

TOSHIBA Bipolar Digital Integrated Circuit Silicon Monolithic

ULN2003AP,ULN2003AFW,ULN2004AP,ULN2004AFW (Manufactured by Toshiba Malaysia)

7ch Darlington Sink Driver

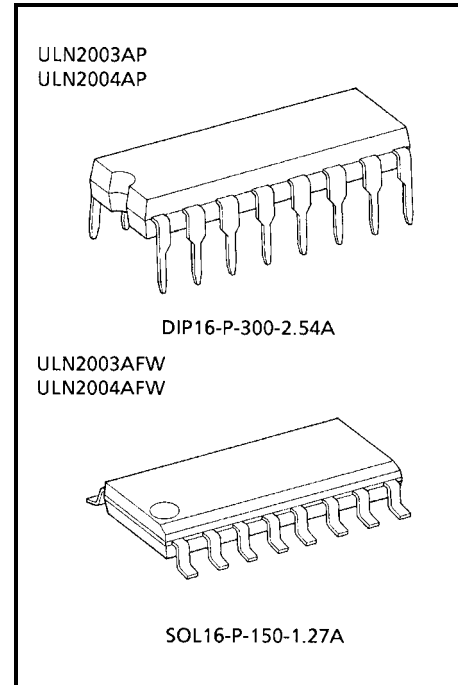
The ULN2003AP/AFW Series are high-voltage, high-current darlington drivers comprised of seven NPN darlington pairs. All units feature integral clamp diodes for switching inductive loads.

Applications include relay, hammer, lamp and display (LED) drivers.

Features

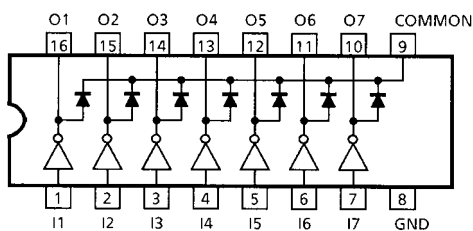
- Output current (single output): 500 mA max
- High sustaining voltage output: 50 V min
- Output clamp diodes
- Inputs compatible with various types of logic
- Package Type-AP: DIP-16pin
- Package Type-AFW: SOL-16pin

Type	Input Base Resistor	Designation
ULN2003AP/AFW	2.7 kΩ	TTL, 5 V CMOS
ULN2004AP/AFW	10.5 kΩ	6~15 V PMOS, CMOS



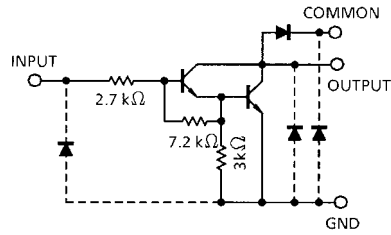
Weight
 DIP16-P-300-2.54A : 1.11 g (typ.)
 SOL16-P-150-1.27A: 0.15 g (typ.)

Pin Connection (top view)

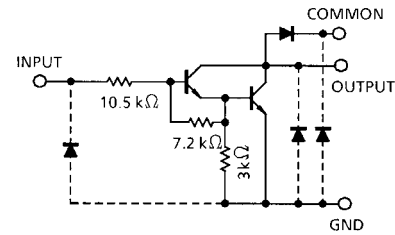


Schematics (each driver)

ULN2003AP/AFW



ULN2004AP/AFW



Note: The input and output parasitic diodes cannot be used as clamp diodes.

Maximum Ratings (Ta = 25°C)

Characteristic	Symbol	Rating	Unit
Output Sustaining Voltage	$V_{CE(SUS)}$	-0.5~50	V
Output Current	I_{OUT}	500	mA/ch
Input Voltage	V_{IN}	-0.5~30	V
Clamp Diode Reverse Voltage	V_R	50	V
Clamp Diode Forward Current	I_F	500	mA
Power Dissipation	AP	1.47	W
	AFW	1.25 (Note)	
Operating Temperature	T_{opr}	-40~85	°C
Storage Temperature	T_{stg}	-55~150	°C

Note: On PCB (Test Board: JEDEC 2s2p)

Recommended Operating Conditions (Ta = -40 to 85°C)

