ULN2003/ULN2004 Seven Darlington array

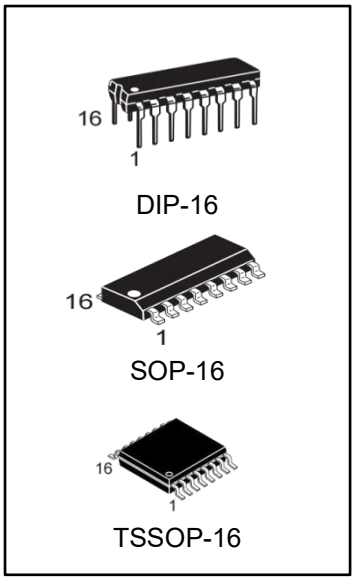
Description

The ULN2003, ULN2004,are high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters. Each channel rated at 500 mA and can withstand peak currents of 600 mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout.

The versions interface to all common logic families:

- ULN2003 (5 V TTL, CMOS)
- ULN2004 (6 - 15 V CMOS, PMOS)

These versatile devices are useful for driving a wide range of loads including solenoids, relays DC motors, LED displays filament lamps, thermal printheads and high power buffers.



Features

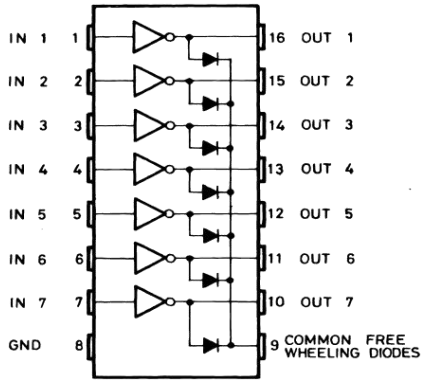
- Seven Darlingtons per package
- Output current 500 mA per driver (600 mA peak)
- Output voltage 50 V
- Integrated suppression diodes for inductive loads
- Outputs can be paralleled for higher current
- TTL/CMOS/PMOS/DTL compatible inputs
- Inputs pinned opposite outputs to simplify layout

Ordering Information

DEVICE	Package Type	MARKING	Packing	Packing Qty
ULN2003N	DIP-16	ULN2003	TUBE	1000pcs/Box
ULN2004N	DIP-16	ULN2004	TUBE	1000pcs/Box
ULN2003M/TR	SOP-16	ULN2003	REEL	2500pcs/Reel
ULN2004M/TR	SOP-16	ULN2004	REEL	2500pcs/Reel
ULN2003MT/TR	TSSOP-16	ULN2003	REEL	2500pcs/Reel
ULN2004MT/TR	TSSOP-16	ULN2004	REEL	2500pcs/Reel

Pin configuration

DIP-16/SOP-16/TSSOP-16



Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_O	Output voltage	50	V
V_I	Input voltage (for ULN2003 - 2004)	30	V
I_C	Continuous collector current	500	mA
I_B	Continuous base current	25	mA
T_A	Operating ambient temperature range	- 40 to 85	°C
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Junction temperature	150	°C
T_L	Lead Temperature (Soldering, 10 seconds)	245	°C

