TPIC2601
6-CHANNEL COMMON-SOURCE POWER DMOS ARRAY

- **Low $r_{DS(on)}$ . . . 0.25 Ω Typ**
- **High Output Voltage . . . 60 V**
- **Pulsed Current . . . 10 A Per Channel**
- **Avalanche Energy Capability . . . 105 mJ**
- **Input Transient Protection . . . 2000 V**

KTC or KTD† PACKAGE
(TOP VIEW)

| Pin	Signal
15	DRAIN6
14	GATE6
13	DRAIN5
12	GATE5
11	DRAIN4
10	DRAIN4
9	GATE4
8	SOURCE/GND
7	GATE3
6	DRAIN3
5	DRAIN3
4	GATE2
3	DRAIN2
2	GATE1
1	DRAIN1
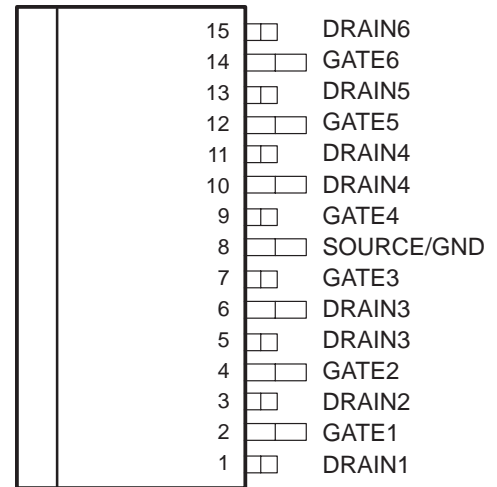
† TI Japan only

description

The TPIC2601 is a monolithic power DMOS array that consists of six 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 TPIC2601 is offered in a 15-pin PowerFLEX™ (KTC) package and is characterized for operation over the case temperature range of −40°C to 125°C. *A 15-pin PowerFLEX™ (KTD) package is also available for TI Japan only.*

schematic
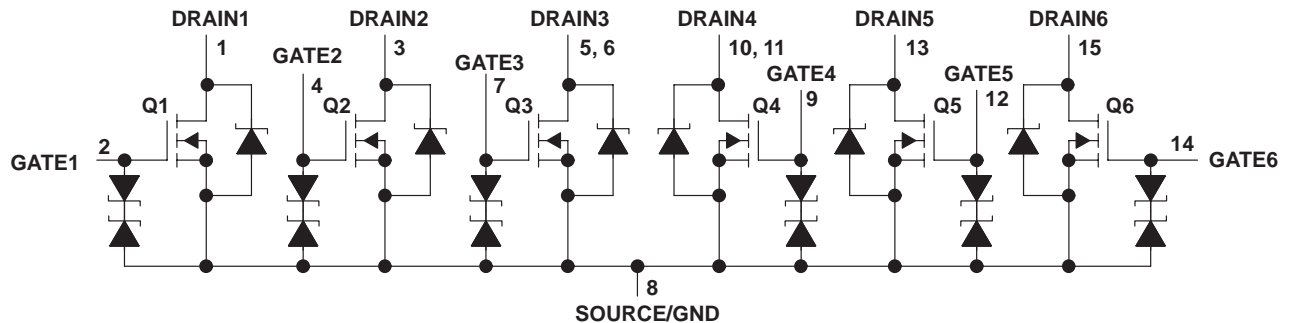
NOTE A: For correct operation, no drain terminal may be taken below GND.

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TPIC2601
6-CHANNEL COMMON-SOURCE POWER DMOS ARRAY

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	2 A
Pulsed drain current, each output, $I_O$max, T_C = 25°C (see Note 1 and Figure 7)	10 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 16)	105 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	18.75 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},	1.5	2.05	2.2	V
$V_{GS(th)match}$	Gate-to-source threshold voltage matching	See Figure 5			5	40	mV
$V_{(BR)GS}$	Gate-to-source breakdown voltage	I_{GS} = 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 = 2 A, See Notes 2 and 3	V_{GS} = 10 V,		0.5	0.6	V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	I_S = 2A, See Notes 2 and 3 and Figure 12	V_{GS} = 0,		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} = 10 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 =2 A, See Notes 2 and 3 and Figures 6 and 7	T_C = 25°C		0.25	0.3	Ω
			T_C = 125°C		0.4	0.5	
g_{fs}	Forward transconductance	V_{DS} = 15 V, See Notes 2 and 3 and Figure 9	I_D = 1 A	1.3	1.95		S
C_{iss}	Short-circuit input capacitance, common source				180	225	pF
C_{oss}	Short-circuit output capacitance, common source	V_{DS} = 25 V, f = 1 MHz,	V_{GS} = 0, See Figure 11		110	138	
C_{rss}	Short-circuit reverse transfer capacitance, common source				80	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.

