

4-CHANNEL INDEPENDENT GATE-PROTECTED LOGIC-LEVEL POWER DMOS ARRAY

SLIS045 – NOVEMBER 1994

- Low $r_{DS(on)}$. . . 0.32 Ω Typ
- Voltage Output . . . 60 V
- Input Protection Circuitry . . . 18 V
- Pulsed Current . . . 4 A Per Channel
- Extended ESD Capability . . . 4000 V
- Direct Logic-Level Interface

description

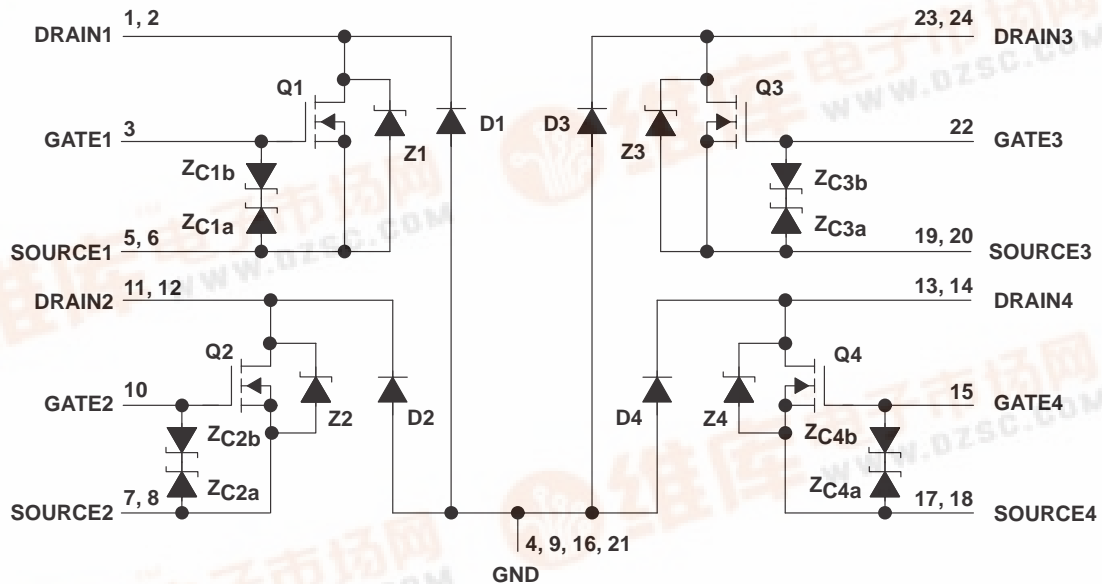
The TPIC5423L is a monolithic gate-protected logic-level power DMOS array that consists of four electrically isolated independent N-channel enhancement-mode DMOS transistors. Each transistor features integrated high-current zener diodes (Z_{CXa} and Z_{CXb}) to prevent gate damage in the event that an 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-k Ω resistor.

The TPIC5423L is offered in a 24-pin wide-body surface-mount (DW) package and is characterized for operation over the case temperature of -40°C to 125°C .

DW PACKAGE
(TOP VIEW)

DRAIN1	1	24	DRAIN3
DRAIN1	2	23	DRAIN3
GATE1	3	22	GATE3
GND	4	21	GND
SOURCE1	5	20	SOURCE3
SOURCE1	6	19	SOURCE3
SOURCE2	7	18	SOURCE4
SOURCE2	8	17	SOURCE4
GND	9	16	GND
GATE2	10	15	GATE4
DRAIN2	11	14	DRAIN4
DRAIN2	12	13	DRAIN4

schematic



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



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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, $T_C = 25^\circ\text{C}$	1.25 A
Continuous source-to-drain diode current, $T_C = 25^\circ\text{C}$	1.25 A
Pulsed drain current, each output, I_{max} , $T_C = 25^\circ\text{C}$ (see Note 1 and Figure 15)	4 A
Continuous gate-to-source zener-diode current, $T_C = 25^\circ\text{C}$	± 50 mA
Pulsed gate-to-source zener-diode current, $T_C = 25^\circ\text{C}$	± 500 mA
Single-pulse avalanche energy, E_{AS} , $T_C = 25^\circ\text{C}$ (see Figures 4 and 16)	96 mJ
Continuous total dissipation, $T_C = 25^\circ\text{C}$ (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	-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%

