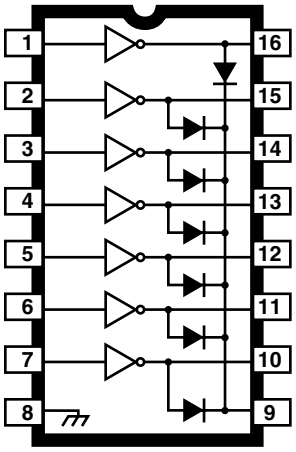
2003 THRU 2024

Data Sheet 29304F

HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON ARRAYS



Dwg. No. A-9594

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, V_{CE}
(ULN200xA and ULN200xL) ..... **50 V**
(ULN202xA and ULN202xL) ..... **95 V**
Input Voltage, V_{IN} ..... **30 V**
Continuous Output Current,
I_C ..... **500 mA**
Continuous Input Current, I_{IN} ..... **25 mA**
Power Dissipation, P_D
(one Darlington pair) ..... **1.0 W**
(total package) ..... **See Graph**
Operating Temperature Range,
T_A ..... **-20°C to +85°C**
Storage Temperature Range,
T_S ..... **-55°C to +150°C**

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

x = digit to identify specific device. Characteristic shown applies to family of devices with remaining digits as shown. See matrix on next page.

2003 THRU 2024
HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON ARRAYS

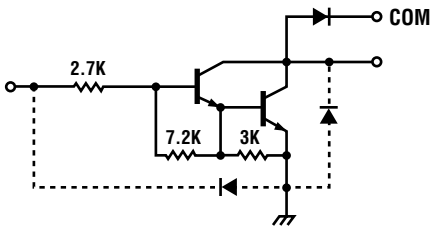
DEVICE PART NUMBER DESIGNATION

$V_{CE(MAX)}$	50 V	95 V
$I_{C(MAX)}$	500 mA	500 mA
Logic	**Part Number**	
5V TTL, CMOS	ULN2003A* ULN2003L*	ULN2023A* ULN2023L
6-15 V CMOS, PMOS	ULN2004A* ULN2004L*	ULN2024A ULN2024L

*Also available for operation between -40°C and +85°C. To order, change prefix from "ULN" to "ULQ".

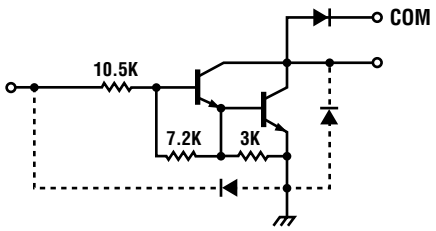
PARTIAL SCHEMATICS

ULN20x3A/L (Each Driver)

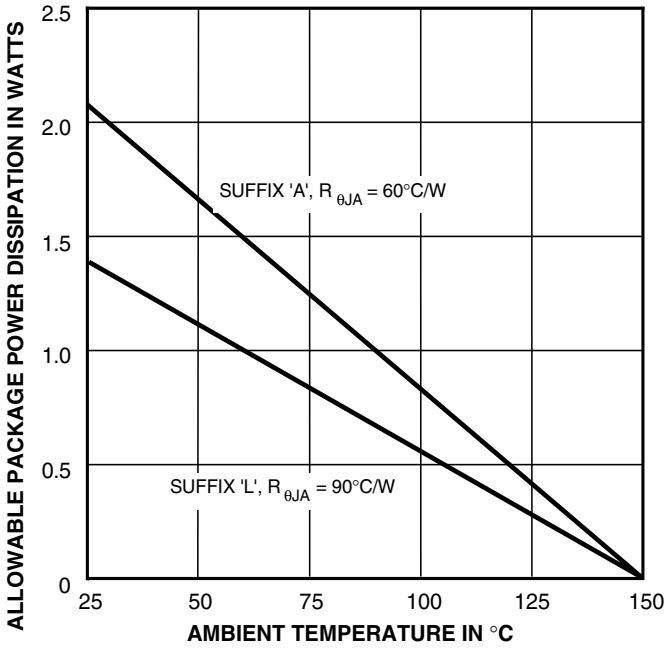


Dwg. No. A-9651

ULN20x4A/L (Each Driver)



