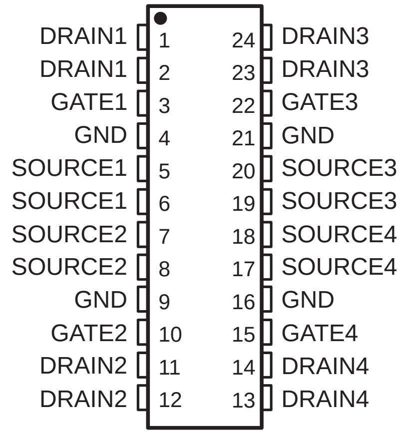
- **Low $r_{DS(on)}$ . . . 0.23 Ω Typ**
- **High Voltage Output . . . 60 V**
- **Extended ESD Capability . . . 4000 V**
- **Pulsed Current . . . 11.25 A Per Channel**
- **Fast Commutation Speed**

DW PACKAGE
(TOP VIEW)

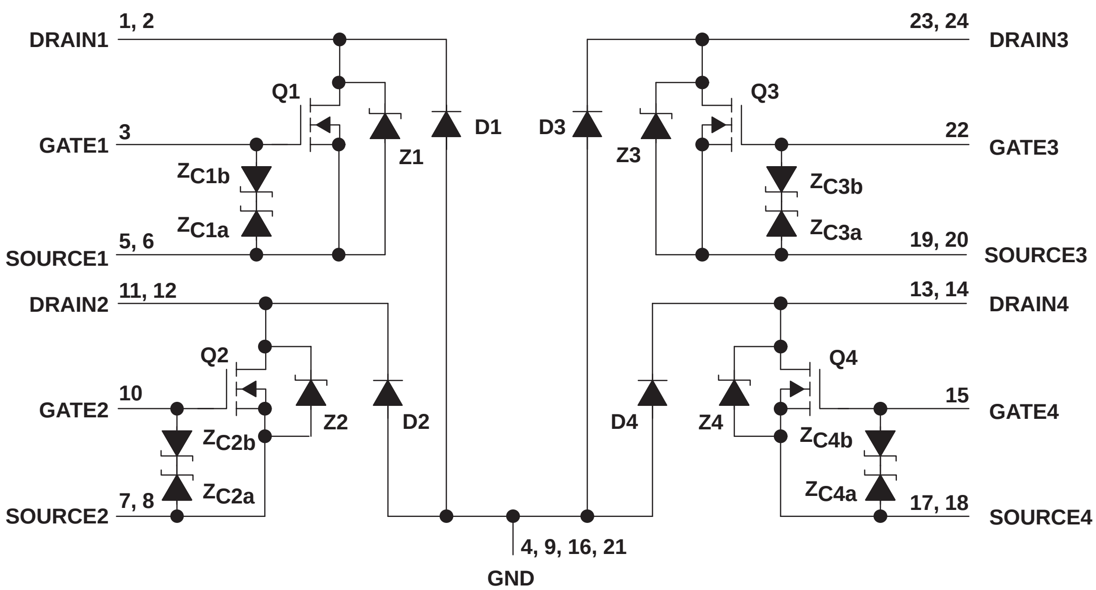


description

The TPIC5403 is a monolithic gate-protected power DMOS array that consists of four independent electrically isolated N-channel enhancement-mode DMOS transistors. Each transistor features integrated high-current zener diodes (Z_{CXa} and Z_{CXb}) to prevent gate damage in the event that an overstress condition occurs. These zener diodes also provide up to 4000 V of ESD protection when tested using the human-body model of a 100-pF capacitor in series with a 1.5-kΩ resistor.

The TPIC5403 is offered in a 24-pin wide-body surface-mount (DW) package and is characterized for operation over the case temperature range of –40°C to 125°C.

schematic



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

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

Drain-to-source voltage, V_{DS}	60 V
Source-to-GND voltage	100 V
Drain-to-GND voltage	100 V
Gate-to-source voltage range, V_{GS}	–9 V to 18 V
Continuous drain current, each output, T_C = 25°C	2.25 A
Continuous source-to-drain diode current, T_C = 25°C	2.25 A
Pulsed drain current, each output, I_{max}, T_C = 25°C (see Note 1 and Figure 15)	11.25 A
Continuous gate-to-source zener diode current, T_C = 25°C	±50 mA
Pulsed gate-to-source zener diode current, T_C = 25°C	±500 mA
Single-pulse avalanche energy, E_{AS}, T_C = 25°C (see Figures 4, 15, and 16)	17.2 mJ
Continuous total power dissipation, T_C = 25°C (see Figure 15)	1.39 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}	–65°C to 150°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	1.75	2.2	V
$V_{(BR)GS}$	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
$V_{(BR)}$	Reverse drain-to-GND breakdown voltage (across D1, D2, D3, and D4)	Drain-to-GND current = 250 µA		100			V
$V_{DS(on)}$	Drain-to-source on-state voltage	I_D = 2.25 A, V_{GS} = 10 V, See Notes 2 and 3			0.5	0.62	V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	I_S = 2.25 A, V_{GS} = 0 (Z1, Z2, Z3, Z4), See Notes 2 and 3 and Figure 12			0.9	1.1	V
V_F	Forward on-state voltage, GND-to-drain	I_D = 2.25 A (D1, D2, D3, D4), See Notes 2 and 3			2.5		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
I_{lkg}	Leakage current, drain-to-GND	V_{DGND} = 48 V	T_C = 25°C		0.05	1	µA
			T_C = 125°C		0.5	10	
$r_{DS(on)}$	Static drain-to-source on-state resistance	V_{GS} = 10 V, I_D = 2.25 A, See Notes 2 and 3 and Figures 6 and 7	T_C = 25°C		0.23	0.27	Ω
			T_C = 125°C		0.35	0.4	
g_{fs}	Forward transconductance	V_{DS} = 15 V, I_D = 1.125 A, See Notes 2 and 3 and Figure 9		1.6	2.1		S
C_{iss}	Short-circuit input capacitance, common source	V_{DS} = 25 V, V_{GS} = 0, f = 1 MHz, See Figure 11			200	250	pF
C_{oss}	Short-circuit output capacitance, common source				100	175	
C_{rss}	Short-circuit reverse-transfer capacitance, common source				60	75	

