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LP395 Ultra Reliable Power Transistor

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FEATURES

- Internal Thermal Limiting
- Internal Current and Power Limiting
- Specified 100 mA Output Current
- 0.5 μ A Typical Base Current
- Directly Interfaces with TTL or CMOS
- +36 Volts On Base Causes No Damage
- 2 μ s Switching Time

DESCRIPTION

The LP395 is a fast monolithic transistor with complete overload protection. This very high gain transistor has included on the chip, current limiting, power limiting, and thermal overload protection, making it difficult to destroy from almost any type of overload. Available in an epoxy TO-92 transistor package this device is specified to deliver 100 mA.

Thermal limiting at the chip level, a feature not available in discrete designs, provides comprehensive protection against overload. Excessive power dissipation or inadequate heat sinking causes the thermal limiting circuitry to turn off the device preventing excessive die temperature.

The LP395 offers a significant increase in reliability while simplifying protection circuitry. It is especially attractive as a small incandescent lamp or solenoid driver because of its low drive requirements and blowout-proof design.

The LP395 is easy to use and only a few precautions need be observed. Excessive collector to emitter voltage can destroy the LP395 as with any transistor. When the device is used as an emitter follower with a low source impedance, it is necessary to insert a 4.7 k Ω resistor in series with the base lead to prevent possible emitter follower oscillations. Also since it has good high frequency response, supply by-passing is recommended.

Areas where the LP395 differs from a standard NPN transistor are in saturation voltage, leakage (quiescent) current and in base current. Since the internal protection circuitry requires voltage and current to function, the minimum voltage across the device in the on condition (saturated) is typically 1.6 Volts, while in the off condition the quiescent (leakage) current is typically 200 μ A. Base current in this device flows out of the base lead, rather than into the base as is the case with conventional NPN transistors. Also the base can be driven positive up to 36 Volts without damage, but will draw current if driven negative more than 0.6 Volts. Additionally, if the base lead is left open, the LP395 will turn on.

The LP395 is a low-power version of the 1-Amp LM195/LM295/LM395 Ultra Reliable Power Transistor.

The LP395 is rated for operation over a -40°C to $+125^{\circ}\text{C}$ range.

Connection Diagram

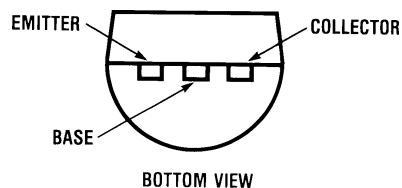


Figure 1. TO-92 Package
See NS Package LP0003A

Typical Applications

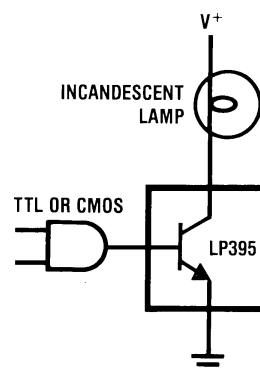


Figure 2. Fully Protected Lamp Driver



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LP395



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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Collector to Emitter Voltage	36V
Collector to Base Voltage	36V
Base to Emitter Voltage (Forward)	36V
Base to Emitter Voltage (Reverse)	10V
Base to Emitter Current (Reverse)	20 mA
Collector Current Limit	Internally Limited
Power Dissipation	Internally Limited
Operating Temperature Range	–40°C to +125°C
Storage Temperature Range	–65°C to +150°C
Lead Temp. (Soldering, 10 seconds)	260°C

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits.