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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	$I_D = 1 \text{ mA}$, See Figure 5	$V_{DS} = V_{GS}$,	1.5	1.75	2.2	V
$V_{(BR)GS}$	Gate-to-source breakdown voltage	$I_{GS} = 250 \mu\text{A}$		18			V
$V_{(BR)SG}$	Source-to-gate breakdown voltage	$I_{SG} = 250 \mu\text{A}$		9			V
$V_{(BR)}$	Reverse drain-to-GND breakdown voltage	Drain-to-GND current = $250 \mu\text{A}$		100			V
$V_{DS(on)}$	Drain-to-source on-state voltage	$I_D = 1.25 \text{ A}$, See Notes 2 and 3	$V_{GS} = 5 \text{ V}$,		0.4	0.47	V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	$I_S = 1.25 \text{ A}$, $V_{GS} = 0$ (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	$I_D = 1.25 \text{ A}$ (D1, D2, D3, D4), See Notes 2 and 3			2		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	μA
			$T_C = 125^\circ\text{C}$		0.5	10	
I_{GSSF}	Forward-gate current, drain short circuited to source	$V_{GS} = 15 \text{ V}$,	$V_{DS} = 0$		20	200	nA
I_{GSSR}	Reverse-gate current, drain short circuited to source	$V_{SG} = 5 \text{ V}$,	$V_{DS} = 0$		10	100	nA
I_{lkg}	Leakage current, drain-to-GND	$V_{DGND} = 48 \text{ V}$	$T_C = 25^\circ\text{C}$		0.05	1	μA
			$T_C = 125^\circ\text{C}$		0.5	10	
$r_{DS(on)}$	Static drain-to-source on-state resistance	$V_{GS} = 5 \text{ V}$, $I_D = 1.25 \text{ A}$, See Notes 2 and 3 and Figures 6 and 7	$T_C = 25^\circ\text{C}$		0.32	0.375	Ω
			$T_C = 125^\circ\text{C}$		0.44	0.55	
g_{fs}	Forward transconductance	$V_{DS} = 15 \text{ V}$, See Notes 2 and 3 and Figure 9	$I_D = 0.625 \text{ A}$,	1.25	1.63		S
C_{iss}	Short-circuit input capacitance, common source				200	250	pF
C_{oss}	Short-circuit output capacitance, common source	$V_{DS} = 25 \text{ V}$, $f = 1 \text{ MHz}$,	$V_{GS} = 0$, See Figure 11		100	125	
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, $T_C = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{rr}	Reverse-recovery time	$I_S = 0.625 \text{ A}$, $V_{GS} = 0$, See Figures 1 and 14	$V_{DS} = 48 \text{ V}$, $di/dt = 100 \text{ A}/\mu\text{s}$,	Z1, Z2, Z3, and Z4	80		ns
				D1, D2, D3, and D4	130		
Q_{RR}	Total diode charge			Z1, Z2, Z3, and Z4	0.8		μC
				D1, D2, D3, and D4	0.66		

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

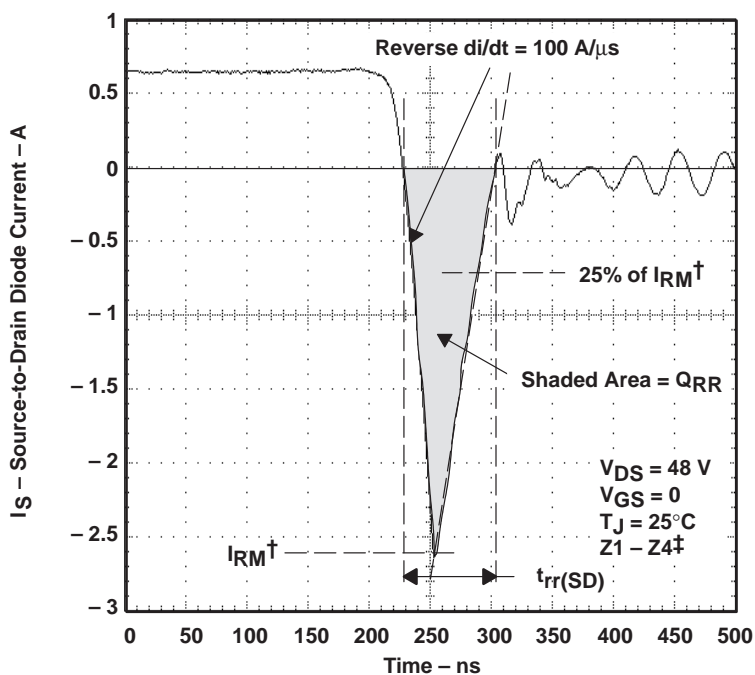
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(on)}$ Turn-on delay time	$V_{DD} = 25\text{ V}$, $R_L = 40\ \Omega$, $t_{en} = 10\text{ ns}$, $t_{dis} = 10\text{ ns}$, See Figure 2		34	70	ns
$t_{d(off)}$ Turn-off delay time			20	40	
t_r Rise time			28	55	
t_f Fall time			15	30	
Q_g Total gate charge	$V_{DS} = 48\text{ V}$, $I_D = 0.625\text{ A}$, $V_{GS} = 5\text{ V}$, See Figure 3		6.6	8	nC
$Q_{gs(th)}$ Threshold gate-to-source charge			0.5	0.6	
Q_{gd} Gate-to-drain charge			2.6	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		$^\circ\text{C}/\text{W}$
$R_{\theta JB}$ Junction-to-board thermal resistance	See Notes 5 and 7		49		
$R_{\theta JP}$ Junction-to-pin thermal resistance	See Notes 6 and 7		28		

- NOTES:
- Package mounted on an FR4 printed-circuit board with no heatsink.
 - Package mounted on a 24 in², 4-layer FR4 printed-circuit board.
 - Package mounted in intimate contact with infinite heatsink.
 - All outputs with equal power.

