2003 THRU
2024

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.
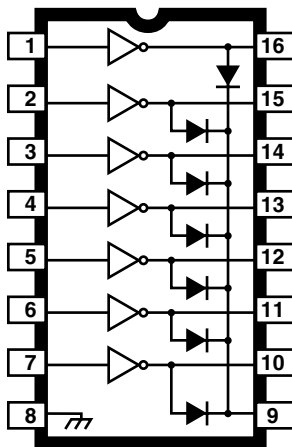
Ideally suited for interfacing between low-level logic circuitry and multiple peripheral power loads, the Series ULN20xxA/L high-voltage, high-current Darlington arrays feature continuous load current ratings to 500 mA for each of the seven drivers. At an appropriate duty cycle depending on ambient temperature 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".

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**

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.
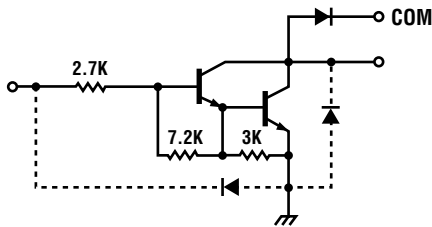
Allegro® MicroSystems, Inc.

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

SUFFIX 'A', $R_{\theta JA}$ = 60°C/W

SUFFIX 'L', $R_{\theta JA}$ = 90°C/W

ALLOWABLE PACKAGE POWER DISSIPATION IN WATTS

AMBIENT TEMPERATURE IN °C
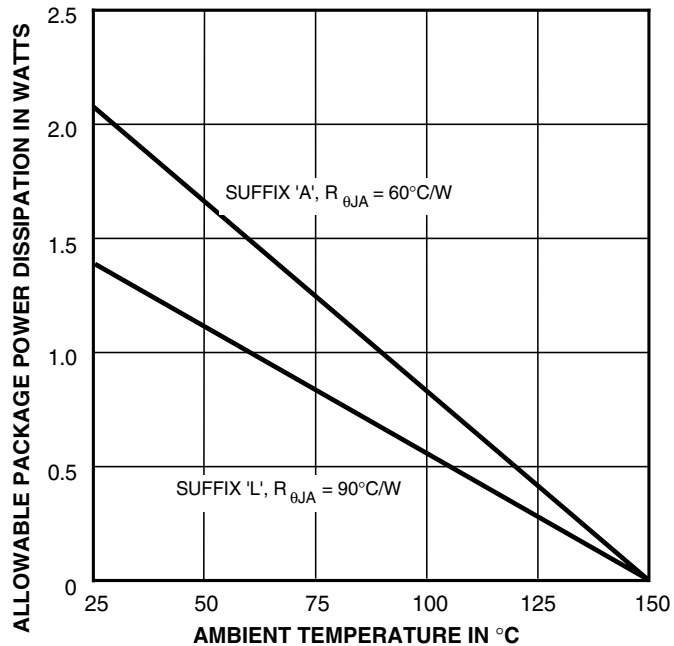
Dwg. GP-006A

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

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

Characteristic	Symbol	Test Fig.	Applicable Devices	Test Conditions	Limits			Units
					Min.	Typ.	Max.	
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.

**Types ULN2023A, ULN2023L, ULN2024A, and ULN2024L
ELECTRICAL CHARACTERISTICS at +25°C (unless otherwise noted).**

Characteristic	Symbol	Test Fig.	Applicable Devices	Test Conditions	Limits			Units
					Min.	Typ.	Max.	
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

