TN0104

N-Channel Enhancement-Mode Vertical DMOS FET

Features

- 1.6V Maximum Low Threshold
- High Input Impedance
- Low Input Capacitance
- Fast Switching Speeds
- Low On-Resistance
- Free from Secondary Breakdown
- Low Input and Output Leakage

Applications

- Logic-Level Interfaces (Ideal for TTL and CMOS)
- Solid-State Relays
- Battery-Operated Systems
- Photovoltaic Drives
- Analog Switches
- General Purpose Line Drivers
- Telecommunication Switches

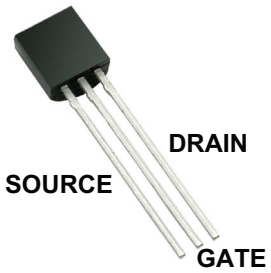
General Description

The TN0104 low-threshold, Enhancement-mode (normally-off) transistor uses a vertical DMOS structure and a well-proven silicon-gate manufacturing process. This combination produces a device with the power handling capabilities of bipolar transistors and the high input impedance and positive temperature coefficient inherent in MOS devices. Characteristic of all MOS structures, this device is free from thermal runaway and thermally induced secondary breakdown.

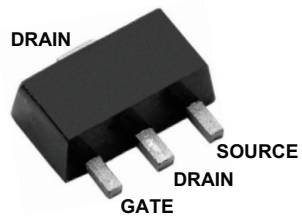
Microchip's vertical DMOS FETs are ideally suited to a wide range of switching and amplifying applications where very low threshold voltage, high breakdown voltage, high input impedance, low input capacitance, and fast switching speeds are desired.

Package Types

3-lead TO-92
(Top view)



3-lead SOT-89
(Top view)



See Table 3-1 and Table 3-2 for pin information.

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Drain-to-Source Voltage ..... BV_{DSS}
Drain-to-Gate Voltage ..... BV_{DGS}
Gate-to-Source Voltage ..... ±20V
Operating Ambient Temperature, T_A ..... –55°C to +150°C
Storage Temperature, T_S ..... –55°C to +150°C

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: T_A = 25°C unless otherwise specified. All DC parameters are 100% tested at 25°C unless otherwise stated. (Pulse test: 300 µs pulse, 2% duty cycle)

Parameter		Sym.	Min.	Typ.	Max.	Unit	Conditions
Drain-to-Source Breakdown Voltage		BV_{DSS}	40	—	—	V	V_{GS} = 0V, I_D = 1 mA
Gate Threshold Voltage		$V_{GS(th)}$	0.6	—	1.6	V	V_{GS} = V_{DS}, I_D = 500 µA
Change in $V_{GS(th)}$ with Temperature		$\Delta V_{GS(th)}$	—	–3.8	–5	mV/°C	V_{GS} = V_{DS}, I_D = 1 mA (**Note 1**)
Gate Body Leakage Current		I_{GSS}	—	0.1	100	nA	V_{GS} = ±20V, V_{DS} = 0V
Zero-Gate Voltage Drain Current		I_{DSS}	—	—	1	µA	V_{GS} = 0V, V_{DS} = Maximum rating
			—	—	100	µA	V_{DS} = 0.8 Maximum rating, V_{GS} = 0V, T_A = 125°C (**Note 1**)
On-State Drain Current		$I_{D(ON)}$	—	0.35	—	A	V_{GS} = 3V, V_{DS} = 20V
			0.5	1.1	—	A	V_{GS} = 5V, V_{DS} = 20V
			2	2.6	—	A	V_{GS} = 10V, V_{DS} = 20V
Static Drain-to-Source On-State Resistance	Both packages	$R_{DS(ON)}$	—	5	—	Ω	V_{GS} = 3V, I_D = 50 mA
			—	2.3	2.5	Ω	V_{GS} = 5V, I_D = 250 mA
	TO-92		—	1.5	1.8	Ω	V_{GS} = 10V, I_D = 1A
	SOT-89		—	—	2	Ω	
Change in $R_{DS(ON)}$ with Temperature		$\Delta R_{DS(ON)}$	—	0.7	1	%/°C	V_{GS} = 10V, I_D = 1A (**Note 1**)

Note 1: Specification is obtained by characterization and is not 100% tested.

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: T_A = 25°C unless otherwise specified. Specification is obtained by characterization and is not 100% tested.