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 and GND-to-drain diode characteristics, T_C = 25°C

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{rr}	Reverse-recovery time	I_S = 1.125 A, V_{DS} = 48 V, V_{GS} = 0, di/dt = 100 A/µs, See Figures 1 and 14	Z1, Z2, Z3, and Z4		80		ns
			D1, D2, D3, and D4		160		
Q_{RR}	Total diode charge		Z1, Z2, Z3, and Z4		0.12		µC
			D1, D2, D3, and D4		0.5		

resistive-load switching characteristics, T_C = 25°C

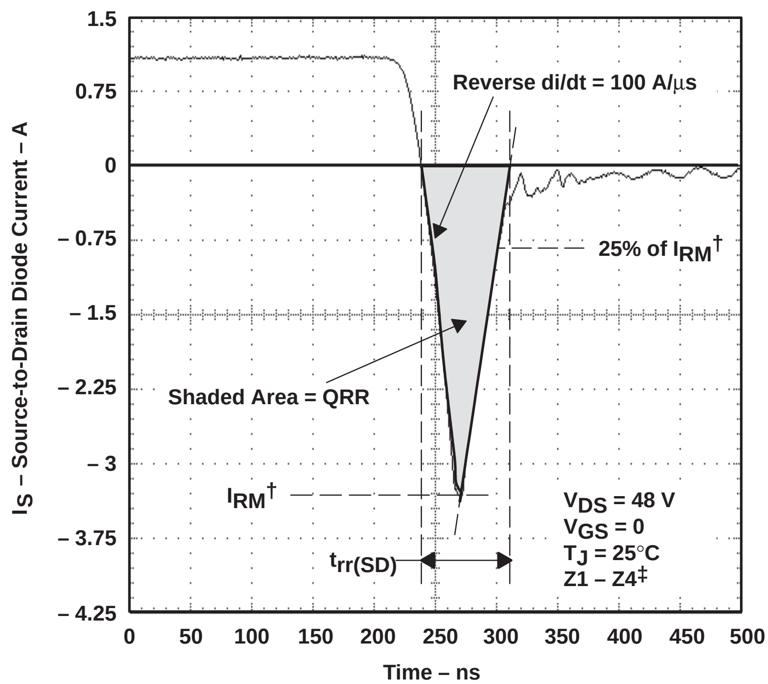
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(on)}$	Turn-on delay time	V_{DD} = 25 V, R_L = 20 Ω, t_{r1} = 10 ns, t_{f1} = 10 ns, See Figure 2		32	55	ns
$t_{d(off)}$	Turn-off delay time			27	50	
t_{r2}	Rise time			14	30	
t_{f2}	Fall time			7	15	
Q_g	Total gate charge	V_{DS} = 48 V, I_D = 1.125 A, V_{GS} = 10 V, See Figure 3		6.6	8	nC
$Q_{gs(th)}$	Threshold gate-to-source charge			0.6	0.7	
Q_{gd}	Gate-to-drain charge			2.8	3.2	
L_D	Internal drain inductance			5		nH
L_S	Internal source inductance			5		
R_g	Internal gate resistance			0.25		Ω

thermal resistance

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	See Notes 4 and 7		90		°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	See Notes 5 and 7		49		°C/W
$R_{\theta JP}$	Junction-to-pin thermal resistance	See Notes 6 and 7		28		°C/W

NOTES: 4. Package mounted on an FR4 printed-circuit board with no heatsink
5. Package mounted on a 24 $inch^2$, 4-layer FR4 printed-circuit board
6. Package mounted in intimate contact with infinite heatsink
7. All outputs with equal power

