

TPIC2401 4-CHANNEL COMMON-SOURCE POWER DMOS ARRAY

SLIS049 – NOVEMBER 1996

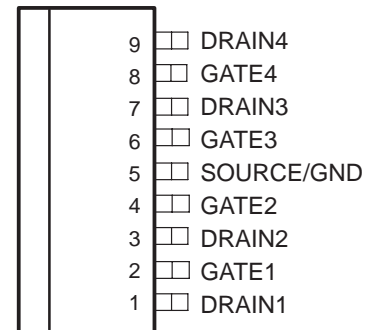
- Low $r_{DS(on)}$. . . 0.3 Ω Typ
- High Output Voltage . . . 60 V
- Pulsed Current . . . 6 A Per Channel
- Avalanche Energy Capability . . . 36 mJ
- Input Transient Protection . . . 2000 V

description

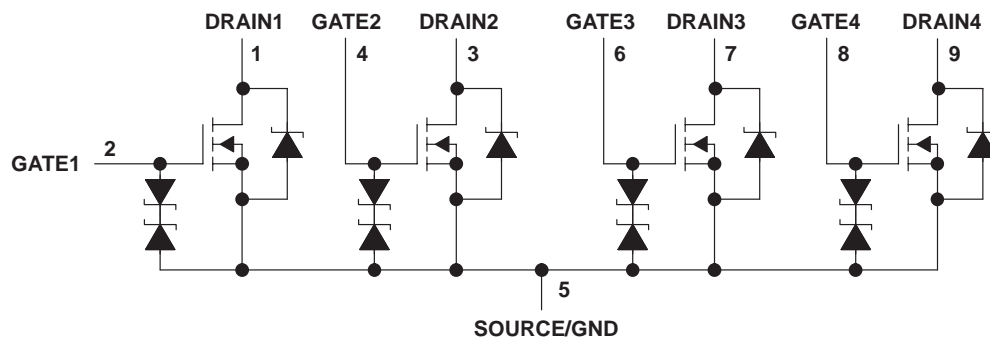
The TPIC2401 is a monolithic power DMOS array that consists of four electrically isolated N-channel enhancement-mode DMOS transistors configured with a common source and open drains. Each transistor features integrated high-current zener diodes to prevent gate damage in the event that an overstress condition 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 .

KTA PACKAGE
(TOP VIEW)



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 Instruments Incorporated.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77251-1443

Copyright © 1996, Texas Instruments Incorporated

TPIC2401

4-CHANNEL COMMON-SOURCE POWER DMOS ARRAY

SLIS049 – NOVEMBER 1996

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, $T_C = 25^\circ\text{C}$	1.5 A
Pulsed drain current, each output, I_{Dmax} , $T_C = 25^\circ\text{C}$ (see Note 1 and Figure 7)	6 A
Continuous gate-to-source zener diode current, $T_C = 25^\circ\text{C}$	± 25 mA
Pulsed gate-to-source zener diode current, $T_C = 25^\circ\text{C}$	± 250 mA
Single-pulse avalanche energy, E_{AS} , $T_C = 25^\circ\text{C}$ (see Figures 4 and 6)	36 mJ
Continuous total power dissipation at (or below) $T_A = 25^\circ\text{C}$	1.7 W
Power dissipation at (or below) $T_C = 75^\circ\text{C}$, 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, $T_C = 25^\circ\text{C}$ (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	$I_D = 1 \text{ mA}$,	$V_{DS} = V_{GS}$,	1.5	2.05	2.2	V	
$V_{GS(th)match}$	Gate-to-source threshold voltage matching	See Figure 5			5	40		
$V_{(BR)GS}$	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	
$V_{DS(on)}$	Drain-to-source on-state voltage	$I_D = 1.5 \text{ A}$,	$V_{GS} = 10 \text{ V}$,		0.45	0.54	V	
		See Notes 2 and 3						
$V_F(SD)$	Forward on-state voltage, source-to-drain	$I_S = 1.5 \text{ A}$,	$V_{GS} = 0 \text{ V}$,		0.85	1	V	
		See Notes 2 and 3 and Figure 12						
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	
$r_{DS(on)}$	Static drain-to-source on-state resistance	$V_{GS} = 10 \text{ V}$,	$I_D = 1.5 \text{ A}$,	$T_C = 25^\circ\text{C}$	0.3	0.36	Ω	
				$T_C = 125^\circ\text{C}$	0.48	0.6		
g_{fs}	Forward transconductance	$V_{DS} = 15 \text{ V}$,	$I_D = 1 \text{ A}$,	0.9	1.15		S	
C_{iss}	Short-circuit input capacitance, common source	$V_{DS} = 25 \text{ V}$,	$V_{GS} = 0$,		180	225	pF	
C_{oss}	Short-circuit output capacitance, common source			$f = 1 \text{ MHz}$,	See Figure 11	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.



