National Semiconductor

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.

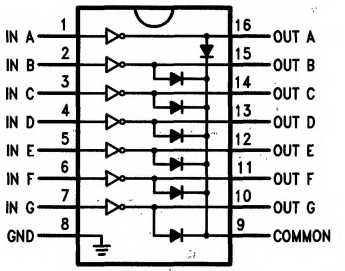
The DS2003/DS9667/DS2004 offer solutions to a great many interface needs, including solenoids, relays, lamps, small motors, and LEDs. Applications requiring sink currents beyond the capability of a single output may be accommodated by paralleling the outputs.

Features

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

Connection Diagram

16-Lead DIP



TL/F/9647–1

Top View

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°C, unless otherwise specified (Note 2)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
I_{CEX}	Output Leakage Current	T_A = 85°C for Commercial V_{CE} = 50V *(Figure 1a)*				100	μA
		V_{CE} = 50V, V_I = 1.0V *(Figure 1b)*	DS2004			500	
$V_{CE(Sat)}$	Collector-Emitter Saturation Voltage	I_C = 350 mA, I_B = 500 μA *(Figure 2)* (Note 3)			1.25	1.6	V
		I_C = 200 mA, I_B = 350 μA *(Figure 2)*			1.1	1.3	
		I_C = 100 mA, I_B = 250 μA *(Figure 2)*			0.9	1.1	
$I_{I(ON)}$	Input Current	V_I = 3.85V *(Figure 3)*	DS2003/DS9667		0.93	1.35	mA
		V_I = 5.0V *(Figure 3)*	DS2004		0.35	0.5	
		V_I = 12V *(Figure 3)*			1.0	1.45	
$I_{I(OFF)}$	Input Current (Note 4)	T_A = 85°C for Commercial I_C = 500 μA *(Figure 4)*		50	100		μA
$V_{I(ON)}$	Input Voltage (Note 5)	V_{CE} = 2.0V, I_C = 200 mA *(Figure 5)*	DS2003/DS9667			2.4	V
		V_{CE} = 2.0V, I_C = 250 mA *(Figure 5)*				2.7	
		V_{CE} = 2.0V, I_C = 300 mA *(Figure 5)*				3.0	
		V_{CE} = 2.0V, I_C = 125 mA *(Figure 5)*	DS2004			5.0	
		V_{CE} = 2.0V, I_C = 200 mA *(Figure 5)*				6.0	
		V_{CE} = 2.0V, I_C = 275 mA *(Figure 5)*				7.0	
		V_{CE} = 2.0V, I_C = 350 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 = 50V *(Figure 6)*	T_A = 25°C T_A = 85°C			50 100	μA μA
V_F	Clamp Diode Forward Voltage	I_F = 350 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.

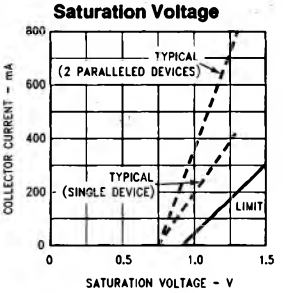
Note 3: Under normal operating conditions these units will sustain 350 mA per output with $V_{CE(Sat)}$ = 1.6V at 70°C with a pulse width of 20 ms and a duty cycle of 30%.

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

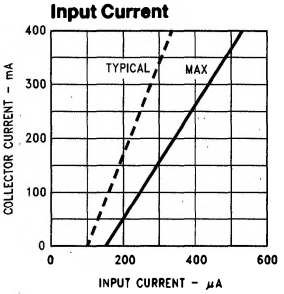
Note 5: The $V_{I(ON)}$ voltage limit guarantees a minimum output sink current per the specified test conditions.

Typical Performance Characteristics

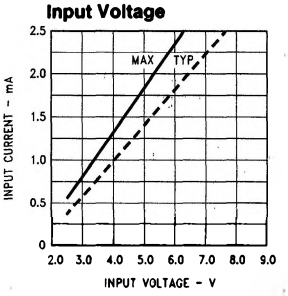
Collector Current vs Saturation Voltage



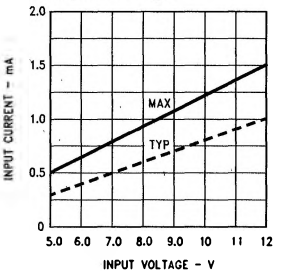
Collector Current vs Input Current



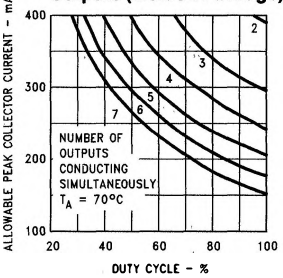
DS2003/DS9667 Input Current vs Input Voltage



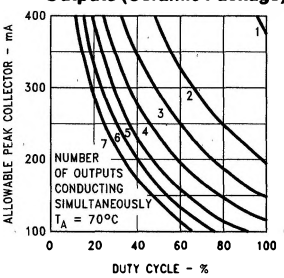
DS2004 Input Current vs Input Voltage



Peak Collector Current vs Duty Cycle and Number of Outputs (Molded Package)

