DS26C31M,DS26C31T

DS26C31T/DS26C31M CMOS Quad TRI-STATE Differential Line Driver

![Texas Instruments logo]

Literature Number: SNLS375A

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National Semiconductor

DS26C31T/DS26C31M
CMOS Quad TRI-STATE® Differential Line Driver

General Description

The DS26C31 is a quad differential line driver designed for digital data transmission over balanced lines. The DS26C31T meets all the requirements of EIA standard RS-422 while retaining the low power characteristics of CMOS. The DS26C31M is compatible with EIA standard RS-422; however, one exception in test methodology is taken (Note 8). This enables the construction of serial and terminal interfaces while maintaining minimal power consumption.

The DS26C31 accepts TTL or CMOS input levels and translates these to RS-422 output levels. This part uses special output circuitry that enables the drivers to power down without loading down the bus. This device has enable and disable circuitry common to all four drivers. The DS26C31 is pin compatible to the AM26LS31 and the DS26LS31.

All inputs are protected against damage due to electrostatic discharge by diodes to V_{CC} and ground.

Features

- TTL input compatible
- Typical propagation delays: 6 ns
- Typical output skew: 0.5 ns
- Outputs will not load line when $V_{CC} = 0V$
- DS26C31T meets the requirements of EIA standard RS-422
- Operation from single 5V supply
- TRI-STATE outputs for connection to system buses
- Low quiescent current
- Available in surface mount
- Mil-Std-883C compliant

Connection Diagrams

Dual-In-Line Package
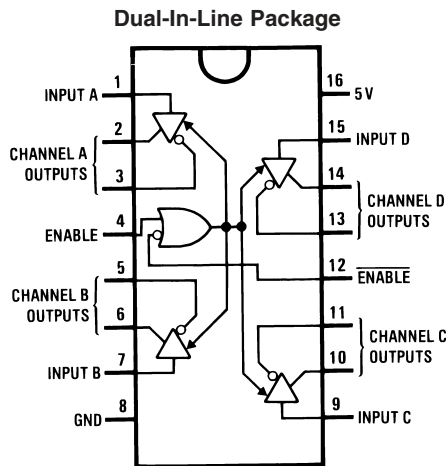
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Top View
Order Number DS26C31TM or DS26C31TN
See NS Package Number M16A or N16E
For Complete Military Product Specifications,
refer to the appropriate SMD or MDS.
Order Number DS26C31ME/883, DS26C31MJ/883
or DS26C31MW/883
See NS Package Number E20A, J16A or W16A

20-Lead Ceramic Leadless Chip Carrier (E)
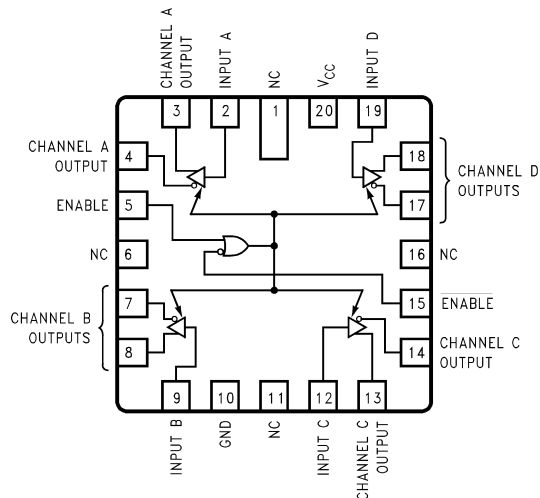
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Truth Table

ENABLE	ENABLE	Input	Non-Inverting Output	Inverting Output
L	H	X	Z	Z
All other		L	L	H
combinations of		H	H	L
enable inputs				

L = Low logic state
X = Irrelevant
H = High logic state
Z = TRI-STATE (high impedance)

Absolute Maximum Ratings (Notes 1, 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage (V_{CC})	−0.5V to 7.0V
DC Input Voltage (V_{IN})	−1.5V to V_{CC} +1.5V
DC Output Voltage (V_{OUT})	−0.5V to 7V
Clamp Diode Current (I_{IK}, I_{OK})	±20 mA
DC Output Current, per pin (I_{OUT})	±150 mA
DC V_{CC} or GND Current, per pin (I_{CC})	±150 mA
Storage Temperature Range (T_{STG})	−65˚C to +150˚C
Max. Power Dissipation (P_D) @25˚C (Note 3)	
Ceramic "J" Pkg.	2419 mW
Plastic "N" Pkg.	1736 mW
SOIC "M" Pkg.	1226 mW
Ceramic "W" Pkg.	1182 mW
Ceramic "E" Pkg.	2134 mW
Lead Temperature (T_L)	
(Soldering, 4 sec.)	260˚C

This device does not meet 2000V ESD Rating. (Note 13)

Operating Conditions

	Min	Max	Units
Supply Voltage (V_{CC})	4.50	5.50	V
DC Input or Output Voltage (V_{IN}, V_{OUT})	0	V_{CC}	V
Operating Temperature Range (T_A)			
DS26C31T	−40	+85	˚C
DS26C31M	−55	+125	˚C
Input Rise or Fall Times (t_r, t_f)		500	ns

