LM136-2.5-N, LM236-2.5-N, LM336-2.5-NV Reference Diode

Check for Samples: LM136-2.5-N

FEATURES

- **Low Temperature Coefficient**
- **Wide Operating Current of 400 µA to 10 mA**
- **0.2Ω Dynamic Impedance**
- **±1% Initial Tolerance Available**
- **Specified Temperature Stability**
- **Easily Trimmed for Minimum Temperature Drift**
- **Fast Turn-On**

DESCRIPTION

The LM136-2.5-N/LM236-2.5-N and LM336-2.5-N integrated circuits are precision 2.5V shunt regulator diodes. These monolithic IC voltage references operate as a low-temperature-coefficient 2.5V zener with 0.2Ω dynamic impedance. A third terminal on the LM136-2.5-N allows the reference voltage and temperature coefficient to be trimmed easily.

The LM136-2.5-N series is useful as a precision 2.5V low voltage reference for digital voltmeters, power supplies or op amp circuitry. The 2.5V make it convenient to obtain a stable reference from 5V logic supplies. Further, since the LM136-2.5-N operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

The LM136-2.5-N is rated for operation over −55°C to +125°C while the LM236-2.5-N is rated over a −25°C to +85°C temperature range.

The LM336-2.5-N is rated for operation over a 0°C to +70°C temperature range. See the connection diagrams for available packages.

Connection Diagram

TO-92 Plastic Package

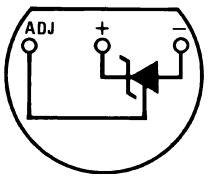


Figure 1. Bottom View
See Package Number LP

TO Metal Can Package

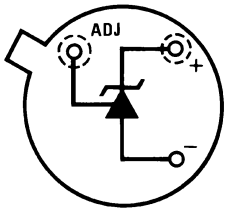


Figure 2. Bottom View
See Package Number NDV

SOIC Package

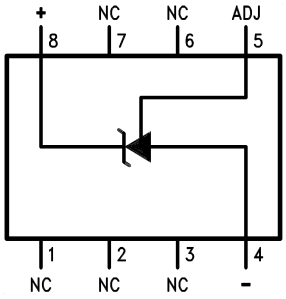


Figure 3. Top View
See Package Number D

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Typical Applications

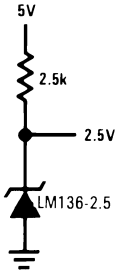
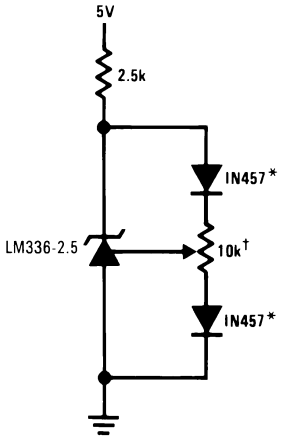


Figure 4. 2.5V Reference



†Adjust to 2.490V
*Any silicon signal diode

Figure 5. 2.5V Reference with Minimum Temperature Coefficient

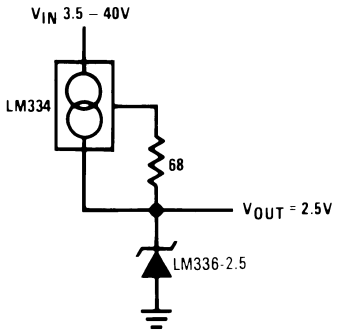


Figure 6. Wide Input Range Reference

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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)(2)

Reverse Current			15 mA
Forward Current			10 mA
Storage Temperature			−60°C to +150°C
Operating Temperature Range(3)		LM136	−55°C to +150°C
		LM236	−25°C to +85°C
		LM336	0°C to +70°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

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its specified operating conditions.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
(3) For elevated temperature operation, T_j max is:
LM136 150°C
LM236 125°C
LM336 100°C

Thermal Resistance	TO-92	TO	SOIC
θ_{ja} (Junction to Ambient)	180°C/W (0.4″ leads)	440°C/W	165°C/W
	170°C/W (0.125″ lead)		
θ_{ja} (Junction to Case)	n/a	80°C/W	n/a

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Electrical Characteristics (1)

Parameter	Conditions		LM136A-2.5-N/ LM236A-2.5-N LM136-2.5-N/ LM236-2.5-N			LM336B-2.5-N LM336-2.5-N			Units
			Min	Typ	Max	Min	Typ	Max	
Reverse Breakdown Voltage	T_A=25°C, I_R=1 mA	LM136, LM236, LM336	2.440	2.490	2.540	2.390	2.490	2.590	V
		LM136A, LM236A, LM336B	2.465	2.490	2.515	2.440	2.490	2.540	V
Reverse Breakdown Change With Current	T_A=25°C, 400 µA≤I_R≤10 mA			2.6	6		2.6	10	mV
Reverse Dynamic Impedance	T_A=25°C, I_R=1 mA, f = 100 Hz			0.2	0.6		0.2	1	Ω
Temperature Stability(2)	V_R Adjusted to 2.490V I_R=1 mAFigure 15	0°C≤T_A≤70°C (LM336)					1.8	6	mV
		−25°C≤T_A≤+85°C (LM236H, LM236Z)		3.5	9				mV
		−25°C ≤ T_A ≤ +85°C (LM236M)		7.5	18				mV
		−55°C≤T_A≤+125°C (LM136)		12	18				mV
Reverse Breakdown Change With Current	400 µA≤I_R≤10 mA			3	10		3	12	mV
Reverse Dynamic Impedance	I_R=1 mA			0.4	1		0.4	1.4	Ω
Long Term Stability	T_A=25°C ±0.1°C, I_R=1 mA, t = 1000 hrs			20			20		ppm

(1) Unless otherwise specified, the LM136-2.5-N is specified from −55°C ≤ T_A ≤ +125°C, the LM236-2.5-N from −25°C ≤ T_A ≤ +85°C and the LM336-2.5-N from 0°C ≤ T_A ≤ +70°C.

(2) Temperature stability for the LM336 and LM236 family is specified by design. Design limits are ensured (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels. Stability is defined as the maximum change in V_{ref} from 25°C to T_A (min) or T_A (max).

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Typical Performance Characteristics

Reverse Voltage Change

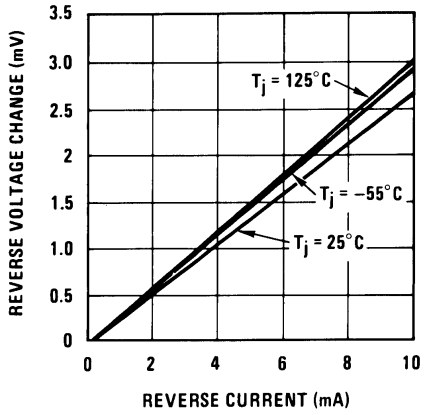


Figure 7.

Zener Noise Voltage

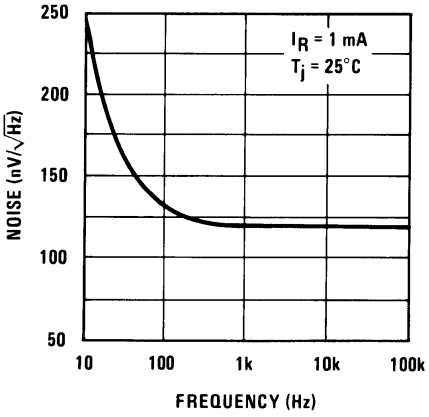


Figure 8.