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions	Typical	Tested Limit ⁽¹⁾	Design Limit ⁽²⁾	Units (Limit)
V_{CE}	Collector to Emitter Operating Voltage	$0.5 \text{ mA} \leq I_C \leq 100 \text{ mA}$		36	36 ⁽³⁾	V(Max)
I_{CL}	Collector Current Limit ⁽⁴⁾	$V_{BE} = 2V, V_{CE} = 36V$	45	25	20	mA(Min)
		$V_{BE} = 2V, V_{CE} = 15V$	90	60	50	mA(Min)
		$V_{BE} = 2V, 2V \leq V_{CE} \leq 6V$	130	100	100	mA(Min)
I_B	Base Current	$0 \leq I_C \leq 100 \text{ mA}$	–0.3	–2.0	–2.5	$\mu\text{A}(\text{Max})$
I_Q	Quiescent Current	$V_{BE} = 0V, 0 \leq V_{CE} \leq 36V$	0.24	0.50	0.60	mA(Max)
$V_{CE(\text{SAT})}$	Saturation Voltage	$V_{BE} = 2V, I_C = 100 \text{ mA}$	1.82	2.00	2.10	V(Max)
BV_{BE}	Base to Emitter Break-down Voltage ⁽⁴⁾	$0 \leq V_{CE} \leq 36V, I_B = 2 \mu\text{A}$		36	36	V(Min)
V_{BE}	Base to Emitter Voltage ⁽⁵⁾	$I_C = 5 \text{ mA}$	0.69	0.79	0.90	V(Max)
		$I_C = 100 \text{ mA}$ ⁽⁴⁾	1.02		1.40	V (Max)
t_S	Switching Time	$V_{CE} = 20V, R_L = 200\Omega$ $V_{BE} = 0V, +2V, 0V$	2			μs
θ_{JA}	Thermal Resistance Junction to Ambient	0.4" leads soldered to printed circuit board	150		180	°C/W (Max)
		0.125" leads soldered to printed circuit board	130		160	°C/W (Max)

(1) Specified and 100% production tested.

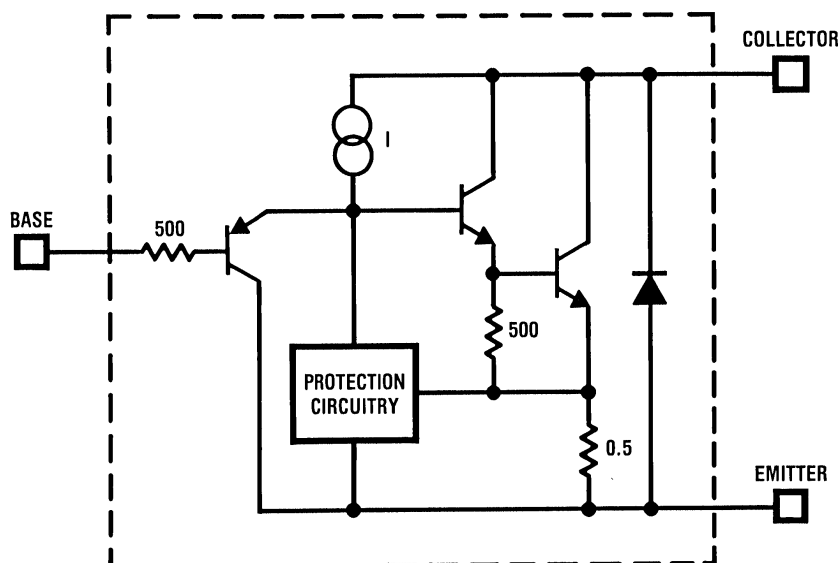
(2) Specified (but not 100% production tested) over the operating temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels.

(3) Parameters identified with **boldface type** apply at temp. extremes. All other numbers, unless noted apply at +25°C.

(4) These numbers apply for pulse testing with a low duty cycle.

(5) Base positive with respect to emitter.

SIMPLIFIED CIRCUIT



APPLICATIONS INFORMATION

One failure mode incandescent lamps may experience is one in which the filament resistance drops to a very low value before it actually blows out. This is especially rough on most solid-state lamp drivers and in most cases a lamp failure of this type will also cause the lamp driver to fail. Because of its high gain and blowout-proof design, the LP395 is an ideal candidate for reliably driving small incandescent lamps. Additionally, the current limiting characteristics of the LP395 are advantageous as it serves to limit the cold filament inrush current, thus increasing lamp life.

TYPICAL PERFORMANCE CHARACTERISTICS

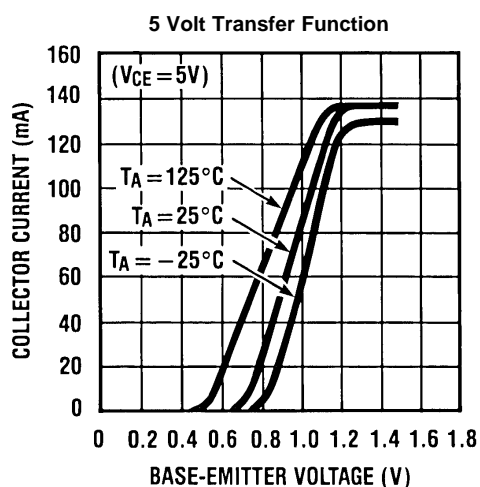


Figure 3.

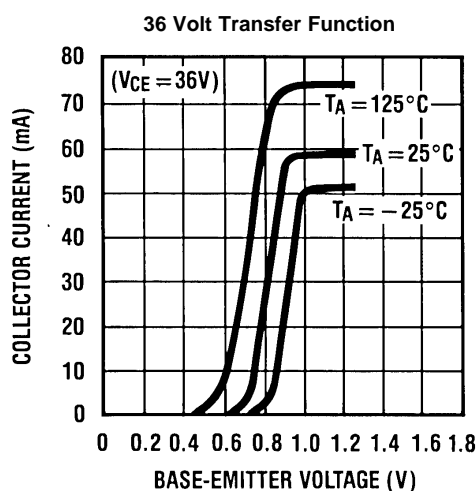


Figure 4.

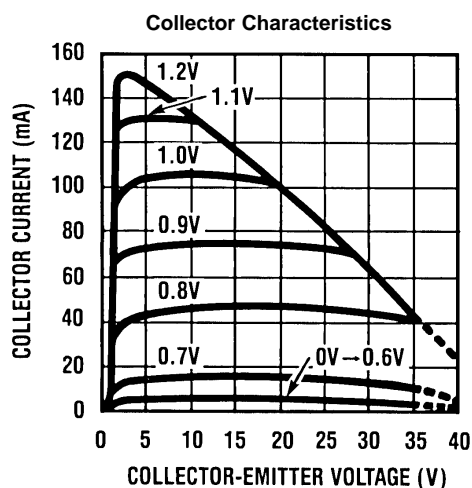


Figure 5.

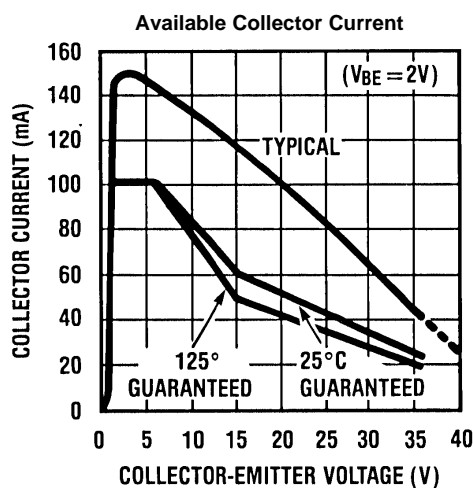


Figure 6.

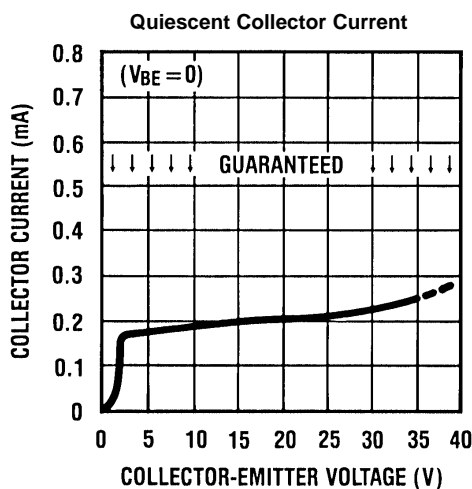


Figure 7.

