National Semiconductor

July 1992

100321
Low Power 9-Bit Inverter

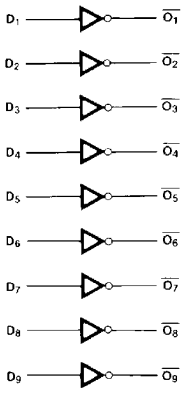
General Description

The 100321 is a monolithic 9-bit inverter. The device contains nine inverting buffer gates with single input and output. All inputs have 50 kΩ pull-down resistors.

Features

- 30% power reduction of the 100121
- 2000V ESD protection
- Pin/function compatible with 100121
- Voltage compensated operating range = −4.2V to −5.7V
- Available to industrial grade temperature range
- Available to MIL-STD-883

Logic Symbol



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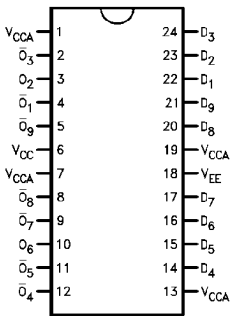
Pin Names	Description
D_1–D_9	Data Inputs
$\overline{O}_1$–$\overline{O}_9$	Data Outputs

Connection Diagrams

24-Pin DIP



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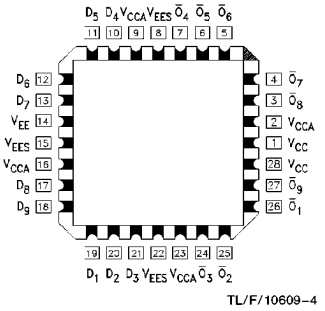
28-Pin PCC



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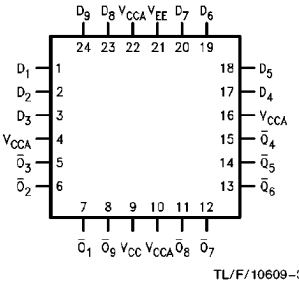
24-Pin Quad Cerpak



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Absolute Maximum Ratings

Above which the useful life may be impaired (Note 1)

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

Storage Temperature (T_{STG})	−65°C to +150°C
Maximum Junction Temperature (T_J)	
Ceramic	+175°C
Plastic	+150°C
V_{EE} Pin Potential to Ground Pin	−7.0V to +0.5V
Input Voltage (DC)	V_{EE} to +0.5V
Output Current (DC Output HIGH)	−50 mA
ESD (Note 2)	≥2000V

Note 1: Absolute maximum ratings are those values beyond which the device may be damaged or have its useful life impaired. Functonal operation under these conditions is not implied.

Note 2: ESD testing conforms to MIL-STD-883, Method 3015.

Recommended Operating Conditions

Case Temperature (T_C)	
Commercial	0°C to +85°C
Industrial	−40°C to +85°C
Military	−55°C to +125°C
Supply Voltage (V_{EE})	−5.7V to −4.2V

Commercial Version

DC Electrical Characteristics

V_{EE} = −4.2V to −5.7V, V_{CC} = V_{CCA} = GND, T_C = 0°C to +85°C (Note 3)

Symbol	Parameter	Min	Typ	Max	Units	Conditions	
V_{OH}	Output HIGH Voltage	−1025	−955	−870	mV	V_{IN} = V_{IH} (Max) or V_{IL} (Min)	Loading with 50Ω to −2.0V
V_{OL}	Output LOW Voltage	−1830	−1705	−1620	mV		
V_{OHC}	Output HIGH Voltage	−1035			mV	V_{IN} = V_{IH} (Min) or V_{IL} (Max)	Loading with 50Ω to −2.0V
V_{OLC}	Output LOW Voltage			−1610	mV		
V_{IH}	Input HIGH Voltage	−1165		−870	mV	Guaranteed HIGH Signal for All Inputs	
V_{IL}	Input LOW Voltage	−1830		−1475	mV	Guaranteed LOW Signal for All Inputs	
I_{IL}	Input LOW Current	0.50			μA	V_{IN} = V_{IL} (Min)	
I_{IH}	Input HIGH Current			240	μA	V_{IN} = V_{IH} (Max)	
I_{EE}	Power Supply Current	−65		−30	mA	Inputs Open	

Note 3: The specified limits represent the "worst case" value for the parameter. Since these values normally occur at the temperature extremes, additional noise immunity and guardbanding can be achieved by decreasing the allowable system operating ranges. Conditions for testing shown in the tables are chosen to guarantee operation under "worst case" conditions.

