

Appendix

HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON ARRAYS

Discontinued Product

Ideally suited for interfacing between low-level logic circuitry and multiple peripheral power loads, the Series ULN20xxA/L high-voltage, high-current Darlington arrays feature continuous load current ratings to 500 mA for each of the seven drivers. At an appropriate duty cycle depending on ambient temperature and number of drivers turned ON simultaneously, typical power loads totaling over 230 W (350 mA x 7, 95 V) can be controlled. Typical loads include relays, solenoids, stepping motors, magnetic print hammers, multiplexed LED and incandescent displays, and heaters. All devices feature open-collector outputs with integral clamp diodes.

The ULN2003A/L and ULN2023A/L have series input resistors selected for operation directly with 5 V TTL or CMOS. These devices will handle numerous interface needs — particularly those beyond the capabilities of standard logic buffers.

The ULN2004A/L and ULN2024A/L have series input resistors for operation directly from 6 to 15 V CMOS or PMOS logic outputs.

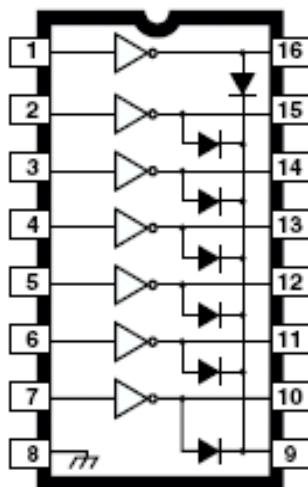
The ULN2003A/L and ULN2004A/L are the standard Darlington arrays. The outputs are capable of sinking 500 mA and will withstand at least 50 V in the OFF state. Outputs may be paralleled for higher load current capability. The ULN2023A/L and ULN2024A/L will

withstand 95 V in the OFF state.

These Darlington arrays are furnished in 16-pin dual in-line plastic packages (suffix "A") and 16-lead surface-mountable SOICs (suffix "L"). All devices are pinned with outputs opposite inputs to facilitate ease of circuit board layout. All devices are rated for operation over the temperature range of -20°C to +85°C. Most (see matrix, next page) are also available for operation to -40°C; to order, change the prefix from "ULN" to "ULQ".

FEATURES

- _ TTL, DTL, PMOS, or CMOS-Compatible Inputs
- _ Output Current to 500 mA
- _ Output Voltage to 95 V
- _ Transient-Protected Outputs
- _ Dual In-Line Plastic Package or Small-Outline IC Package



Note that the ULN20xxA series (dual in-line package) and ULN20xxL series (small-outline

IC package) are electrically identical and share a common terminal number assignment.

ABSOLUTE MAXIMUM RATINGS

Output Voltage, VC E

(ULN200xA and ULN200xL) 50 V

(ULN20xA and ULN202xL) 95 V

Input Voltage, VIN 30 V

Continuous Output Current,

IC 500 mA

Continuous Input Current, II N 25 mA

Power Dissipation, PD

(one Darlington pair) 1.0 W

(total package) See Graph

Operating Temperature Range,

TA -20°C to +85°C

Storage Temperature Range,

TS -55°C to +150°C

DEVICE PART NUMBER DESIGNATION

VCE(MAX)	50 V	95 V
IC(MAX)	500 mA	500
Logic	Part Number	
5V TTL, CMOS	ULN2003A*	ULN2023A*
6-15 V CMOS, PMOS	ULN2004A* ULN2004L*	ULN2024A ULN2024L

Types ULN2003A, ULN2003L, ULN2004A, and ULN2004L
ELECTRICAL CHARACTERISTICS at +25°C (unless otherwise noted).

Characteristic	Symbol	Test Fig.	Applicable Devices	Test Conditions	Limits			
					Min.	Typ.	Max.	Units
Output Leakage Current	I_{CEX}	1A	All	$V_{CE} = 50 \text{ V}, T_A = 25^\circ\text{C}$	—	< 1	50	μA
				$V_{CE} = 50 \text{ V}, T_A = 70^\circ\text{C}$	—	< 1	100	μA
		1B	ULN2004A/L	$V_{CE} = 50 \text{ V}, T_A = 70^\circ\text{C}, V_{IN} = 1.0 \text{ V}$	—	< 5	500	μA
Collector-Emitter Saturation Voltage	$V_{CE(\text{SAT})}$	2	All	$I_C = 100 \text{ mA}, I_B = 250 \mu\text{A}$	—	0.9	1.1	V
				$I_C = 200 \text{ mA}, I_B = 350 \mu\text{A}$	—	1.1	1.3	V
				$I_C = 350 \text{ mA}, I_B = 500 \mu\text{A}$	—	1.3	1.6	V
Input Current	$I_{IN(\text{ON})}$	3	ULN2003A/L	$V_{IN} = 3.85 \text{ V}$	—	0.93	1.35	mA
			ULN2004A/L	$V_{IN} = 5.0 \text{ V}$	—	0.35	0.5	mA
				$V_{IN} = 12 \text{ V}$	—	1.0	1.45	mA
	$I_{IN(\text{OFF})}$	4	All	$I_C = 500 \mu\text{A}, T_A = 70^\circ\text{C}$	50	65	—	μA
Input Voltage	$V_{IN(\text{ON})}$	5	ULN2003A/L	$V_{CE} = 2.0 \text{ V}, I_C = 200 \text{ mA}$	—	—	2.4	V
				$V_{CE} = 2.0 \text{ V}, I_C = 250 \text{ mA}$	—	—	2.7	V
				$V_{CE} = 2.0 \text{ V}, I_C = 300 \text{ mA}$	—	—	3.0	V
			ULN2004A/L	$V_{CE} = 2.0 \text{ V}, I_C = 125 \text{ mA}$	—	—	5.0	V
				$V_{CE} = 2.0 \text{ V}, I_C = 200 \text{ mA}$	—	—	6.0	V
				$V_{CE} = 2.0 \text{ V}, I_C = 275 \text{ mA}$	—	—	7.0	V
				$V_{CE} = 2.0 \text{ V}, I_C = 350 \text{ mA}$	—	—	8.0	V
					—	15	25	pF
Input Capacitance	C_{IN}	—	All		—	0.25	1.0	μs
Turn-On Delay	t_{PLH}	8	All	0.5 E_{IN} to 0.5 E_{OUT}	—	0.25	1.0	μs
Turn-Off Delay	t_{PHL}	8	All	0.5 E_{IN} to 0.5 E_{OUT}	—	0.25	1.0	μs
Clamp Diode Leakage Current	I_R	6	All	$V_R = 50 \text{ V}, T_A = 25^\circ\text{C}$	—	—	50	μA
				$V_R = 50 \text{ V}, T_A = 70^\circ\text{C}$	—	—	100	μA
Clamp Diode Forward Voltage	V_F	7	All	$I_F = 350 \text{ mA}$	—	1.7	2.0	V

