# TN2504

## N-Channel Enhancement-Mode Vertical DMOS FET

### Features

- 1.6V Maximum Low Threshold
- High Input Impedance
- 125 pF Maximum 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

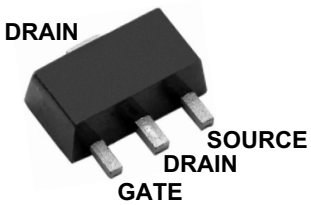
### General Description

The TN2504 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 Type

**3-lead SOT-89**
(Top view)




See Table 3-1 for pin information.

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## 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, $I_D$ = 2 mA |
| Gate Threshold Voltage | $V_{GS(th)}$ | 0.6 | — | 1.6 | V | $V_{GS}$ = $V_{DS}$, $I_D$ = 1 mA |
| Change in $V_{GS(th)}$ with Temperature | $\Delta V_{GS(th)}$ | — | –3.8 | –4.5 | mV/°C | $V_{GS}$ = $V_{DS}$, $I_D$= 1 mA (**Note 1**) |
| Gate Body Leakage Current | $I_{GSS}$ | — | — | 100 | nA | $V_{GS}$ = ± 20V, $V_{DS}$ = 0V |
| Zero-Gate Voltage Drain Current | $I_{DSS}$ | — | — | 10 | µA | $V_{GS}$ = 0V, $V_{DS}$ = Maximum rating |
| | | — | — | 1 | mA | $V_{DS}$ = 0.8 Maximum rating, $V_{GS}$ = 0V, $T_A$ = 125°C (**Note 1**) |
| On-State Drain Current | $I_{D(ON)}$ | 1 | 1.7 | — | A | $V_{GS}$ = 5V, $V_{DS}$ = 15V |
| | | 4 | 4.5 | — | A | $V_{GS}$ = 10V, $V_{DS}$ = 15V |
| Static Drain-to-Source On-State Resistance | $R_{DS(ON)}$ | — | 1.25 | 1.5 | Ω | $V_{GS}$ = 5V, $I_D$ = 300 mA |
| | | — | 0.8 | 1 | Ω | $V_{GS}$ = 10V, $I_D$ = 1.5A |
| Change in $R_{DS(ON)}$ with Temperature | $\Delta R_{DS(ON)}$ | — | — | 0.75 | %/°C | $V_{GS}$ = 10V, $I_D$ = 1.5A (**Note 1**) |

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


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## AC ELECTRICAL CHARACTERISTICS

| **Electrical Specifications:** $T_A$ = 25°C unless otherwise specified. All AC parameters are not 100% sample tested. | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Sym.** | **Min.** | **Typ.** | **Max.** | **Unit** | **Conditions** |
| Forward Transconductance | $G_{FS}$ | 500 | 700 | — | mmho | $V_{DS}$ = 15V, $I_D$ = 2A |
| Input Capacitance | $C_{ISS}$ | — | 70 | 125 | pF | $V_{GS}$ = 0V, $V_{DS}$ = 20V, f = 1 MHz |
| Common-Source Output Capacitance | $C_{OSS}$ | — | 50 | 70 | pF | |
| Reverse Transfer Capacitance | $C_{RSS}$ | — | 20 | 25 | pF | |
| Turn-On Delay Time | $t_{d(ON)}$ | — | — | 10 | ns | $V_{DD}$ = 20V, $I_D$ = 500 mA, $R_{GEN}$ = 25Ω |
| Rise Time | $t_r$ | — | — | 10 | ns | |
| Turn-Off Delay Time | $t_{d(OFF)}$ | — | — | 25 | ns | |
| Fall Time | $t_f$ | — | — | 13 | ns | |
| **DIODE PARAMETER** | | | | | | |
| Diode Forward Voltage Drop | $V_{SD}$ | — | 1.2 | 1.8 | V | $V_{GS}$ = 0V, $I_{SD}$ = 1.5A (**Note 1**) |
| Reverse Recovery Time | $t_{rr}$ | — | 300 | — | ns | $V_{GS}$ = 0V, $I_{SD}$ = 1 mA |

**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 SOT-89 | $\theta_{JA}$ | — | 73 | — | °C/W | |

## THERMAL CHARACTERISTICS

| **Package** | **$I_D$ (Note 1) (Continuous) (mA)** | **$I_D$ (Pulsed) (A)** | **Power Dissipation at $T_A$ = 25°C (Note 2) (W)** | **$I_{DR}$ (Note 1) (mA)** | **$I_{DRM}$ (A)** |
|---|---|---|---|---|---|
| 3-lead SOT-89 | 890 | 4.5 | 1.6 | 890 | 4.5 |

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

**2:** $T_A$ = 25°C. Mounted on an FR5 Board, 25 mm x 25 mm x 1.57 mm.

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## 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.

