

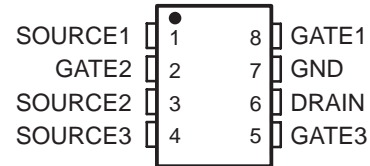
# TPIC3302

## 3-CHANNEL COMMON-DRAIN POWER DMOS ARRAY

SLIS021B – APRIL 1994 – REVISED JULY 1995

- Low  $r_{DS(on)}$  . . . 0.4  $\Omega$  Typ
- High-Voltage Outputs . . . 60 V
- Pulsed Current . . . 5 A Per Channel
- Fast Commutation Speed

D PACKAGE  
(TOP VIEW)

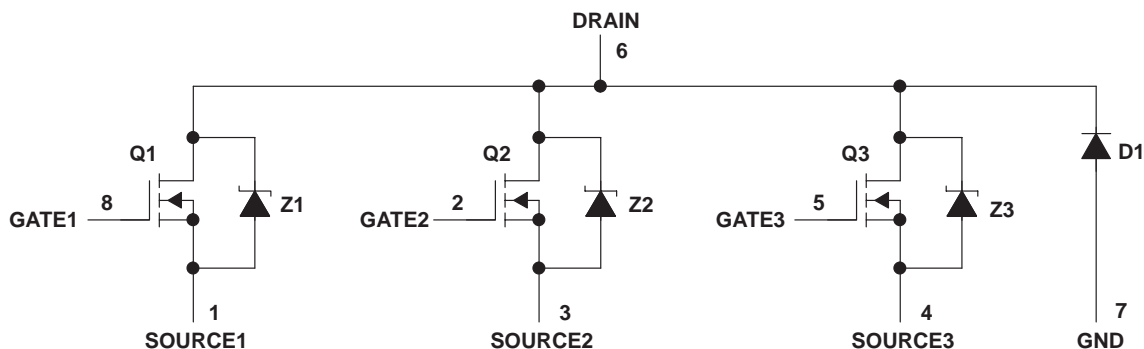


### description

The TPIC3302 is a monolithic power DMOS array that consists of three electrically isolated N-channel enhancement-mode DMOS transistors configured with a common drain and open sources. The TPIC3302 is offered in a standard eight-pin small-outline surface-mount (D) package.

The TPIC3302 is characterized for operation over the case temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

### schematic



### absolute maximum ratings over operating case temperature range (unless otherwise noted)<sup>†</sup>

Drain-to-source voltage, $V_{DS}$ .....	60 V
Source-to-GND voltage .....	100 V
Drain-to-GND voltage .....	100 V
Gate-to-source voltage, $V_{GS}$ .....	$\pm 20$ V
Continuous drain current, each output, all outputs on, $T_C = 25^{\circ}\text{C}$ .....	1 A
Continuous source-to-drain diode current .....	1 A
Pulsed drain current, each output, $T_C = 25^{\circ}\text{C}$ (see Note 1 and Figure 6) .....	5 A
Single-pulse avalanche energy, $T_C = 25^{\circ}\text{C}$ , $E_{AS}$ (see Figure 4) .....	9 mJ
Continuous total power dissipation at (or below) $T_C = 25^{\circ}\text{C}$ .....	0.95 W
Operating virtual junction temperature range, $T_J$ .....	$-40^{\circ}\text{C}$ to $150^{\circ}\text{C}$
Operating case temperature range, $T_C$ .....	$-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$
Storage temperature range, $T_{stg}$ .....	$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds .....	$260^{\circ}\text{C}$

<sup>†</sup> Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: Pulse duration = 10 ms, duty cycle = 2%

# TPIC3302

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SLIS021B – APRIL 1994 – REVISED JULY 1995