Complete part number includes suffix to identify package style:
A = DIP, L = SOIC.

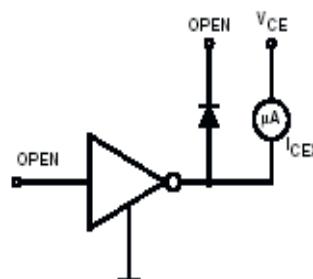
Types ULN2023A, ULN2023L, ULN2024A, and ULN2024L

ELECTRICAL CHARACTERISTICS at +25°C (unless otherwise noted).

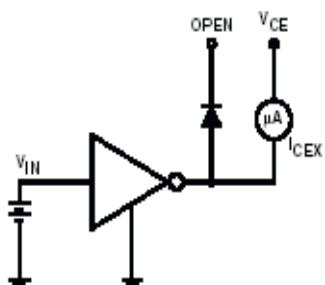
Characteristic	Symbol	Test Fig.	Applicable Devices	Test Conditions	Limits			
					Min.	Typ.	Max.	Units
Output Leakage Current	I _{CEX}	1A	All	V _{CE} = 95 V, T _A = 25°C	—	< 1	50	μA
				V _{CE} = 95 V, T _A = 70°C	—	< 1	100	μA
		1B	ULN2024A/L	V _{CE} = 95 V, T _A = 70°C, V _{IN} = 1.0 V	—	< 5	500	μA
Collector-Emitter Saturation Voltage	V _{CE(SAT)}	2	All	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	V
				I _C = 350 mA, I _B = 500 μA	—	1.3	1.6	V
Input Current	I _{IN(ON)}	3	ULN2023A/L	V _{IN} = 3.85 V	—	0.93	1.35	mA
			ULN2024A/L	V _{IN} = 5.0 V	—	0.35	0.5	mA
				V _{IN} = 12 V	—	1.0	1.45	mA
	I _{IN(OFF)}	4	All	I _C = 500 μA, T _A = 70°C	50	65	—	μA
Input Voltage	V _{IN(ON)}	5	ULN2023A/L	V _{CE} = 2.0 V, I _C = 200 mA	—	—	2.4	V
				V _{CE} = 2.0 V, I _C = 250 mA	—	—	2.7	V
				V _{CE} = 2.0 V, I _C = 300 mA	—	—	3.0	V
			ULN2024A/L	V _{CE} = 2.0 V, I _C = 125 mA	—	—	5.0	V
				V _{CE} = 2.0 V, I _C = 200 mA	—	—	6.0	V
				V _{CE} = 2.0 V, I _C = 275 mA	—	—	7.0	V
				V _{CE} = 2.0 V, I _C = 350 mA	—	—	8.0	V
Input Capacitance	C _{IN}	—	All		—	15	25	pF
Turn-On Delay	t _{PLH}	8	All	0.5 E _{IN} to 0.5 E _{OUT}	—	0.25	1.0	μs
Turn-Off Delay	t _{PHL}	8	All	0.5 E _{IN} to 0.5 E _{OUT}	—	0.25	1.0	μs
Clamp Diode Leakage Current	I _R	6	All	V _R = 95 V, T _A = 25°C	—	—	50	μA
				V _R = 95 V, T _A = 70°C	—	—	100	μA
Clamp Diode Forward Voltage	V _F	7	All	I _F = 350 mA	—	1.7	2.0	V

Complete part number includes suffix to identify package style: A = DIP, L = SOIC.