DC Electrical Characteristics

V_{CC} = 5V ± 10% (unless otherwise specified) (Note 4)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{IH}	High Level Input Voltage			2.0			V
V_{IL}	Low Level Input Voltage					0.8	V
V_{OH}	High Level Output Voltage	V_{IN} = V_{IH} or V_{IL}, I_{OUT} = −20 mA		2.5	3.4		V
V_{OL}	Low Level Output Voltage	V_{IN} = V_{IH} or V_{IL}, I_{OUT} = 20 mA			0.3	0.5	V
V_T	Differential Output Voltage	R_L = 100Ω (Note 5)		2.0	3.1		V
$|V_T| - |\overline{V_T}|$	Difference In Differential Output	R_L = 100Ω (Note 5)				0.4	V
V_{OS}	Common Mode Output Voltage	R_L = 100Ω (Note 5)			1.8	3.0	V
$|V_{OS} - \overline{V_{OS}}|$	Difference In Common Mode Output	R_L = 100Ω (Note 5)				0.4	V
I_{IN}	Input Current	V_{IN} = V_{CC}, GND, V_{IH}, or V_{IL}				±1.0	µA
I_{CC}	Quiescent Supply Current (Note 6)	DS26C31T I_{OUT} = 0 µA	V_{IN} = V_{CC} or GND		200	500	µA
			V_{IN} = 2.4V or 0.5V (Note 6)		0.8	2.0	mA
		DS26C31M I_{OUT} = 0 µA	V_{IN} = V_{CC} or GND		200	500	µA
			V_{IN} = 2.4V or 0.5V (Note 6)		0.8	2.1	mA
I_{OZ}	TRI-STATE Output Leakage Current	V_{OUT} = V_{CC} or GND ENABLE = V_{IL} $\overline{ENABLE}$ = V_{IH}			±0.5	±5.0	µA
I_{SC}	Output Short Circuit Current	V_{IN} = V_{CC} or GND (Notes 5, 7)		−30		−150	mA
I_{OFF}	Output Leakage Current Power Off (Note 5)	DS26C31T V_{CC} = 0V	V_{OUT} = 6V			100	µA
			V_{OUT} = −0.25V			−100	µA
		DS26C31M V_{CC} = 0V	V_{OUT} = 6V			100	µA
			V_{OUT} = 0V (Note 8)			−100	µA

DC Electrical Characteristics (Continued)

Note 1: Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The table of "Electrical Characteristics" provide conditions for actual device operation.

Note 2: Unless otherwise specified, all voltages are referenced to ground. All currents into device pins are positive, all currents out of device pins are negative.

Note 3: Ratings apply to ambient temperature at 25˚C. Above this temperature derate N package at 13.89 mW/˚C, J package 16.13 mW/˚C, M package 9.80 mW/˚C, E package 12.20 mW/˚C, and W package 6.75 mW/˚C.

Note 4: Unless otherwise specified, min/max limits apply across the recommended operating temperature range. All typicals are given for V_{CC} = 5V and T_A = 25˚C.

Note 5: See EIA Specification RS-422 for exact test conditions.

Note 6: Measured per input. All other inputs at V_{CC} or GND.

Note 7: This is the current sourced when a high output is shorted to ground. Only one output at a time should be shorted.

Note 8: The DS26C31M (−55˚C to +125˚C) is tested with V_{OUT} between +6V and 0V while RS-422A condition is +6V and −0.25V.

Switching Characteristics

V_{CC} = 5V ±10%, t_r ≤ 6 ns, t_f ≤ 6 ns (*Figures 1, 2, 3, 4*) (Note 4)

Symbol	Parameter	Conditions	Min	Typ	Max		Units
					DS26C31T	CS26C31M	
t_{PLH}, t_{PHL}	Propagation Delays Input to Output	S1 Open	2	6	11	14	ns
Skew	(Note 9)	S1 Open		0.5	2.0	3.0	ns
t_{TLH}, t_{THL}	Differential Output Rise And Fall Times	S1 Open		6	10	14	ns
t_{PZH}	Output Enable Time	S1 Closed		11	19	22	ns
t_{PZL}	Output Enable Time	S1 Closed		13	21	28	ns
t_{PHZ}	Output Disable Time (Note 10)	S1 Closed		5	9	12	ns
t_{PLZ}	Output Disable Time (Note 10)	S1 Closed		7	11	14	ns
C_{PD}	Power Dissipation Capacitance (Note 11)			50			pF
C_{IN}	Input Capacitance			6			pF

Note 9: Skew is defined as the difference in propagation delays between complementary outputs at the 50% point.

Note 10: Output disable time is the delay from ENABLE or $\overline{\text{ENABLE}}$ being switched to the output transistors turning off. The actual disable times are less than indicated due to the delay added by the RC time constant of the load.

Note 11: C_{PD} determines the no load dynamic power consumption, $P_D = C_{PD} V_{CC}2 f + I_{CC} V_{CC}$, and the no load dynamic current consumption, $I_S = C_{PD} V_{CC} f + I_{CC}$.

Comparison Table of Switching Characteristics into "LS-Type" Load

V_{CC} = 5V, T_A = 25˚C, t_r ≤ 6 ns, t_f ≤ 6 ns (*Figures 2, 4, 5, 6*) (Note 12)

Symbol	Parameter	Conditions	DS26C31T		DS26LS31C		Units
			Typ	Max	Typ	Max	
t_{PLH}, t_{PHL}	Propagation Delays Input to Output	C_L = 30 pF S1 Closed S2 Closed	6	8	10	15	ns
Skew	(Note 9)	C_L = 30 pF S1 Closed S2 Closed	0.5	1.0	2.0	6.0	ns
t_{THL}, t_{TLH}	Differential Output Rise and Fall Times	C_L = 30 pF S1 Closed S2 Closed	4	6			ns
t_{PLZ}	Output Disable Time (Note 10)	C_L = 10 pF S1 Closed S2 Open	6	9	15	35	ns

Comparison Table of Switching Characteristics into "LS-Type" Load (Continued)

V_{CC} = 5V, T_A = 25˚C, $t_r \leq$ 6 ns, $t_f \leq$ 6 ns (*Figures 2, 4, 5, 6*) (Note 12)

Symbol	Parameter	Conditions	DS26C31T		DS26LS31C		Units
			Typ	Max	Typ	Max	
t_{PHZ}	Output Disable Time (Note 10)	C_L = 10 pF S1 Open S2 Closed	4	7	15	25	ns
t_{PZL}	Output Enable Time	C_L = 30 pF S1 Closed S2 Open	14	20	20	30	ns
t_{PZH}	Output Enable Time	C_L = 30 pF S1 Open S2 Closed	11	17	20	30	ns

Note 12: This table is provided for comparison purposes only. The values in this table for the DS26C31 reflect the performance of the device but are not tested or guaranteed.

Note 13: ESD Rating:

HBM (1.5 kΩ, 100 pF)

Inputs ≥ 1500V

Outputs ≥ 1000V

EIAJ (0Ω, 200 pF) ≥ 350V

Logic Diagram

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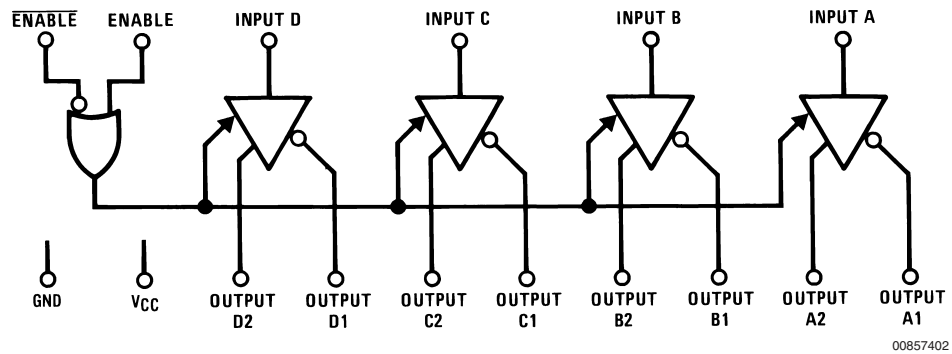
AC Test Circuit and Switching Time Waveforms
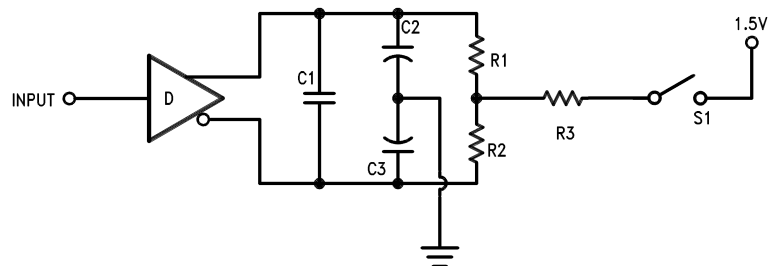
Note: C1 = C2 = C3 = 40 pF (Including Probe and Jig Capacitance), R1 = R2 = 50Ω, R3 = 500Ω.

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FIGURE 1. AC Test Circuit

AC Test Circuit and Switching Time Waveforms (Continued)

INPUT
f = 1 MHz, $t_r \leq$ 6 ns, $t_f \leq$ 6 ns

3.0V
1.3V
0.0V
t_{PLH} t_{PHL}

OUTPUT
1.3V

$\overline{OUTPUT}$
1.3V

t_{PHL} t_{PLH}
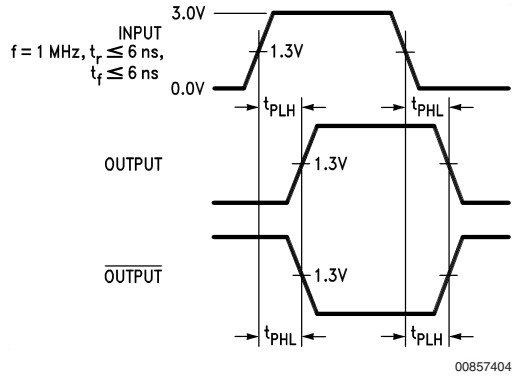
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FIGURE 2. Propagation Delays

ENABLE INPUT
f=1 MHz, $t_r \leq$ 6 ns, $t_f \leq$ 6 ns

3.0V
1.3V
0.0V

$\overline{ENABLE}$ Input High

1.5V
V_{OL}+0.3V
V_{OL}
0.8V
TpLZ   TpZL

V_{OH}
V_{OH}−0.3V
2.0V
1.5V
TpHZ   TpZH
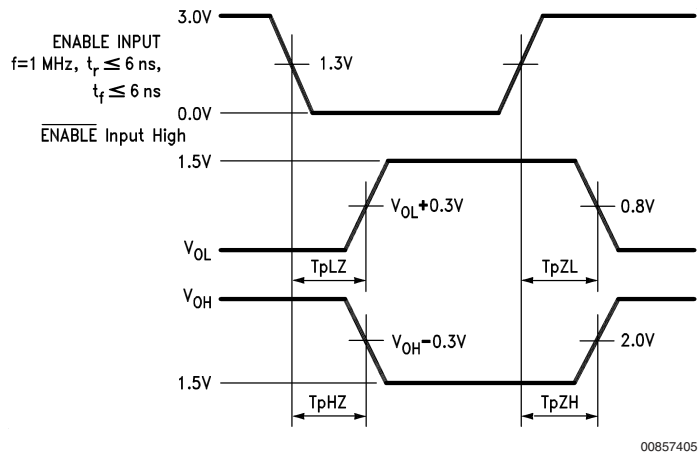
00857405

FIGURE 3. Enable and Disable Times

INPUT
3.0V
0.0V

OUTPUT
(DIFFERENTIAL)
90%   90%
10%   10%
t_{TLH} t_{THL}
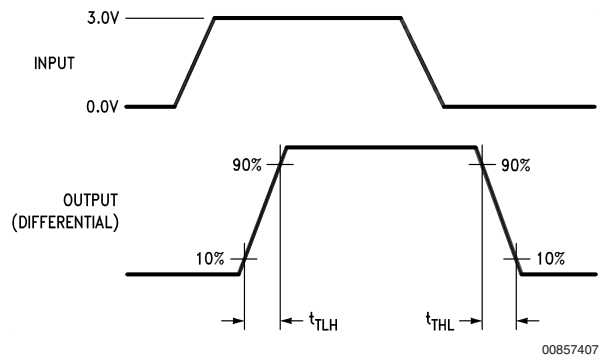
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Input pulse; f = 1 MHz, 50%; $t_r \leq$ 6 ns, $t_f \leq$ 6 ns