OPEN V_{CE}

μA I_{CEX}

OPEN

Dwg. No. A-9729A

FIGURE 1B

OPEN V_{CE}

μA I_{CEX}

V_{IN}
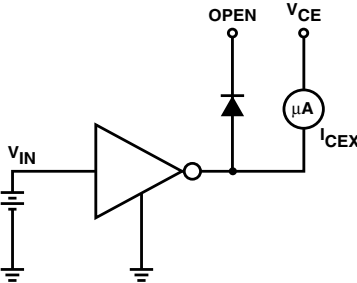
Dwg. No. A-9730A

FIGURE 2

OPEN

$h_{FE} = \dfrac{I_C}{I_B}$

I_B V_{CE} I_C
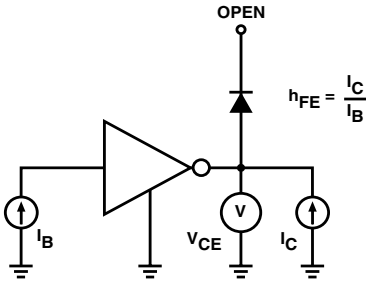
Dwg. No. A-9731A

FIGURE 3

OPEN

I_{IN}

V_{IN} mA   OPEN
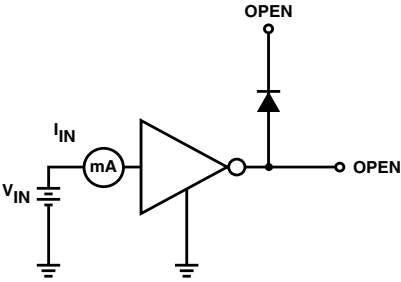
Dwg. No. A-9732A

FIGURE 4

OPEN V_{CE}

I_{IN} μA I_C
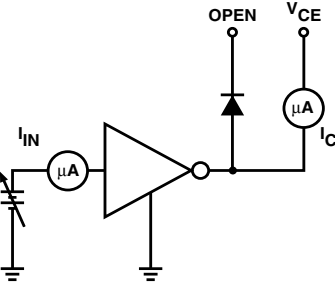
Dwg. No. A-9733A

FIGURE 5

OPEN

V_{IN} V V_{CE} I_C
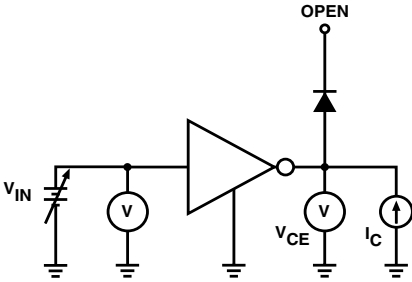
Dwg. No. A-9734A

FIGURE 6

V_R

μA I_R

OPEN
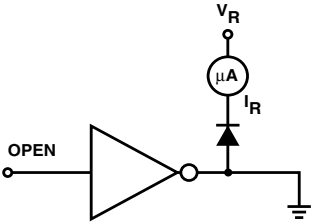
Dwg. No. A-9735A

FIGURE 7

I_F

V V_F

OPEN

Dwg. No. A-9736A

FIGURE 8

INPUT   50% V_{IN} 50%

OUTPUT   t pHL   t pHL

50%   50%

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

PULSE GENERATOR PRR = 10KHz DC = 50%

INPUT 93 Ω   30 Ω   +50 V   100 Ω   OUT   50 pF

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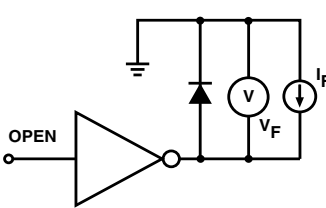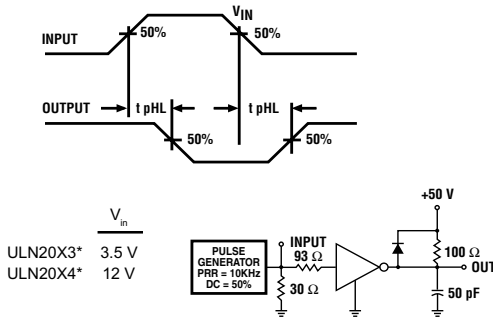
* Complete part number includes a final letter to indicate package.

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')