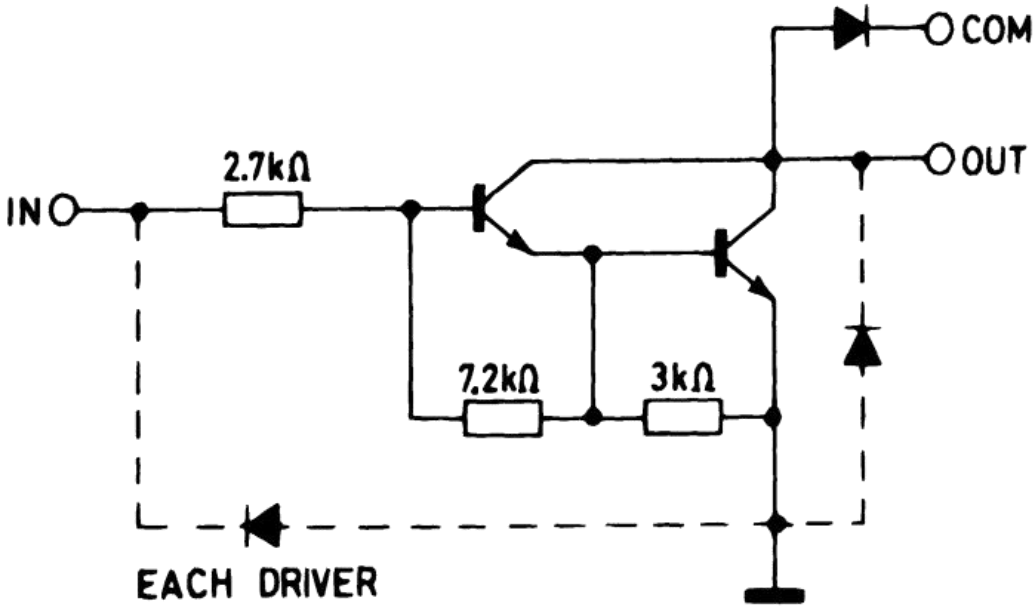
Note:Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not ensured.

Thermal data

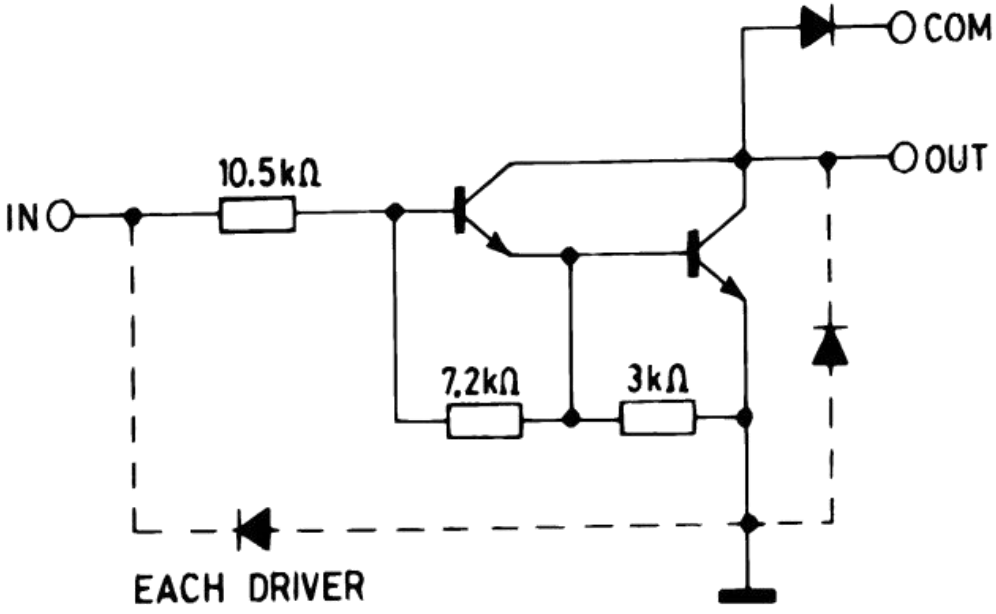
Symbol	Parameter	DIP-16	SOP-16	Unit
R_{thJA}	Thermal resistance junction-ambient, Max.	70	120	℃/W

Diagram

Schematic diagram



ULN2003 (each driver)



ULN2004 (each driver)

Electrical characteristics

TA = 25 °C unless otherwise specified.