Characteristic		Symbol	Test Condition	Min	Typ.	Max	Unit	
Output sustaining voltage		$V_{CE(SUS)}$		0	—	50	V	
Output current	AP	I_{OUT}	$T_{pw} = 25\text{ ms}$ 7 Circuits $T_a = 85^\circ\text{C}$ $T_j = 120^\circ\text{C}$	Duty = 10%	0	—	350	mA/ch
				Duty = 50%	0	—	100	
	AFW			Duty = 10%	0	—	300	
				Duty = 50%	0	—	90	
Input voltage		V_{IN}		0	—	24	V	
Input voltage (output on)	ULN2003A	$V_{IN(ON)}$	$I_{OUT} = 400\text{ mA}$ $h_{FE} = 800$	2.8	—	24	V	
	ULN2004A			6.2	—	24		
Input voltage (output off)	ULN2003A	$V_{IN(OFF)}$		0	—	0.7	V	
	ULN2004A			0	—	1.0		
Clamp diode reverse voltage		V_R		—	—	50	V	
Clamp diode forward current		I_F		—	—	350	mA	
Power dissipation	AP	P_D	$T_a = 85^\circ\text{C}$	—	—	0.76	W	
	AFW		$T_a = 85^\circ\text{C}$ (Note)	—	—	0.65		

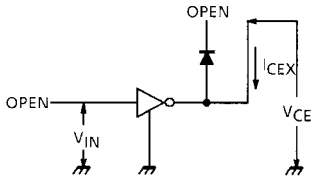
Note: On PCB (Test Board: JEDEC 2s2p)

Electrical Characteristics (Ta = 25°C unless otherwise noted)

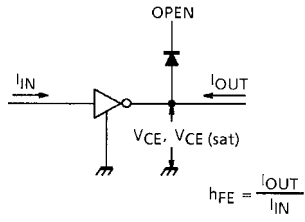
Characteristic	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit		
Output leakage current	I_{CEX}	1	$V_{CE} = 50\text{ V}, T_a = 25^\circ\text{C}$	—	—	50	μA		
			$V_{CE} = 50\text{ V}, T_a = 85^\circ\text{C}$	—	—	100			
Collector-emitter saturation voltage	$V_{CE(sat)}$	2	$I_{OUT} = 350\text{ mA}, I_{IN} = 500\text{ }\mu\text{A}$	—	1.3	1.6	V		
			$I_{OUT} = 200\text{ mA}, I_{IN} = 350\text{ }\mu\text{A}$	—	1.1	1.3			
			$I_{OUT} = 100\text{ mA}, I_{IN} = 250\text{ }\mu\text{A}$	—	0.9	1.1			
DC Current transfer ratio	h_{FE}	2	$V_{CE} = 2\text{ V}, I_{OUT} = 350\text{ mA}$	1000	—	—			
Input current (output on)	ULN2003A	$I_{IN(ON)}$	3	$V_{IN} = 2.4\text{ V}, I_{OUT} = 350\text{ mA}$	—	0.4	0.7	mA	
	ULN2004A								$V_{IN} = 9.5\text{ V}, I_{OUT} = 350\text{ mA}$
Input current (output off)	$I_{IN(OFF)}$	4	$I_{OUT} = 500\text{ }\mu\text{A}, T_a = 85^\circ\text{C}$	50	65	—	μA		
Input voltage (output on)	ULN2003A	$V_{IN(ON)}$	5	$V_{CE} = 2\text{ V}$ $h_{FE} = 800$	—	—	$I_{OUT} = 350\text{ mA}$	2.6	
							$I_{OUT} = 200\text{ mA}$		2.0
	ULN2004A						$I_{OUT} = 350\text{ mA}$		4.7
							$I_{OUT} = 200\text{ mA}$		4.4
Clamp diode reverse current	I_R	6	$V_R = 50\text{ V}, T_a = 25^\circ\text{C}$	—	—	50	μA		
			$V_R = 50\text{ V}, T_a = 85^\circ\text{C}$	—	—	100			
Clamp diode forward voltage	V_F	7	$I_F = 350\text{ mA}$	—	—	2.0	V		
Input capacitance	C_{IN}	—		—	15	—	pF		
Turn-on delay	t_{ON}	8	$V_{OUT} = 50\text{ V}, R_L = 125\text{ }\Omega$ $C_L = 15\text{ pF}$	—	0.1	—	μs		
Turn-off delay	t_{OFF}	8	$V_{OUT} = 50\text{ V}, R_L = 125\text{ }\Omega$ $C_L = 15\text{ pF}$	—	0.2	—			