TPIC2401

4-CHANNEL COMMON-SOURCE POWER DMOS ARRAY

SLIS049 – NOVEMBER 1996

source-to-drain diode characteristics, $T_C = 25^\circ\text{C}$

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

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(on)}$	Delay time, $V_{GS}\uparrow$ to $V_{DS}\downarrow$ turn on	$V_{DD} = 25\text{ V}$, $R_L = 25\ \Omega$, $t_{en} = 10\text{ ns}$, $t_{dis} = 10\text{ ns}$, 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}			180		
t_f	Fall time, V_{DS}			90		
Q_g	Total gate charge	$V_{DD} = 48\text{ V}$, $I_D = 1\text{ A}$, $V_{GS} = 10\text{ V}$, 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		

thermal resistance

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	All outputs with equal power			72	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$	Junction-to-case thermal resistance	All outputs with equal power			5	
		One output dissipating power			8.5	

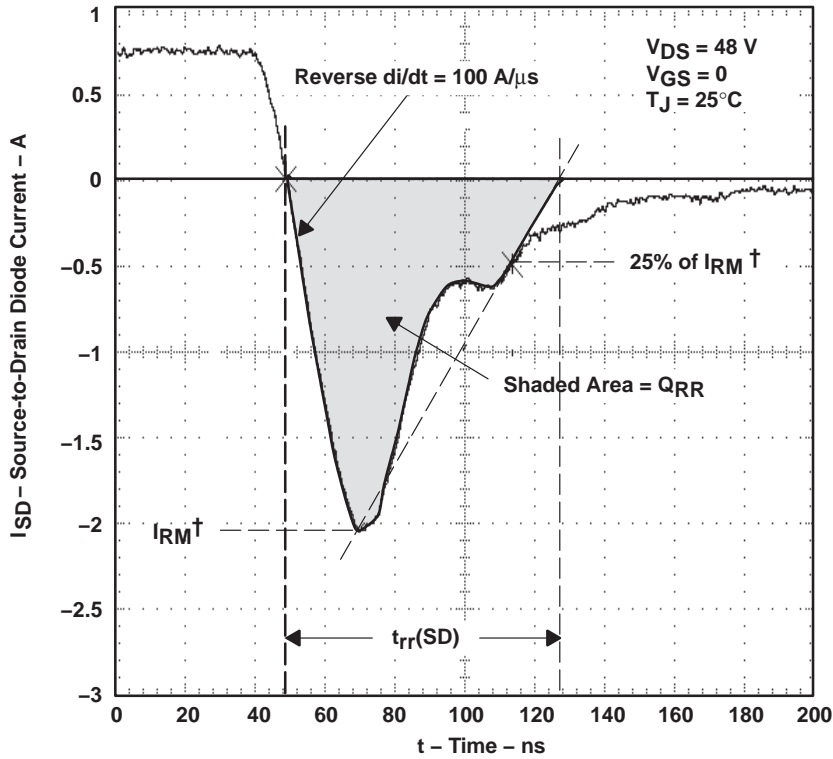
NOTES:



TPIC2401 4-CHANNEL COMMON-SOURCE POWER DMOS ARRAY

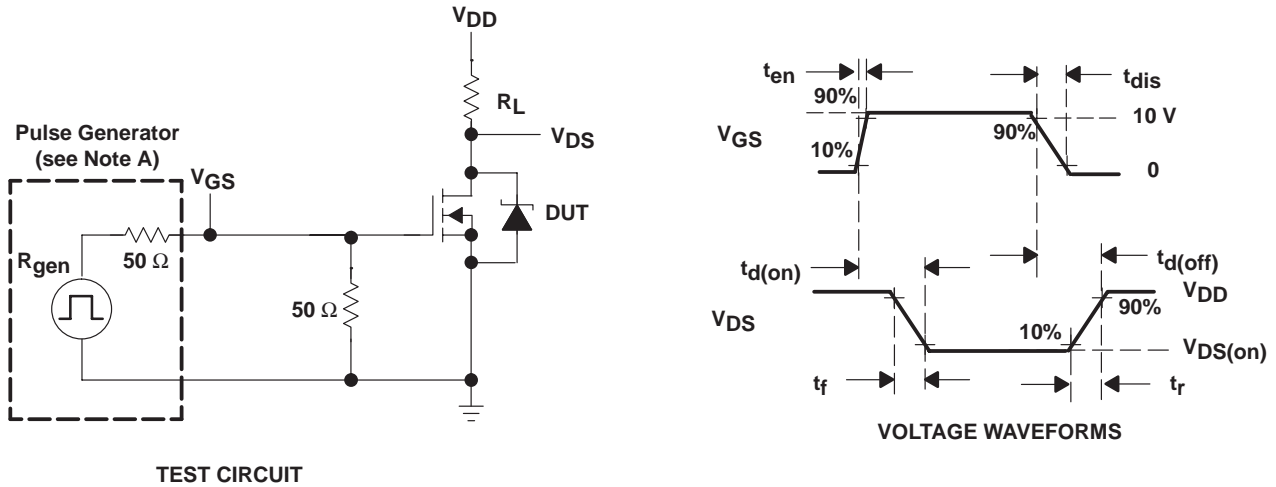
SLIS049 – NOVEMBER 1996

PARAMETER MEASUREMENT INFORMATION



† I_{RM} = maximum recovery current

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



TEST CIRCUIT

