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National Semiconductor

DS1691A/DS3691
(RS-422/RS-423) Line Drivers with TRI-STATE® Outputs

General Description

The DS1691A/DS3691 are low power Schottky TTL line drivers designed to meet the requirements of EIA standards RS-422 and RS-423. They feature 4 buffered outputs with high source and sink current capability with internal short circuit protection. A mode control input provides a choice of operation either as 4 single-ended line drivers or 2 differential line drivers. A rise time control pin allows the use of an external capacitor to slow the rise time for suppression of near end crosstalk to other receivers in the cable. Rise time capacitors are primarily intended for waveshaping output signals in the single-ended driver mode. Multipoint applications in differential mode with waveshaping capacitors is not allowed.

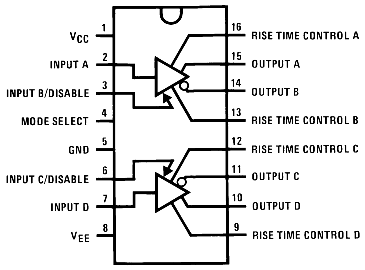
With the mode select pin low, the DS1691A/DS3691 are dual-differential line drivers with TRI-STATE outputs. They feature ±10V output common-mode range in TRI-STATE mode and 0V output unbalance when operated with ±5V supply.

Features

- Dual RS-422 line driver with mode pin low, or quad RS-423 line driver with mode pin high
- TRI-STATE outputs in RS-422 mode
- Short circuit protection for both source and sink outputs
- Outputs will not clamp line with power off or in TRI-STATE
- 100Ω transmission line drive capability
- Low I_{CC} and I_{EE} power consumption
  - RS-422: I_{CC} = 9 mA/driver typ
  - RS-423: I_{CC} = 4.5 mA/driver typ: I_{EE} = 2.5 mA/driver typ
- Low current PNP inputs compatible with TTL, MOS and CMOS
- Pin compatible with AM26LS30

Connection Diagrams

With Mode Select LOW
(RS-422 Connection)



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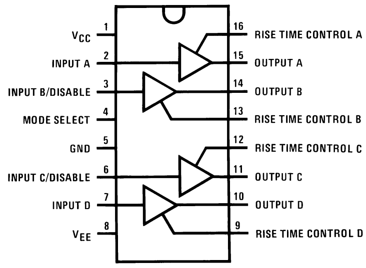
Top View

With Mode Select HIGH
(RS-423 Connection)



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Top View

Ordering Information

Order Number	Package Type	NS Package Number
DS3691M	SO Package	M16A
DS3691N	Molded DIP	N16E
For Complete Military Product Specifications, refer to the appropriate SMD or MDS.		
DS1691AJ/883	Ceramic DIP	J16A

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DS1691A/DS3691 (RS-422/RS-423) Line Drivers with TRI-STATE Outputs

Absolute Maximum Ratings (Note 2)

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

Supply Voltage	
V_{CC}	7V
V_{EE}	−7V
Maximum Power Dissipation (Note 1) at 25˚C	
Cavity Package	1509 mW
Molded DIP Package	1476 mW
SO Package	1051 mW
Input Voltage	15V
Output Voltage (Power OFF)	±15V
Storage Temperature	−65˚C to + 150˚C
Lead Temperature (Soldering, 4 seconds)	260˚C

Operating Conditions

	Min	Max	Units
Supply Voltage			
DS1691A			
V_{CC}	4.5	5.5	V
V_{EE}	−4.5	−5.5	V
DS3691			
V_{CC}	4.75	5.25	V
V_{EE}	−4.75	−5.25	V
Temperature (T_A)			
DS1691A	−55	+125	˚C
DS3691	0	+70	˚C

Note 1: Derate cavity package 10.1 mW/˚C above 25˚C; derate molded DIP package 11.9 mW/˚C above 25˚C. Derate SO package 8.41 mW/˚C above 25˚C.