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{rr(SD)}$	Reverse-recovery time	$I_S = 1$ A, $V_{DS} = 48$ V, $V_{GS} = 0$, di/dt = 100 A/µs, See Figures 1 and 14		72		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, $V_{GS}\uparrow$ to $V_{DS}\downarrow$ 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, $V_{GS}\downarrow$ to $V_{DS}\uparrow$ turn off			430		
t_r	Rise time, V_{DS}			90		
t_f	Fall time, V_{DS}			180		
Q_g	Total gate charge	$V_{DD} = 48$ V, $I_D = 1$ A, $V_{GS} = 10$ V, See Figure 3		5.1	6.4	nC
$Q_{gs(th)}$	Threshold gate-to-source charge			0.5	0.63	
Q_{gd}	Gate-to-drain charge			2.75	3.4	
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
$R_{\theta JA}$	Junction-to-ambient thermal resistance	All outputs with equal power			72	°C/W
$R_{\theta JC}$	Junction-to-case thermal resistance	All outputs with equal power			4	
		One output dissipating power			7	

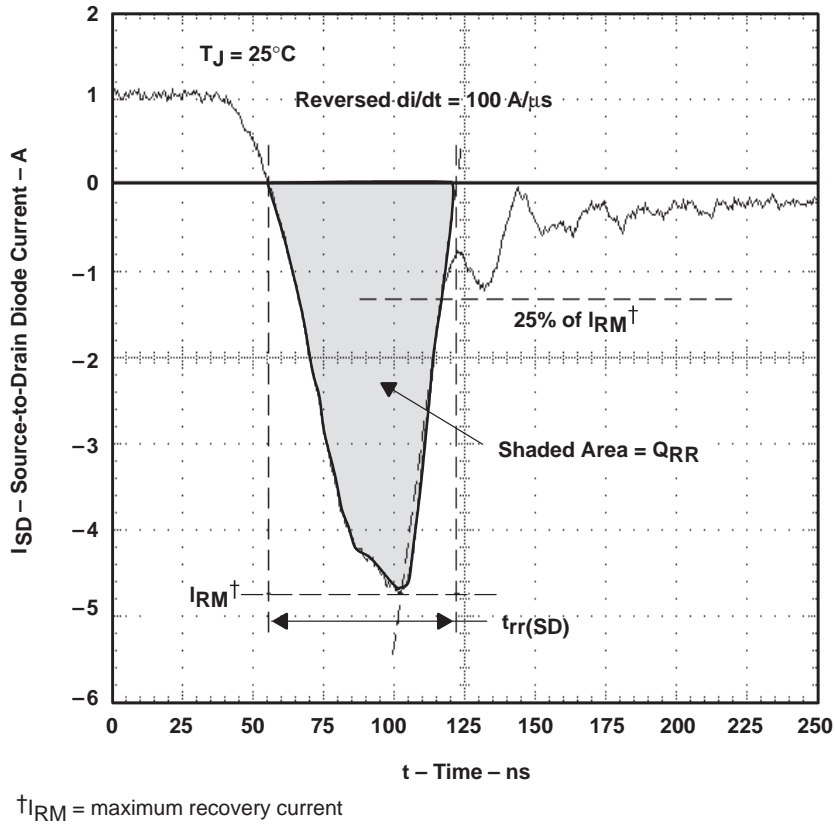## PARAMETER MEASUREMENT INFORMATION

†I_{RM} = maximum recovery current

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

TEST CIRCUIT

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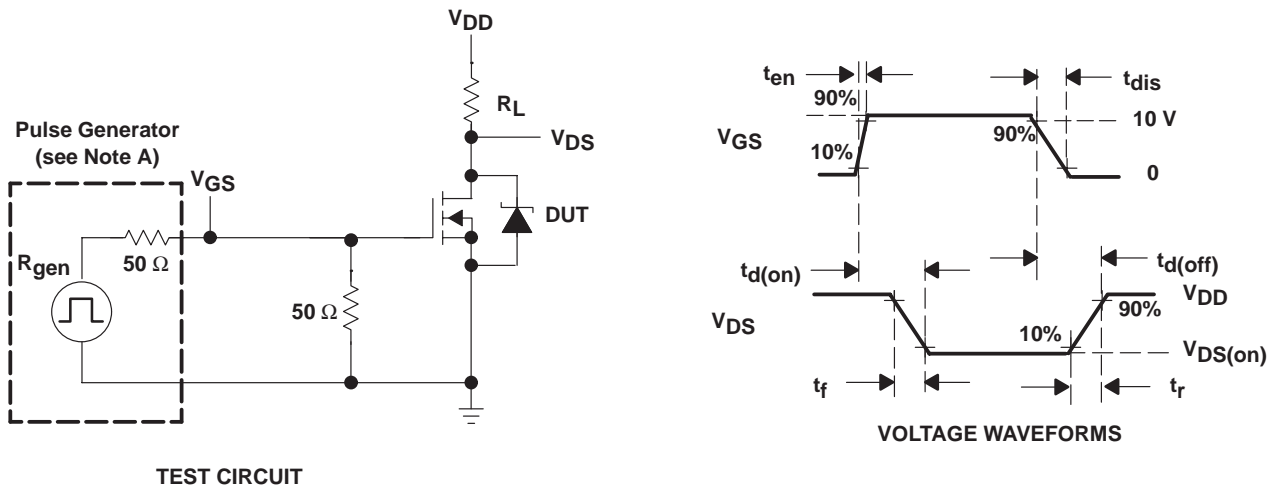
NOTE A: The pulse generator has the following characteristics: $t_{en} \leq 10$ ns, $t_{dis} \leq 10$ ns, $Z_O = 50$ Ω.

Figure 2. Resistive Switching

PARAMETER MEASUREMENT INFORMATION

TEST CIRCUIT

WAVEFORM

$Q_{gs} = Q_g - Q_{gd}$
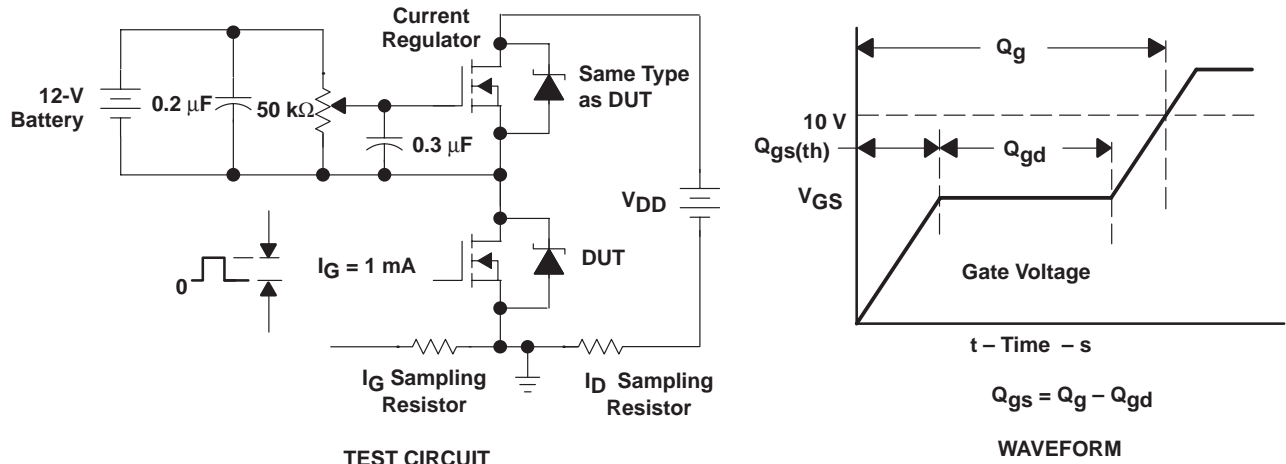
Figure 3. Gate Charge Test Circuit and Waveform