PARAMETER MEASUREMENT INFORMATION



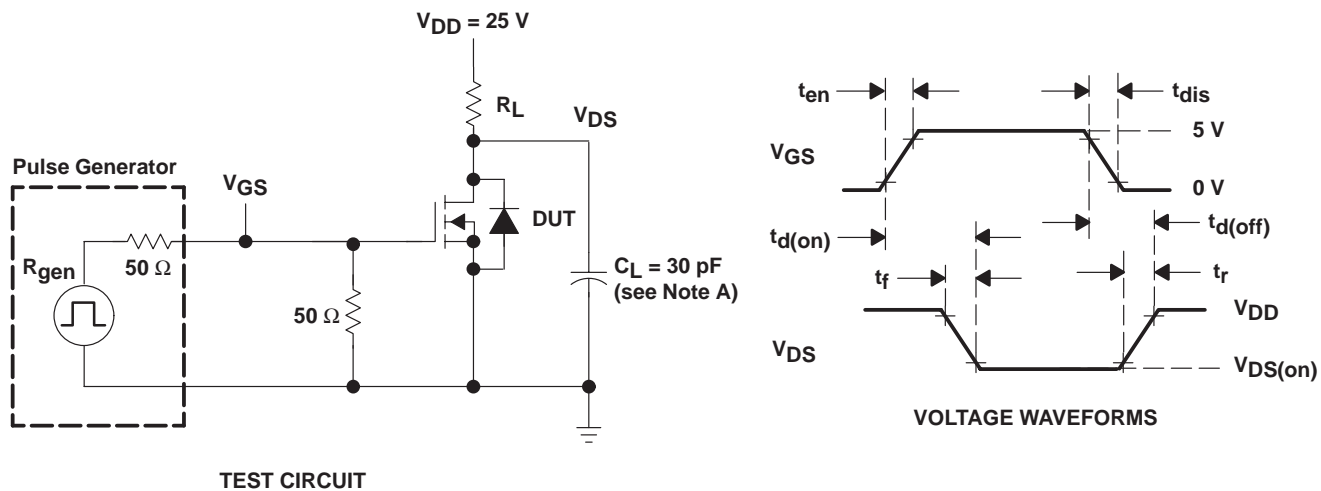
† I_{RM} = maximum recovery current

‡ 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

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NOTE A: C_L includes probe and jig capacitance.