Parameter		Sym.	Min.	Typ.	Max.	Unit	Conditions
Forward Transconductance		G_{FS}	340	450	—	mmho	V_{DS} = 20V, I_D = 500 mA
Input Capacitance		C_{ISS}	—	—	70	pF	V_{GS} = 0V, V_{DS} = 20V, f = 1 MHz
Common-Source Output Capacitance		C_{OSS}	—	—	50	pF	
Reverse Transfer Capacitance		C_{RSS}	—	—	15	pF	
Turn-On Delay Time		$t_{d(ON)}$	—	3	5	ns	V_{DD} = 20V, I_D = 1A, R_{GEN} = 25Ω
Rise Time		t_r	—	7	8	ns	
Turn-Off Delay Time		$t_{d(OFF)}$	—	6	9	ns	
Fall Time		t_f	—	5	8	ns	
DIODE PARAMETER							
Diode Forward Voltage Drop	TO-92	V_{SD}	—	1.2	1.8	V	V_{GS} = 0V, I_{SD} = 1A (**Note 1**)
	SOT-89		—	—	2	V	V_{GS} = 0V, I_{SD} = 0.5A (**Note 1**)
Reverse Recovery Time		t_{rr}	—	300	—	ns	V_{GS} = 0V, I_{SD} = 1A

Note 1: All DC parameters are 100% tested at 25°C unless otherwise stated. (Pulse test: 300 µs pulse, 2% duty cycle)

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Ambient Temperature	T_A	–55	—	+150	°C	
Storage Temperature	T_S	–55	—	+150	°C	
PACKAGE THERMAL RESISTANCE						
3-lead TO-92	θ_{JA}	—	132	—	°C/W	
3-lead SOT-89	θ_{JA}	—	133	—	°C/W	

THERMAL CHARACTERISTICS

Package	I_D (**Note 1**) (Continuous) (mA)	I_D (Pulsed) (A)	Power Dissipation at T_A = 25°C (W)	I_{DR} (**Note 1**) (mA)	I_{DRM} (A)
3-lead TO-92	450	2.4	1	450	2.4
3-lead SOT-89	630	2.9	1.6 (**Note 1**)	630	2.9

Note 1: I_D (continuous) is limited by maximum rated T_J.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g. outside specified power supply range) and therefore outside the warranted range.

