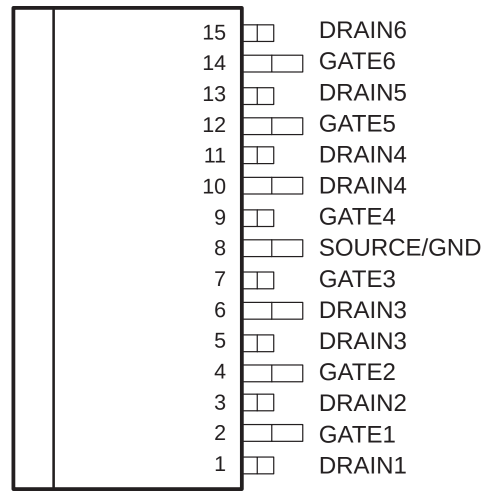
- **Low $r_{DS(on)}$ . . . 0.25 Ω Typ**
- **High Output Voltage . . . 60 V**
- **Pulsed Current . . . 10 A Per Channel**
- **Avalanche Energy Capability . . . 105 mJ**
- **Input Transient Protection . . . 2000 V**

KTC or KTD† PACKAGE
(TOP VIEW)



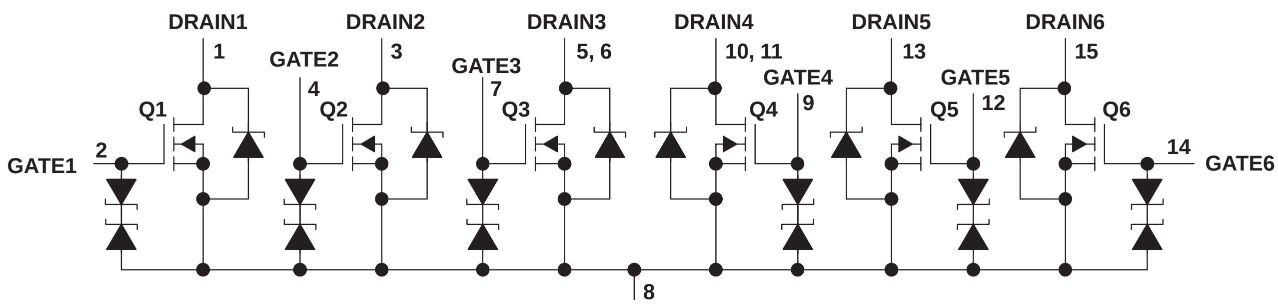
† TI Japan only

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.

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 . . . . . 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, See Figure 5	V_{DS} = V_{GS},	1.5	2.05	2.2	V
$V_{GS(th)match}$	Gate-to-source threshold voltage matching				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	V_{DS} = 25 V, f = 1 MHz,	V_{GS} = 0, See Figure 11		180	225	pF
C_{oss}	Short-circuit output capacitance, common source				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.

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

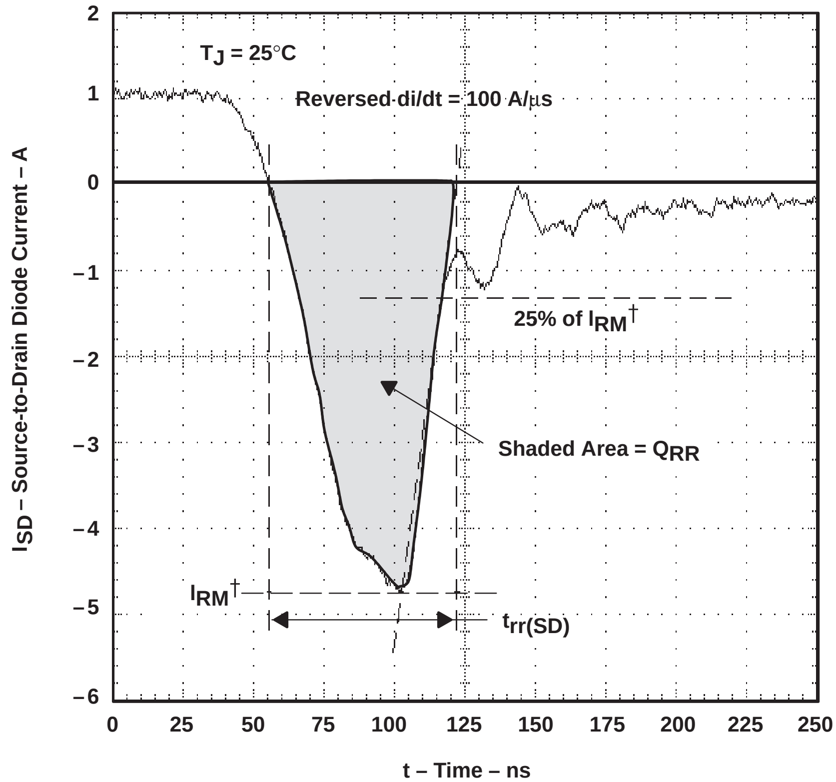
resistive-load switching characteristics, T_C = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(on)}$	Delay time, V_{GS}↑ 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}			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