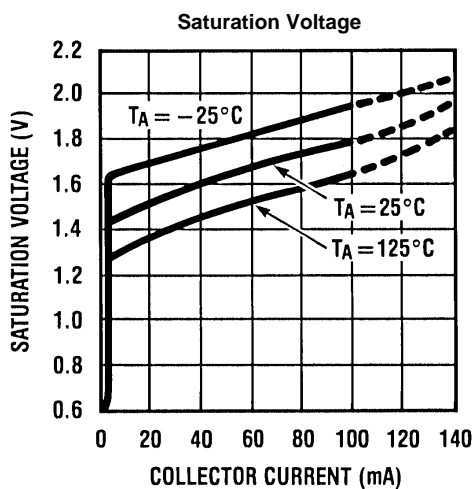
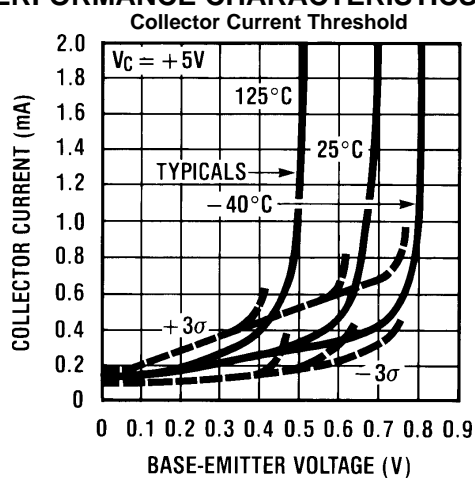


Figure 8.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)



LP395



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TYPICAL APPLICATIONS

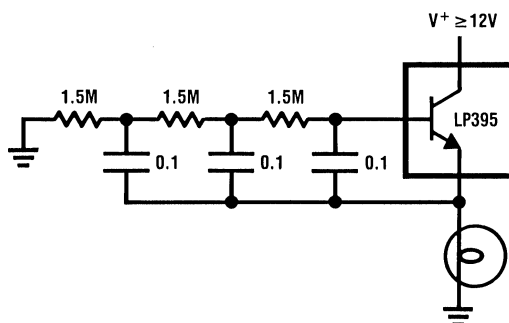


Figure 10. Lamp Flasher
(Short Circuit Proof)

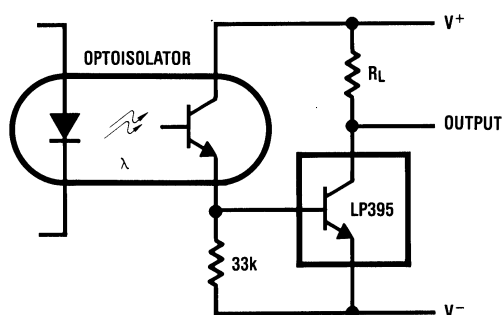


Figure 11. Optically Isolated
Switch

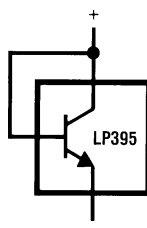


Figure 12. Two Terminal
Current Limiter

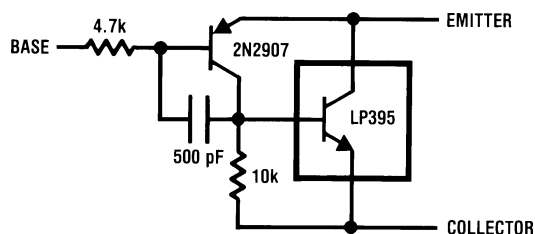


Figure 13. Composite PNP

REVISION HISTORY

Changes from Revision B (March 2013) to Revision C	Page
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- | | |
|--|-------------------|
| • Changed layout of National Data Sheet to TI format | 6 |
|--|-------------------|



PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LP395Z/LFT1	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type		LP 395Z	Samples
LP395Z/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-40 to 125	LP 395Z	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBsolete: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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Datasheet of LP395Z/NOPB - TRANS NPN 36V TO92-3