DIP AC Electrical Characteristics

V_{EE} = −4.2V to −5.7V, V_{CC} = V_{CCA} = GND

Symbol	Parameter	T_C = 0°C		T_C = +25°C		T_C = +85°C		Units	Conditions
		Min	Max	Min	Max	Min	Max		
t_{PLH} t_{PHL}	Propagation Delay Data to Output	0.45	1.45	0.45	1.45	0.45	1.55	ns	*Figures 1* and *2* (Note 1)
t_{TLH} t_{THL}	Transition Time 20% to 80%, 80% to 20%	0.35	1.20	0.35	1.20	0.35	1.20	ns	*Figures 1* and *2*

Note 1: The propagation delay specified is for single output switching. Delays may vary up to 200 ps with multiple outputs switching.

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Commercial Version (Continued)

PCC and Cerpak AC Electrical Characteristics

V_{EE} = −4.2V to −5.7V, V_{CC} = V_{CCA} = GND

Symbol	Parameter	T_C = 0°C		T_C = +25°C		T_C = +85°C		Units	Conditions
		Min	Max	Min	Max	Min	Max		
t_{PLH} t_{PHL}	Propagation Delay Data to Output	0.45	1.25	0.45	1.25	0.45	1.35	ns	*Figures 1* and *2* (Note 2)
t_{TLH} t_{THL}	Transition Time 20% to 80%, 80% to 20%	0.35	1.10	0.35	1.10	0.35	1.10	ns	*Figures 1* and *2*
t_{OSHL}	Maximum Skew Common Edge Output-to-Output Variation Data to Output Path		220		220		220	ps	PCC only (Note 1)
t_{OSLH}	Maximum Skew Common Edge Output-to-Output Variation Data to Output Path		270		270		270	ps	PCC only (Note 1)
t_{OST}	Maximum Skew Opposite Edge Output-to-Output Variation Data to Output Path		320		320		320	ps	PCC only (Note 1)
t_{PS}	Maximum Skew Pin (Signal) Transition Variation Data to Output Path		230		230		230	ps	PCC only (Note 1)

Note 1: Output-to-Output Skew is defined as the absolute value of the difference between the actual propagation delay for any outputs within the same packaged device. The specifications apply to any outputs switching in the same direction either HIGH to LOW (t_{OSHL}), or LOW to HIGH (t_{OSLH}), or in opposite directions both HL and LH (t_{OST}). Parameters t_{OST} and t_{PS} guaranteed by design.

Note 2: The propagation delay specified is for single output switching. Delays may vary up to 200 ps with multiple outputs switching.

Industrial Version

PCC DC Electrical Characteristics

V_{EE} = −4.2V to −5.7V, V_{CC} = V_{CCA} = GND, T_C = −40°C to +85°C (Note 1)

Symbol	Parameter	T_C = −40°C		T_C = 0°C to +85°C		Units	Conditions	
		Min	Max	Min	Max			
V_{OH}	Output HIGH Voltage	−1085	−870	−1025	−870	mV	V_{IN} = V_{IH} (Max) or V_{IL} (Min)	Loading with 50Ω to −2.0V
V_{OL}	Output LOW Voltage	−1830	−1575	−1830	−1620	mV		
V_{OHC}	Output HIGH Voltage	−1095		−1035		mV	V_{IN} = V_{IH} (Min) or V_{IL} (Max)	Loading with 50Ω to −2.0V
V_{OLC}	Output LOW Voltage		−1565		−1610	mV		
V_{IH}	Input HIGH Voltage	−1170	−870	−1165	−870	mV	Guaranteed HIGH Signal for All Inputs	
V_{IL}	Input LOW Voltage	−1830	−1480	−1830	−1475	mV	Guaranteed LOW Signal for All Inputs	
I_{IL}	Input LOW Current	0.50		0.50		μA	V_{IN} = V_{IL} (Min)	
I_{IH}	Input HIGH Current		300		240	μA	V_{IN} = V_{IH} (Max)	
I_{EE}	Power Supply Current	−65	−30	−65	−30	mA	Inputs Open	

Note 1: The specified limits represent the "worst case" value for the parameter. Since these values normally occur at the temperature extremes, additional noise immunity and guardbanding can be achieved by decreasing the allowable system operating ranges. Conditions for testing shown in the tables are chosen to guarantee operation under "worst case" conditions.