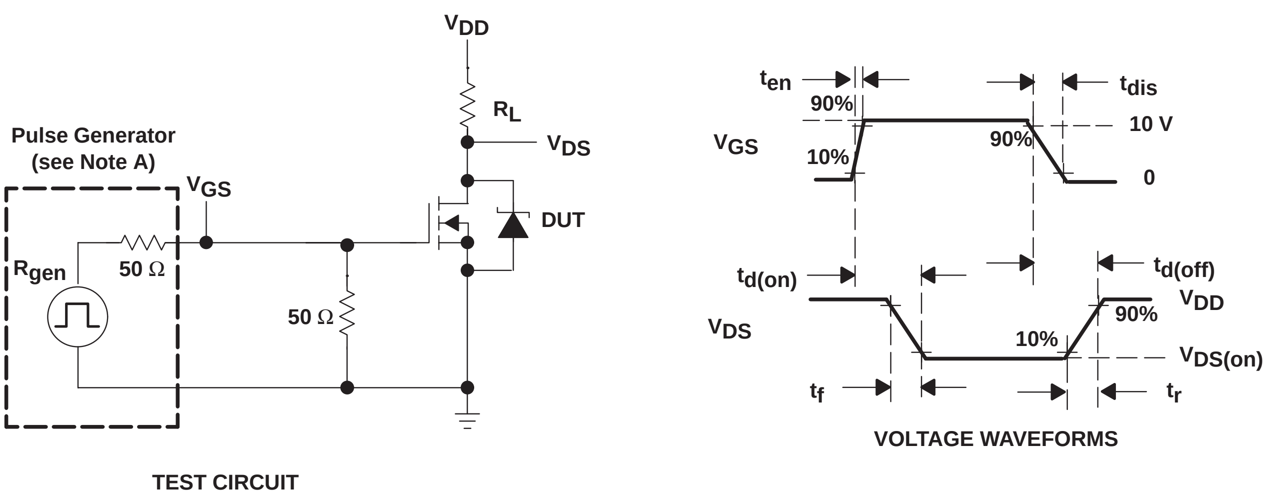
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	All outputs with equal power			72	°C/W
$R_{\theta JC}$	Junction-to-case thermal resistance	All outputs with equal power			4	
		One output dissipating power			7	