Dwg. No. A-9898A



Dwg. GP-006A

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

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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 V, T_A = 25°C	—	< 1	50	µA
				V_{CE} = 50 V, T_A = 70°C	—	< 1	100	µA
		1B	ULN2004A/L	V_{CE} = 50 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	ULN2003A/L	V_{IN} = 3.85 V	—	0.93	1.35	mA
			ULN2004A/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	ULN2003A/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
			ULN2004A/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 = 50 V, T_A = 25°C	—	—	50	µA
				V_R = 50 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.

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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.

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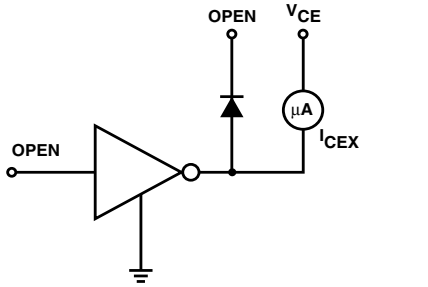
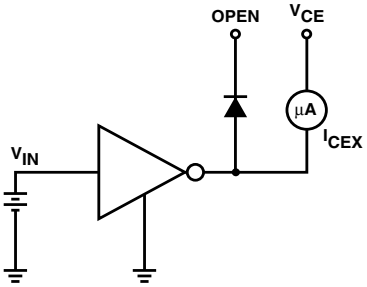
TEST FIGURES

