ULN2003A, ULN2003AD, ULN2004A, ULN2004AD
7CH DARLINGTON SINK DRIVER

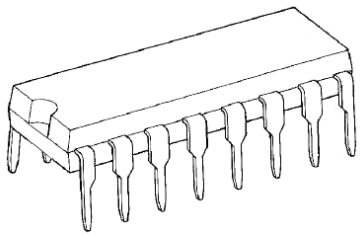
The ULN2003A/AD Series are high-voltage, high-current darlington drivers comprised of seven NPN darlington pairs.
All units feature integral clamp diodes for switching inductive loads.
Applications include relay, hammer, lamp and display (LED) drivers.

FEATURES

- Output current (single output) 500mA MAX.
- High sustaining voltage output
  50V MIN. (ULN2003A/AD Series)
- Output clamp diodes
- Inputs compatible with various types of logic
- Package Type-A : DIP-16pin
- Package Type-AD : SOP-16pin

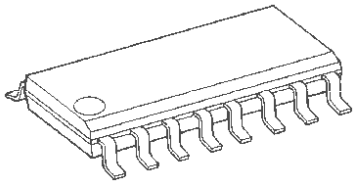
TYPE	INPUT BASE RESISTOR	DESGNATION
ULN2003A/AD	2.7kΩ	TTL, 5V CMOS
ULN2004A/AD	10.5 kΩ	6~15V PMOS, CMOS

ULN2003A
ULN2004A



DIP16-P-300-2.54A

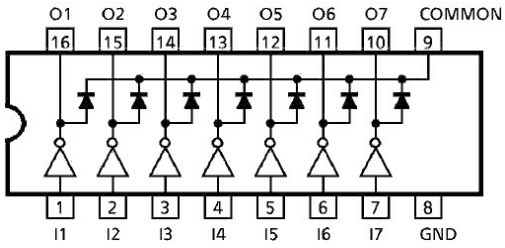
ULN2003AD
ULN2004AD



SOL16-P-150-1.27A

Weight
DIP16-P-300-2.54A : 1.11g (Typ.)
SOP16-P-150-1.27A : 0.15g (Typ.)

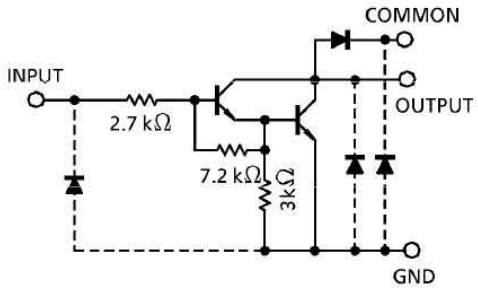
PIN CONNECTION (TOP VIEW)



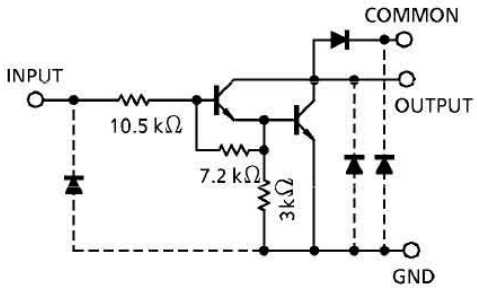
980910EBA1

SCHEMATICS (EACH DRIVER)

ULN2003A/AD



ULN2004A/AD



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

MAXIMUM RATINGS (Ta = 25℃)

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	A	P_D	1.47	W
	AD		0.54/0.625 (Note)	
Operating Temperature		T_{opr}	-40~85	℃
Storage Temperature		T_{stg}	-55~150	℃

(Note) : On glass epoxy PCB (30 x 30 x1.6mm Cu 50%)

RECOMMENDED OPERATING CONDITIONS (Ta= -40~85℃)