DC Electrical Characteristics (Notes 3, 4, 5, 6)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
RS-422 CONNECTION, V_{EE} CONNECTION TO GROUND, MODE SELECT ≤ 0.8V							
V_{IH}	High Level Input Voltage			2			V
V_{IL}	Low Level Input Voltage					0.8	V
I_{IH}	High Level Input Current	V_{IN} = 2.4V			1	40	µA
		V_{IN} ≤ 15V			10	100	µA
I_{IL}	Low Level Input Current	V_{IN} = 0.4V			−30	−200	µA
V_I	Input Clamp Voltage	I_{IN} = −12 mA				−1.5	V
V_O	Differential Output Voltage	R_L = ∞	V_{IN} = 2V		3.6	6.0	V
$\overline{V_O}$	$V_{A,B}$		V_{IN} = 0.8V		−3.6	−6.0	V
V_T	Differential Output Voltage	R_L = 100Ω	V_{IN} = 2V	2	2.4		V
$\overline{V_T}$	$V_{A,B}$	V_{CC} ≥ 4.75V	V_{IN} = 0.8V	−2	−2.4		V
V_{OS}, $\overline{V_{OS}}$	Common-Mode Offset Voltage	R_L = 100Ω			2.5	3	V
$\|V_T\| - \|\overline{V_T}\|$	Difference in Differential Output Voltage	R_L = 100Ω			0.05	0.4	V
$\|V_{OS}\| - \|\overline{V_{OS}}\|$	Difference in Common-Mode Offset Voltage	R_L = 100Ω			0.05	0.4	V
V_{SS}	$\|V_T - \overline{V_T}\|$	R_L = 100Ω, V_{CC} ≥ 4.75V		4.0	4.8		V
V_{CMR}	Output Voltage Common-Mode Range	$V_{DISABLE}$ = 2.4V		±10			V
I_{XA}	Output Leakage Current	V_{CC} = 0V	V_{CMR} = 10V			100	µA
I_{XB}	Power OFF		V_{CMR} = −10V			−100	µA
I_{OX}	TRI-STATE Output Current	V_{CC} = Max	V_{CMR} ≤ 10V			100	µA
		V_{EE} = 0V and −5V	V_{CMR} ≥ −10V			−100	µA
I_{SA}	Output Short Circuit Current	V_{IN} = 0.4V	V_{OA} = 6V		80	150	mA
			V_{OB} = 0V		−80	−150	mA
I_{SB}	Output Short Circuit Current	V_{IN} = 2.4V	V_{OA} = 0V		−80	−150	mA
			V_{OB} = 6V		80	150	mA
I_{CC}	Supply Current				18	30	mA

AC Electrical Characteristics (Note 6)

$T_A = 25˚C$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
RS-422 CONNECTION, V_{CC} = 5V, MODE SELECT = 0.8V						
t_r	Output Rise Time	R_L = 100Ω, C_L = 500 pF *(Figure 1)*		120	200	ns
t_f	Output Fall Time	R_L = 100Ω, C_L = 500 pF *(Figure 1)*		120	200	ns
t_{PDH}	Output Propagation Delay	R_L = 100Ω, C_L = 500 pF *(Figure 1)*		120	200	ns
t_{PDL}	Output Propagation Delay	R_L = 100Ω, C_L = 500 pF *(Figure 1)*		120	200	ns
t_{PZL}	TRI-STATE Delay	R_L = 450Ω, C_L = 500 pF, C_C = 0 pF *(Figure 4)*		250	350	ns
t_{PZH}	TRI-STATE Delay	R_L = 450Ω, C_L = 500 pF, C_C = 0 pF *(Figure 4)*		180	300	ns
t_{PLZ}	TRI-STATE Delay	R_L = 450Ω, C_L = 500 pF, C_C = 0 pF *(Figure 4)*		180	300	ns
t_{PHZ}	TRI-STATE Delay	R_L = 450Ω, C_L = 500 pF, C_C = 0 pF *(Figure 4)*		250	350	ns