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
I_{CEX}	Output leakage current	V_{CE} = 50 V, (Figure 1.)			50	μA
		T_A = 85°C, V_{CE} = 50 V (Figure 1.)			100	
		T_A = 85°C for ULN2002, V_{CE} = 50 V, V_I = 6 V (Figure 2.)			500	
		T_A = 85°C for ULN2002, V_{CE} = 50 V, V_I = 1V (Figure 2.)			500	
$V_{CE(SAT)}$	Collector-emitter saturation voltage (Figure 3.)	I_C = 100 mA, I_B = 250 μA		0.9	1.1	V
		I_C = 200 mA, I_B= 350 μA		1.1	1.3	
		I_C = 350 mA, I_B= 500 μA		1.3	1.6	
$I_{I(ON)}$	Input current (Figure 4.)	for ULN2002, V_I = 17 V		0.82	1.25	mA
		for ULN2003, V_I = 3.85 V		0.93	1.35	
		for ULN2004, V_I = 5 V		0.35	0.5	
		V_I = 12 V		1	1.45	
$I_{I(OFF)}$	Input current (Figure 5.)	T_A = 85°C, I_C = 500 μA	50	65		μA
$V_{I(ON)}$	Input voltage (Figure 6.)	V_{CE}= 2 V, for ULN2002 I_C = 300 mA for ULN2003 I_C = 200 mA I_C = 250 mA I_C = 300 mA for ULN2004 I_C = 125 mA I_C = 200 mA I_C = 275 mA I_C = 350 mA			 13 2.4 2.7 3 5 6 7 8	V
h_{FE}	DC Forward current gain(Figure 3.)	for ULN2001, V_{CE} = 2 V, I_C = 350mA	1000			
C_I	Input capacitance			15	25	pF
t_{PLH}	Turn-on delay time	0.5 V_I to 0.5 V_O		0.25	1	μs
t_{PHL}	Turn-off delay time	0.5 V_I to 0.5 V_O		0.25	1	μs
I_R	Clamp diode leakage current(Figure 7.)	V_R = 50 V			50	μA
		T_A = 85°C, V_R = 50 V			100	
V_F	Clamp diode forward voltage(Figure 8.)	I_F = 350 mA		1.7	2	V

Test circuits

Figure 1. Output leakage currentFigure

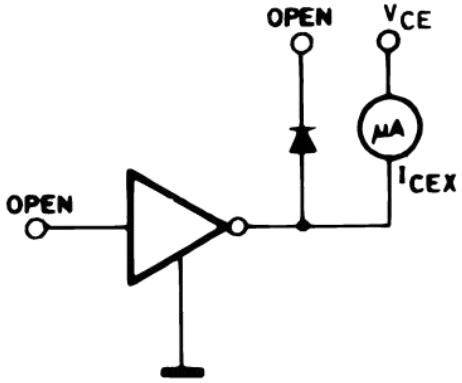


Figure 2. Output leakage current

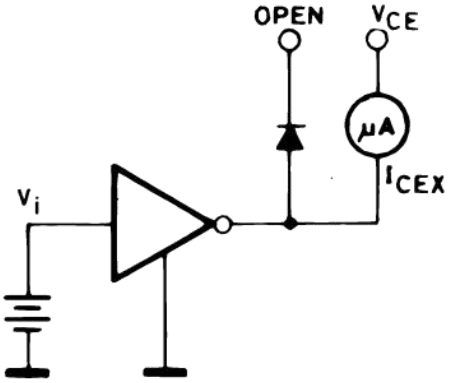


Figure 3.Collector-emitter saturation voltage

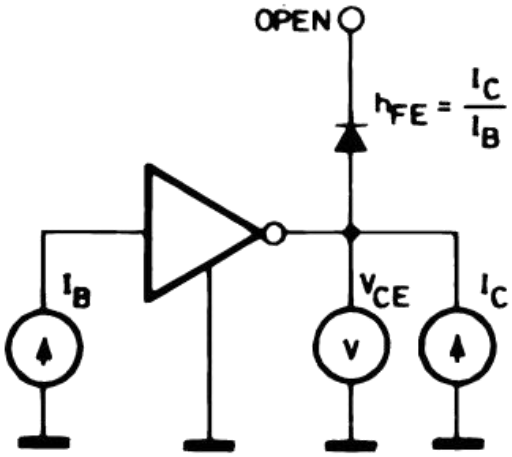


Figure 4.Input current (ON)