FIGURE 4. Differential Rise and Fall Times

AC Test Circuit and Switching Time Waveforms (Continued)
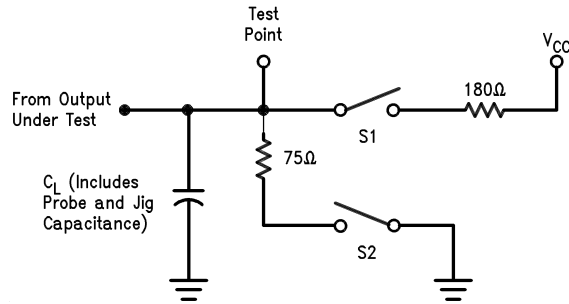
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FIGURE 5. Load AC Test Circuit for "LS-Type" Load
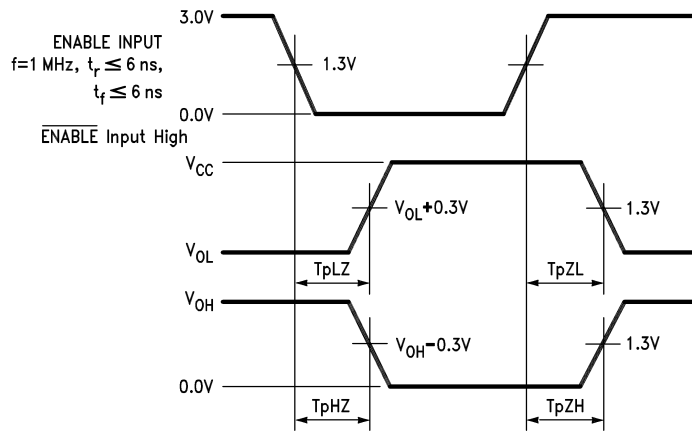
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FIGURE 6. Enable and Disable Times for "LS-Type" Load

Typical Applications

Two-Wire Balanced System, RS-422
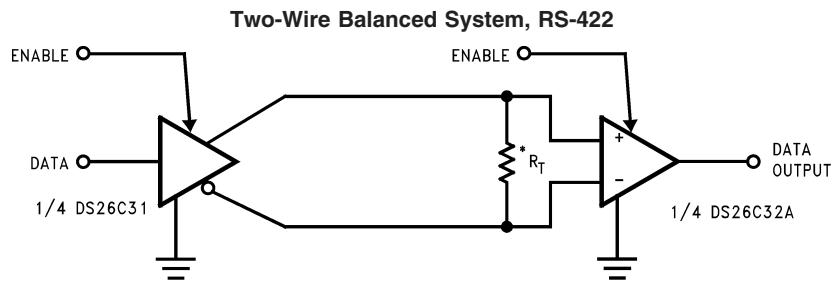
00857409

*R_T is optional although highly recommended to reduce reflection.

Typical Performance Characteristics

Differential Propagation Delay vs Temperature
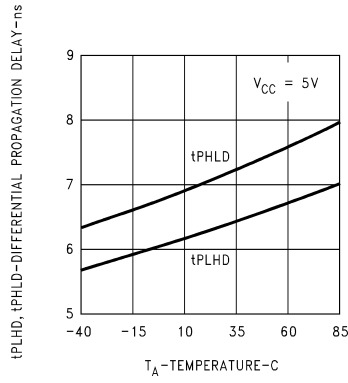
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Differential Propagation Delay vs Power Supply Voltage
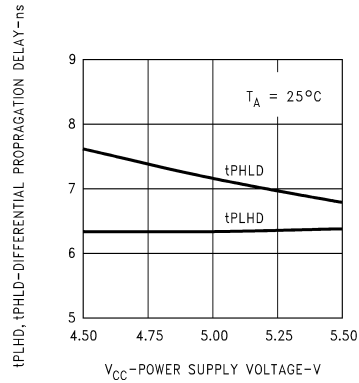
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Differential Skew vs Temperature
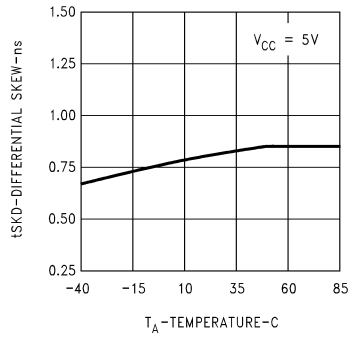
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Differential Skew vs Power Supply Voltage
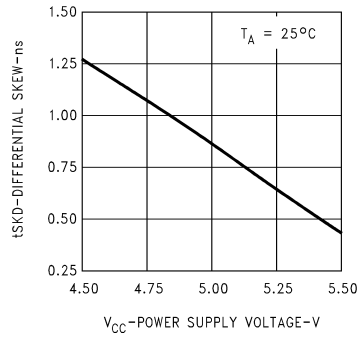
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Differential Transition Time vs Temperature
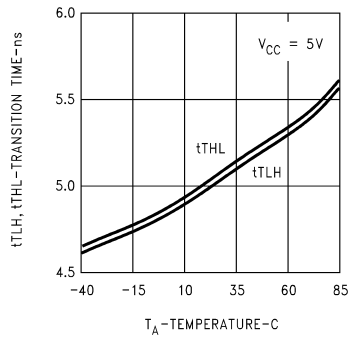
00857418

Differential Transition Time vs Power Supply Voltage
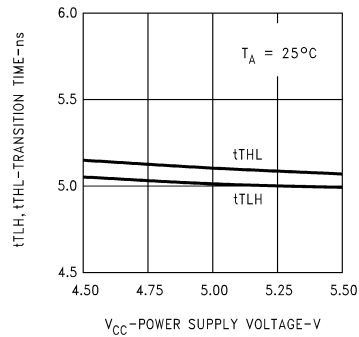
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Typical Performance Characteristics (Continued)