Dynamic Impedance

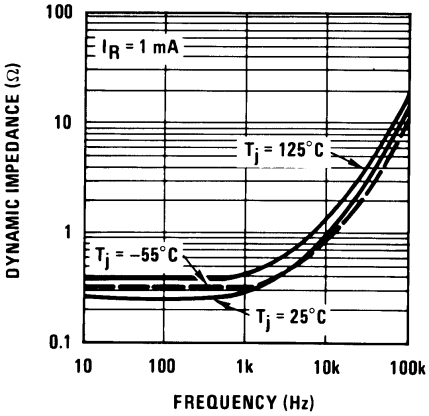


Figure 9.

Response Time

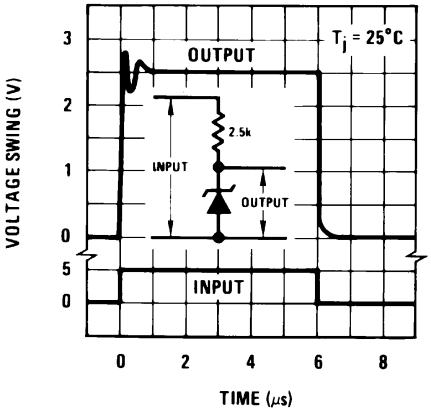


Figure 10.

Reverse Characteristics

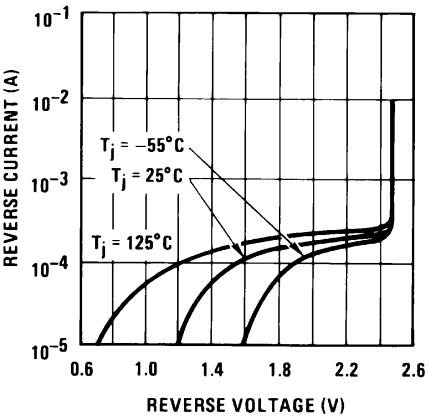


Figure 11.

Forward Characteristics

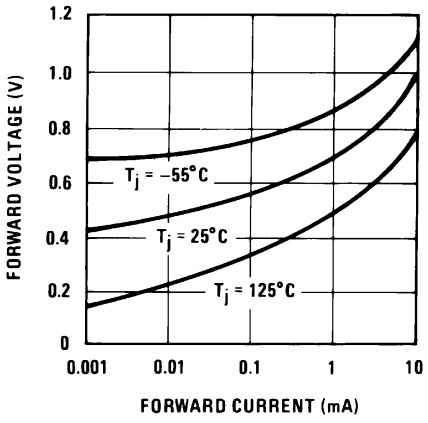


Figure 12.

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Typical Performance Characteristics (continued)

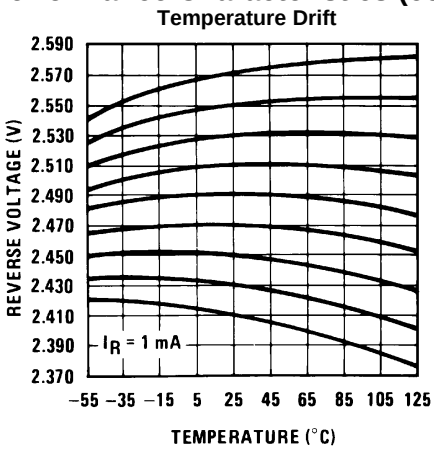


Figure 13.

APPLICATION HINTS

The LM136 series voltage references are much easier to use than ordinary zener diodes. Their low impedance and wide operating current range simplify biasing in almost any circuit. Further, either the breakdown voltage or the temperature coefficient can be adjusted to optimize circuit performance.

Figure 14 shows an LM136 with a 10k potentiometer for adjusting the reverse breakdown voltage. With the addition of R1 the breakdown voltage can be adjusted without affecting the temperature coefficient of the device. The adjustment range is usually sufficient to adjust for both the initial device tolerance and inaccuracies in buffer circuitry.

If minimum temperature coefficient is desired, two diodes can be added in series with the adjustment potentiometer as shown in Figure 15. When the device is adjusted to 2.490V the temperature coefficient is minimized. Almost any silicon signal diode can be used for this purpose such as a 1N914, 1N4148 or a 1N457. For proper temperature compensation the diodes should be in the same thermal environment as the LM136. It is usually sufficient to mount the diodes near the LM136 on the printed circuit board. The absolute resistance of R1 is not critical and any value from 2k to 20k will work.

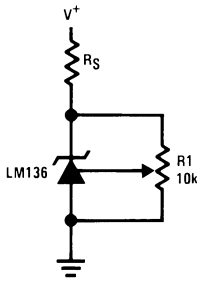


Figure 14. LM136 With Pot for Adjustment of Breakdown Voltage (Trim Range = ±120 mV typical)

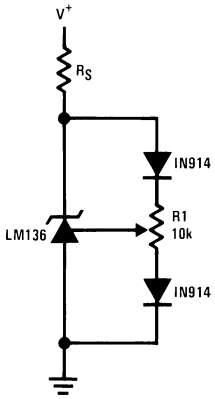
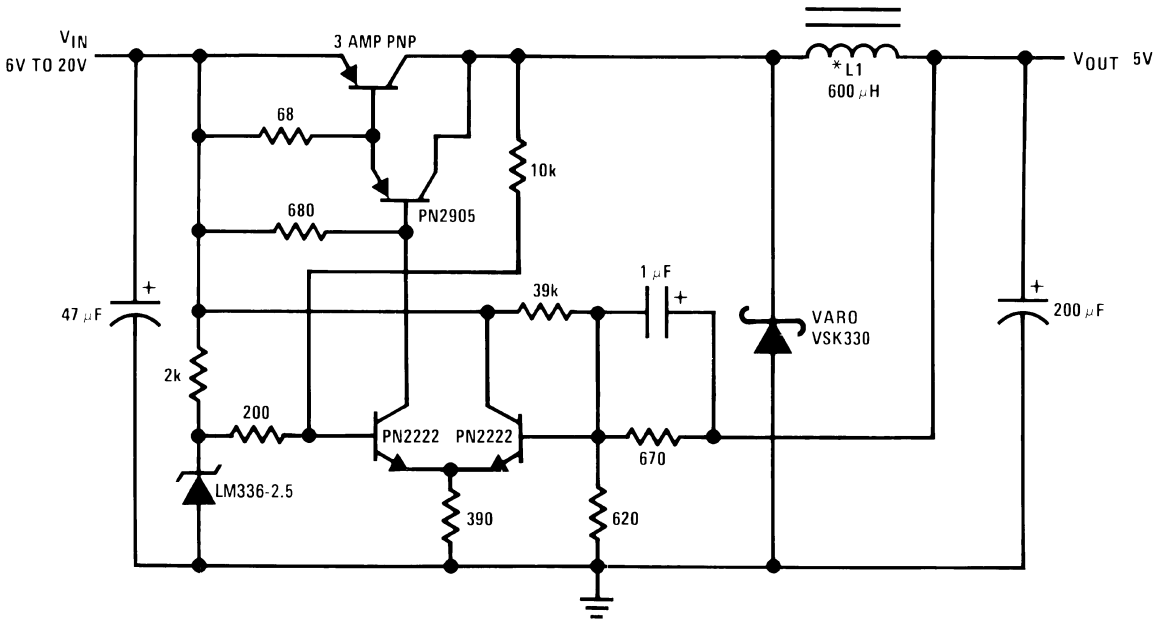


Figure 15. Temperature Coefficient Adjustment (Trim Range = ±70 mV typical)

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*L1 60 turns #16 wire on Arnold Core A-254168-2
†Efficiency ≈ 80%