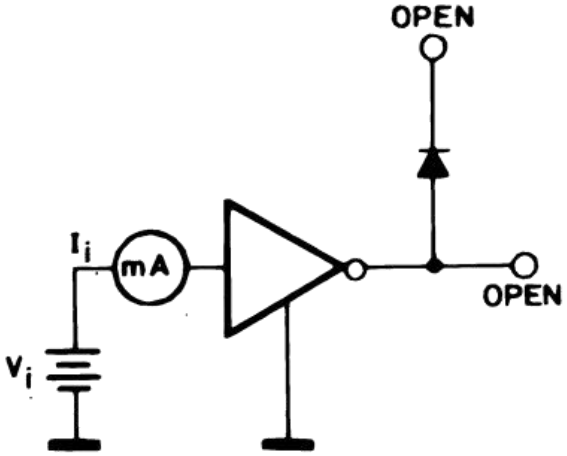


Figure 5.Input current (OFF)

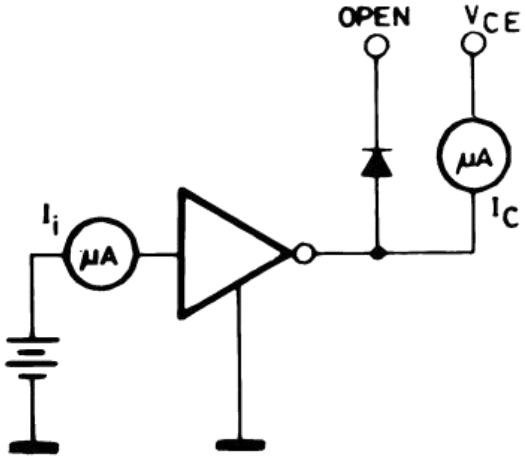


Figure 6.Input voltage

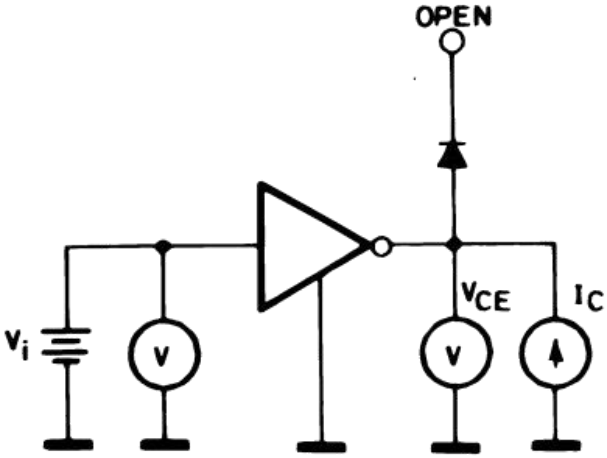


Figure 7.Clamp diode leakage current

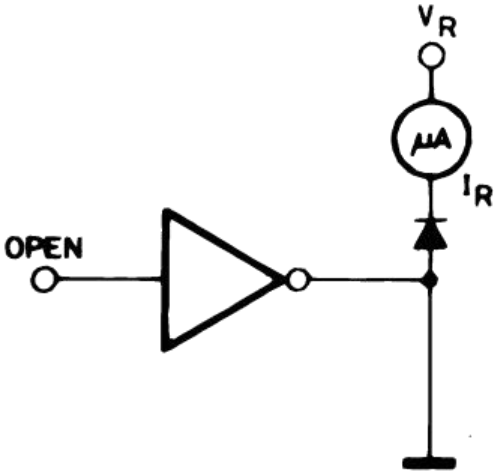
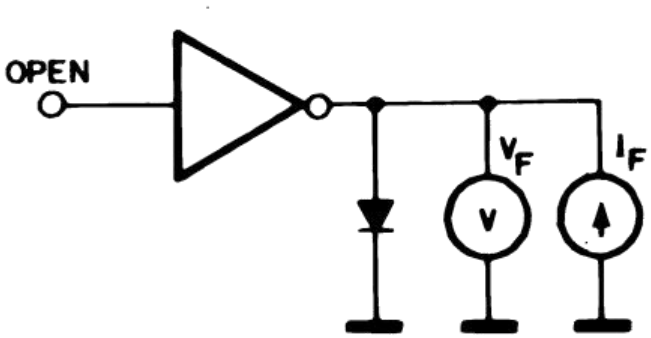


Figure 8.Clamp diode forward voltage