### electrical characteristics, $T_C = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)DSX}$	Drain-to-source breakdown voltage	$I_D = 250\ \mu\text{A}$ ,	$V_{GS} = 0$	60			V
$V_{GS(th)}$	Gate-to-source threshold voltage	$I_D = 1\ \text{mA}$ ,	$V_{DS} = V_{GS}$	1.5	1.85	2.2	V
$V_{(BR)}$	Reverse drain-to-GND breakdown voltage (across D1)	Drain-to-GND current = $250\ \mu\text{A}$		100			V
$V_{DS(on)}$	Drain-to-source on-state voltage	$I_D = 1\ \text{A}$ , See Notes 2 and 3	$V_{GS} = 10\ \text{V}$ ,		0.4	0.475	V
$V_F$	Forward on-state voltage, GND-to-drain	$I_D = 1\ \text{A}$ , See Notes 2 and 3			2		V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	$I_S = 1\ \text{A}$ , See Notes 2 and 3	$V_{GS} = 0$ ,		0.9	1.1	V
$I_{DSS}$	Zero-gate-voltage drain current	$V_{DS} = 48\ \text{V}$ , $V_{GS} = 0$	$T_C = 25^\circ\text{C}$		0.05	1	$\mu\text{A}$
			$T_C = 125^\circ\text{C}$		0.5	10	
$I_{GSSF}$	Forward gate current, drain short circuited to source	$V_{GS} = 16\ \text{V}$ ,	$V_{DS} = 0$		10	100	nA
$I_{GSSR}$	Reverse gate current, drain short circuited to source	$V_{SG} = 16\ \text{V}$ ,	$V_{DS} = 0$		10	100	nA
$I_{lkg}$	Leakage current, drain-to-GND	$V_R = 48\ \text{V}$	$T_C = 25^\circ\text{C}$		0.05	1	$\mu\text{A}$
			$T_C = 125^\circ\text{C}$		0.5	10	
$r_{DS(on)}$	Static drain-to-source on-state resistance	$V_{GS} = 10\ \text{V}$ , $I_D = 1\ \text{A}$ , See Notes 2 and 3 and Figures 6 and 7	$T_C = 25^\circ\text{C}$		0.4	0.475	$\Omega$
			$T_C = 125^\circ\text{C}$		0.63	0.7	
$g_{fs}$	Forward transconductance	$V_{DS} = 10\ \text{V}$ , See Notes 2 and 3	$I_D = 0.5\ \text{A}$ ,	0.85	1.02		S
$C_{iss}$	Short-circuit input capacitance, common source	$V_{DS} = 25\ \text{V}$ , $f = 1\ \text{MHz}$	$V_{GS} = 0$ ,		115	145	pF
$C_{oss}$	Short-circuit output capacitance, common source				60	75	
$C_{rss}$	Short-circuit reverse-transfer capacitance, common source				30	40	

- NOTES: 2. Technique should limit  $T_J - T_C$  to  $10^\circ\text{C}$  maximum, pulse duration  $\leq 5\ \text{ms}$ .  
3. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

### source-to-drain diode characteristics, $T_C = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{rr(SD)}$	Reverse-recovery time	$I_S = 0.5\ \text{A}$ ,	$V_{GS} = 0$ , $V_{DS} = 48\ \text{V}$ ,		35		ns
$Q_{RR}$	Total diode charge	$di/dt = 100\ \text{A}/\mu\text{s}$ ,	See Figure 1		0.03		$\mu\text{C}$

### GND-to-drain diode characteristics, $T_C = 25^\circ\text{C}$ (see schematic, D1)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{rr}$	Reverse-recovery time	$I_F = 0.5\ \text{A}$ ,	$V_{DS} = 48\ \text{V}$ ,		90		ns
$Q_{RR}$	Total diode charge	$di/dt = 100\ \text{A}/\mu\text{s}$ ,	See Figure 1		0.2		$\mu\text{C}$

# TPIC3302

## 3-CHANNEL COMMON-DRAIN POWER DMOS ARRAY

SLIS021B – APRIL 1994 – REVISED JULY 1995

### resistive-load switching characteristics, $T_C = 25^\circ\text{C}$

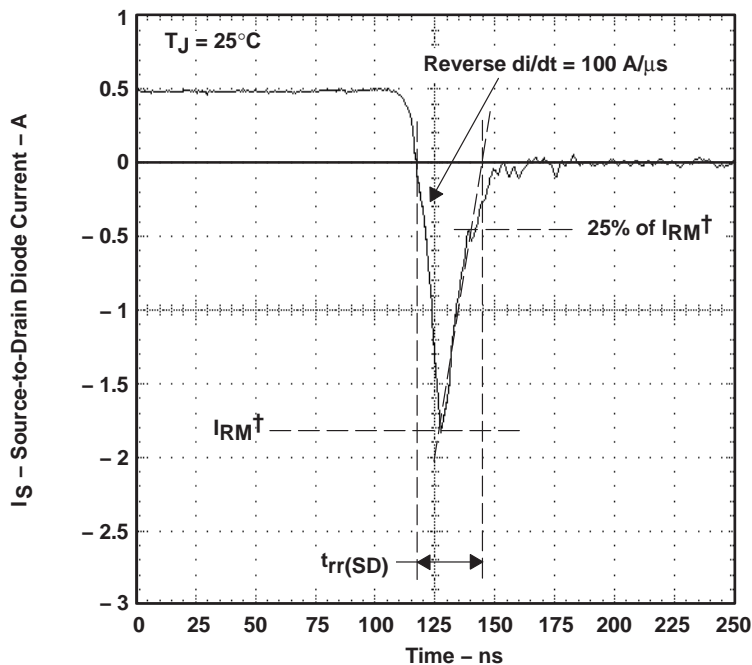
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(on)}$ Turn-on delay time	$V_{DD} = 25\text{ V}$ , $R_L = 50\ \Omega$ , $t_{en} = 10\text{ ns}$ , $t_{dis} = 10\text{ ns}$ , See Figure 2		21	42	ns
$t_{d(off)}$ Turn-off delay time			20	40	
$t_r$ Rise time			5	10	
$t_f$ Fall time			13	26	
$Q_g$ Total gate charge	$V_{DS} = 48\text{ V}$ , $I_D = 0.5\text{ A}$ , $V_{GS} = 10\text{ V}$ , See Figure 3		3.1	3.8	nC
$Q_{gs(th)}$ Threshold gate-to-source charge			0.4	0.5	
$Q_{gd}$ Gate-to-drain charge			1.3	1.6	
$L_D$ Internal drain inductance			5		nH
$L_S$ Internal source inductance			5		
$R_g$ Internal gate resistance			0.25		$\Omega$