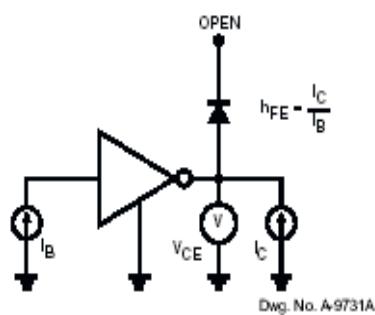
TEST FIGURES

FIGURE 1A

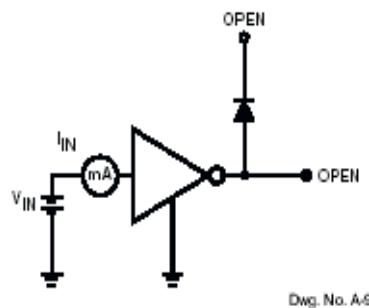
Dwg. No. A-9729A

FIGURE 1B

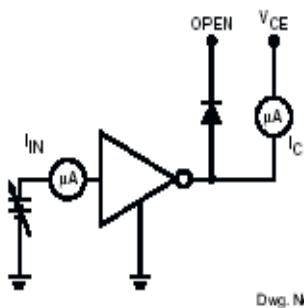
Dwg. No. A-9730A

FIGURE 2

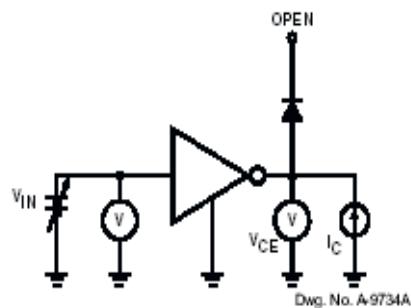
Dwg. No. A-9731A

FIGURE 3

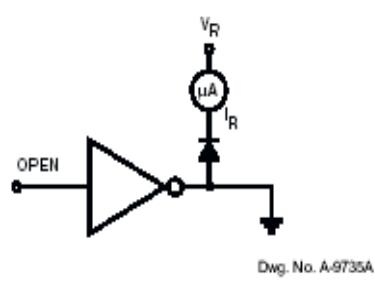
Dwg. No. A-9732A

FIGURE 4

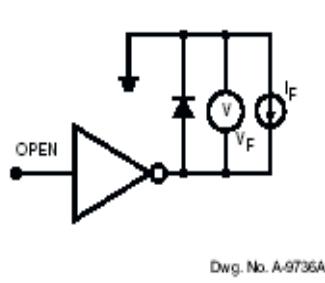
Dwg. No. A-9733A

FIGURE 5

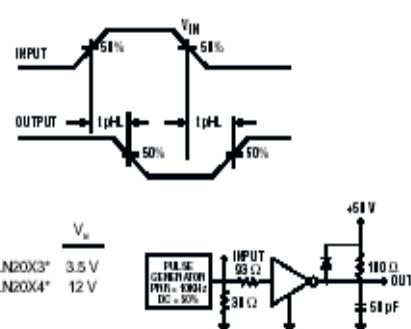
Dwg. No. A-9734A

FIGURE 6

Dwg. No. A-9735A

FIGURE 7

Dwg. No. A-9736A

FIGURE 8

* Complete part number includes a final letter to indicate package.

X = Digit to identify specific device. Specification shown applies to family of devices with remaining digits as shown.