Typical performance characteristics

Figure 9.Collector current vs. saturation voltage(TJ = 25°C)

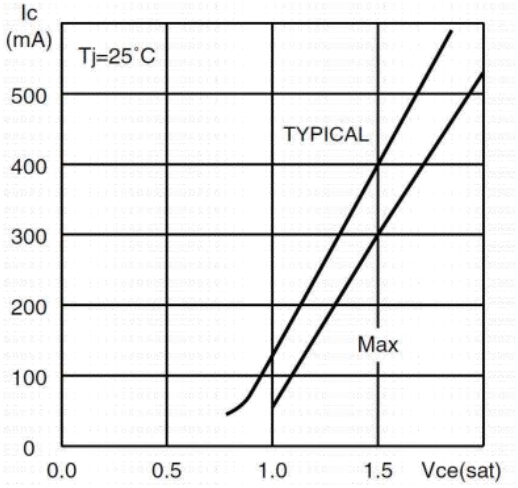


Figure 10.Collector current vs. saturation voltage

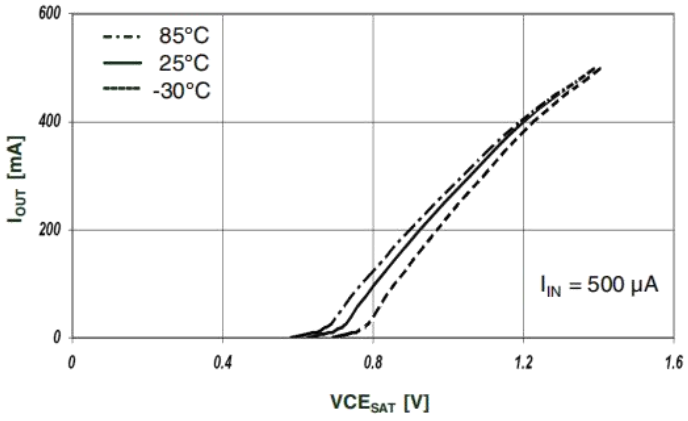


Figure 11.Input current vs. input voltage

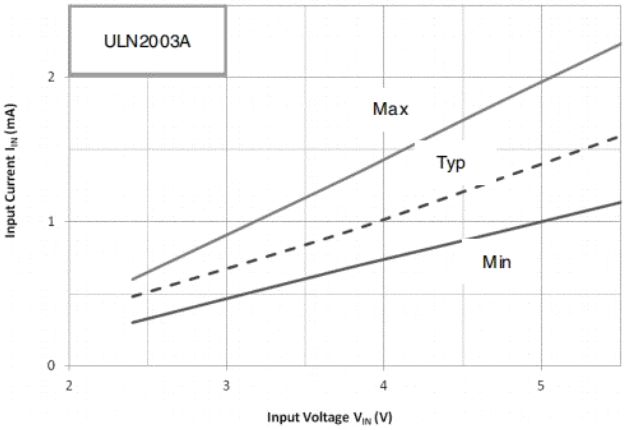


Figure 12.Input current vs. input voltage (Ta = 25°C)