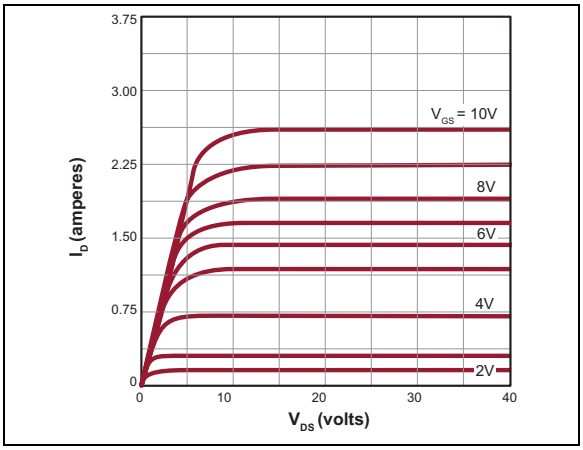


FIGURE 2-1: *Output Characteristics.*

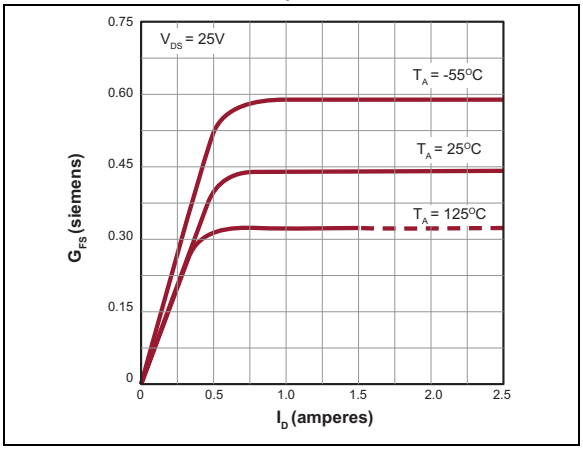


FIGURE 2-2: *Transconductance vs. Drain Current.*

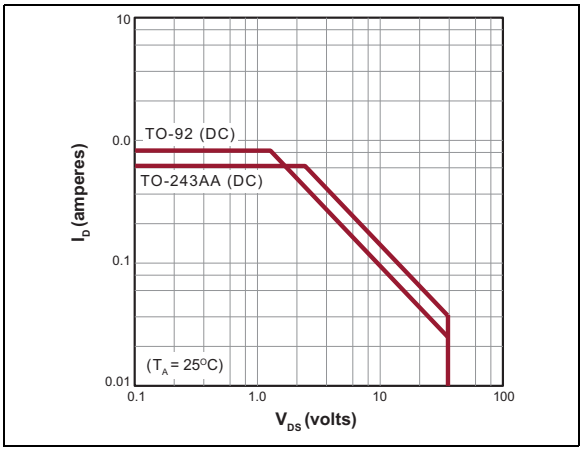


FIGURE 2-3: *Maximum Rated Safe Operating Area.*

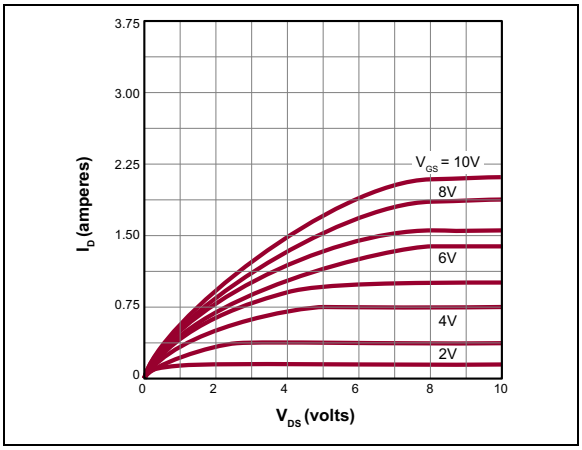


FIGURE 2-4: *Saturation Characteristics.*

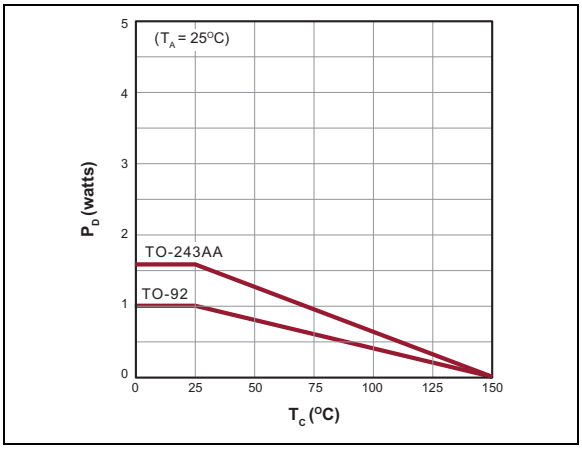


FIGURE 2-5: *Power Dissipation vs. Case Temperature.*

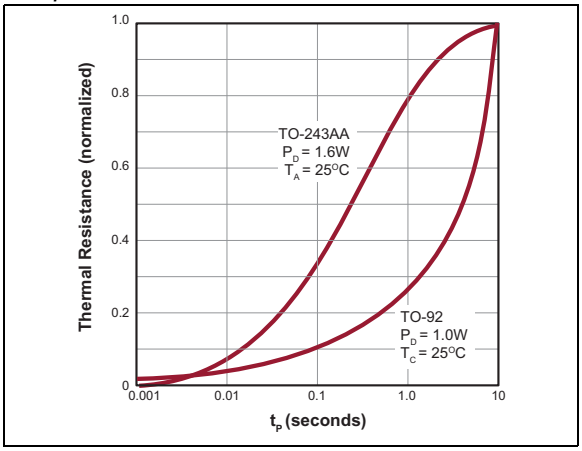


FIGURE 2-6: *Thermal Response Characteristics.*

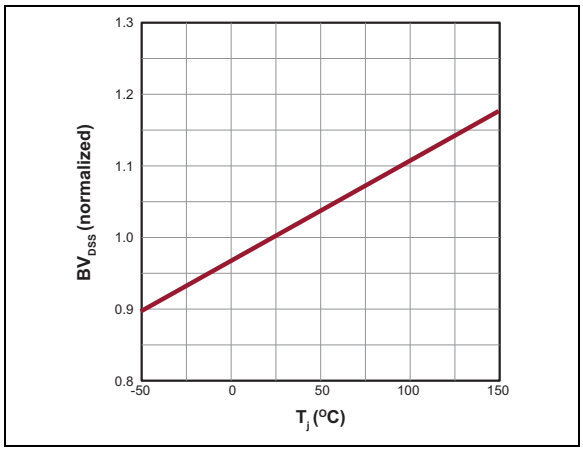


FIGURE 2-7: *BV_{DSS} Variation with Temperature.*

