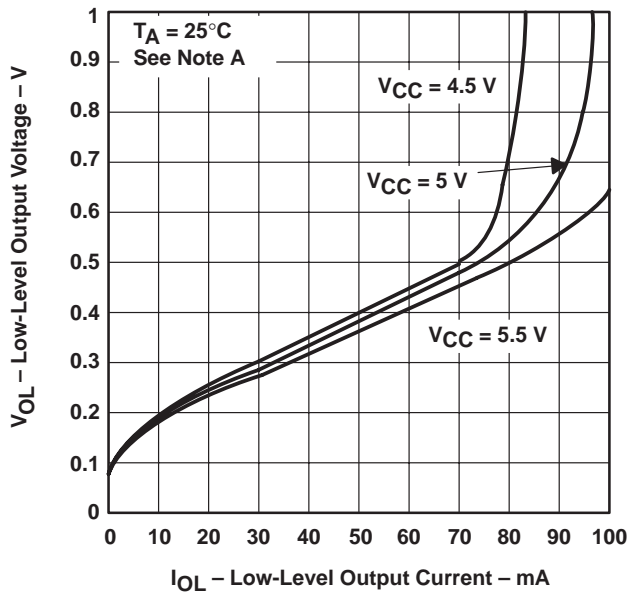


Figure 14

NOTE A: The A input is connected to GND during the testing of the Y outputs and to V<sub>CC</sub> during the testing of the Z outputs.

SUPPLY CURRENT  
 vs  
 SUPPLY VOLTAGE

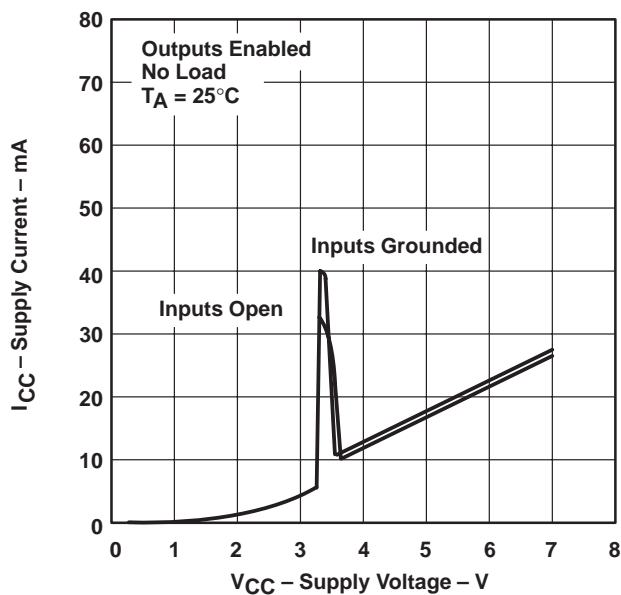


Figure 15

SUPPLY CURRENT  
 vs  
 SUPPLY VOLTAGE

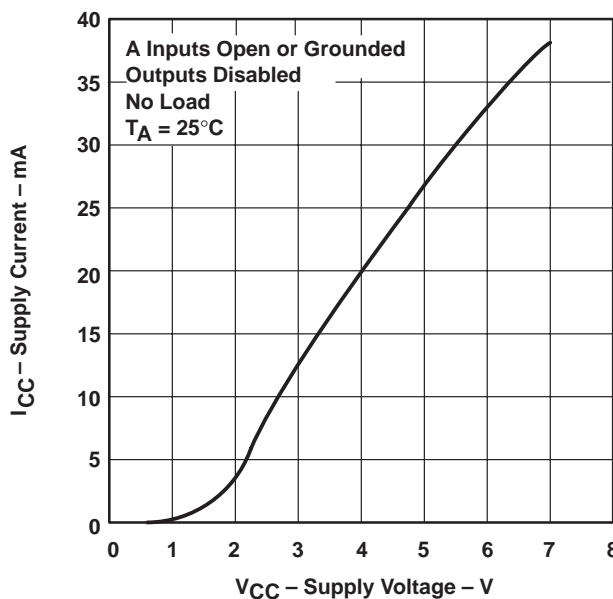


Figure 16

† Data for temperatures below 0°C and above 70°C are applicable to the SN55ALS194 circuits only.

