TP2535

P-Channel Enhancement-Mode Vertical DMOS FET

Features

- –2.4V Maximum Low Threshold
- High Input Impedance
- 60 pF 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

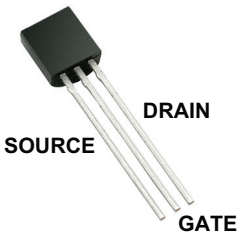
General Description

The TP2535 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 TO-92
(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}	–350	—	—	V	V_{GS} = 0V, I_D = –2 mA
Gate Threshold Voltage	$V_{GS(th)}$	–1	—	–2.4	V	V_{GS} = V_{DS}, I_D = –1 mA
Change in $V_{GS(th)}$ with Temperature	$\Delta V_{GS(th)}$	—	—	4.8	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	$I_{D(ON)}$	–0.2	–0.3	—	A	V_{GS} = –4.5V, V_{DS} = –25V
		–0.4	–1.1	—	A	V_{GS} = –10V, V_{DS} = –25V
Static Drain-to-Source On-State Resistance	$R_{DS(ON)}$	—	20	30	Ω	V_{GS} = –4.5V, I_D = –100 mA
		—	19	25	Ω	V_{GS} = –10V, I_D = –100 mA
Change in $R_{DS(ON)}$ with Temperature	$\Delta R_{DS(ON)}$	—	—	0.75	%/°C	V_{GS} = –10V, I_D = –100 mA (**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. Specification is obtained by characterization and is not 100% tested.						
Parameter	**Sym.**	**Min.**	**Typ.**	**Max.**	**Unit**	**Conditions**
Forward Transconductance	G_{FS}	100	175	—	mmho	V_{DS} = –25V, I_D = –100 mA
Input Capacitance	C_{ISS}	—	60	125	pF	V_{GS} = 0V, V_{DS} = –25V, f = 1 MHz
Common-Source Output Capacitance	C_{OSS}	—	20	70	pF	
Reverse Transfer Capacitance	C_{RSS}	—	10	25	pF	
Turn-On Delay Time	$t_{d(ON)}$	—	—	10	ns	V_{DD} = –25V, I_D = –0.4A, R_{GEN} = 25Ω
Rise Time	t_r	—	—	10	ns	
Turn-Off Delay Time	$t_{d(OFF)}$	—	—	20	ns	
Fall Time	t_f	—	—	13	ns	
DIODE PARAMETER						
Diode Forward Voltage Drop	V_{SD}	—	—	–1.8	V	V_{GS} = 0V, I_{SD} = –100 mA (**Note 1**)
Reverse Recovery Time	t_{rr}	—	300	—	ns	V_{GS} = 0V, I_{SD} = –100 mA

Note 1: Unless otherwise stated, all DC parameters are 100% tested at 25°C. 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	

THERMAL CHARACTERISTICS

Package	**I_D (Note 1) (Continuous) (mA)**	**I_D (Pulsed) (mA)**	**Power Dissipation at T_A = 25°C (W)**	**I_{DR} (Note 1) (mA)**	**I_{DRM} (mA)**
3-lead TO-92	–86	–600	0.74	–86	–600

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

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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.

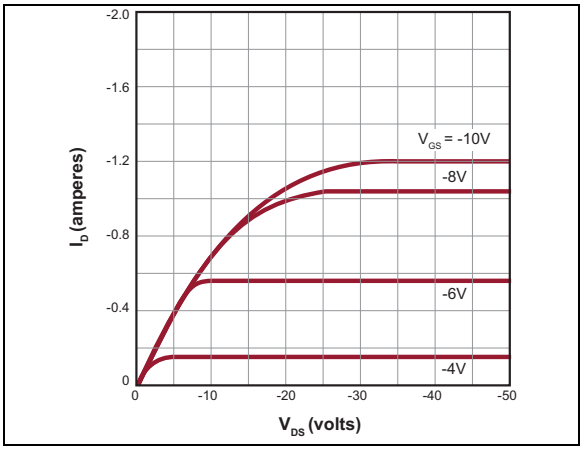


FIGURE 2-1: *Output Characteristics.*

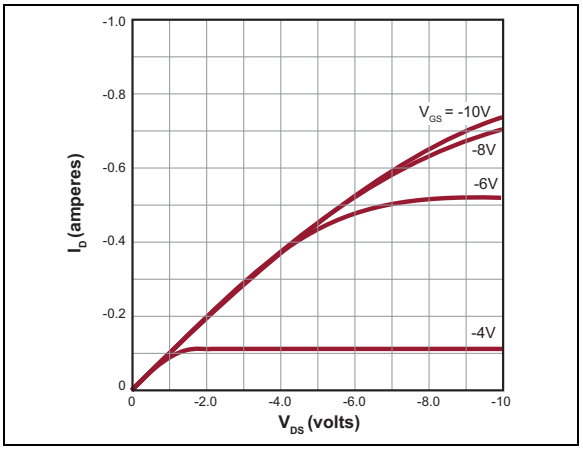


FIGURE 2-4: *Saturation Characteristics.*

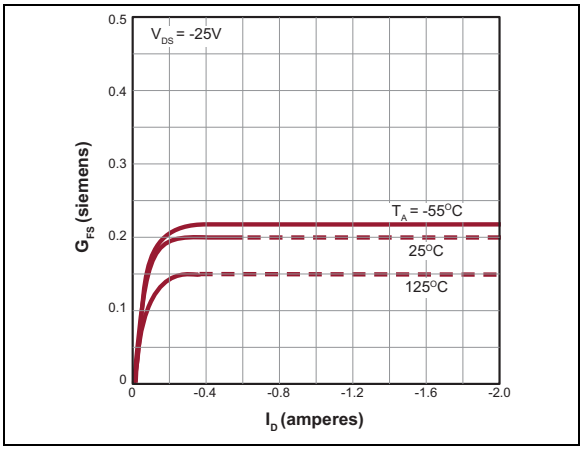


FIGURE 2-2: *Transconductance vs. Drain Current.*

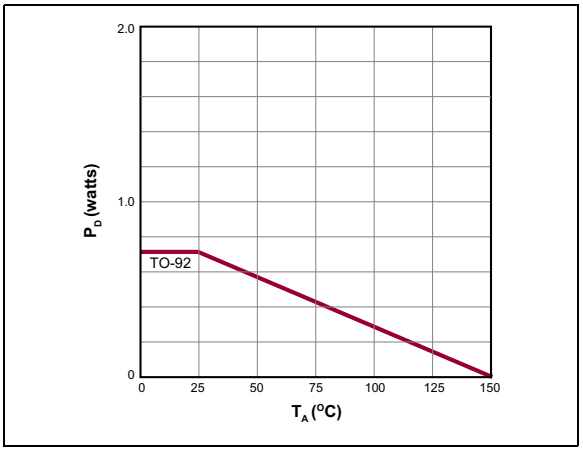


FIGURE 2-5: *Power Dissipation vs. Ambient Temperature.*

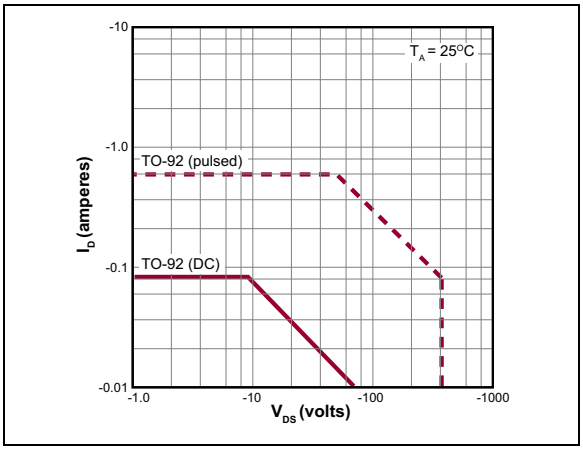


FIGURE 2-3: *Maximum Rated Safe Operating Area.*

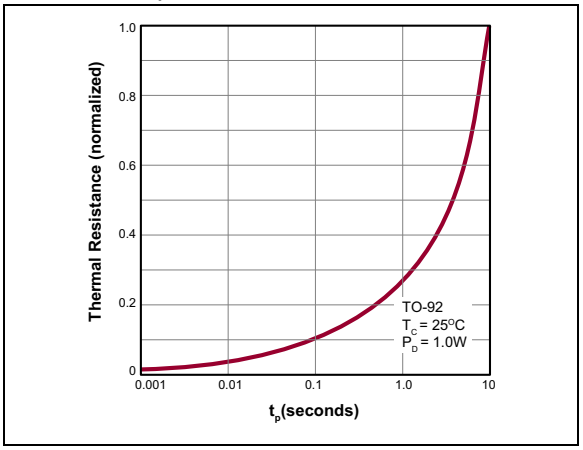


FIGURE 2-6: *Thermal Response Characteristics.*

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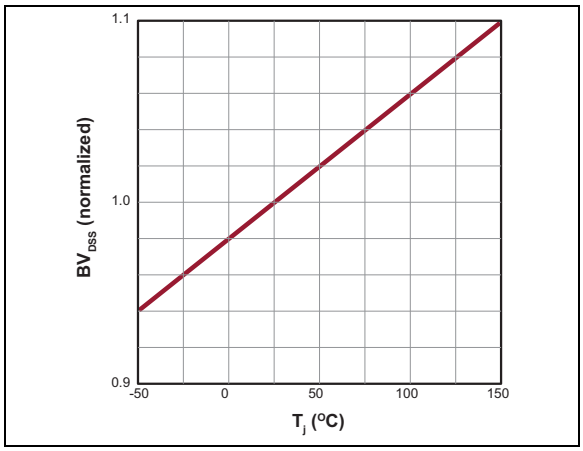


FIGURE 2-7: *BV_{DSS} Variation with Temperature.*

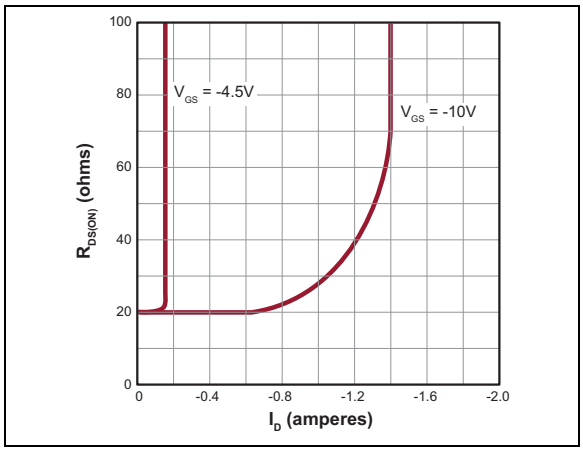


FIGURE 2-10: *On-Resistance vs. Drain Current.*

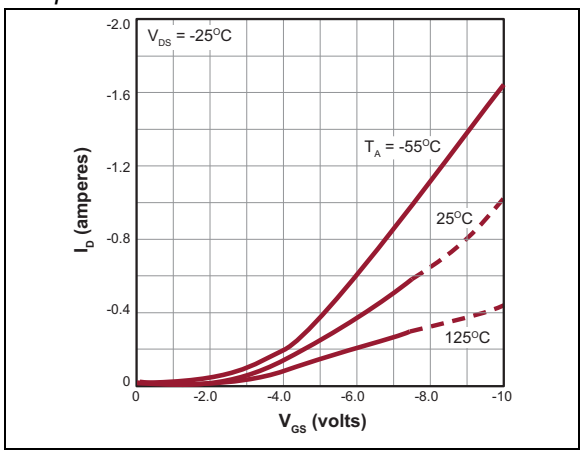


FIGURE 2-8: *Transfer Characteristics.*

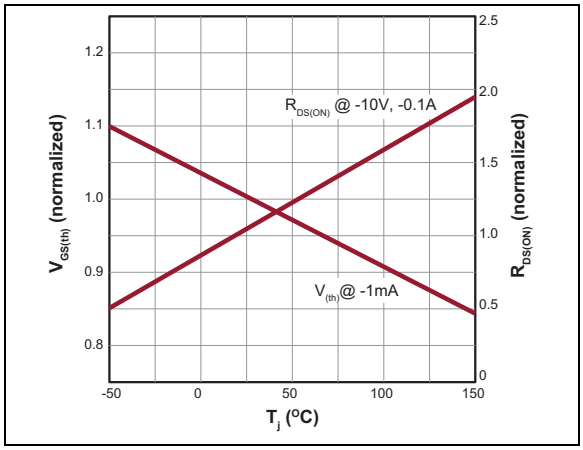


FIGURE 2-11: *$V_{(th)}$ and R_{DS} Variation with Temperature.*

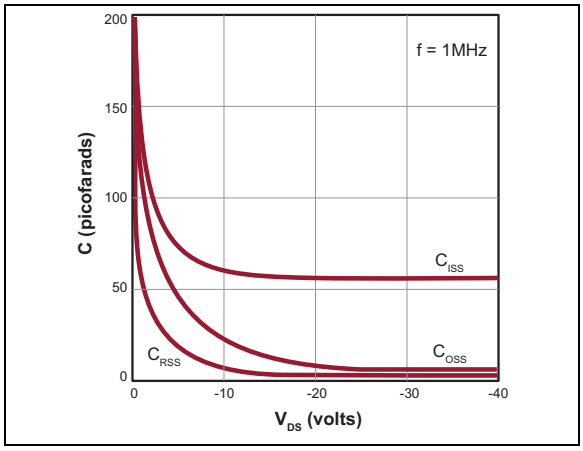


FIGURE 2-9: *Capacitance vs. Drain-to-Source Voltage.*

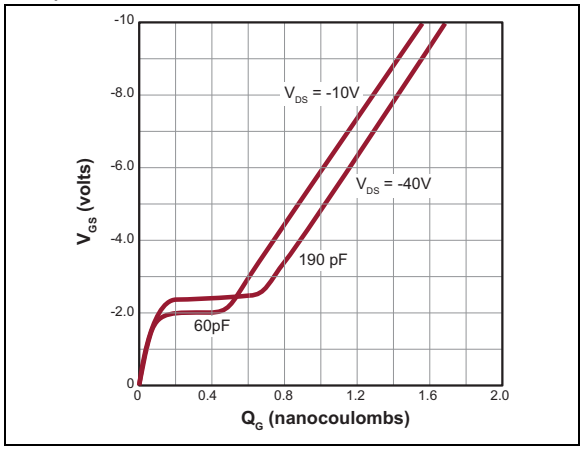


FIGURE 2-12: *Gate Drive Dynamic Characteristics.*

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3.0 PIN DESCRIPTION

The details on the pins of TP2535 TO-92 package are listed in Table 3-1. Refer to **Package Type** 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

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4.0 FUNCTIONAL DESCRIPTION

Figure 4-1 illustrates the switching waveforms and test circuit for the TP2535.

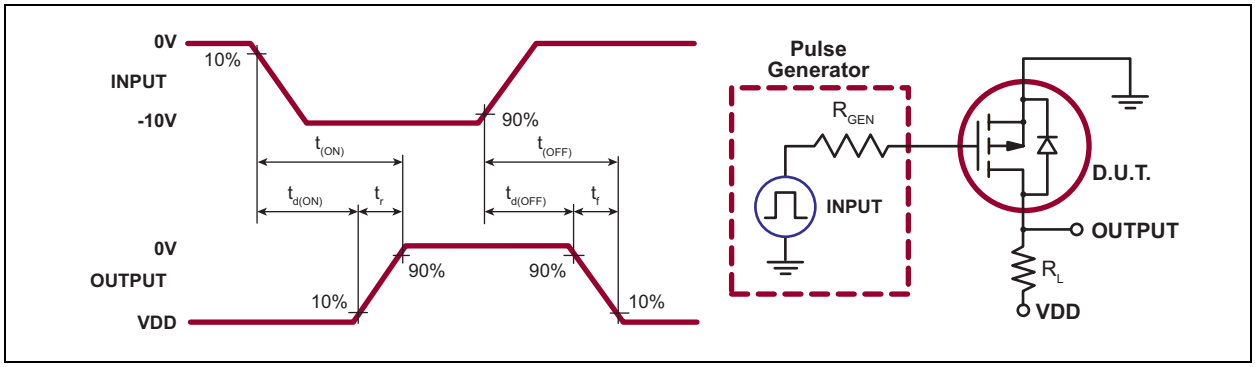


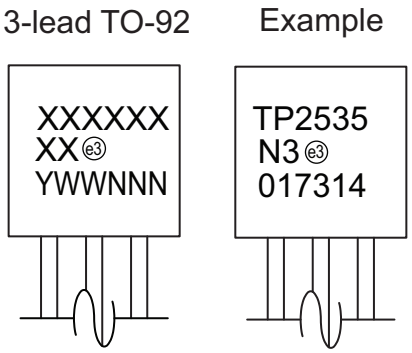
FIGURE 4-1: *Switching Waveforms and Test Circuit.*

TABLE 4-1: PRODUCT SUMMARY

BV_{DSS}/BV_{DGS} (V)	$R_{DS(ON)}$ (Maximum) (Ω)	$V_{GS(TH)}$ (Maximum) (V)	$I_{D(ON)}$ (Minimum) (A)
–350	25	–0.4	–2.4

5.0 PACKAGE MARKING INFORMATION

5.1 Package Marking Information

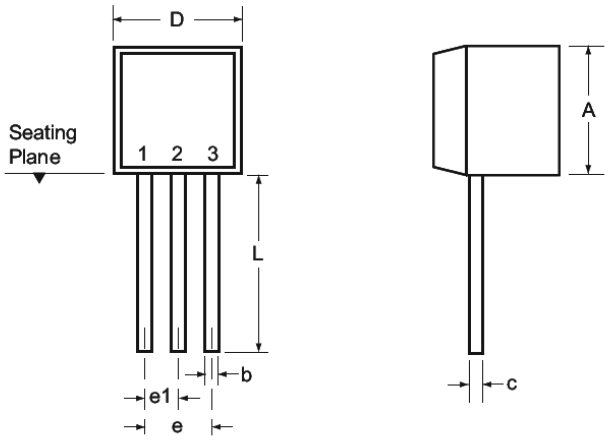


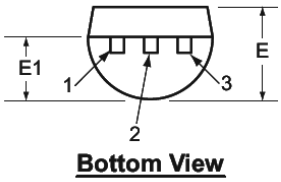
Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package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

NOTES:

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APPENDIX A: REVISION HISTORY

Revision A (June 2020)

- Converted Supertex Doc# DSFP-TP2535 to Microchip DS20005971A
- Added a pin function table
- Changed the package marking format
- Removed the 3-Lead TO-92 N3 P003, P005, P013, and P014 media types
- 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:	TP2535	=	P-Channel Enhancement-Mode Vertical DMOS FET
Package:	N3	=	3-lead TO-92
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank)	=	1000/Bag for an N3 Package

Example:

a) TP2535N3-G:	P-Channel Enhancement-Mode, Vertical DMOS FET, 3-lead TO-92, 1000/Bag

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ISBN:978-1-5224-6257-6

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