PARAMETER MEASUREMENT INFORMATION



†I_{RM} = maximum recovery current

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



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

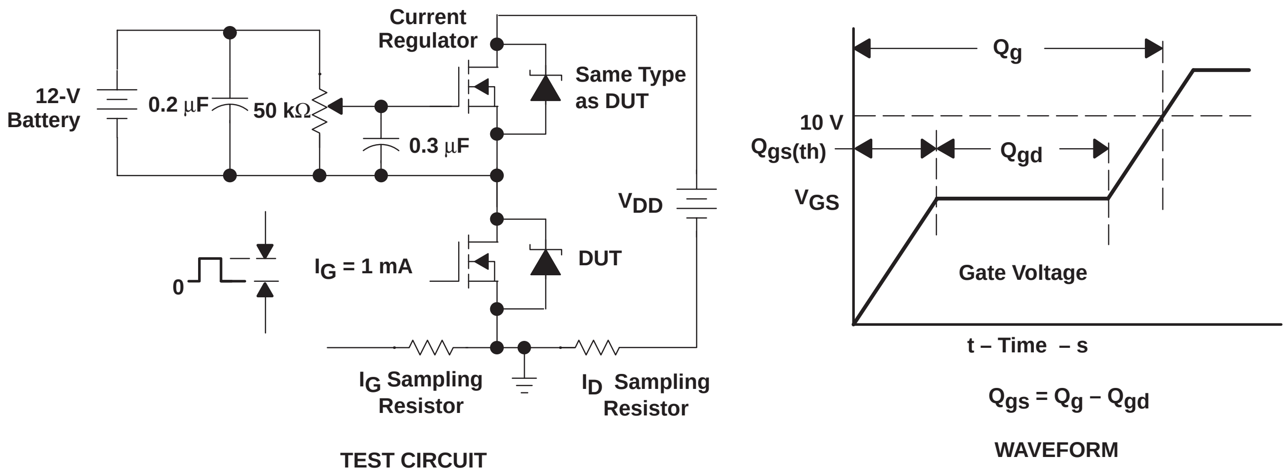
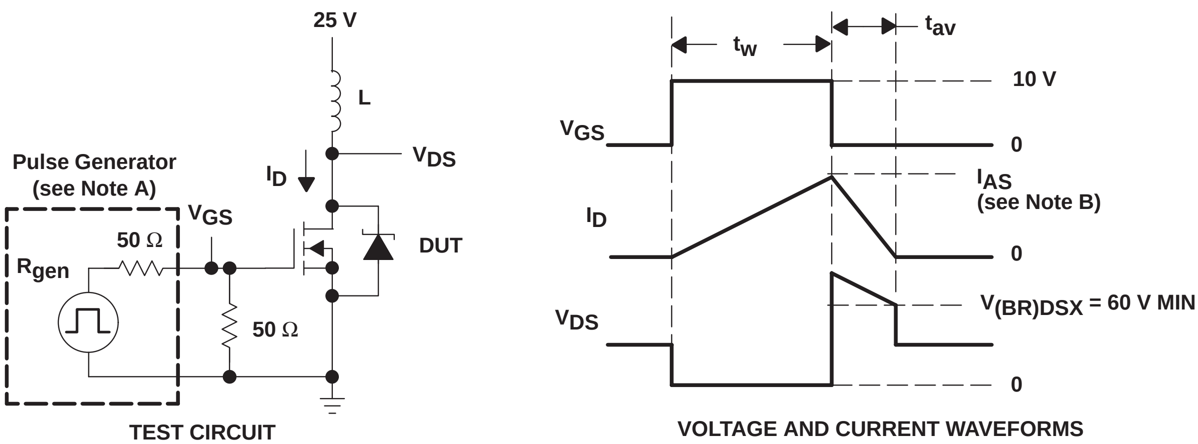


Figure 3. Gate Charge Test Circuit and Waveform



NOTES: A. The pulse generator has the following characteristics: $t_r \leq 10$ ns, $t_f \leq 10$ ns, $Z_O = 50\ \Omega$.
B. Input pulse duration (t_w) is increased until peak current $I_{AS} = 2$ 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