**ALLOWABLE COLLECTOR CURRENT
AS A FUNCTION OF DUTY CYCLE**
(Dual In-line-Packaged Devices, Suffix 'A')

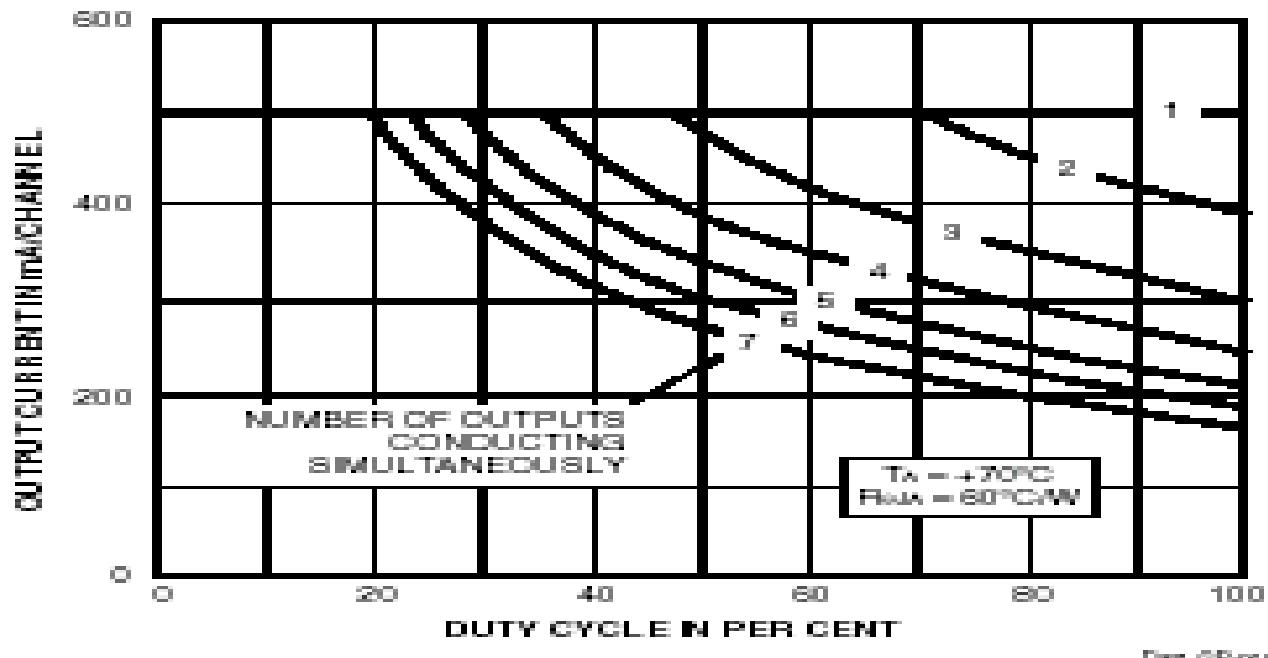
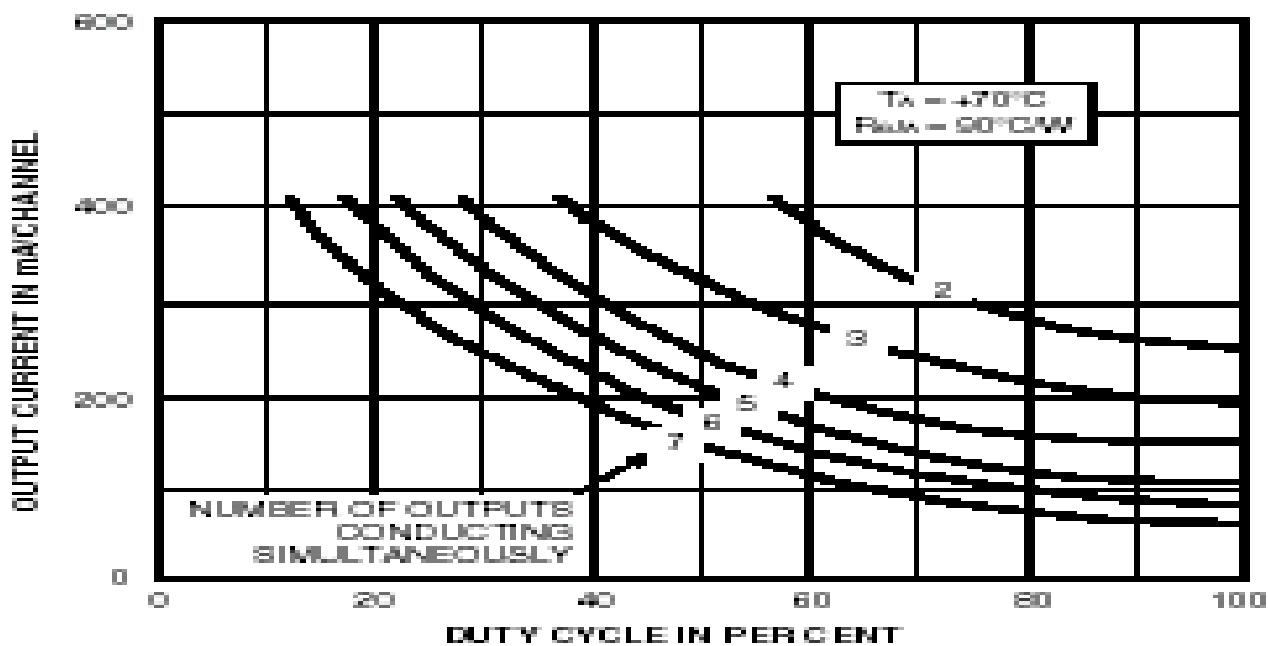
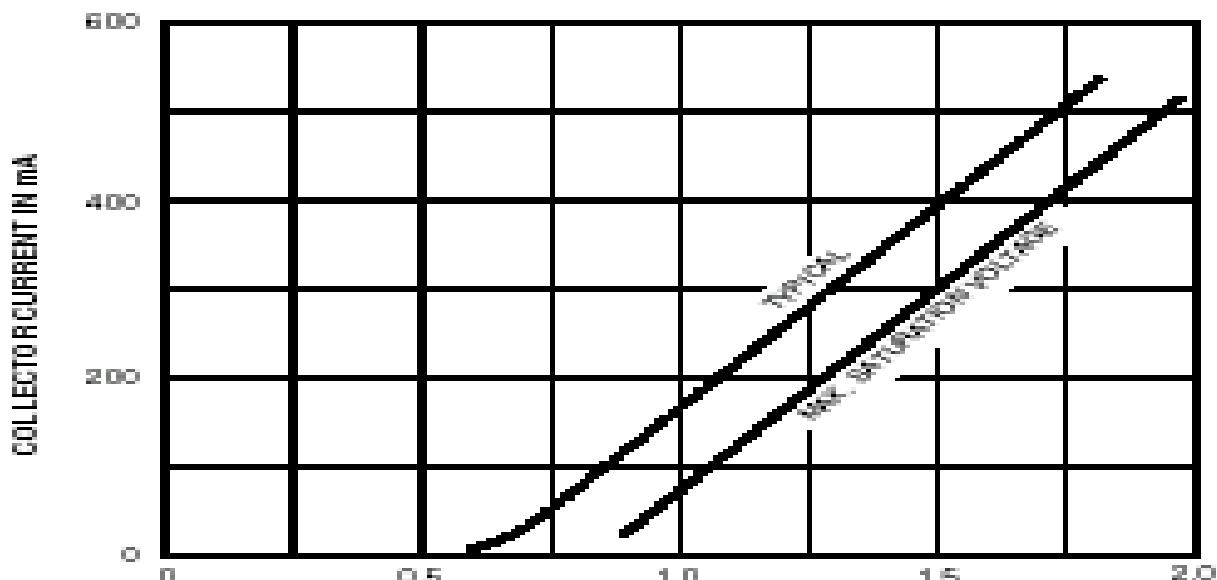