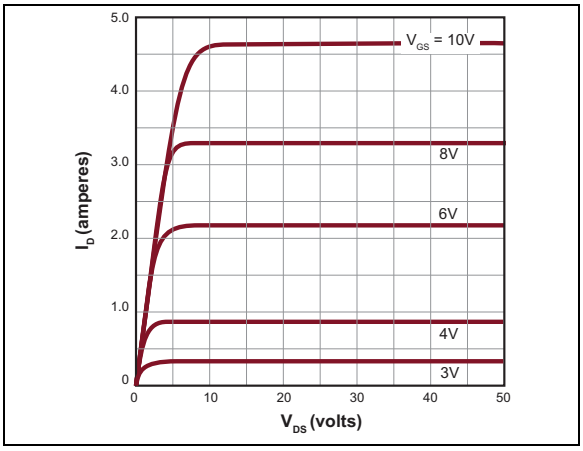



***FIGURE 2-1:*** *Output Characteristics.*

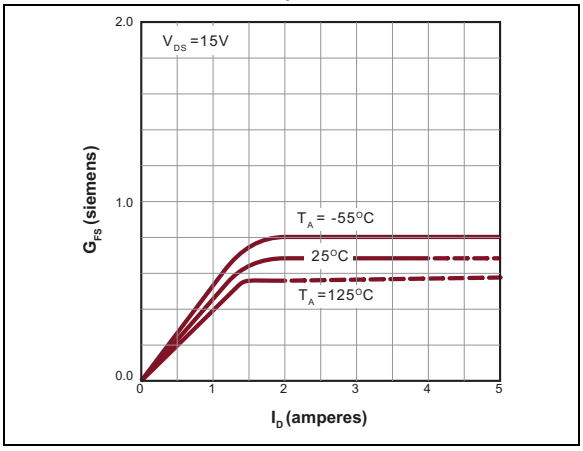



***FIGURE 2-2:*** *Transconductance vs. Drain Current.*

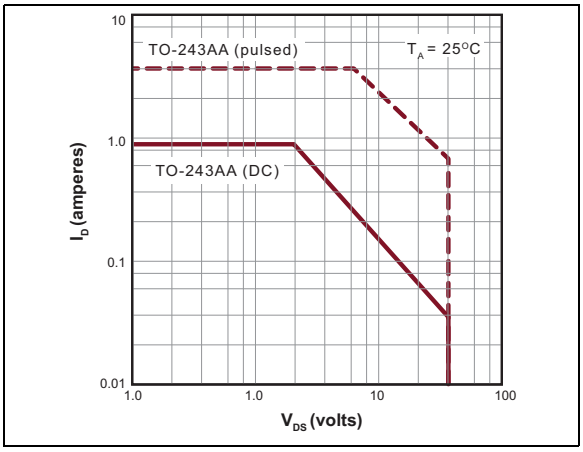



***FIGURE 2-3:*** *Maximum Rated Safe Operating Area.*

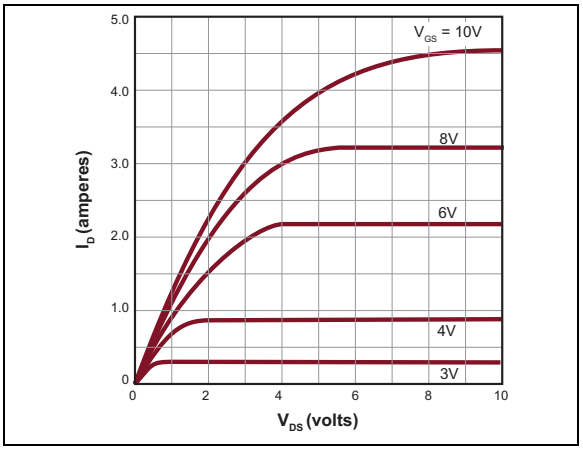