### thermal resistance

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$R_{\theta JA}$ Junction-to-ambient thermal resistance	All outputs with equal power, See Note 4		130		$^\circ\text{C/W}$
$R_{\theta JP}$ Junction-to-pin thermal resistance			44		

NOTE 4: Package mounted on an FR4 printed-circuit board with no heat sink

### PARAMETER MEASUREMENT INFORMATION



$\dagger I_{RM}$  = maximum recovery current

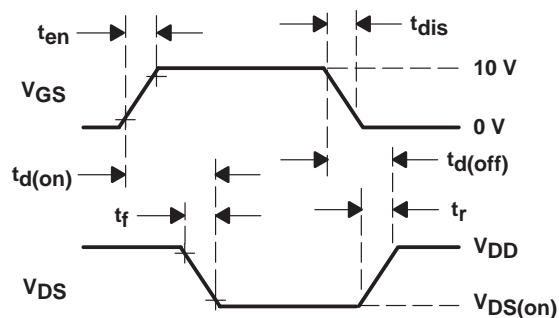
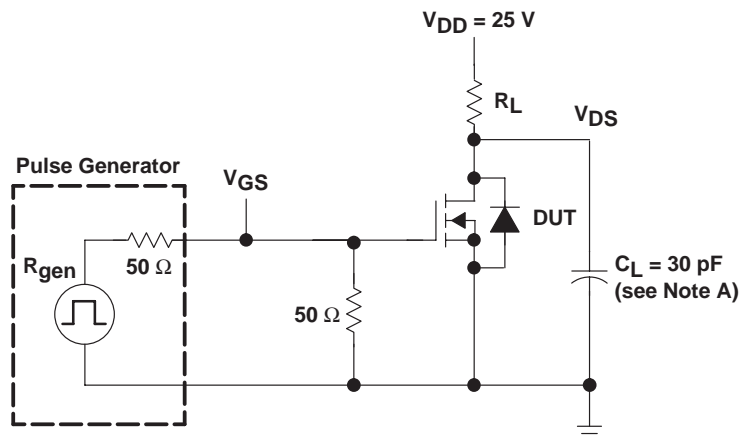
Figure 1. Reverse-Recovery-Current Waveform of Source-to-Drain Diode



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## PARAMETER MEASUREMENT INFORMATION

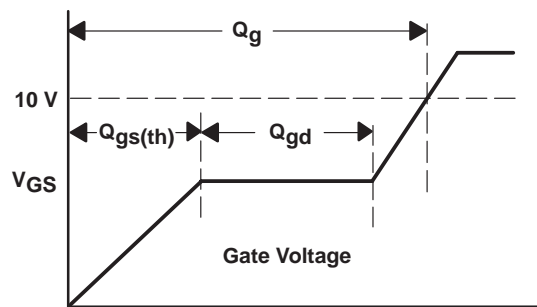
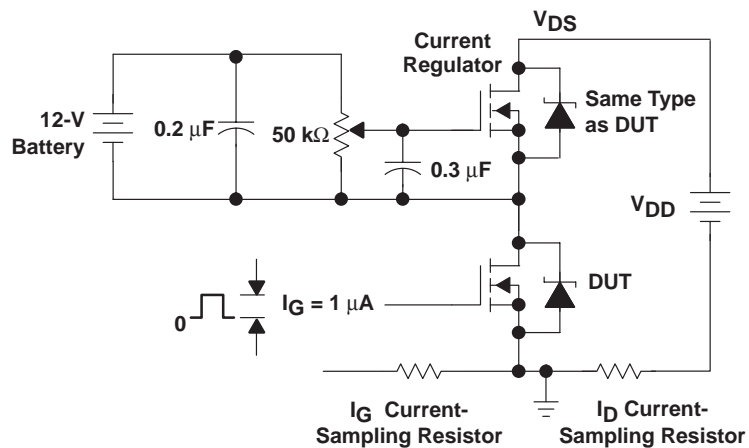


VOLTAGE WAVEFORMS

TEST CIRCUIT

NOTE A: C<sub>L</sub> includes probe and jig capacitance.