Figure 2. Resistive-Switching Test Circuit and Voltage Waveforms

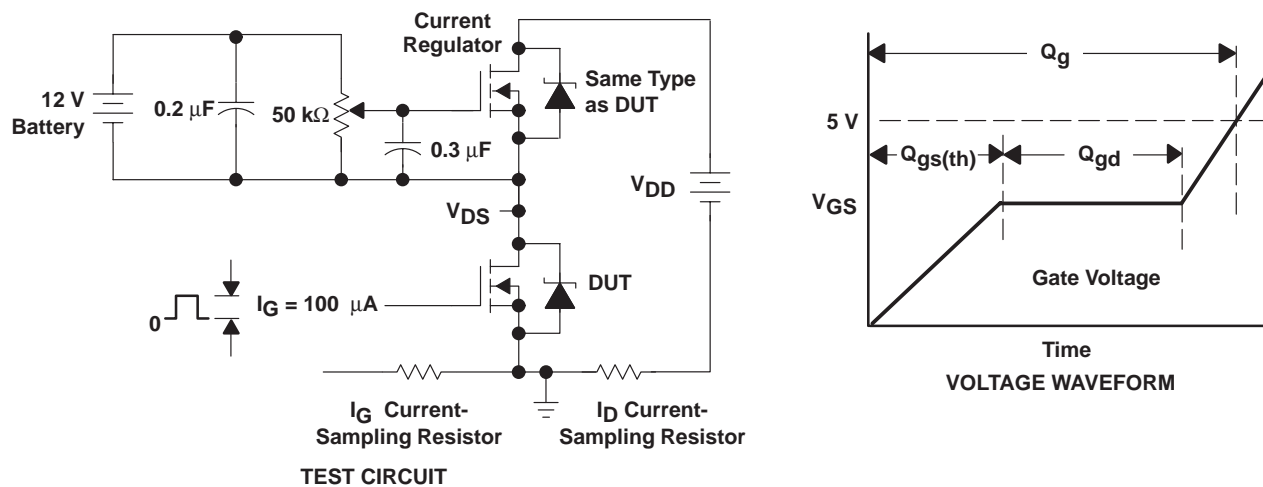


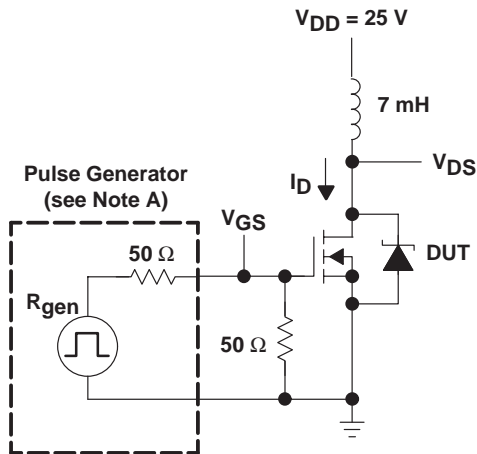
Figure 3. Gate-Charge Test Circuit and Voltage Waveform

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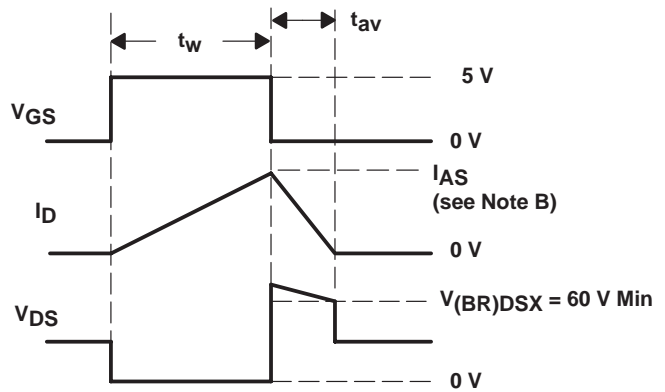
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PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

- NOTES: A. The pulse generator has the following characteristics: $t_r \leq 10 \text{ ns}$, $t_f \leq 10 \text{ ns}$, $Z_O = 50 \Omega$.
 B. Input pulse duration (t_w) is increased until peak current $I_{AS} = 4 \text{ A}$.

$$\text{Energy test level is defined as } E_{AS} = \frac{I_{AS} \times V_{(BR)DSX} \times t_{av}}{2} = 96 \text{ mJ.}$$