FIGURE 1A



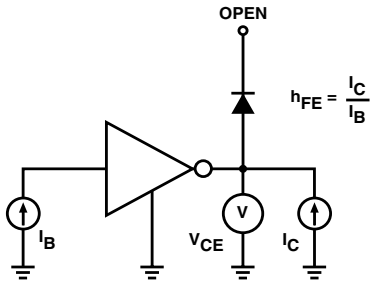
Dwg. No. A-9729A

FIGURE 1B



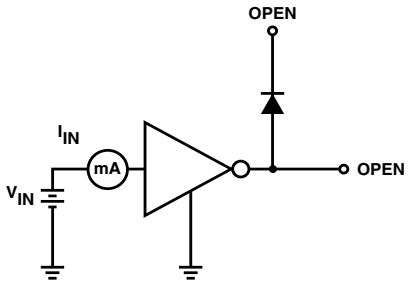
Dwg. No. A-9730A

FIGURE 2



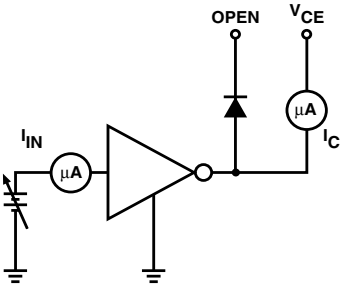
Dwg. No. A-9731A

FIGURE 3



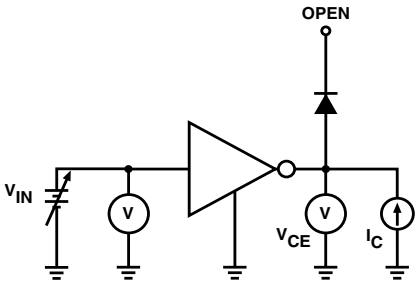
Dwg. No. A-9732A

FIGURE 4



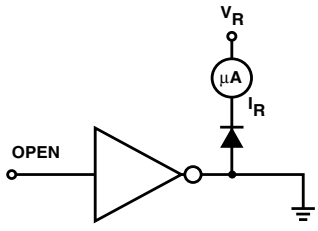
Dwg. No. A-9733A

FIGURE 5



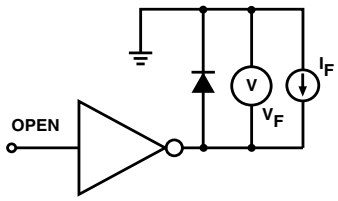
Dwg. No. A-9734A

FIGURE 6



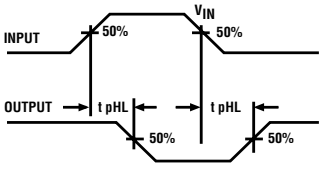
Dwg. No. A-9735A

FIGURE 7

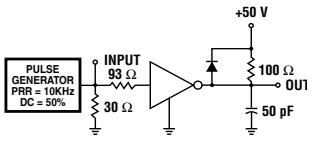


Dwg. No. A-9736A

FIGURE 8



	V_{in}
ULN20X3*	3.5 V
ULN20X4*	12 V



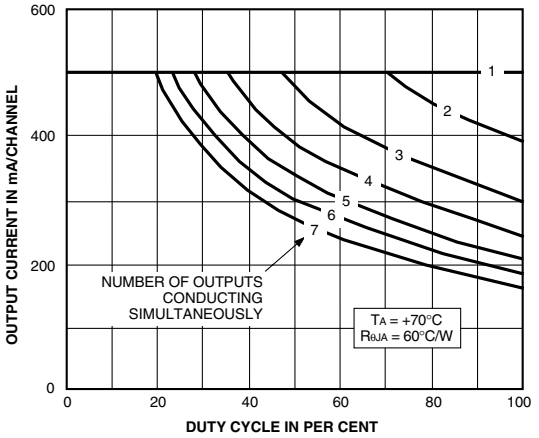
* Complete part number includes a final letter to indicate package.

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

2003 THRU 2024
HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON ARRAYS

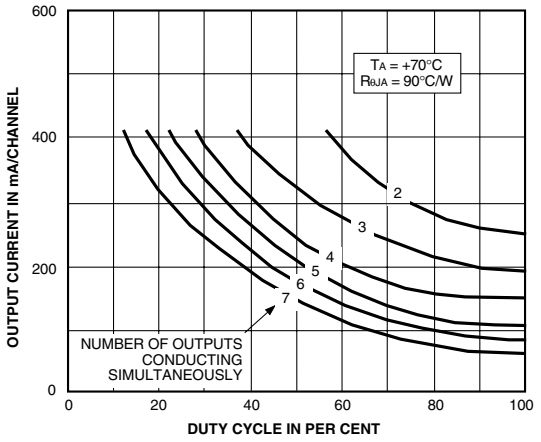
ALLOWABLE COLLECTOR CURRENT AS A FUNCTION OF DUTY CYCLE

(Dual In-line-Packaged Devices, Suffix 'A')