Diagram 52-002

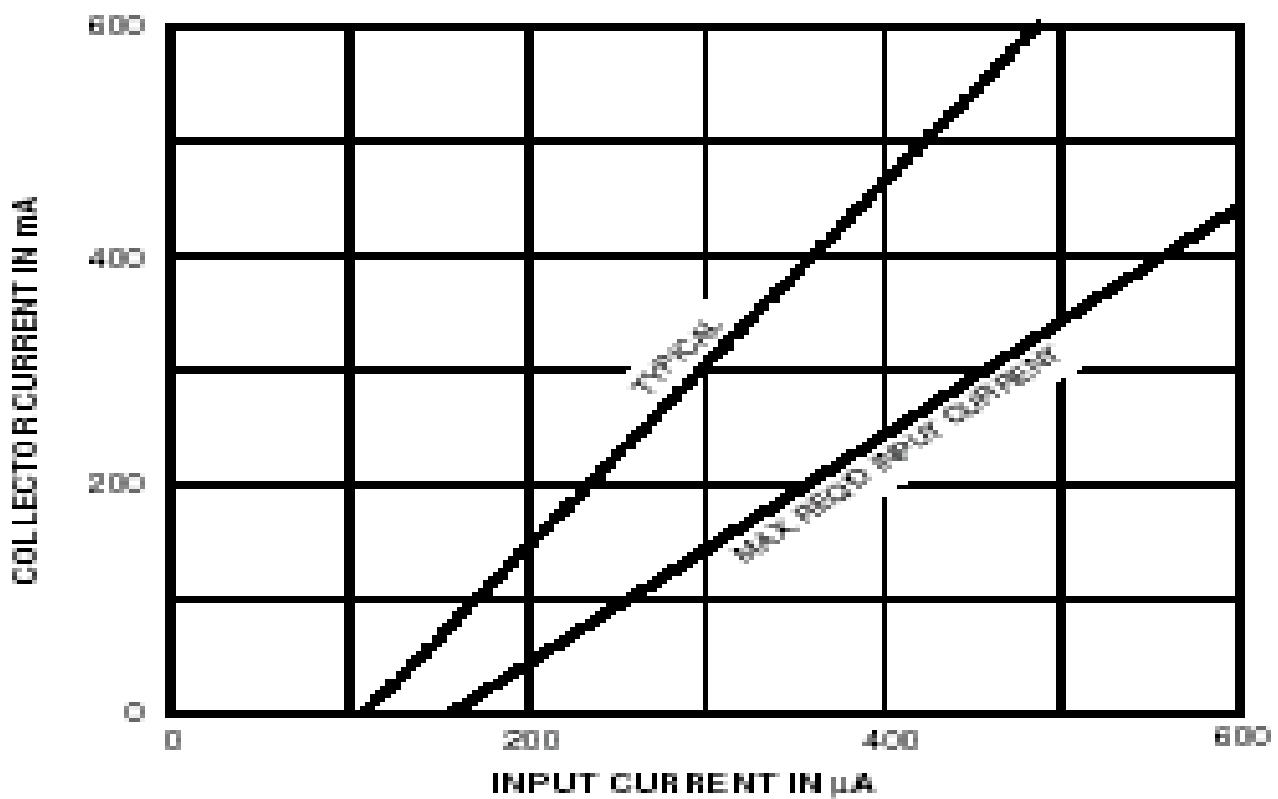
(Small-Outline-Packaged Devices, Suffix 'L')