CHARACTERISTIC		SYMBOL	CONDITION		MIN.	TYP.	MAX.	UNIT
Output Sustaining Voltage		V_{CE} (SUS)			0	—	50	
Output current	A	I_{OUT}	T_{pw} = 25ms 7 Circuits Ta =85℃ Tj=120℃	Duty=10%	0	—	370	mA/ch
				Duty=50%	0	—	130	
	AD			Duty=10%	0	—	233	
				Duty=50%	0	—	70	
Input Voltage		V_{IN}			0	—	24	V
Input Voltage (Output On)	ULN2003A	$V_{IN(ON)}$	I_{OUT} =400mA 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	A	P_D	Ta =85℃		—	—	0.76	W
	AD		(Note) Ta =85℃		—	—	0.325	

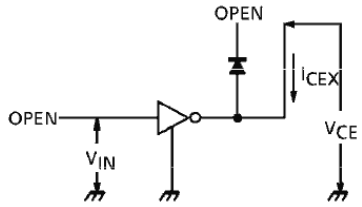
(Note) : On glass epoxy PCB (30 X 30 X1.6mm Cu 50%)

ELECTRICAL CHARACTERISTICS (Ta =25℃ unless otherwise noted)

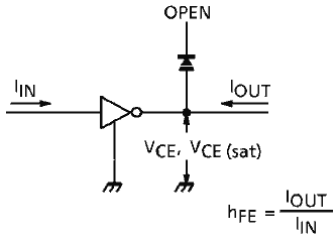
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Output Leakage Current		I_{CEX}	1	V_{CE} = 50V, Ta = 25℃		—	—	50	μA
				V_{CE} = 50V, Ta = 85℃		—	—	100	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	2	I_{OUT} = 350mA, I_{IN} = 500μA		—	1.3	1.6	V
				I_{OUT} = 200mA, I_{IN} = 350μA		—	1.1	1.3	
				I_{OUT} = 100mA, I_{IN} = 250μA		—	0.9	1.1	
DC Current Transfer Ratio		h_{FE}	2	V_{CE} = 2V, I_{OUT} = 350mA		1000	—	—	
Input Current (Output On)	ULN2003A	$I_{IN(ON)}$	3	V_{IN} = 2.4V, I_{OUT} = 350mA		—	0.4	0.7	mA
	ULN2004A			V_{IN} = 9.5V, I_{OUT} = 350mA		—	0.8	1.2	
Input Current (Output Off)		$I_{IN(OFF)}$	4	I_{OUT} = 500μA, Ta =85℃		50	65	—	μA
Input Voltage (Output On)	ULN2003A	$V_{IN(ON)}$	5	V_{CE} = 2V H_{FE} = 800	I_{OUT} = 350mA	—	—	3.2	V
					I_{OUT} = 200mA	—	—	2.5	
	ULN2004A				I_{OUT} = 350mA	—	—	4.7	
					I_{OUT} = 200mA	—	—	4.4	
Clamp Diode Reverse Current		I_R	6	V_R = 50V, Ta = 25℃		—	—	50	μA
				V_R = 50V, Ta = 85℃		—	—	100	
Clamp Diode Forward Voltage		V_F	7	I_F = 350 mA		—	—	2.0	V
Input Capacitance		C_{IN}	—			—	15	—	pF
Turn-On Delay		t_{ON}	8	V_{OUT} = 50V, R_L = 125Ω C_L = 15pF		—	0.1	—	μS
Turn-Off Delay		t_{OFF}	8	V_{OUT} = 50V, R_L = 125Ω C_L = 15pF		—	0.2	—	