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

TYPICAL CHARACTERISTICS

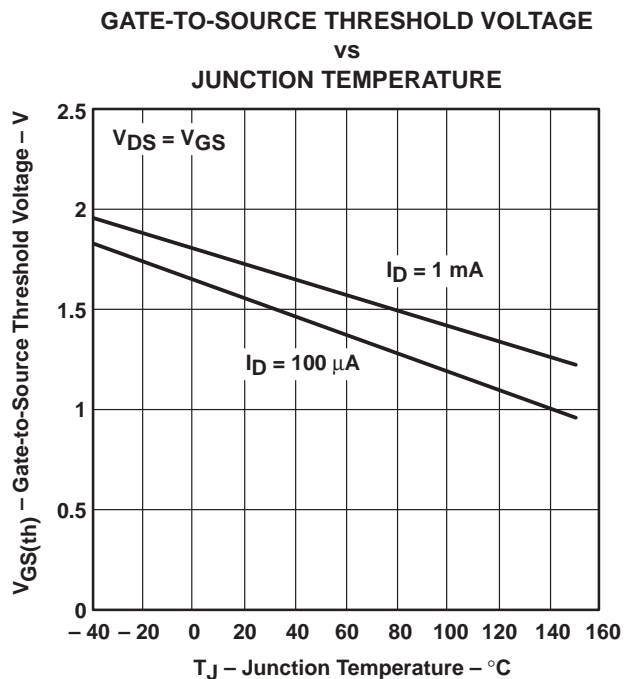


Figure 5

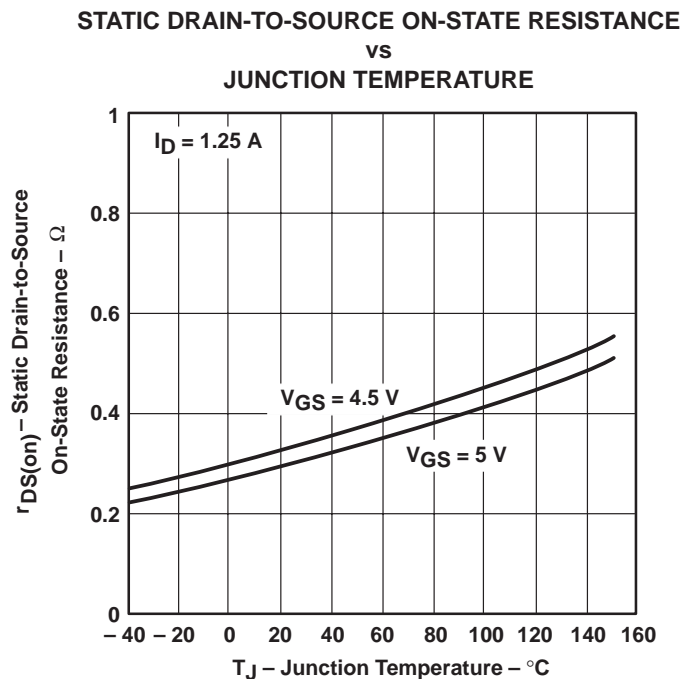


Figure 6

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4-CHANNEL INDEPENDENT GATE-PROTECTED LOGIC-LEVEL
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TYPICAL CHARACTERISTICS