TEST CIRCUIT

VOLTAGE AND CURRENT WAVEFORMS
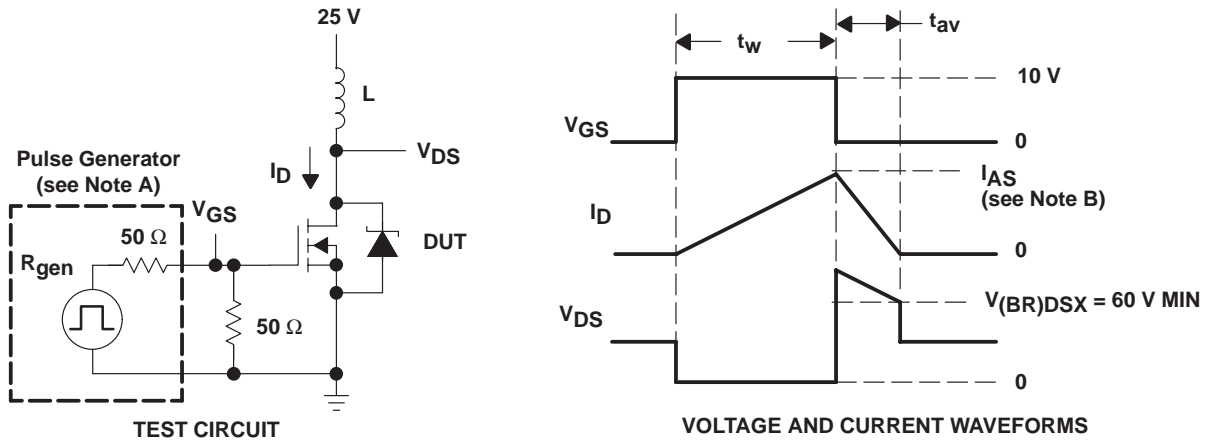
NOTES: A. The pulse generator has the following characteristics: $t_r \leq 10$ ns, $t_f \leq 10$ ns, $Z_O = 50$ Ω.
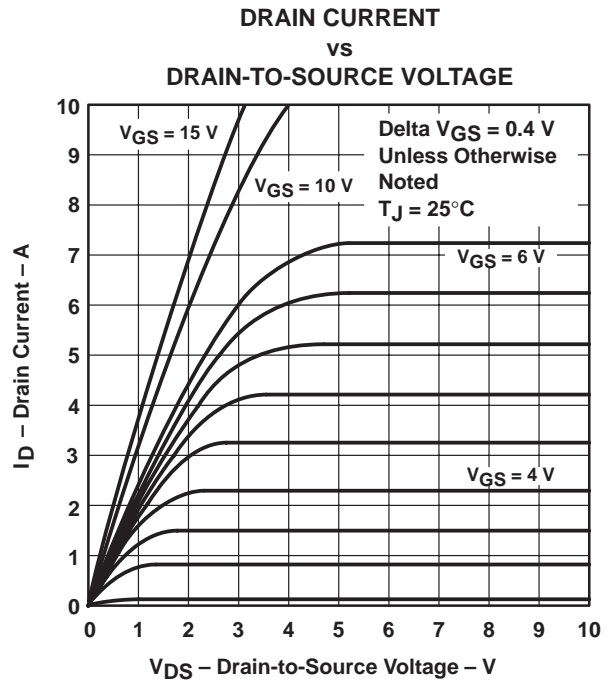B. Input pulse duration (t_w) is increased until peak current $I_{AS} = 2$ A.
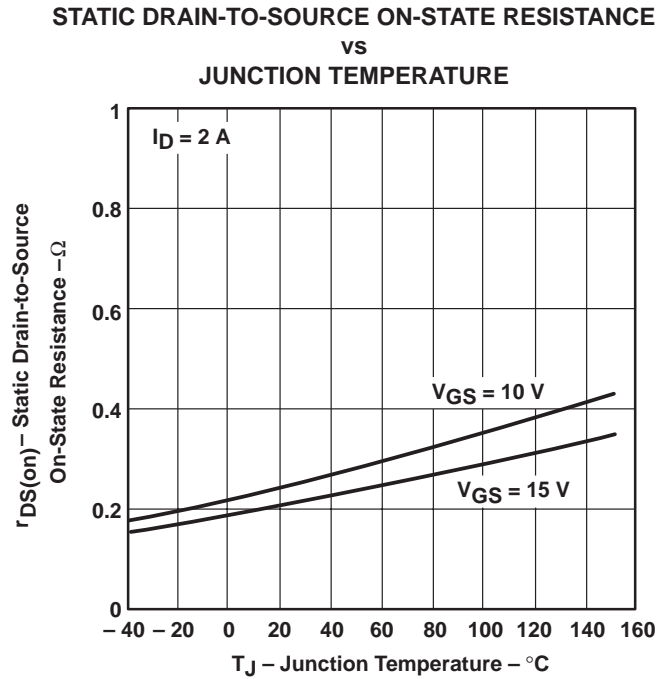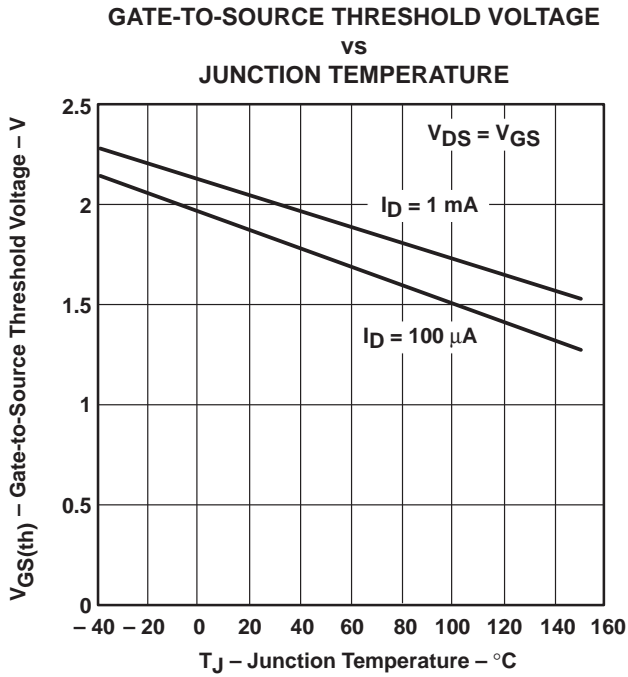
Energy test level is defined as $E_{AS} = \dfrac{I_{AS} \times V_{(BR)DSX} \times t_{av}}{2} = 105$ mJ minimum where t_{av} = avalanche time.