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Industrial Version (Continued)

PCC AC Electrical Characteristics

V_{EE} = −4.2V to −5.7V, V_{CC} = V_{CCA} = GND

Symbol	Parameter	T_C = −40°C		T_C = +25°C		T_C = +85°C		Units	Conditions
		Min	Max	Min	Max	Min	Max		
t_{PLH} t_{PHL}	Propagation Delay Data to Output	0.45	1.25	0.45	1.25	0.45	1.35	ns	*Figures 1* and *2* (Note 1)
t_{TLH} t_{THL}	Transition Time 20% to 80%, 80% to 20%	0.30	1.20	0.35	1.10	0.35	1.10	ns	*Figures 1* and *2*

Note 1: The propagation delay specified is for single output switching. Delays may vary up to 200 ps with multiple outputs switching.

Military Version

DC Electrical Characteristics

V_{EE} = −4.2V to −5.7V, V_{CC} = V_{CCA} = GND, T_C = −55°C to +125°C

Symbol	Parameter	Min	Max	Units	T_C	Conditions		Notes
V_{OH}	Output HIGH Voltage	−1025	−870	mV	0°C to +125°C	V_{IN} = V_{IH} (Max) or V_{IL} (Min)	Loading with 50Ω to −2.0V	1, 2, 3
		−1085	−870	mV	−55°C			
V_{OL}	Output LOW Voltage	−1830	−1620	mV	0°C to +125°C			
		−1830	−1555	mV	−55°C			
V_{OHC}	Output HIGH Voltage	−1035		mV	0°C to +125°C	V_{IN} = V_{IH} (Min) or V_{IL} (Max)	Loading with 50Ω to −2.0V	1, 2, 3
		−1085		mV	−55°C			
V_{OLC}	Output LOW Voltage		−1610	mV	0°C to +125°C			
			−1555	mV	−55°C			
V_{IH}	Input HIGH Voltage	−1165	−870	mV	−55°C to +125°C	Guaranteed HIGH Signal for All Inputs		1, 2, 3, 4
V_{IL}	Input LOW Voltage	−1830	−1475	mV	−55°C to +125°C	Guaranteed LOW Signal for All Inputs		1, 2, 3, 4
I_{IL}	Input LOW Current	0.50		μA	−55°C to +125°C	V_{EE} = −4.2V V_{IN} = V_{IL} (Min)		1, 2, 3
I_{IH}	Input HIGH Current		240	μA	0°C to +125°C	V_{EE} = −5.7V V_{IN} = V_{IH} (Max)		1, 2, 3
			340	μA	−55°C			
I_{EE}	Power Supply Current	−70	−25	mA	−55°C to +125°C	Inputs Open		1, 2, 3

Note 1: F100K 300 Series cold temperature testing is performed by temperature soaking (to guarantee junction temperature equals −55°C), then testing immediately without allowing for the junction temperature to stabilize due to heat dissipation after power-up. This provides "cold start" specs which can be considered a worst case condition at cold temperatures.

Note 2: Screen tested 100% on each device at −55°C, +25°C, and +125°C, Subgroups 1, 2, 3, 7, and 8.

Note 3: Sample tested (Method 5005, Table 1) on each manufactured lot at −55°C, +25°C and +125°C, Subgroups A1, 2, 3, 7, and 8.

Note 4: Guaranteed by applying specified input condition and testing V_{OH}/V_{OL}.

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Military Version (Continued)

AC Electrical Characteristics

V_{EE} = −4.2V to −5.7V, V_{CC} = V_{CCA} = GND

Symbol	Parameter	T_C = −55°C		T_C = +25°C		T_C = +125°C		Units	Conditions	Notes
		Min	Max	Min	Max	Min	Max			
t_{PLH} t_{PHL}	Propagation Delay Data to Output	0.30	1.80	0.40	1.60	0.40	1.80	ns	*Figures 1* and *2*	1, 2, 3, 5
t_{TLH} t_{THL}	Transition Time 20% to 80%, 80% to 20%	0.30	1.20	0.30	1.20	0.30	1.20	ns		4

Note 1: F100K 300 Series cold temperature testing is performed by temperature soaking (to guarantee junction temperature equals −55°C), then testing immediately after power-up. This provides "cold start" specs which can be considered a worst case condition at cold temperatures.

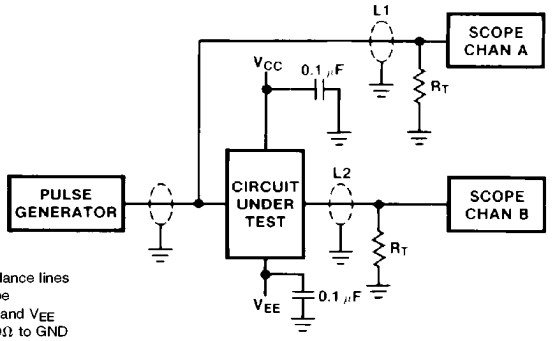
Note 2: Screen tested 100% on each device at +25°C temperature only, Subgroup A9.

Note 3: Sample tested (Method 5005, Table 1) on each mfg. lot at +25°C, Subgroup A9, and at +125°C and −55°C temperatures, Subgroups A10 and A11.

Note 4: Not tested at +25°C, +125°C, and −55°C temperature (design characterization data).

Note 5: The propagation delay specified is for single output switching. Delays may vary up to 200 ps with multiple outputs switching.

Test Circuitry



Notes:

V_{CC}, V_{CCA} = +2V, V_{EE} = −2.5V
L1 and L2 = equal length 50Ω impedance lines
R_T = 50Ω terminator internal to scope
Decoupling 0.1 μF from GND to V_{CC} and V_{EE}
All unused outputs are loaded with 50Ω to GND
C_L = Fixture and stray capacitance ≤ 3 pF

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FIGURE 1. AC Test Circuit

Switching Waveforms

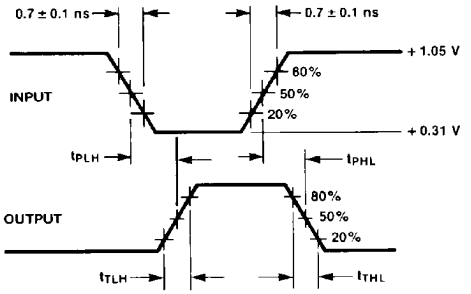

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FIGURE 2. Propagation Delay and Transition Times

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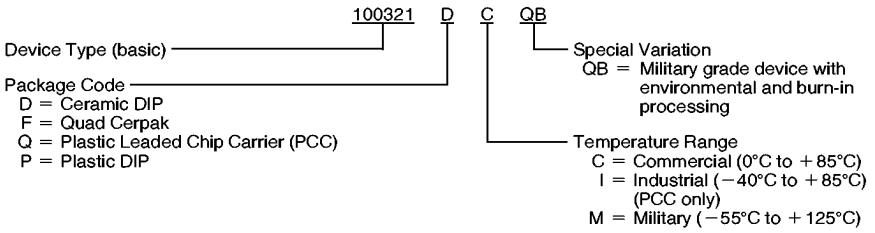
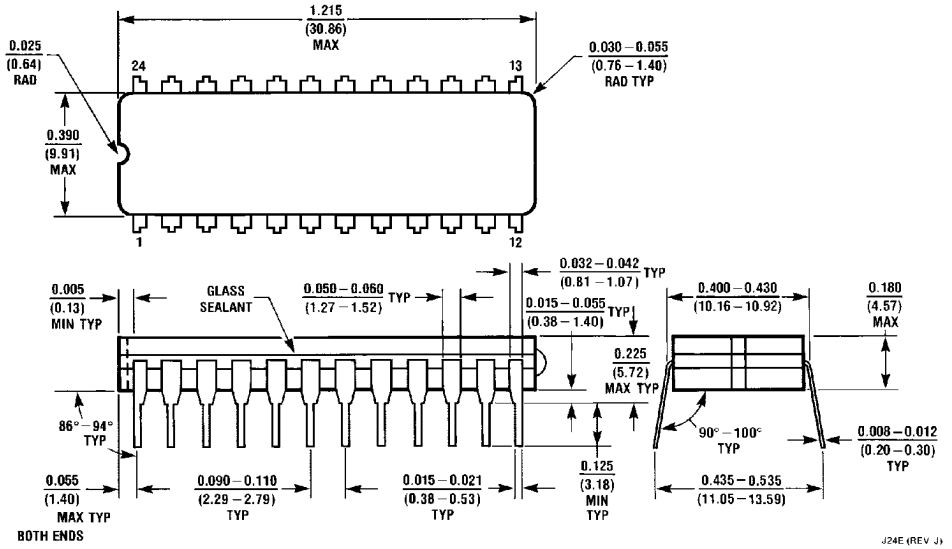
Ordering Information

The device number is used to form part of a simplified purchasing code where a package type and temperature range are defined as follows:



Physical Dimensions inches (millimeters)