Figure 2. Resistive-Switching Test Circuit and Voltage Waveforms

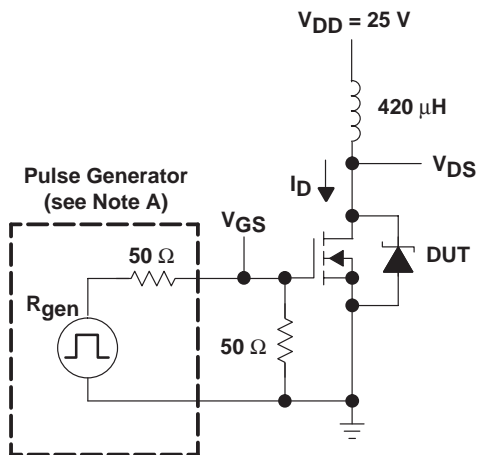


Q<sub>gs</sub> = Q<sub>g</sub> - Q<sub>gd</sub>  
VOLTAGE WAVEFORM

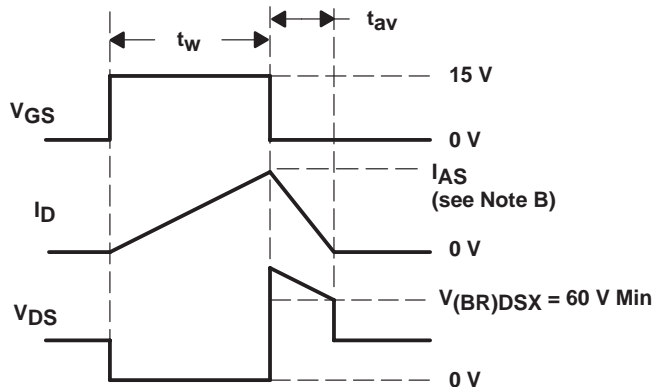
TEST CIRCUIT

Figure 3. Gate-Charge Test Circuit and Voltage Waveform

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

- NOTES: A. The pulse generator has the following characteristics:  $t_r \leq 10$  ns,  $t_f \leq 10$  ns,  $Z_O = 50 \Omega$ .  
B. Input pulse duration ( $t_w$ ) is increased until peak current  $I_{AS} = 5$  A.

$$\text{Energy test level is defined as } E_{AS} = \frac{I_{AS} \times V_{(BR)DSX} \times t_{av}}{2} = 9 \text{ mJ.}$$

Figure 4. Single-Pulse Avalanche-Energy Test Circuit and Waveforms

TYPICAL CHARACTERISTICS

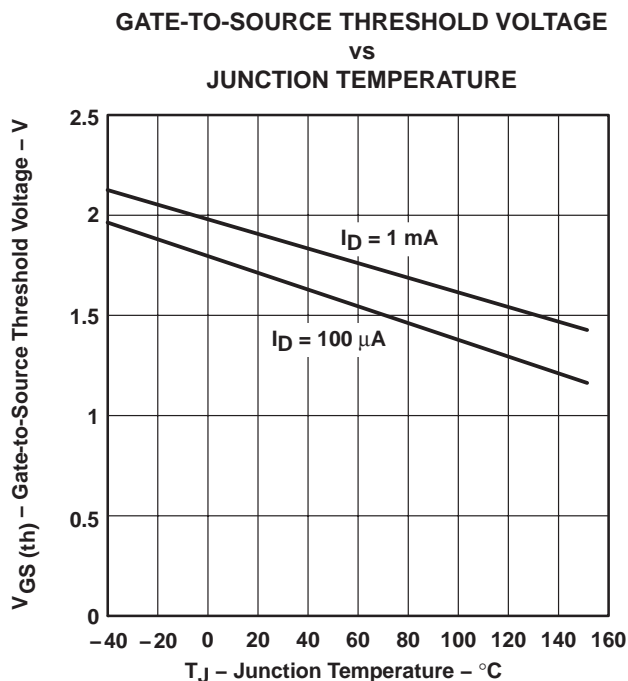


Figure 5

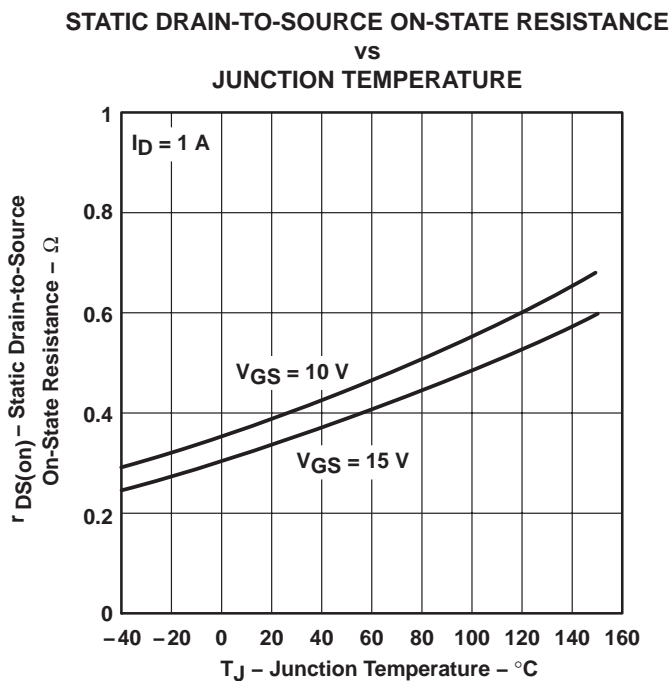


Figure 6

# TPIC3302 3-CHANNEL COMMON-DRAIN POWER DMOS ARRAY

SLIS021B – APRIL 1994 – REVISED JULY 1995

## TYPICAL CHARACTERISTICS

STATIC DRAIN-TO-SOURCE ON-STATE RESISTANCE  
vs  
DRAIN CURRENT

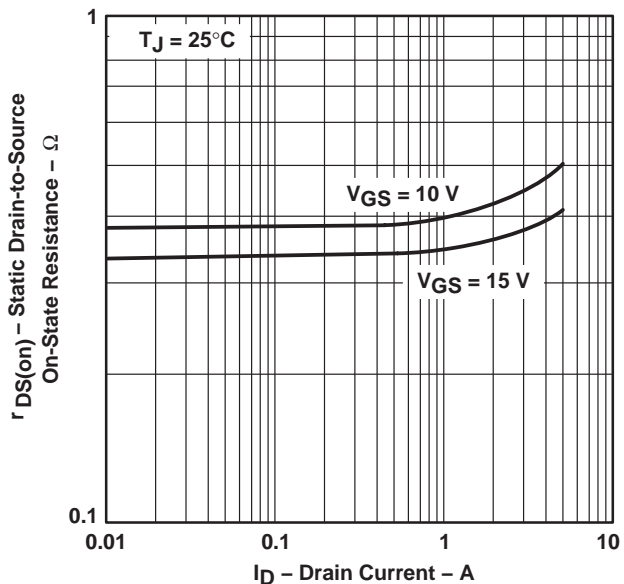


Figure 7

DRAIN CURRENT  
vs  
DRAIN-TO-SOURCE VOLTAGE

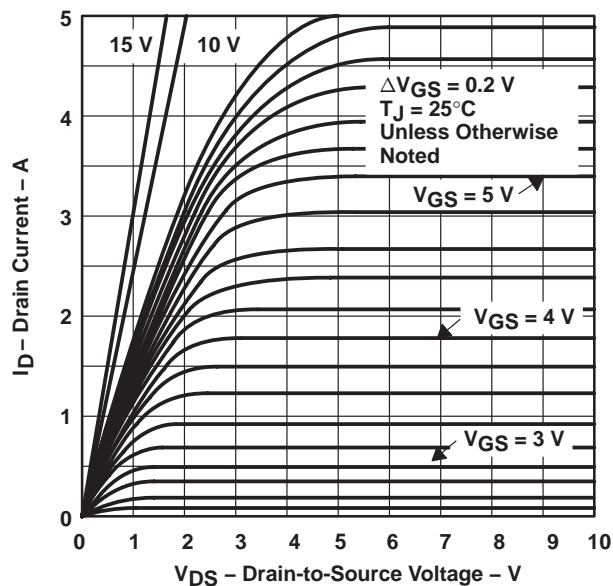


Figure 8

DISTRIBUTION OF  
FORWARD TRANSCONDUCTANCE

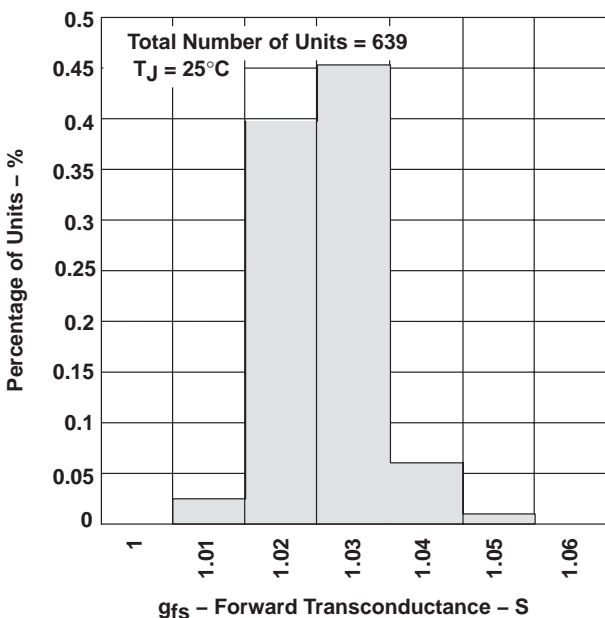


Figure 9

DRAIN CURRENT  
vs  
GATE-TO-SOURCE VOLTAGE

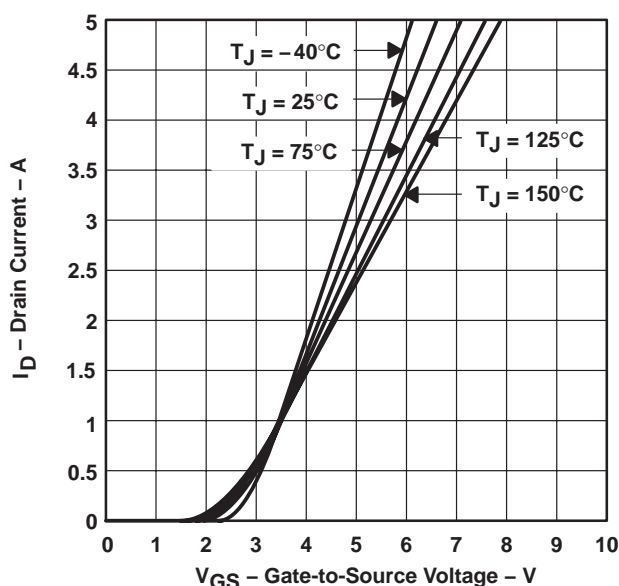
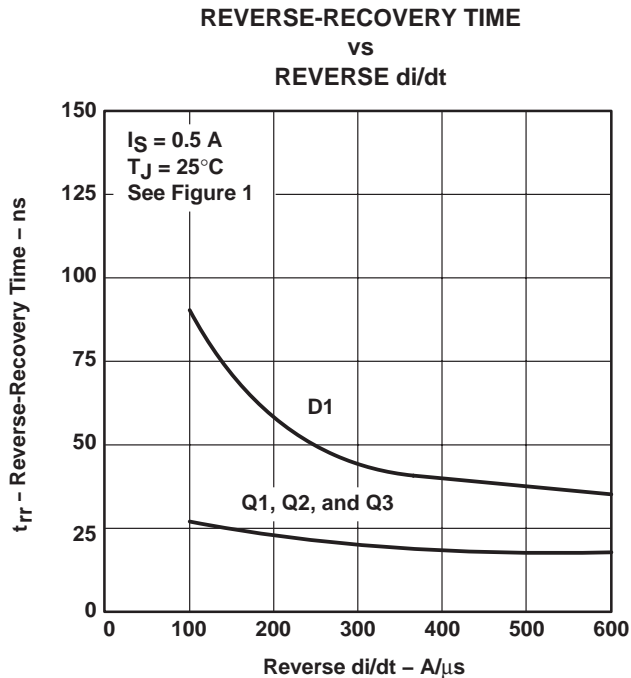
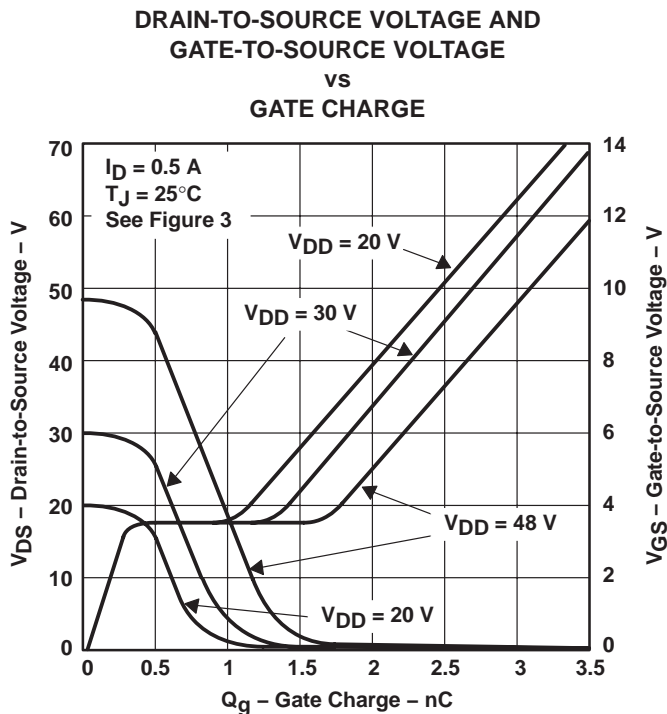
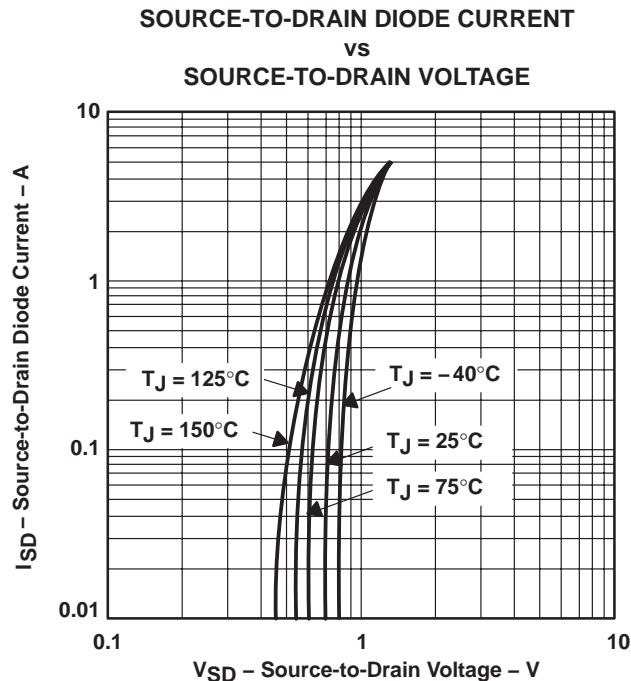
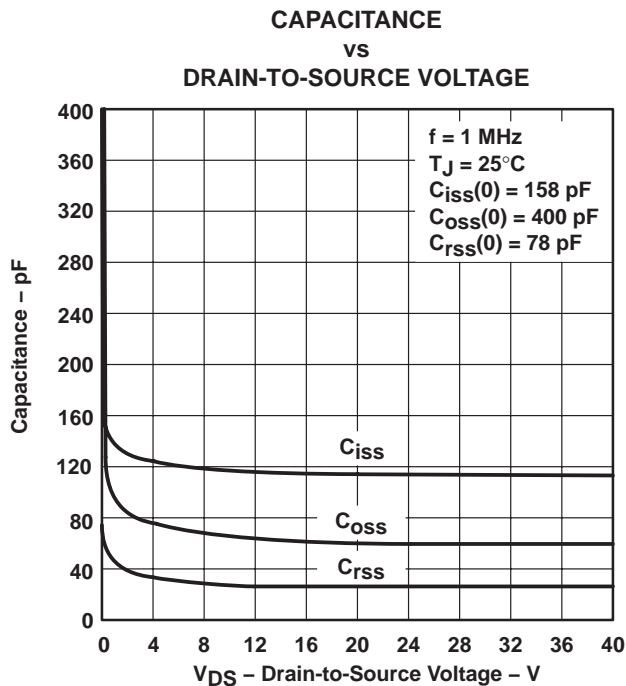


Figure 10

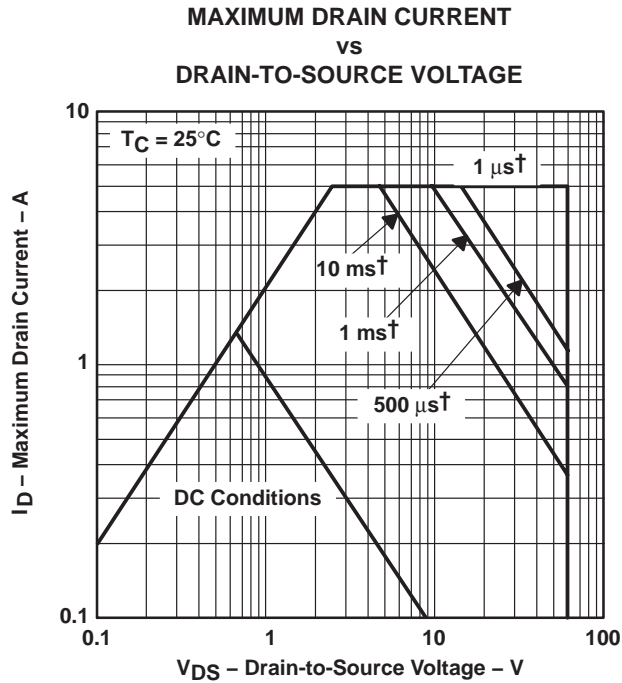
**TYPICAL CHARACTERISTICS**



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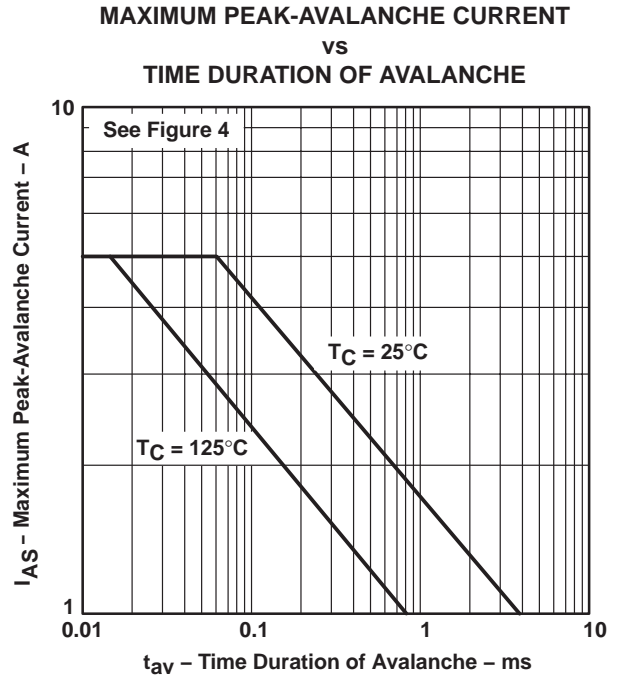
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## THERMAL INFORMATION



$^\dagger$  Less than 0.1 duty cycle

**Figure 15**

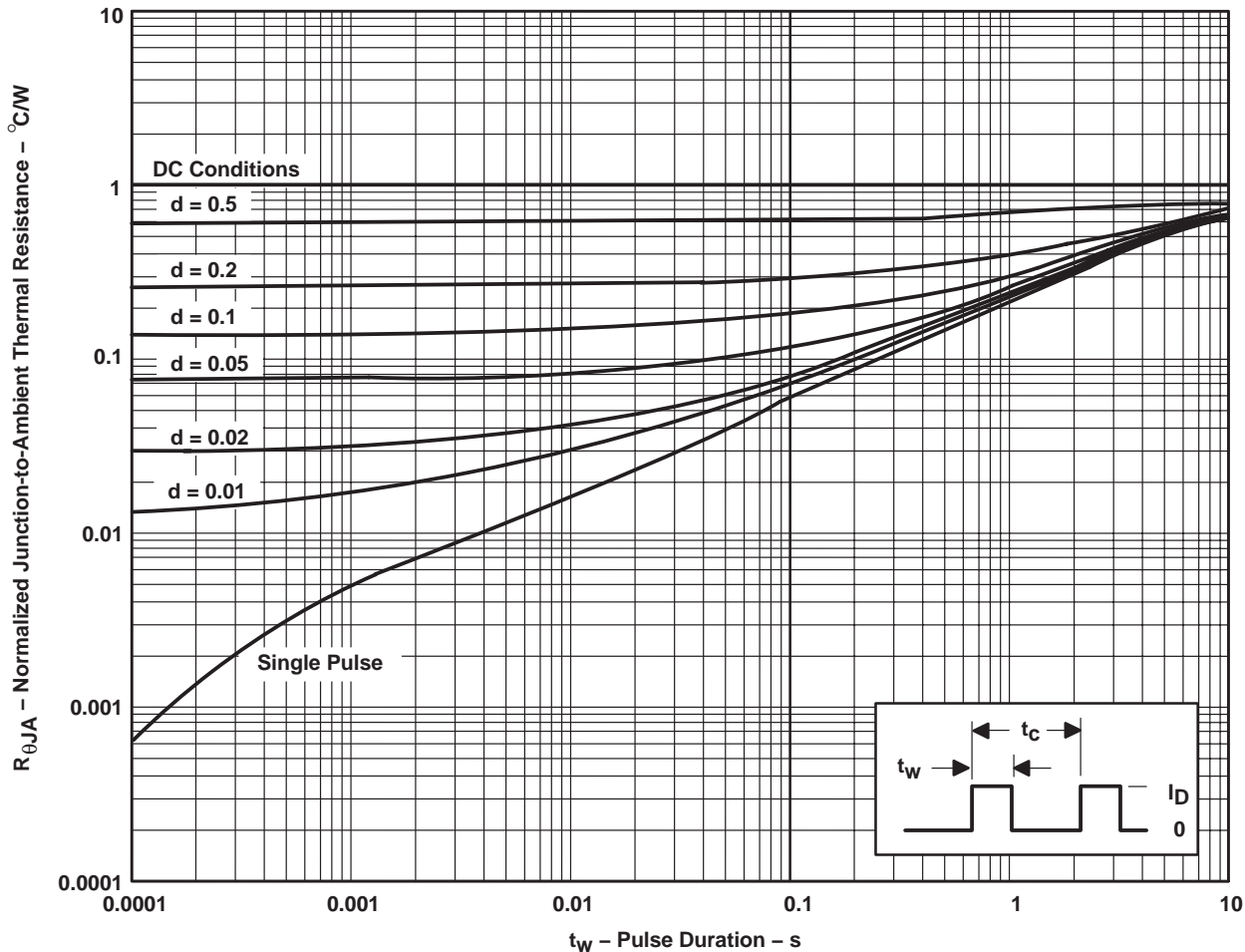


**Figure 16**



THERMAL INFORMATION

D PACKAGE†  
NORMALIZED JUNCTION-TO-AMBIENT THERMAL RESISTANCE  
VS  
PULSE DURATION



† Device mounted on FR4 printed-circuit board with no heat sink

NOTES:  $Z_{\theta A}(t) = r(t) R_{\theta JA}$   
 $t_w$  = pulse duration  
 $t_c$  = cycle time  
 $d$  = duty cycle =  $t_w/t_c$

Figure 17

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TPIC3302D	OBSOLETE	SOIC	D	8		TBD	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

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<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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