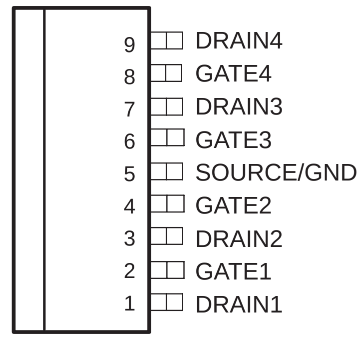
- **Low $r_{DS(on)}$ . . . 0.3 Ω Typ**
- **High Output Voltage . . . 60 V**
- **Pulsed Current . . . 6 A Per Channel**
- **Avalanche Energy Capability . . . 36 mJ**
- **Input Transient Protection . . . 2000 V**

KTA PACKAGE
(TOP VIEW)

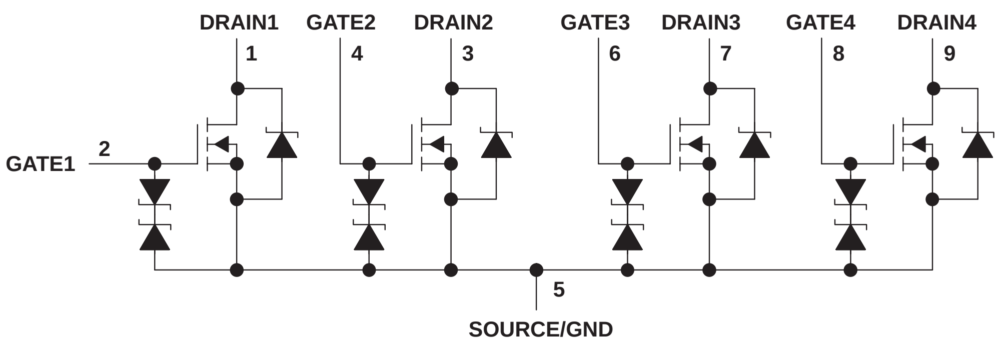


description

The TPIC2401 is a monolithic power DMOS array that consists of four electrically isolated N-channel enhancement-mode DMOS transistors configured with a common source and open drains. Each transistor features integrated high-current zener diodes to prevent gate damage in the event that an overstress condition occurs. These zener diodes also provide up to 2000 V of ESD protection when tested using the human-body model.

The TPIC2401 is offered in a 9-pin PowerFLEX™ (KTA) package and is characterized for operation over the case temperature range of −40°C to 125°C.

schematic



NOTE A: For correct operation, no output pin may be taken below GND.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PowerFLEX is a trademark of Texas Intruments Incorporated.

absolute maximum ratings over operating case temperature range (unless otherwise noted)†

Drain-to-source voltage, V_{DS} . . . . . 60 V
Gate-to-source voltage, V_{GS} . . . . . −9 V to 18 V
Continuous drain current, each output, all outputs on, T_C = 25°C . . . . . 1.5 A
Pulsed drain current, each output, $I_O$max, T_C = 25°C (see Note 1 and Figure 7) . . . . . 6 A
Continuous gate-to-source zener diode current, T_C = 25°C . . . . . ±25 mA
Pulsed gate-to-source zener diode current, T_C = 25°C . . . . . ±250 mA
Single-pulse avalanche energy, E_{AS}, T_C = 25°C (see Figures 4 and 6) . . . . . 36 mJ
Continuous total power dissipation at (or below) T_A = 25°C . . . . . 1.7 W
Power dissipation at (or below) T_C = 75°C, all outputs on . . . . . 15 W
Operating virtual junction temperature range, T_J . . . . . −40°C to 150°C
Operating case temperature range, T_C . . . . . −40°C to 125°C
Storage temperature range, T_{stg} . . . . . −40°C to 125°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C

† 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%

electrical characteristics, T_C = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{(BR)DSX}$	Drain-to-source breakdown voltage	I_D = 250 µA, V_{GS} = 0		60			V
$V_{GS(th)}$	Gate-to-source threshold voltage	I_D = 1 mA, V_{DS} = V_{GS}, See Figure 5		1.5	2.05	2.2	V
$V_{GS(th)match}$	Gate-to-source threshold voltage matching				5	40	
$V_{(BR)GS}$	Gate-to-source breakdown voltage	IGS = 250 µA		18			V
$V_{(BR)SG}$	Source-to-gate breakdown voltage	I_{SG} = 250 µA		9			V
$V_{DS(on)}$	Drain-to-source on-state voltage	I_D = 1.5A, V_{GS} = 10 V, See Notes 2 and 3			0.45	0.54	V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	I_S = 1.5A, V_{GS} = 0 V, See Notes 2 and 3 and Figure 12			0.85	1	V
I_{DSS}	Zero-gate-voltage drain current	V_{DS} = 48 V, V_{GS} = 0	T_C = 25°C		0.05	1	µA
			T_C = 125°C		0.5	10	
I_{GSSF}	Forward gate current, drain short circuited to source	V_{GS} = 15 V, V_{DS} = 0			20	200	nA
I_{GSSR}	Reverse gate current, drain short circuited to source	V_{SG} = 5 V, V_{DS} = 0			10	100	nA
$r_{DS(on)}$	Static drain-to-source on-state resistance	V_{GS} = 10 V, I_D =1.5 A, See Notes 2 and 3 and Figures 6 and 7	T_C = 25°C		0.3	0.36	Ω
			T_C = 125°C		0.48	0.6	
g_{fs}	Forward transconductance	V_{DS} = 15 V, I_D = 1 A, See Notes 2 and 3 and Figure 9		0.9	1.15		S
C_{iss}	Short-circuit input capacitance, common source	V_{DS} = 25 V, V_{GS} = 0, f = 1 MHz, See Figure 11			180	225	pF
C_{oss}	Short-circuit output capacitance, common source				100	138	
C_{rss}	Short-circuit reverse transfer capacitance, common source				75	100	

NOTES: 2. Technique should limit T_J − T_C to 10°C maximum.
3. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

source-to-drain diode characteristics, T_C = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{rr}	Reverse-recovery time	I_S = 0.75 A, V_{DS} = 48 V, V_{GS} = 0, di/dt = 100 A/µs, See Figures 1 and 14		80		ns
Q_{RR}	Total diode charge			180		nC

resistive-load switching characteristics, T_C = 25°C

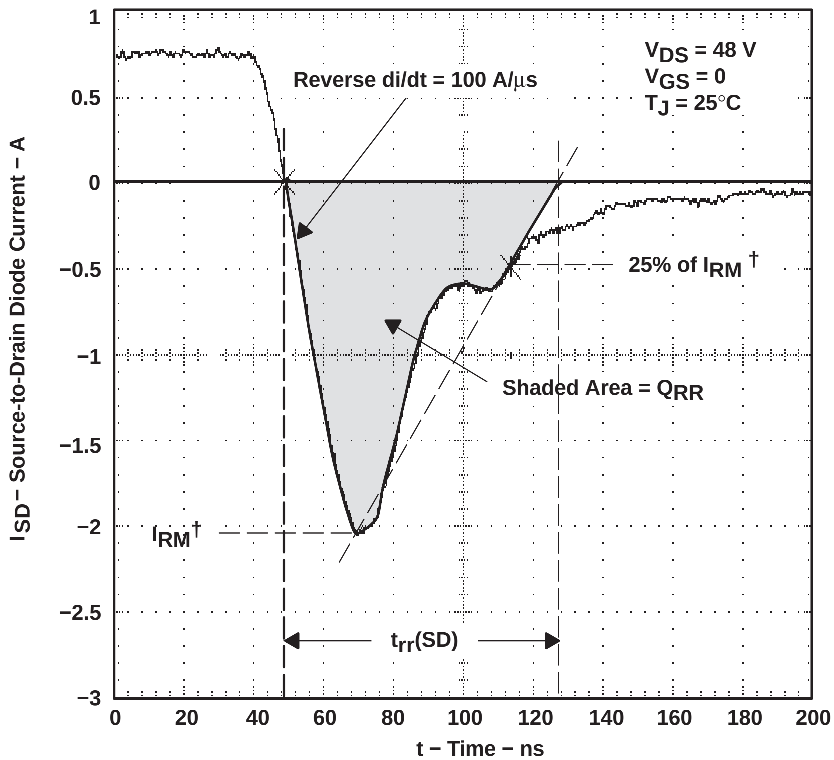
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(on)}$	Delay time, V_{GS}↑ to V_{DS}↓ turn on	V_{DD} = 25 V, R_L = 25 Ω, t_{en} = 10 ns, t_{dis} = 10 ns, See Figure 2		194		ns
$t_{d(off)}$	Delay time, V_{GS}↓ to V_{DS}↑ turn off			430		
t_r	Rise time, V_{DS}			180		
t_f	Fall time, V_{DS}			90		
Q_g	Total gate charge	V_{DD} = 48 V, I_D = 1 A, V_{GS} = 10 V, See Figure 3		4	5	nC
$Q_{gs(th)}$	Threshold gate-to-source charge			0.45	0.56	
Q_{gd}	Gate-to-drain charge			1.55	1.93	
L_D	Internal drain inductance			5		nH
L_S	Internal source inductance			5		
R_g	Internal gate resistance			500		Ω

thermal resistance

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$R_{θJA}$	Junction-to-ambient thermal resistance	All outputs with equal power			72	°C/W
$R_{θJC}$	Junction-to-case thermal resistance	All outputs with equal power			5	
		One output dissipating power			8.5	

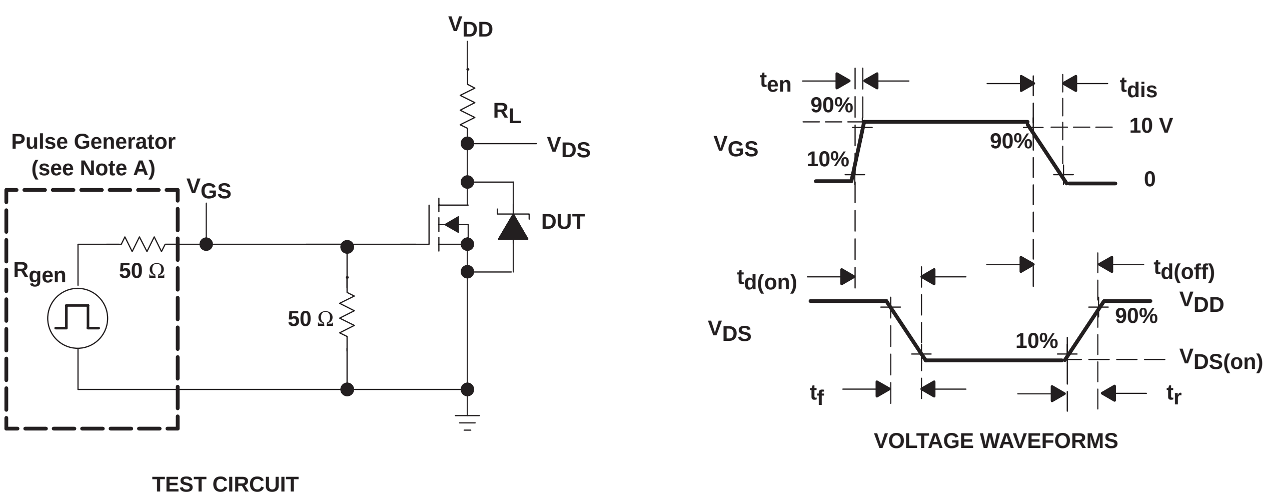
NOTES:

PARAMETER MEASUREMENT INFORMATION



† I_{RM} = maximum recovery current

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



NOTE A: The pulse generator has the following characteristics: $t_{en} \leq 10$ ns, $t_{dis} \leq 10$ ns, $Z_O = 50\ \Omega$.

Figure 2. Resistive Switching

PARAMETER MEASUREMENT INFORMATION

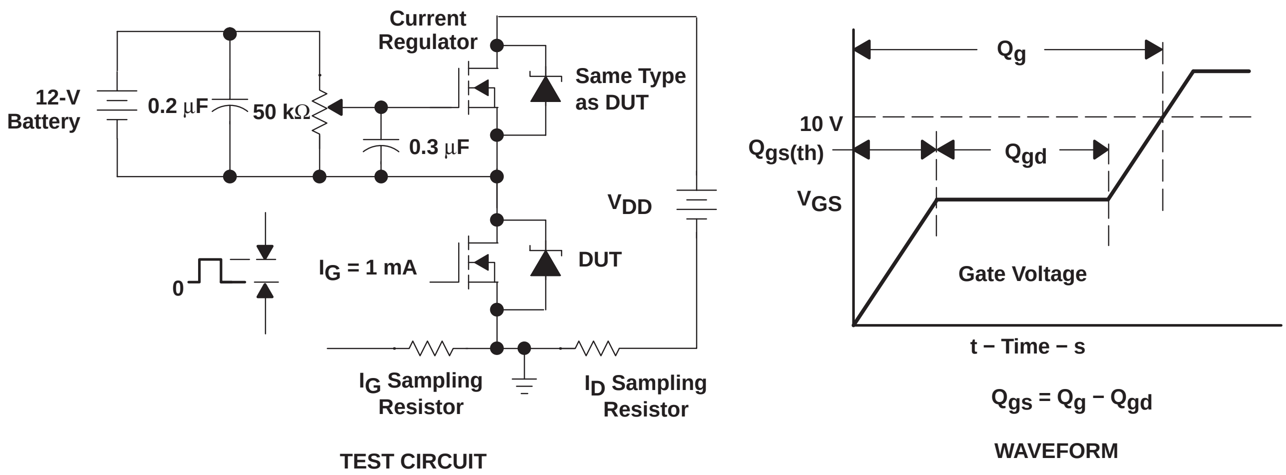
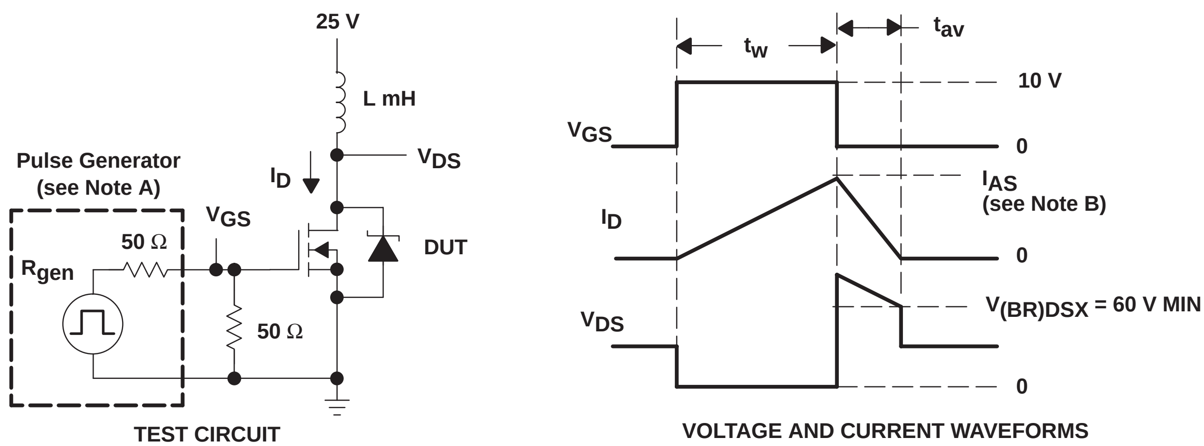


Figure 3. Gate Charge Test Circuit and Waveform



NOTES: A. The pulse generator has the following characteristics: $t_r \le 10$ ns, $t_f \le 10$ ns, $Z_O = 50\ \Omega$.

B. Input pulse duration (t_W) is increased until peak current I_{AS} = 1.5 A.

Energy test level is defined as $E_{AS} = \frac{I_{AS} \times V_{(BR)DSX} \times t_{av}}{2} = 36$ mJ minimum where t_{av} = avalanche time.

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

TYPICAL CHARACTERISTICS

GATE-TO-SOURCE THRESHOLD VOLTAGE
vs
JUNCTION TEMPERATURE

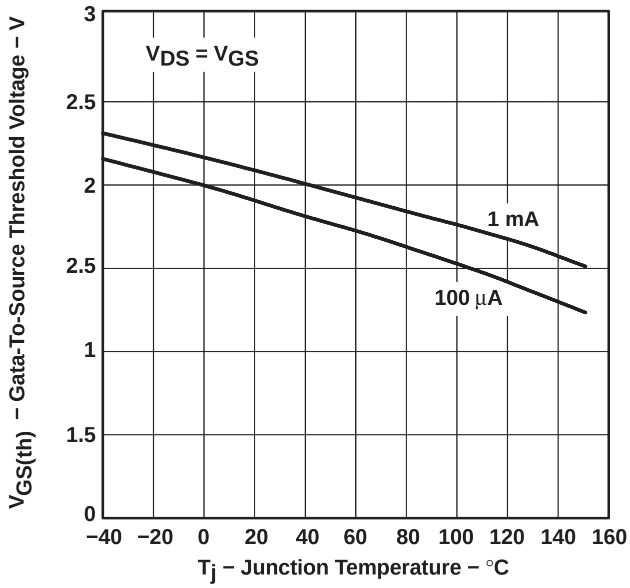


Figure 5

STATIC DRAIN-TO-SOURCE ON-STATE RESISTANCE
vs
JUNCTION TEMPERATURE

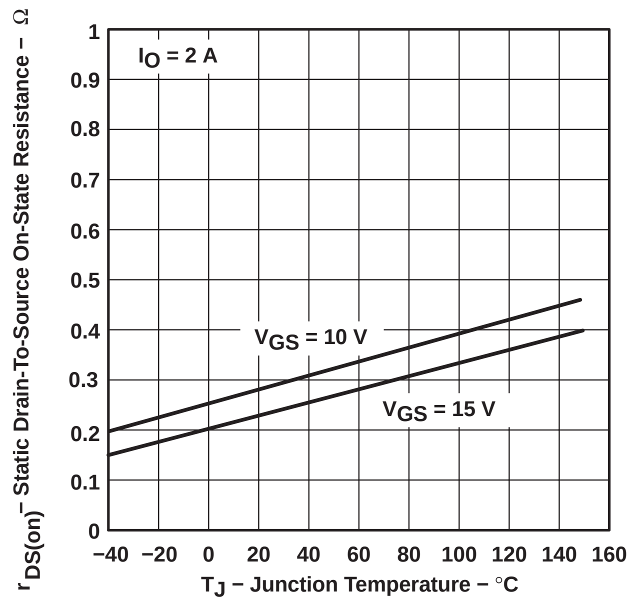


Figure 6

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

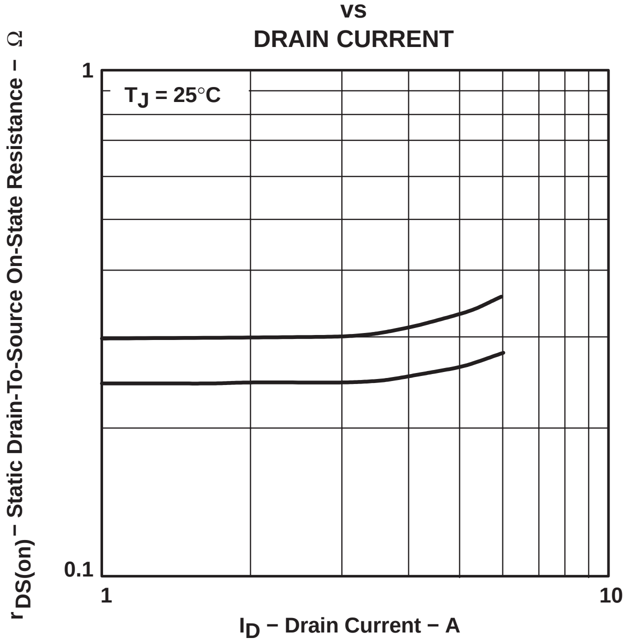


Figure 7

DRAIN CURRENT
vs
DRAIN-TO-SOURCE VOLTAGE

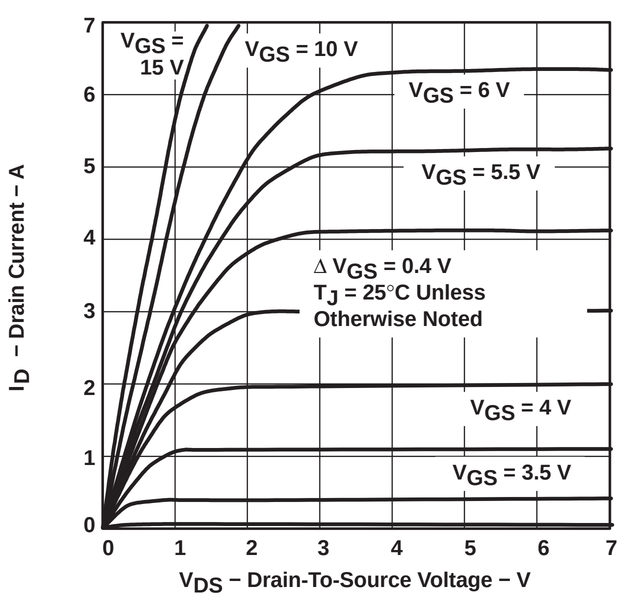


Figure 8

TYPICAL CHARACTERISTICS

PERCENTAGE OF UNITS vs FORWARD TRANSCONDUCTANCE

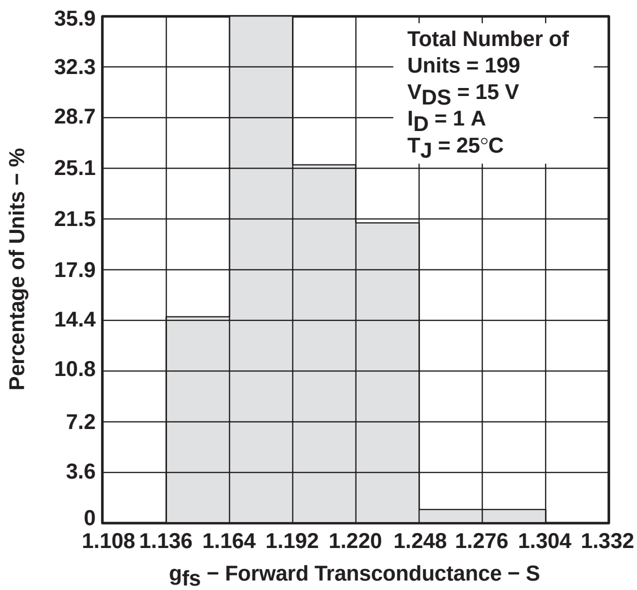


Figure 9

DRAIN CURRENT vs GATE-TO-SOURCE VOLTAGE

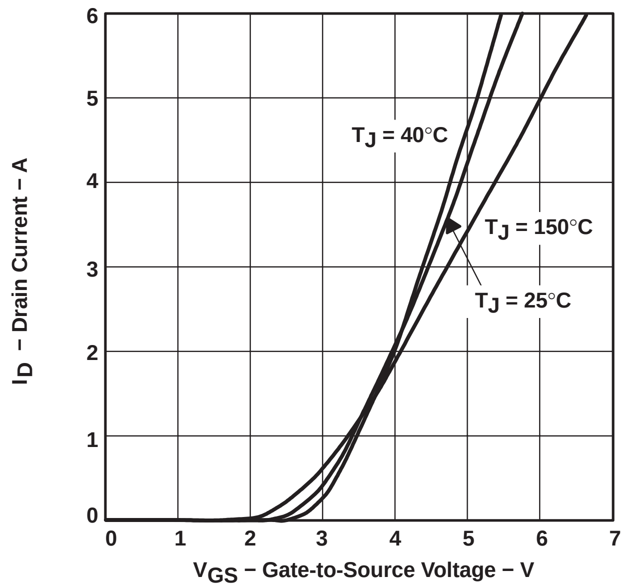


Figure 10

CAPACITANCE vs DRAIN-TO-SOURCE VOLTAGE

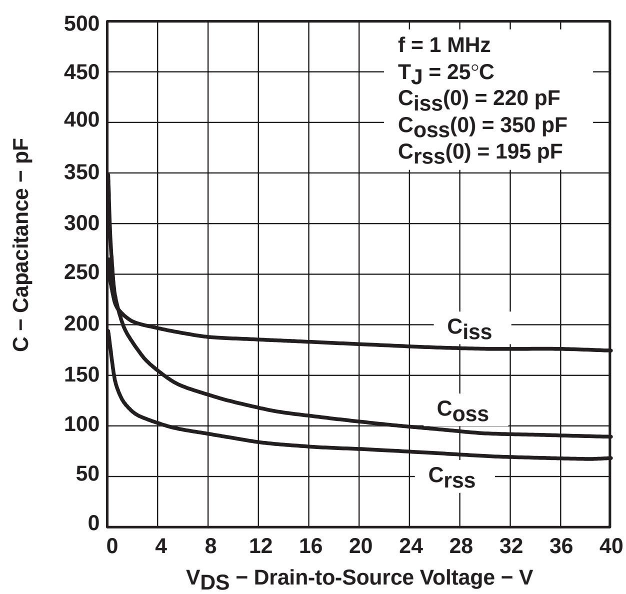


Figure 11

SOURCE-TO-DRAIN DIODE CURRENT vs SOURCE-TO-DRAIN VOLTAGE