NUMBER OF OUTPUTS CONDUCTING SIMULTANEOUSLY

$T_A = +70°C$
$R_{\theta JA} = 60°C/W$

OUTPUT CURRENT IN mA/CHANNEL

DUTY CYCLE IN PER CENT
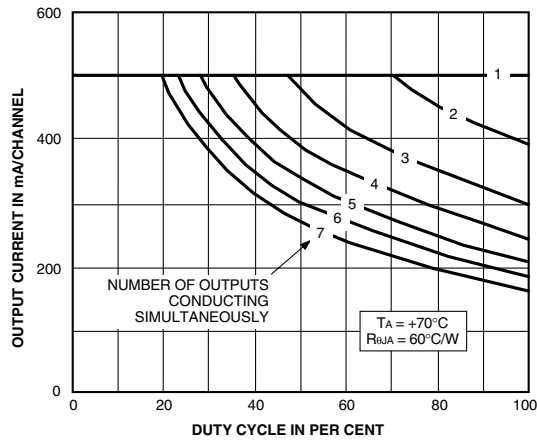
Dwg. GP-070

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

$T_A = +70°C$
$R_{\theta JA} = 90°C/W$

NUMBER OF OUTPUTS CONDUCTING SIMULTANEOUSLY

OUTPUT CURRENT IN mA/CHANNEL

DUTY CYCLE IN PER CENT
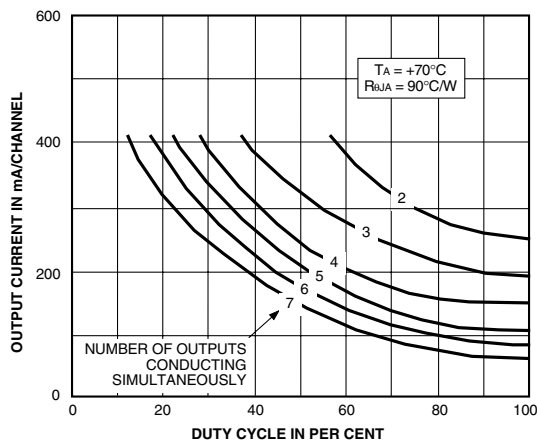
Dwg. GP-044A

TYPICAL APPLICATIONS

+V_SS   +V

PMOS OUTPUT

Dwg. No. A-9652

+V_DD   +V

200 Ω
200 Ω
2N4901

CMOS OUTPUT
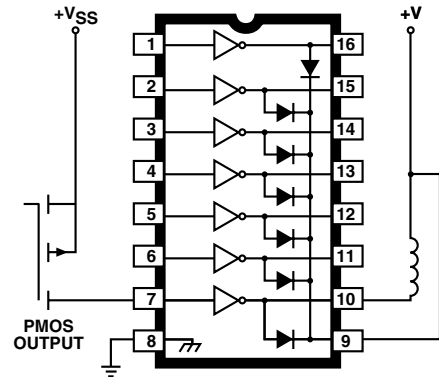
Dwg. No. A-9654A

SATURATION VOLTAGE AS A FUNCTION OF COLLECTOR CURRENT

COLLECTOR CURRENT IN mA

TYPICAL

MAX. SATURATION VOLTAGE

COLLECTOR-EMITTER SATURATION VOLTAGE
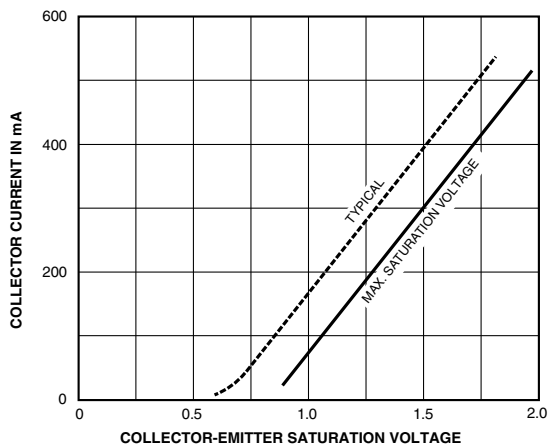
Dwg. GP-067