TEST CIRCUIT

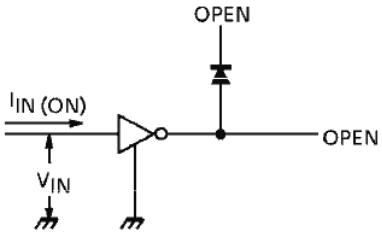
1. I_{CEX}



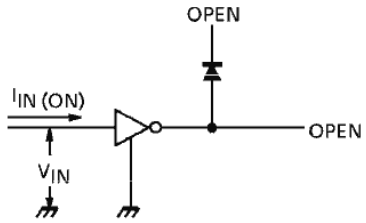
2. $V_{CE(sat)}$, h_{FE}



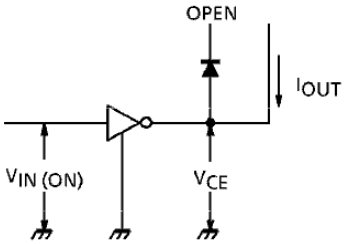
3. $I_{IN(ON)}$



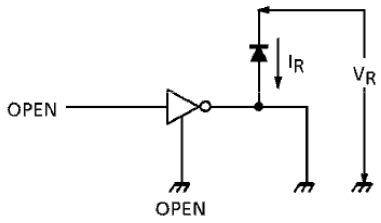
4. $I_{IN(OFF)}$



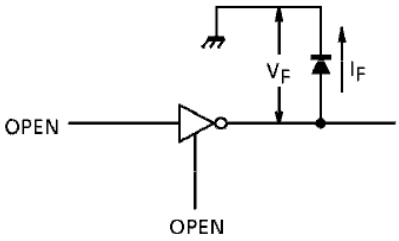
5. $V_{IN(ON)}$



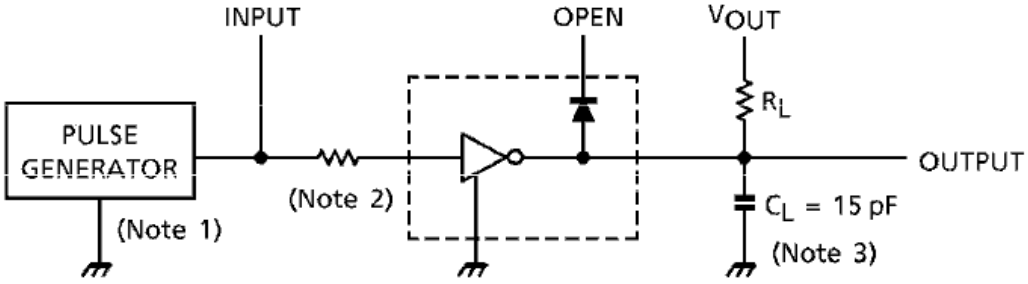
6. I_R

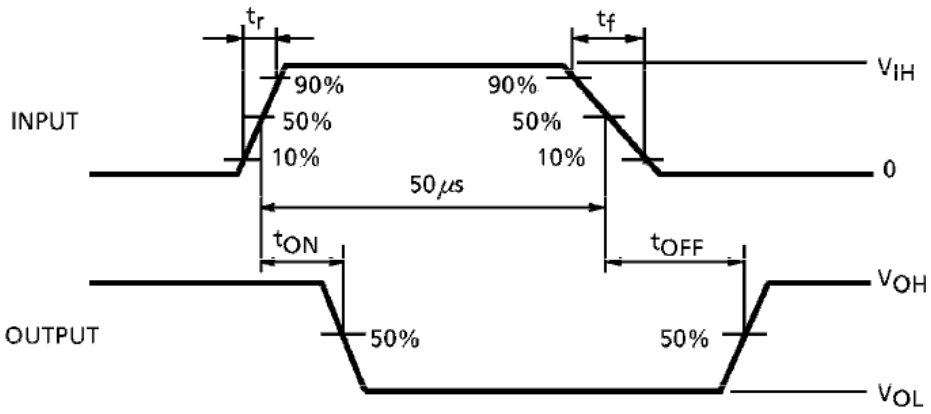


7. V_F



8. t_{ON}, t_{OFF}





(Note 1) : Pulse width 50 μ s, duty cycle 10%

Output impedance 50Ω, $t_r \leq 5$ns, $t_f \leq 10$ns

(Note 2) : See below

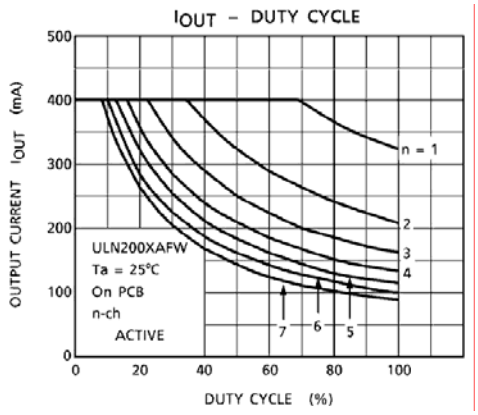
