

DS2003/DS9667/DS2004 High Current/Voltage Darlington Drivers

General Description

The DS2003/DS9667/DS2004 are comprised of seven high voltage, high current NPN Darlington transistor pairs. All units feature common emitter, open collector outputs. To maximize their effectiveness, these units contain suppression diodes for inductive loads and appropriate emitter base resistors for leakage.

The DS2003/DS9667 has a series base resistor to each Darlington pair, thus allowing operation directly with TTL or CMOS operating at supply voltages of 5.0V.

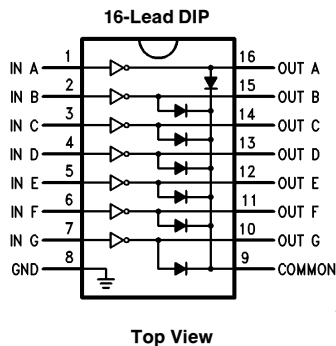
The DS2004 has an appropriate input resistor to allow direct operation from CMOS or PMOS outputs operating from supply voltages of 6.0V to 15V.

The DS2003/DS9667/DS2004 offer solutions to a great many interface needs, including solenoids, relays, lamps, small motors, and LEDs. Applications requiring sink currents beyond the capability of a single output may be accommodated by paralleling the outputs.

Features

- Seven high gain Darlington pairs
- High output voltage ($V_{CE} = 50V$)
- High output current ($I_C = 350\text{ mA}$)
- TTL, PMOS, CMOS compatible
- Suppression diodes for inductive loads
- Extended temperature range

Connection Diagram



TL/F/9647-1

Order Numbers

| | J Package Number J16A | N Package Number N16E | M Package Number M16A |
|------------------|--|--|--------------------------------------|
| DS2003 DS9667 | DS2003MJ DS2003TJ DS2003CJ DS9667MJ DS9667TJ DS9667CJ | DS2003TN DS2003CN DS9667TN DS9667CN | DS2003TM DS2003CM |
| DS2004 | DS2004MJ DS2004TJ DS2004CJ | DS2004TN DS2004CN | DS2004TM DS2004CM |

Absolute Maximum Ratings (Note 1)

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

Storage Temperature Range

| | |
|-------------|-----------------|
| Ceramic DIP | -65°C to +175°C |
| Molded DIP | -65°C to +150°C |

Operating Temperature Range

| | |
|-----------------|-----------------|
| DS2003M/DS9667M | -55°C to +125°C |
| DS2004M | -55°C to +125°C |
| DS2003T/DS9667T | -40°C to +105°C |
| DS2004T | -40°C to +105°C |
| DS2003C/DS9667C | 0°C to +85°C |
| DS2004C | 0°C to +85°C |

Lead Temperature

| | |
|-------------------------------------|-------|
| Ceramic DIP (Soldering, 60 seconds) | 300°C |
| Molded DIP (Soldering, 10 seconds) | 265°C |

Maximum Power Dissipation* at 25°C

| | |
|----------------|---------|
| Cavity Package | 2016 mW |
| Molded Package | 1838 mW |
| S.O. Package | 926 mW |

*Derate cavity package 16.13 mW/°C above 25°C; derate molded DIP package 14.7 mW/°C above 25°C. Derate S.O. package 7.4 mW/°C.

| | |
|------------------------------|--------|
| Input Voltage | 30V |
| Output Voltage | 55V |
| Emitter-Base Voltage | 6.0V |
| Continuous Collector Current | 500 mA |
| Continuous Base Current | 25 mA |