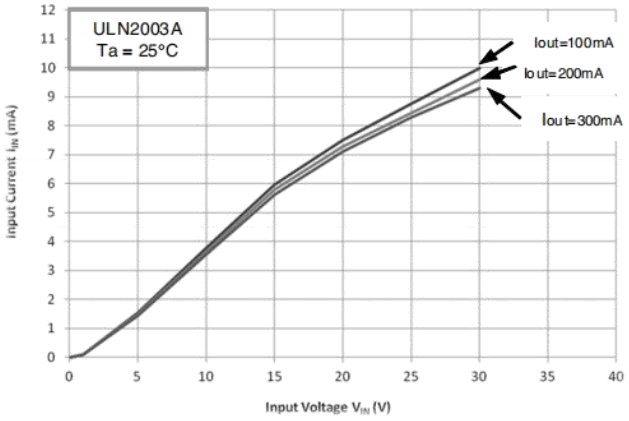


Figure 13.Collector current vs. input current

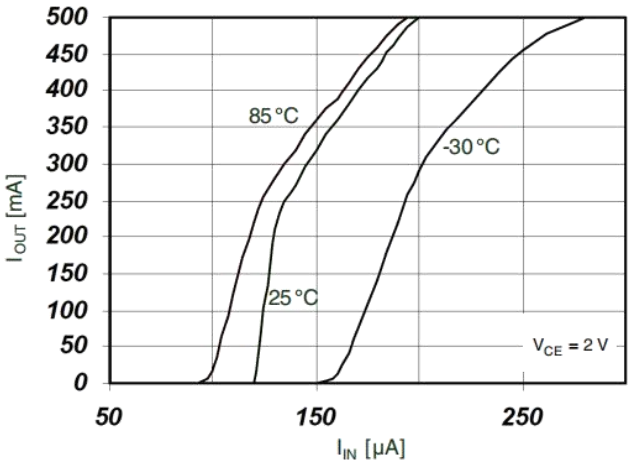
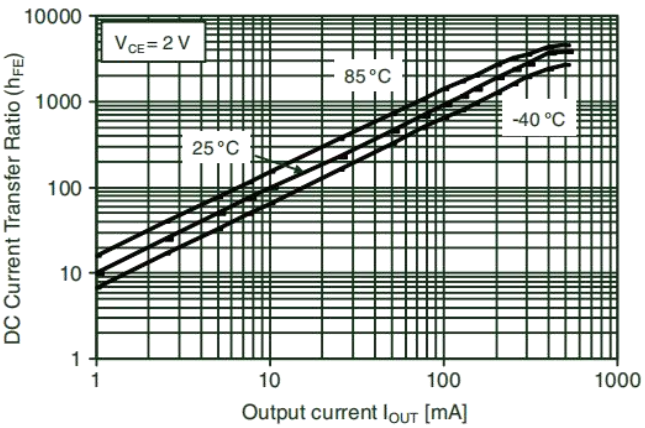


Figure 14.h FE vs. output current



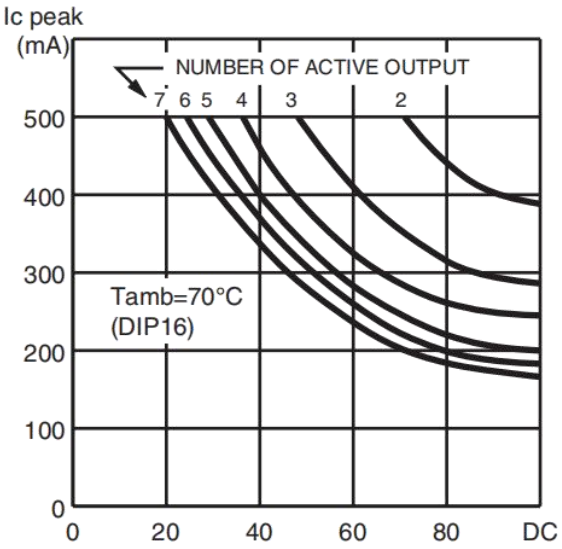


Figure 15.Peak collector current vs. duty cycle (DIP-16)