STATIC DRAIN-TO-SOURCE ON-STATE RESISTANCE

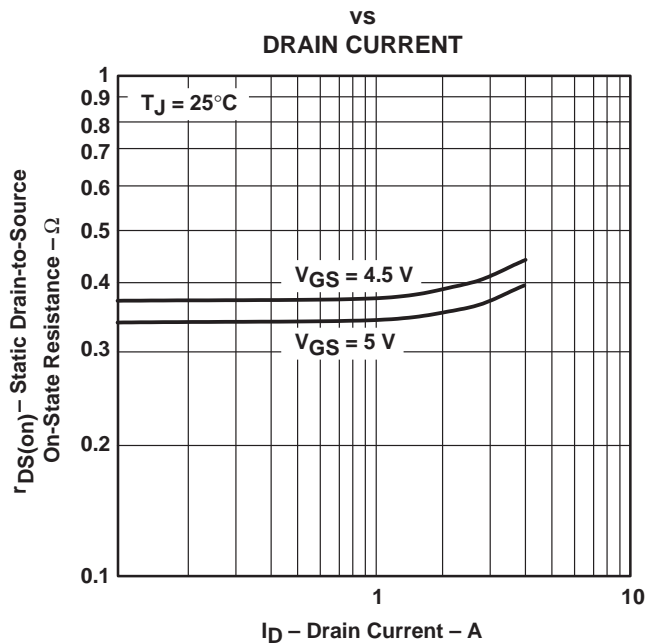


Figure 7

DRAIN CURRENT

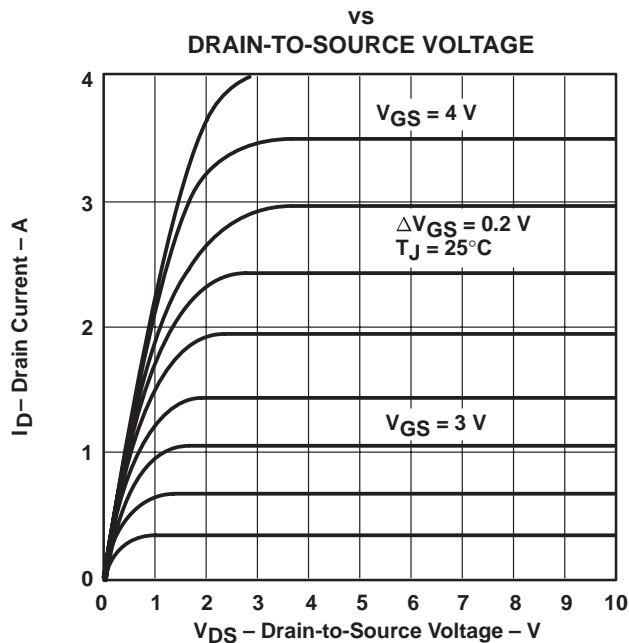


Figure 8

DISTRIBUTION OF FORWARD TRANSCONDUCTANCE

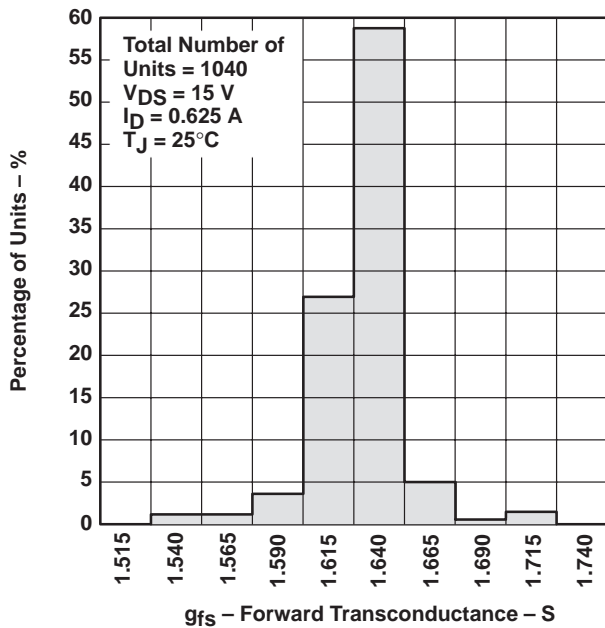


Figure 9

DRAIN CURRENT

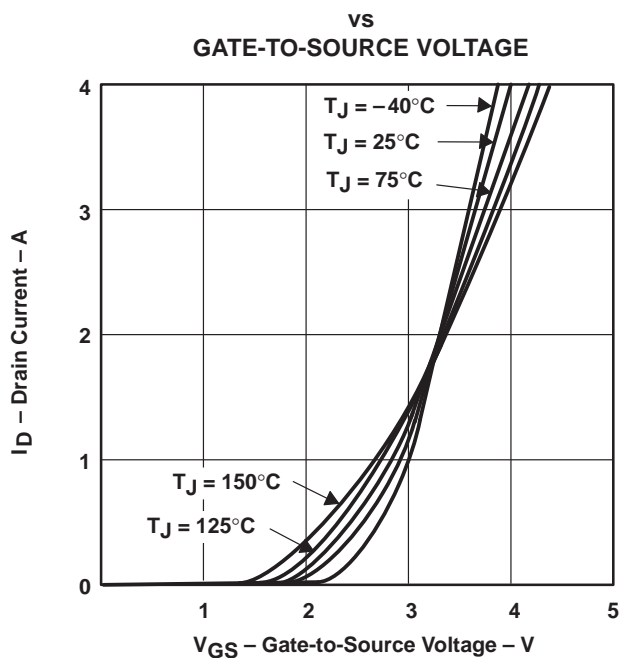


Figure 10