NOTE A: The pulse generator has the following characteristics: $t_{en} \leq 10$ ns, $t_{dis} \leq 10$ ns, $Z_0 = 50 \Omega$.

Figure 2. Resistive Switching



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77251-1443

PARAMETER MEASUREMENT INFORMATION

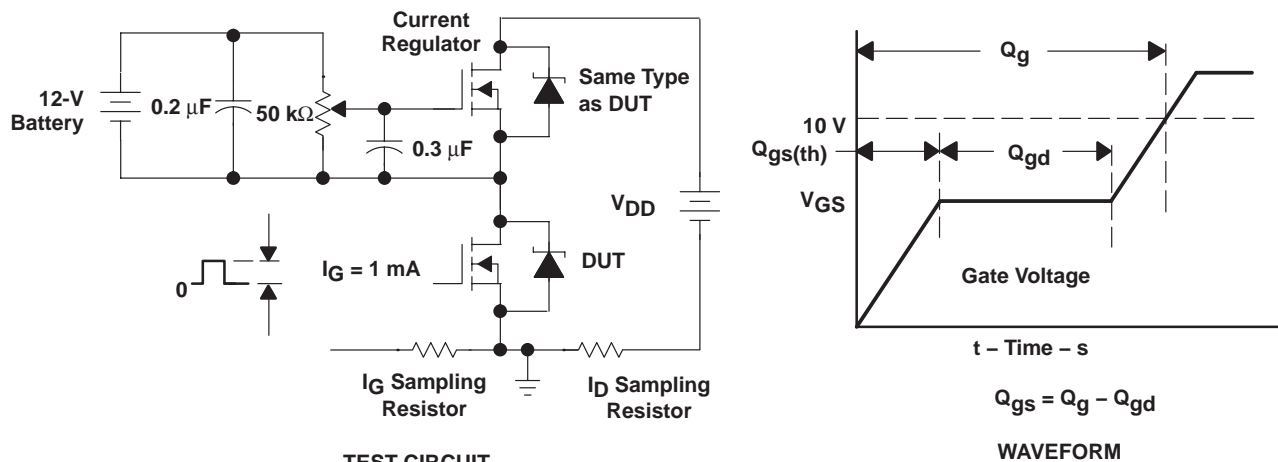
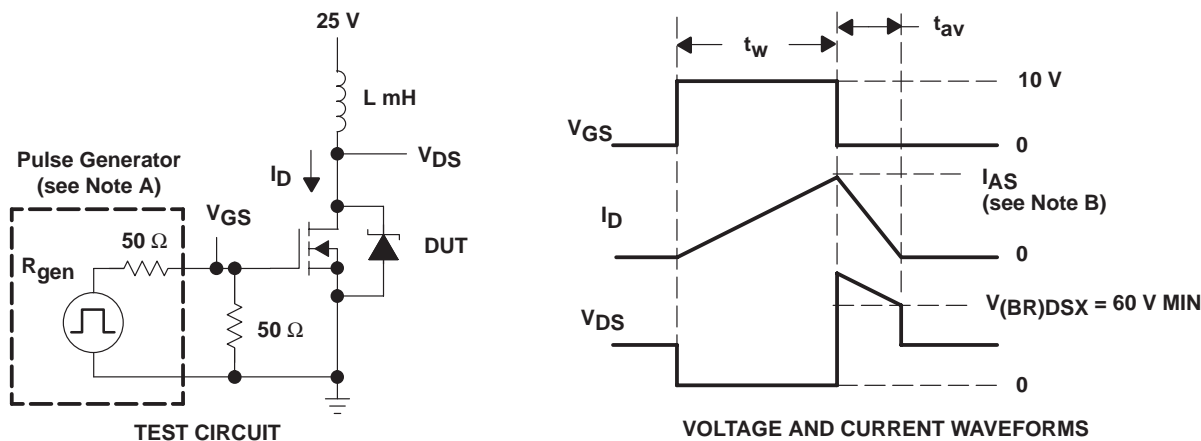