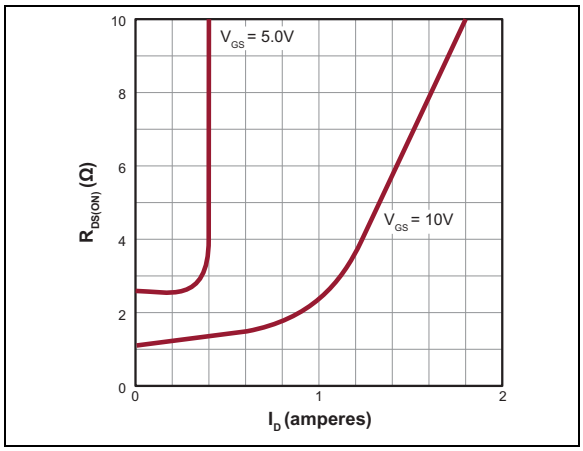


FIGURE 2-10: *On-Resistance vs. Drain Current.*

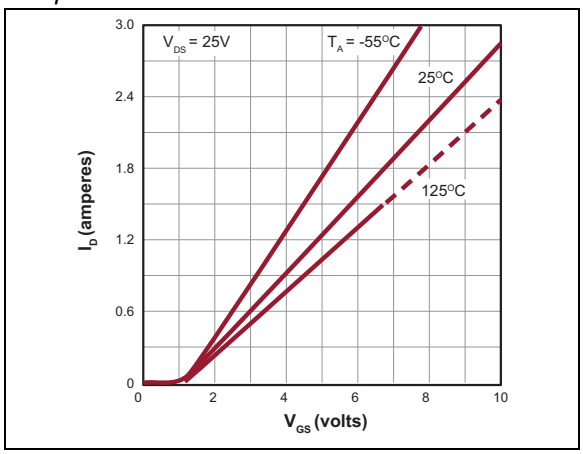


FIGURE 2-8: *Transfer Characteristics.*

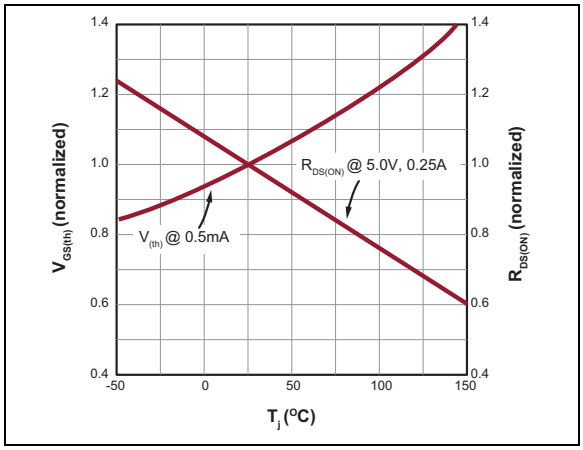


FIGURE 2-11: *$V_{(th)}$ and R_{DS} Variation with Temperature.*

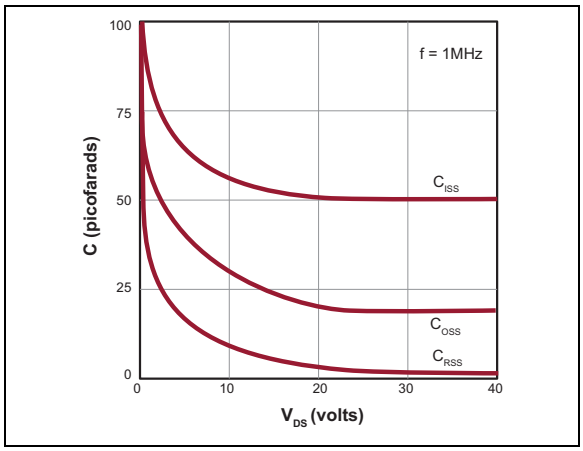


FIGURE 2-9: *Capacitance vs. Drain-to-Source Voltage.*

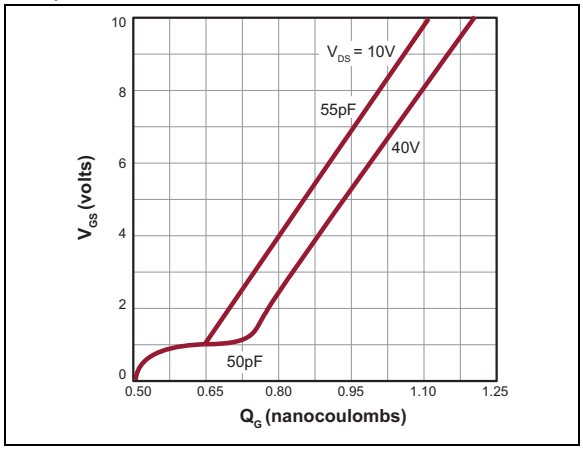


FIGURE 2-12: *Gate Drive Dynamic Characteristics.*

3.0 PIN DESCRIPTION

The details on the pins of TN0104 TO-92 and SOT-89 are listed in Table 3-1 and Table 3-2, respectively. Refer to **Package Types** for the location of pins.