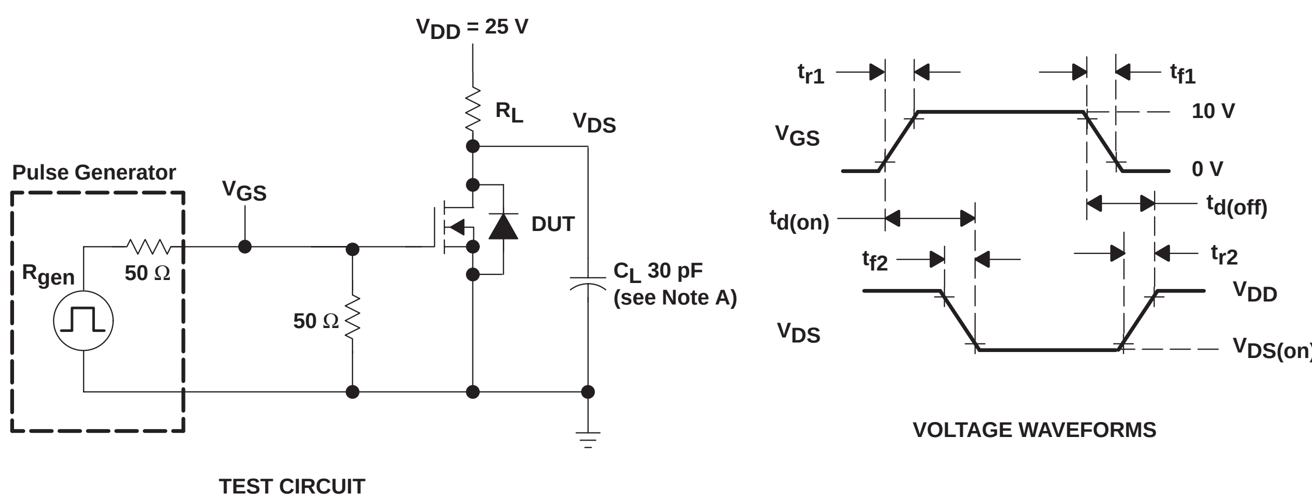
PARAMETER MEASUREMENT INFORMATION



† I_{RM} = maximum recovery current

‡ The above waveform is representative of D1, D2, D3, and D4 in shape only.

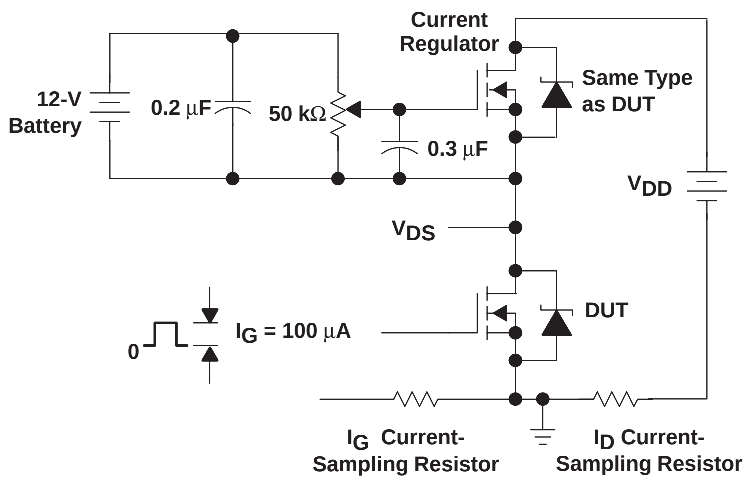
Figure 1. Reverse-Recovery-Current Waveform of Source-to-Drain Diode



NOTE A: C_L includes probe and jig capacitance.

Figure 2. Resistive-Switching Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION



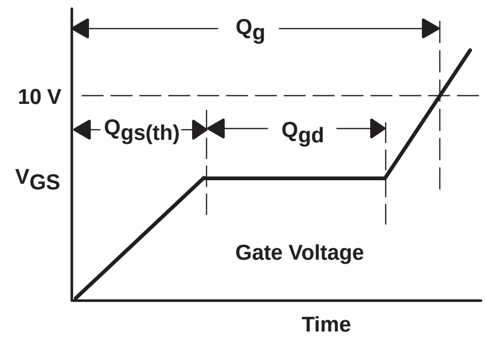
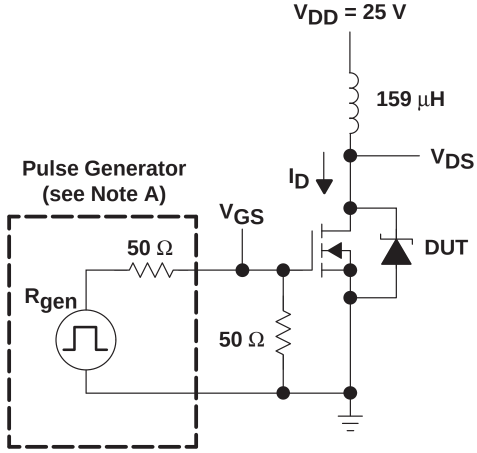
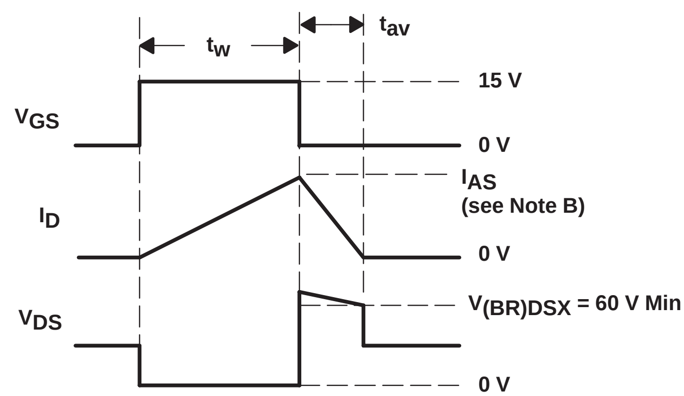


Figure 3. Gate-Charge Test Circuit and Voltage Waveform





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 $I_{AS} = 11.25$ A.

