LM60/LM60-Q1 2.7V, SOT-23 or TO-92 Temperature Sensor

Check for Samples: LM60/LM60-Q1

FEATURES

- **Calibrated linear scale factor of +6.25 mV/°C**
- **Rated for full −40°C to +125°C range**
- **Suitable for remote applications**
- **Available in SOT-23 and TO-92 packages**
- **LM60Q is AEC-Q100 Grade 1 qualified and is manufactured on an Automotive Grade flow.**

APPLICATIONS

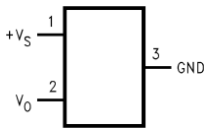
- **Automotive**
- **Cell Phones & Computers**
- **Power Supply Modules**
- **Battery Management**
- **FAX Machines & Printers**
- **HVAC & Disk Drives**
- **Appliances**

KEY SPECIFICATIONS

- **Accuracy at 25°C: ±2.0°C and ±3.0°C (max)**
- **Accuracy for −40°C to +125°C: ±4.0°C (max)**
- **Accuracy for −25°C to +125°C: ±3.0°C (max)**
- **Temperature Slope: +6.25mV/°C**
- **Power Supply Voltage Range: +2.7V to +10V**
- **Current Drain at 25°C: 110µA (max)**
- **Nonlinearity: ±0.8°C (max)**
- **Output Impedance: 800Ω (max)**

CONNECTION DIAGRAMS

SOT-23 (TOP VIEW)



SVA-1268101

TO-92 (BOTTOM VIEW)

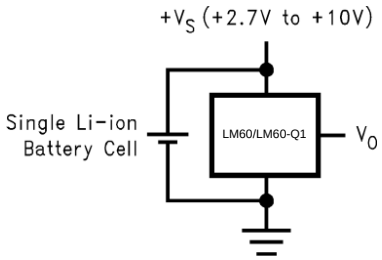
SVA-1268123

DESCRIPTION

The LM60/LM60-Q1 is a precision integrated-circuit temperature sensor that can sense a −40°C to +125°C temperature range while operating from a single +2.7V supply. The LM60/LM60-Q1's output voltage is linearly proportional to Celsius (Centigrade) temperature (+6.25 mV/°C) and has a DC offset of +424 mV. The offset allows reading negative temperatures without the need for a negative supply. The nominal output voltage of the LM60/LM60-Q1 ranges from +174 mV to +1205 mV for a −40°C to +125°C temperature range. The LM60/LM60-Q1 is calibrated to provide accuracies of ±2.0°C at room temperature and ±3°C over the full −25°C to +125°C temperature range.

The LM60/LM60-Q1's linear output, +424 mV offset, and factory calibration simplify external circuitry required in a single supply environment where reading negative temperatures is required. Because the LM60/LM60-Q1's quiescent current is less than 110 µA, self-heating is limited to a very low 0.1°C in still air in the SOT-23 package. Shutdown capability for the LM60/LM60-Q1 is intrinsic because its inherent low power consumption allows it to be powered directly from the output of many logic gates.

TYPICAL APPLICATION



SVA-1268102

V_O = (+6.25 mV/°C × T°C) + 424 mV

Temperature (T)	Typical VO
+125°C	+1205 mV
+100°C	+1049 mV
+25°C	+580 mV
0°C	+424 mV
–25°C	+268 mV
–40°C	+174 mV

Figure 1. Full-Range Centigrade Temperature Sensor (−40°C to 125°C) Operating from a Single Li-Ion Battery Cell

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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.

ORDERING INFORMATION

ORDER NUMBER	DEVICE TOP MARK	ACCURACY OVER SPECIFIED TEMPERATURE RANGE	SPECIFIED TEMPERATURE RANGE
LM60BIM3	T6B	±3	–25°C ≤ T_A ≤ +125°C
LM60BIM3X	T6B		
LM60CIM3	T6C	±4	–40°C ≤ T_A ≤ +125°C
LM60CIM3X	T6C		
LM60QIM3	L60Q	±4	–40°C ≤ T_A ≤ +125°C
LM60QIM3X	L60Q		
LM60BIZ	LM60BIZ	±3	–25°C ≤ TA ≤ +125°C
LM60CIZ	LM60CIZ	±4	–40°C ≤ TA ≤ +125°C

ABSOLUTE MAXIMUM RATINGS(1)

over operating free-air temperature range (unless otherwise noted)

			VALUE	UNIT
Supply voltage			+12 to −0.2	V
Output voltage			(+V_S + 0.6) to −0.6	V
Output current			10	mA
Input Current at any pin (2)			5	mA
ESD Susceptibility(3)	Human Body Model		2500	V
	Machine Model	SOT-23	250	V
		TO-92	200	V
Storage temperature			−65 to +150	°C
Maximum junction temperature (T_{JMAX})			125	°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** guarantee specific performance limits. For specified specifications and test conditions, see the Electrical Characteristics. The specified specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
(2) When the input voltage (V_I) at any pin exceeds power supplies (V_I < GND or V_I > +V_S), the current at that pin should be limited to 5 mA.
(3) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin. The machine model is a 200 pF capacitor discharged directly into each pin.

RECOMMENDED OPERATING CONDITIONS(1)

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Specified Temperature Range:	T_{MIN} ≤ T_A ≤ T_{MAX}				
	LM60B			–25 ≤ T_A ≤ +125	°C
	LM60C/LM60-Q1			–40 ≤ T_A ≤ +125	°C
Supply Voltage Range (+V_S)		2.7		10	V
Thermal Resistance, θ_{JA} (2)	SOT-23			450	°C/W
	TO-92			180	°C/W

(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** guarantee specific performance limits. For specified specifications and test conditions, see the Electrical Characteristics. The specified specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
(2) The junction to ambient thermal resistance (θ_{JA}) is specified without a heat sink in still air.

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ELECTRICAL CHARACTERISTICS

Unless otherwise noted, these specifications apply for $+V_S$ = +3.0 V_{DC} and I_{LOAD} = 1 µA. **Boldface limits apply for $T_A = T_J = T_{MIN}$ to T_{MAX}**; all other limits $T_A = T_J$ = 25°C.

PARAMETER	CONDITIONS	TYPICAL (1)	LM60B Limits (2)	LM60C/LM60-Q1 Limits (2)	UNITS (Limit)
Accuracy (3)			±2.0	±3.0	°C (max)
			±3.0	**±4.0**	°C (max)
Output Voltage at 0°C		+424			mV
Nonlinearity (4)			**±0.6**	**±0.8**	°C (max)
Sensor Gain (Average Slope)		+6.25	**6.06**	**6**	mV/°C (min)
			6.44	**6.5**	mV/°C (max)
Output Impedance			**800**	**800**	Ω (max)
Line Regulation (5)	+3.0 V ≤ $+V_S$ ≤ +10 V		**±0.3**	**±0.3**	mV/V (max)
	+2.7 V ≤ $+V_S$ ≤ +3.3 V		**±2.3**	**±2.3**	mV (max)
Quiescent Current	+2.7 V ≤ $+V_S$ ≤ +10 V	82	110	110	µA (max)
			125	**125**	µA (max)
Change of Quiescent Current	+2.7 V ≤ $+V_S$ ≤ +10 V	±5.0			µA (max)
Temperature Coefficient of Quiescent Current		0.2			µA/°C
Long Term Stability (6)	$T_J = T_{MAX}$ = +125°C for 1000 hours	±0.2			°C

(1) Typicals are at $T_J = T_A$ = 25°C and represent most likely parametric norm.
(2) Limits are specified to National's AOQL (Average Outgoing Quality Level).
(3) Accuracy is defined as the error between the output voltage and +6.25 mV/°C times the device's case temperature plus 424 mV, at specified conditions of voltage, current, and temperature (expressed in °C).
(4) Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.
(5) Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.
(6) For best long-term stability, any precision circuit will give best results if the unit is aged at a warm temperature, and/or temperature cycled for at least 46 hours before long-term life test begins. This is especially true when a small (Surface-Mount) part is wave-soldered; allow time for stress relaxation to occur. The majority of the drift will occur in the first 1000 hours at elevated temperatures. The drift after 1000 hours will not continue at the first 1000 hour rate.

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TAPE AND REEL INFORMATION

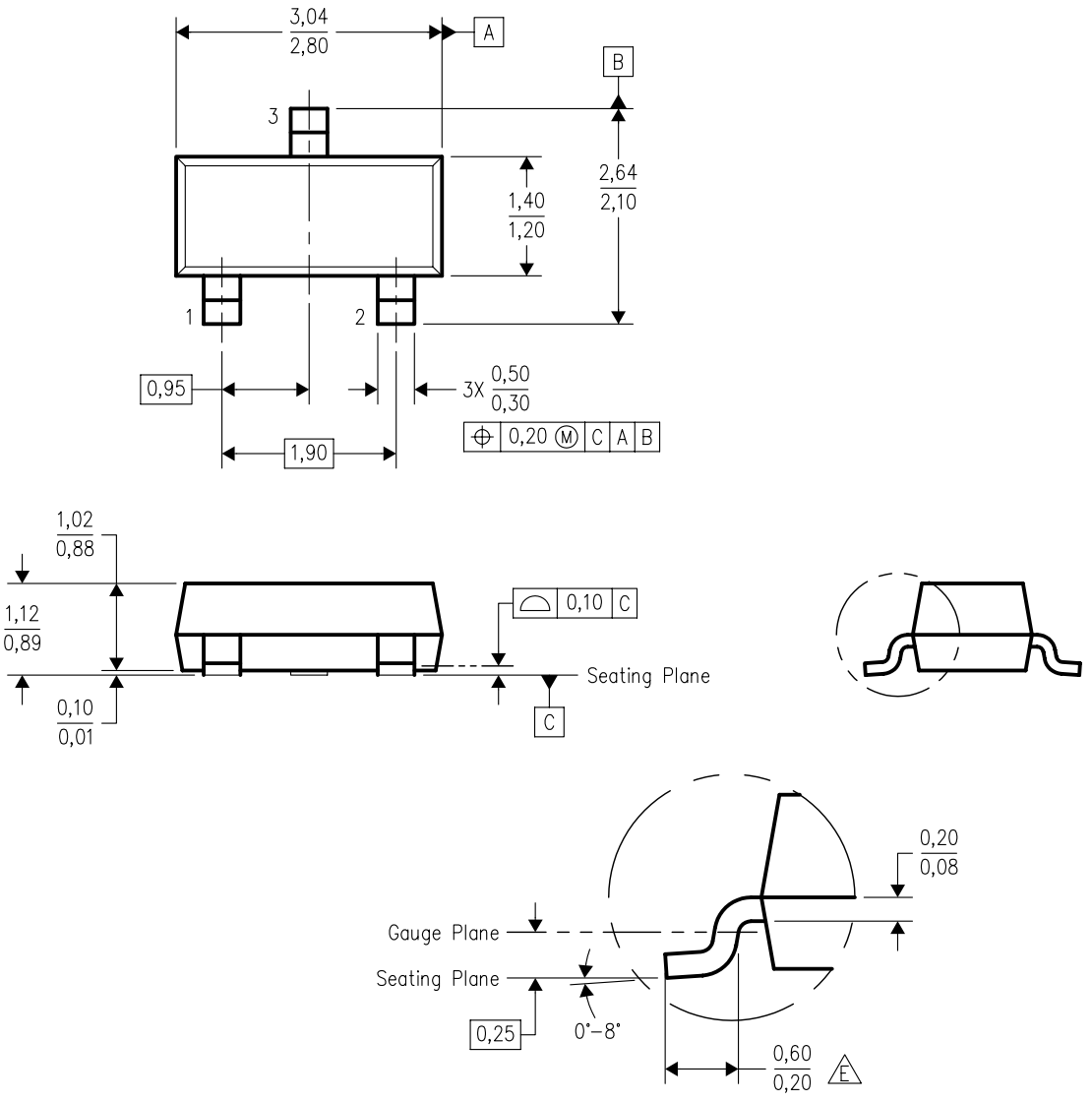
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM60BIM3	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60BIM3/NOPB	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60BIM3X	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60BIM3X/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60CIM3	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60CIM3/NOPB	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60CIM3X	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60CIM3X/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60QIM3/NOPB	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LM60QIM3X/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3