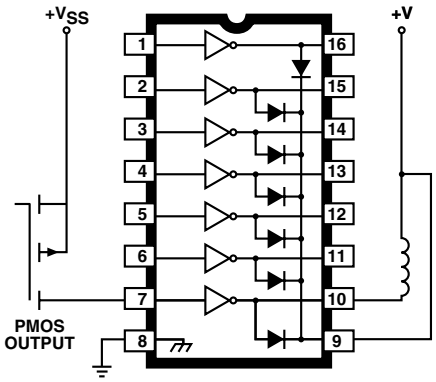
Dwg. GP-070

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

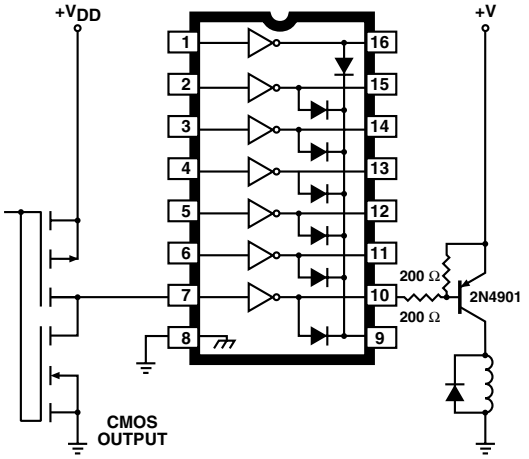


Dwg. GP-044A

TYPICAL APPLICATIONS

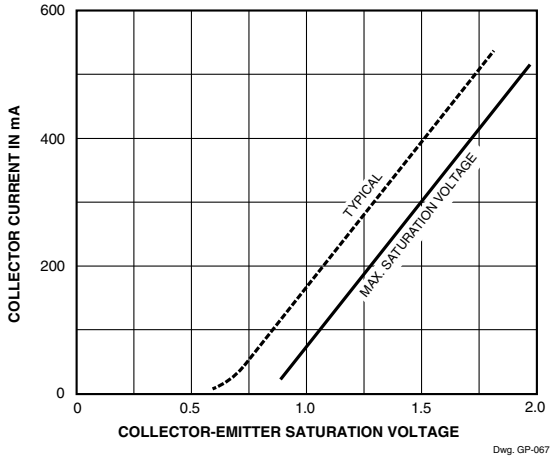


Dwg. No. A-9652



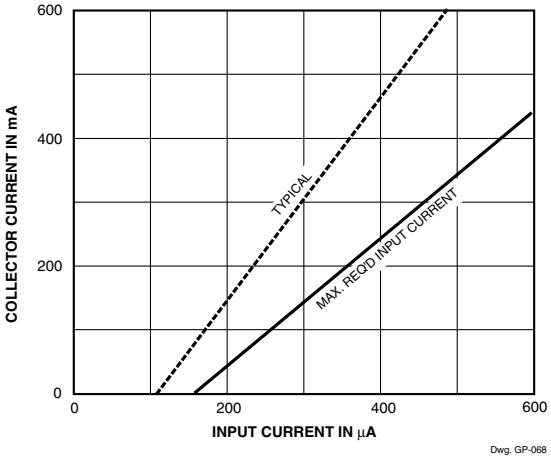
Dwg. No. A-9654A

SATURATION VOLTAGE AS A FUNCTION OF COLLECTOR CURRENT



Dwg. GP-067

COLLECTOR CURRENT AS A FUNCTION OF INPUT CURRENT



Dwg. GP-068

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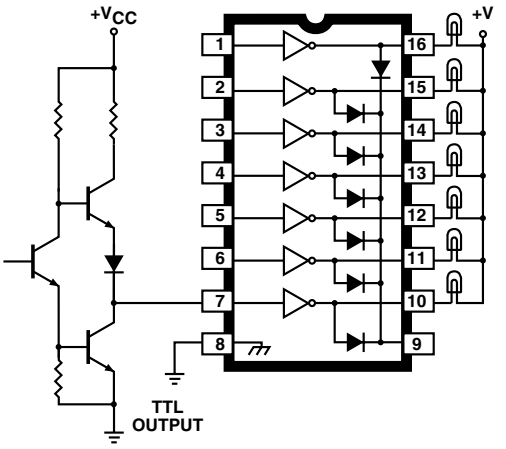
TYPICAL APPLICATIONS



