

TPIC1505 QUAD AND HEX POWER DMOS ARRAY

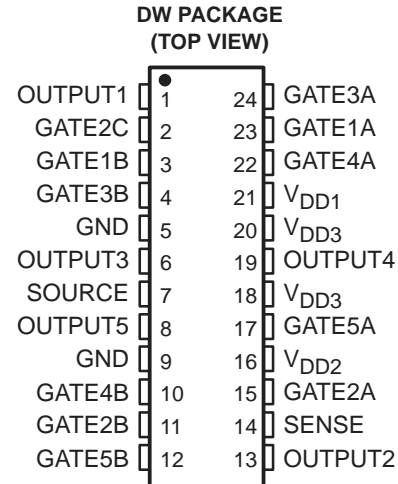
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- **Low $r_{DS(on)}$:**
0.25 Ω Typ (Full H-Bridge)
0.35 Ω Typ (Triple Half H-Bridge)
- **Pulsed Current:**
6 A Per Channel (Full H-Bridge)
4 A Per Channel (Triple Half H-Bridge)
- **Matched Sense Transistor for Class A-B Linear Operation**
- **Fast Commutation Speed**

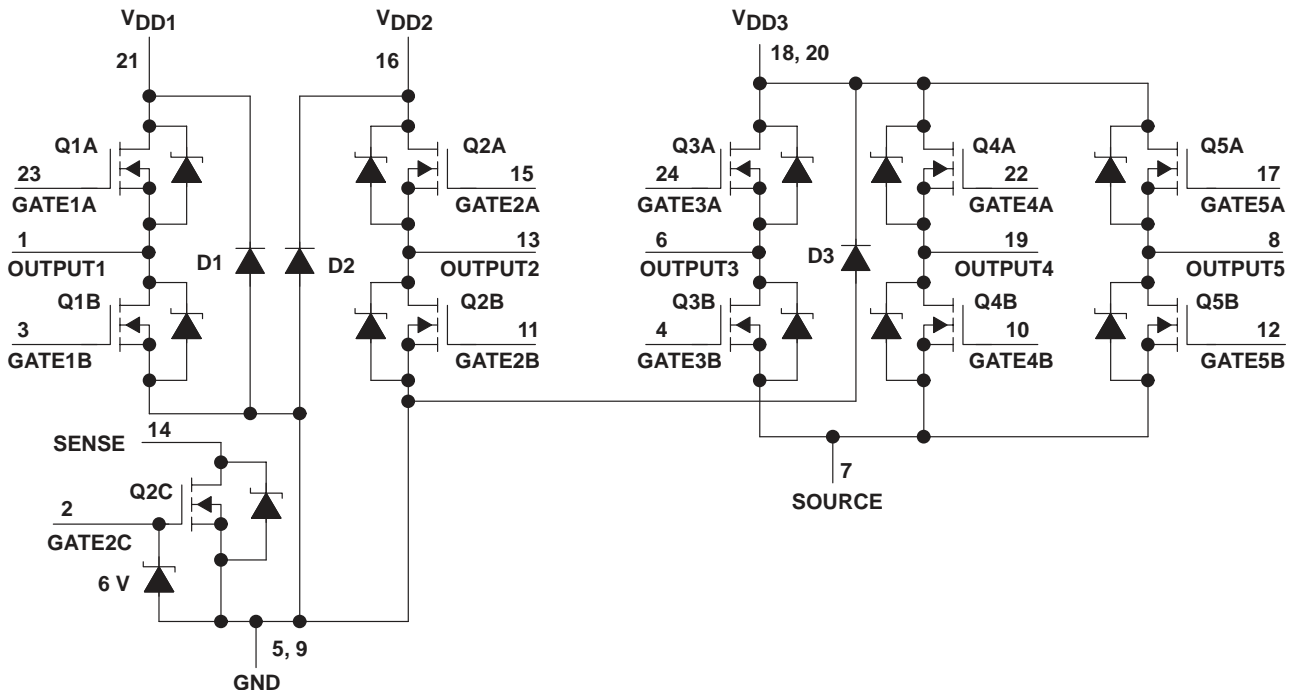
description

The TPIC1505 is a monolithic power array that consists of ten electrically isolated N-channel enhancement-mode power DMOS transistors, four of which are configured as a full H-bridge and six as a triple half H-bridge. The lower stage of the full H-bridge features an integrated sense FET to allow biasing of the bridge in class A-B operation.

The TPIC1505 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



- NOTES: A. Pins 5 and 9 must be externally connected.
B. Pins 18 and 20 must be externally connected.
C. No output may be taken greater than 0.5 V 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.

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**

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TPIC1505

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absolute maximum ratings, $T_C = 25^\circ\text{C}$ (unless otherwise noted)[†]

Supply-to-GND voltage	20 V
Source-to-GND voltage (Q3A, Q4A, Q5A)	20 V
Output-to-GND voltage	20 V
Sense-to-GND voltage	20 V
Gate-to-source voltage range, V_{GS} (Q1A, Q1B, Q2A, Q2B, Q3A, Q3B, Q4A, Q4B, Q5A, Q5B)	-0.5 V to 20 V
Gate-to-source voltage, V_{GS} (Q2C)	-0.7 V to 6 V
Continuous gate-to-source zener-diode current (Q2C)	± 10 mA
Pulsed gate-to-source zener-diode current (Q2C)	± 50 mA
Continuous drain current, each output (Q1A, Q1B, Q2A, Q2B)	1.5 A
Continuous drain current, each output (Q3A, Q3B, Q4A, Q4B, Q5A, Q5B)	1 A
Continuous drain current (Q2C)	5 mA
Continuous source-to-drain diode current (Q1A, Q1B, Q2A, Q2B)	1.5 A
Continuous source-to-drain diode current (Q3A, Q3B, Q4A, Q4B, Q5A, Q5B)	1 A
Continuous source-to-drain diode current (Q2C)	5 mA
Pulsed drain current, each output, I_{max} (Q1A, Q1B, Q2A, Q2B) (see Note 1 and Figure 24)	6 A
Pulsed drain current, each output, I_{max} (Q3A, Q3B, Q4A, Q4B, Q5A, Q5B) (see Note 1 and Figure 25)	4 A
Pulsed drain current, I_{max} (Q2C) (see Note 1)	20 mA
Continuous total power dissipation, $T_C = 70^\circ\text{C}$ (see Note 2 and Figures 24 and 25)	2.86 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.