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4-CHANNEL INDEPENDENT GATE-PROTECTED LOGIC-LEVEL POWER DMOS ARRAY

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TYPICAL CHARACTERISTICS

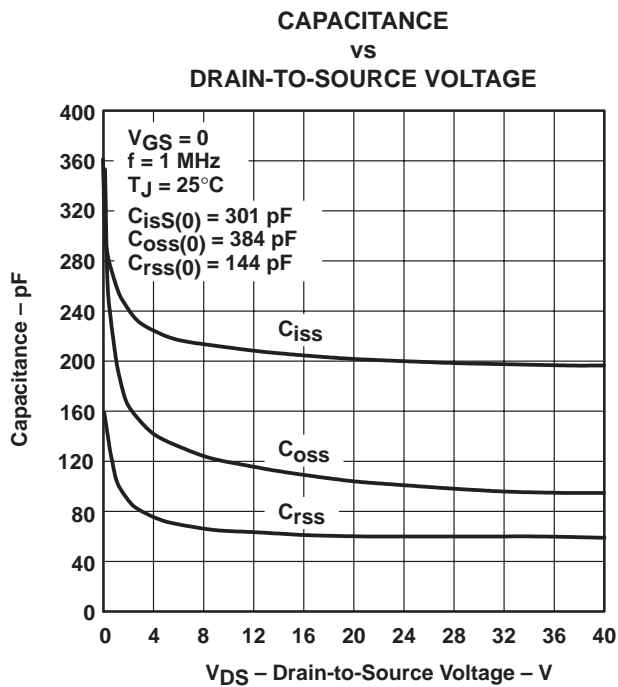


Figure 11

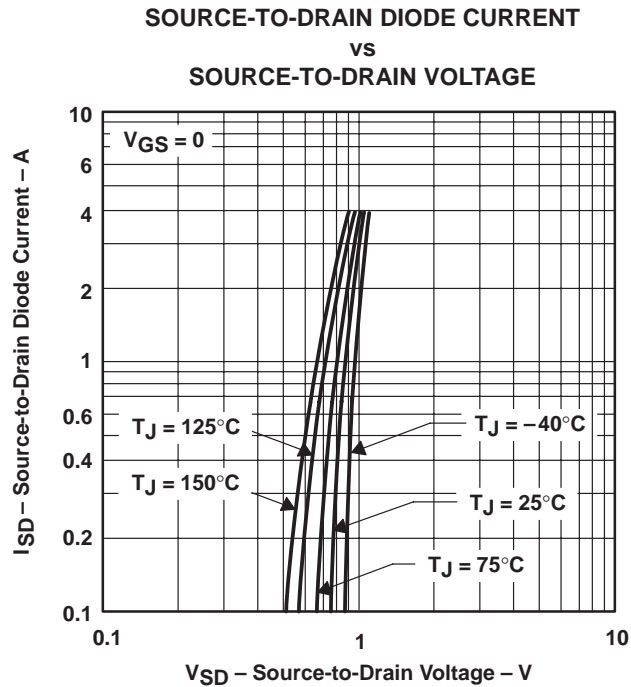


Figure 12

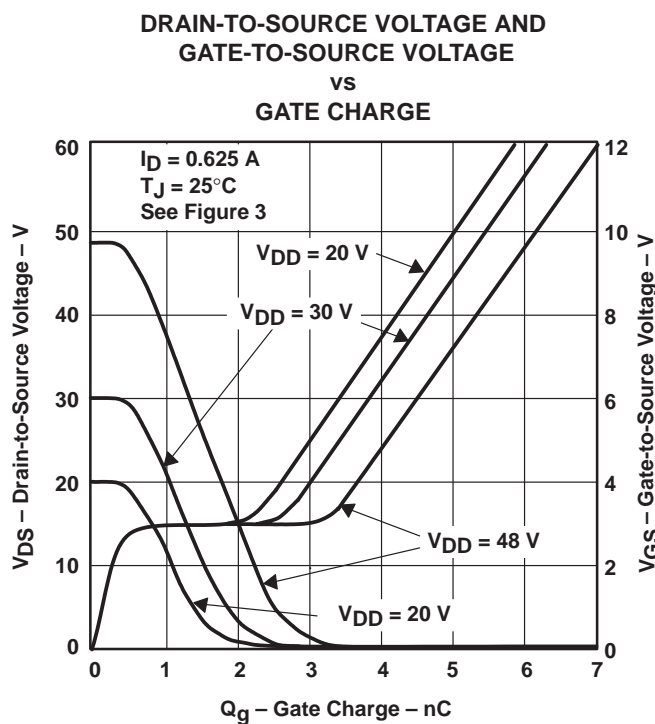


Figure 13

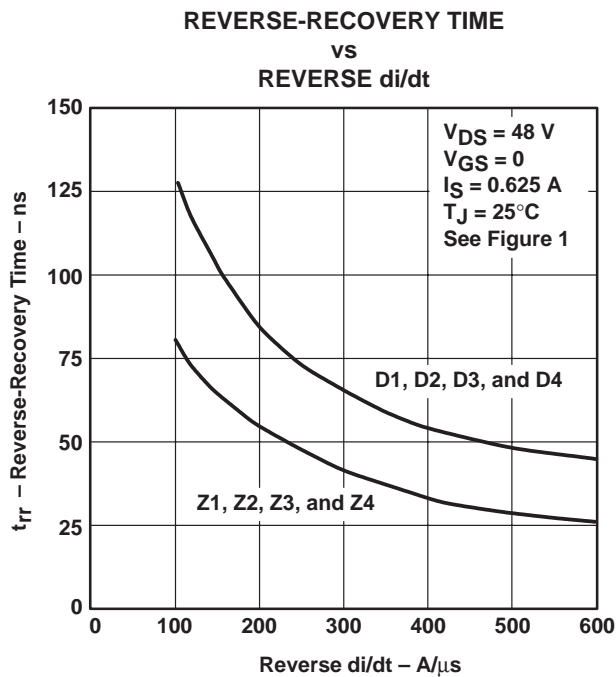
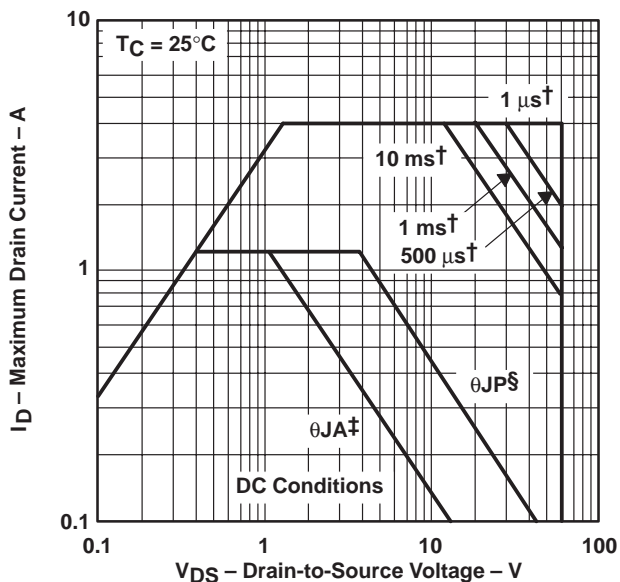