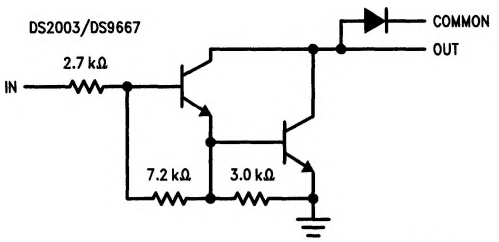


Peak Collector Current vs Duty Cycle and Number of Outputs (Ceramic Package)

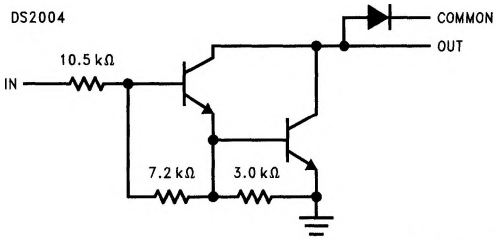


TL/F/9647-6

Equivalent Circuits

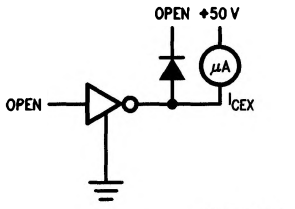


TL/F/9647–3



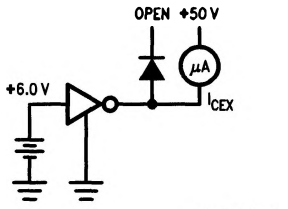
TL/F/9647–5

Test Circuits



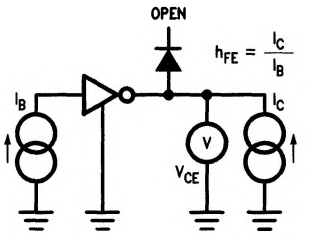
TL/F/9647–7

FIGURE 1a



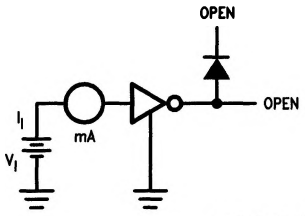
TL/F/9647–8

FIGURE 1b



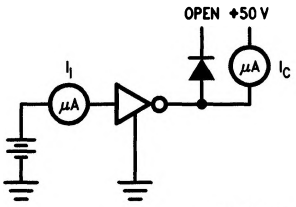
TL/F/9647–9

FIGURE 2



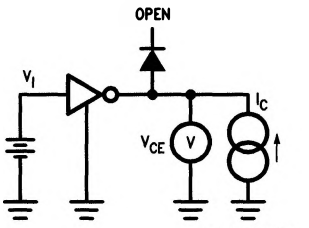
TL/F/9647–10

FIGURE 3



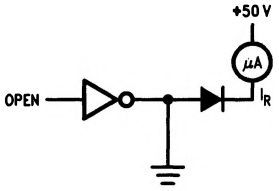
TL/F/9647–11

FIGURE 4



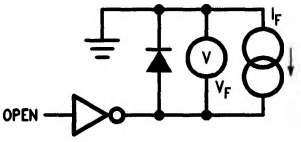
TL/F/9647–12

FIGURE 5



TL/F/9647–13

FIGURE 6

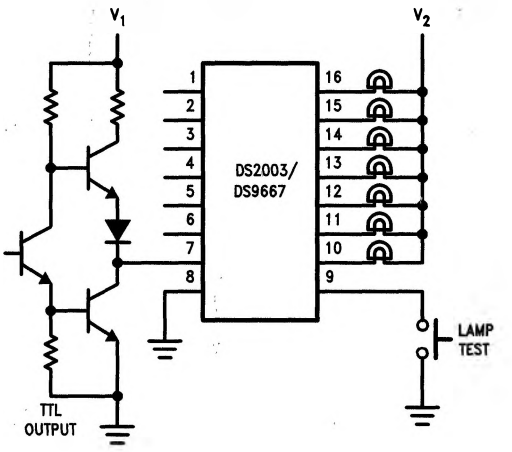


TL/F/9647–14

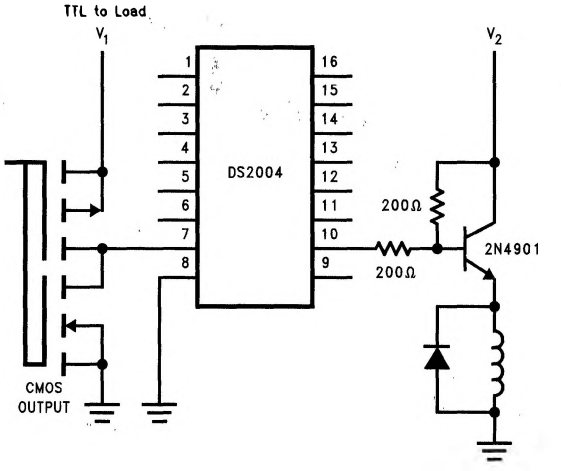
FIGURE 7

Typical Applications

Buffer for Higher Current Loads



TL/F/9647–16



TL/F/9647–17