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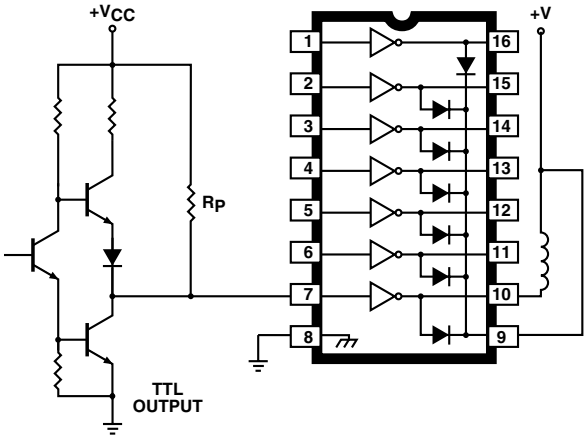
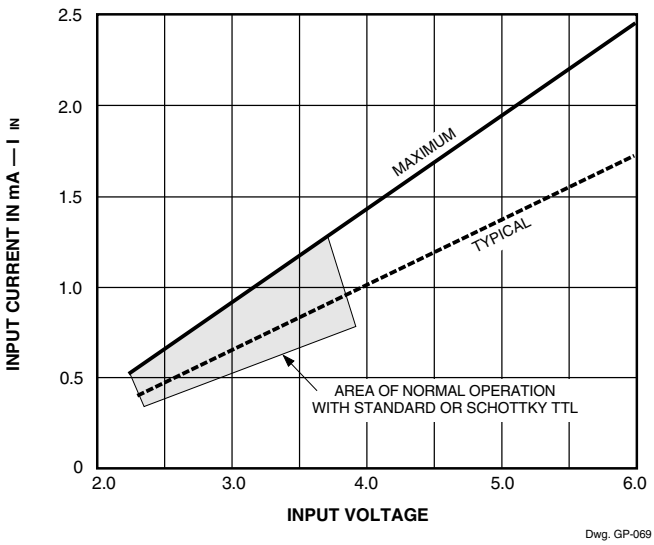


Dwg. No. A-10,175

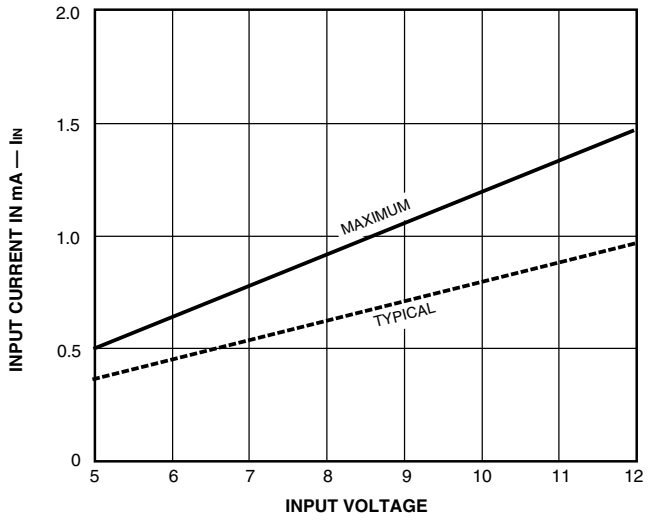
INPUT CURRENT AS A FUNCTION OF INPUT VOLTAGE

Types ULN2003A, ULN2003L, ULN2023A, and ULN2023L



Dwg. GP-069

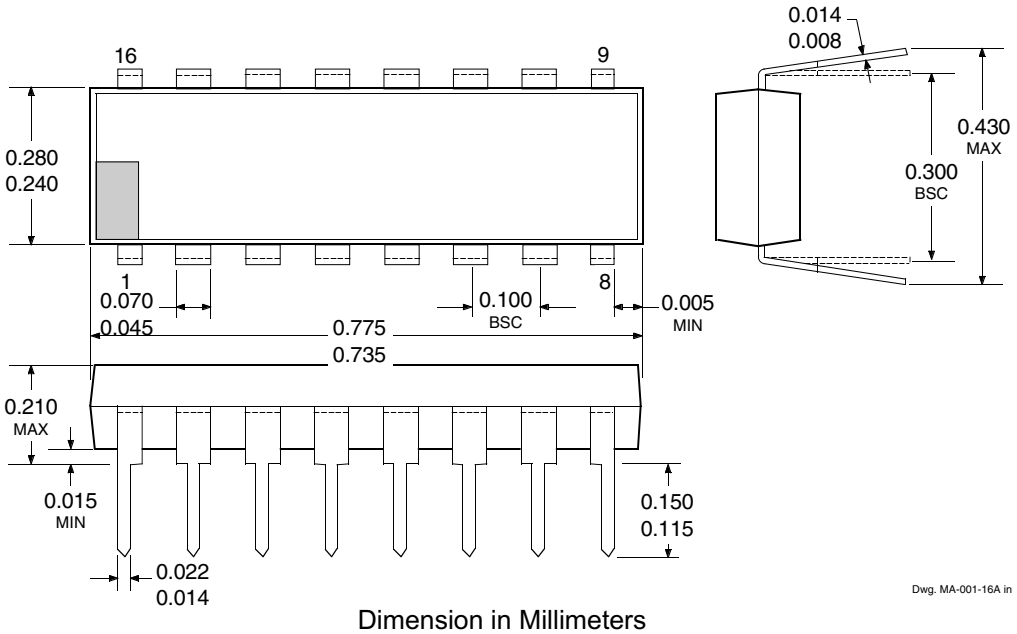
Types ULN2004A, ULN2004L, ULN2024A, and ULN2024L