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 RESISTANCE
vs
DRAIN CURRENT

Figure 7

DRAIN CURRENT
vs
DRAIN-TO-SOURCE VOLTAGE

Figure 8

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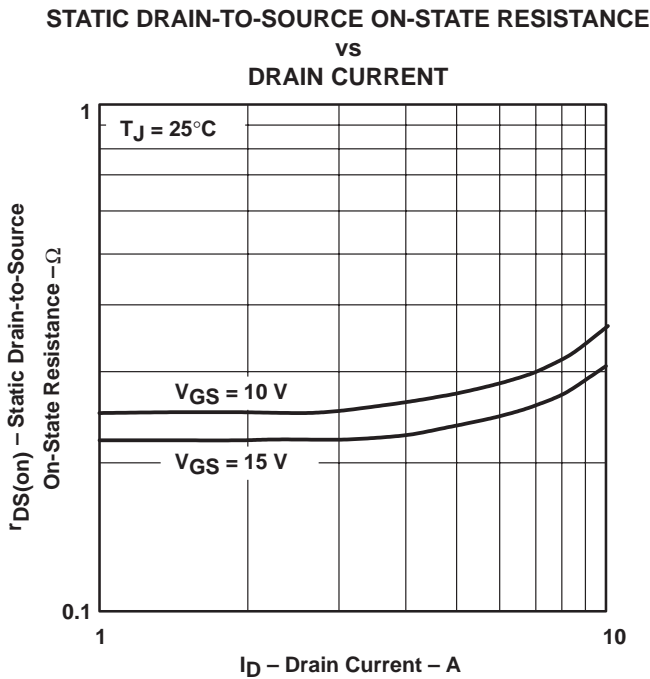
TYPICAL CHARACTERISTICS

DISTRIBUTION OF FORWARD TRANSCONDUCTANCE

Total Number of
Units = 367
V_{DS} = 15 V
I_D = 1 A
T_J = 25°C

Percentage of Units – %

g_{fs} – Forward Transconductance – S
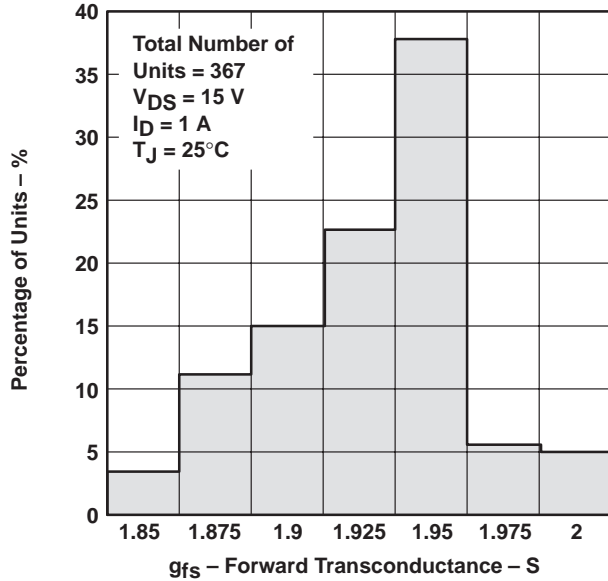
Figure 9