Complementary Skew vs Temperature

tSK–COMPLEMENTARY SKEW–ns

V_{CC} = 5V

T_A–TEMPERATURE–C
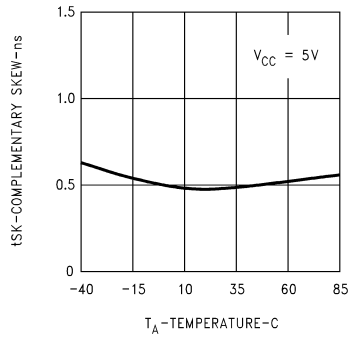
00857420

Complementary Skew vs Power Supply Voltage

tSK–COMPLEMENTARY SKEW–ns

T_A = 25°C

V_{CC}–POWER SUPPLY VOLTAGE–V
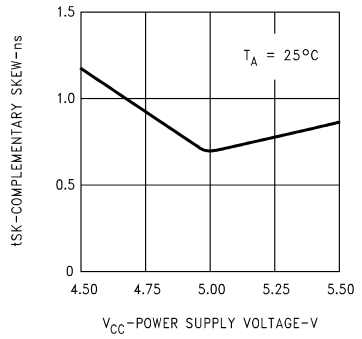
00857421

Differential Output Voltage vs Output Current

V_{OD}–DIFFERENTIAL OUTPUT VOLTAGE–V

V_{CC} = 5V

T = −40°C
T = 25°C
T = 85°C

I_O–OUTPUT CURRENT–mA
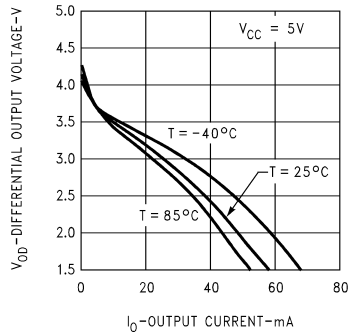
00857422

Differential Output Voltage vs Output Current

V_{OD}–DIFFERENTIAL OUTPUT VOLTAGE–V

T_A = 25°C

V_{CC} = 5.5V
V_{CC} = 5.0V
V_{CC} = 4.5V

I_O–OUTPUT CURRENT–mA
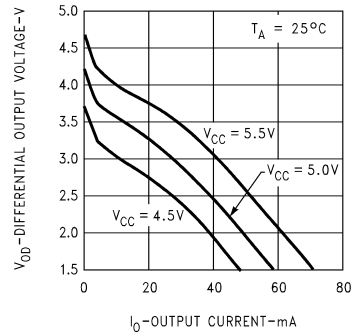
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Output High Voltage vs Output High Current

V_{OH}–OUTPUT HIGH VOLTAGE–V

V_{CC} = 5V

T = −40°C
T = 25°C
T = 85°C

I_{OH}–OUTPUT HIGH CURRENT–mA
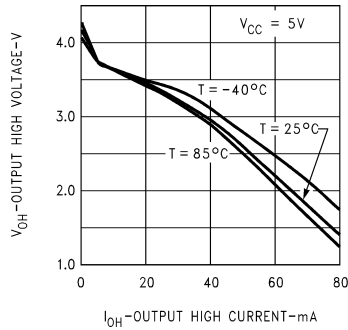
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Output High Voltage vs Output High Current

V_{OH}–OUTPUT HIGH VOLTAGE–V

T_A = 25°C

V_{CC} = 5.5V
V_{CC} = 5.0V
V_{CC} = 4.5V

I_{OH}–OUTPUT HIGH CURRENT–mA
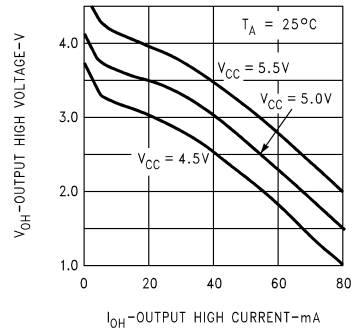
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Typical Performance Characteristics (Continued)

Output Low Voltage vs Output Low Current
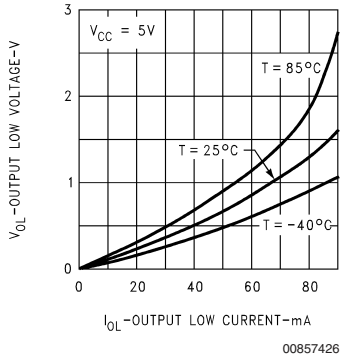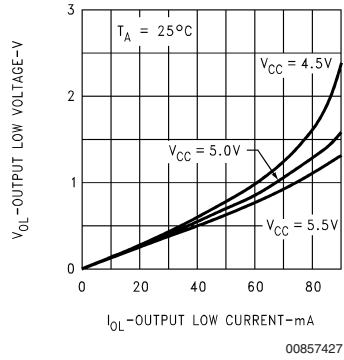
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Output Low Voltage vs Output Low Current

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Supply Current vs Temperature

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Output Low Voltage vs Output Low Current
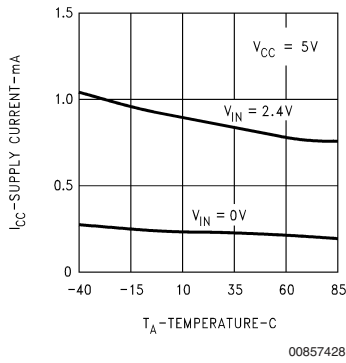
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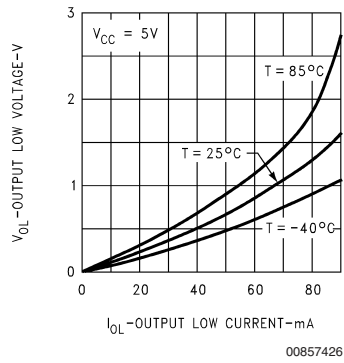
Output Low Voltage vs Output Low Current
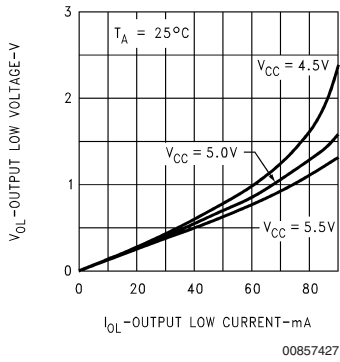
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Supply Current vs Temperature
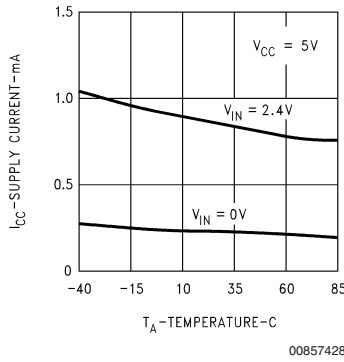
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Typical Performance Characteristics (Continued)