DC Electrical Characteristics (Notes 3, 4, 5, 6)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
RS-423 CONNECTION, $\|V_{CC}\|$ = $\|V_{EE}\|$, MODE SELECT ≥ 2V							
V_{IH}	High Level Input Voltage			2			V
V_{IL}	Low Level Input Voltage					0.8	V
I_{IH}	High Level Input Current	V_{IN} = 2.4V			1	40	µA
		V_{IN} ≤ 15V			10	100	µA
I_{IL}	Low Level Input Current	V_{IN} = 0.4V			−30	−200	µA
V_I	Input Clamp Voltage	I_{IN} = −12 mA				−1.5	V
V_O	Output Voltage	R_L = ∞, (Note 7)	V_{IN} = 2V	4.0	4.4	6.0	V
$\overline{V_O}$		V_{CC} ≥ 4.75V	V_{IN} = 0.4V	−4.0	−4.4	−6.0	V
V_T	Output Voltage	R_L = 450Ω	V_{IN} = 2.4V	3.6	4.1		V
$\overline{V_T}$		V_{CC} ≥ 4.75V	V_{IN} = 0.4V	−3.6	−4.1		V
$\|V_T\| - \|\overline{V_T}\|$	Output Unbalance	$\|V_{CC}\|$ = $\|V_{EE}\|$ = 4.75V, R_L = 450Ω			0.02	0.4	V
I_X^+	Output Leakage Power OFF	V_{CC} = V_{EE} = 0V	V_O = 6V		2	100	µA
I_X^-	Output Leakage Power OFF	V_{CC} = V_{EE} = 0V	V_O = −6V		−2	−100	µA
I_S^+	Output Short Circuit Current	V_O = 0V	V_{IN} = 2.4V		−80	−150	mA
I_S^-	Output Short Circuit Current	V_O = 0V	V_{IN} = 0.4V		80	150	mA
I_{SLEW}	Slew Control Current				±140		µA
I_{CC}	Positive Supply Current	V_{IN} = 0.4V, R_L = ∞			18	30	mA
I_{EE}	Negative Supply Current	V_{IN} = 0.4V, R_L = ∞			−10	−22	mA

Note 2: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.

Note 3: Unless otherwise specified, min/max limits apply across the −55˚C to +125˚C temperature range for the DS1691A and across the 0˚C to +70˚C range for the DS3691. All typicals are given for V_{CC} = 5V and T_A = 25˚C. V_{CC} and V_{EE} as listed in operating conditions.

Note 4: All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to ground unless otherwise specified.

Note 5: Only one output at a time should be shorted.

Note 6: Symbols and definitions correspond to EIA RS-422 and/or RS-423 where applicable.

Note 7: At −55˚C, the output voltage is +3.9V minimum and −3.9V minimum.

AC Electrical Characteristics (Note 6)

$T_A = 25˚C$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
RS-423 CONNECTION, V_{CC} = 5V, V_{EE} −5V, MODE SELECT = 2.4V						
t_r	Rise Time	R_L = 450Ω, C_L = 500 pF, C_C = 0 (*Figure 2*)		120	300	ns
t_f	Fall Time	R_L = 450Ω, C_L = 500 pF, C_C = 0 (*Figure 2*)		120	300	ns
t_r	Rise Time	R_L = 450Ω, C_L = 500 pF C_C = 50 pF (*Figure 3*)		3.0		µs
t_f	Fall Time	R_L = 450Ω, C_L = 500 pF C_C = 50 pF (*Figure 3*)		3.0		µs
t_{rc}	Rise Time Coefficient	R_L = 450Ω, C_L = 500 pF, C_C = 50 pF (*Figure 3*)		0.06		µs/pF

AC Electrical Characteristics (Note 6) (Continued)

T_A = 25˚C

Symbol	Parameter	Conditions	Min	Typ	Max	Units
RS-423 CONNECTION, V_{CC} = 5V, V_{EE} −5V, MODE SELECT = 2.4V						
t_{PDH}	Output Propagation Delay	R_L = 450Ω, C_L = 500 pF, C_C = 0 (*Figure 2*)		180	300	ns
t_{PDL}	Output Propagation Delay	R_L = 450Ω, C_L = 500 pF, C_C = 0 (*Figure 2*)		180	300	ns