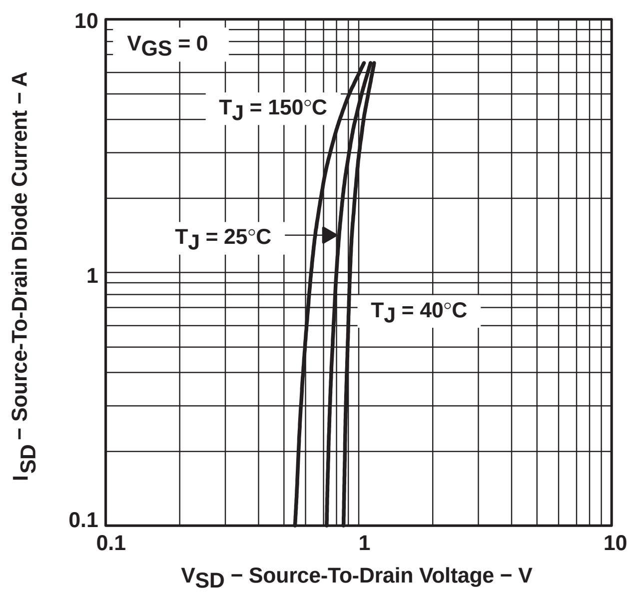


Figure 12

TYPICAL CHARACTERISTICS

DRAIN-TO-SOURCE VOLTAGE AND GATE-TO-SOURCE VOLTAGE vs GATE CHARGE

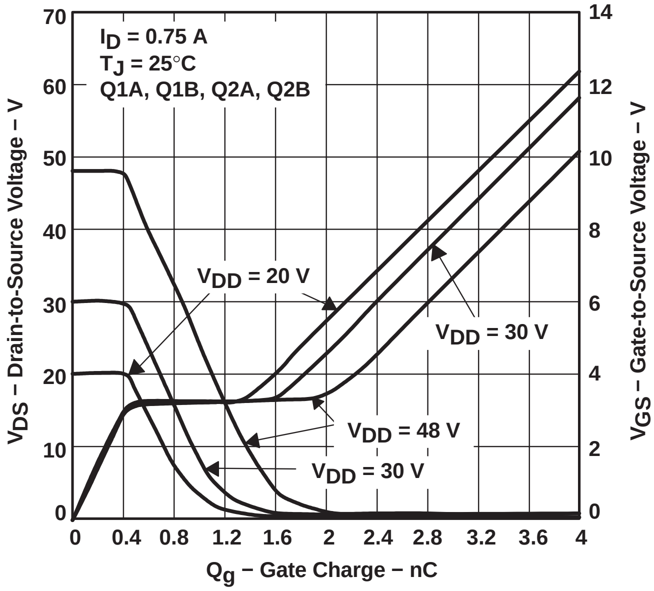


Figure 13

REVERSE RECOVERY TIME vs REVERSE di/dt

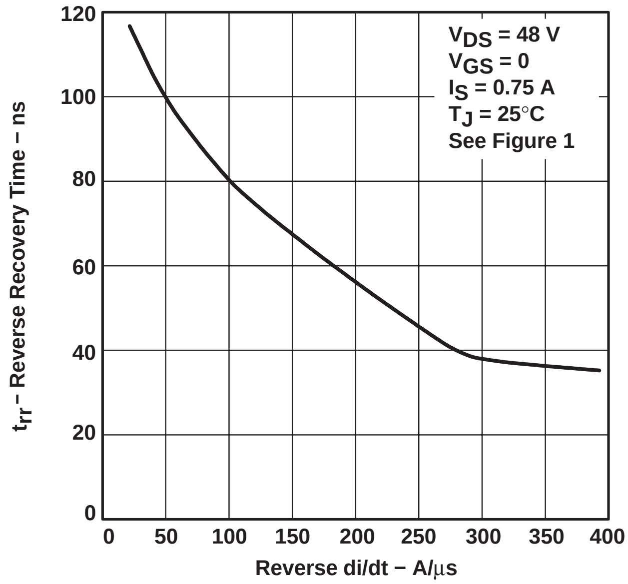


Figure 14

MAXIMUM DRAIN CURRENT vs DRAIN-TO-SOURCE VOLTAGE INFINITE HEATSINK

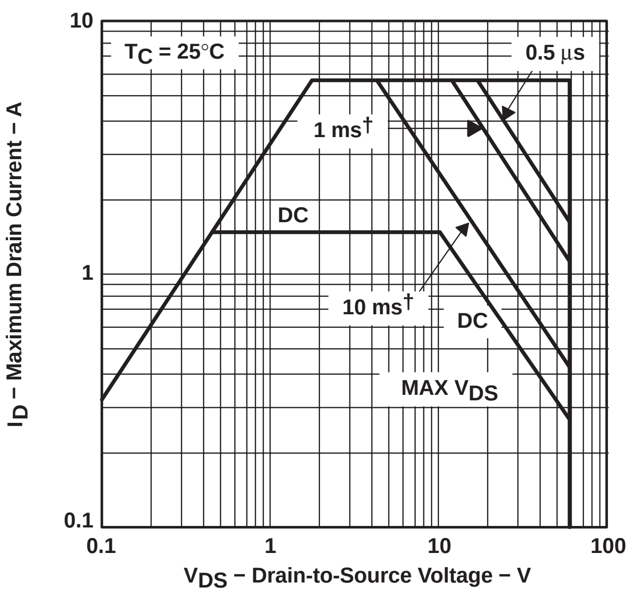


Figure 15