24-Lead Ceramic Dual-In-Line Package (D)
NS Package Number J24E

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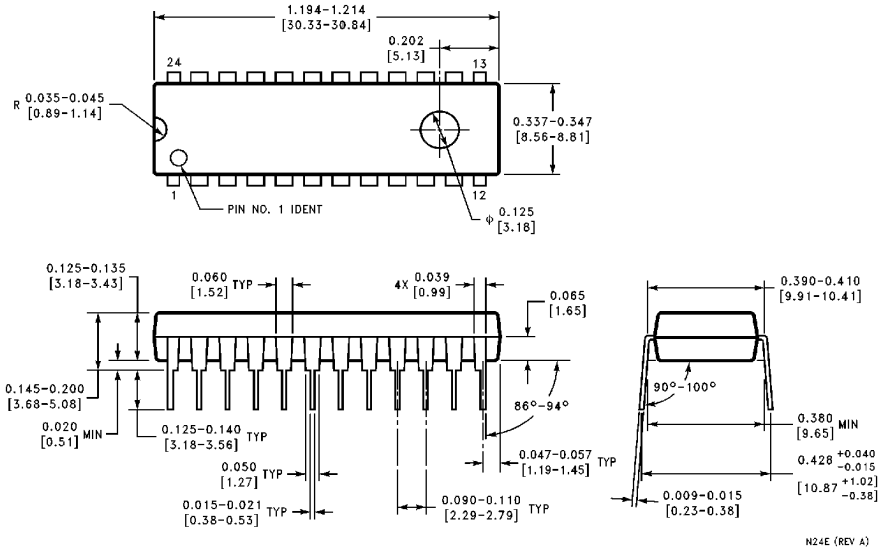
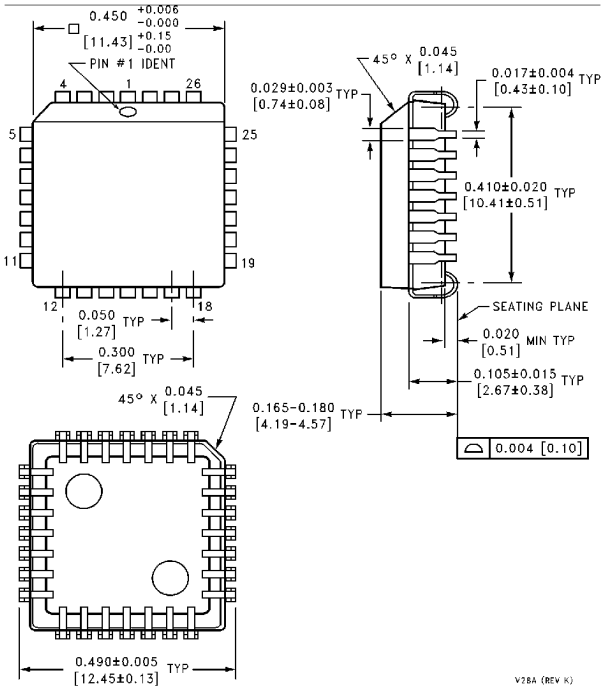
Physical Dimensions inches (millimeters) (Continued)



24-Lead Plastic Dual-In-Line Package (P)
NS Package Number N24E



28-Lead Plastic Chip Carrier (Q)
NS Package Number V28A

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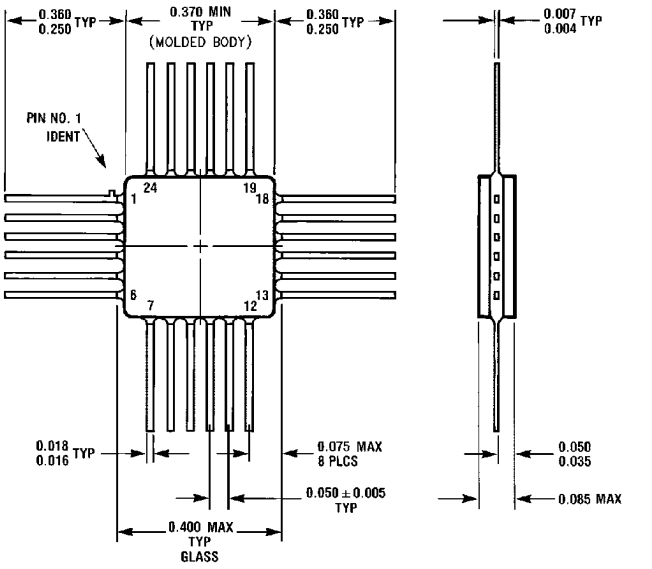
Physical Dimensions inches (millimeters) (Continued)

Lit. # 114906



24-Lead Quad Cerpak (F)
NS Package Number W24B

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