**Supply Current vs
Power Supply Voltage**

$T_A = 25°C$

I_{CC}-SUPPLY CURRENT-mA

V_{CC}-POWER SUPPLY VOLTAGE-V
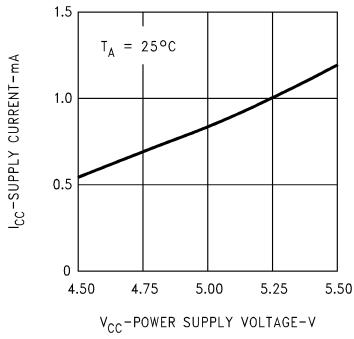
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**No Load Supply Current
vs Data Rate**

$V_{CC} = 5V$
$T_A = 25°C$

I_{CC}-NO LOAD SUPPLY CURRENT-mA

DATA RATE-kBaud
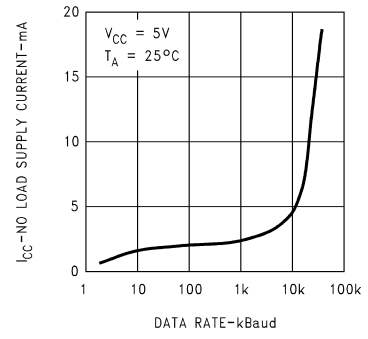
00857430

**Loaded Supply Current
vs Data Rate**

$100Ω$ LOADS
$V_{CC} = 5V$
$T_A = 25°C$

I_{CCT}-LOADED SUPPLY CURRENT-mA

DATA RATE-kBaud
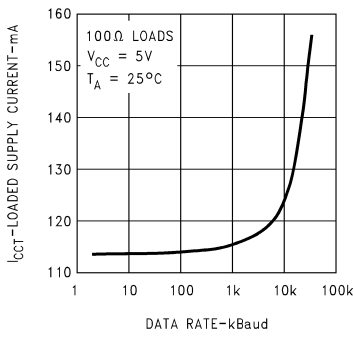
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**Output Short Circuit Current
vs Temperature**

$V_{CC} = 5V$

I_{SC}-OUTPUT SHORT CIRCUIT CURRENT-mA

T_A-TEMPERATURE-C
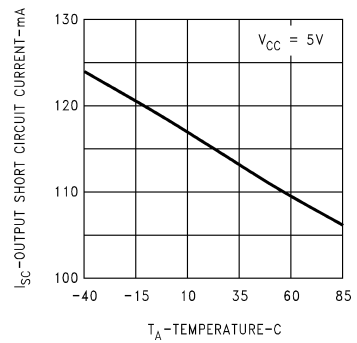
00857432

**Output Short Circuit Current
vs Power Supply Voltage**

$T_A = 25°C$

I_{SC}-OUTPUT SHORT CIRCUIT CURRENT-mA

V_{CC}-POWER SUPPLY VOLTAGE-V
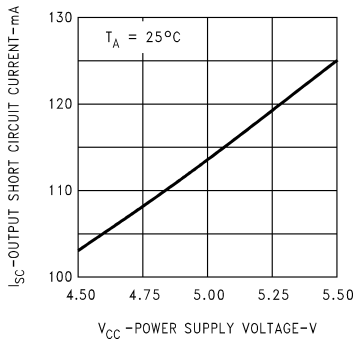
00857433

Physical Dimensions   inches (millimeters)
unless otherwise noted

0.350 ± 0.008
(8.890 ± 0.203)

Top View

0.063 − 0.075
(1.600 − 1.905)

DETAIL A

Side View

0.200 ± 0.005
(5.080 ± 0.127)
TYP

45° × 0.015 ± 0.010
(0.381 ± 0.254)

0.015
(0.381)
MIN TYP

0.007 − 0.011
(0.178 − 0.279)
R TYP

0.077 − 0.093
(1.959 − 2.362)

0.022 − 0.028
(0.559 − 0.711)
TYP

PIN #1
INDEX

0.045 − 0.055
(1.143 − 1.397)
TYP

0.067 − 0.083
(1.702 − 2.108)
TYP

0.045 − 0.055
(1.143 − 1.397)
TYP

45° × 0.040 ± 0.010
(1.016 ± 0.254)
3 PLCS

Bottom View

0.003
(0.076)
MIN TYP

0.015
(0.381)
MAX TYP

0.022
(0.559)
MAX TYP

0.006
(0.152)
MIN TYP

Detail A
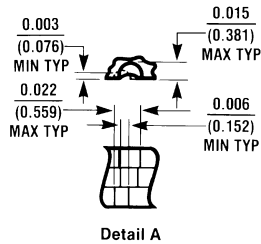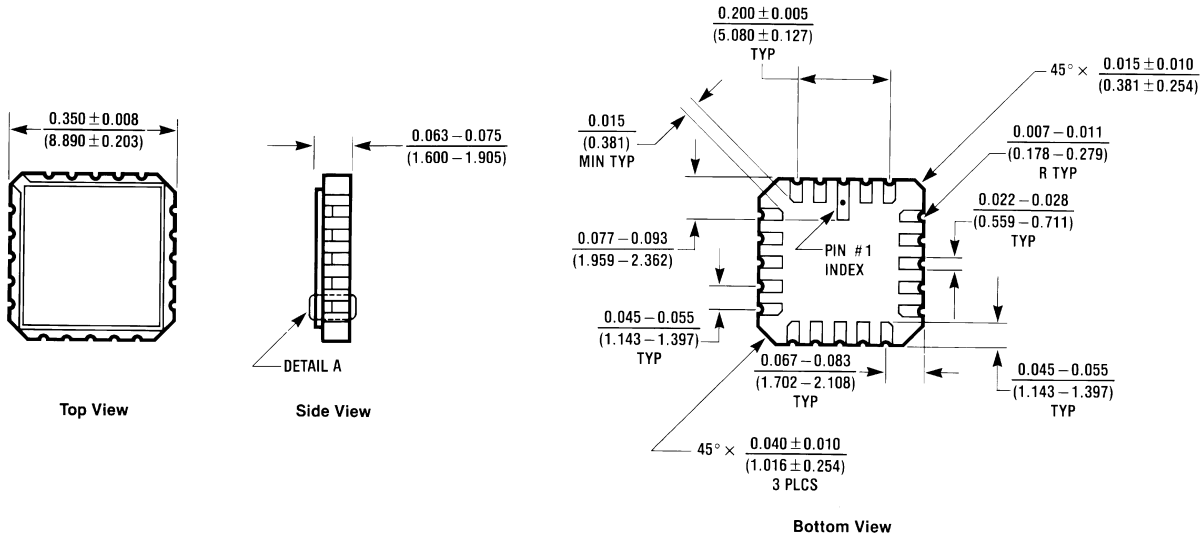
E20A (REV D)