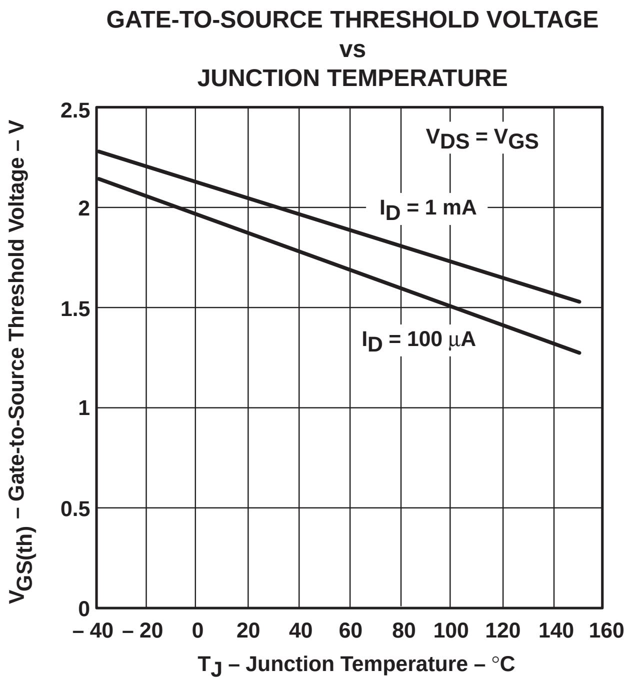


Figure 5

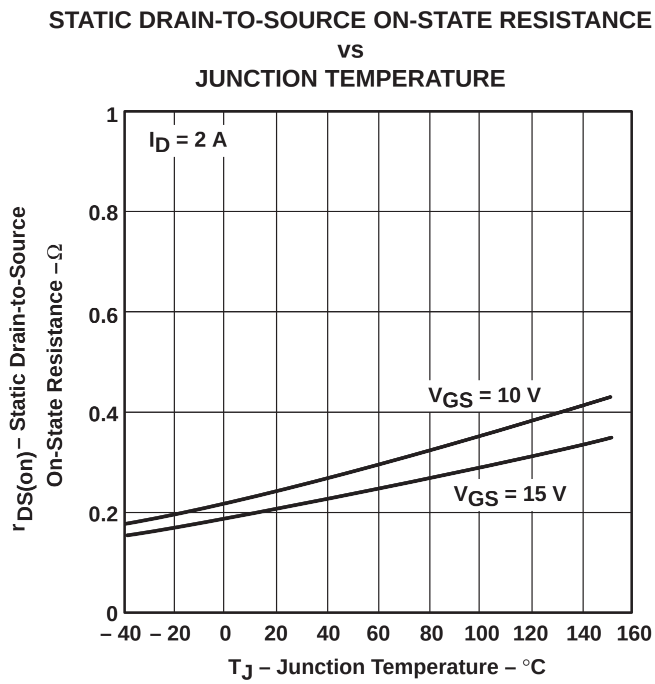


Figure 6

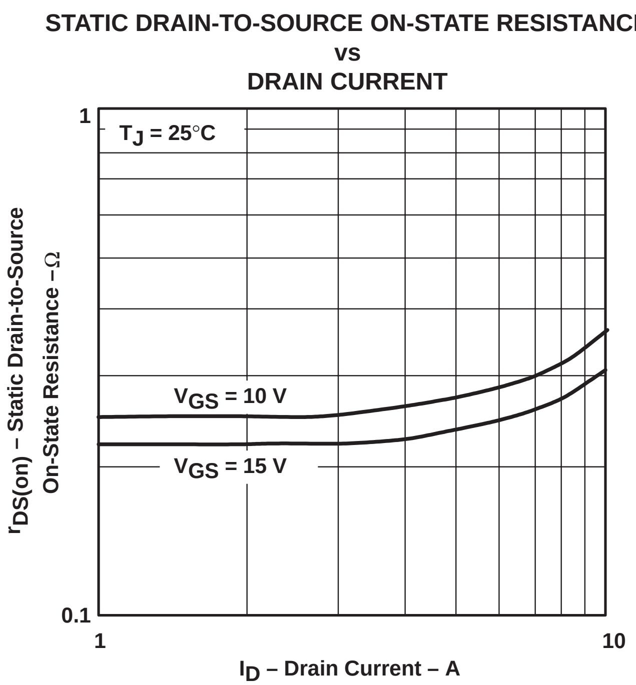


Figure 7

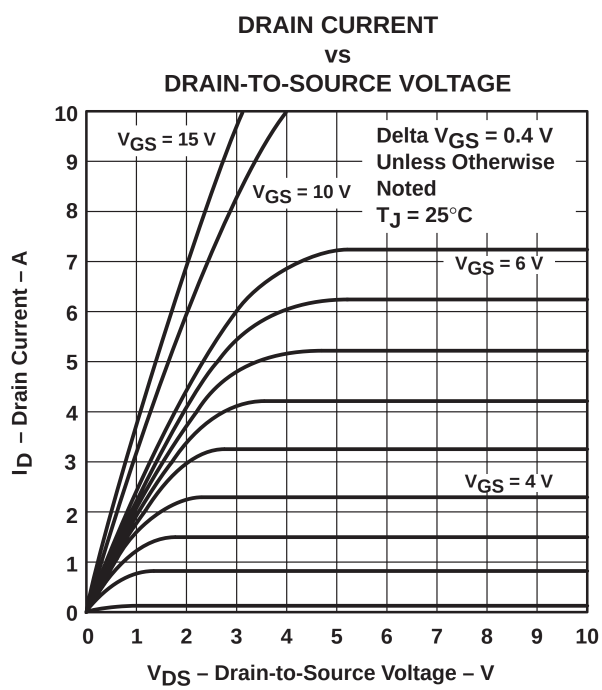


Figure 8

TYPICAL CHARACTERISTICS

DISTRIBUTION OF FORWARD TRANSCONDUCTANCE

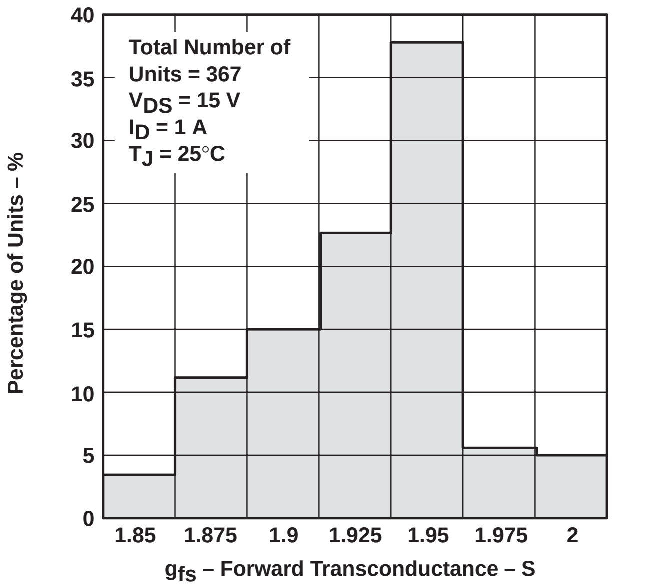


Figure 9

DRAIN CURRENT
vs
GATE-TO-SOURCE VOLTAGE