Figure 16. Low Cost 2 Amp Switching Regulator†

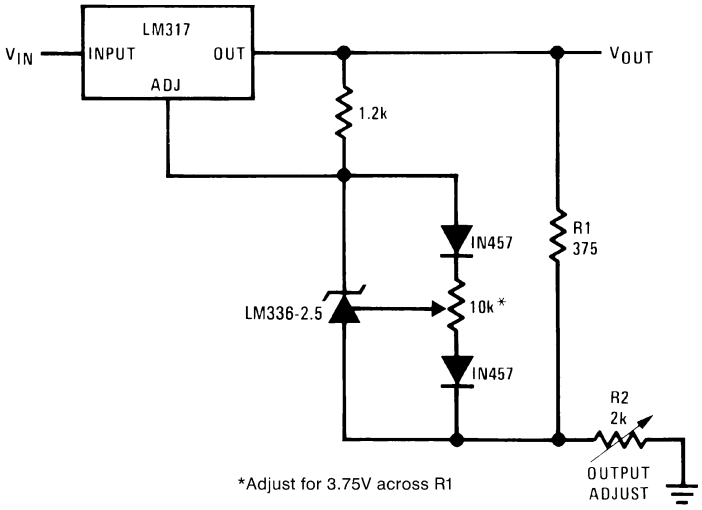


Figure 17. Precision Power Regulator with Low Temperature Coefficient

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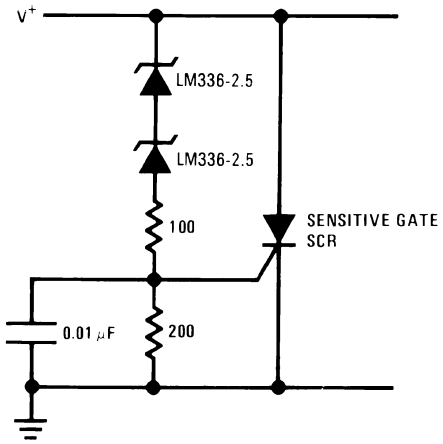
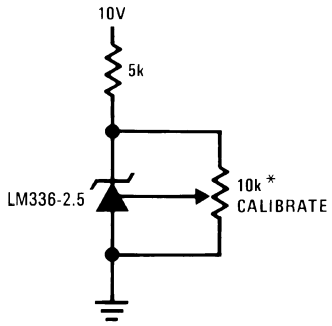


Figure 18. 5V Crowbar



*Does not affect temperature coefficient

Figure 19. Trimmed 2.5V Reference with Temperature Coefficient Independent of Breakdown Voltage

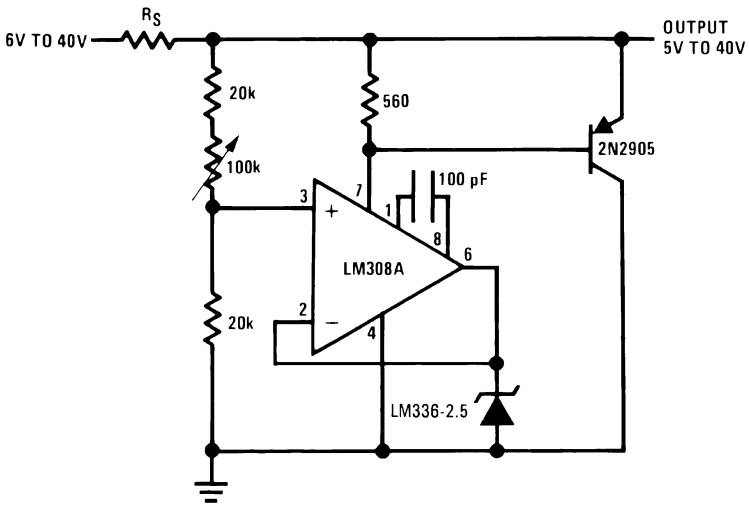


Figure 20. Adjustable Shunt Regulator

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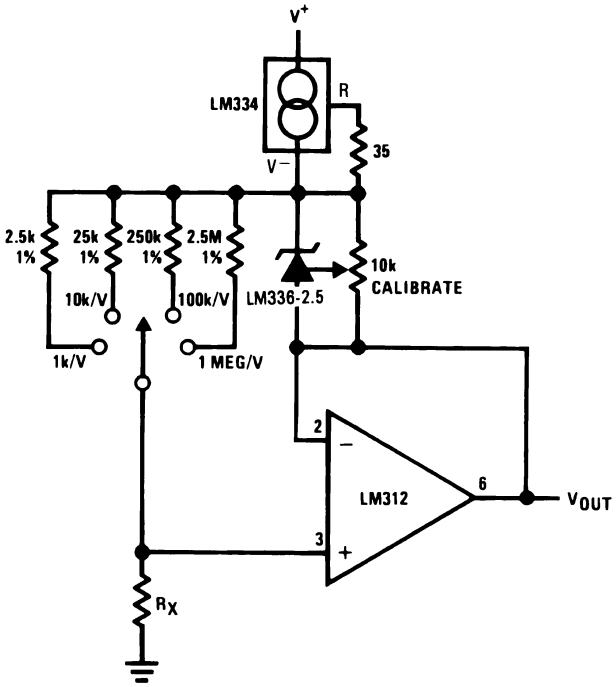