Dwg. GP-069-1

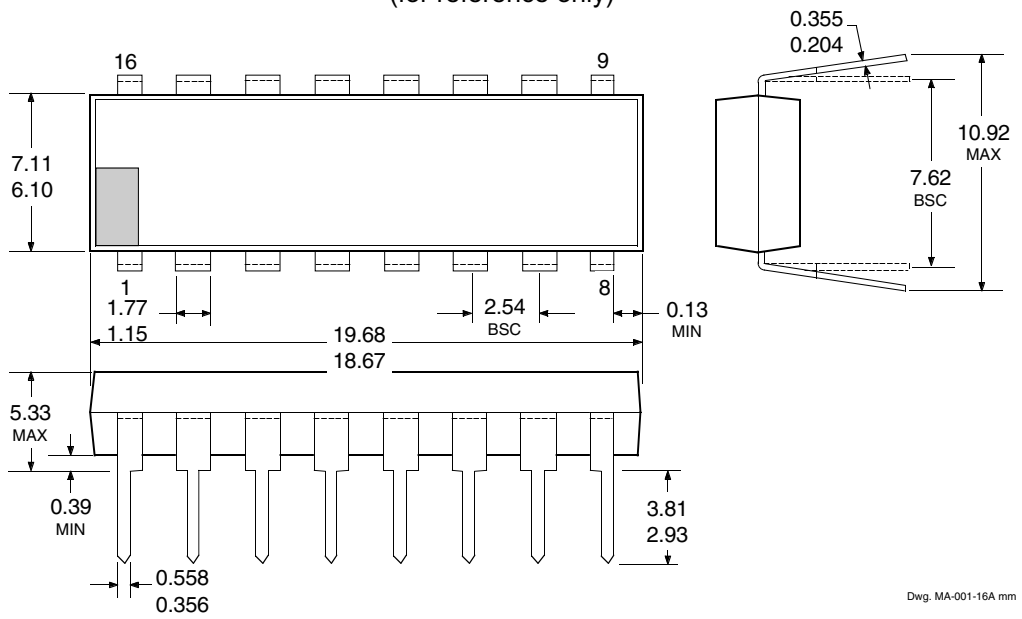
PACKAGE DESIGNATOR "A"

Dimensions in Inches
(controlling dimensions)



Dwg. MA-001-16A in

Dimension in Millimeters
(for reference only)