Figure 3. Gate Charge Test Circuit and Waveform



- 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 $I_{AS} = 1.5$ 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.

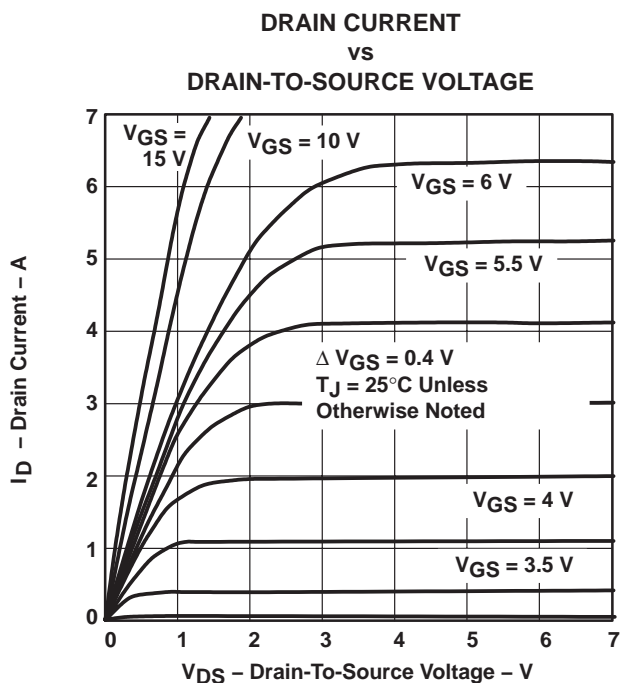
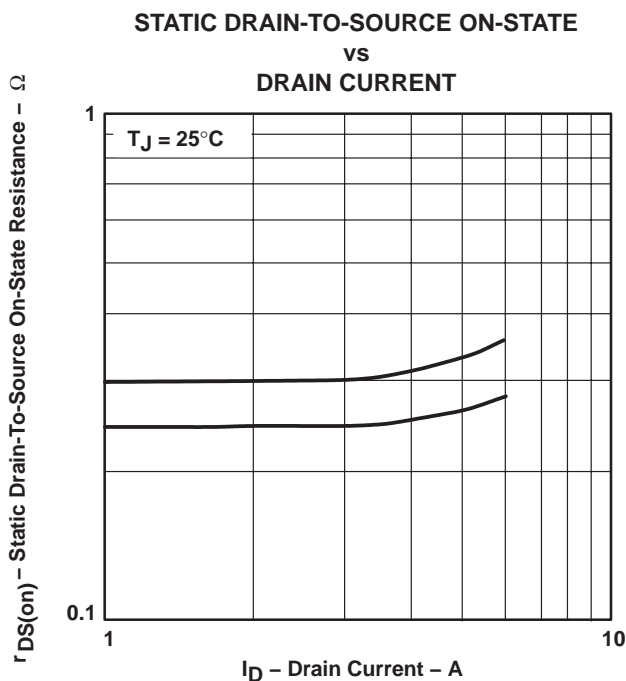
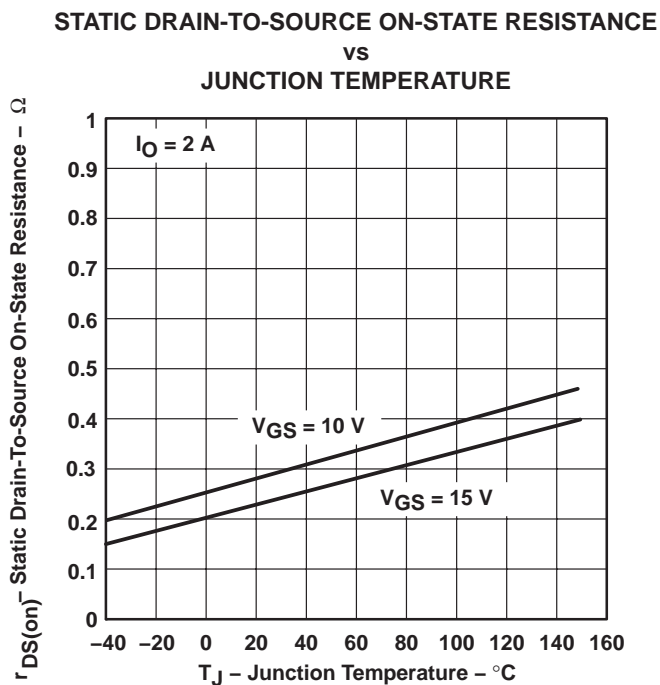
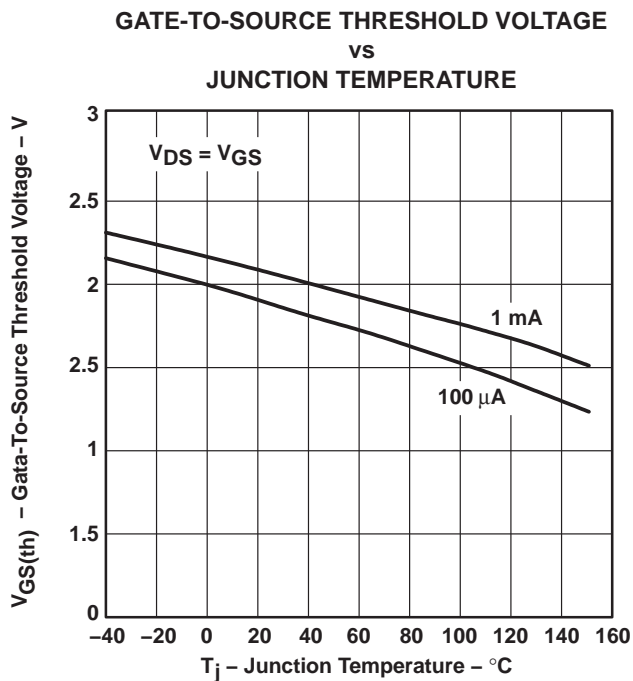
Figure 4. Single-Pulse Avalanche-Energy Test Circuit and Waveforms