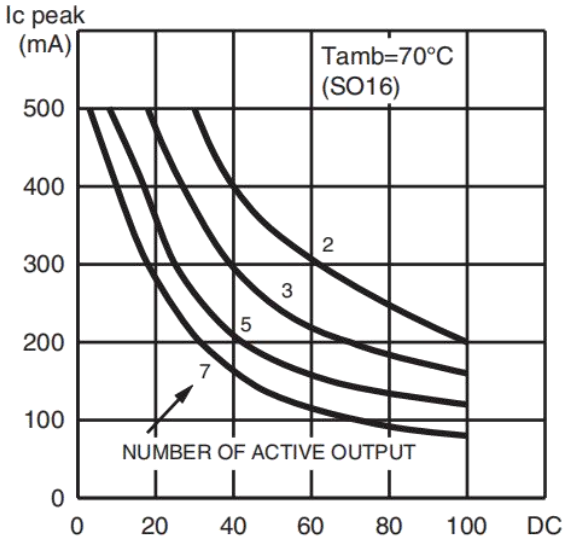
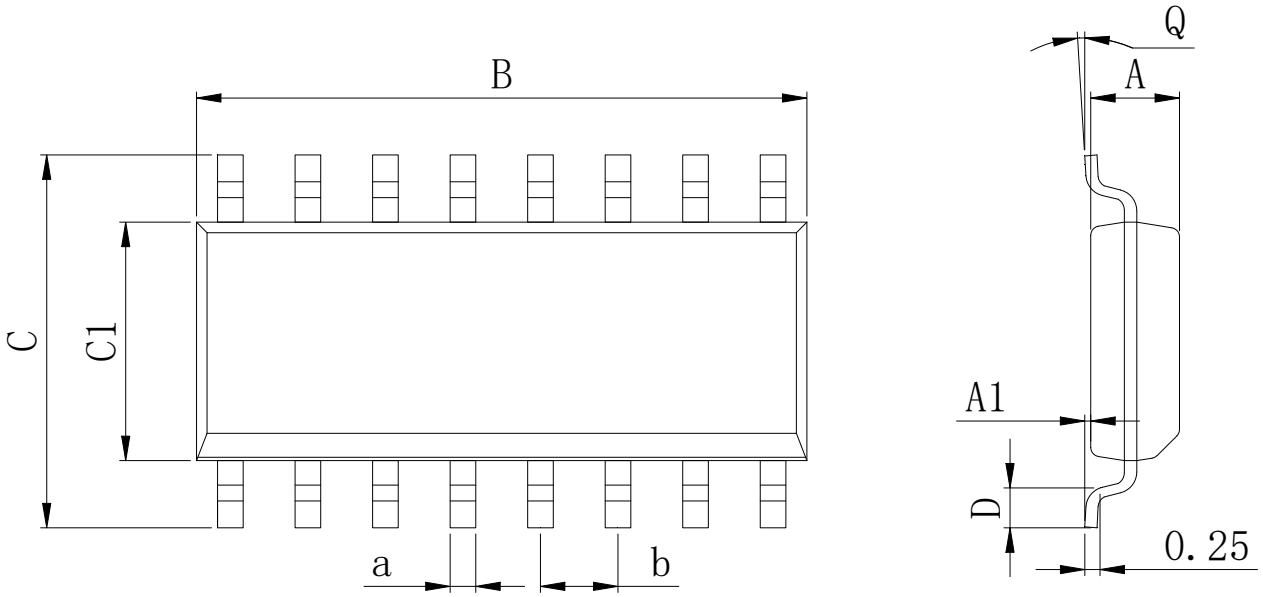