Electrical Characteristics $T_A = 25^\circ\text{C}$, unless otherwise specified (Note 2)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---------------|--------------------------------------|---|--------------------------|------|------|---------------|
| I_{CEX} | Output Leakage Current | $T_A = 25^\circ\text{C}$, $V_{CE} = 50\text{V}$ (Figure 1a) | | | 20 | μA |
| | | $T_A = 85^\circ\text{C}$, $V_{CE} = 50\text{V}$ (Figure 1a) for Commercial Grade | | | 100 | |
| | | $T_A = 25^\circ\text{C}$, $V_{CE} = 50\text{V}$, $V_I = 1.0\text{V}$ (Figure 1b) DS2004 | | | 500 | |
| $V_{CE(Sat)}$ | Collector-Emitter Saturation Voltage | $I_C = 350\text{ mA}$, $I_B = 500\ \mu\text{A}$ (Figure 2) (Note 3) | | 1.25 | 1.6 | V |
| | | $I_C = 200\text{ mA}$, $I_B = 350\ \mu\text{A}$ (Figure 2) | | 1.1 | 1.3 | |
| | | $I_C = 100\text{ mA}$, $I_B = 250\ \mu\text{A}$ (Figure 2) | | 0.9 | 1.1 | |
| $I_{I(ON)}$ | Input Current | $V_I = 3.85\text{V}$ (Figure 3) DS2003/DS9667 | | 0.93 | 1.35 | mA |
| | | $V_I = 5.0\text{V}$ (Figure 3) DS2004 | | 0.35 | 0.5 | |
| | | $V_I = 12\text{V}$ (Figure 3) | | 1.0 | 1.45 | |
| $I_{I(OFF)}$ | Input Current (Note 4) | $T_A = 85^\circ\text{C}$ for Commercial $I_C = 500\ \mu\text{A}$ (Figure 4) | 50 | 100 | | μA |
| $V_{I(ON)}$ | Input Voltage (Note 5) | $V_{CE} = 2.0\text{V}$, $I_C = 200\text{ mA}$ (Figure 5) DS2003/DS9667 | | | 2.4 | V |
| | | $V_{CE} = 2.0\text{V}$, $I_C = 250\text{ mA}$ (Figure 5) | | | 2.7 | |
| | | $V_{CE} = 2.0\text{V}$, $I_C = 300\text{ mA}$ (Figure 5) | | | 3.0 | |
| | | $V_{CE} = 2.0\text{V}$, $I_C = 125\text{ mA}$ (Figure 5) DS2004 | | | 5.0 | |
| | | $V_{CE} = 2.0\text{V}$, $I_C = 200\text{ mA}$ (Figure 5) | | | 6.0 | |
| | | $V_{CE} = 2.0\text{V}$, $I_C = 275\text{ mA}$ (Figure 5) | | | 7.0 | |
| | | $V_{CE} = 2.0\text{V}$, $I_C = 350\text{ mA}$ (Figure 5) | | | 8.0 | |
| C_I | Input Capacitance | | | 15 | 30 | pF |
| t_{PLH} | Turn-On Delay | $0.5 V_I$ to $0.5 V_O$ | | | 1.0 | μs |
| t_{PHL} | Turn-Off Delay | $0.5 V_I$ to $0.5 V_O$ | | | 1.0 | μs |
| I_R | Clamp Diode Leakage Current | $V_R = 50\text{V}$ (Figure 6) | $T_A = 25^\circ\text{C}$ | | 50 | μA |
| | | | $T_A = 85^\circ\text{C}$ | | 100 | μA |
| V_F | Clamp Diode Forward Voltage | $I_F = 350\text{ mA}$ (Figure 7) | | 1.7 | 2.0 | V |

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 devices should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.

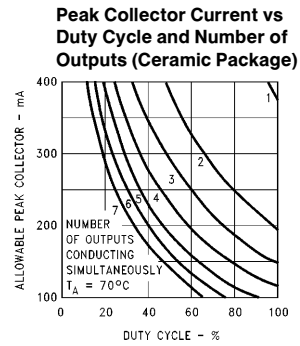
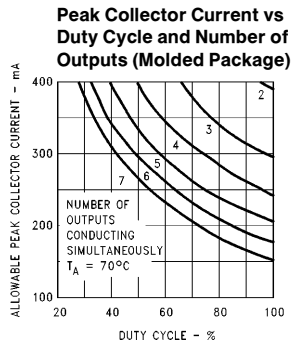
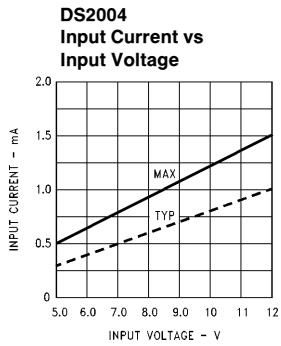
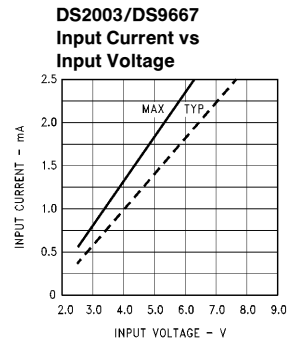
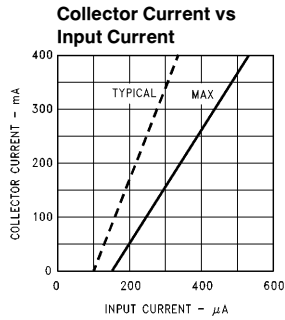
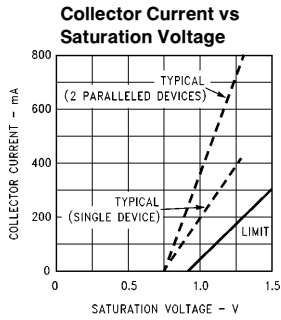
Note 2: All limits apply to the complete Darlington series except as specified for a single device type.