Energy test level is defined as $E_{AS} = \frac{I_{AS} \times V_{(BR)DSX} \times t_{av}}{2} = 17.2$ mJ.

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

TYPICAL CHARACTERISTICS

GATE-TO-SOURCE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

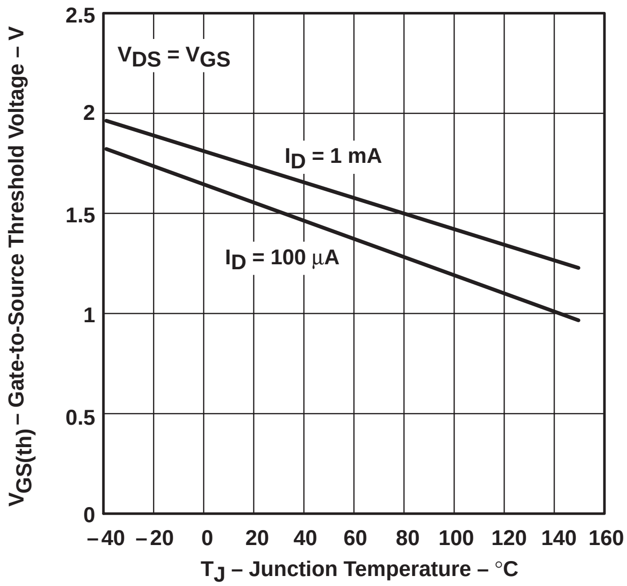


Figure 5

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

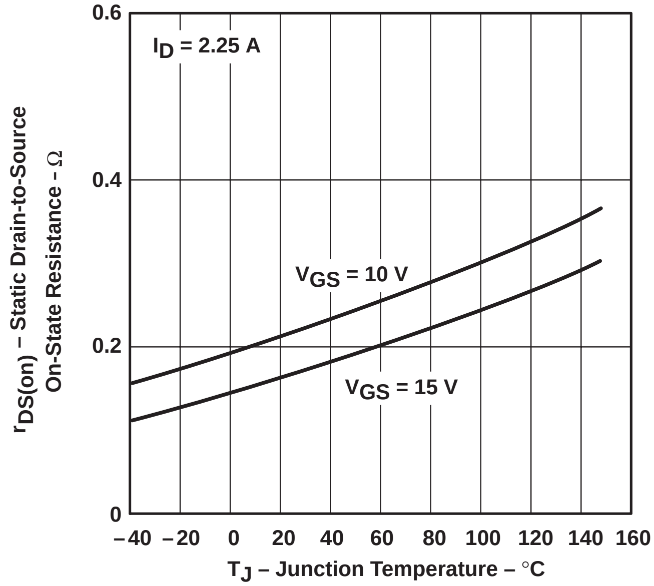


Figure 6

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

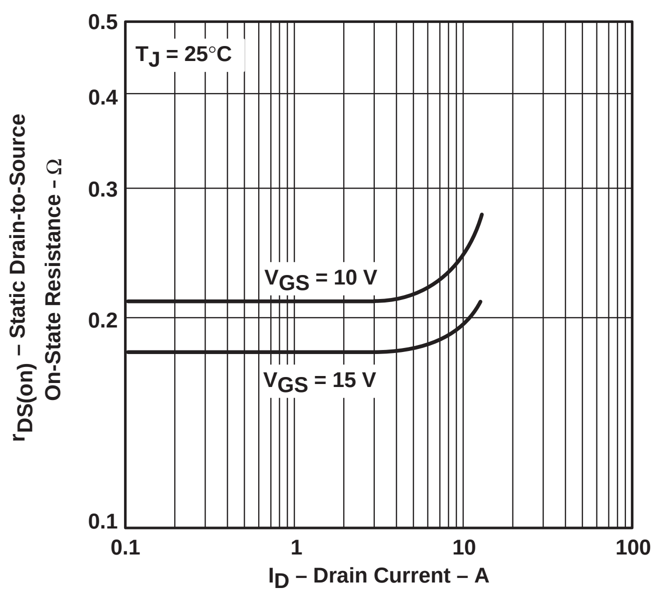