**DRAIN CURRENT
vs
GATE-TO-SOURCE VOLTAGE**

T_J = −40°C
T_J = 25°C
V_{DS} = 15 V
T_J = 150°C

I_D – Drain Current – A

V_{GS} – Gate-to-Source Voltage – V
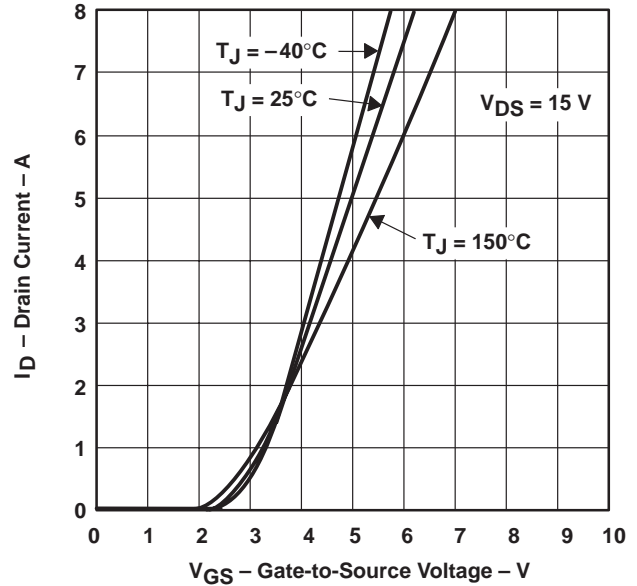
Figure 10

**CAPACITANCE
vs
DRAIN-TO-SOURCE VOLTAGE**

f = 1 MHz
T_J = 25°C
$C_{iss}(0)$ = 257 pF
$C_{oss}(0)$ = 488 pF
$C_{rss}(0)$ = 213 pF

C_{iss}
C_{oss}
C_{rss}

Capacitance – pF

V_{DS} – Drain-to-Source Voltage – V
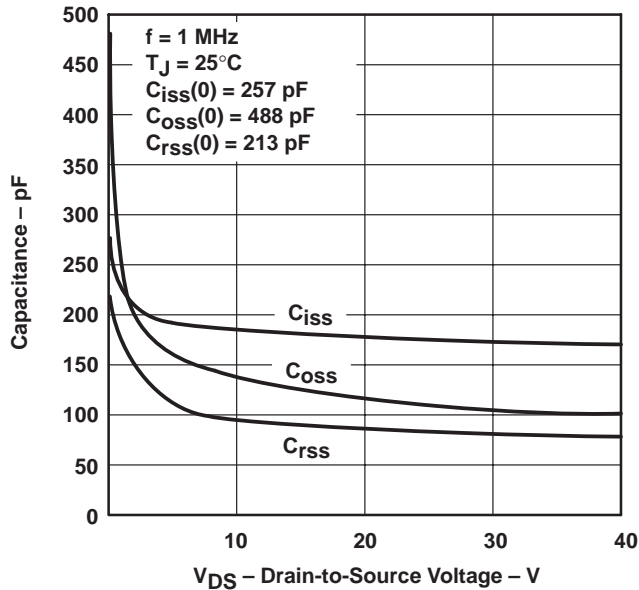
Figure 11

**SOURCE-TO-DRAIN DIODE CURRENT
vs
SOURCE-TO-DRAIN VOLTAGE**
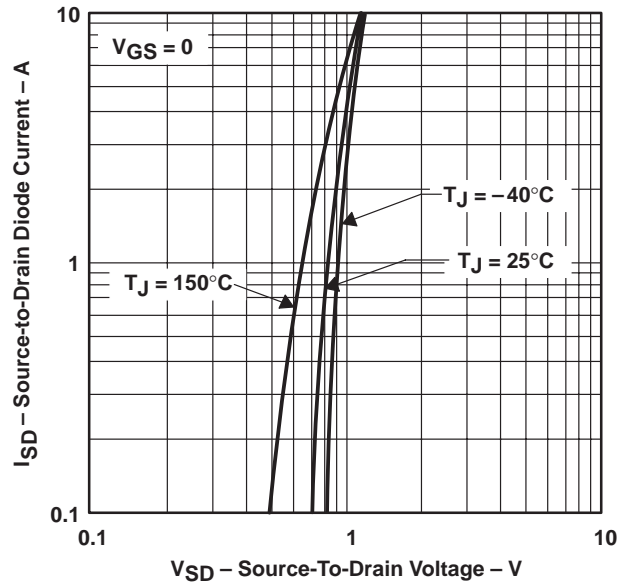
V_{GS} = 0
T_J = −40°C
T_J = 25°C
T_J = 150°C

