LM185/LM285/LM385 Adjustable Micropower Voltage References

Check for Samples: LM185-ADJ, LM285-ADJ, LM385-ADJ

FEATURES

- **Adjustable from 1.24V to 5.30V**
- **Operating Current of 10μA to 20mA**
- **1% and 2% Initial Tolerance**
- **1Ω Dynamic Impedance**
- **Low Temperature Coefficient**

DESCRIPTION

The LM185/LM285/LM385 are micropower 3-terminal adjustable band-gap voltage reference diodes. Operating from 1.24 to 5.3V and over a 10μA to 20mA current range, they feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming is used to provide tight voltage tolerance. Since the LM185 band-gap reference uses only transistors and resistors, low noise and good long-term stability result.

Careful design of the LM185 has made the device tolerant of capacitive loading, making it easy to use in almost any reference application. The wide dynamic operating range allows its use with widely varying supplies with excellent regulation.

The extremely low power drain of the LM185 makes it useful for micropower circuitry. This voltage reference can be used to make portable meters, regulators or general purpose analog circuitry with battery life approaching shelf life. Further, the wide operating current allows it to replace older references with a tighter tolerance part.

The LM185 is rated for operation over a −55°C to 125°C temperature range, while the LM285 is rated −40°C to 85°C and the LM385 0°C to 70°C. The LM185 is available in a hermetic TO package and a LCCC package, while the LM285/LM385 are available in a low-cost TO-92 package, as well as SOIC.

Connection Diagram

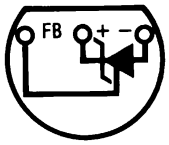


Figure 1. TO-92 Package
Bottom View

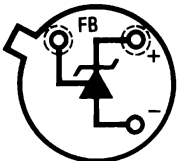


Figure 2. TO Package
Bottom View

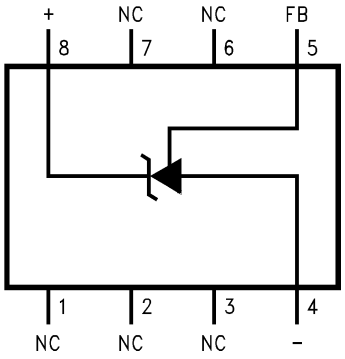


Figure 3. SOIC Package
Top View

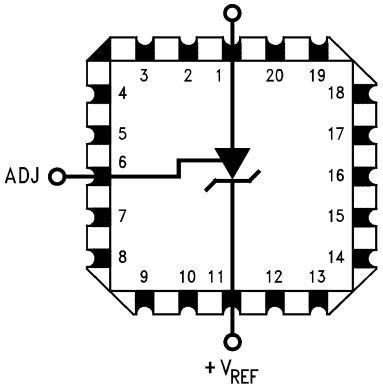


Figure 4. 20-LCCC
Top View

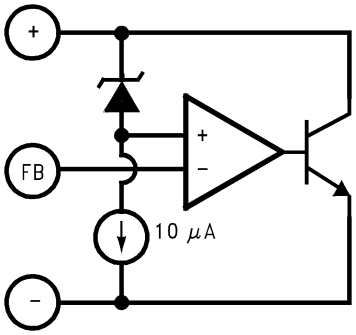
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Block Diagram



Typical Applications

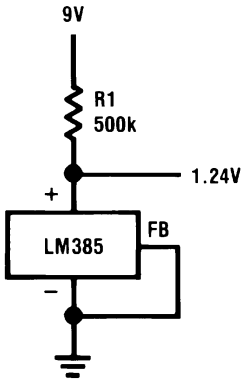
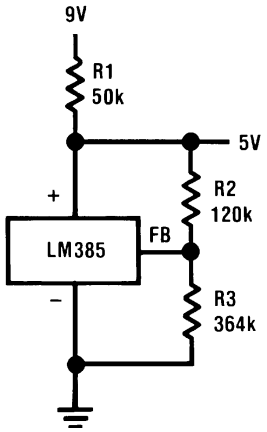


Figure 5. 1.2V Reference



$$V_{OUT} = 1.24 \left(\frac{R3}{R2} + 1 \right)$$

Figure 6. 5.0V Reference

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.

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Absolute Maximum Ratings(1)(2)(3)

Reverse Current	30mA
Forward Current	10mA
Operating Temperature Range (4)	
LM185 Series	−55°C to 125°C
LM285 Series	−40°C to 85°C
LM385 Series	0°C to 70°C
ESD Susceptibility (5)	2kV
Storage Temperature	−55°C to 150°C
Soldering Information	
TO-92 Package (10 sec.)	260°C
TO Package (10 sec.)	300°C
SOIC Package	
Vapor Phase (60 sec.)	215°C
Infrared (15 sec.)	220°C
See An-450 “Surface Mounting Methods and Their Effect on Product Reliability” for other methods of soldering surface mount devices.	

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional. For specifications and test conditions, see the Electrical Characteristics. The specifications apply only for the test conditions listed.
(2) Refer to RETS185H for military specifications.
(3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.
(4) For elevated temperature operation, see Table 1 and Thermal Characteristics.
(5) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin.

Table 1. $T_{J(max)}$ for Elevated Temperature Operation

DEVICE	$T_{J(max)}$ (°C)
LM185	150
LM285	125
LM385	100

Thermal Characteristics

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

Thermal Resistance	TO-92	TO-46	SOIC
θ_{JA} (Junction to Ambient)	180°C/W (0.4″ leads)	440°C/W	165°C/W
	170°C/W (0.125″ leads)		
θ_{JC} (Junction to Case)	N/A	80°C/W	N/A

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Electrical Characteristics (1)

Parameter	Conditions		LM185, LM285					LM385					Units (Limit)
			Typ	LM185BX, LM185BY LM185B, LM285BX, LM285BY		LM285		Typ	LM385BX, LM385BY		LM385		
				Tested Limit (2)	Design Limit (3)	Tested Limit (2)	Design Limit (3)		Tested Limit (2)	Design Limit (3)	Tested Limit (2)	Design Limit (3)	
Reference Voltage	I_R = 100µA		1.240	1.252 **1.255** 1.228 **1.215**		1.265 1.215	**1.270** **1.205**	1.240	1.252 1.228	**1.255** **1.215**	1.265 1.215	**1.270** **1.205**	V (max) V (min)
Reference Voltage Change with Current	I_{MIN}< I_R < 1mA 1mA < I_R < 20mA		0.2 4	1 10	**1.5** **20**	1 10	**1.5** **20**	0.2 5	1 15	**1.5** **25**	1 15	**1.5** **25**	mV (max)
Dynamic Output Impedance	I_R = 100µA, I_{AC} = 0.1 I_R	f = 100Hz V_{OUT} = V_{REF} V_{OUT} = 5.3V	 0.3 0.7					 0.4 1					Ω
Reference Voltage Change with Output Voltage	I_R = 100µA		1	3	**6**	3	**6**	2	5	**10**	5	**10**	mV (max)
Feedback Current			13	20	**25**	20	**25**	16	30	**35**	30	**35**	nA (max)
Minimum Operating Current (see curve)	V_{OUT} = V_{REF} V_{OUT} = 5.3V		6 30	9 45	**10** **50**	9 45	**10** **50**	7 35	11 55	**13** **60**	11 55	**13** **60**	µA (max)
Output Wideband Noise	I_R = 100µA, 10Hz < f < 10kHz V_{OUT} = V_{REF} V_{OUT} = 5.3V		 50 170					 50 170					μV_{rms}
Average Temperature Coefficient (4)	I_R = 100µA	X Suffix Y Suffix All Others		**30** **50**	 **150**		 **150**		**30** **50**	 **150**		 **150**	ppm/°c (max)
Long Term Stability	I_R = 100µA, T = 1000 Hr, T_A = 25°C ± 0.1°C		20					20					ppm

(1) Parameters identified with **boldface type** apply at temperature extremes. All other numbers apply at T_A = T_J = 25°C. Unless otherwise specified, all parameters apply for V_{REF} < V_{OUT} < 5.3V.
(2) Production tested.
(3) Not production tested. These limits are not to be used to calculate average outgoing quality levels.
(4) The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures from T_{MIN} to T_{MAX}, divided by T_{MAX} − T_{MIN}. The measured temperatures are −55, −40, 0, 25, 70, 85, 125°C.