Figure 7

DRAIN CURRENT vs DRAIN-TO-SOURCE VOLTAGE

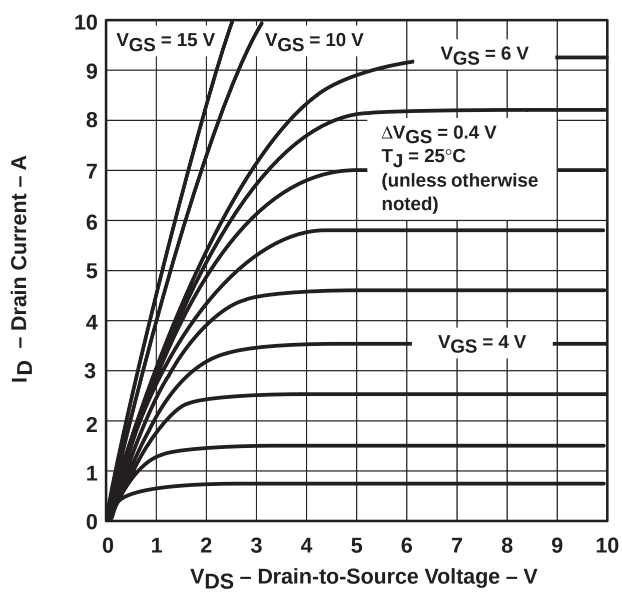


Figure 8

PRODUCT PREVIEW

TYPICAL CHARACTERISTICS

DISTRIBUTION OF
FORWARD TRANSCONDUCTANCE

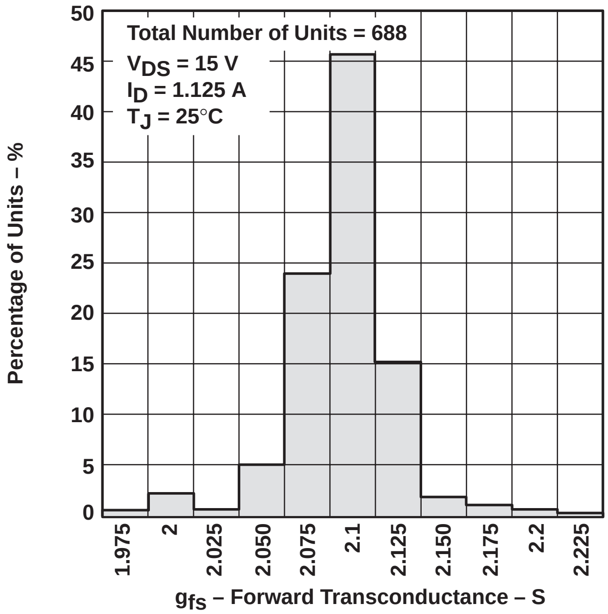


Figure 9

DRAIN CURRENT
vs
GATE-TO-SOURCE VOLTAGE

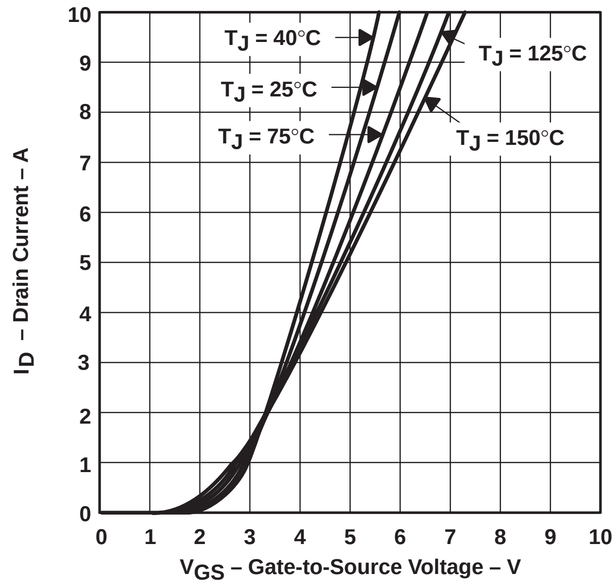


Figure 10

CAPACITANCE
vs
DRAIN-TO-SOURCE VOLTAGE

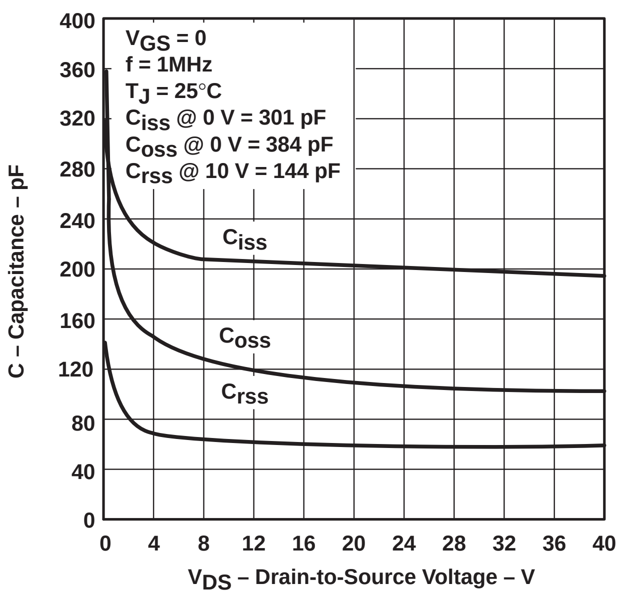


Figure 11

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

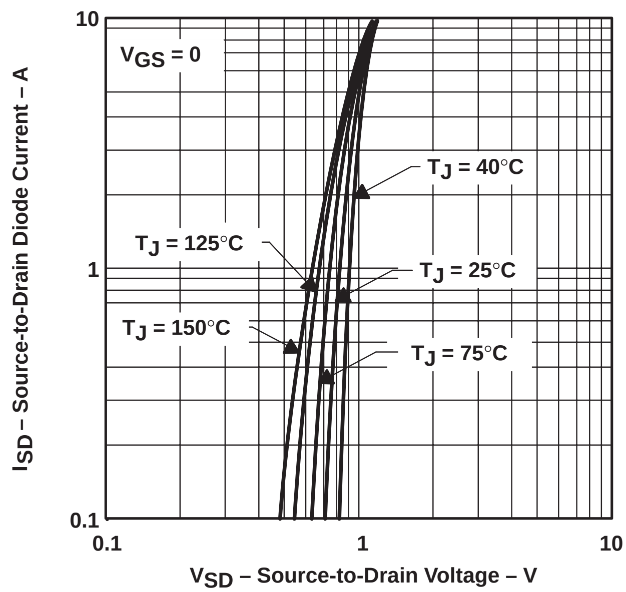