Test Circuit

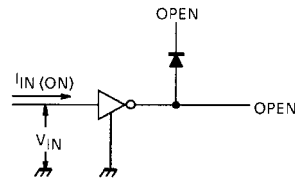
1. I_{CEX}



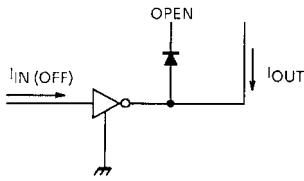
2. $V_{CE(sat)}$, h_{FE}



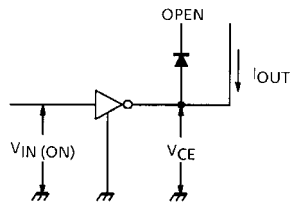
3. $I_{IN(ON)}$



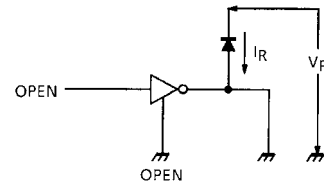
4. $I_{IN(OFF)}$



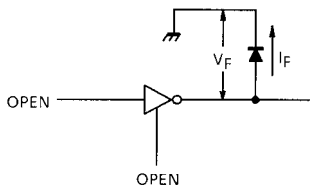
5. $V_{IN(ON)}$



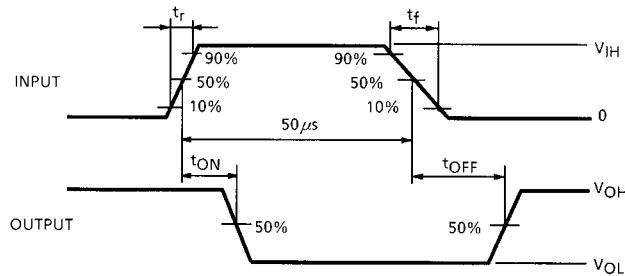
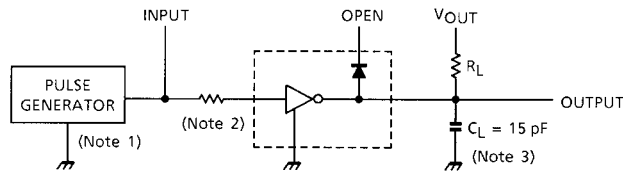
6. I_R



7. V_F



8. t_{ON} , t_{OFF}



- Note 1: Pulse width 50 μ s, duty cycle 10%
Output impedance 50 Ω , $t_r \leq 5$ ns, $t_f \leq 10$ ns
- Note 2: See below