Figure 21. Linear Ohmmeter

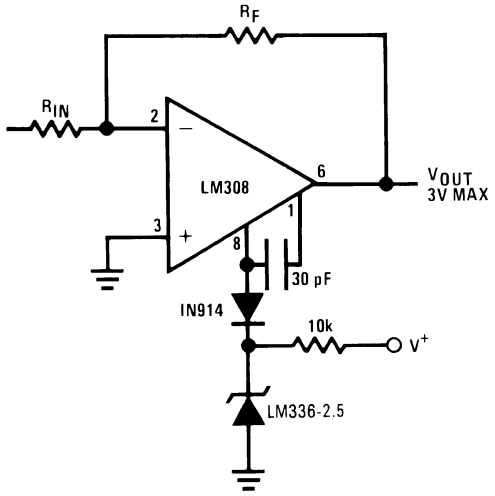


Figure 22. Op Amp with Output Clamped

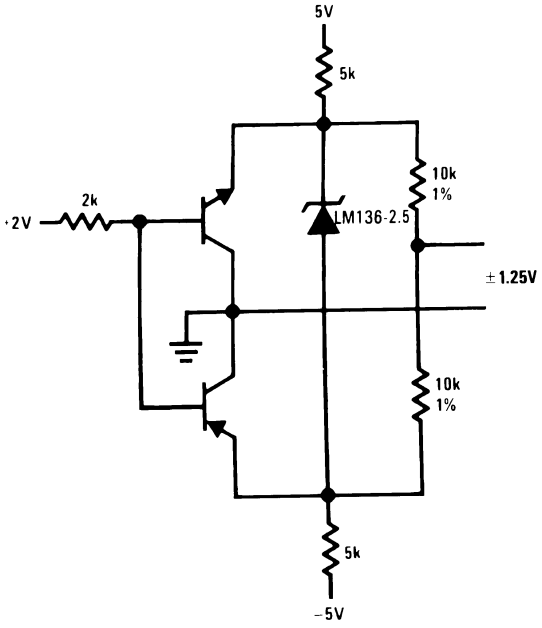


Figure 23. Bipolar Output Reference

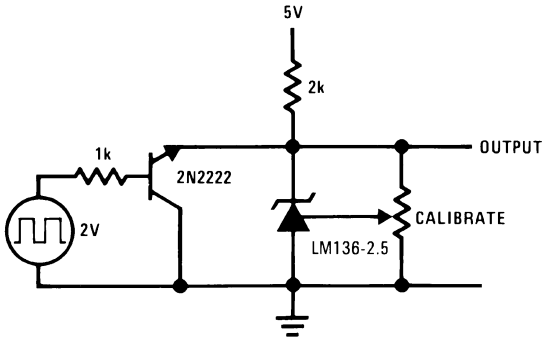


Figure 24. 2.5V Square Wave Calibrator

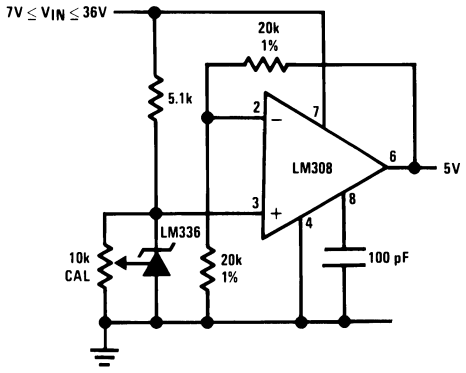


Figure 25. 5V Buffered Reference

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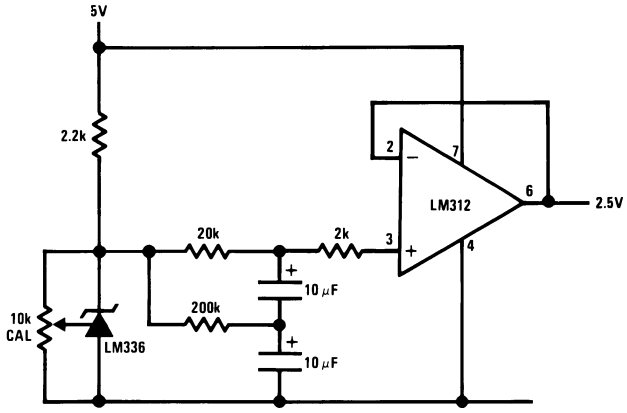
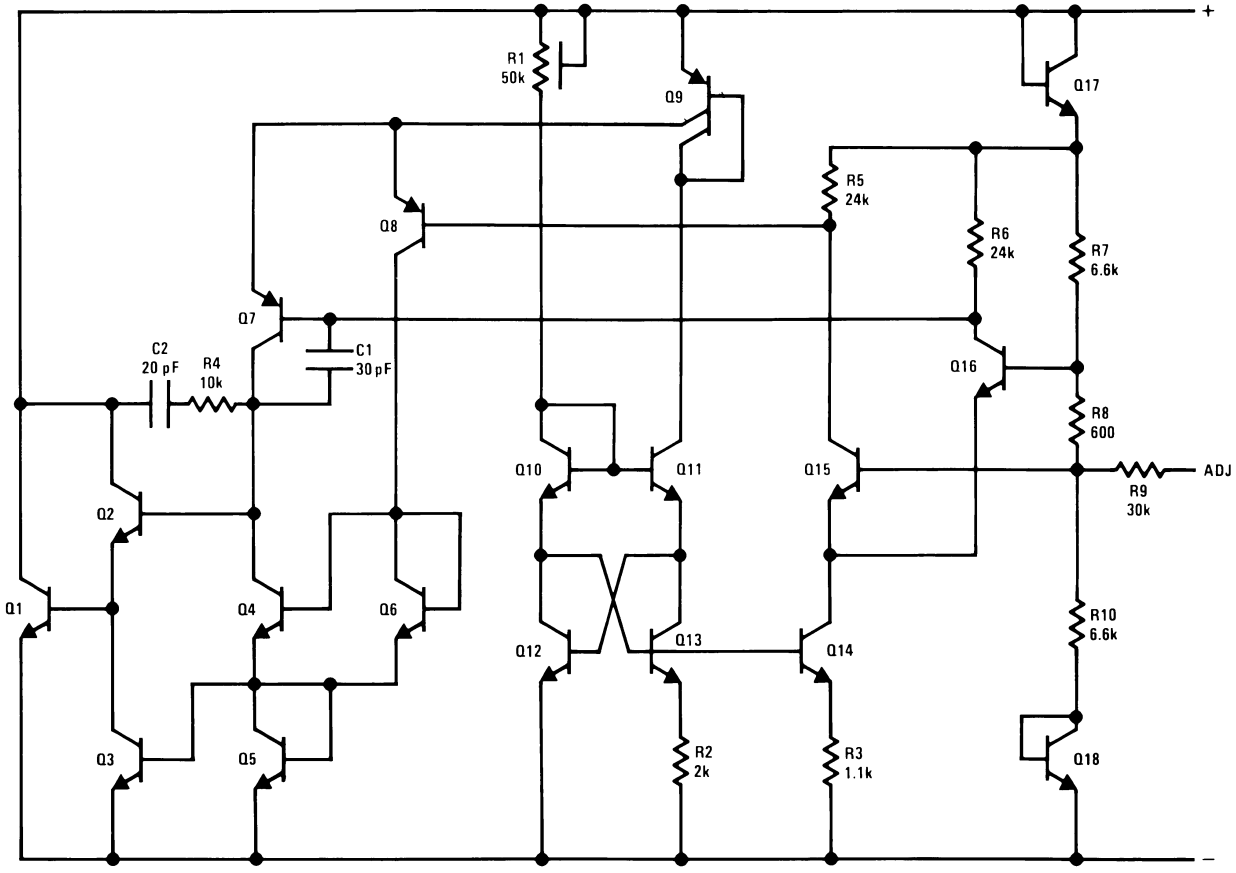


Figure 26. Low Noise Buffered Reference

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)
LM136AH-2.5	Active	Production	TO (NDV) | 3	1000 | BULK	No	Call TI	Level-1-NA-UNLIM	-40 to 125	(LM136AH2.5, LM136AH2.5)
LM136AH-2.5/NOPB	Active	Production	TO (NDV) | 3	1000 | BULK	Yes	Call TI	Level-1-NA-UNLIM	-40 to 125	(LM136AH2.5, LM136AH2.5)
LM136H-2.5	Active	Production	TO (NDV) | 3	1000 | BULK	No	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM136H2.5, LM136H2.5)
LM136H-2.5/NOPB	Active	Production	TO (NDV) | 3	1000 | BULK	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM136H2.5, LM136H2.5)
LM236H-2.5	Active	Production	TO (NDV) | 3	1000 | BULK	No	Call TI	Level-1-NA-UNLIM	-25 to 85	(LM236H2.5, LM236H2.5)
LM236H-2.5/NOPB	Active	Production	TO (NDV) | 3	1000 | BULK	Yes	Call TI	Level-1-NA-UNLIM	-25 to 85	(LM236H2.5, LM236H2.5)
LM336BM-2.5/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM336BM2.5
LM336BM-2.5/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM336BM2.5
LM336BMX-2.5/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM336BM2.5
LM336BMX-2.5/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM336BM2.5
LM336BZ-2.5/LFT7	Active	Production	TO-92 (LP) | 3	2000 | LARGE T&R	Yes	Call TI	N/A for Pkg Type	-	LM336BZ2.5
LM336BZ-2.5/LFT7.B	Active	Production	TO-92 (LP) | 3	2000 | LARGE T&R	Yes	Call TI	N/A for Pkg Type	0 to 70	LM336BZ2.5
LM336BZ-2.5/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM336BZ2.5
LM336BZ-2.5/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM336BZ2.5
LM336M-2.5/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM336M2.5
LM336M-2.5/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM336M2.5