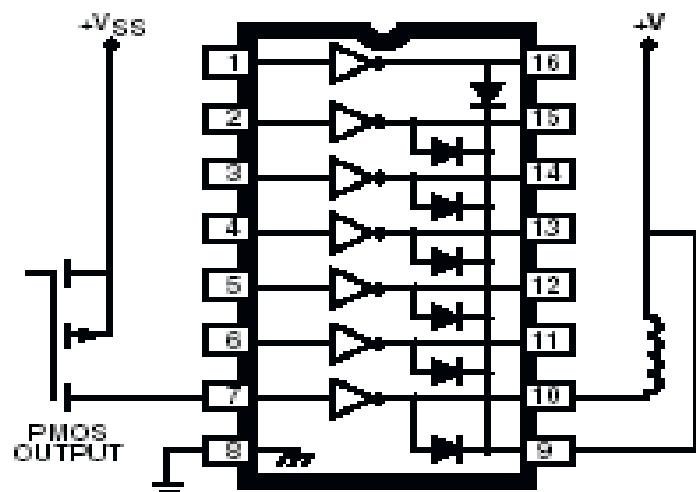
**SATURATION VOLTAGE
AS A FUNCTION OF COLLECTOR CURRENT**



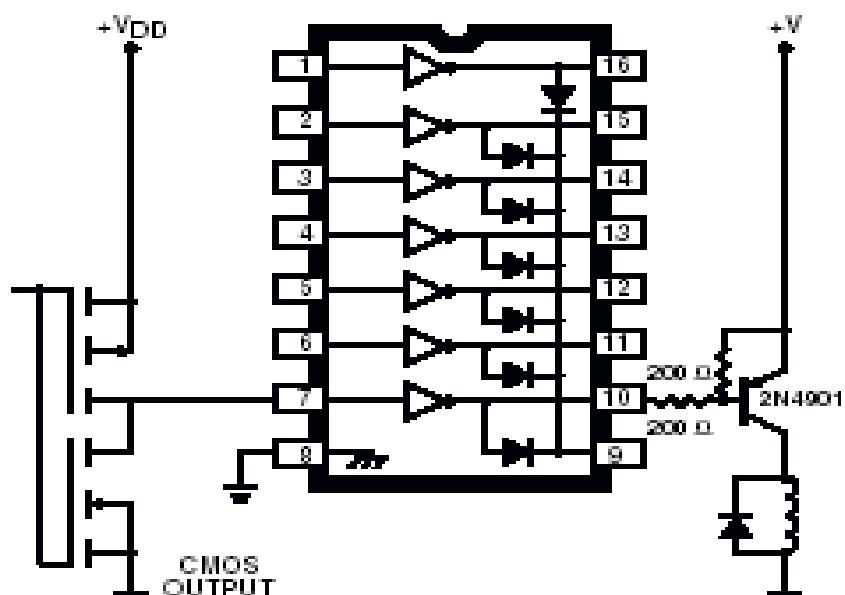
**COLLECTOR-EMITTER SATURATION VOLTAGE
COLLECTOR CURRENT AS A
FUNCTION OF INPUT CURRENT**