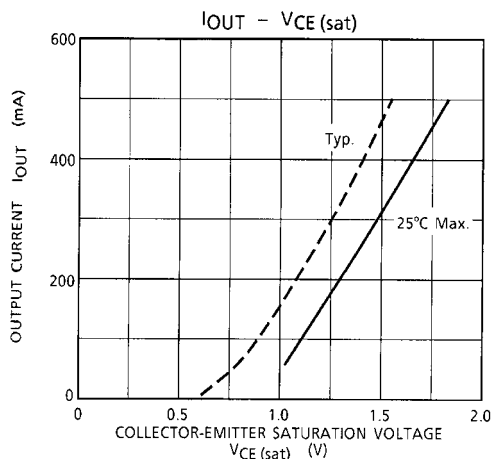
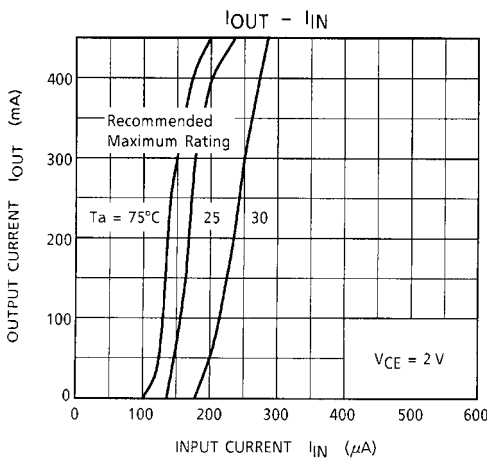
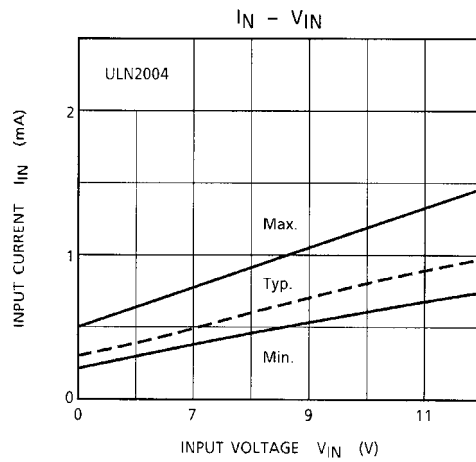
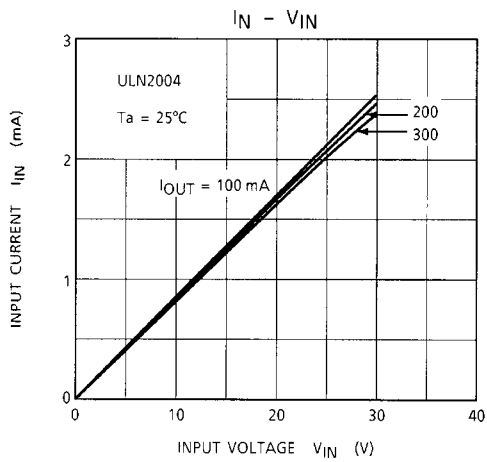
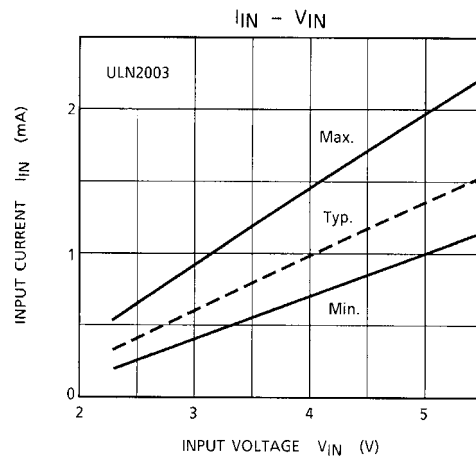
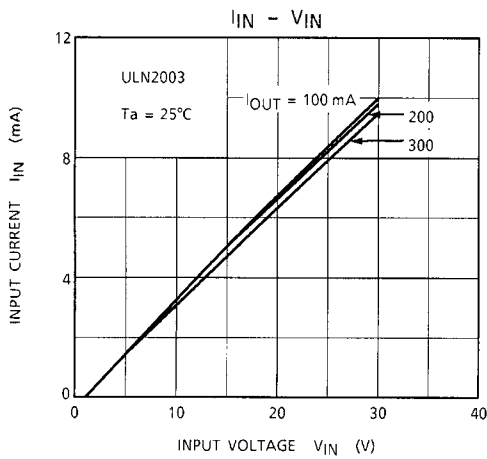
Input Condition