AC Test Circuits and Switching Time Waveforms

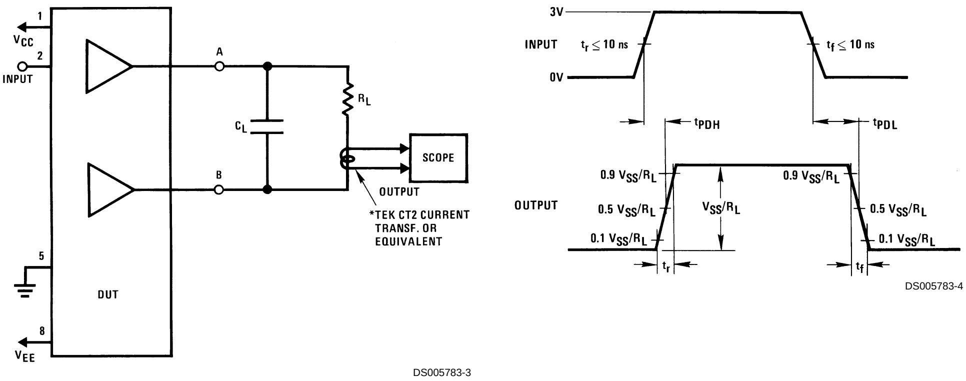


FIGURE 1. Differential Connection

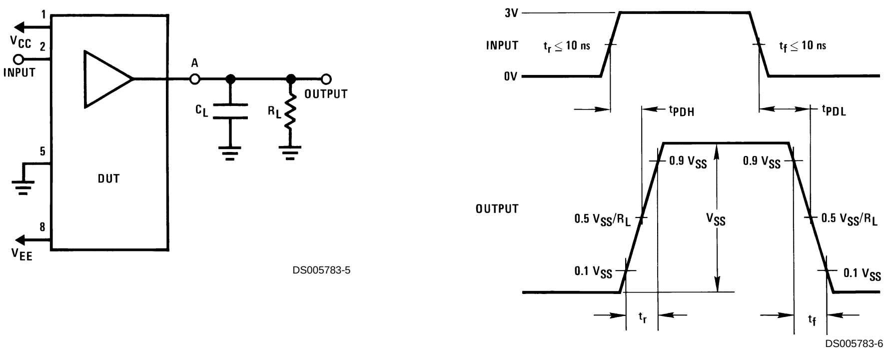


FIGURE 2. RS-423 Connection

AC Test Circuits and Switching Time Waveforms (Continued)