20-Lead Ceramic Leadless Chip Carrier (E)
Order Number DS26C31ME/883
NS Package Number E20A

0.785
[19.94] MAX

16   9

R 0.025
[0.64]

1   8

0.220−0.310
[5.59−7.87]

R 0.005−0.020
[0.13−0.51] TYP

0.037 ± 0.005
[0.94 ± 0.13] TYP

0.005
[0.13]
MIN TYP

0.055 ± 0.005
[1.40 ± 0.13] TYP

0.200
[5.08]
MAX TYP

0.020−0.060
[0.51−1.52] TYP

0.150
[3.81] MIN TYP

0.125−0.200
[3.18−5.08] TYP

90° ± 4°
TYP

0.080
[2.03] MAX
BOTH ENDS

0.018 ± 0.003
[0.46 ± 0.08] TYP

0.100 ± 0.010
[2.54 ± 0.25] TYP

0.290−0.320
[7.37−8.13]

GLASS SEALANT

0.180
[4.57] MAX

0.010 ± 0.002
[0.25 ± 0.05] TYP

95° ± 5°
TYP

0.310−0.410
[7.87−10.41]
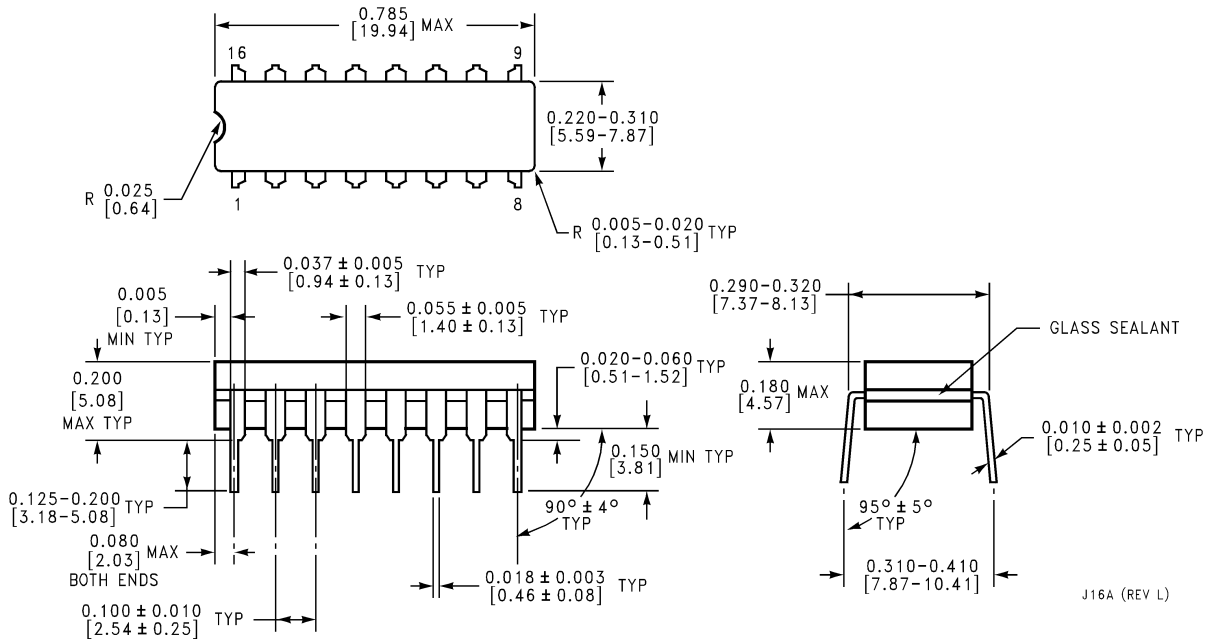
J16A (REV L)

16-Lead Ceramic Dual-In-Line Package (J)
Order Number DS26C31MJ/883
NS Package Number J16A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

0.386 − 0.394
(9.804 − 10.00)

16 15 14 13 12 11 10 9

0.228 − 0.244
(5.791 − 6.198)

30°
TYP

LEAD NO.1
IDENT

1 2 3 4 5 6 7 8

0.010 MAX
(0.254)

0.150 − 0.157
(3.810 − 3.988)

0.010 − 0.020
(0.254 − 0.508) ×45°

8° MAX TYP
ALL LEADS

0.008 − 0.010
(0.203 − 0.254)
TYP ALL LEADS

0.004
(0.102)
ALL LEAD TIPS

0.016 − 0.050
(0.406 − 1.270)
TYP ALL LEADS

0.053 − 0.069
(1.346 − 1.753)

0.004 − 0.010
(0.102 − 0.254)

SEATING
PLANE

0.014
(0.356)