TPIC2401

4-CHANNEL COMMON-SOURCE POWER DMOS ARRAY

SLIS049 – NOVEMBER 1996

TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS

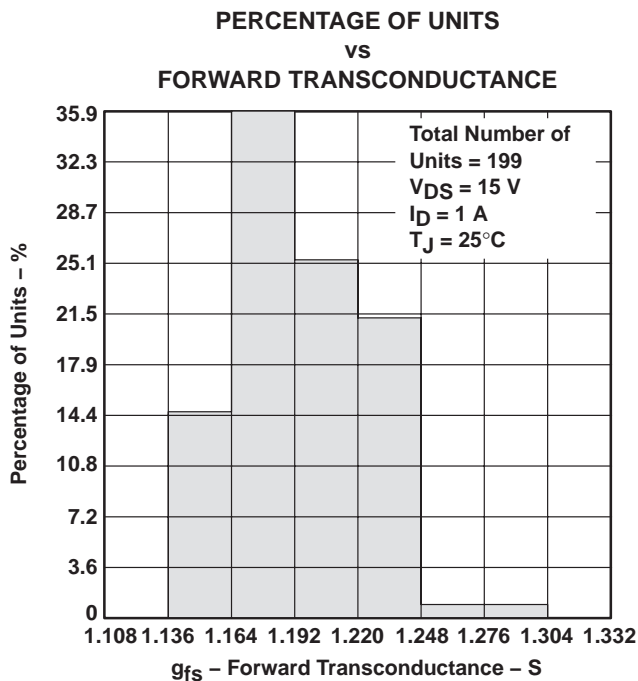


Figure 9

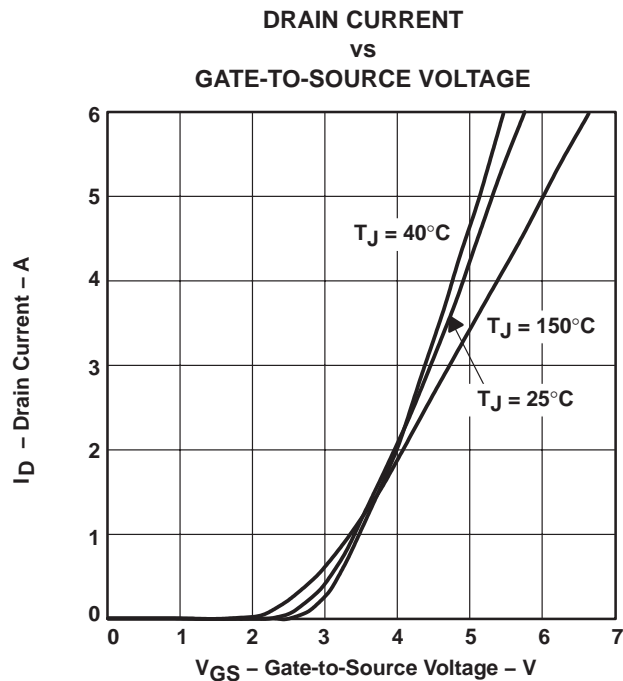


Figure 10

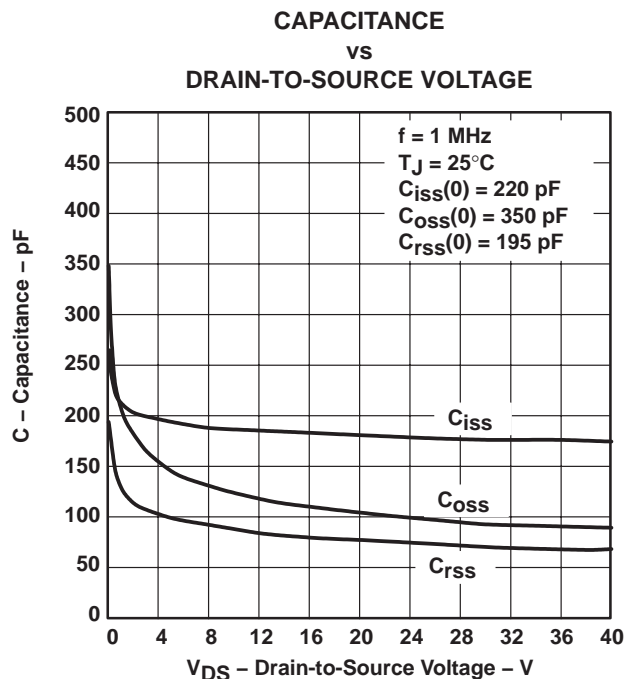


Figure 11

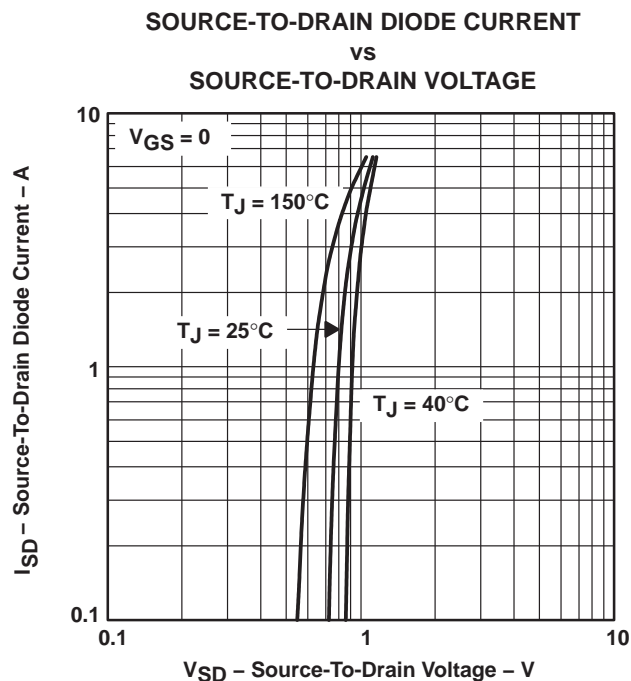


Figure 12