TYPICAL APPLICATIONS

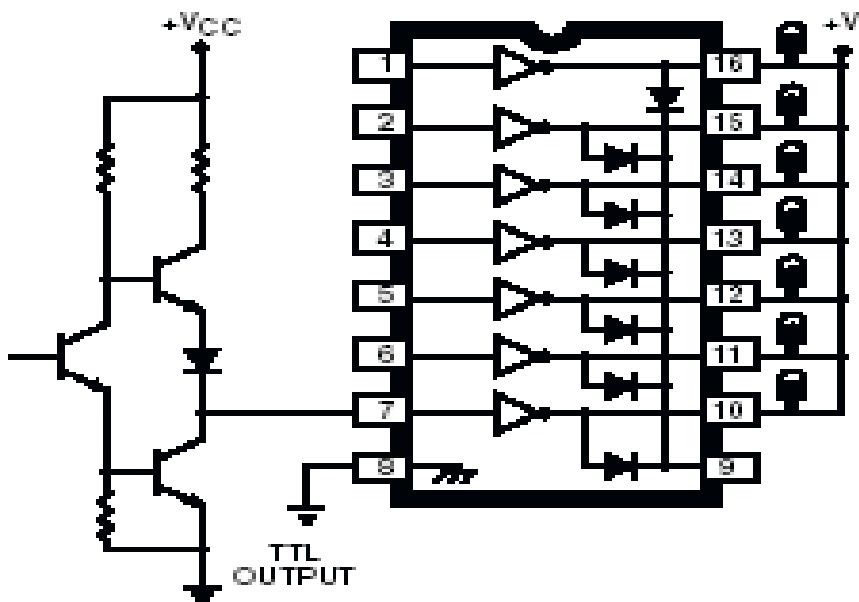


Dwg. No. A-9652

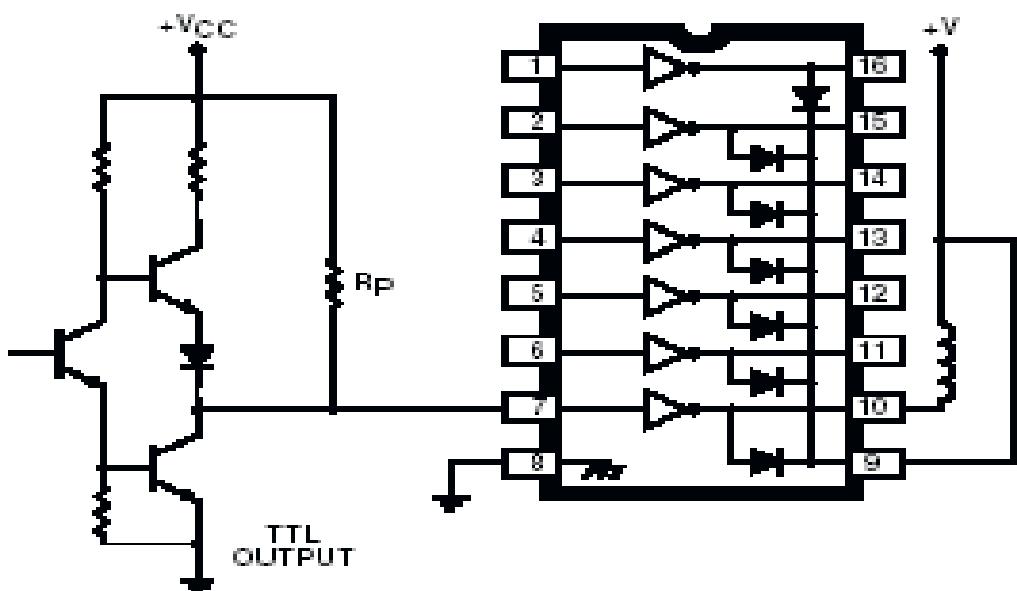


Dwg. No. A-9654A

TYPICAL APPLICATIONS



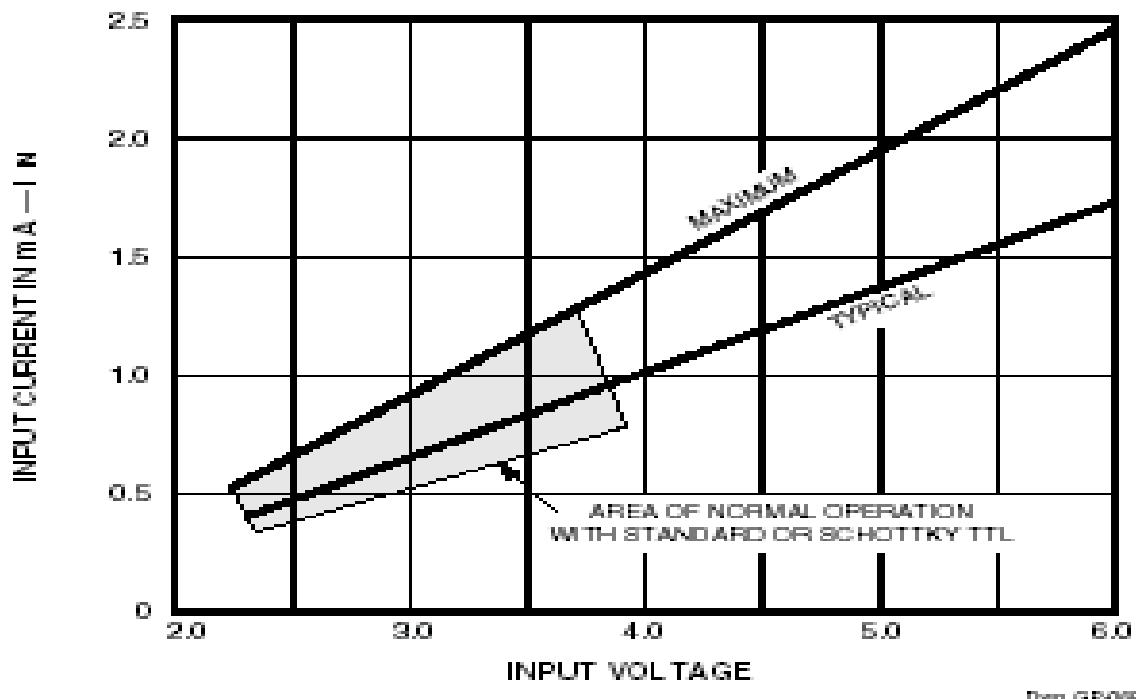
Diag. No. A-9653A



Diag. No. A-10,175

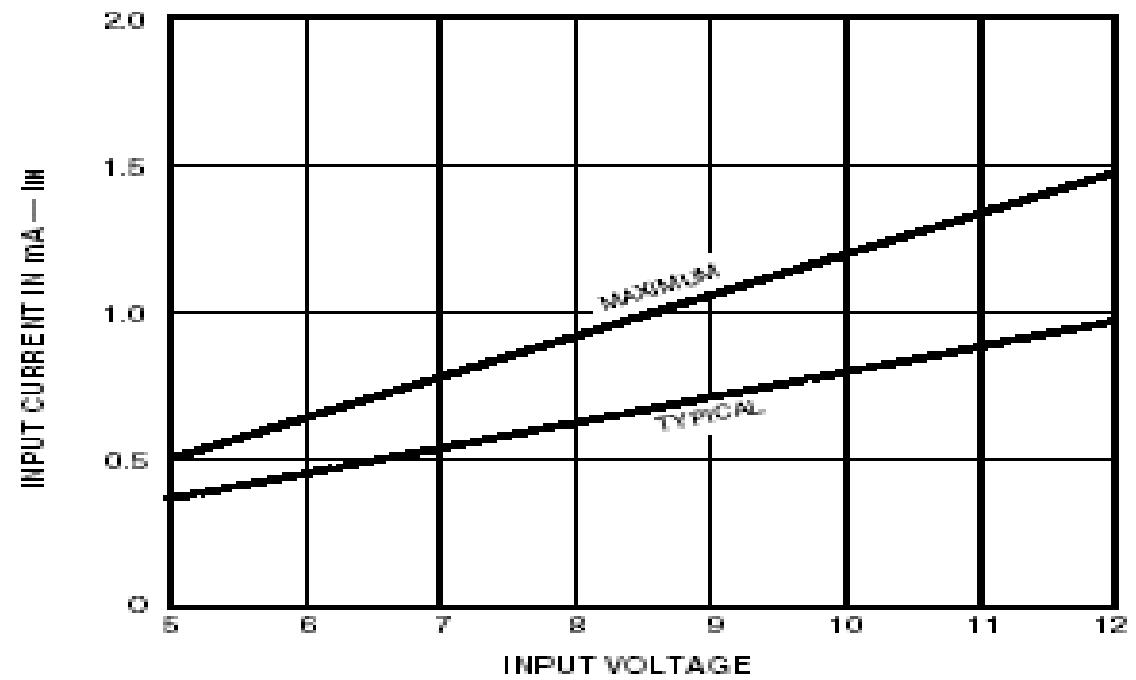
INPUT CURRENT AS A FUNCTION OF INPUT VOLTAGE