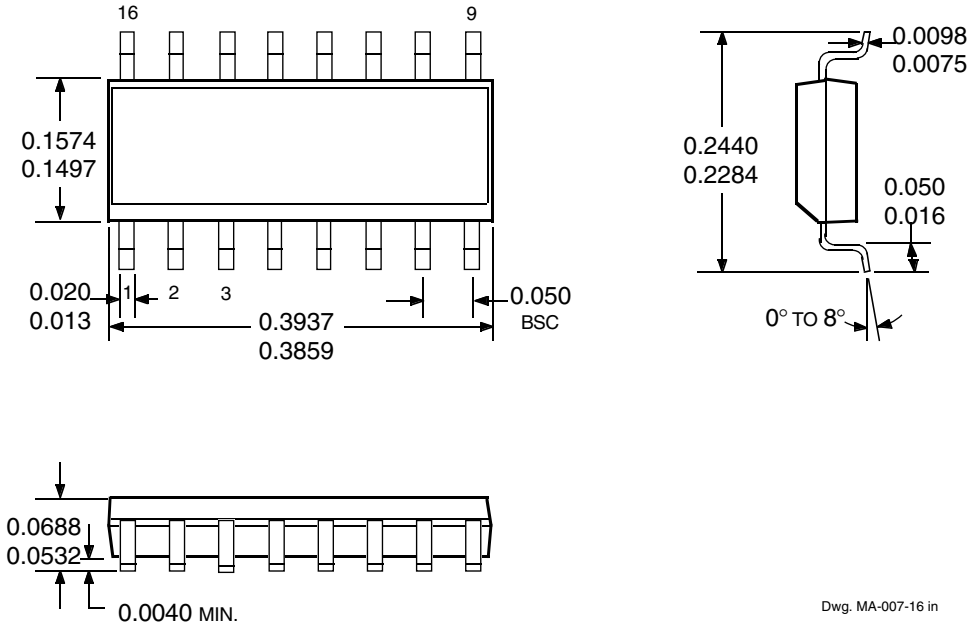


Dwg. MA-001-16A mm

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.

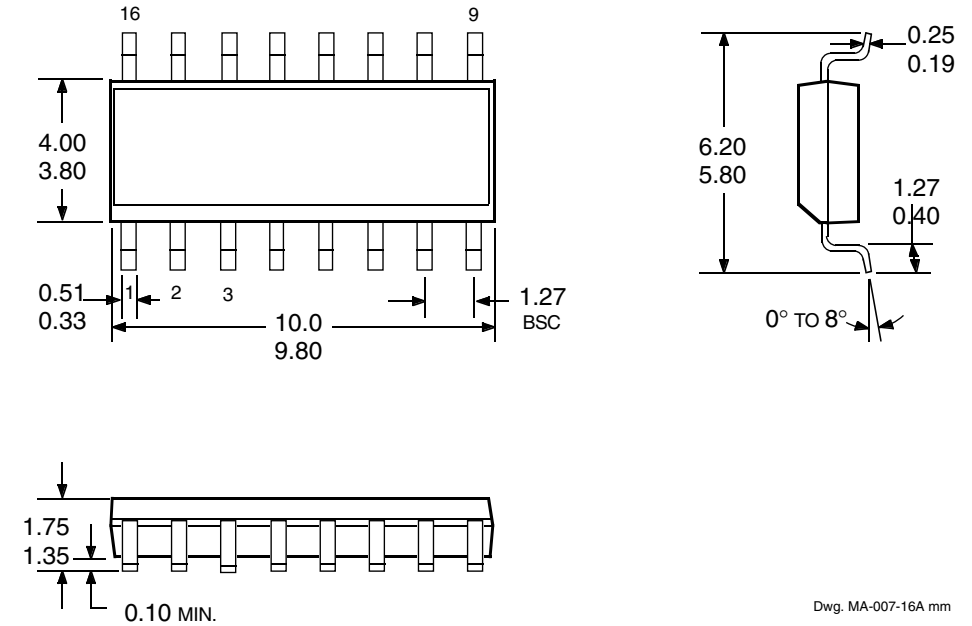
PACKAGE DESIGNATOR "L"

Dimensions in Inches
(for reference only)



Dwg. MA-007-16 in

Dimension in Millimeters
(controlling dimensions)



Dwg. MA-007-16A mm

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

2003 THRU 2024
HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON ARRAYS

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