TPIC2401 4-CHANNEL COMMON-SOURCE POWER DMOS ARRAY

SLIS049 – NOVEMBER 1996

TYPICAL CHARACTERISTICS

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

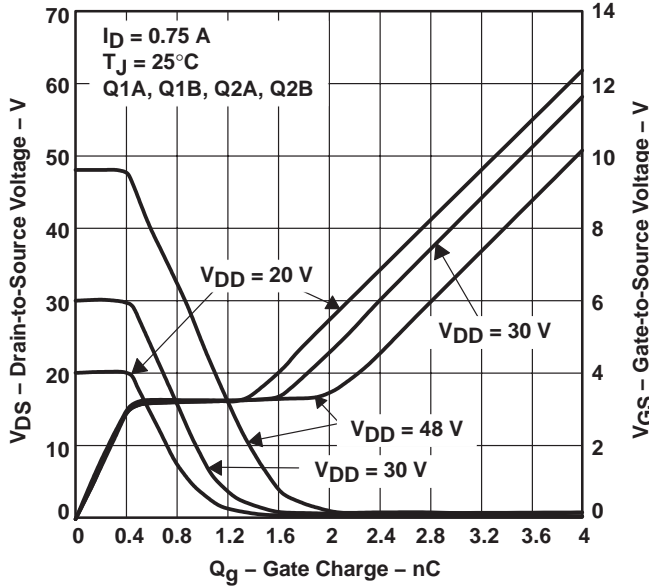


Figure 13

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

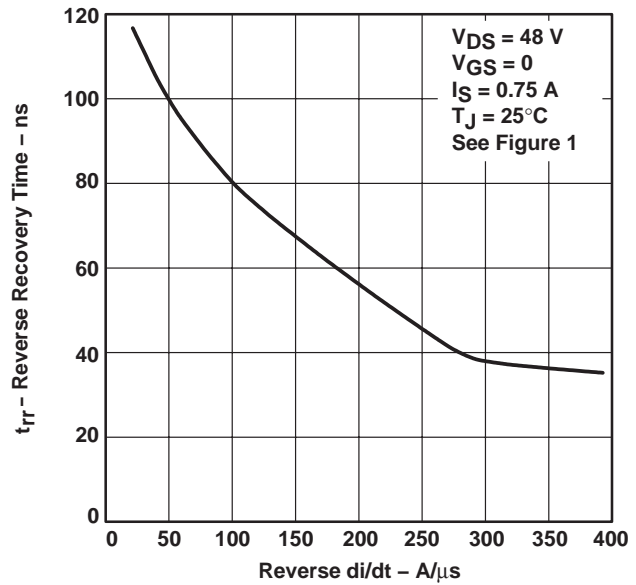


Figure 14