COLLECTOR CURRENT AS A FUNCTION OF INPUT CURRENT
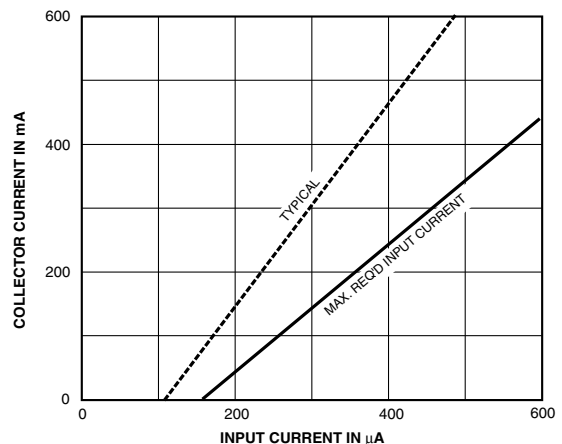
COLLECTOR CURRENT IN mA

TYPICAL

MAX. REQ'D INPUT CURRENT

INPUT CURRENT IN μA

Dwg. GP-068

TYPICAL APPLICATIONS
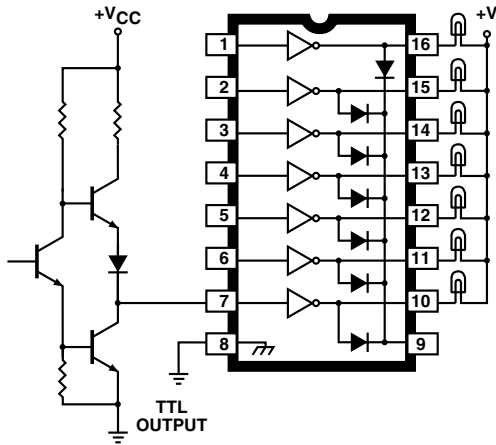
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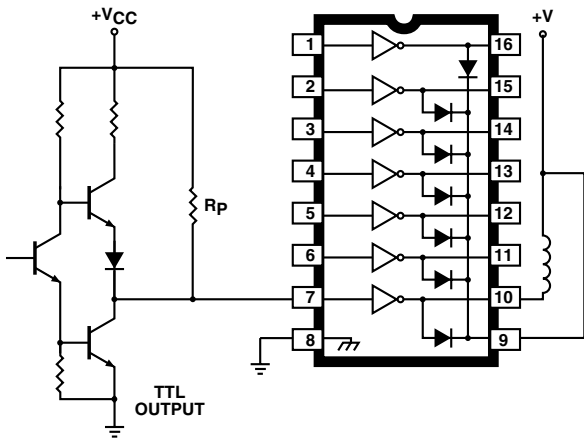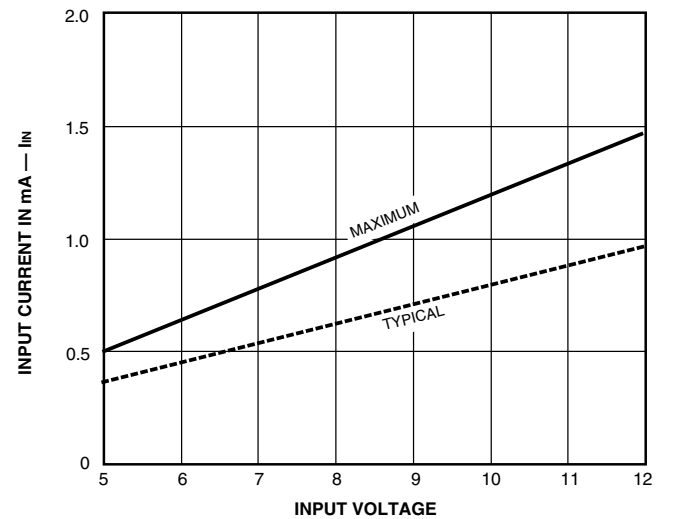

Dwg. No. A-10,175

INPUT CURRENT AS A FUNCTION OF INPUT VOLTAGE

Types ULN2003A, ULN2003L, ULN2023A, and ULN2023L
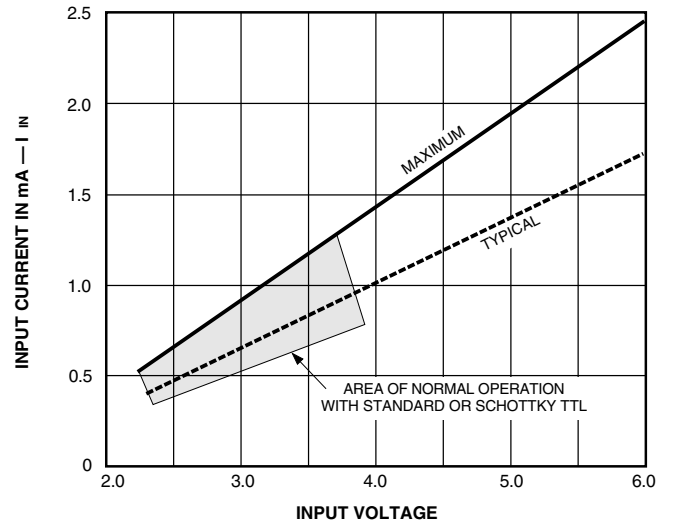
Dwg. GP-069