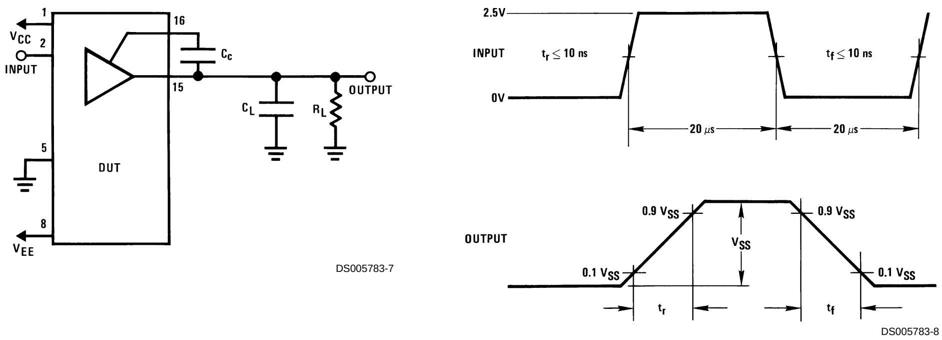


FIGURE 3. Rise Time Control for RS-423

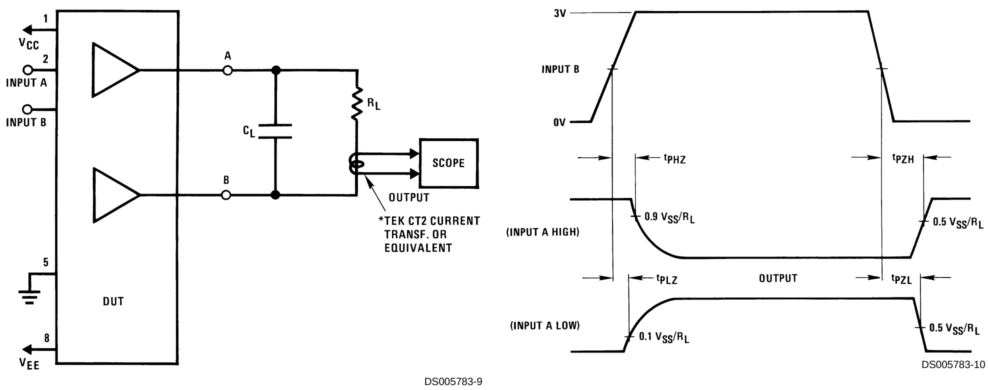


FIGURE 4. TRI-STATE Delays

Switching Waveforms

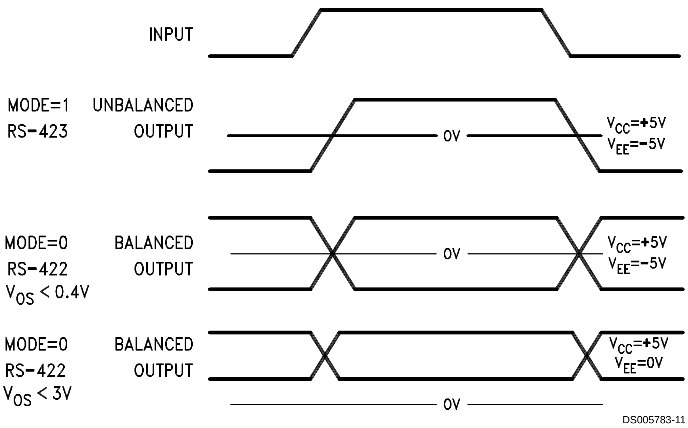


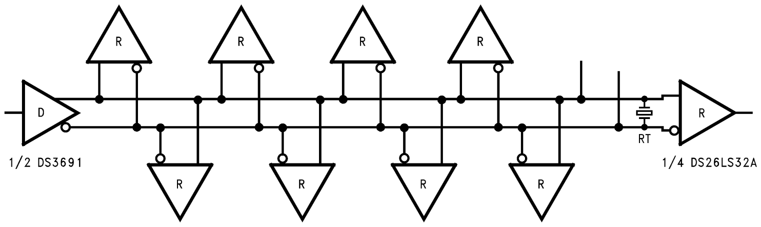
FIGURE 5. Typical Output Voltage

Truth Table

Operation	Inputs			Outputs	
	Mode	**A (D)**	**B (C)**	**A (D)**	**B (C)**
RS-422	0	0	0	0	1
	0	0	1	TRI-STATE	TRI-STATE
	0	1	0	1	0
	0	1	1	TRI-STATE	TRI-STATE
RS-423	1	0	0	0	0
	1	0	1	0	1
	1	1	0	1	0
	1	1	1	1	1

Typical Application Information

Fully Loaded RS-422 Interface



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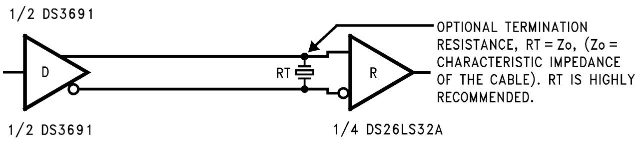
RS-422 Point to Point Application