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Typical Performance Characteristics

Temperature Drift of 3 Representative Units

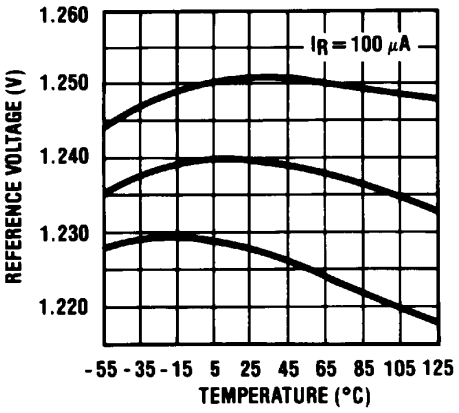


Figure 7.

Feedback Current

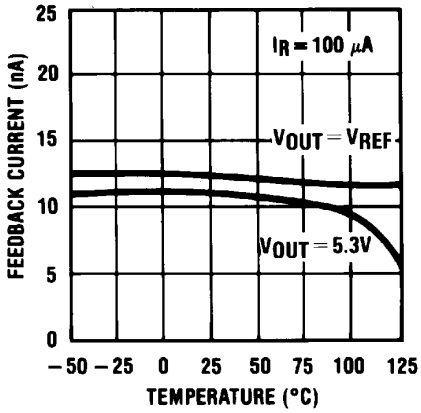


Figure 8.

Minimum Operating Current

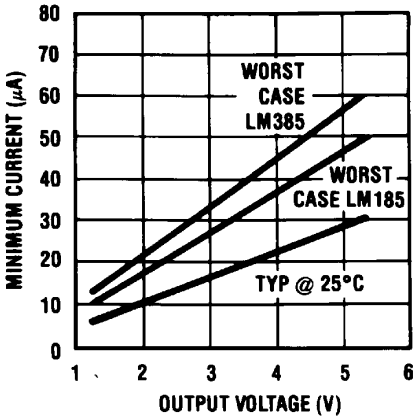


Figure 9.

Reverse Characteristics

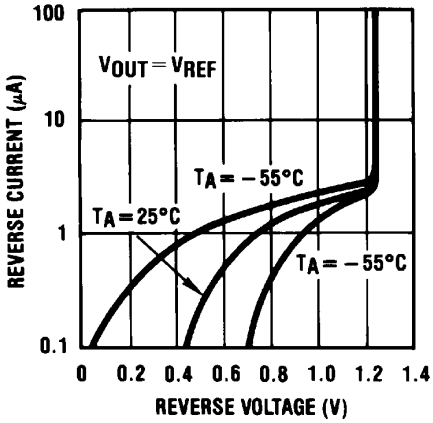


Figure 10.

Reverse Characteristics

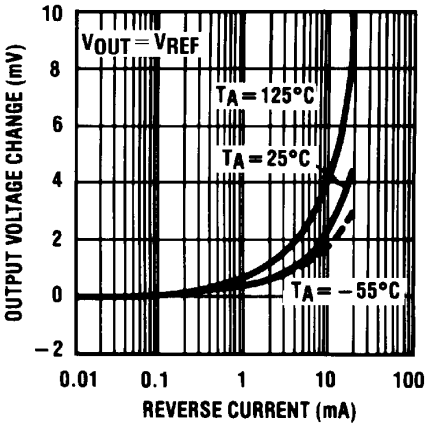


Figure 11.

Forward Characteristics

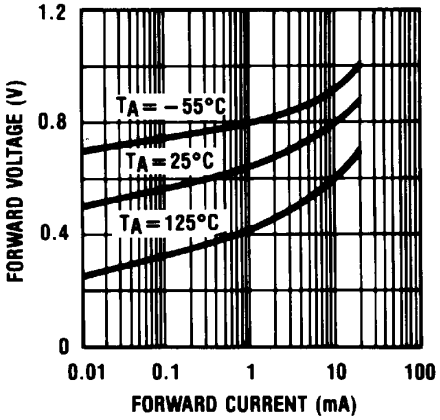


Figure 12.

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Typical Performance Characteristics (continued)

Output Noise Voltage

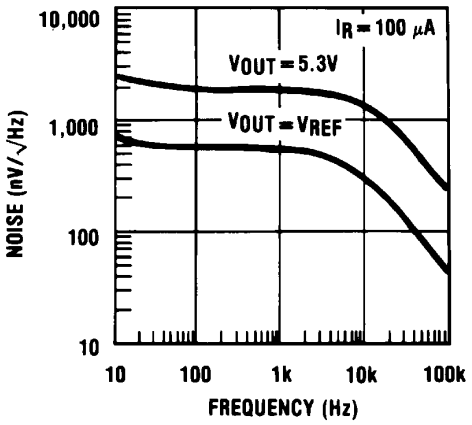


Figure 13.

Dynamic Output Impedance

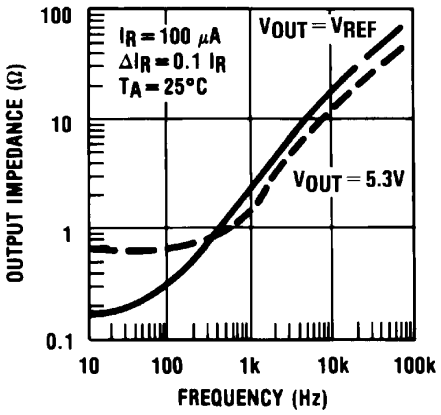


Figure 14.

Response Time

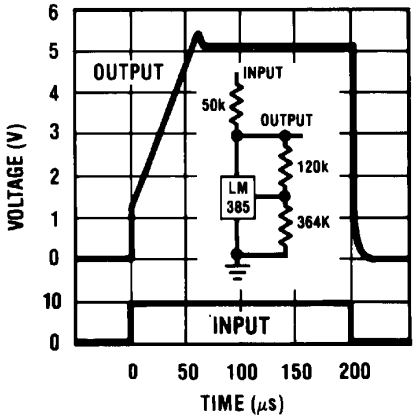
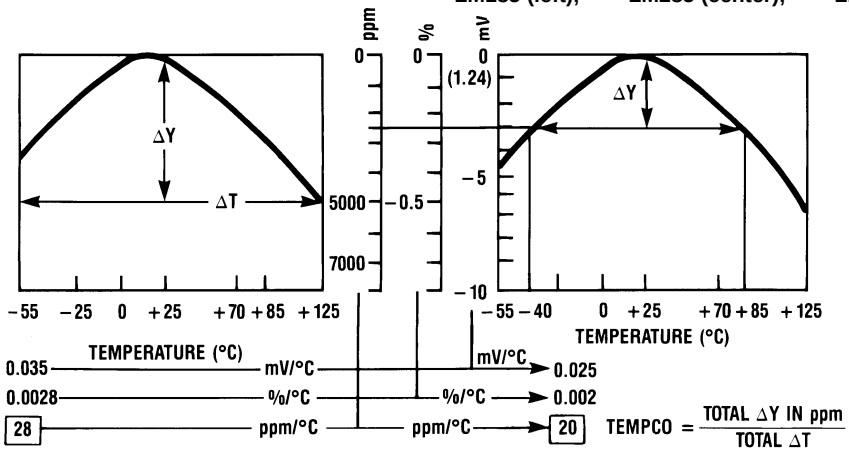


Figure 15.