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PACKAGE OPTION ADDENDUM

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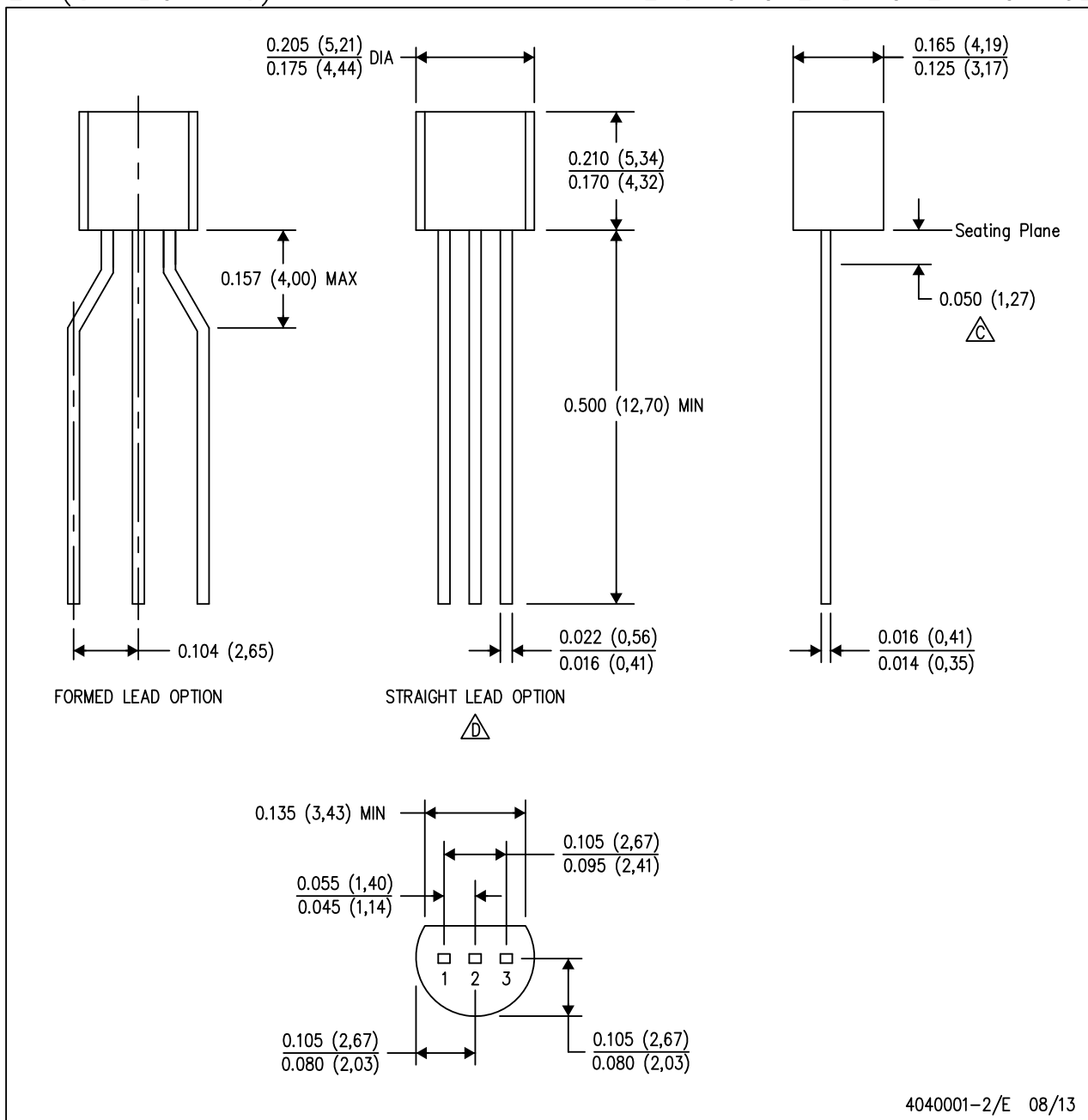
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MECHANICAL DATA

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE

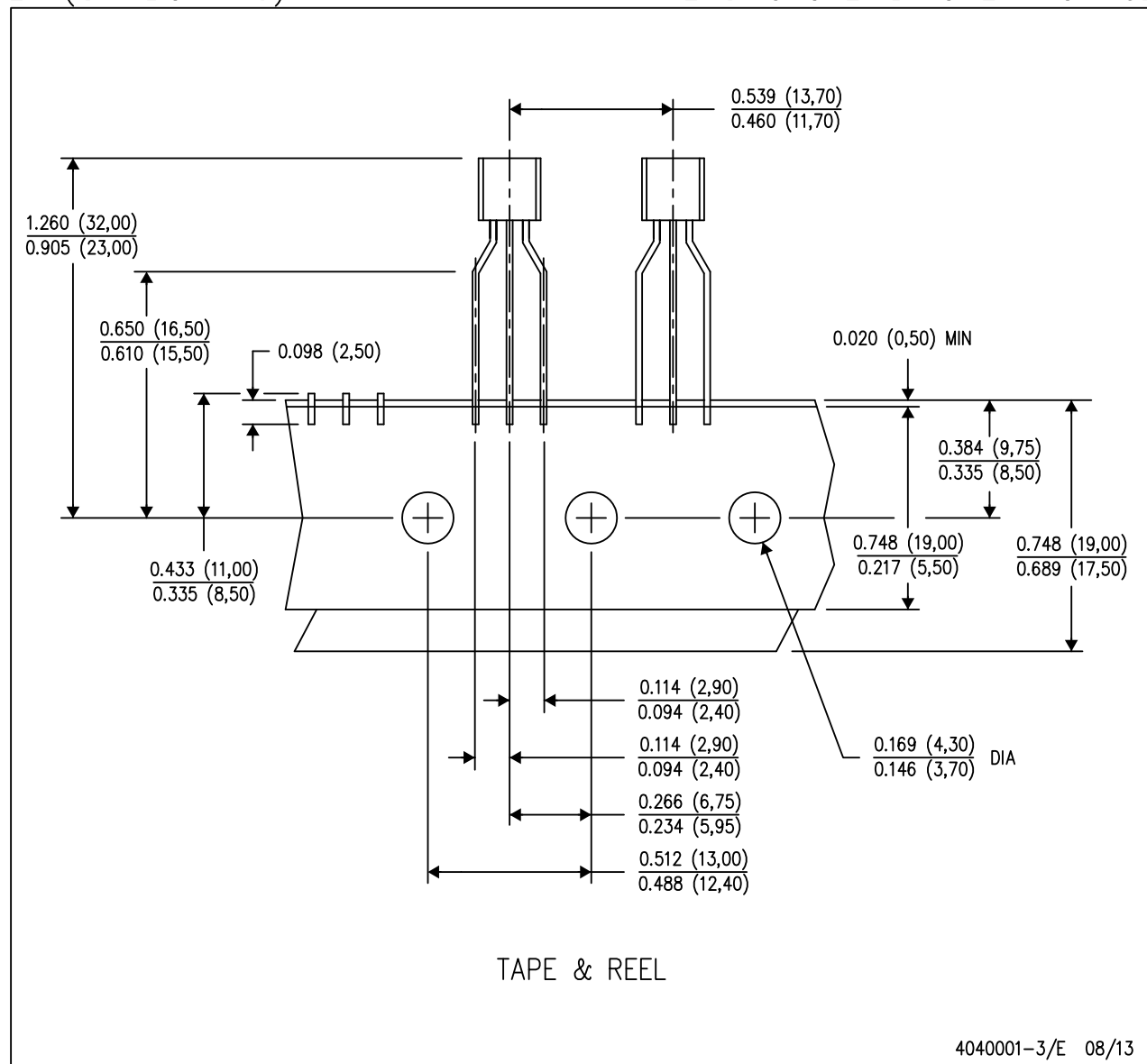


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 -  C. Lead dimensions are not controlled within this area.
 -  D. Falls within JEDEC TO-226 Variation AA (TO-226 replaces TO-92).
 - E. Shipping Method:
 - Straight lead option available in bulk pack only.
 - Formed lead option available in tape & reel or ammo pack.
 - Specific products can be offered in limited combinations of shipping mediums and lead options.
 - Consult product folder for more information on available options.

MECHANICAL DATA

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Tape and Reel information for the Formed Lead Option package.

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