***FIGURE 2-4:*** *Saturation Characteristics.*

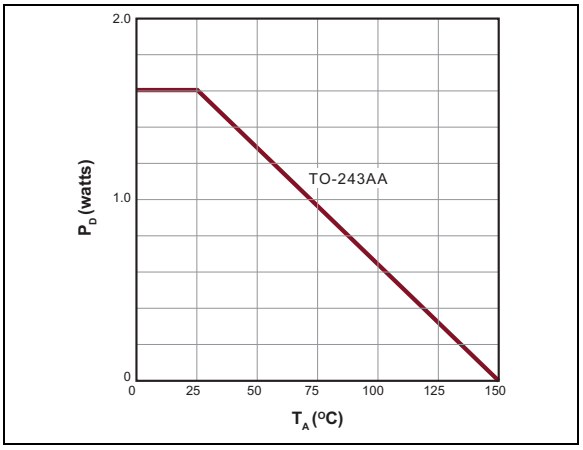



***FIGURE 2-5:*** *Power Dissipation vs. Ambient Temperature.*

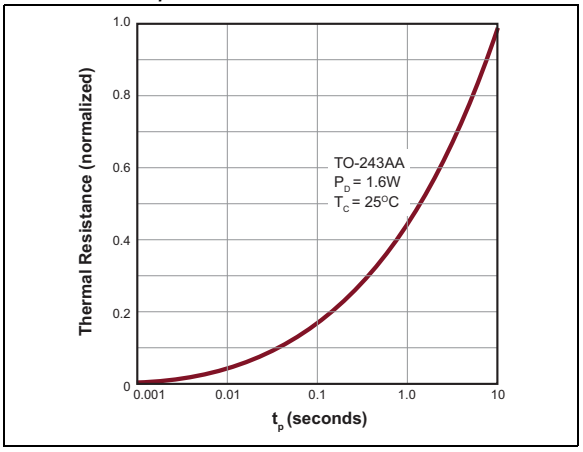



***FIGURE 2-6:*** *Thermal Response Characteristics.*


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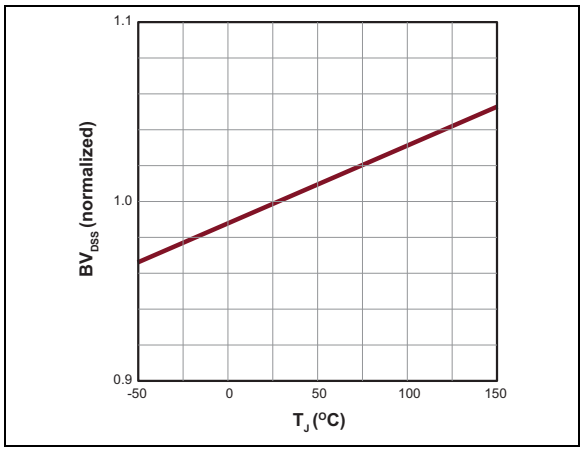