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)
LM336MX-2.5/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM336 M2.5
LM336MX-2.5/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM336 M2.5
LM336Z-2.5/LFT1	Active	Production	TO-92 (LP) | 3	2000 | LARGE T&R	Yes	SN	N/A for Pkg Type	-	LM336 Z2.5
LM336Z-2.5/LFT1.B	Active	Production	TO-92 (LP) | 3	2000 | LARGE T&R	Yes	SN	N/A for Pkg Type	0 to 70	LM336 Z2.5
LM336Z-2.5/LFT3	Active	Production	TO-92 (LP) | 3	2000 | LARGE T&R	Yes	SN	N/A for Pkg Type	-	LM336 Z2.5
LM336Z-2.5/LFT3.B	Active	Production	TO-92 (LP) | 3	2000 | LARGE T&R	Yes	SN	N/A for Pkg Type	0 to 70	LM336 Z2.5
LM336Z-2.5/LFT7	Active	Production	TO-92 (LP) | 3	2000 | LARGE T&R	Yes	SN	N/A for Pkg Type	-	LM336 Z2.5
LM336Z-2.5/LFT7.B	Active	Production	TO-92 (LP) | 3	2000 | LARGE T&R	Yes	SN	N/A for Pkg Type	0 to 70	LM336 Z2.5
LM336Z-2.5/NOPB	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM336 Z2.5
LM336Z-2.5/NOPB.B	Active	Production	TO-92 (LP) | 3	1800 | BULK	Yes	Call TI	N/A for Pkg Type	0 to 70	LM336 Z2.5

(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.

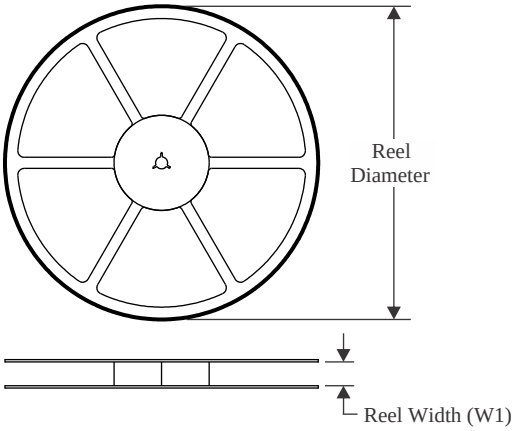
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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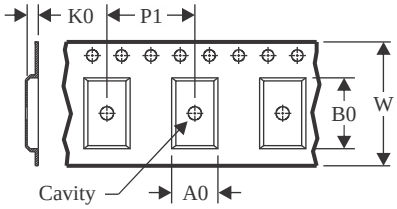
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

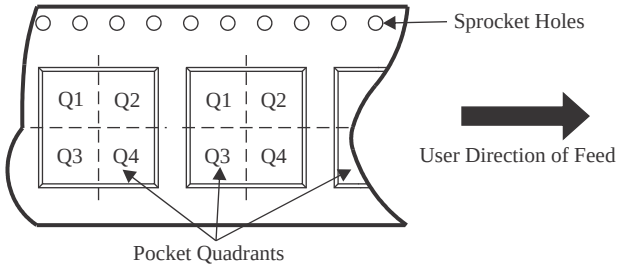


TAPE DIMENSIONS



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

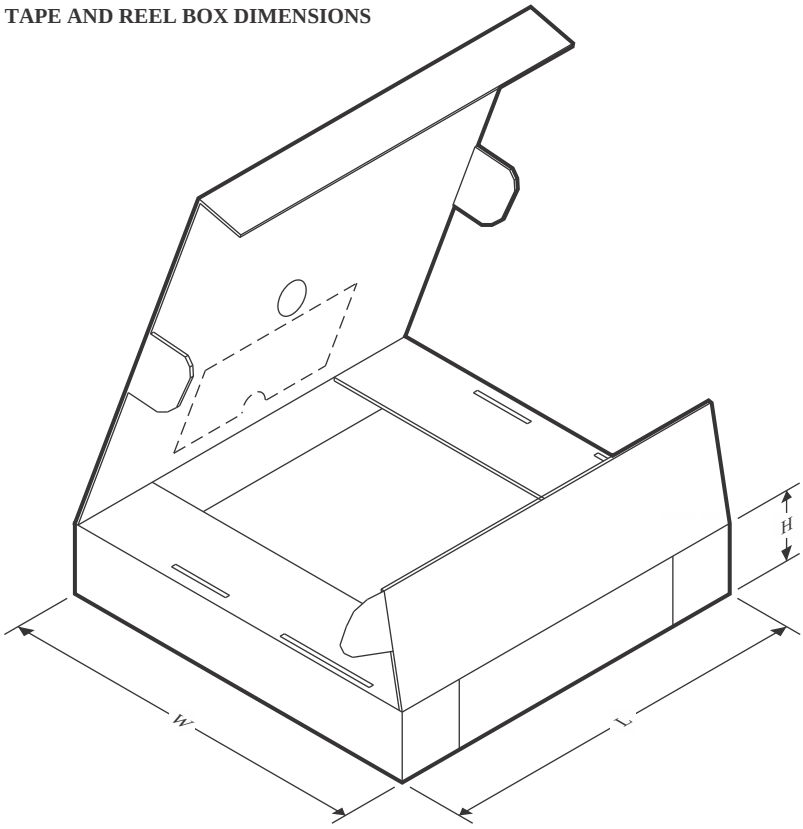
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM336BMX-2.5/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM336MX-2.5/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

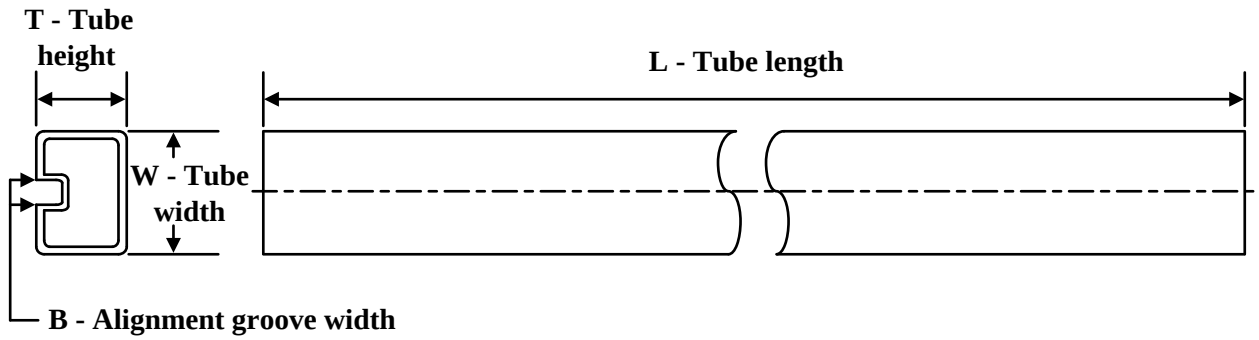
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM336BMX-2.5/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM336MX-2.5/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)
LM336BM-2.5/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM336BM-2.5/NOPB.B	D	SOIC	8	95	495	8	4064	3.05
LM336M-2.5/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM336M-2.5/NOPB.B	D	SOIC	8	95	495	8	4064	3.05