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

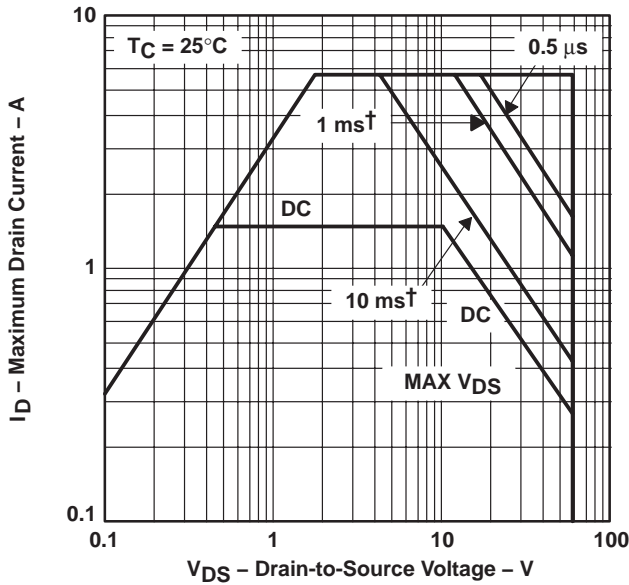


Figure 15

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

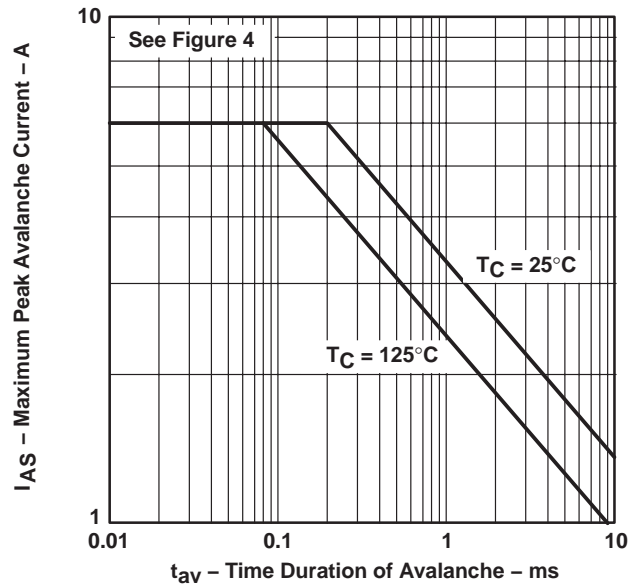
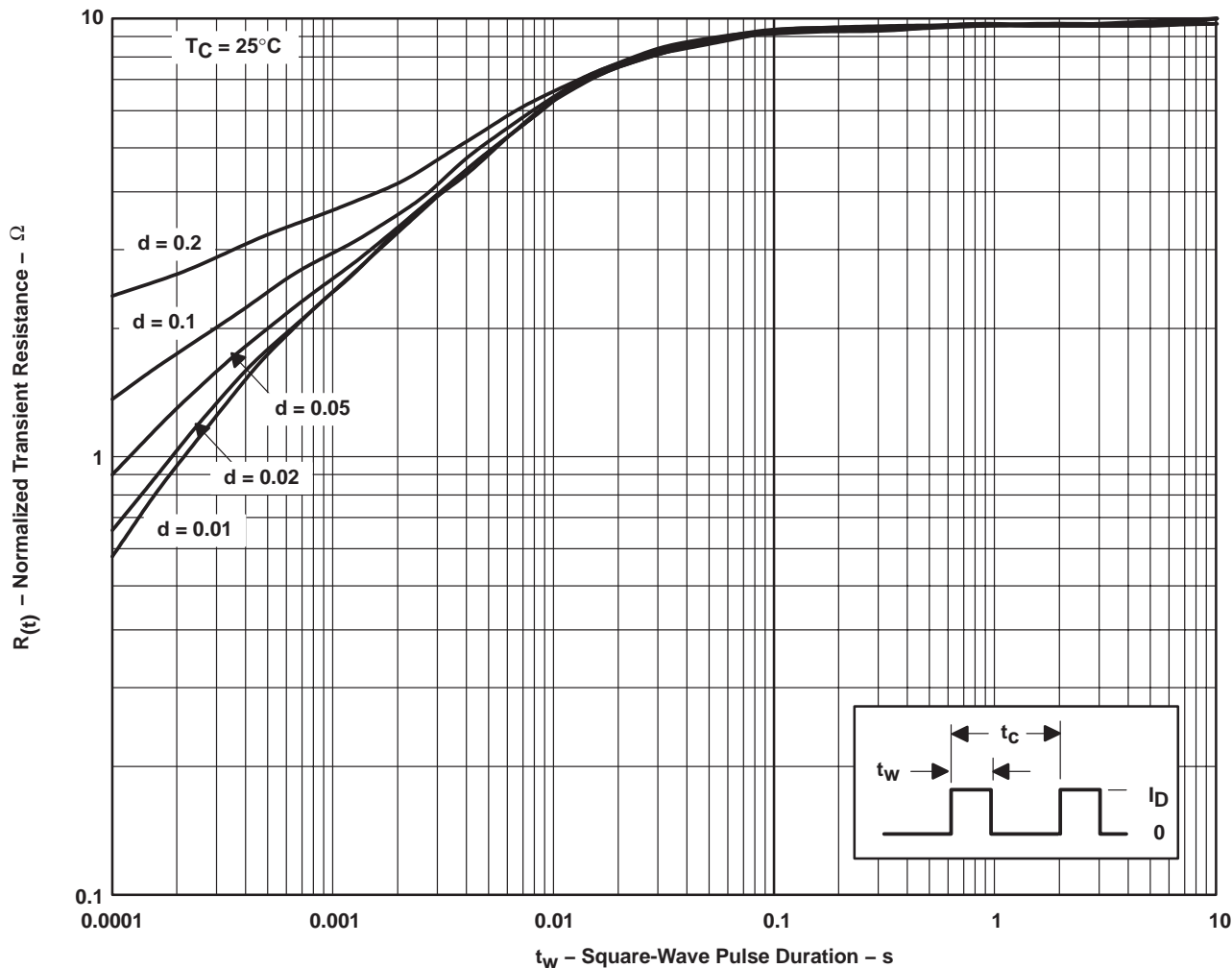


Figure 16



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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated