



# N-Channel Depletion-Mode Vertical DMOS FETs

#### Features

- High input impedance
- Low input capacitance
- Fast switching speeds
- Low on-resistance
- Free from secondary breakdown
- Low input and output leakage

### Applications

- Normally-on switches
- Solid state relays
- Converters
- Linear amplifiers
- Constant current sources

Ordering Information

- Power supply circuits
- Telecom

## General Description

The Supertex DN3135 is a low threshold depletion-mode (normally-on) transistor utilizing an advanced vertical DMOS structure and Supertex's well-proven silicon-gate manufacturing process. This combination produces a device with the power handling capabilities of bipolar transistors and with 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.

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

Device	Package	Options	BV <sub>DSX</sub> /BV <sub>DGX</sub>	R <sub>DS(ON)</sub>	DSS
Device	TO-236AB (SOT-23)	TO-243AA (SOT-89)	(V)	(max) (Ω)	(min) (mA)
DN3135	DN3135K1-G	DN3135N8-G	350	35	180

-G indicates package is RoHS compliant ('Green')



#### **Absolute Maximum Ratings**

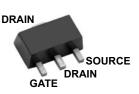
Parameter	Value
Drain-to-source voltage	BV <sub>DSX</sub>
Drain-to-gate voltage	BV <sub>DGX</sub>
Gate-to-source voltage	±20V
Operating and storage temperature	-55°C to +150°C
Soldering temperature*	300°C

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. Continuous operation of the device at the absolute rating level may affect device reliability. All voltages are referenced to device ground.

\* Distance of 1.6mm from case for 10 seconds.

### Pin Configurations





TO-243AA (SOT-89) (N8)

### Product Marking



W = Code for week sealed = "Green" Packaging

Package may or may not include the following marks: Si or 👘

TO-236AB (SOT-23) (K1)

W = Code for week sealed

DN1SW = "Green" Packaging

Package may or may not include the following marks: Si or 🕼

TO-243AA (SOT-89) (N8)

## **Thermal Characteristics**

Package	Ι <sub>D</sub> (continuous) <sup>†</sup> (mA)	l <sub>D</sub> (pulsed) (mA)	Power Dissipation @T <sub>A</sub> = 25°C (W)	θ <sub>jc</sub> (°C/W)	<b>θ</b> <sub>ja</sub> (°C/W)	l <sub>DR</sub> † (mA)	l <sub>DRM</sub> (mA)
TO-236AB	72	300	0.36	200	350	72	300
TO-243AA	135	300	1.3 <sup>‡</sup>	34	97 <sup>‡</sup>	135	300

Notes:

*†*  $I_{D}$  (continuous) is limited by max rated  $T_{r}$ 

# Mounted on FR4 board, 25mm x 25mmx 1.57mm.

#### Electrical Characteristics (T<sub>A</sub> = 25°C unless otherwise specified)

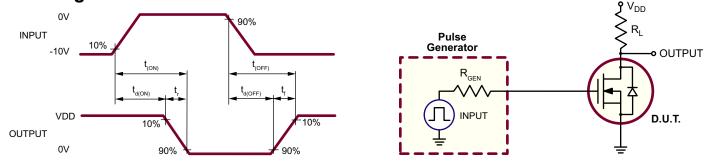
SymParameterMinTypMaxUnitsConditions $BV_{DSX}$ Drain-to-source breakdown voltage350V $V_{GS} = -5.0V, I_p = 100\muA$ $V_{GS(OFF)}$ Gate-to-source off voltage-1.53.5V $V_{DS} = 15V, I_p = 10\muA$ $\Delta V_{GS(OFF)}$ Change in $V_{GS(OFF)}$ with temperature4.5mV/°C $V_{DS} = 15V, I_p = 10\muA$ $I_{GSS}$ Gate body leakage current4.5mV/°C $V_{DS} = 15V, I_p = 10\muA$ $I_{GSS}$ Gate body leakage current100nA $V_{GS} = \pm 20V, V_{DS} = 0V$ $I_{D(OFF)}$ Drain-to-source leakage current1.0 $\mu A$ $V_{DS} = 0.8$ Max rating, $V_{GS} = -5.0V$ $I_{D(OFF)}$ Drain-to-source current180mA $V_{GS} = 0.V, I_D = 150^{-1}$ $I_{D(OFF)}$ Saturated drain-to-source current180mA $V_{GS} = 0.V, I_D = 150^{-1}$ $R_{DS(ON)}$ Static drain-to-source on-state resistance-355 $\Omega$ $\Omega$ $V_{GS} = 0.V, I_D = 150^{-1}$ $G_{FS}$ Forward transconductance140mmho $V_{GS} = 5.0V, V_{DS} = 15^{-1}$ $G_{SS}$ Input capacitance-600120 $V_{GS} = 5.0V, V_{DS} = 150^{-1}$ $G_{SS}$ Input capacitance-6.0155 $V_{SS} = 25V, I_{S} = 150^{-1}$ $C_{GSS}$ Reverse transfer capacitance-100 $V_{GS} = -5.0V, V_{S} = 25V, I_{S} = 150^{-1}$ <th>LIECUI</th> <th></th> <th>ounci wise</th> <th>specifica)</th> <th>1</th> <th></th> <th></th>	LIECUI		ounci wise	specifica)	1		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Sym	Parameter	Min	Тур	Max	Units	Conditions
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	BV <sub>DSX</sub>	Drain-to-source breakdown voltage	350	-	-	V	V <sub>GS</sub> = -5.0V, I <sub>D</sub> = 100µA
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	V <sub>GS(OFF)</sub>	Gate-to-source off voltage	-1.5	-	-3.5	V	$V_{\rm DS}$ = 15V, $I_{\rm D}$ = 10 $\mu$ A
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Change in $V_{GS(OFF)}$ with temperature	-	-	-4.5	mV/ºC	V <sub>DS</sub> = 15V, Ι <sub>D</sub> = 10μΑ
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		Gate body leakage current	-	-	100	nA	$V_{GS} = \pm 20V, V_{DS} = 0V$
$ \begin{array}{ c c c c c c } \hline I & I & I & I & I & I & I & V_{GS}^{*} = -5.0V, T_{A} = 125^{\circ}C \\ \hline I_{DSS} & Saturated drain-to-source current & 180 & - & - & mA & V_{GS} = 0V, V_{DS} = 15V \\ \hline R_{DS(ON)} & Static drain-to-source on-state resistance & - & - & 35 & \Omega & V_{GS} = 0V, I_{D} = 150mA \\ \hline \Delta R_{DS(ON)} & Change in R_{DS(ON)} with temperature & - & - & 1.1 & \%/^{\circ}C & V_{GS} = 0V, I_{D} = 150mA \\ \hline \Delta R_{DS(ON)} & Change in R_{DS(ON)} with temperature & - & - & 1.1 & \%/^{\circ}C & V_{GS} = 0V, I_{D} = 150mA \\ \hline \Delta R_{DS(ON)} & Change in R_{DS(ON)} with temperature & - & - & 1.1 & \%/^{\circ}C & V_{GS} = 0V, I_{D} = 150mA \\ \hline \Delta R_{DS(ON)} & Change in R_{DS(ON)} with temperature & - & - & 1.1 & \%/^{\circ}C & V_{GS} = 0V, I_{D} = 100mA \\ \hline \Delta R_{DS(ON)} & Change in R_{DS(ON)} with temperature & - & - & 1.1 & \%/^{\circ}C & V_{GS} = 0V, I_{D} = 100mA \\ \hline \Delta R_{DS(ON)} & Change in R_{DS(ON)} with temperature & - & - & 600 & 120 \\ \hline C_{CSS} & Forward transconductance & - & 600 & 150 \\ \hline C_{CSS} & Common source output capacitance & - & 6.0 & 15 \\ \hline C_{RSS} & Reverse transfer capacitance & - & 3.0 & 10 \\ \hline t_{d(ON)} & Turn-on delay time & - & - & 100 \\ \hline t_{d(OFF)} & Turn-off delay time & - & - & 155 \\ \hline t_{d(OFF)} & Turn-off delay time & - & - & 155 \\ \hline t_{d(OFF)} & Turn-off delay time & - & - & 155 \\ \hline t_{d(OFF)} & Turn-off delay time & - & - & 20 \\ \hline V_{SD} & Diode forward voltage drop & - & - & 1.8 & V & V_{GS} = -5.0V, I_{SD} = 150mA \\ \hline \end{array}$			-	-	1.0	μA	$V_{\rm DS}$ = Max rating, $V_{\rm GS}$ = -5.0V
$ \begin{array}{ c c c c c c } \hline P_{DSS} & Static drain-to-source on-state resistance & - & - & 35 & \Omega & V_{GS} = 0 V, I_{D} = 150 mA \\ \hline & & & & & & & & & & & \\ \hline & & & & &$	I <sub>D(OFF)</sub>	Drain-to-source leakage current	-	-	1.0	mA	$V_{DS} = 0.8$ Max Rating, $V_{GS} = -5.0V$ , $T_{A} = 125^{\circ}C$
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	I <sub>DSS</sub>	Saturated drain-to-source current	180	-	-	mA	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 15V
$ \begin{array}{ c c c c c } \hline G_{FS} & Forward transconductance & 140 & - & - & mmho & V_{DS} = 10V, I_D = 100mA \\ \hline C_{ISS} & Input capacitance & - & 60 & 120 \\ \hline C_{OSS} & Common source output capacitance & - & 6.0 & 15 \\ \hline C_{RSS} & Reverse transfer capacitance & - & 3.0 & 10 \\ \hline t_{d(ON)} & Turn-on delay time & - & - & 10 \\ \hline t_r & Rise time & - & - & 15 \\ \hline t_r & Rise time & - & - & 15 \\ \hline t_f & Fall time & - & - & 15 \\ \hline t_f & Fall time & - & - & 20 \\ \hline V_{SD} & Diode forward voltage drop & - & - & 1.8 & V & V_{GS} = -5.0V, I_{SD} = 150mA \\ \hline \end{array} $	R <sub>DS(ON)</sub>		-	-	35	Ω	V <sub>GS</sub> = 0V, I <sub>D</sub> = 150mA
$ \begin{array}{ c c c c c } \hline G_{FS} & Forward transconductance & 140 & - & - & mmho & V_{DS} = 10V, I_D = 100mA \\ \hline C_{ISS} & Input capacitance & - & 60 & 120 \\ \hline C_{OSS} & Common source output capacitance & - & 6.0 & 15 \\ \hline C_{RSS} & Reverse transfer capacitance & - & 3.0 & 10 \\ \hline t_{d(ON)} & Turn-on delay time & - & - & 10 \\ \hline t_r & Rise time & - & - & 15 \\ \hline t_r & Rise time & - & - & 15 \\ \hline t_f & Fall time & - & - & 15 \\ \hline t_f & Fall time & - & - & 20 \\ \hline V_{SD} & Diode forward voltage drop & - & - & 1.8 & V & V_{GS} = -5.0V, I_{SD} = 150mA \\ \hline \end{array} $	$\Delta R_{DS(ON)}$	Change in R <sub>DS(ON)</sub> with temperature	-	-	1.1	%/°C	V <sub>GS</sub> = 0V, I <sub>D</sub> = 150mA
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Forward transconductance	140	-	-	mmho	V <sub>DS</sub> = 10V, I <sub>D</sub> = 100mA
	C <sub>ISS</sub>	Input capacitance	-	60	120		$V_{cc} = -5.0V,$
$C_{RSS}$ Reverse transfer capacitationImage: State of the sector	C <sub>oss</sub>			6.0	15	pF	$V_{DS}^{0} = 25V,$
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	C <sub>RSS</sub>	Reverse transfer capacitance	-	3.0	10		f = 1.0MHz
t d(OFF)Rise time15ID IDID IDID 		Turn-on delay time	-	-	10		V = 25V
$t_{d(OFF)}$ Turn-off delay time15 $R_{GEN} = 25\Omega, V_{GS} = 0 \times to -10V$ $t_{f}$ Fall time-20 $V_{GS} = 0 \times to -10V$ $V_{SD}$ Diode forward voltage drop-1.8V $V_{GS} = -5.0V, I_{SD} = 150$ mA		Rise time	-	-	15	ne	$I_{\rm D} = 150 {\rm mA},$
$t_{f}$ Fall time20 $v_{GS}$ 0.00000000000000000000000000000000000	t <sub>d(OFF)</sub>	Turn-off delay time	-	-	15	115	Ř <sub>GEN</sub> = 25Ω,
$V_{sD}$ Diode forward voltage drop1.8V $V_{gS}$ = -5.0V, $I_{sD}$ = 150mA $t_{rr}$ Reverse recovery time-800-ns $V_{gS}$ = -5.0V, $I_{sD}$ = 150mA	t <sub>r</sub>	Fall time	-	-	20		$V_{GS} = 0v \text{ to } -10V$
$t_{rr}$ Reverse recovery time - 800 - ns $V_{GS}$ = -5.0V, $I_{SD}$ = 150mA	V <sub>SD</sub>	Diode forward voltage drop	-	-	1.8	V	V <sub>GS</sub> = -5.0V, I <sub>SD</sub> = 150mA
	t <sub>rr</sub>	Reverse recovery time	-	800	-	ns	V <sub>GS</sub> = -5.0V, I <sub>SD</sub> = 150mA

Notes:

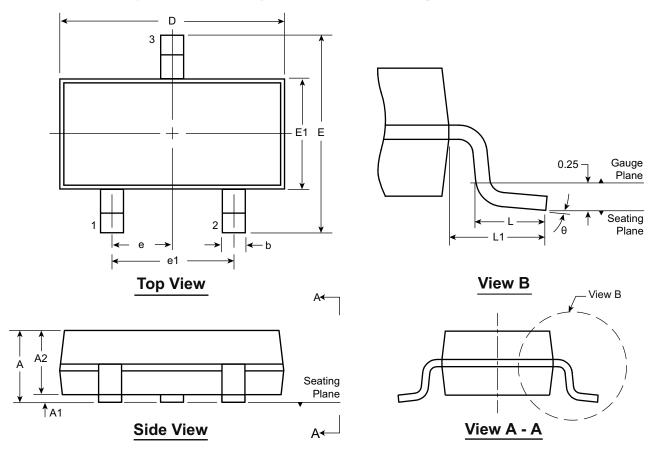
1. All D.C. parameters 100% tested at 25°C unless otherwise stated. (Pulse test: 300µs pulse, 2% duty cycle.)

2. All A.C. parameters sample tested.

### **Switching Waveforms and Test Circuit**



## 3-Lead TO-236AB (SOT-23) Package Outline (K1) 2.90x1.30mm body, 1.12mm height (max), 1.90mm pitch



Symb	ol	Α	A1	A2	b	D	E	E1	е	e1	L	L1	θ
Dimension	MIN	0.89	0.01	0.88	0.30	2.80	2.10	1.20	0.05	1.00	0.20†	0.54	<b>0</b> 0
Dimension (mm)	NOM	-	-	0.95	-	2.90	-	1.30	0.95 BSC	1.90 BSC	0.50	0.54 REF	-
	MAX	1.12	0.10	1.02	0.50	3.04	2.64	1.40	000	DOO	0.60		<b>8</b> 0

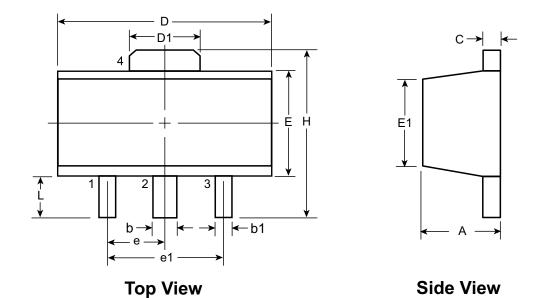
JEDEC Registration TO-236, Variation AB, Issue H, Jan. 1999.

† This dimension differs from the JEDEC drawing.

Drawings not to scale.

Supertex Doc.#: DSPD-3TO236ABK1, Version C041309.

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



Symbo	bl	Α	b	b1	С	D	D1	Е	E1	е	e1	н	L
	MIN	1.40	0.44	0.36	0.35	4.40	1.62	2.29	2.00†			3.94	0.89
Dimensions (mm)	NOM	-	-	-	-	-	-	-	-	1.50 3.00 BSC BSC	3.00 BSC	-	-
	MAX	1.60	0.56	0.48	0.44	4.60	1.83	2.60	2.29	200	200	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.

Supertex Doc. #: DSPD-3TO243AAN8, Version E051509.

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to <u>http://www.supertex.com/packaging.html</u>.)

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