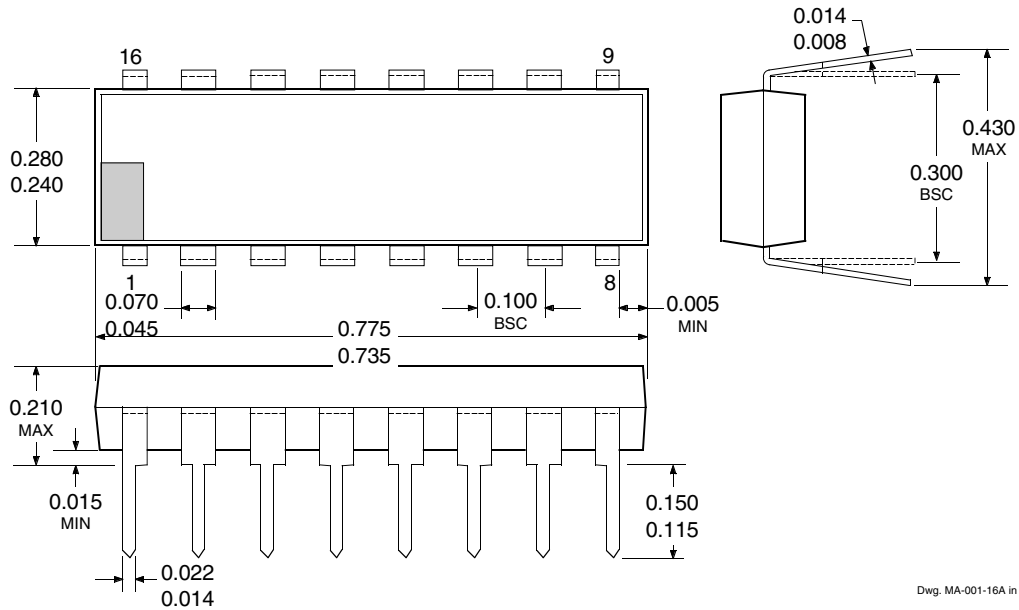### Types ULN2004A, ULN2004L, ULN2024A, and ULN2024L

Dwg. GP-069-1

PACKAGE DESIGNATOR "A"

Dimensions in Inches
(controlling dimensions)

16   9

0.280
0.240

1   8

0.070
0.045

0.100
BSC

0.005
MIN

0.775
0.735

0.210
MAX

0.015
MIN

0.150
0.115

0.022
0.014

0.014
0.008

0.430
MAX

0.300
BSC

Dwg. MA-001-16A in

Dimension in Millimeters
(for reference only)