I_{SD} – Source-to-Drain Diode Current – A

V_{SD} – Source-To-Drain Voltage – V

Figure 12

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TYPICAL CHARACTERISTICS

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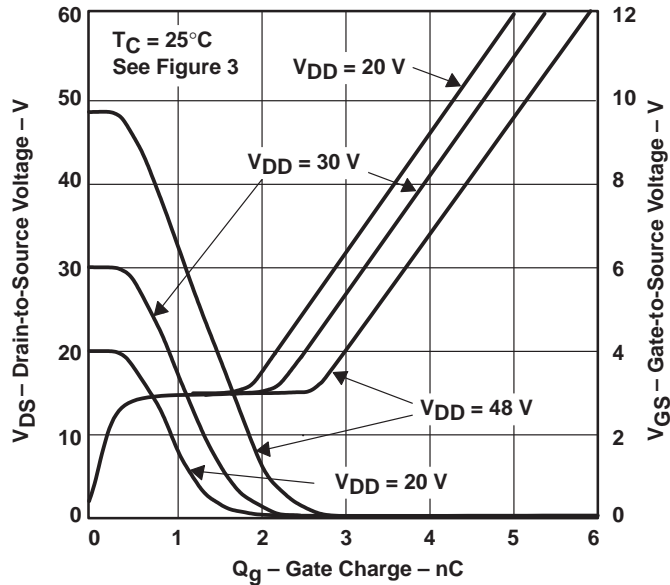GATE-TO-SOURCE VOLTAGE
vs
GATE CHARGE**

Figure 13

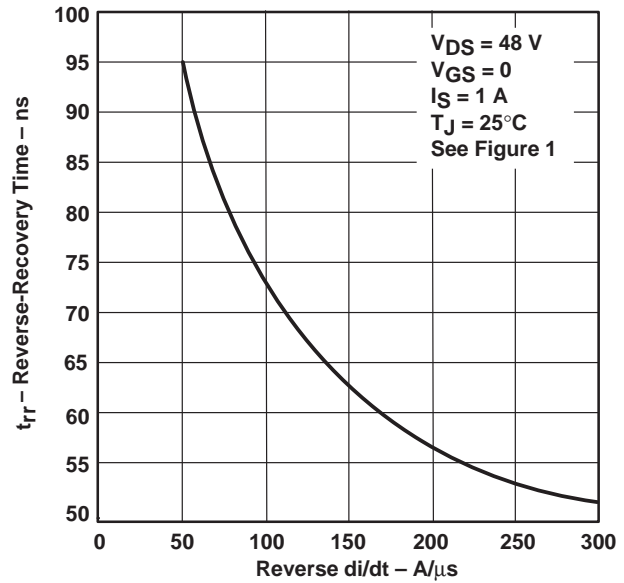**REVERSE-RECOVERY TIME
vs
REVERSE di/dt**

Figure 14

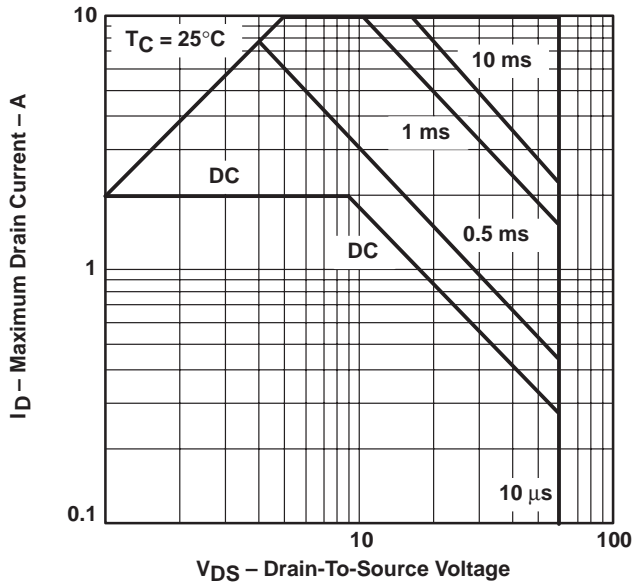**MAXIMUM DRAIN CURRENT
vs
DRAIN-TO-SOURCE VOLTAGE**