Figure 14

THERMAL INFORMATION

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



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

Figure 15

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

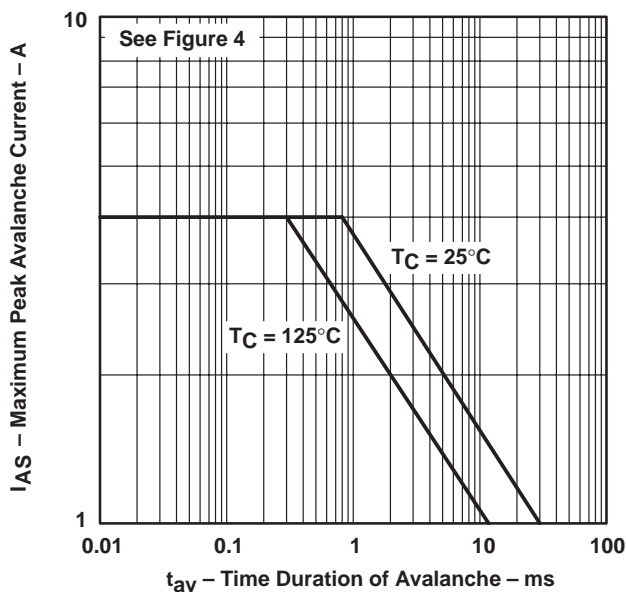


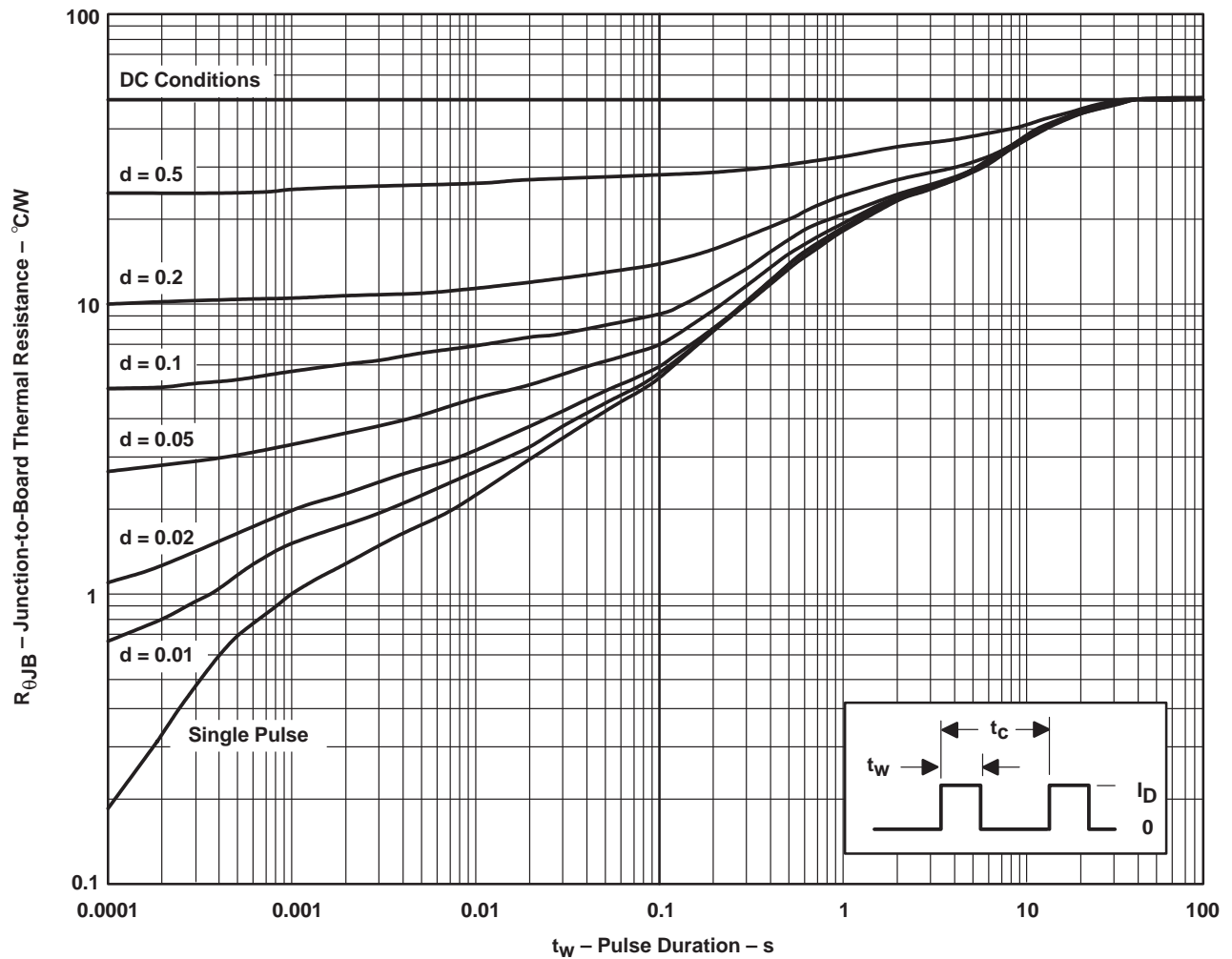
Figure 16

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4-CHANNEL INDEPENDENT GATE-PROTECTED LOGIC-LEVEL
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THERMAL INFORMATION

DW PACKAGE†
JUNCTION-TO-BOARD THERMAL RESISTANCE
VS
PULSE DURATION



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

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

Figure 17

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