Note 3: Under normal operating conditions these units will sustain 350 mA per output with $V_{CE(Sat)} = 1.6\text{V}$ at 70°C with a pulse width of 20 ms and a duty cycle of 30%.

Note 4: The $I_{I(OFF)}$ current limit guaranteed against partial turn-on of the output.

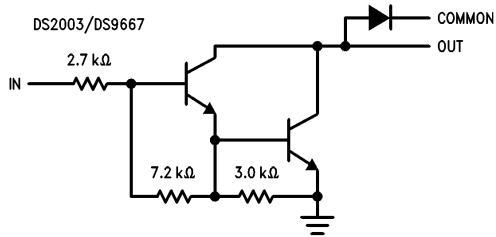
Note 5: The $V_{I(ON)}$ voltage limit guarantees a minimum output sink current per the specified test conditions.

Typical Performance Characteristics

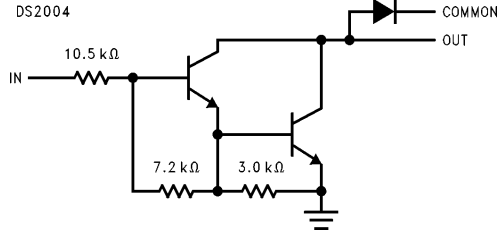


TL/F/9647-6

Equivalent Circuits

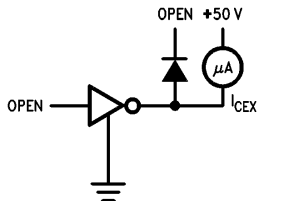


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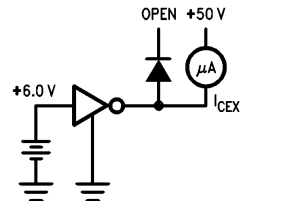
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Test Circuits



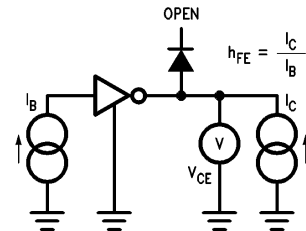
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FIGURE 1a



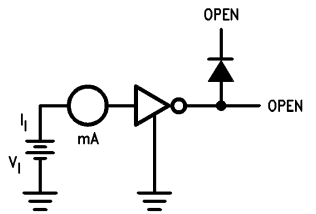
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FIGURE 1b



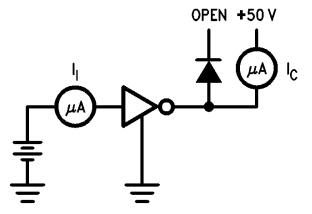
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FIGURE 2



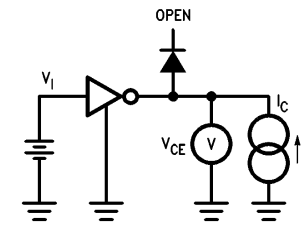
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FIGURE 3



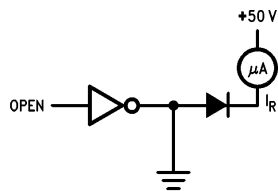
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FIGURE 4



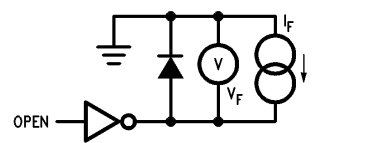
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FIGURE 5



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FIGURE 6

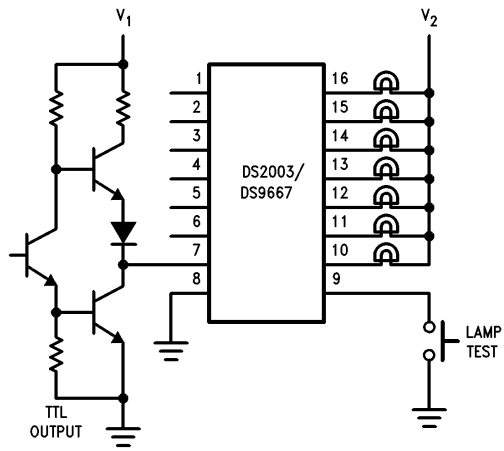


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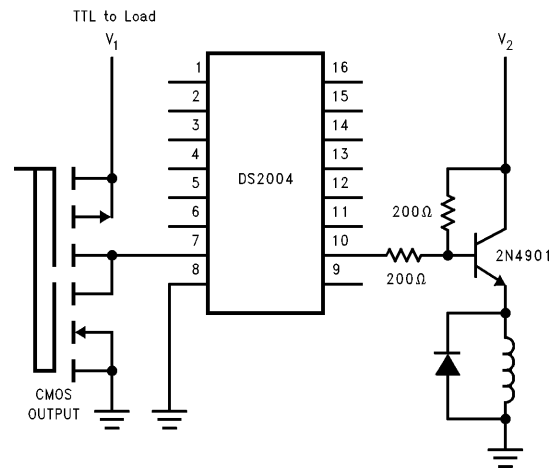
FIGURE 7