Figure 12

TYPICAL CHARACTERISTICS

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

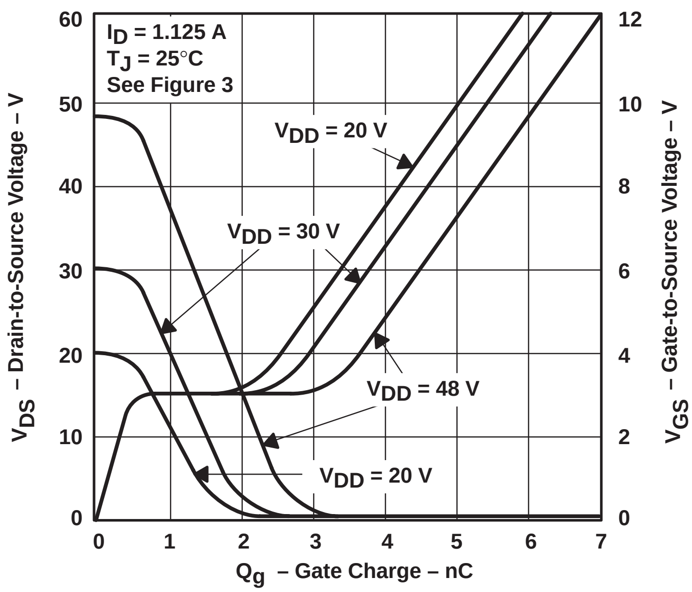


Figure 13

REVERSE-RECOVERY TIME vs REVERSE di/dt

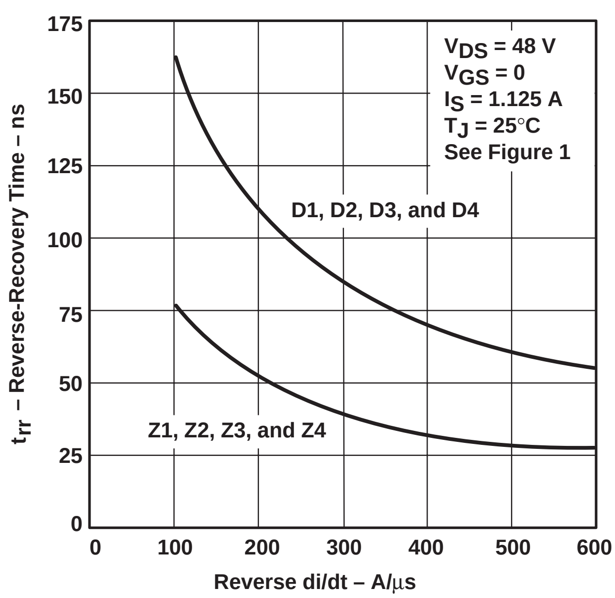
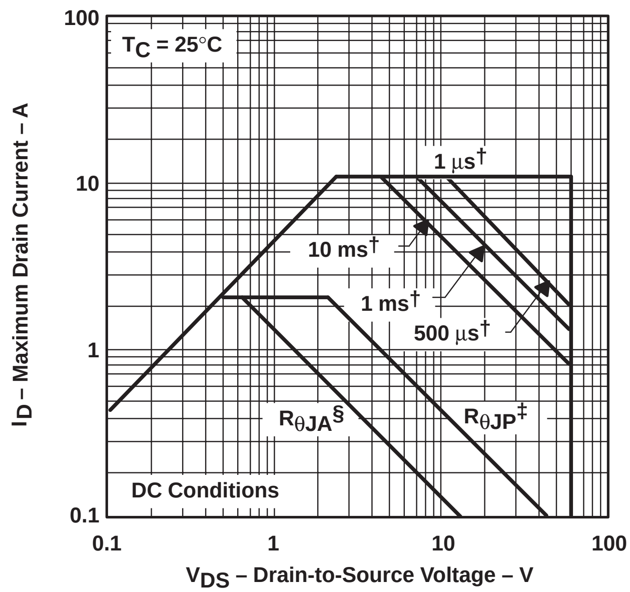


Figure 14

THERMAL INFORMATION

MAXIMUM DRAIN CURRENT
vs
DRAIN-TO-SOURCE VOLTAGE



† Less than 2% duty cycle
‡ Device mounted in intimate contact with infinite heatsink.
§ Device mounted on FR4 printed circuit board with no heatsink.