0.050
(1.270)
TYP

0.008
(0.203) TYP

0.014 − 0.020 TYP
(0.356 − 0.508)
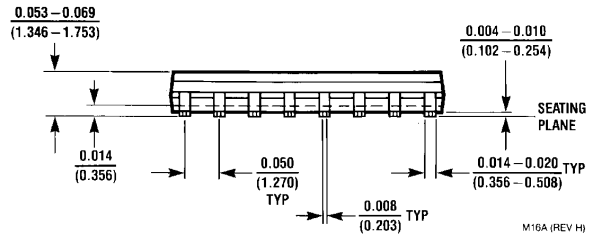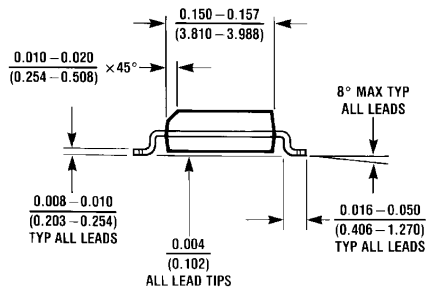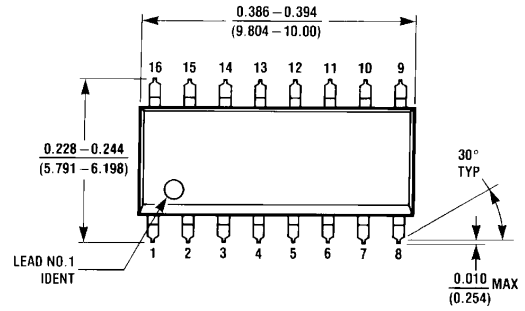
M16A (REV H)

Molded Package Small Outline (M)
Order Number DS26C31TM
NS Package Number M16A

0.740 − 0.780
(18.80 − 19.81)

0.090
(2.286)

16 15 14 13 12 11 10 9

0.250 ± 0.010
(6.350 ± 0.254)

PIN NO. 1
IDENT

1 2 3 4 5 6 7 8

OPTION 01

INDEX
AREA

16 15

PIN NO. 1
IDENT

1 2

OPTION 02

0.130 ± 0.005
(3.302 ± 0.127)

0.060
(1.524) TYP

4° TYP
OPTIONAL

0.065
(1.651)

0.145 − 0.200
(3.683 − 5.080)

0.300 − 0.320
(7.620 − 8.128)

0.020
(0.508) MIN

95° ± 5°

0.008 − 0.016 TYP
(0.203 − 0.406)

0.125 − 0.150
(3.175 − 3.810)

90° ± 4° TYP

0.280
(7.112)
MIN

0.014 − 0.023
(0.356 − 0.584)
TYP

0.030 ± 0.015
(0.762 ± 0.381)

(0.325 +0.040
−0.015)

0.050 ± 0.010
(1.270 ± 0.254)
TYP

0.100 ± 0.010
(2.540 ± 0.254)
TYP

(8.255 +1.016
−0.381)

N16E (REV F)

16-Lead Molded Dual-In-Line Package (N)
Order Number DS26C31TN
NS Package Number N16E

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

0.050 − 0.080
(1.270 − 2.032)

0.004 − 0.006
(0.102 − 0.152) TYP

0.371 − 0.390
(9.423 − 9.906)

0.007 − 0.018
(0.178 − 0.457)
TYP

0.050 ± 0.005
(1.270 ± 0.127) TYP

0.000 MIN TYP

0.250 − 0.370
(6.350 − 9.398)

16 15 14 13 12 11 10 9

0.300
(7.620)
MAX GLASS

0.245 − 0.275
(6.223 − 6.985)

DETAIL A

PIN NO. 1
IDENT

2 3 4 5 6 7 8

0.250 − 0.370
(6.350 − 9.398)

0.008 − 0.012
(0.203 − 0.305)

DETAIL A

0.026 − 0.040
(0.660 − 1.016) TYP

0.015 − 0.019
(0.381 − 0.482)
TYP

W16A (REV H)
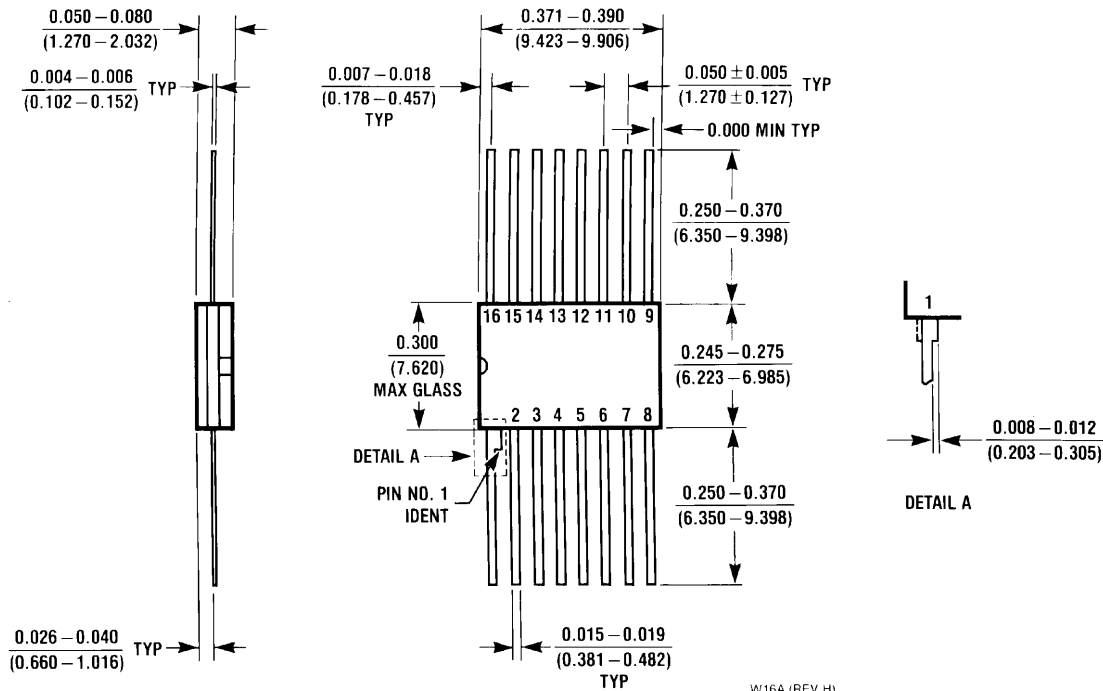
16-Lead Ceramic Flatpak Package (W)
Order Number DS26C31MW/883
NS Package Number W16A

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

BANNED SUBSTANCE COMPLIANCE

National Semiconductor certifies that the products and packing materials meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no ''Banned Substances'' as defined in CSP-9-111S2.

IMPORTANT NOTICE