MAXIMUM PEAK AVALANCHE CURRENT vs TIME DURATION OF AVALANCHE

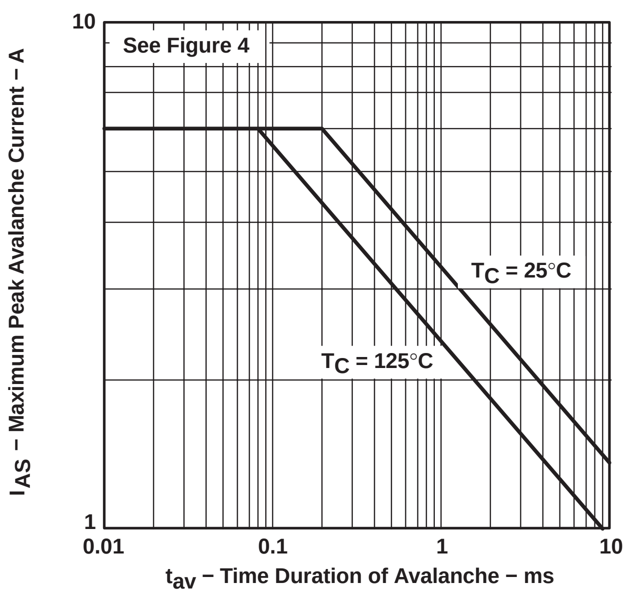
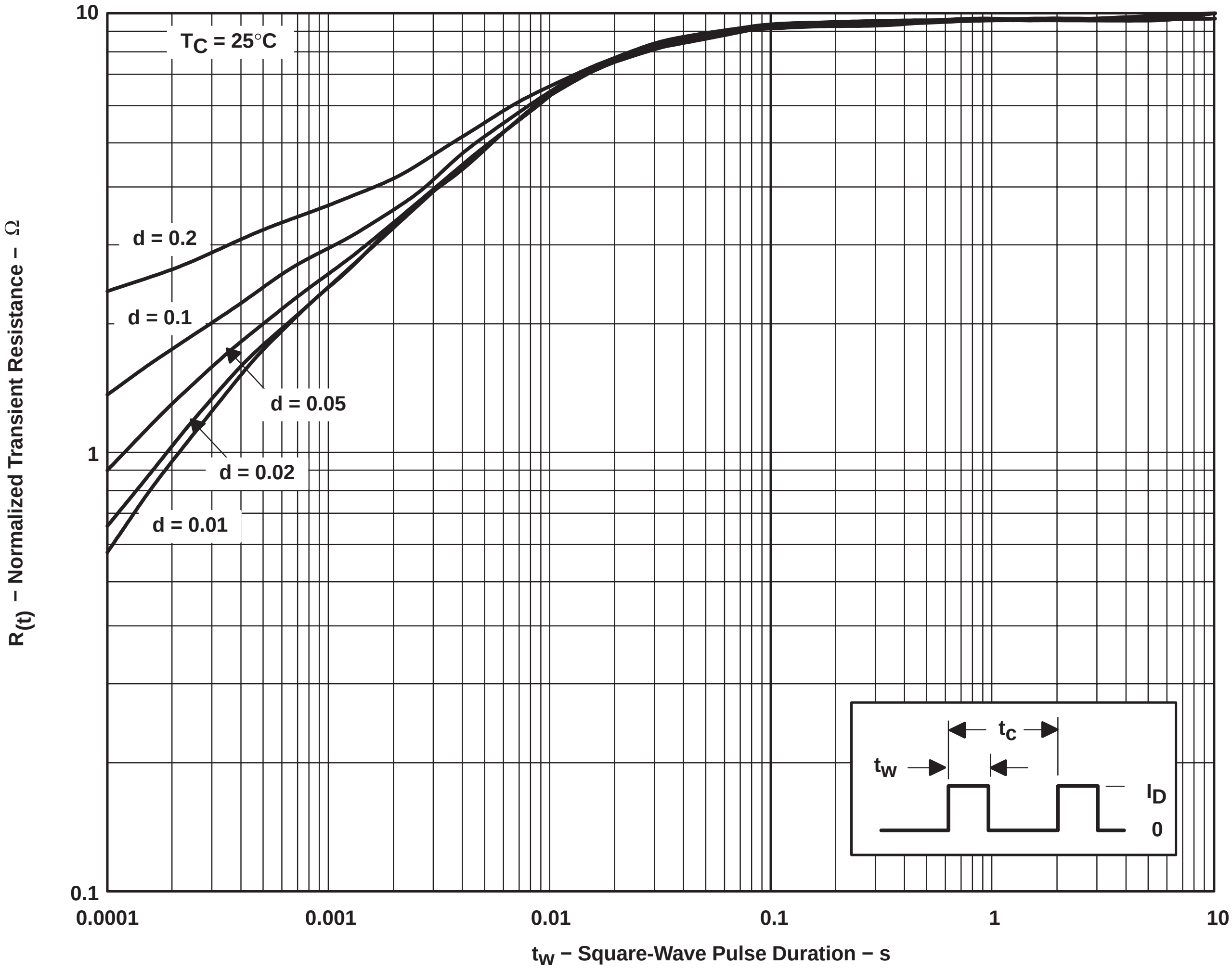


Figure 16

THERMAL INFORMATION

NORMALIZED TRANSIENT RESISTANCE
vs
SQUARE-WAVE PULSE DURATION



† Package mounted in intimate contact with infinite heat sink.

NOTE A: $Z_{\theta JC}(t) = r(t) R_{\theta JC}$
t_W = pulse duration
t_C = cycle time
d = duty cycle = t_W / t_C

Figure 17