TABLE 3-1: TO-92 PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	Source	Source
2	Gate	Gate
3	Drain	Drain

TABLE 3-2: SOT-89 PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	Gate	Gate
2,4	Drain	Drain
3	Source	Source

4.0 FUNCTIONAL DESCRIPTION

Figure 4-1 illustrates the switching waveforms and test circuit for TN0104.

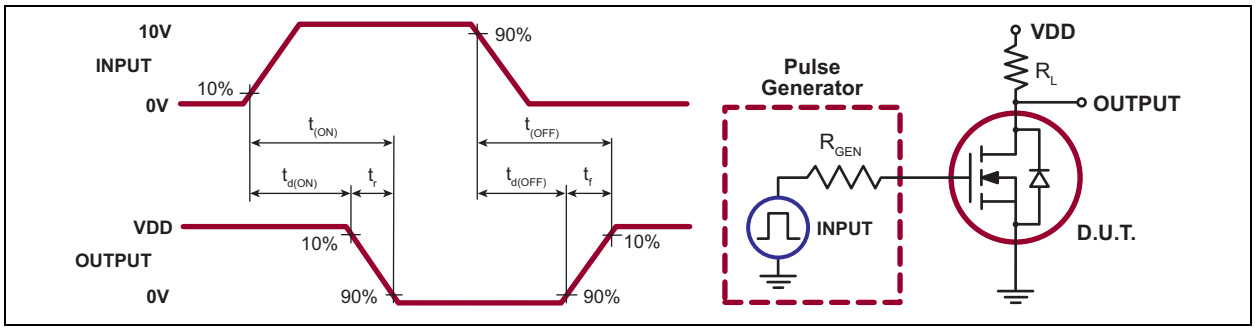


FIGURE 4-1: *Switching Waveforms and Test Circuit.*

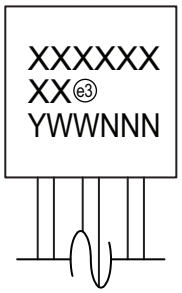
TABLE 4-1: PRODUCT SUMMARY

BV_{DSX}/BV_{DGX} (V)	$R_{DS(ON)}$ (Maximum) (Ω)	$I_{DSS(ON)}$ (Minimum) (A)
40	1.8	2

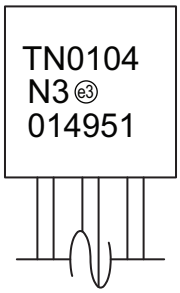
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