INPUT CONDITION

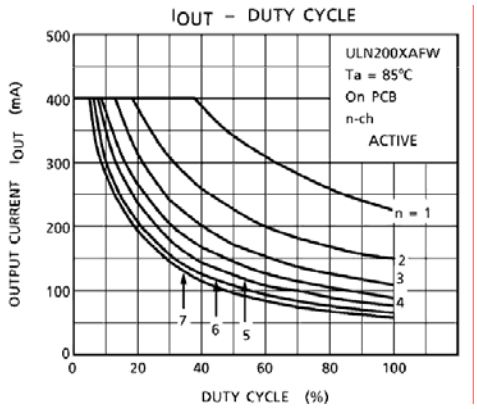
TYPE NUMBER	R1	V_{IH}
ULN2003A/AD	0	3V
ULN2004A/AD	0	8V

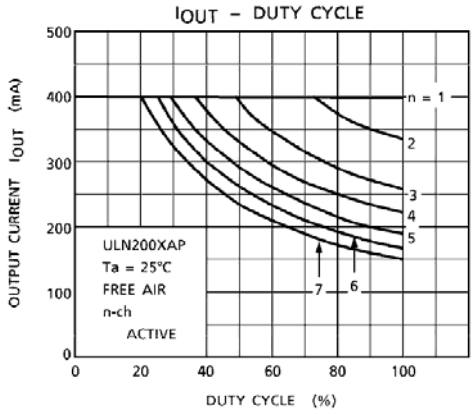
(Note 3) : C_L includes probe and jig capacitance.

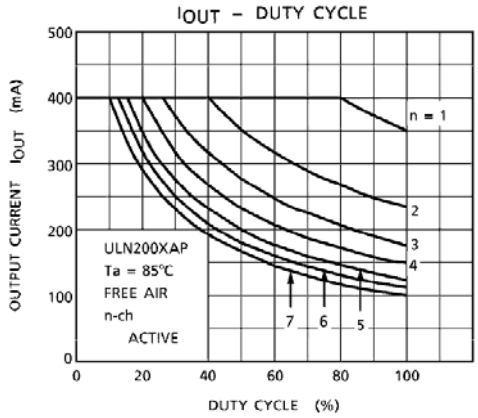
PRECAUTIONS for USING

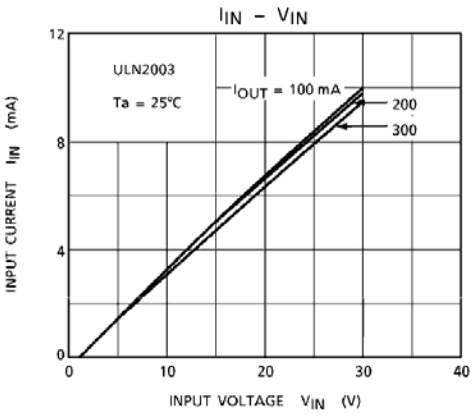
Utmost care is necessary in the design of the output line, COMMON and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.

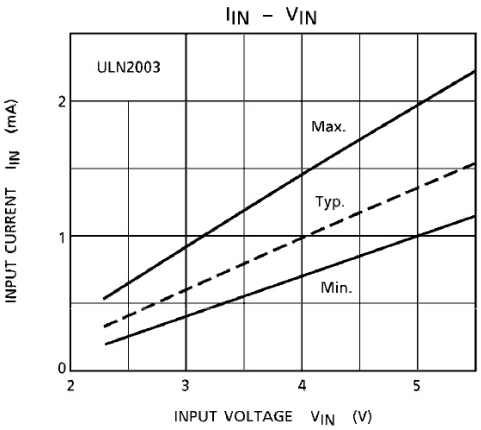

IOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
DUTY CYCLE (%)
ULN200XAFW
Ta = 25°C
On PCB
n-ch
ACTIVE
n = 1
2
3
4
5
6
7