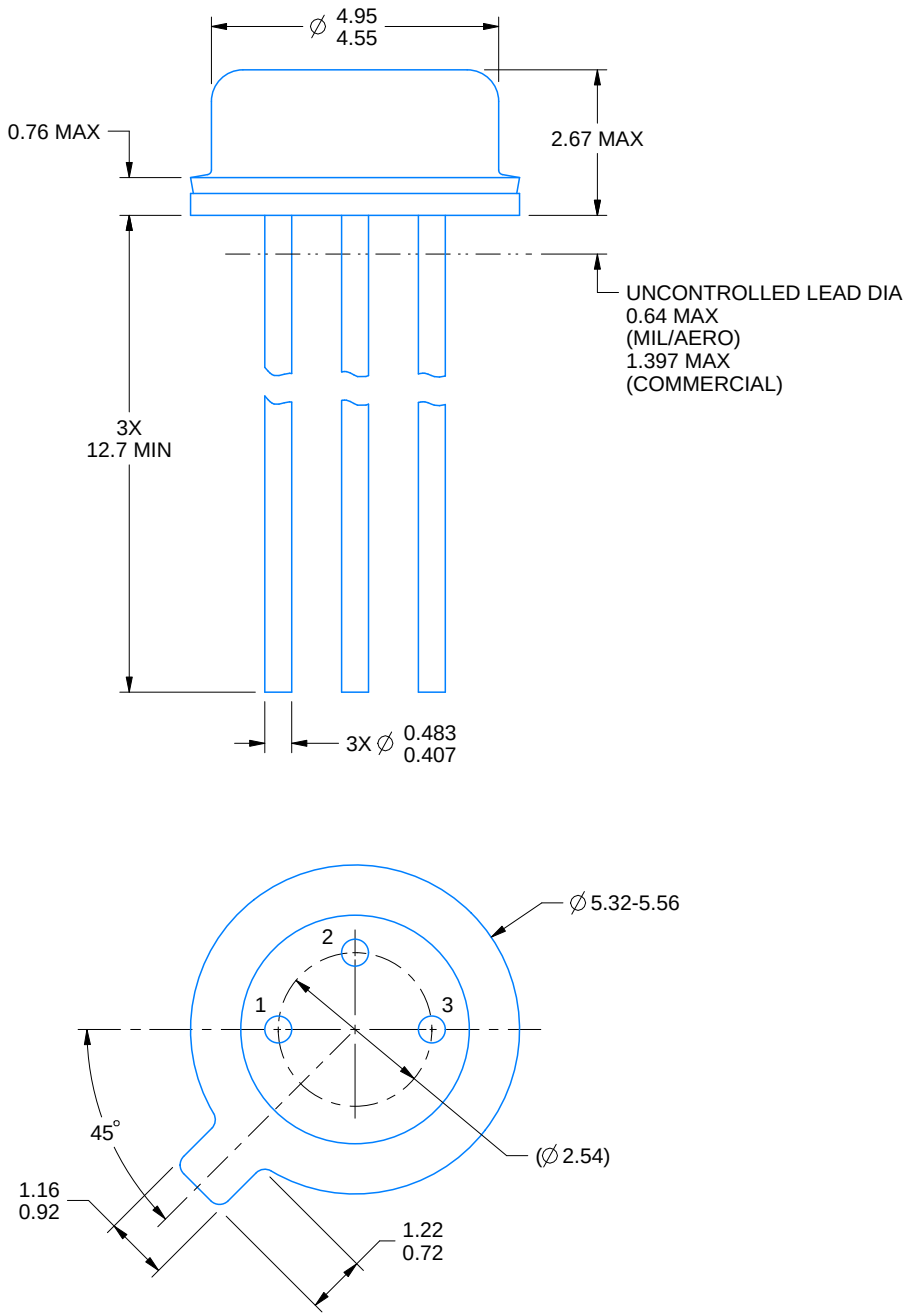
NDV0003H



PACKAGE OUTLINE

TO-CAN - 2.67 mm max height

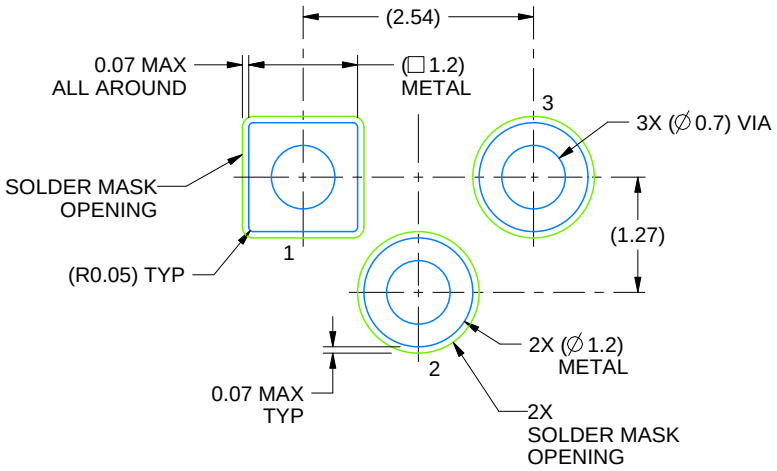
TRANSISTOR OUTLINE



4219876/B 09/2024

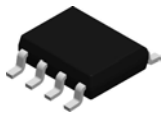
NOTES:

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

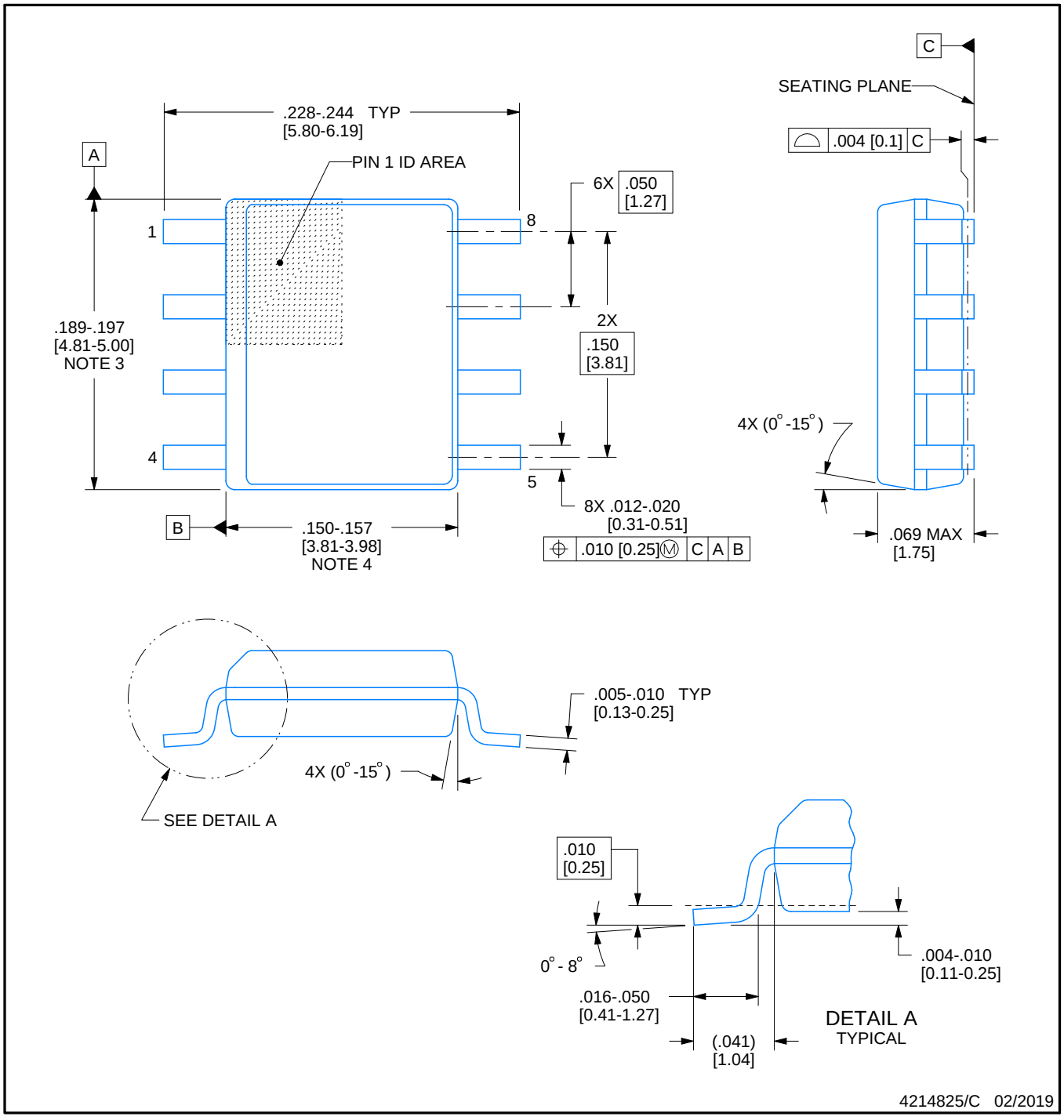


PACKAGE OUTLINE

D0008A

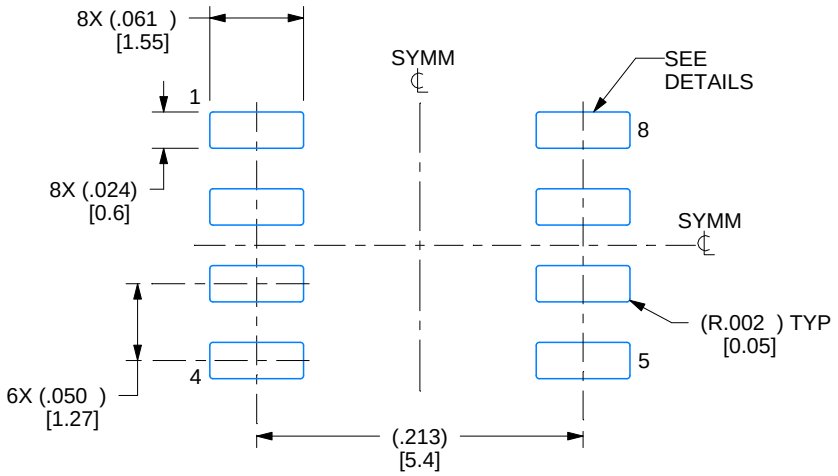
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

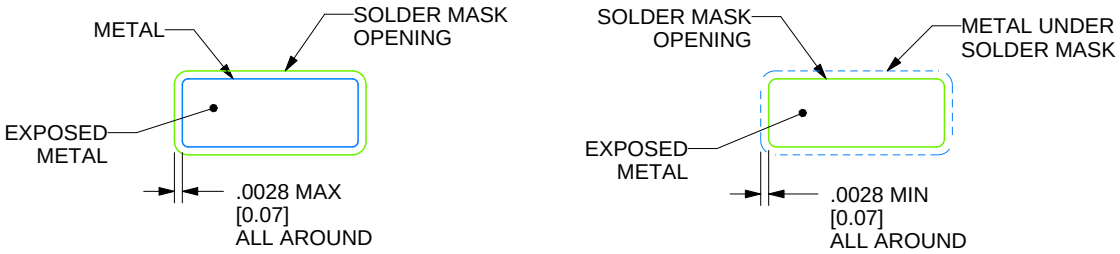


NOTES:

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)

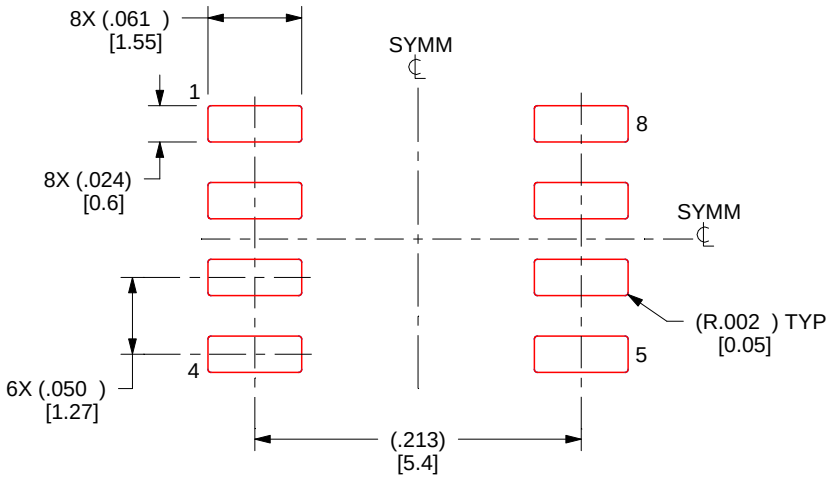
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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.