***FIGURE 2-7:*** *$BV_{DSS}$ Variation with Temperature.*

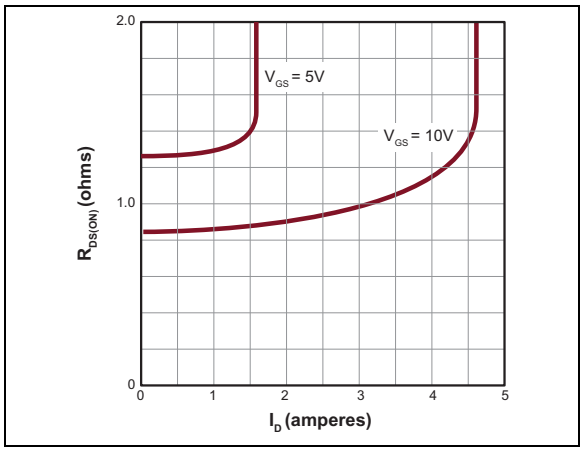



***FIGURE 2-10:*** *On-Resistance vs. Drain Current.*

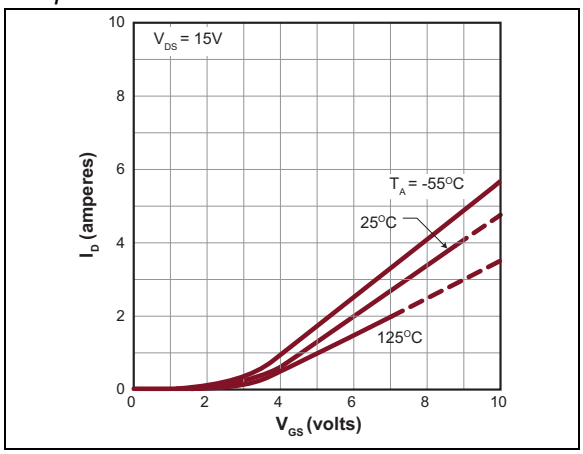



***FIGURE 2-8:*** *Transfer Characteristics.*

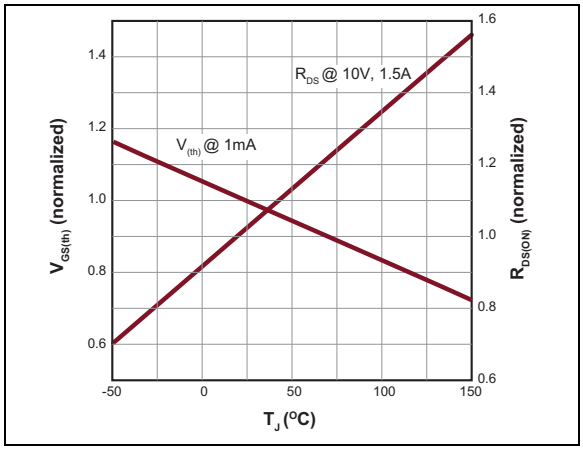



***FIGURE 2-11:*** *$V_{GS(th)}$ and $R_{DS(ON)}$ with Temperature.*

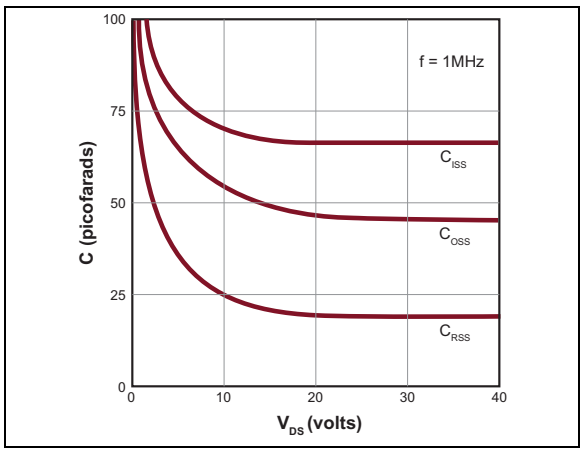



***FIGURE 2-9:*** *Capacitance vs. Drain-to-Source Voltage.*

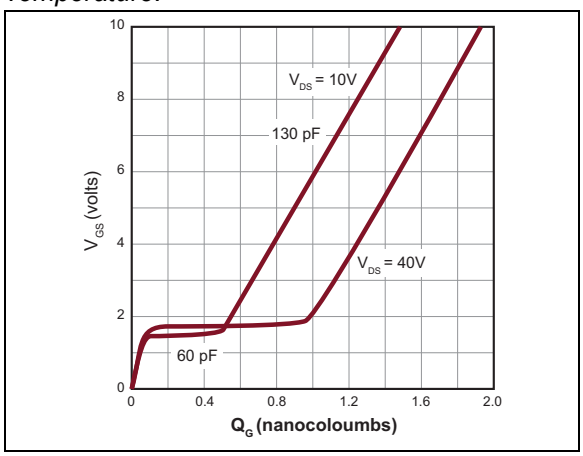



***FIGURE 2-12:*** *Gate Drive Dynamic Characteristics.*

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## 3.0 PIN DESCRIPTION

Table 3-1 shows details on the pins of TN2504. Refer to **Package Type** for the location of the pins.

**TABLE 3-1: PIN FUNCTION TABLE**

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


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## 4.0 FUNCTIONAL DESCRIPTION

Figure 4-1 illustrates the switching waveforms and test circuit for TN2504.