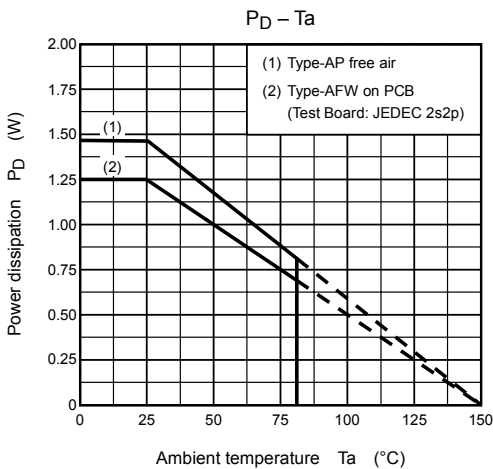
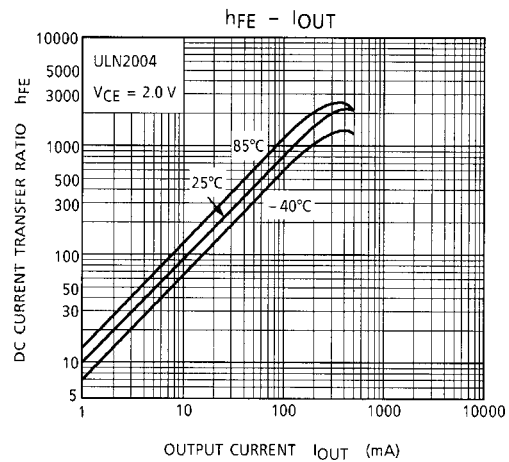
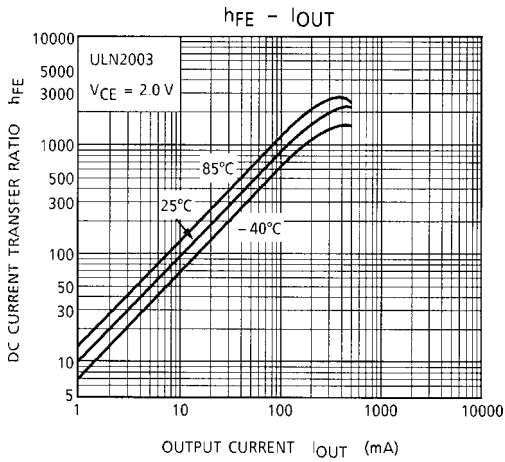
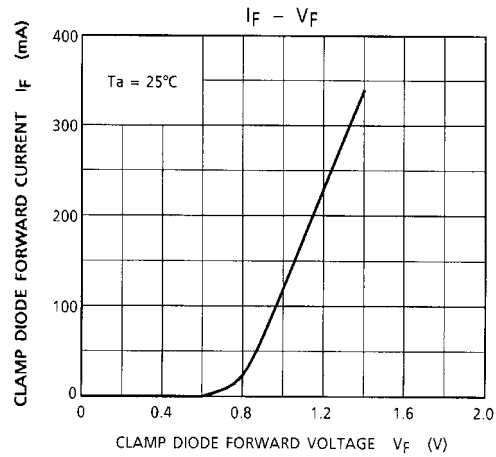
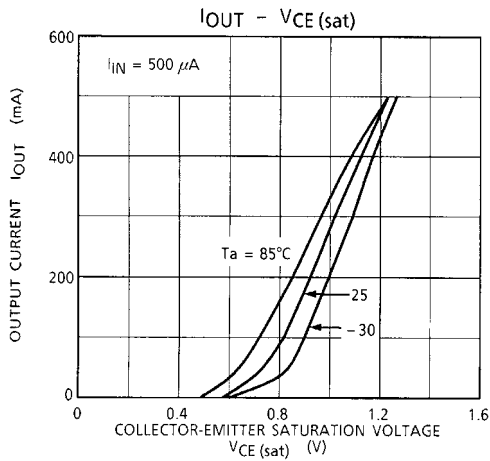
Type Number	R1	V _{IH}
ULN2003AP/AFW	0	3 V
ULN2004AP/AFW	0	8 V

Note 3: C_L includes probe and jig capacitance.

Precautions for Using

This IC does not include built-in protection circuits for excess current or overvoltage. If this IC is subjected to excess current or overvoltage, it may be destroyed. Hence, the utmost care must be taken when systems which incorporate this IC are designed. Utmost care is necessary in the design of the output line, COMMON and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.