16   9

7.11
6.10

1   8

1.77
1.15

2.54
BSC

0.13
MIN

19.68
18.67

5.33
MAX

0.39
MIN

3.81
2.93

0.558
0.356

0.355
0.204

10.92
MAX

7.62
BSC
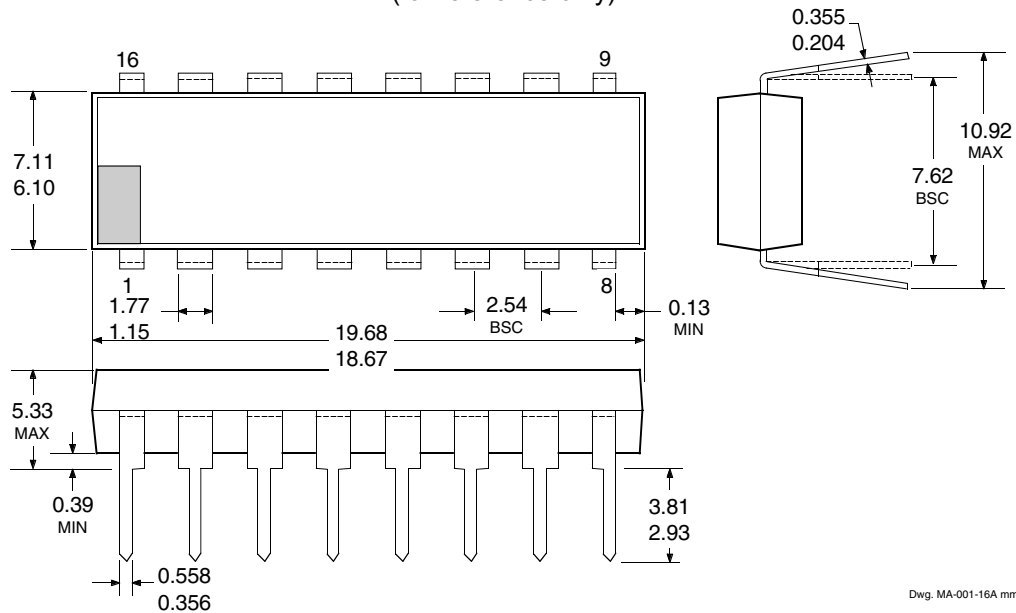
Dwg. MA-001-16A mm

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.

Allegro® MicroSystems, Inc.

115 Northeast Cutoff, Box 15036
Worcester, Massachusetts 01615-0036 (508) 853-5000

PACKAGE DESIGNATOR "L"

Dimensions in Inches
(for reference only)

16   9

0.1574
0.1497

0.020
0.013

1 2 3

0.3937
0.3859

0.050
BSC

0.0098
0.0075

0.2440
0.2284

0.050
0.016

0° TO 8°

0.0688
0.0532

0.0040 MIN.
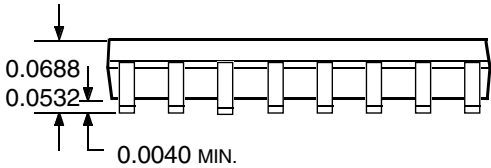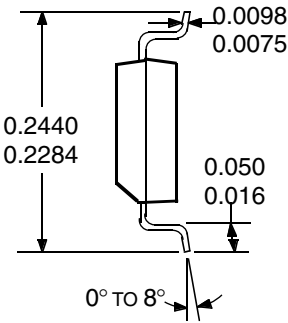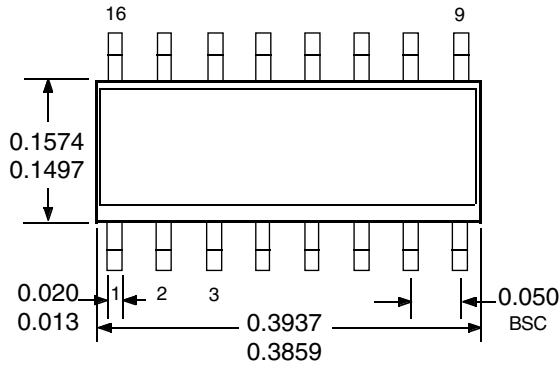
Dwg. MA-007-16 in

Dimension in Millimeters
(controlling dimensions)

16   9

4.00
3.80

0.51
0.33

1 2 3

10.0
9.80

1.27
BSC

0.25
0.19

6.20
5.80

1.27
0.40

0° TO 8°

1.75
1.35

0.10 MIN.
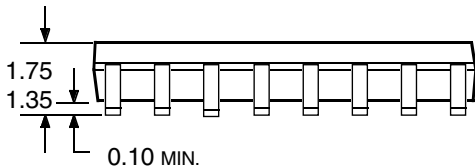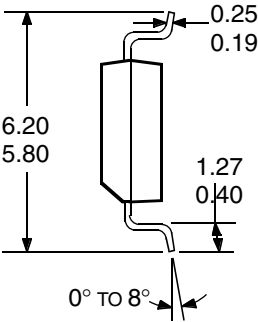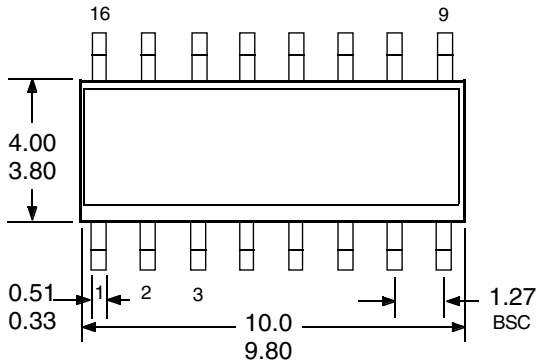
Dwg. MA-007-16A mm

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