# SN55ALS194, SN75ALS194 QUADRUPLE DIFFERENTIAL LINE DRIVERS

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## TYPICAL CHARACTERISTICS

### SUPPLY CURRENT vs FREQUENCY

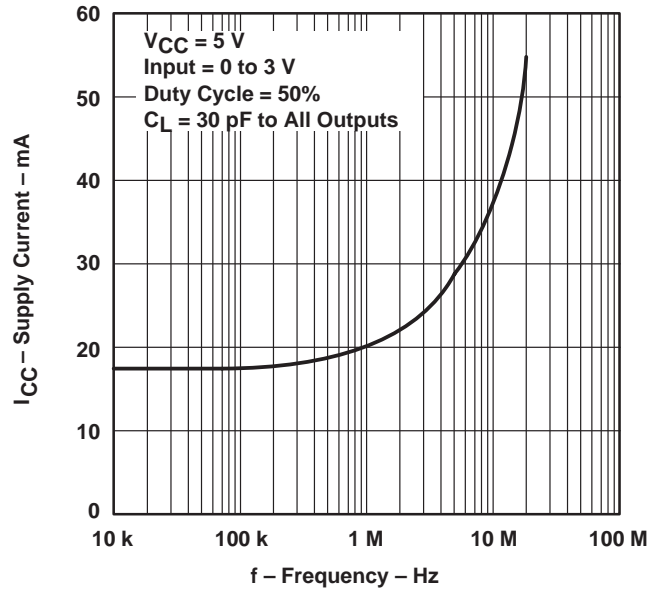


Figure 17

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Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>	Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
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**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
SN55ALS194J	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
SN75ALS194D	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN75ALS194DE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN75ALS194DG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN75ALS194DR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN75ALS194DRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN75ALS194DRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN75ALS194N	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN75ALS194NE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN75ALS194NSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN75ALS194NSRE4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN75ALS194NSRG4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SNJ55ALS194FK	OBSOLETE	LCCC	FK	20		TBD	Call TI	Call TI
SNJ55ALS194J	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
SNJ55ALS194W	OBSOLETE	CFP	W	16		TBD	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**TAPE AND REEL INFORMATION**



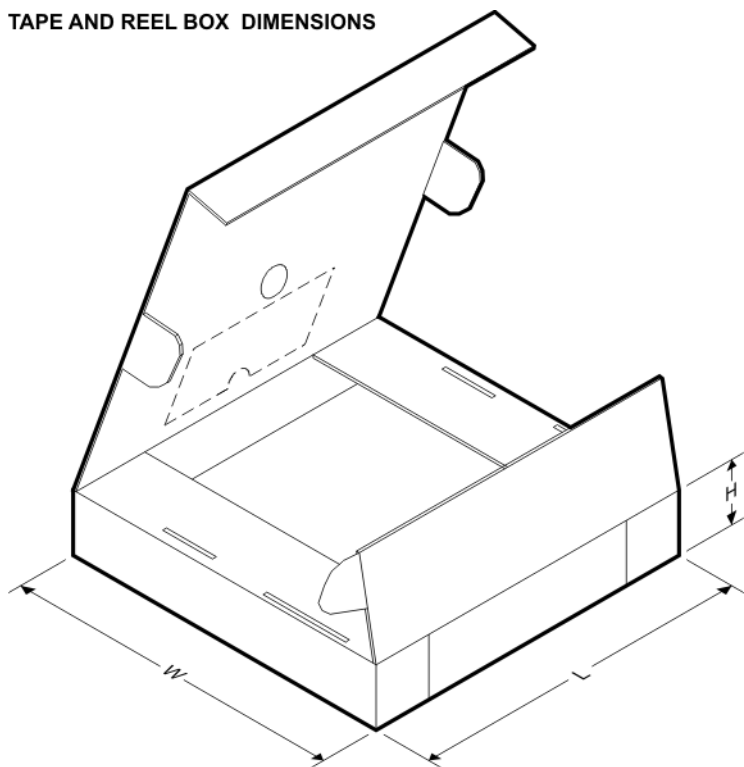
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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
SN75ALS194DR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
SN75ALS194NSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	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)
SN75ALS194DR	SOIC	D	16	2500	333.2	345.9	28.6
SN75ALS194NSR	SO	NS	16	2000	346.0	346.0	33.0

J (R-GDIP-T\*\*)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package is hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.



FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a metal lid.
  - D. The terminals are gold plated.
  - E. Falls within JEDEC MS-004

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

W (R-GDFP-F16)

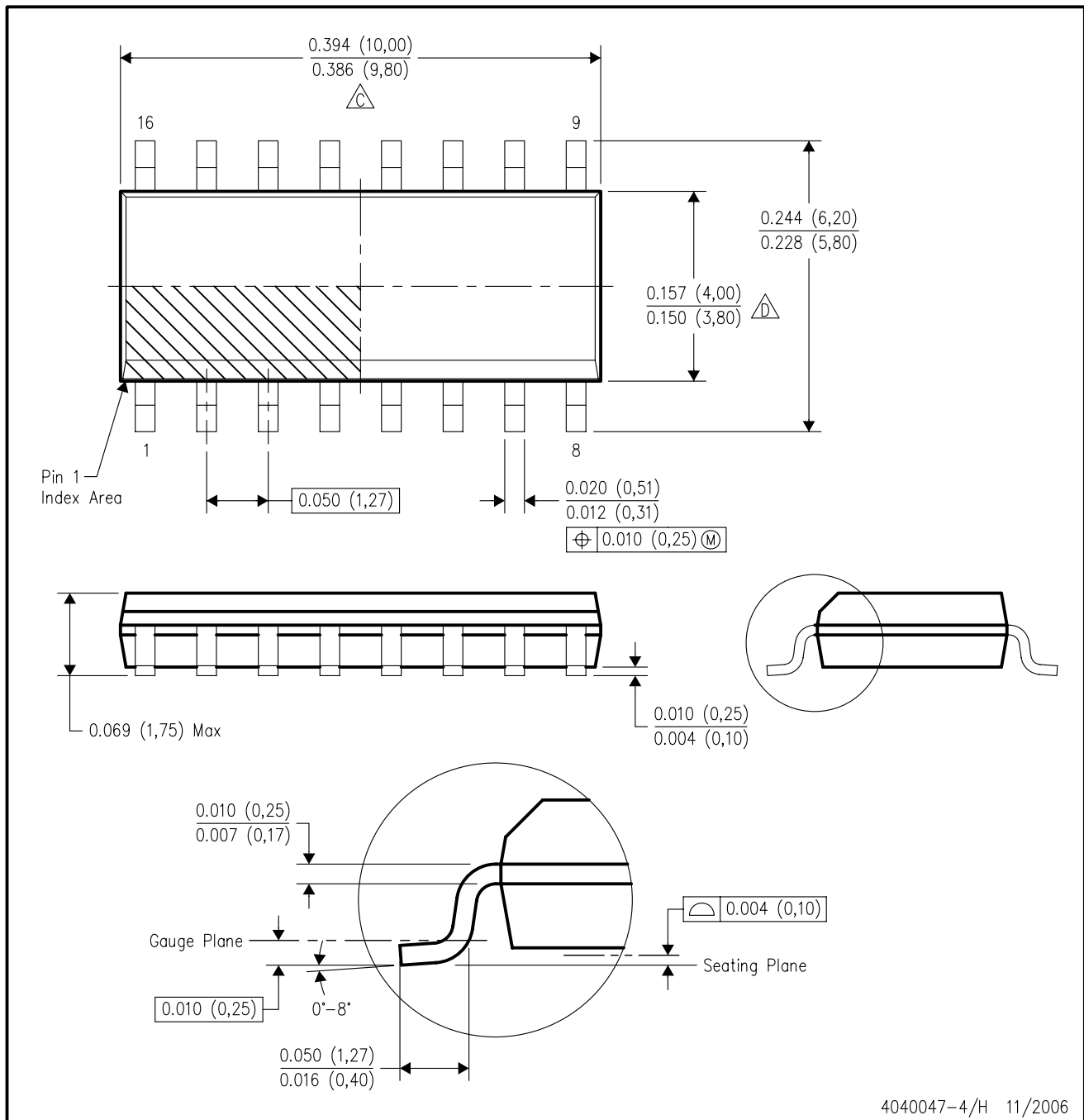
CERAMIC DUAL FLATPACK



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only.
  - E. Falls within MIL STD 1835 GDFP1-F16 and JEDEC MO-092AC

D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-4/H 11/2006

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AC.

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



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

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