Types ULN2003A, ULN2003L, ULN2023A, and
ULN2023L



Dwg. GP-009

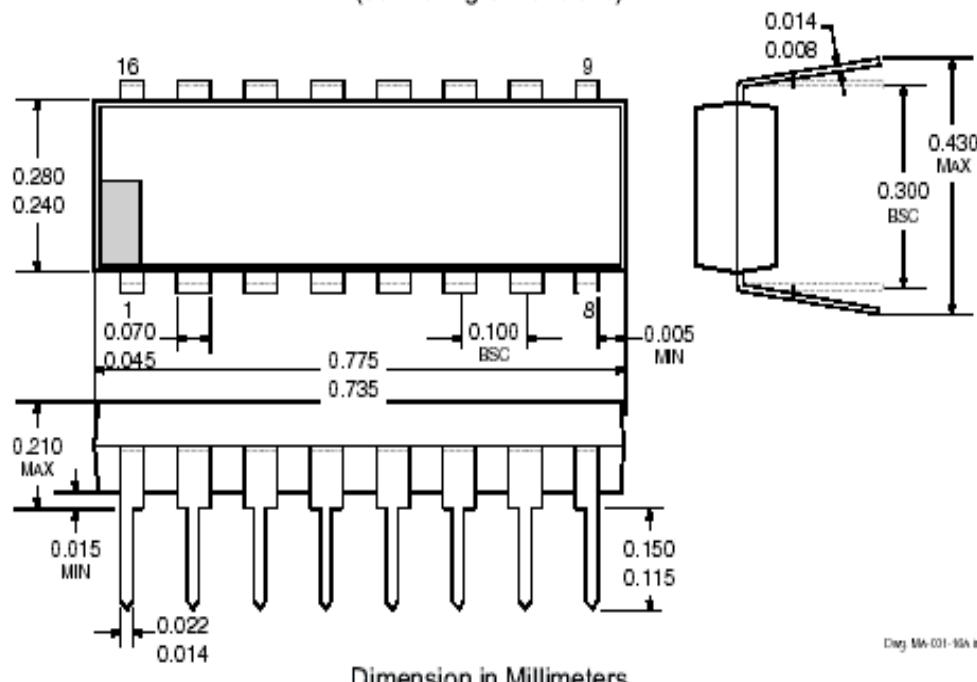
Types ULN2004A, ULN2004L, ULN2024A, and
ULN2024L



Dwg. GP-009-1

PACKAGE DESIGNATOR "A"

Dimensions in Inches
(controlling dimensions)



Dimension in Millimeters
(for reference only)

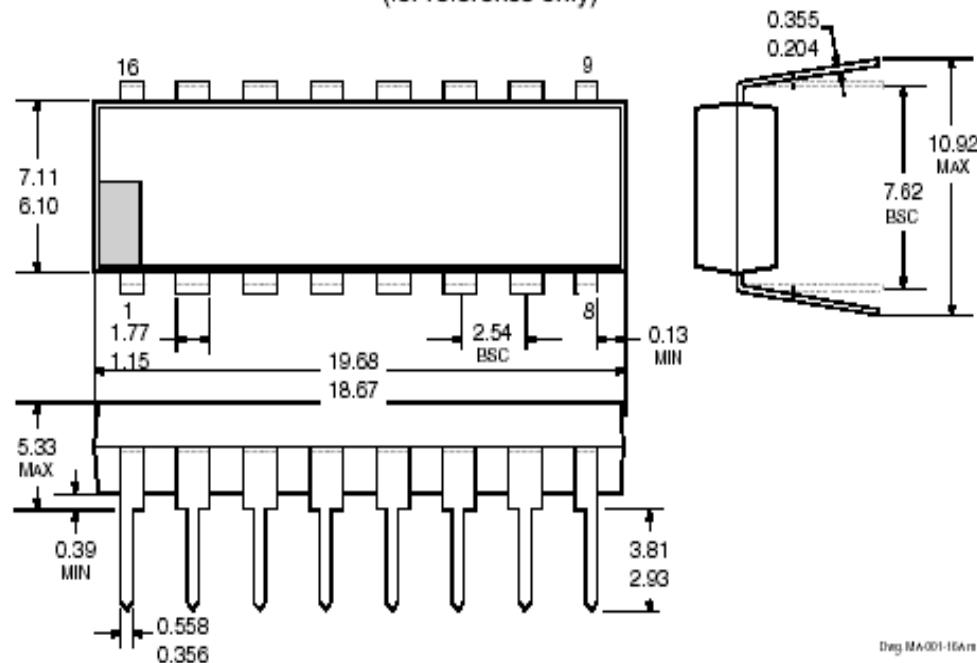
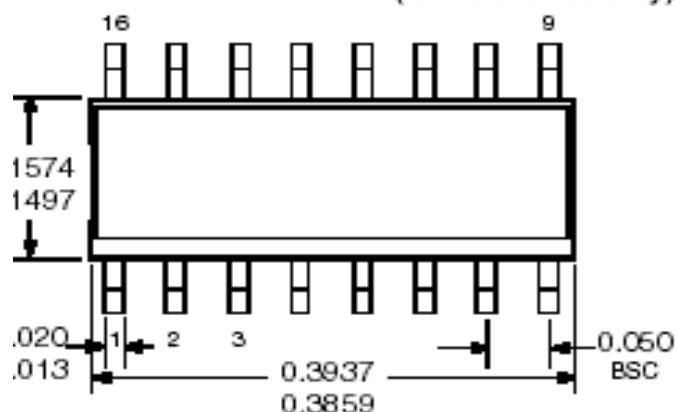


Diagram 15A-001-15A.mif

NOTES: 1. Leads 1, 8, 9, and 16 may be half leads at vendor's option.
2. Lead thickness is measured at seating plane or below.
3. Lead spacing tolerance is non-cumulative.
4. Exact body and lead configuration at vendor's option within limits shown.

PACKAGE DESIGNATOR "L"

Dimensions in Inches
(for reference only)



NOTES:

- 1. Lead spacing tolerance is non-cumulative.**
- 2. Exact body and lead configuration at vendor's option within limits shown.**



Dimension in Millimeters
(controlling dimensions)