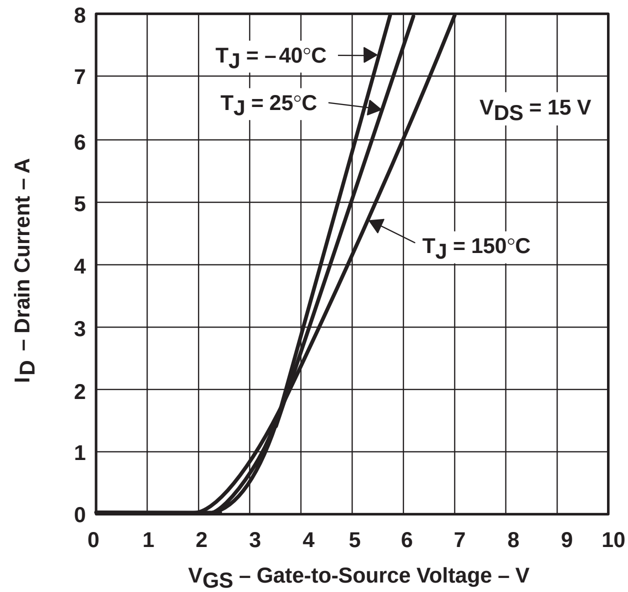


Figure 10

CAPACITANCE
vs
DRAIN-TO-SOURCE VOLTAGE

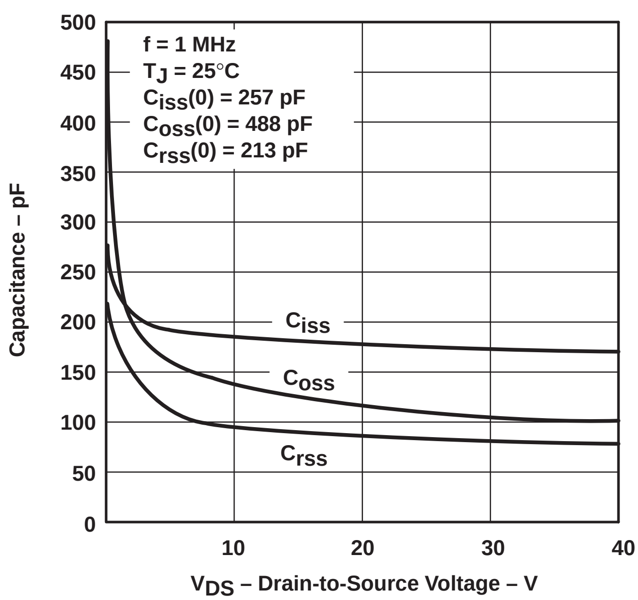


Figure 11

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

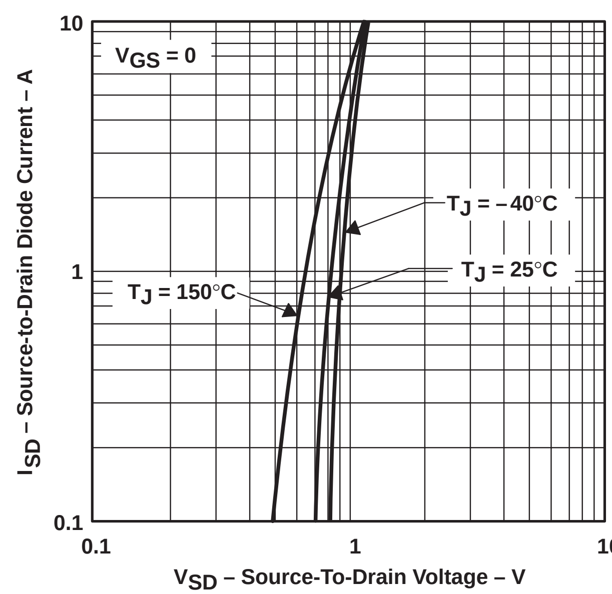


Figure 12

TYPICAL CHARACTERISTICS

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