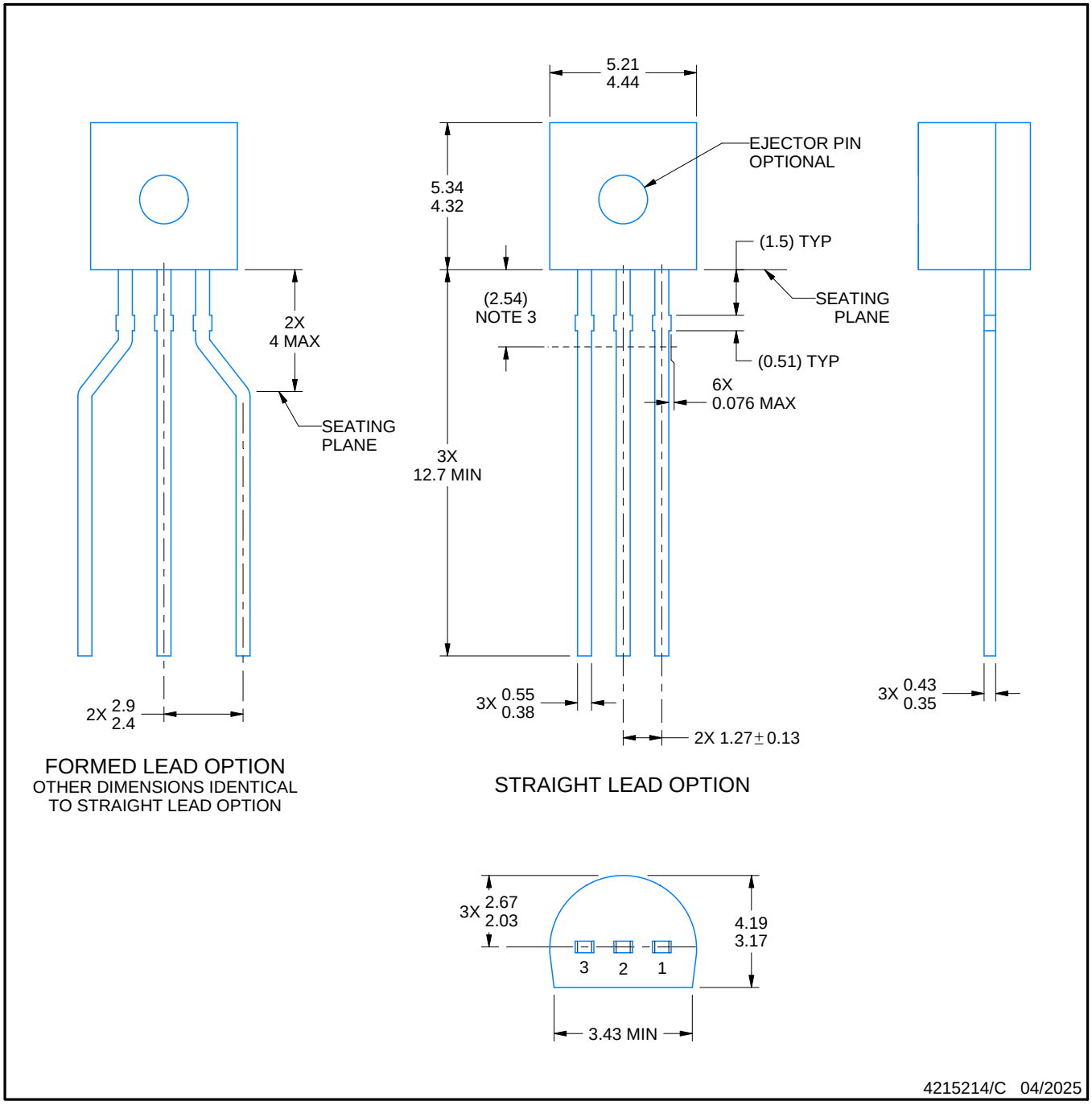
LP0003A



PACKAGE OUTLINE

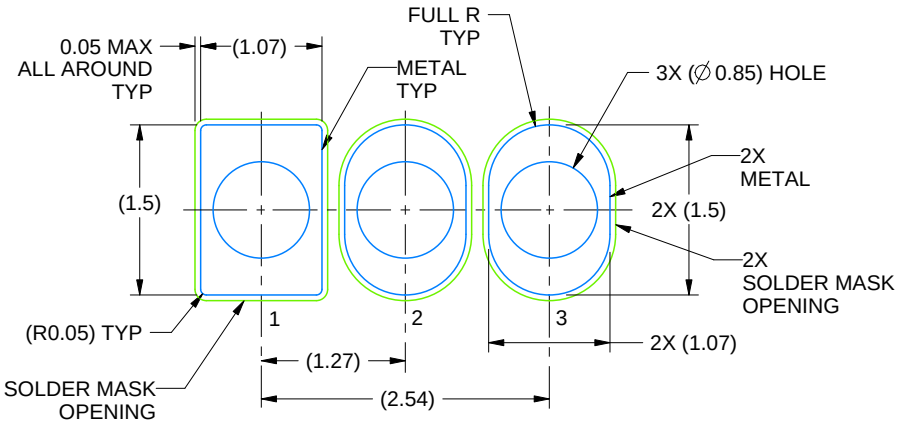
TO-92 - 5.34 mm max height

TO-92

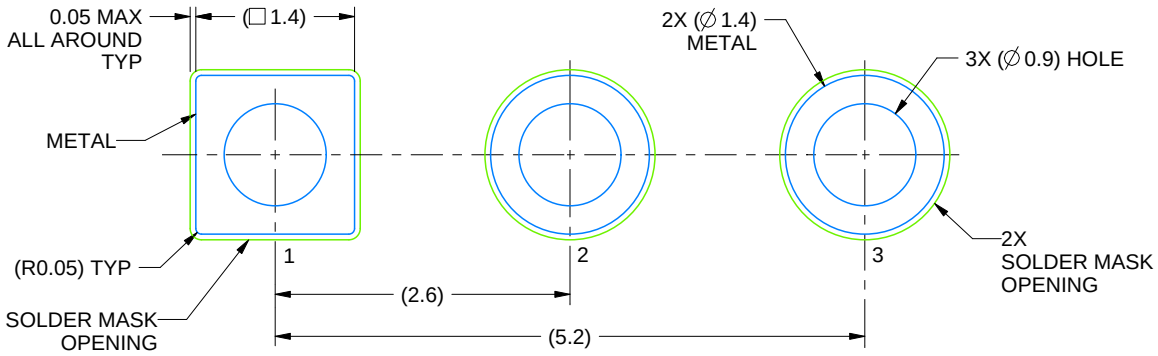


NOTES:

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



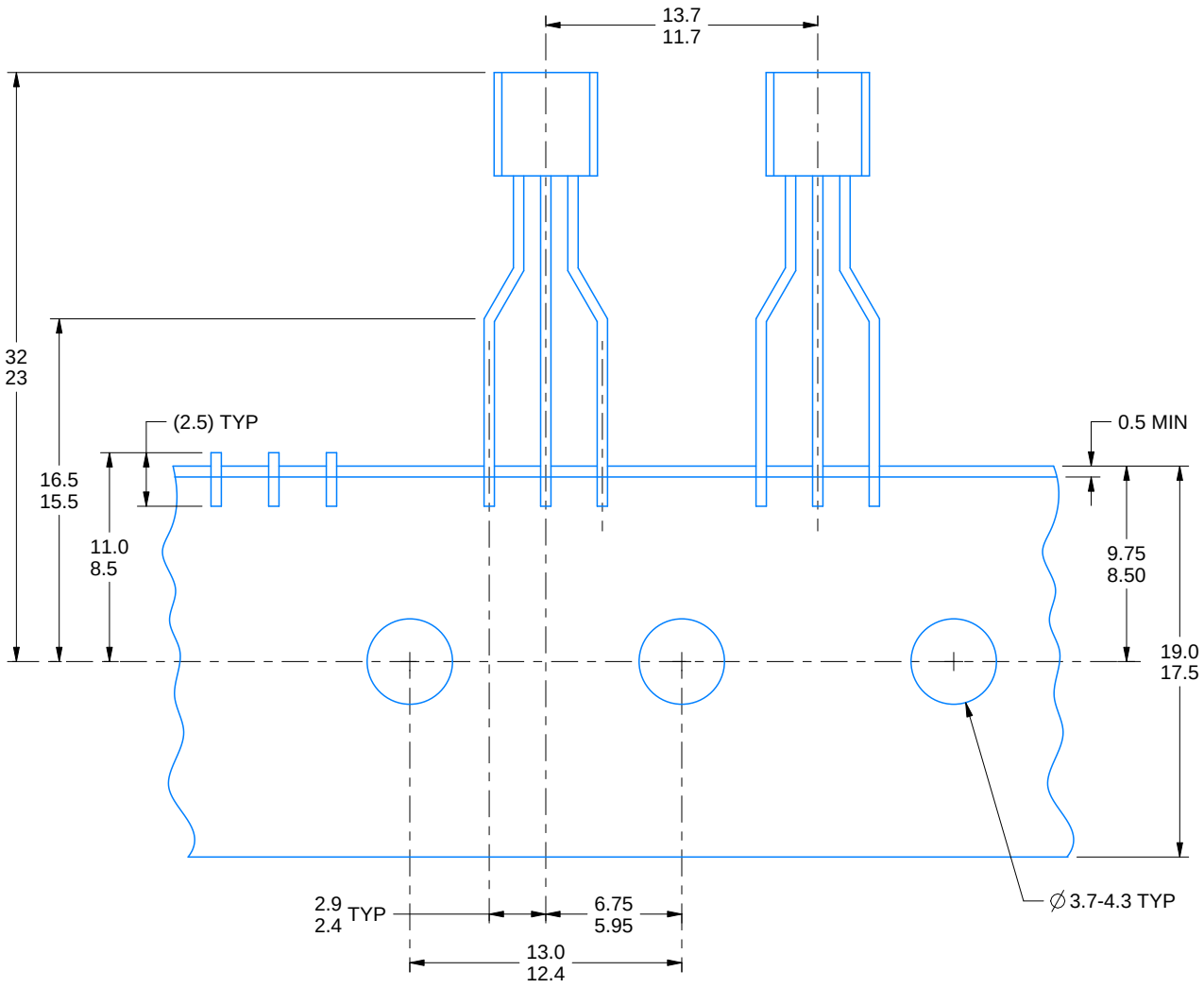
LAND PATTERN EXAMPLE
FORMED LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X

4215214/C 04/2025

LP0003A

TO-92 - 5.34 mm max height

TO-92



FOR FORMED LEAD OPTION PACKAGE

4215214/C 04/2025

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