Temperature Coefficient Typical
LM185 (left), LM285 (center), LM385 (right)



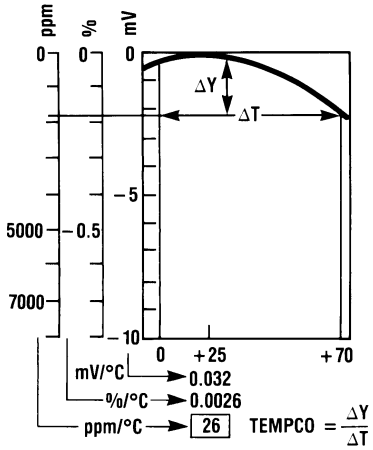


Figure 16.

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TYPICAL APPLICATIONS

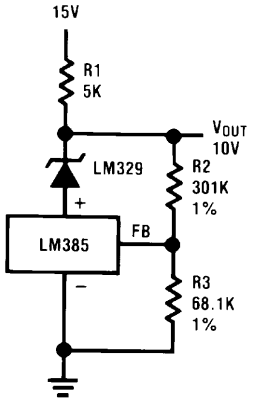


Figure 17. Precision 10V Reference

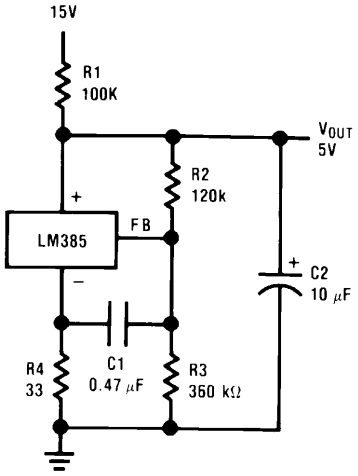


Figure 18. Low AC Noise Reference

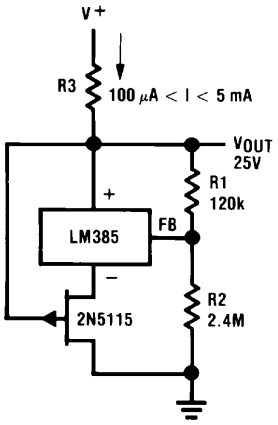


Figure 19. 25V Low Current Shunt Regulator

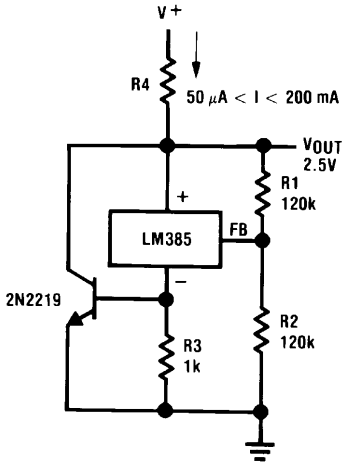


Figure 20. 200 mA Shunt Regulator

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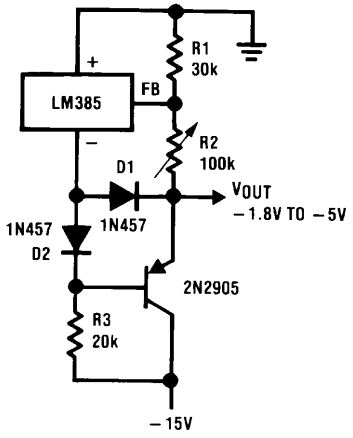


Figure 21. Series-Shunt 20 mA Regulator

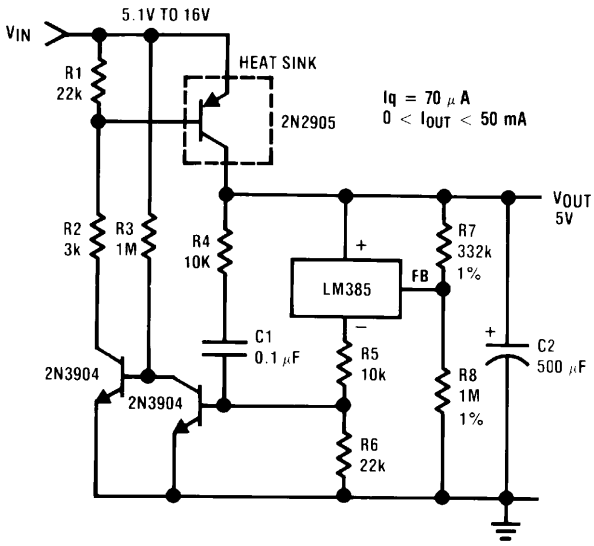


Figure 22. High Efficiency Low Power Regulator

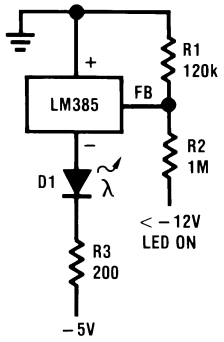


Figure 23. Voltage Level Detector

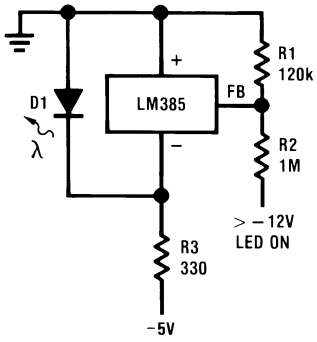


Figure 24. Voltage Level Detector

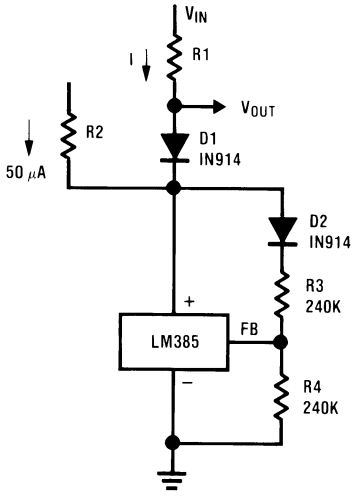


Figure 25. Fast Positive Clamp
$2.4V + \Delta V_{D1}$

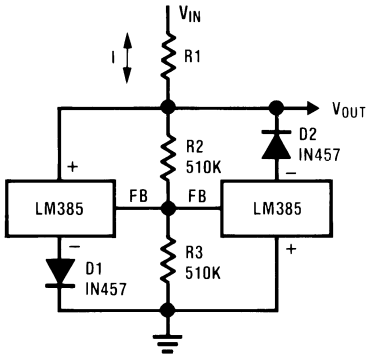


Figure 26. Bidirectional Clamp
±2.4V

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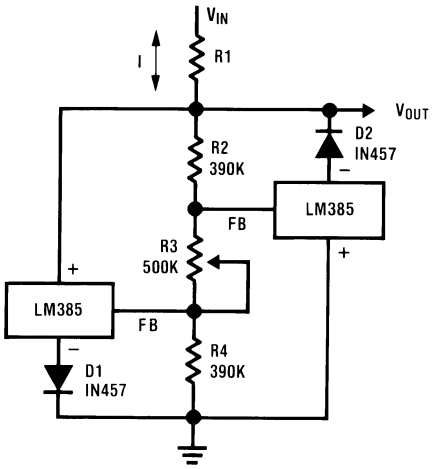