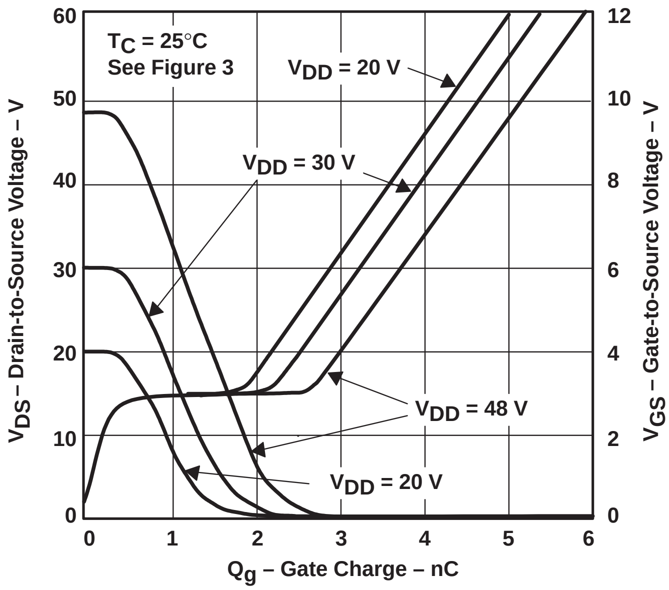


Figure 13

REVERSE-RECOVERY TIME vs REVERSE di/dt

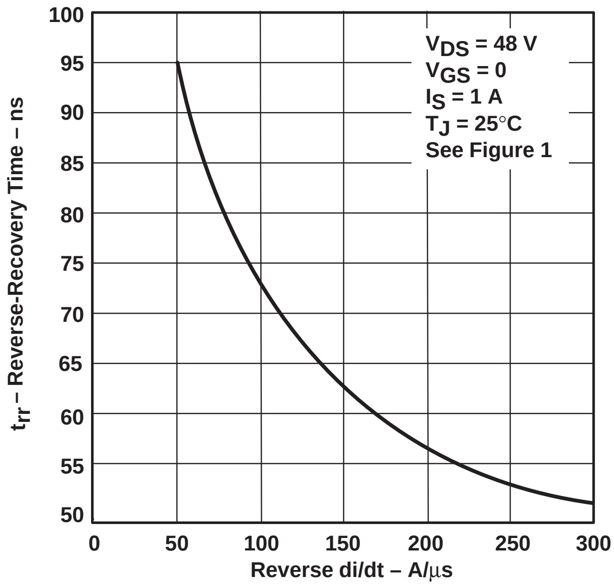


Figure 14

MAXIMUM DRAIN CURRENT vs DRAIN-TO-SOURCE VOLTAGE

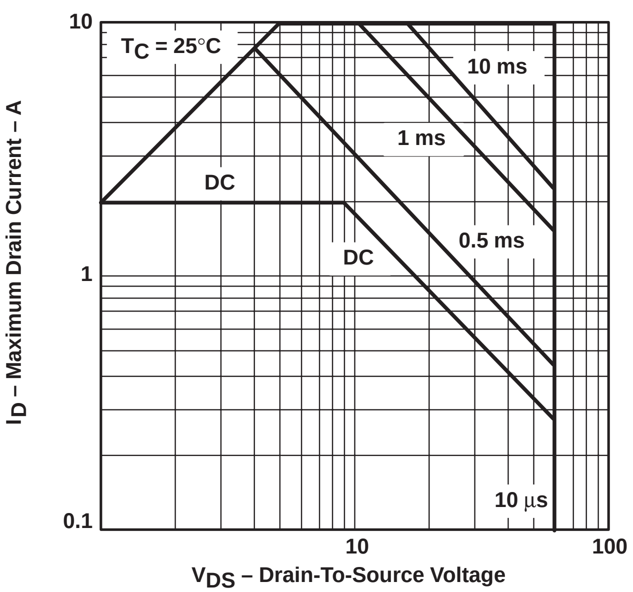


Figure 15

MAXIMUM PEAK AVALANCHE CURRENT vs TIME DURATION OF AVALANCHE

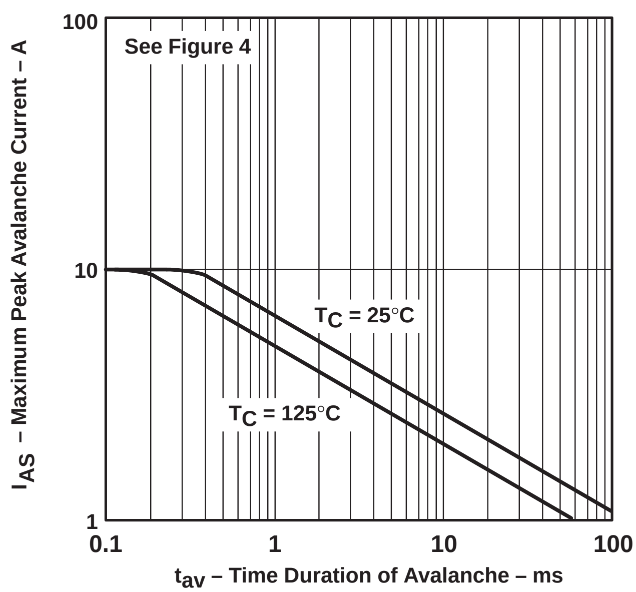