Figure 16.Peak collector current vs. duty cycle (SO-16)

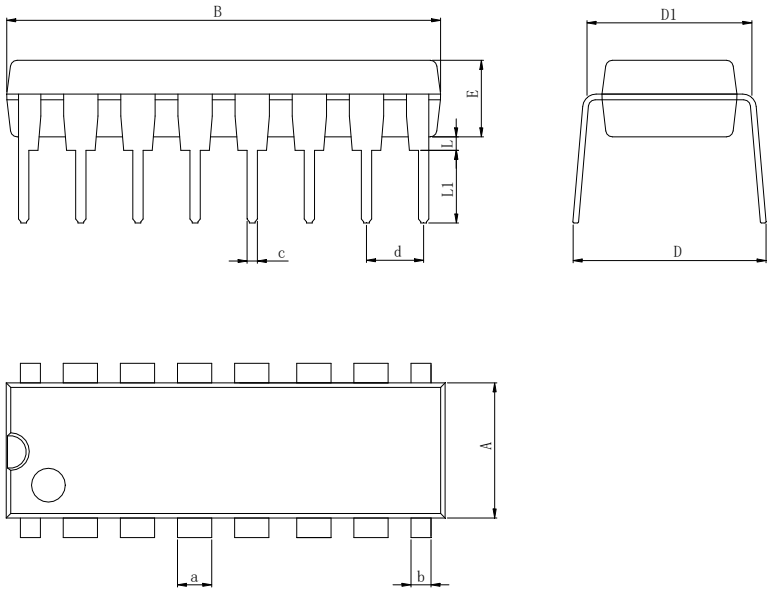
Physical Dimensions

SOP-16



Dimensions In Millimeters(SOP-16)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	9.80	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	10.0	6.20	4.00	0.80	8°	0.45	

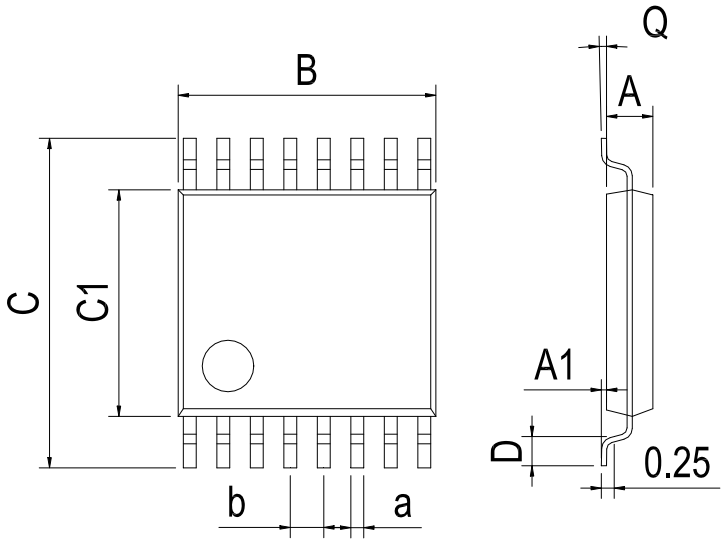
DIP-16



Dimensions In Millimeters(DIP-16)											
Symbol:	A	B	D	D1	E	L	L1	a	b	c	d
Min:	6.10	18.94	8.10	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max:	6.68	19.56	10.9	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

Physical Dimensions

TSSOP-16



Dimensions In Millimeters(TSSOP-16)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.85	0.05	4.90	6.20	4.30	0.40	0°	0.20	0.65 BSC
Max:	0.95	0.20	5.10	6.60	4.50	0.80	8°	0.25	

Revision History

DATE	REVISION	PAGE
2016-8-14	New	1-12
2023-9-14	Modify the package dimension diagram TSSOP-16、Update encapsulation type、Update Lead Temperature、Updated DIP-16 dimension、Add annotation for Maximum Ratings.	1、2、9、10

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