Figure 15

MAXIMUM PEAK AVALANCHE CURRENT
vs
TIME DURATION OF AVALANCHE

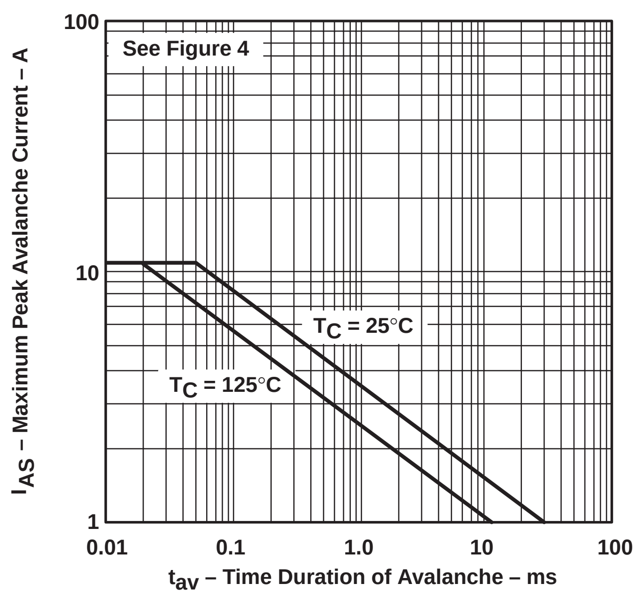
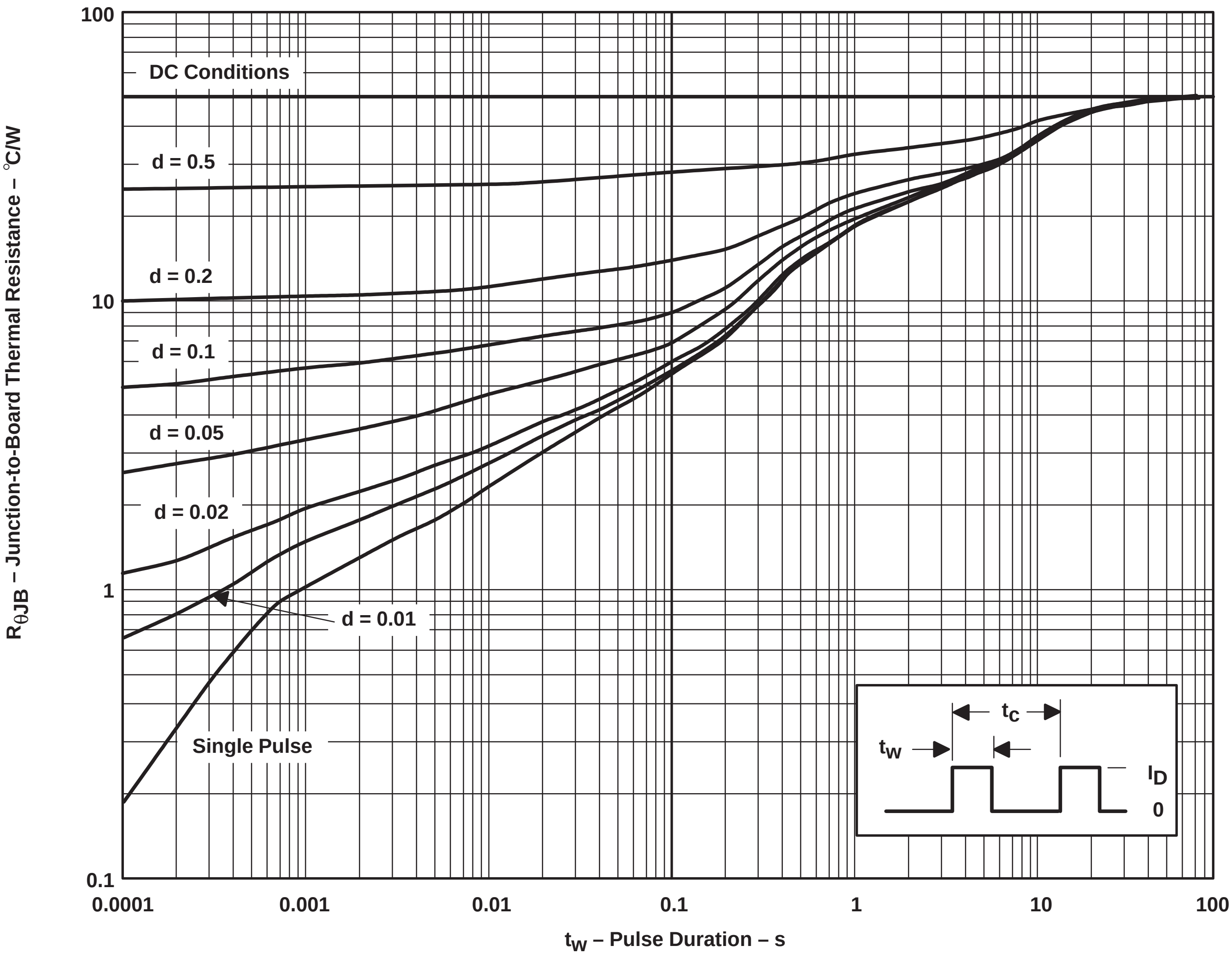