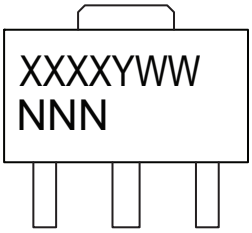
3-lead TO-92



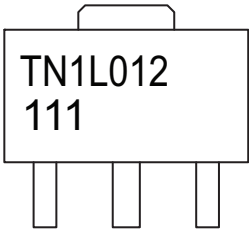
Example



3-lead SOT-89



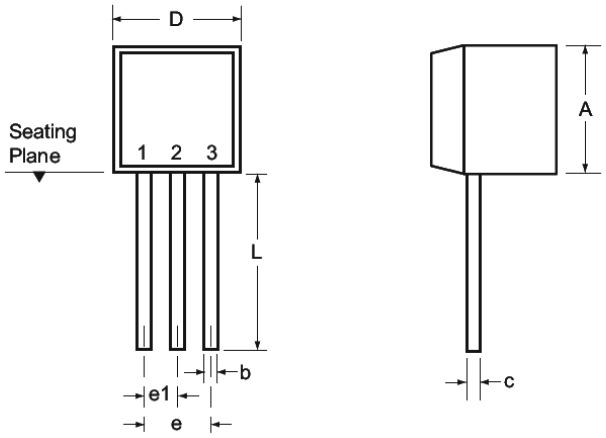
Example

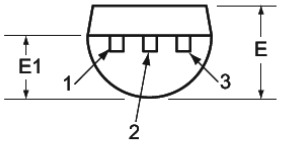


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

3-Lead TO-92 Package Outline (L/LL/N3)



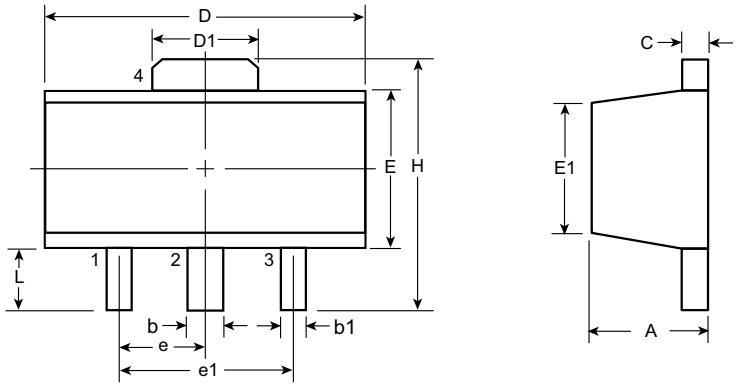


Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Symbol		A	b	c	D	E	E1	e	e1	L
Dimensions (inches)	MIN	.170	.014†	.014†	.175	.125	.080	.095	.045	.500
	NOM	-	-	-	-	-	-	-	-	-
	MAX	.210	.022†	.022†	.205	.165	.105	.105	.055	.610*

JEDEC Registration TO-92.
** This dimension is not specified in the JEDEC drawing.*
† This dimension differs from the JEDEC drawing.
Drawings not to scale.

3-Lead TO-243AA (SOT-89) Package Outline (N8)



Top View **Side View**

Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Symbol		A	b	b1	C	D	D1	E	E1	e	e1	H	L
Dimensions (mm)	MIN	1.40	0.44	0.36	0.35	4.40	1.62	2.29	2.00†	1.50 BSC	3.00 BSC	3.94	0.73†
	NOM	-	-	-	-	-	-	-	-			-	-
	MAX	1.60	0.56	0.48	0.44	4.60	1.83	2.60	2.29			4.25	1.20

JEDEC Registration TO-243, Variation AA, Issue C, July 1986.
† This dimension differs from the JEDEC drawing
***Drawings not to scale**.*

APPENDIX A: REVISION HISTORY

Revision A (June 2020)

- Converted Supertex Doc# DSFP-TN0104 to Microchip DS20005930A
- Changed the package marking format
- Updated the packing medium of the TN0104 N3 P014 media type from 2000/Reel to 2000/AMMO to align with actual specifications
- Made minor text changes throughout the document

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	XX	-	X	-	X
Device	Package Options		Environmental		Media Type

Device:	TN0104	=	N-Channel Enhancement-Mode Vertical DMOS FET
Packages:	N3	=	3-lead TO-92
	N8	=	3-lead SOT-89
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Types:	(blank)	=	1000/Bag for an N3 Package
		=	2000/Reel for an N8 Package
	P003	=	2000/Reel for an N3 Package
	P014	=	2000/AMMO for an N3 Package

Examples:

a) TN0104N3-G:	N-Channel Enhancement-Mode, Vertical DMOS FET, 3-lead TO-92,1000/Bag
b) TN0104N3-G-P003:	N-Channel Enhancement-Mode, Vertical DMOS FET, 3-lead TO-92, 2000/Reel
c) TN0104N3-G-P014:	N-Channel Enhancement-Mode, Vertical DMOS FET, 3-lead TO-92, 2000/AMMO
d) TN0104N8-G:	N-Channel Enhancement-Mode, Vertical DMOS FET, 3-lead SOT-89, 2000/Reel

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- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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