Figure 27. Bidirectional Adjustable Clamp ±1.8V to ±2.4V

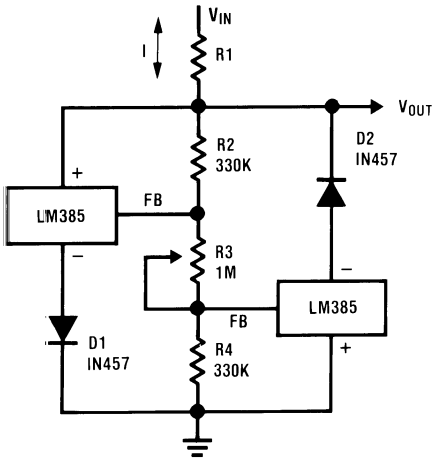


Figure 28. Bidirectional Adjustable Clamp ±2.4V to ±6V

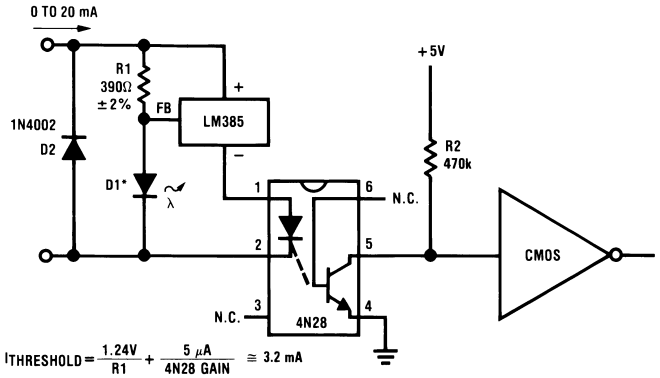


Figure 29. Simple Floating Current Detector

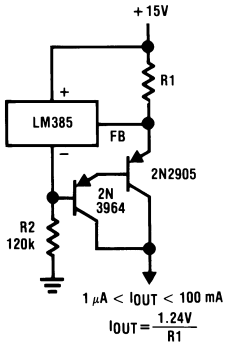
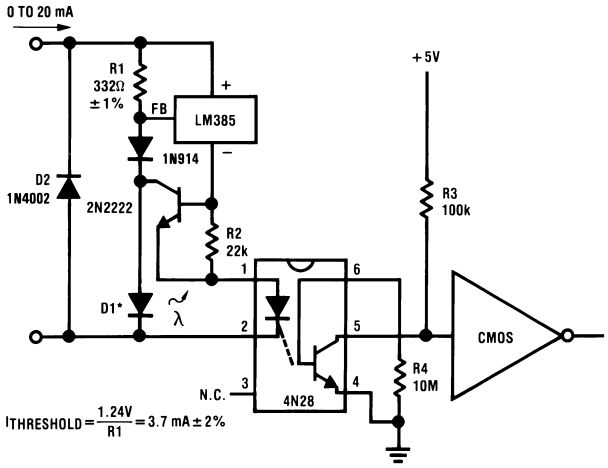


Figure 30. Current Source



*D1 can be any LED, V_F=1.5V to 2.2V at 3 mA. D1 may act as an indicator. D1 will be on if $I_{THRESHOLD}$ falls below the threshold current, except with I=O.

Figure 31. Precision Floating Current Detector

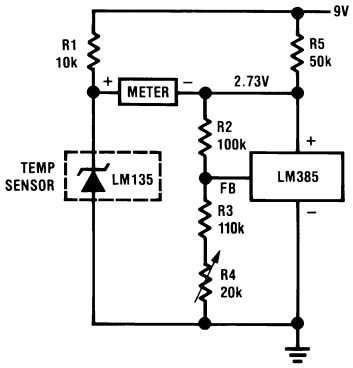


Figure 32. Centigrade Thermometer, 10mV/°C

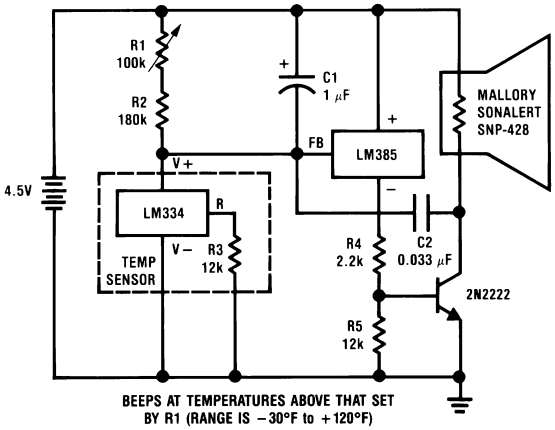
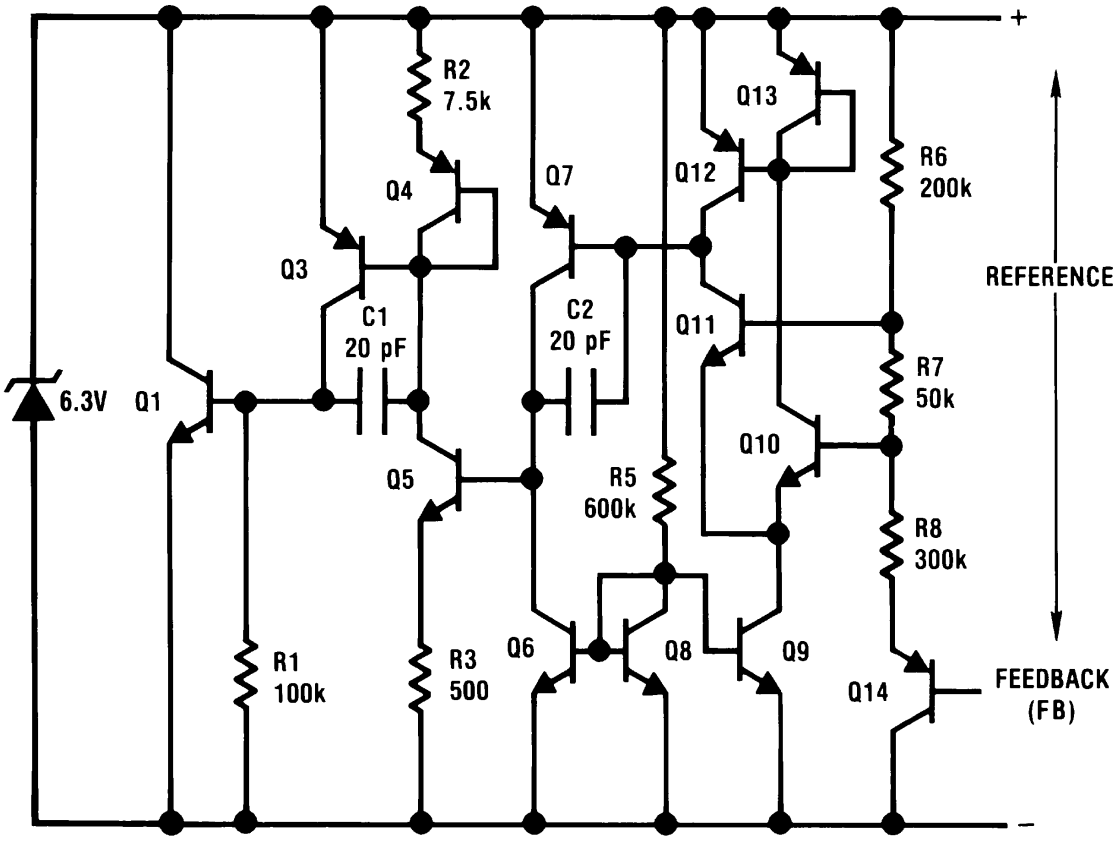


Figure 33. Freezer Alarm

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Schematic Diagram



REVISION HISTORY

Changes from Revision E (April 2013) to Revision F	Page
• Changed layout of National Data Sheet to TI format	11