Figure 16

THERMAL INFORMATION

**DW PACKAGE†
JUNCTION-TO-BOARD THERMAL RESISTANCE
vs
PULSE DURATION**



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

NOTE A: $Z_{\theta JB}(t) = r(t)\, R_{\theta JB}$
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]
TPIC5403DW	OBSOLETE	SOIC	DW	24		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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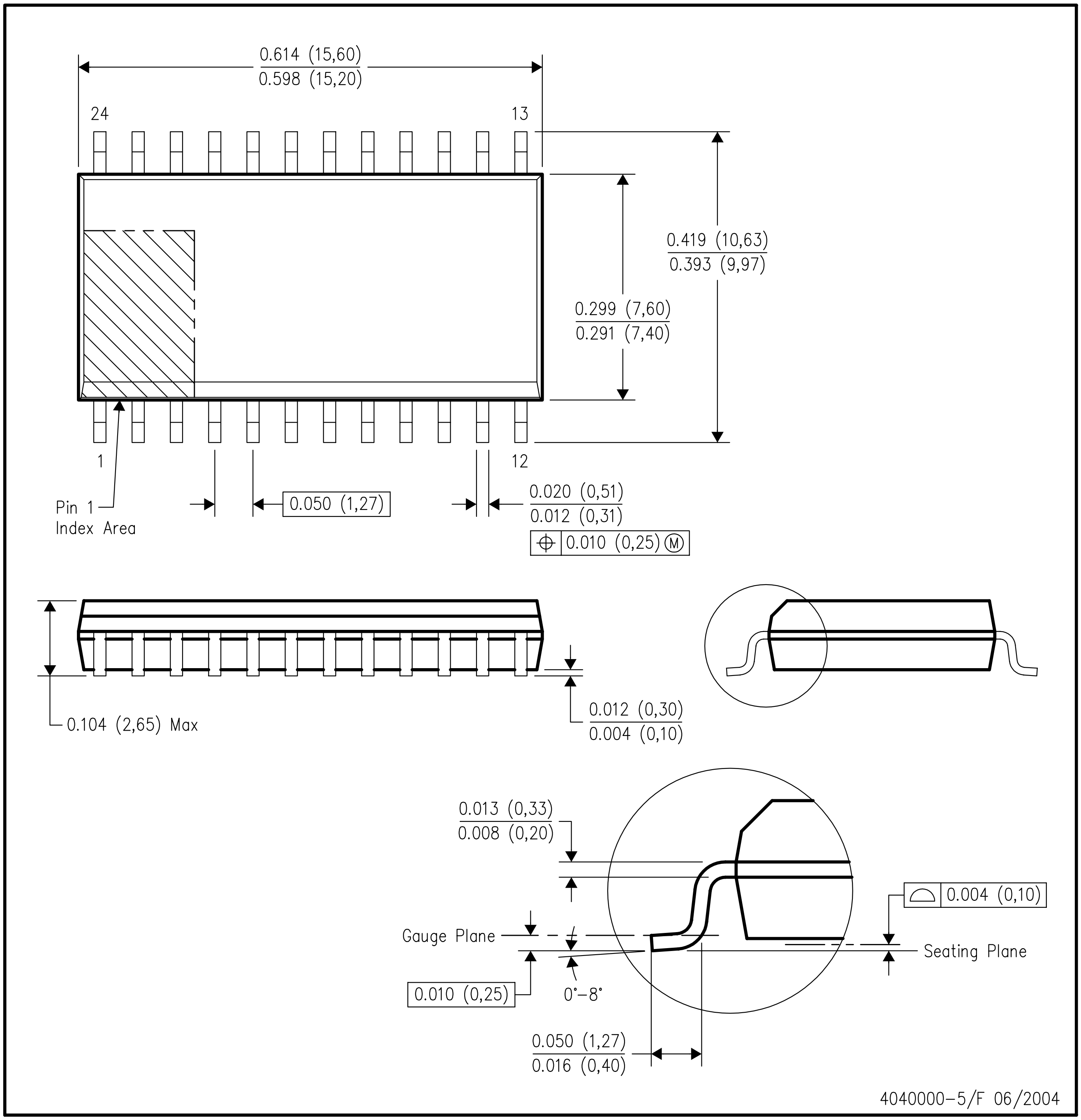
DW (R-PDSO-G24) PLASTIC SMALL-OUTLINE PACKAGE



NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
- D. Falls within JEDEC MS-013 variation AD.

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