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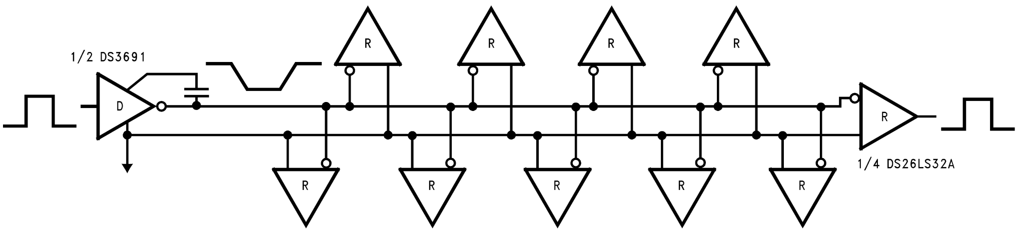
Fully Loaded RS-423 Interface



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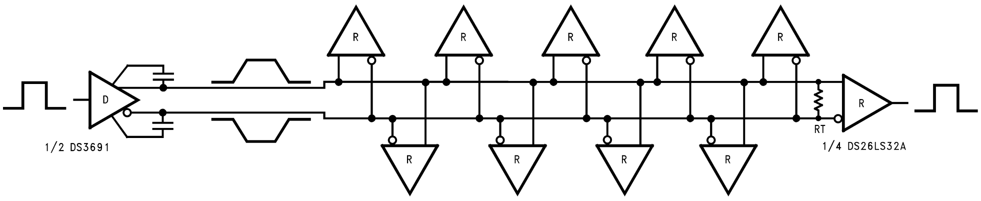
Typical Application Information (Continued)

Differential Application with Rise Time Control



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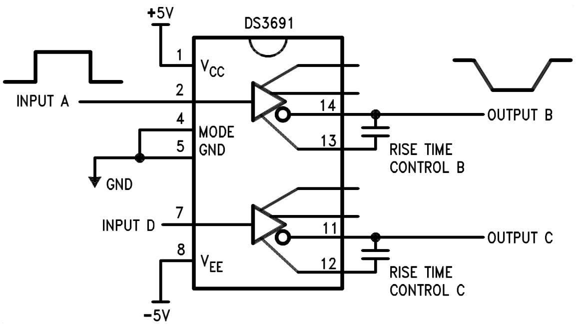
***Note:** Controlled edge allows longer stub lengths. Multiple Drivers are NOT allowed.

Dual RS-423 Inverting Driver



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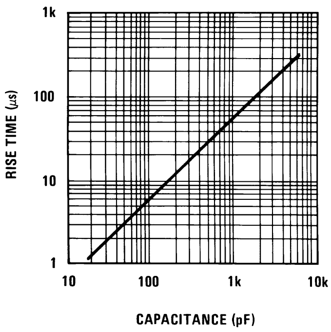
Typical Rise Time Control Characteristics (RS-423 Mode)