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PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM185BH	Active	Production	TO (NDV) | 3	1000 | BULK	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM185BH, LM185BH)
LM185BH/NOPB	Active	Production	TO (NDV) | 3	1000 | BULK	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM185BH, LM185BH)
LM285BXZ/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	-40 to 85	LM285 BXZ
LM285BXZ/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	-40 to 85	LM285 BXZ
LM285BYM/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM285 BYM
LM285BYM/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM285 BYM
LM285BYMX/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM285 BYM
LM285BYMX/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM285 BYM
LM285BYZ/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	-40 to 85	LM285 BYZ
LM285BYZ/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	-40 to 85	LM285 BYZ
LM285M/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM285 M
LM285M/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM285 M
LM285MX/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM285 M
LM285MX/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM285 M
LM285Z/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	-40 to 85	LM285 Z
LM285Z/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	-40 to 85	LM285 Z

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM385BM/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM385 BM
LM385BM/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM385 BM
LM385BMX/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM385 BM
LM385BMX/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM385 BM
LM385BXZ/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM385 BXZ
LM385BXZ/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM385 BXZ
LM385BYZ/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM385 BYZ
LM385BYZ/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM385 BYZ
LM385BZ/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM385 BZ
LM385BZ/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM385 BZ
LM385M/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM385 M
LM385M/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM385 M
LM385MX/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM385 M
LM385MX/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM385 M
LM385Z/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM385 Z
LM385Z/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM385 Z

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

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

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

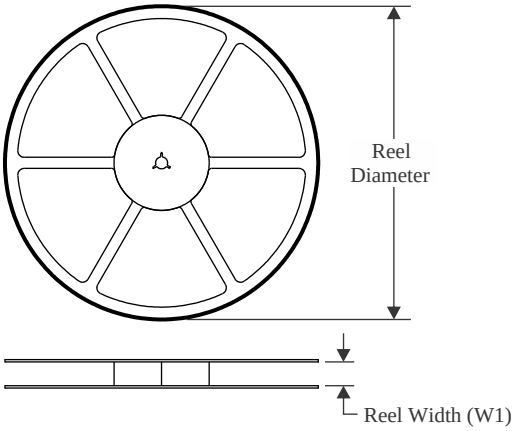
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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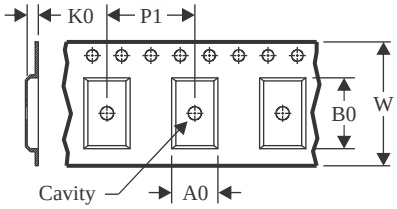
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

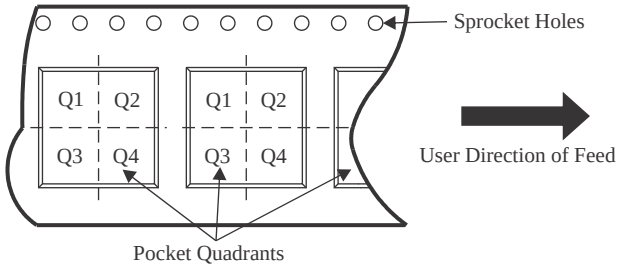


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

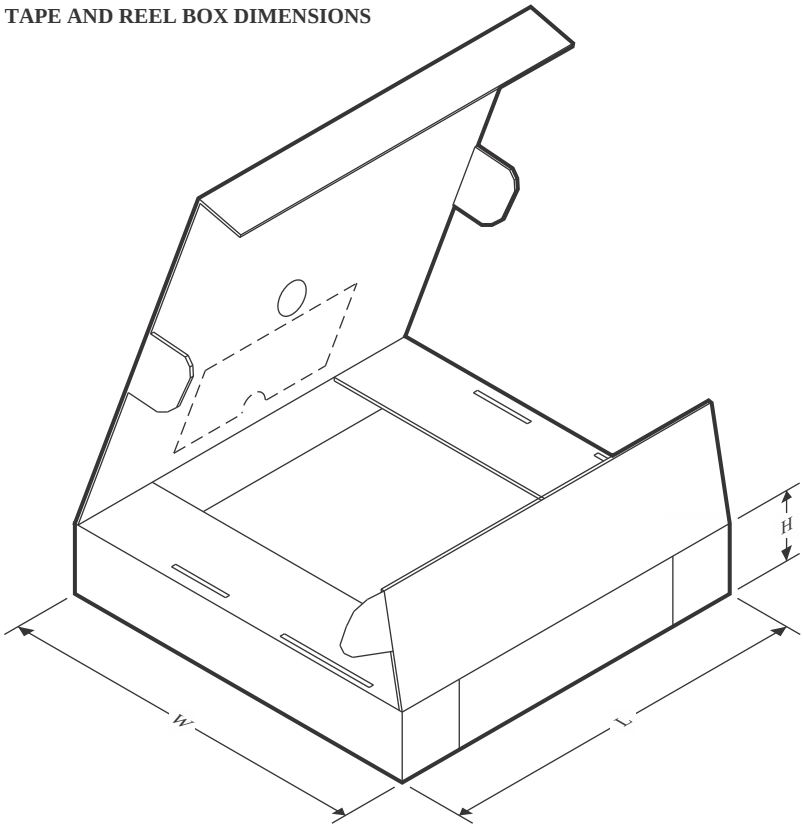
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM285BYMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM285MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM385BMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM385MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

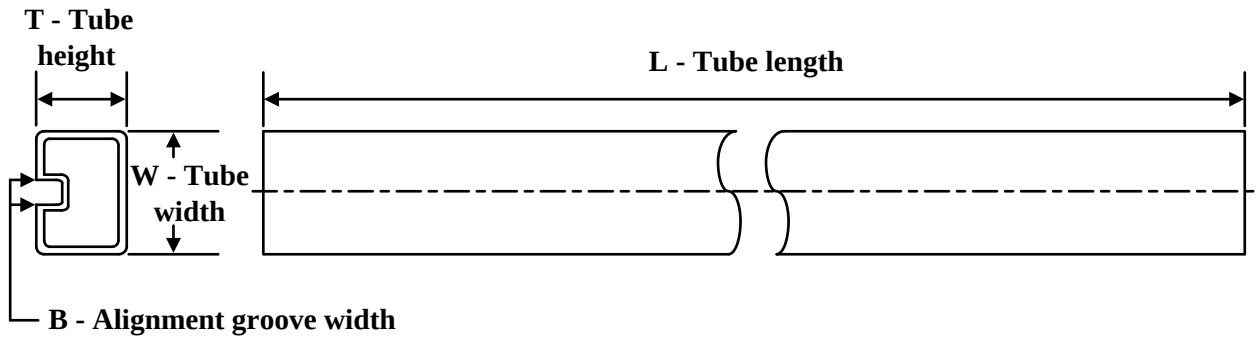
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

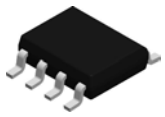
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM285BYMX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM285MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM385BMX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM385MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM285BYM/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM285BYM/NOPB.B	D	SOIC	8	95	495	8	4064	3.05
LM285M/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM285M/NOPB.B	D	SOIC	8	95	495	8	4064	3.05
LM385BM/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM385BM/NOPB.B	D	SOIC	8	95	495	8	4064	3.05
LM385M/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM385M/NOPB.B	D	SOIC	8	95	495	8	4064	3.05