Typical Applications

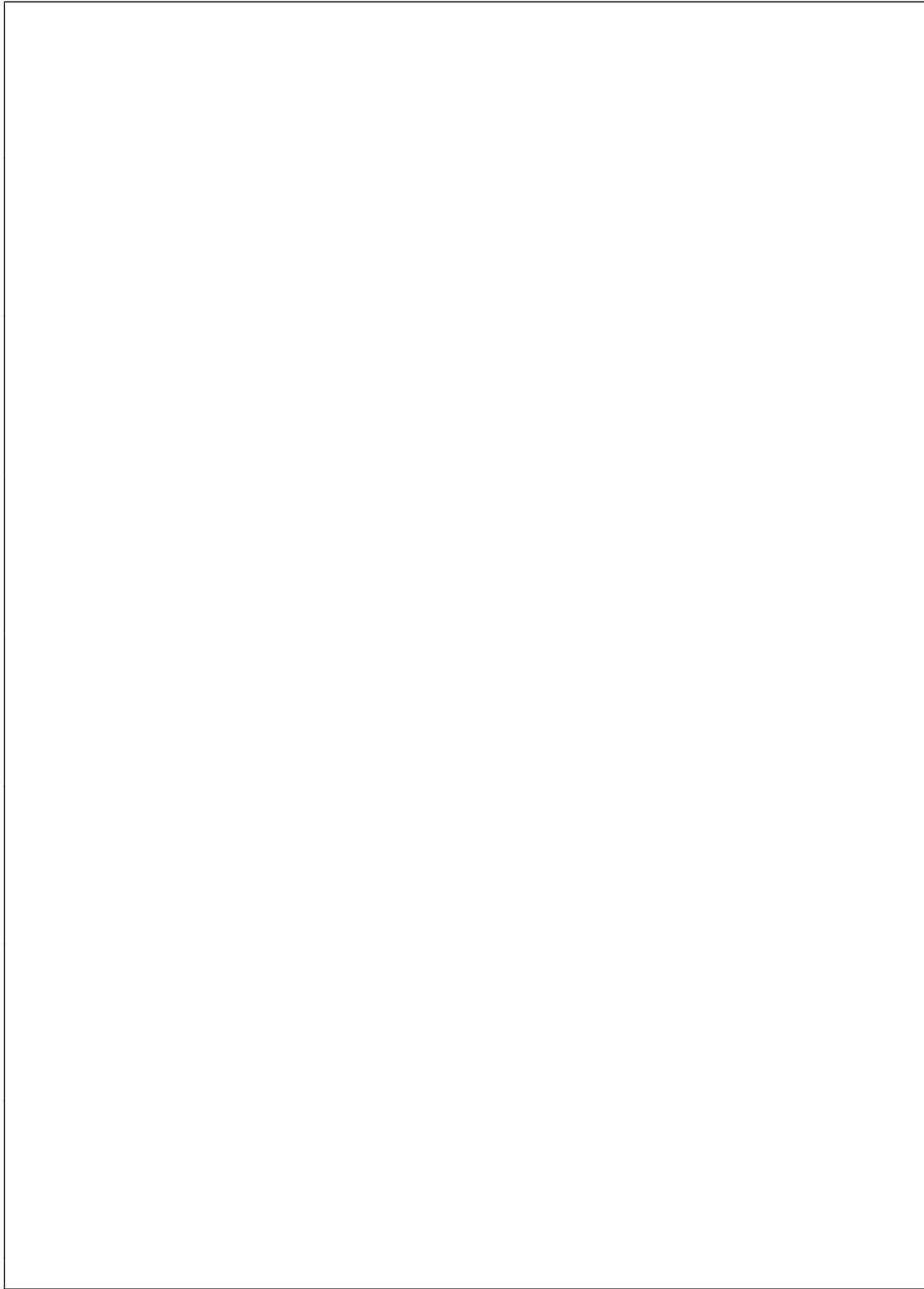
Buffer for Higher Current Loads



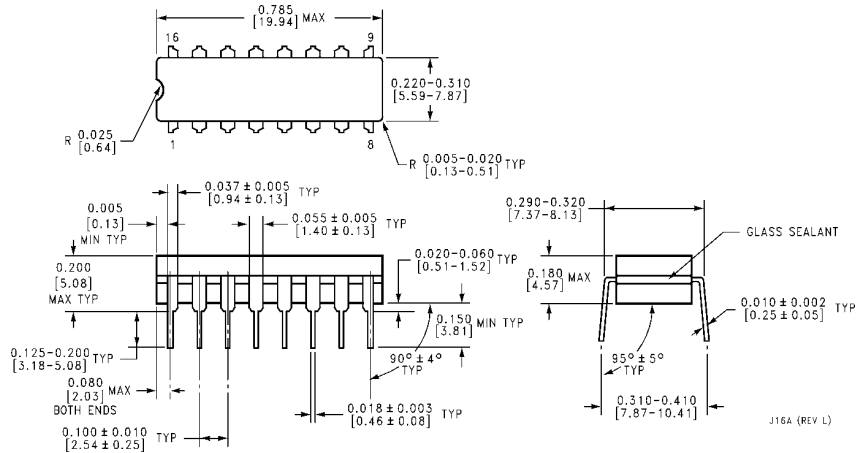
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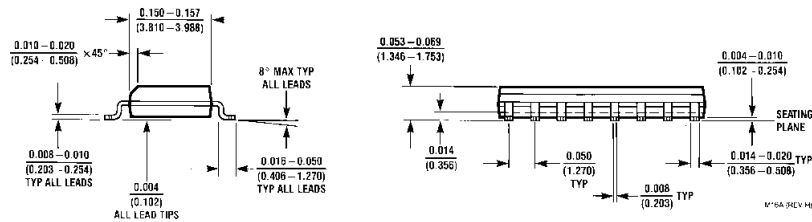
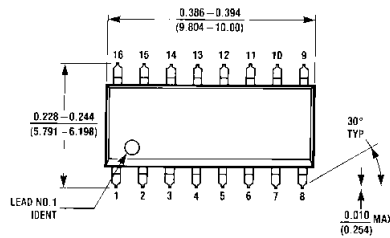
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Physical Dimensions inches (millimeters) unless otherwise noted

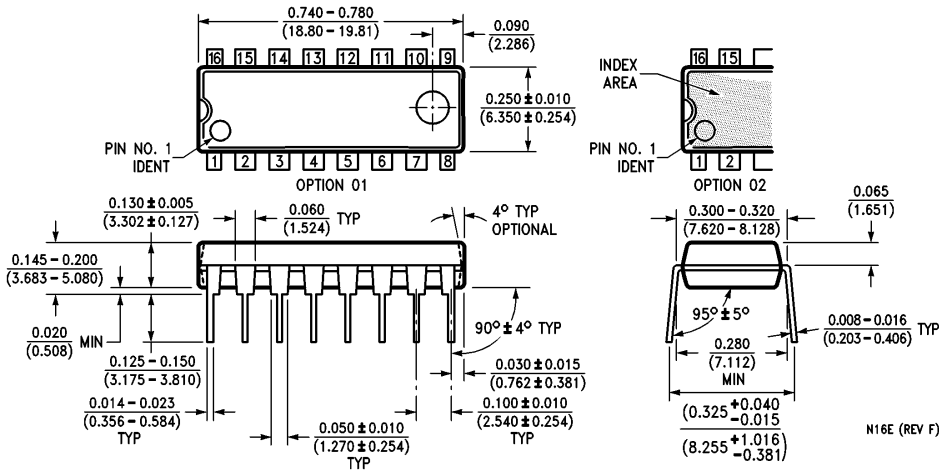


Ceramic Dual-In-Line Package (J)
Order Number DS2003CJ, DS9667CJ, DS2003MJ, D9667MJ,
DS2003TJ, DS9667TJ, DS2004CJ, DS2004MJ or DS2004TJ
NS Package Number J16A



Surface Mount Package (M)
Order Number DS2003CM, DS9667CM, DS2003TM, DS9667TM, DS2004CM or DS2004TM
NS Package Number M16A

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




Molded Dual-In-Line Package (N)

Order Number DS2003CN, DS9667CN, DS2003TN, DS9667TN, DS2004CN or DS2004TN
 NS Package Number N16E

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