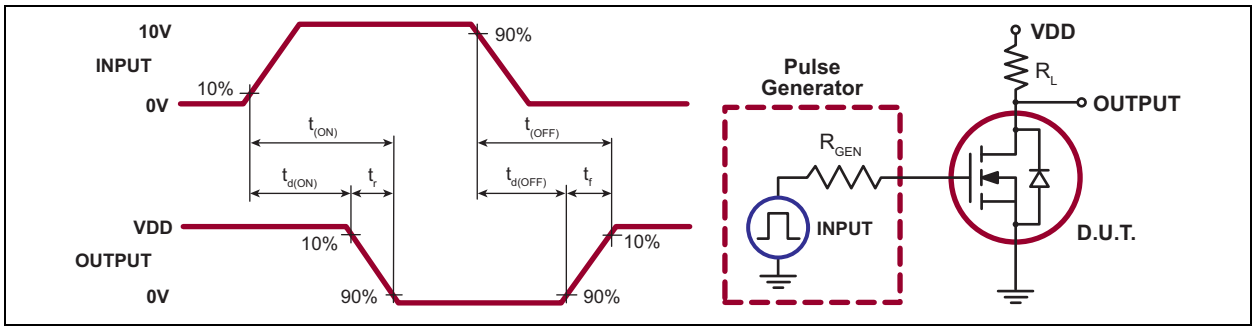



***FIGURE 4-1:*** *Switching Waveforms and Test Circuit.*

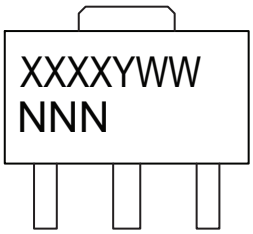
**TABLE 4-1: PRODUCT SUMMARY**

| $BV_{DSS}/BV_{DGS}$ (V) | $R_{DS(ON)}$ (Maximum) (Ω) | $I_{D(ON)}$ (Minimum) (A) | $V_{GS(TH)}$ (Maximum) (V) |
|---|---|---|---|
| 40 | 1 | 4 | 1.6 |

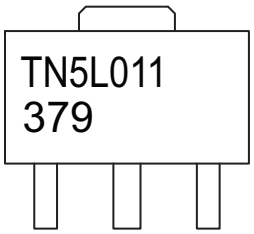
## 5.0 PACKAGING INFORMATION

### 5.1 Package Marking Information

3-lead SOT-89




Example

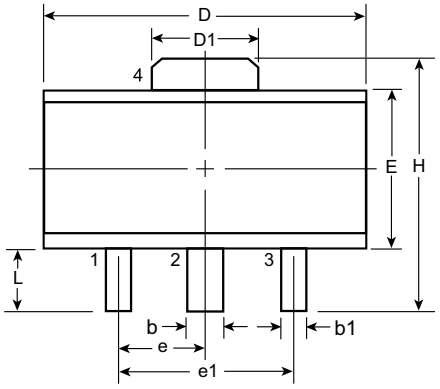



| | | |
|---|---|---|
| **Legend:** | XX...X | Product Code or Customer-specific information |
| | Y | Year code (last digit of calendar year) |
| | YY | Year code (last 2 digits of calendar year) |
| | WW | Week code (week of January 1 is week ‘01’) |
| | NNN | Alphanumeric traceability code |
| | (e3) | 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. |

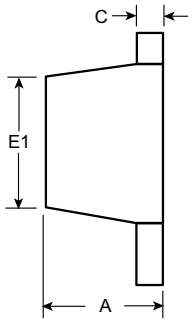
**Note**: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.


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## 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**.*

**NOTES:**


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# APPENDIX A: REVISION HISTORY

## Revision A (November 2020)

- Converted Supertex Doc# DSFP-TN2504 to Microchip DS20005949A
- Changed the package marking format
- 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: | TN2504 | = | N-Channel Enhancement-Mode Vertical DMOS FET |
| Package: | N8 | = | 3-lead SOT-89 |
| Environmental: | G | = | Lead (Pb)-free/RoHS-compliant Package |
| Media Type: | (blank) | = | 2000/Reel for an N8 Package |

**Example:**

a) TN2504N8-G: N-Channel Enhancement-Mode, Vertical DMOS FET, 3-lead SOT-89, 2000/Reel


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# Elektronik komponent tedarikinde Entegreci

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