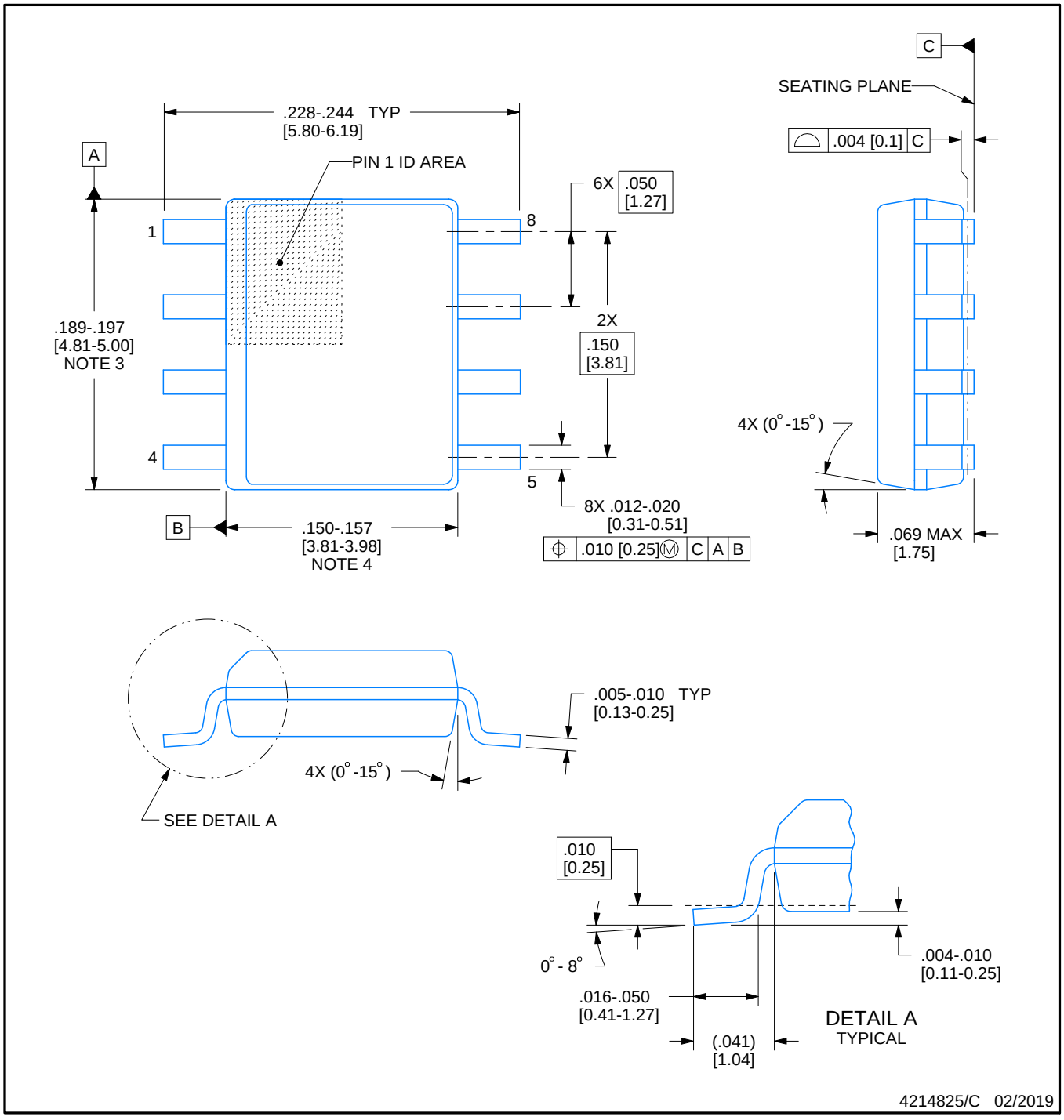


PACKAGE OUTLINE

D0008A

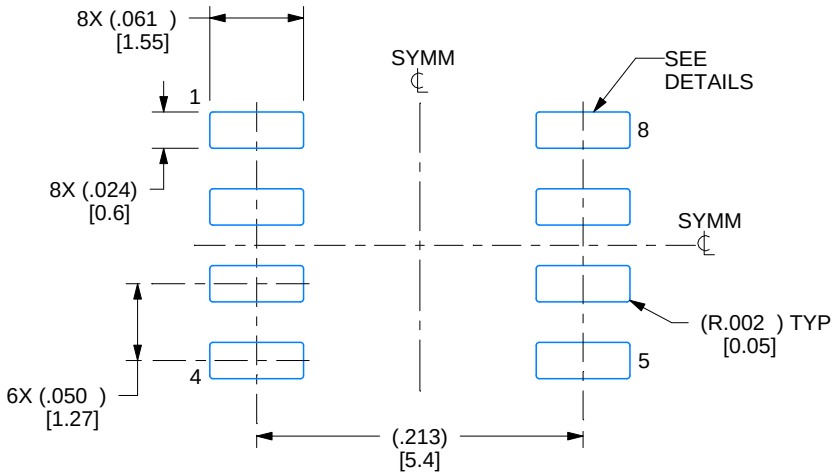
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

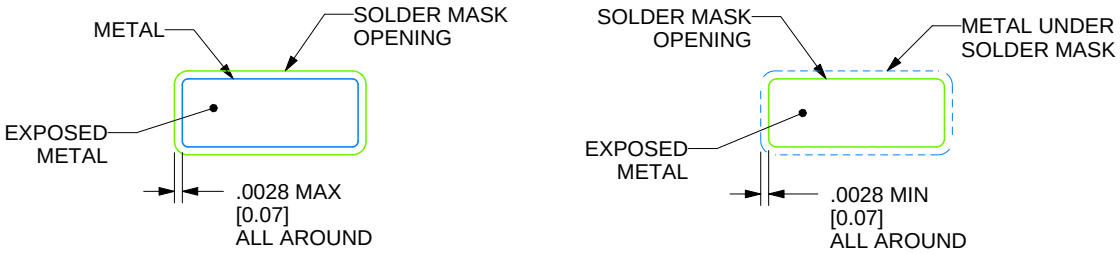


NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

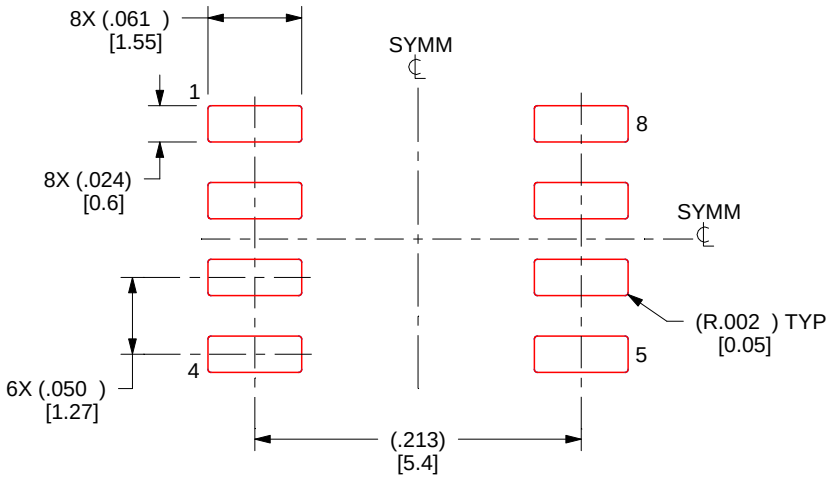
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

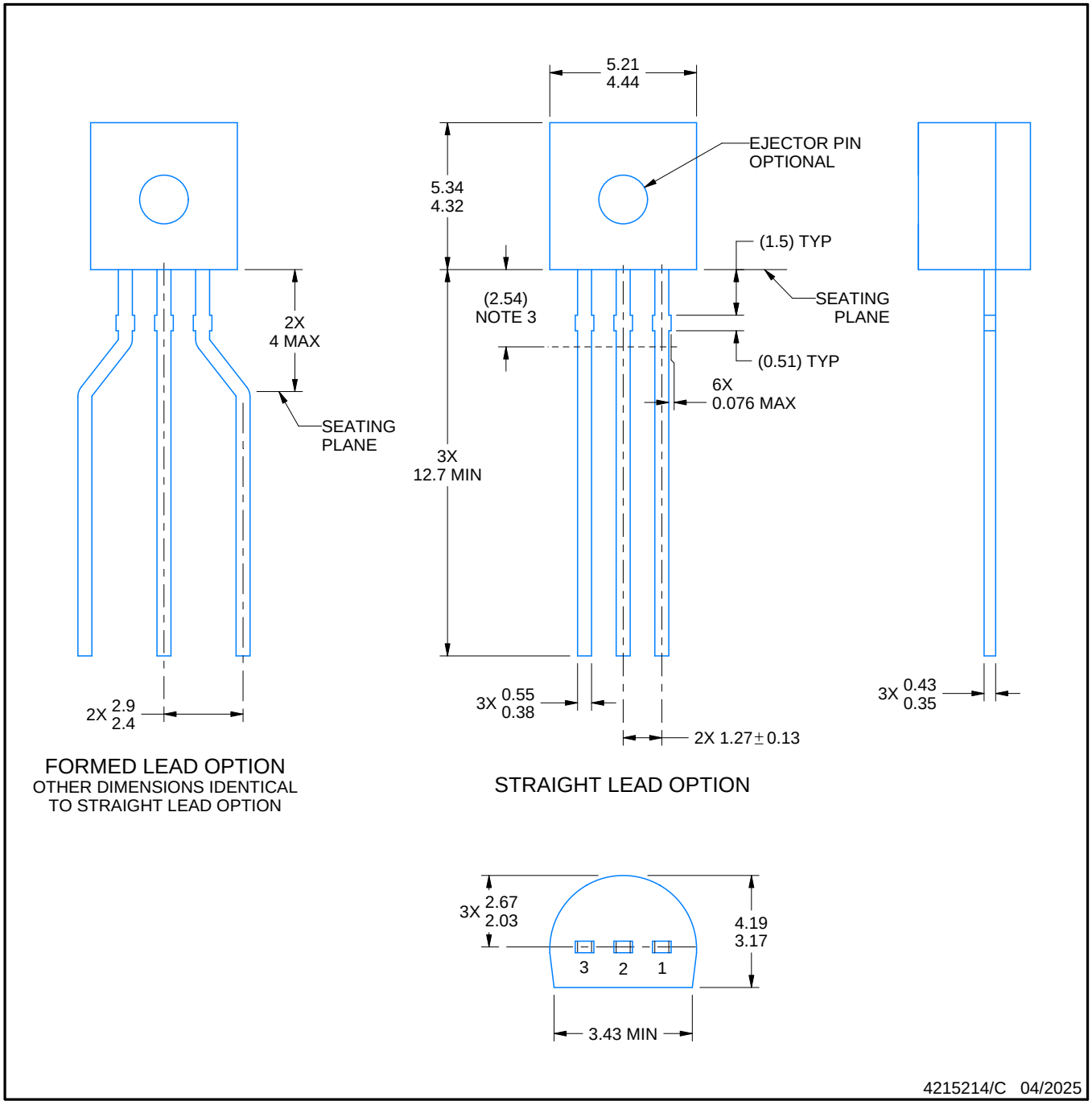
LP0003A



PACKAGE OUTLINE

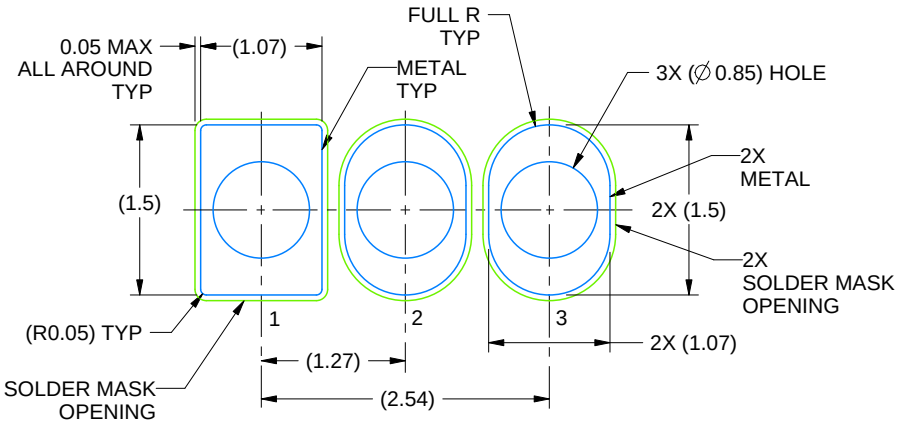
TO-92 - 5.34 mm max height

TO-92

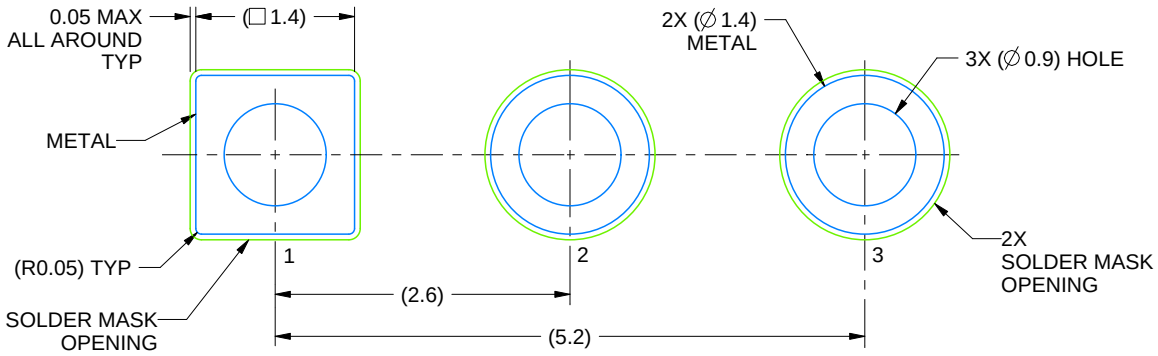


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping method:
   a. Straight lead option available in bulk pack only.
   b. Formed lead option available in tape and reel or ammo pack.
   c. Specific products can be offered in limited combinations of shipping medium and lead options.
   d. Consult product folder for more information on available options.



LAND PATTERN EXAMPLE
STRAIGHT LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X



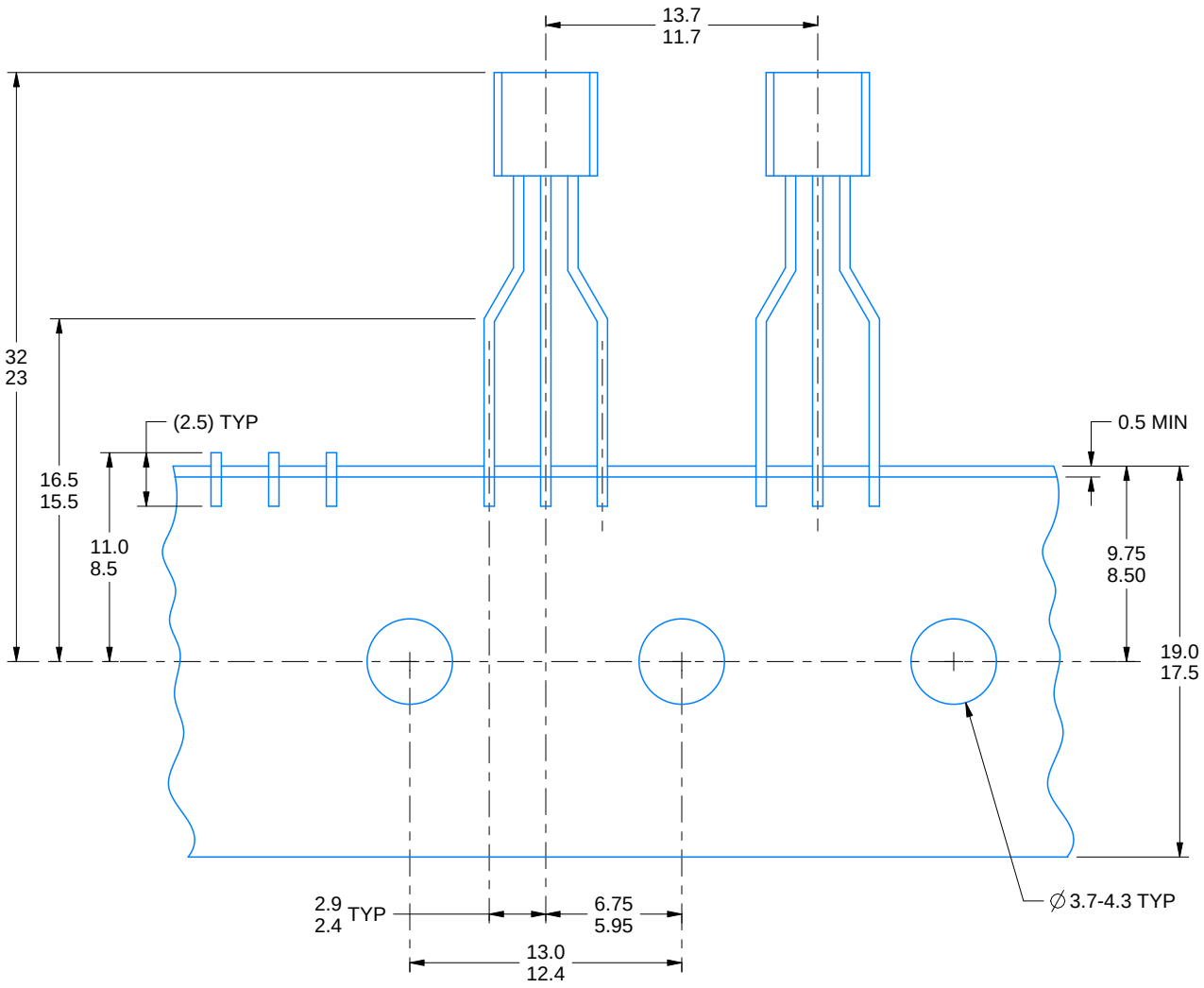
LAND PATTERN EXAMPLE
FORMED LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X

4215214/C 04/2025

LP0003A

TO-92 - 5.34 mm max height

TO-92



FOR FORMED LEAD OPTION PACKAGE

4215214/C 04/2025

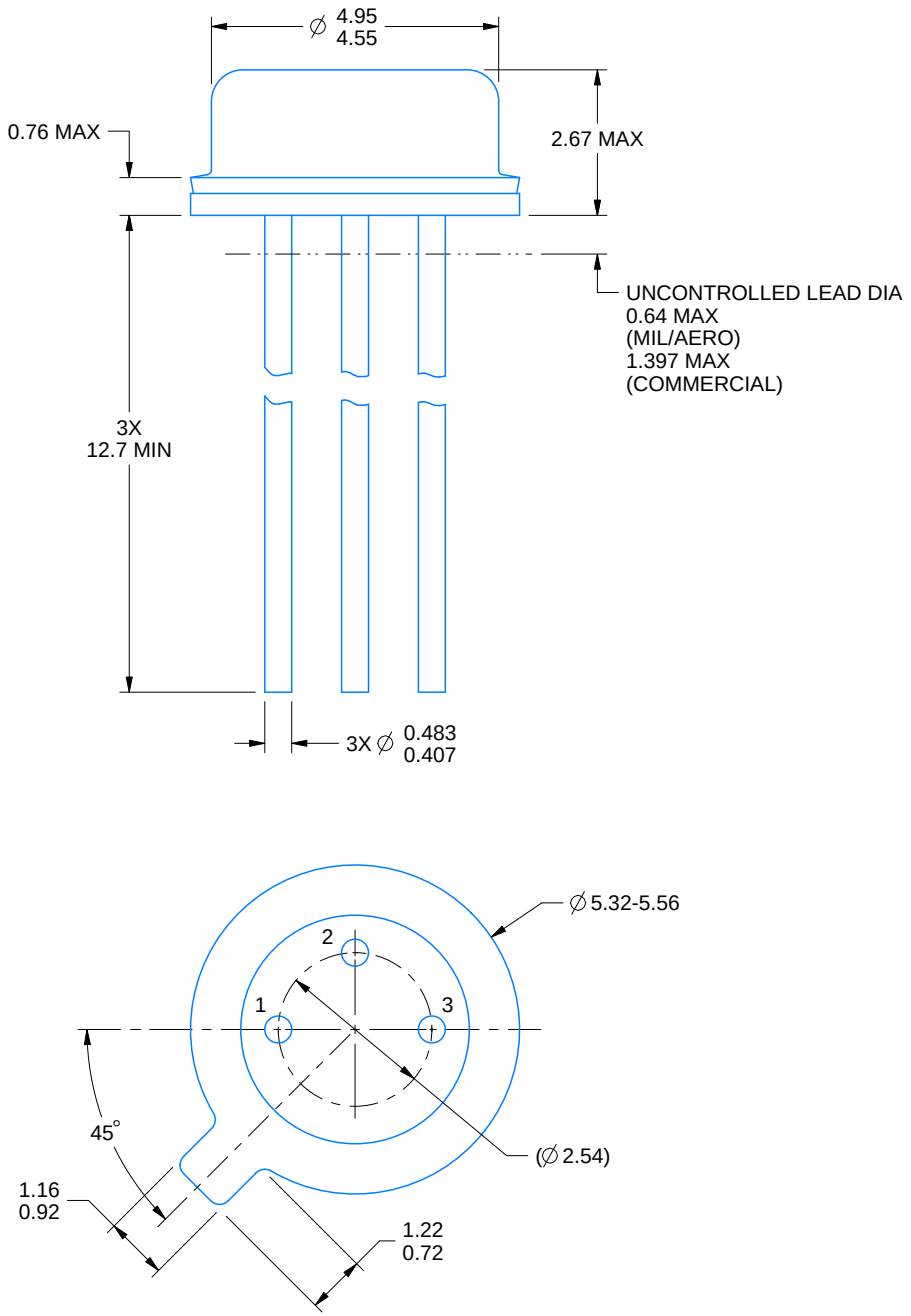
NDV0003H



PACKAGE OUTLINE

TO-CAN - 2.67 mm max height

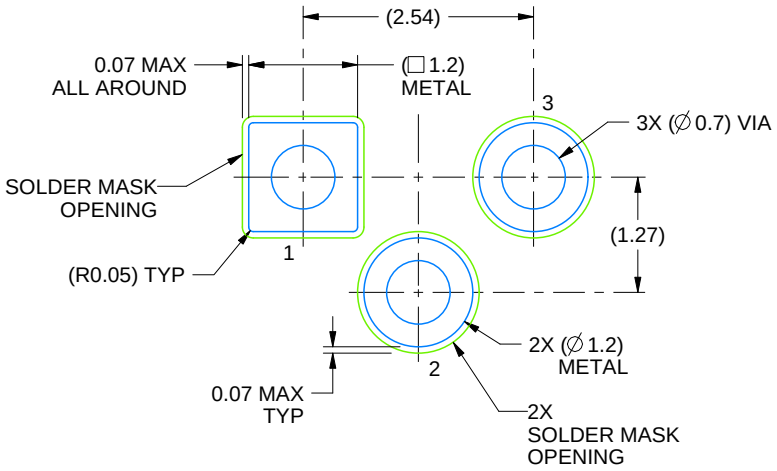
TRANSISTOR OUTLINE



4219876/B 09/2024

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-46.



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE:12X

4219876/B 09/2024

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