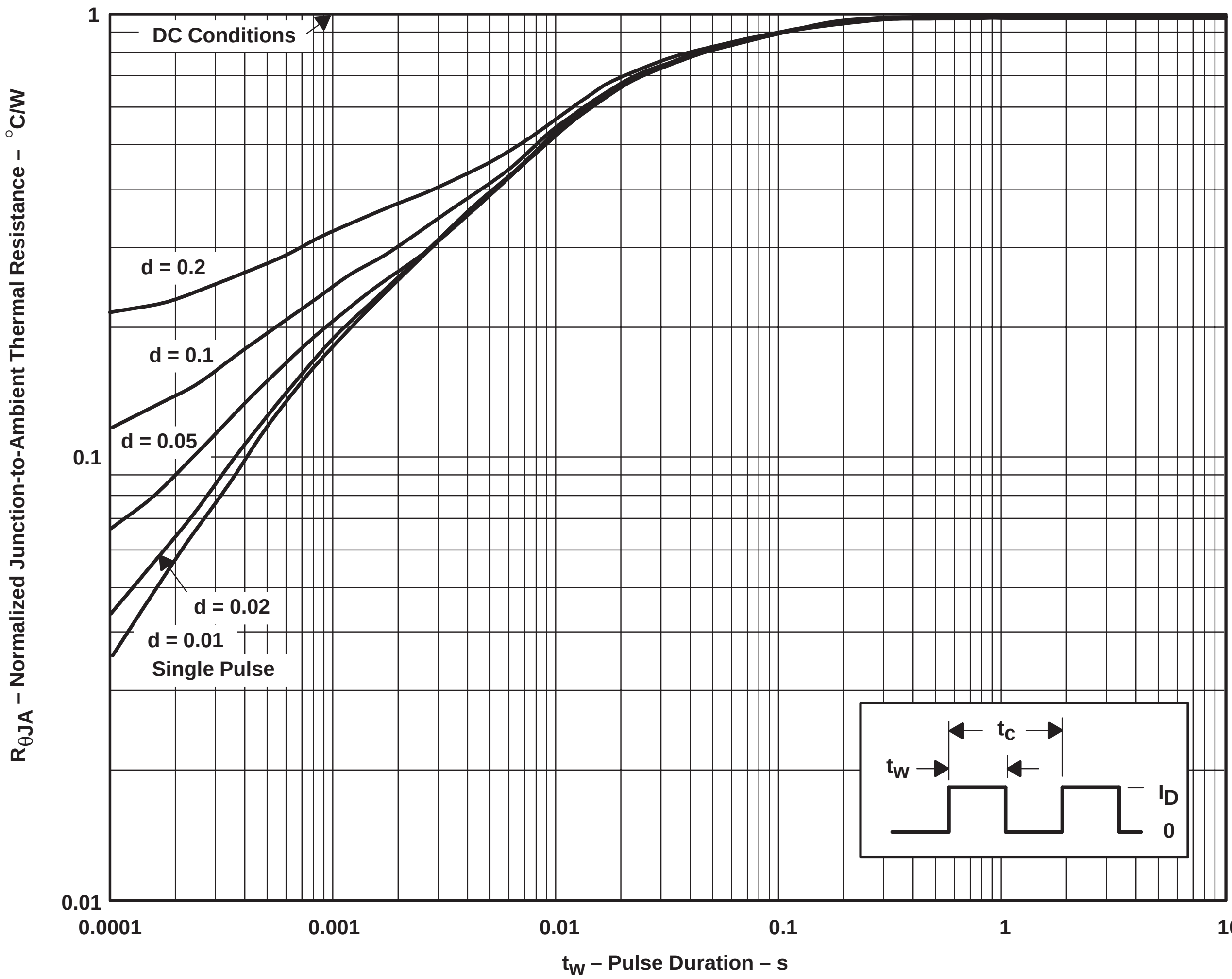


Figure 16

THERMAL INFORMATION

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



† Device mounted on 24 in^2, 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

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TPIC2601KTC	OBSOLETE	PFM	KTC	15		TBD	Call TI	Call TI

(1) 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.