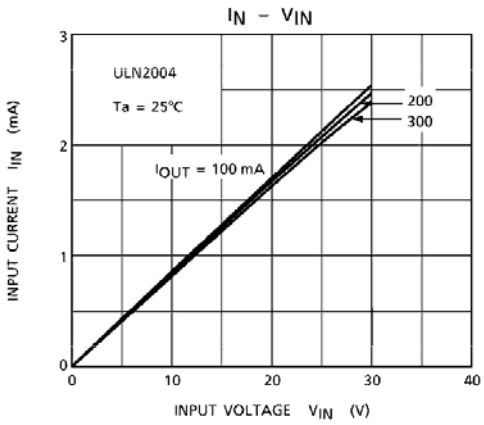

IOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
DUTY CYCLE (%)
ULN200XAFW
Ta = 85°C
On PCB
n-ch
ACTIVE
n = 1
2
3
4
5
6
7

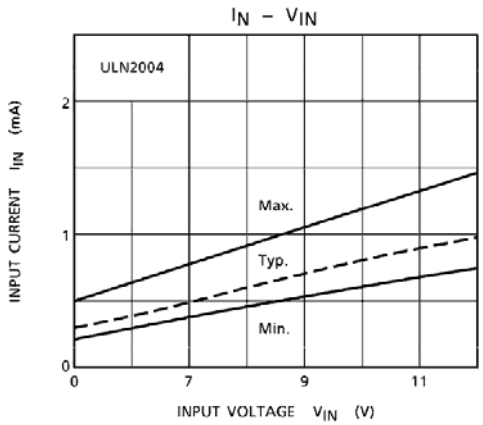

IOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
DUTY CYCLE (%)
ULN200XAP
Ta = 25°C
FREE AIR
n-ch
ACTIVE
n = 1
2
3
4
5
6
7

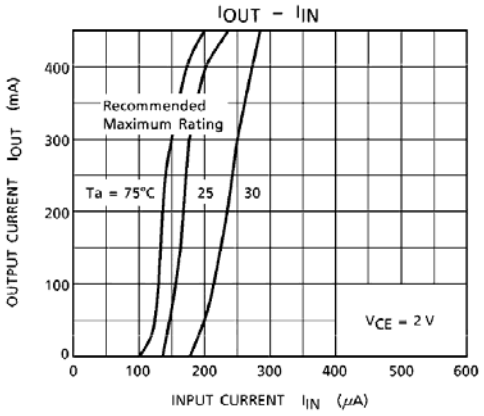

IOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
DUTY CYCLE (%)
ULN200XAP
Ta = 85°C
FREE AIR
n-ch
ACTIVE
n = 1
2
3
4
5
6
7

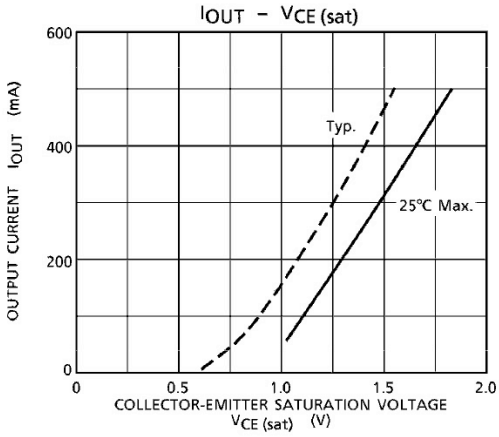

IIN – VIN
INPUT CURRENT IIN (mA)
INPUT VOLTAGE VIN (V)
ULN2003
Ta = 25°C
IOUT = 100 mA
200
300

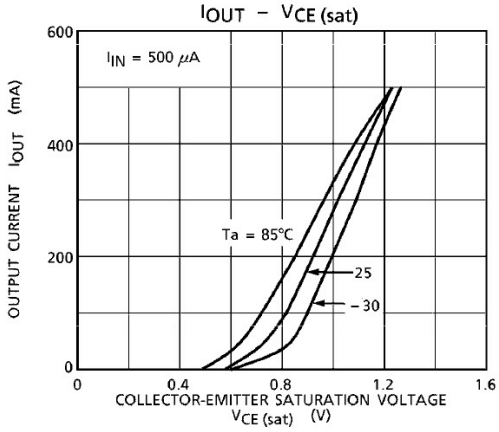

IIN – VIN
INPUT CURRENT IIN (mA)
INPUT VOLTAGE VIN (V)
ULN2003
Max.
Typ.
Min.

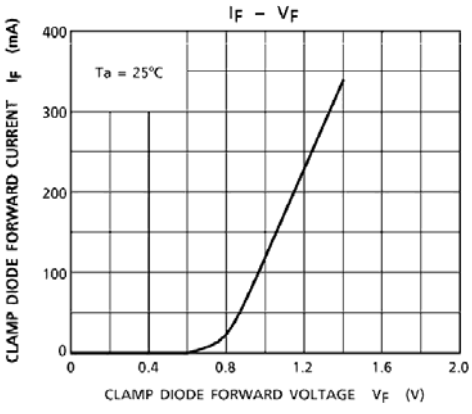

IN – VIN
ULN2004
Ta = 25°C
IOUT = 100 mA
200
300
INPUT CURRENT IIN (mA)
INPUT VOLTAGE VIN (V)

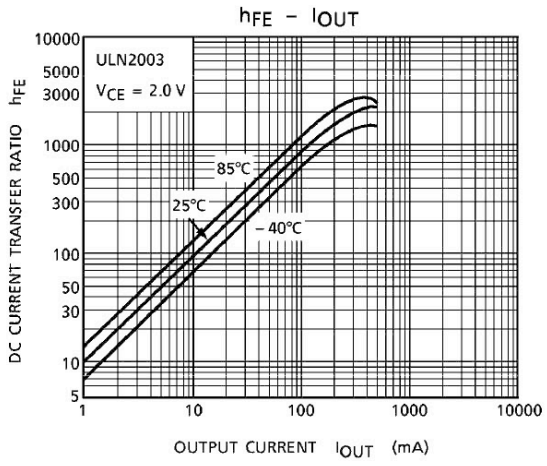

IN – VIN
ULN2004
Max.
Typ.
Min.
INPUT CURRENT IIN (mA)
INPUT VOLTAGE VIN (V)

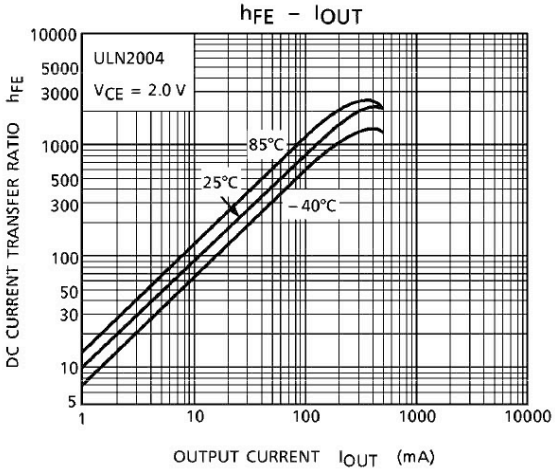

IOUT – IIN
Recommended
Maximum Rating
Ta = 75°C
25
30
VCE = 2 V
OUTPUT CURRENT IOUT (mA)
INPUT CURRENT IIN (μA)

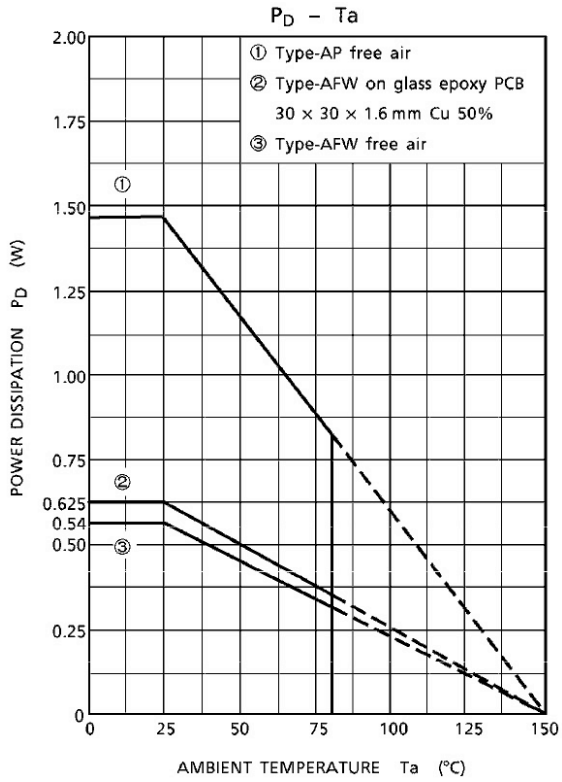

IOUT – VCE (sat)
Typ.
25°C Max.
OUTPUT CURRENT IOUT (mA)
COLLECTOR-EMITTER SATURATION VOLTAGE
VCE (sat) (V)


IOUT – VCE (sat)
IIN = 500 μA
Ta = 85°C
25
30
OUTPUT CURRENT IOUT (mA)
COLLECTOR-EMITTER SATURATION VOLTAGE
VCE (sat) (V)


IF – VF
Ta = 25°C
CLAMP DIODE FORWARD CURRENT IF (mA)
CLAMP DIODE FORWARD VOLTAGE VF (V)

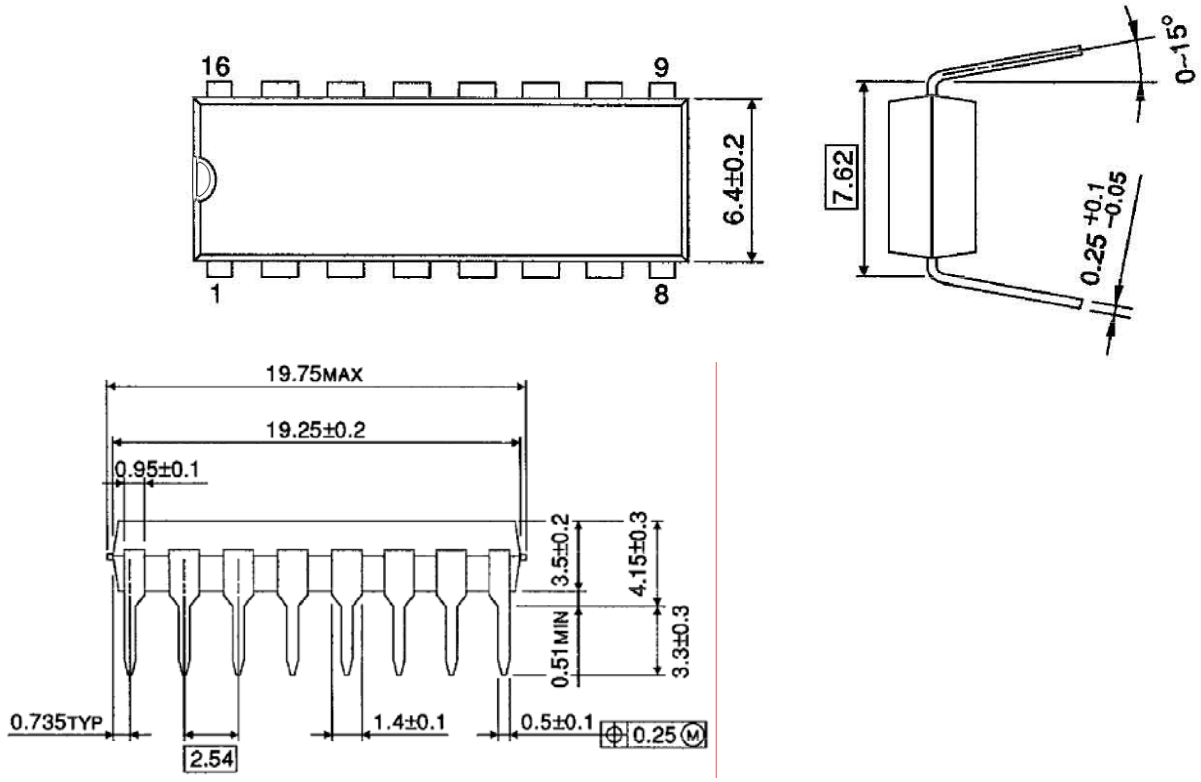

hFE – IOUT
ULN2003
VCE = 2.0 V
85°C
25°C
– 40°C
DC CURRENT TRANSFER RATIO hFE
OUTPUT CURRENT IOUT (mA)
10000
5000
3000
1000
500
300
100
50
30
10
5
1
10
100
1000
10000


hFE – IOUT
ULN2004
VCE = 2.0 V
85°C
25°C
– 40°C
DC CURRENT TRANSFER RATIO hFE
OUTPUT CURRENT IOUT (mA)
10000
5000
3000
1000
500
300
100
50
30
10
5
1
10
100
1000
10000


PD – Ta
① Type-AP free air
② Type-AFW on glass epoxy PCB
30 × 30 × 1.6 mm Cu 50%
③ Type-AFW free air
POWER DISSIPATION PD (W)
AMBIENT TEMPERATURE Ta (°C)
2.00
1.75
1.50
1.25
1.00
0.75
0.625
0.54
0.50
0.25
0
0
25
50
75
100
125
150

OUTLINE DRAWING

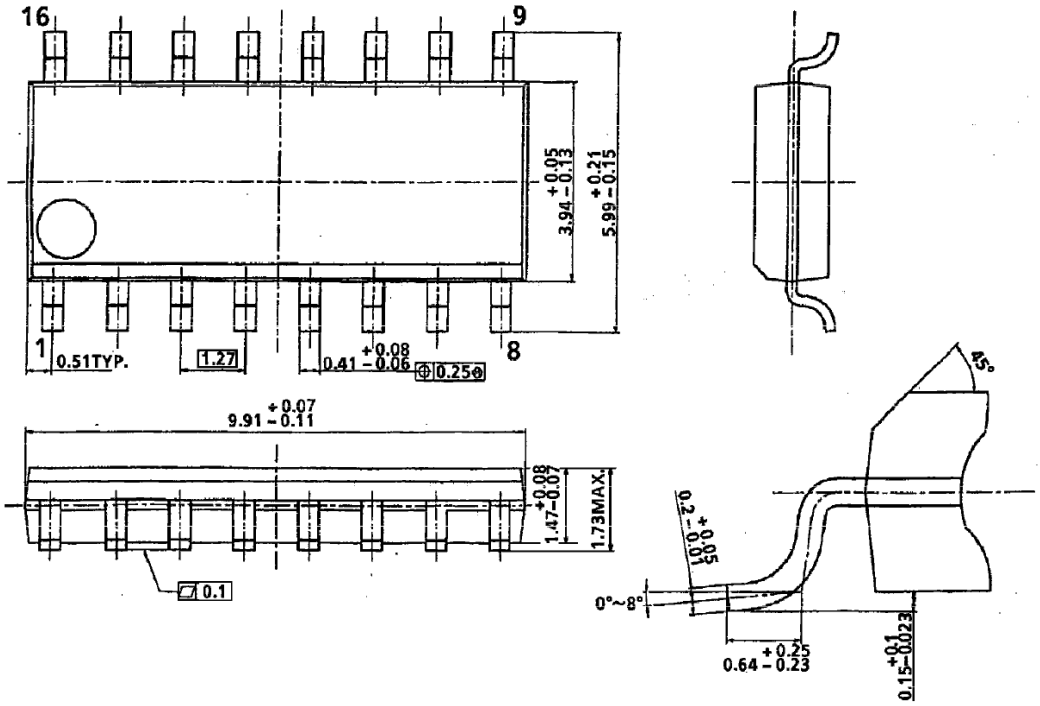
DIP16-P-300-2.54A



Weight : 1.11g (Typ.)

OUTLINE DRAWING

SOL16-P-150-1.27A



Weight : 0.15g (Typ.)