Rise Time vs External Capacitor



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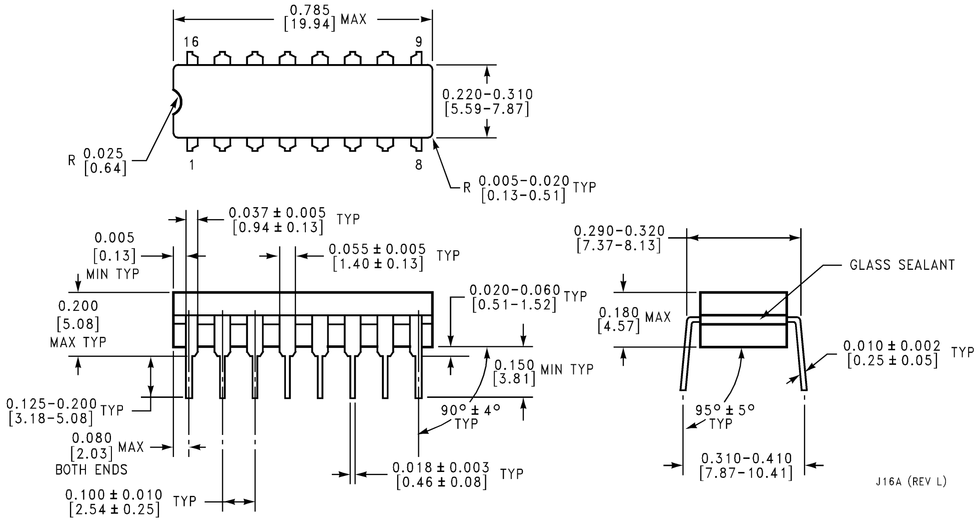
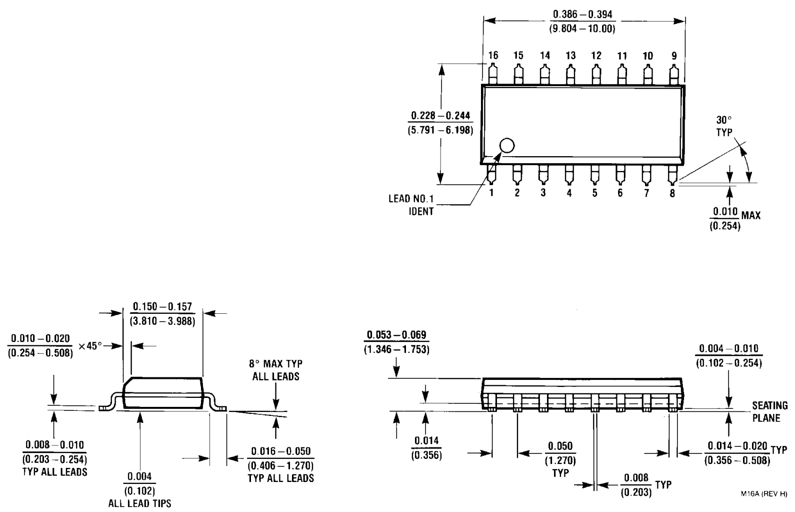
Physical Dimensions inches (millimeters) unless otherwise noted

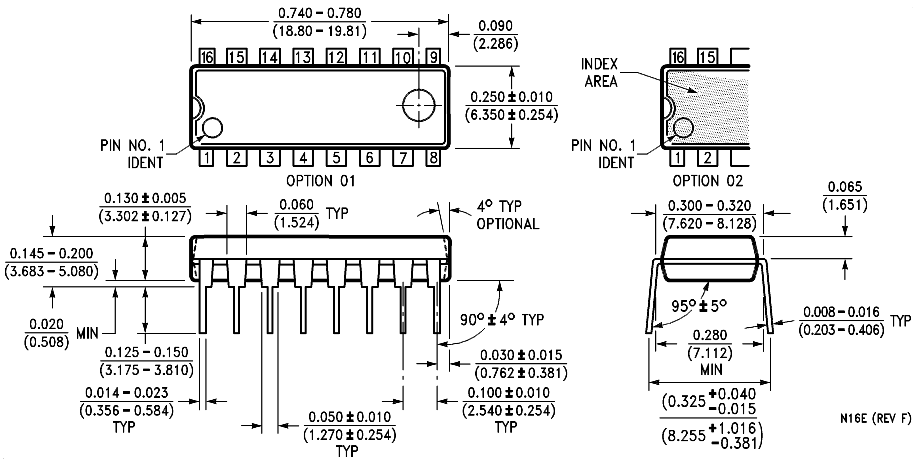


Ceramic Dual-In-Line Package (J)
Order Number DS1691AJ/883
NS Package Number J16A



SO Package (M)
Order Number DS3691M
NS Package Number M16A

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



Molded Dual-In-Line Package (N)
Order Number DS3691N
NS Package Number N16E

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National Semiconductor Corporation
Americas
Tel: 1-800-272-9959
Fax: 1-800-737-7018
Email: support@nsc.com

www.national.com

National Semiconductor Europe
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 1 80-530 85 85
English Tel: +49 (0) 1 80-532 78 32
Français Tel: +49 (0) 1 80-532 93 58
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National Semiconductor Asia Pacific Customer Response Group
Tel: 65-2544466
Fax: 65-2504466
Email: sea.support@nsc.com

National Semiconductor Japan Ltd.
Tel: 81-3-5620-6175
Fax: 81-3-5620-6179