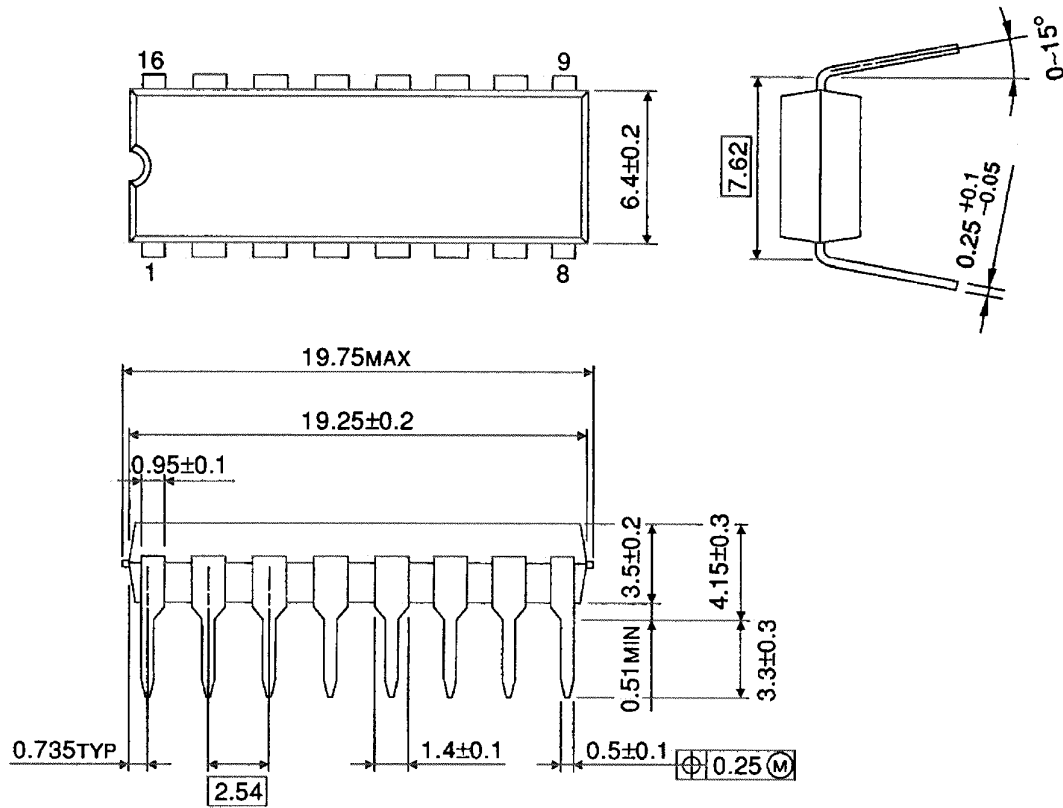




Package Dimensions

DIP16-P-300-2.54A

Unit : mm

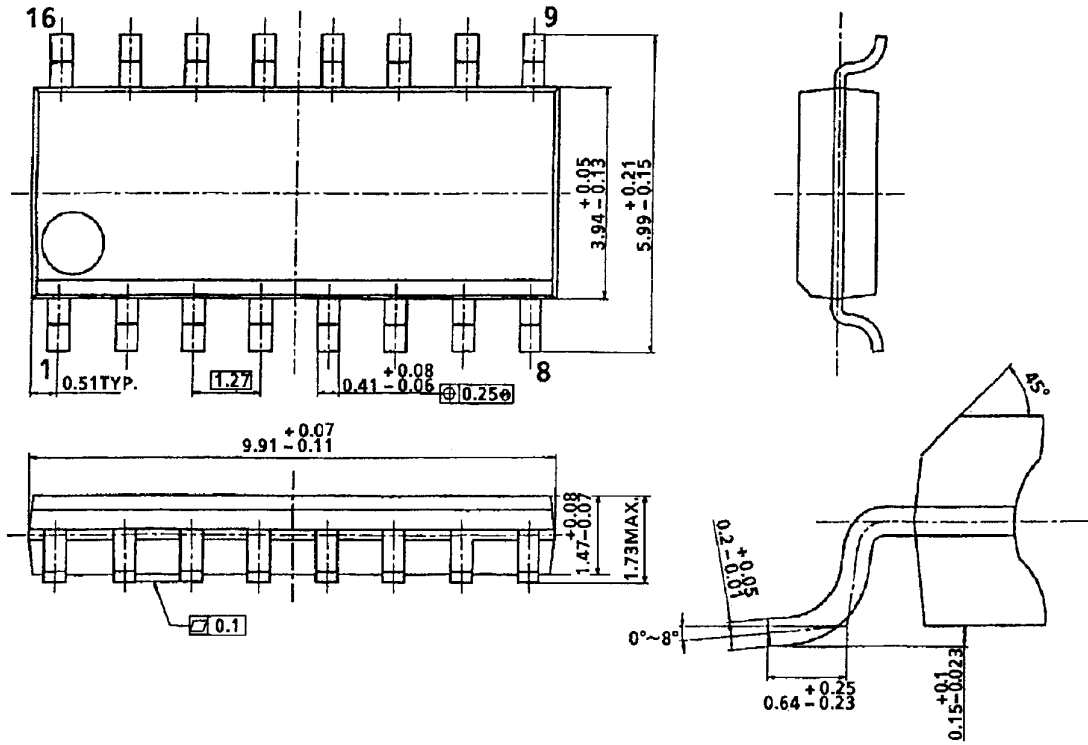


Weight: 1.11 g (typ.)

Package Dimensions

SOL16-P-150-1.27A

Unit : mm



Weight: 0.15 g (typ.)

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