(2) 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.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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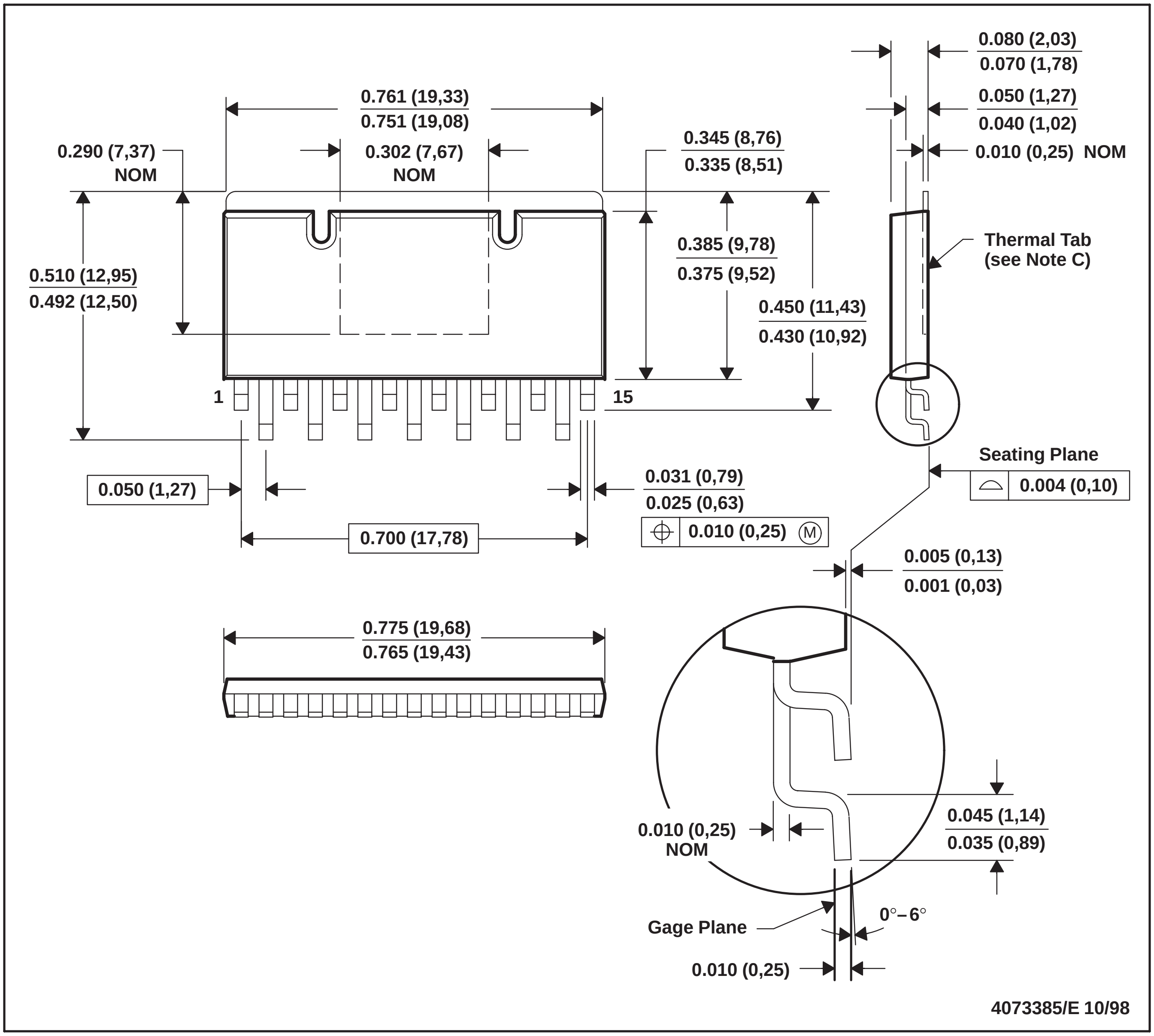
KTC (R-PSFM-G15) **PowerFLEX™ PLASTIC FLANGE-MOUNT**



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. The heatsink area is approximately 78K sq mils.
D. Dimensions do not include mold protrusions, not to exceed 0.006 (0,15).

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Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
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