*All dimensions are nominal

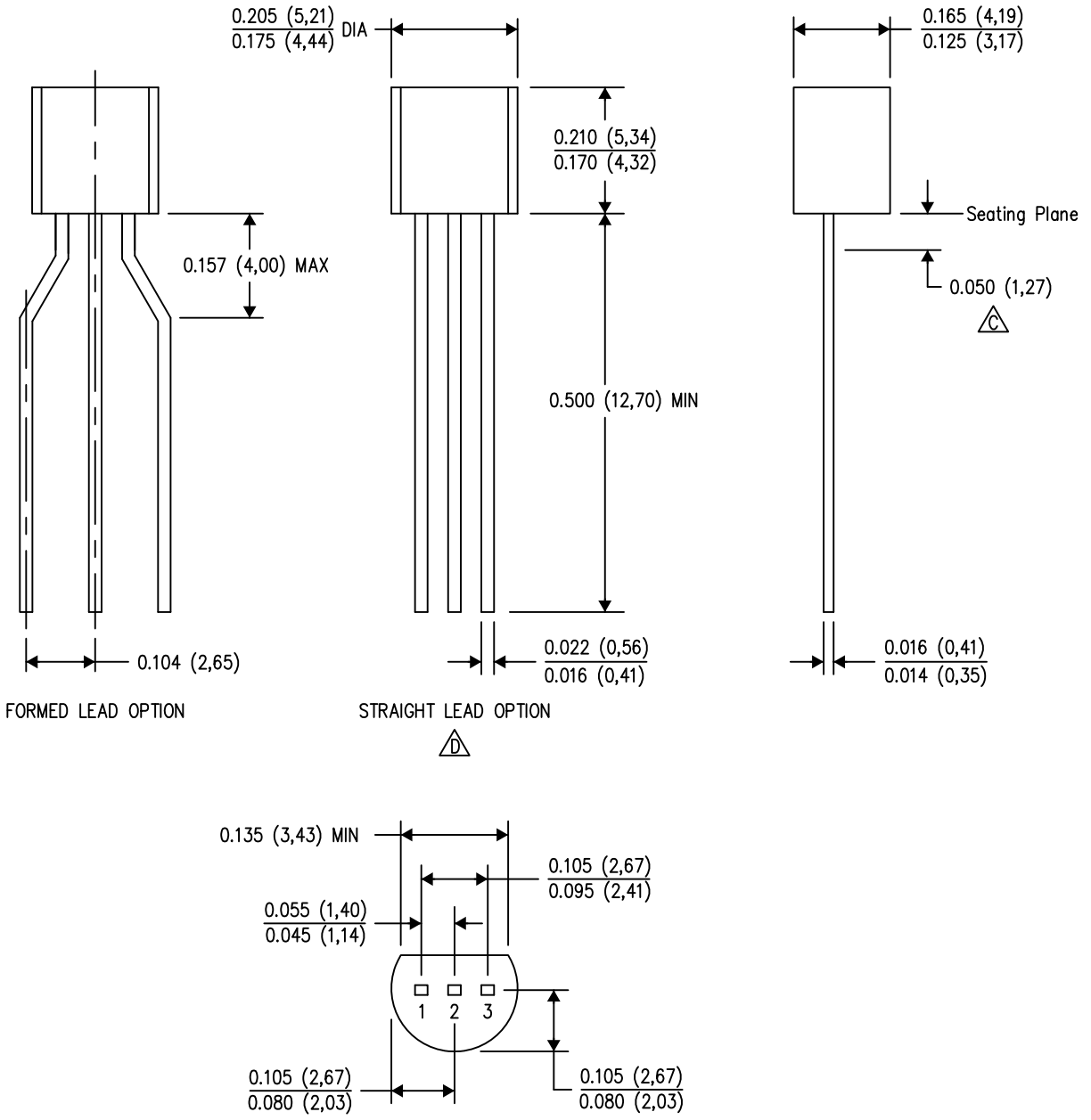
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM60BIM3	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LM60BIM3/NOPB	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LM60BIM3X	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM60BIM3X/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM60CIM3	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LM60CIM3/NOPB	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LM60CIM3X	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM60CIM3X/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LM60QIM3/NOPB	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LM60QIM3X/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0

DBZ (R–PDSO–G3) PLASTIC SMALL–OUTLINE



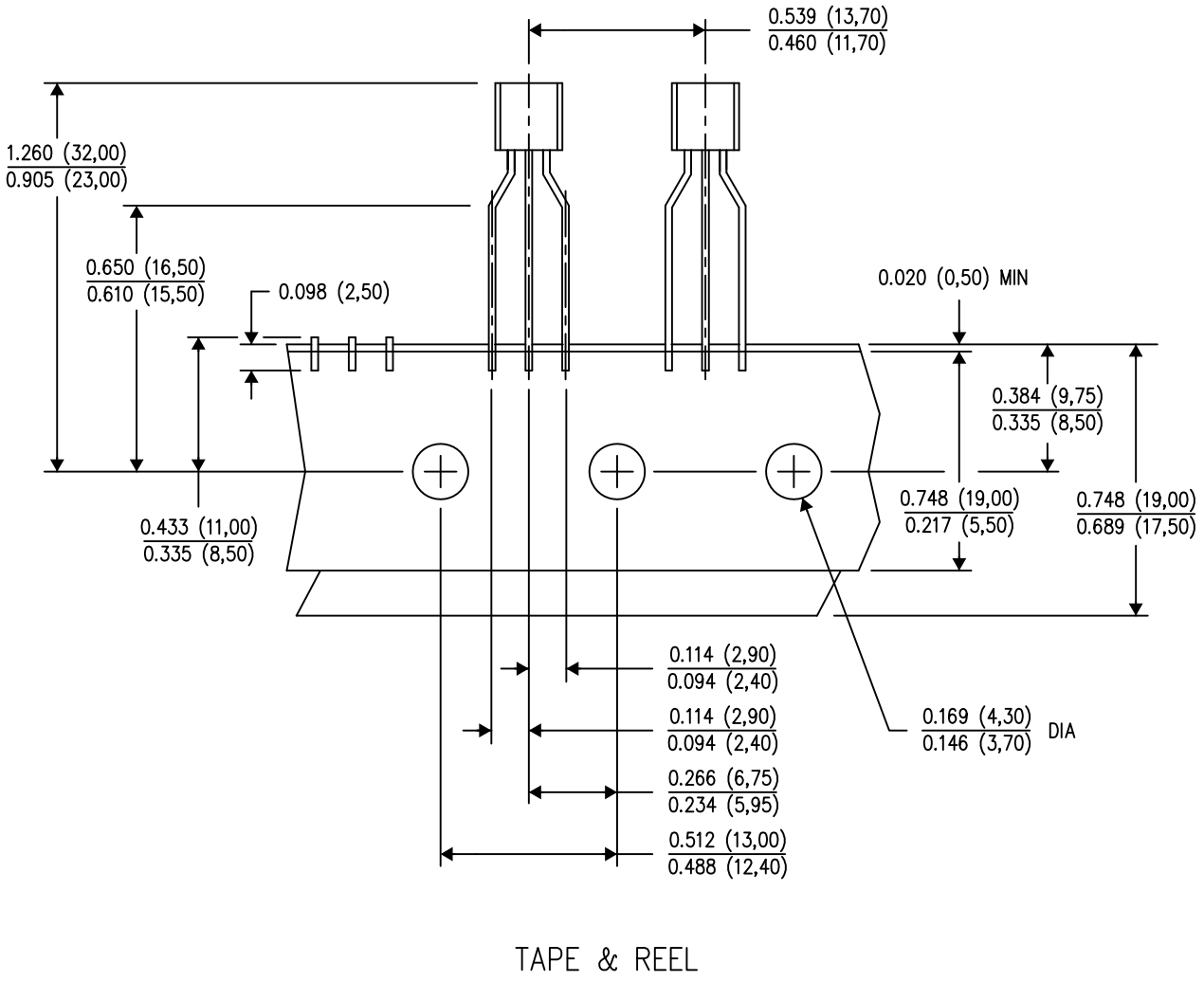
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Lead dimensions are inclusive of plating.
D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
E. Falls within JEDEC TO–236 variation AB, except minimum foot length.

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.

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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