Figure 15

**MAXIMUM PEAK AVALANCHE CURRENT
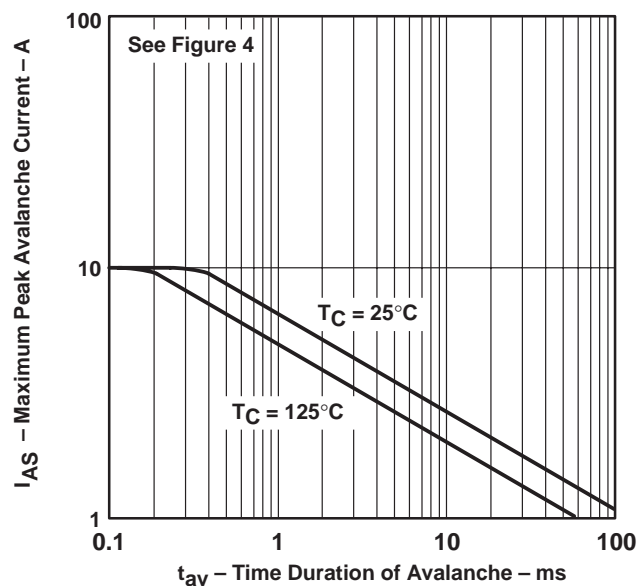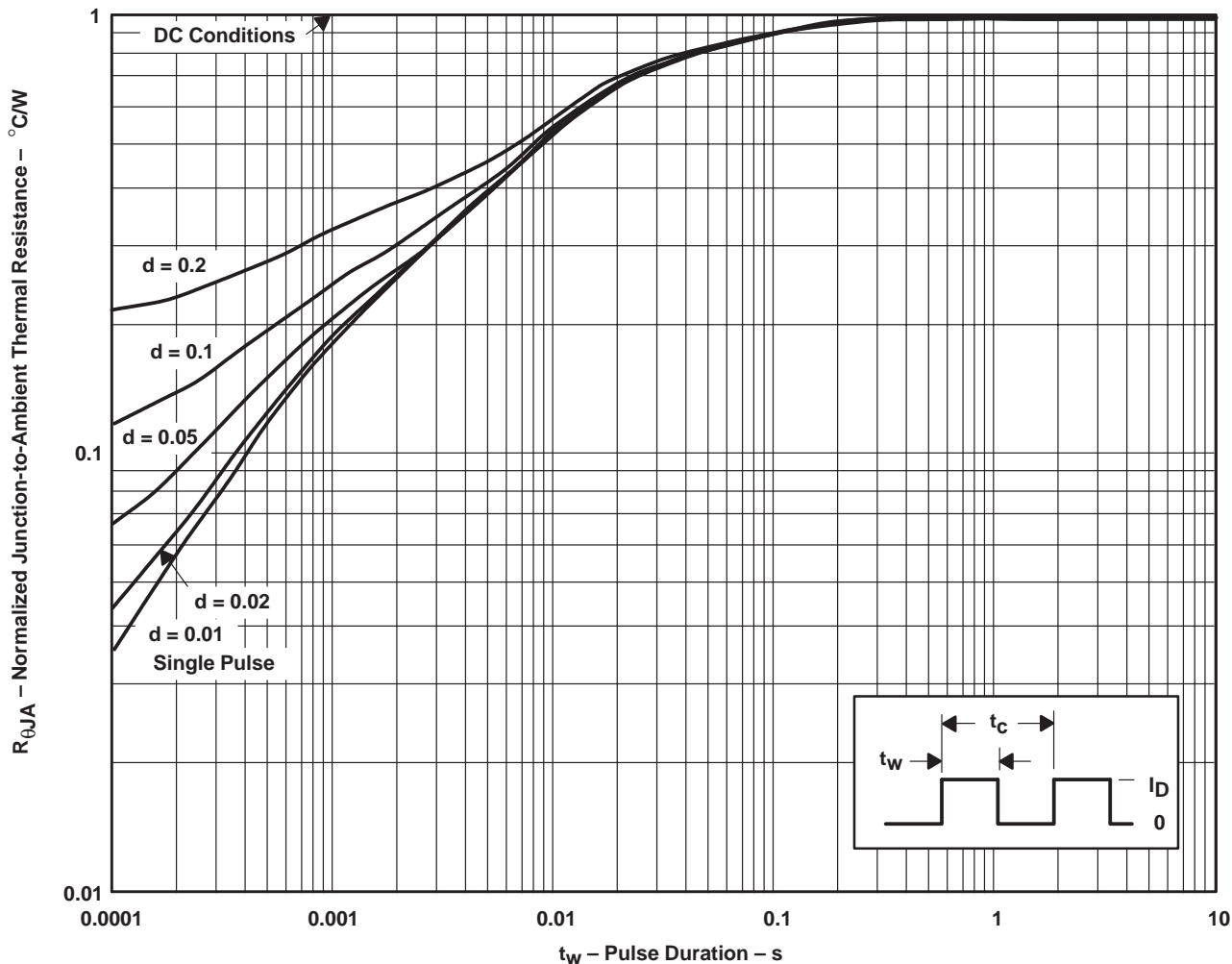vs
TIME DURATION OF AVALANCHE**

Figure 16

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THERMAL INFORMATION

KTC PACKAGE†
NORMALIZED JUNCTION-TO-AMBIENT THERMAL RESISTANCE
vs
PULSE DURATION

† Device mounted on 24 in², 4-layer FR4 printed-circuit board with no heatsink.

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

Figure 17

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