- NOTES: 1. Pulse duration = 10 ms, duty cycle = 2%
 2. Package is mounted in intimate contact with infinite heat sink.



electrical characteristics, Q1A, Q1B, Q2A, Q2B, 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	20			V	
V _{GS(th)}	Gate-to-source threshold voltage	I _D = 1 mA, V _{DS} = V _{GS} , See Figure 5	1.5	1.9	2.2	V	
V _{GS(th)match}	Gate-to-source threshold voltage matching	I _D = 1 mA, V _{DS} = V _{GS}	40			mV	
V _(BR)	Reverse drain-to-GND breakdown voltage	Drain-to-GND current = 250 μA (D1, D2)	20			V	
V _{(BR)GS}	Gate-to-source breakdown voltage, Q2C	I _{GS} = 100 μA	6			V	
V _{(BR)SG}	Source-to-gate breakdown voltage, Q2C	I _{SG} = 100 μA	0.5			V	
V _{(DS)on}	Drain-to-source on-state voltage	I _D = 1.5 A, V _{GS} = 10 V, See Notes 3 and 4	0.38		0.45	V	
V _F	Forward on-state voltage, GND-to-V _{DD1} , GND-to-V _{DD2}	I _D = 1.5 A (D1, D2), See Notes 3 and 4	1.5			V	
V _{F(SD)}	Forward on-state voltage, source-to-drain	I _S = 1.5 A, V _{GS} = 0, See Notes 3 and 4 and Figure 19	1		1.2	V	
I _{DSS}	Zero-gate-voltage drain current	V _{DS} = 16 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} = 16 V, V _{DS} = 0	10		100	nA	
I _{lkg}	Leakage current, V _{DD1} -to-GND, V _{DD2} -to-GND, gate shorted to source	V _{DGND} = 16 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 = 1.5 A, See Notes 3 and 4 and Figure 9	T _C = 25°C		0.25	0.3	Ω
			T _C = 125°C		0.4	0.48	
g _{fs}	Forward transconductance	V _{DS} = 14 V, V _{GS} = 0, See Notes 3 and 4	I _D = 0.75 A,		0.7	1.1	S
C _{iss}	Short-circuit input capacitance, common source	V _{DS} = 14 V, V _{GS} = 0, f = 1 MHz, See Figure 17	100		pF		
C _{oss}	Short-circuit output capacitance, common source		75				
C _{rss}	Short-circuit reverse transfer capacitance, common source		60				
α _S	Sense-FET drain current ratio	V _{DS} = 6 V, I _{D(Q2C)} = 40 μA	100	150	200		

NOTES: 3. Technique should limit T_J – T_C to 10°C maximum.
4. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

source-to-drain diode characteristics, Q1A, Q2A, T_C = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{rr}	Reverse-recovery time	I _S = 750 mA, V _{GS} = 0, V _{DS} = 14 V, di/dt = 100 A/μs,	18			ns
Q _{RR}	Total diode charge	See Figures 1 and 23	15			nC

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resistive-load switching characteristics, Q1A, Q1B, Q2A, Q2B, T_C = 25°C

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{d(on)}	Turn-on delay time		11		ns
t _{d(off)}	Turn-off delay time	V _{DD} = 14 V, R _L = 18.7 Ω, t _{en} = 10 ns, t _{dis} = 10 ns, See Figure 3	16		
t _r	Rise time		3		
t _f	Fall time		4		
Q _g	Total gate charge			2	2.5
Q _{gs(th)}	Threshold gate-to-source charge	V _{DS} = 14 V, I _D = 750 mA, V _{GS} = 10 V, See Figure 4	0.35	0.4	
Q _{gd}	Gate-to-drain charge		0.5	0.6	
L _(drain)	Internal drain inductance			7	
L _(source)	Internal source inductance		7		
r _(gate)	Internal gate resistance		10		Ω

electrical characteristics, Q3A, Q3B, Q4A, Q4B, Q5A, Q5B, 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	20		V	
V _{GS(th)}	Gate-to-source threshold voltage	I _D = 1 mA, V _{DS} = V _{GS} , See Figure 6	1.5	1.9	2.2	V
V _{GS(th)match}	Gate-to-source threshold voltage matching	I _D = 1 mA, V _{DS} = V _{GS}		40		mV
V _(BR)	Reverse drain-to-GND breakdown voltage	Drain-to-GND current = 250 μA (D3)	20			V
V _{(DS)on}	Drain-to-source on-state voltage	I _D = 1 A, V _{GS} = 10 V, See Notes 3 and 4	0.35	0.48		V
V _F	Forward on-state voltage, GND-to-V _{DD3}	I _D = 1 A (D3), I _D = 1 A (D3), See Notes 3 and 4	1.5			V
V _{F(SD)}	Forward on-state voltage, source-to-drain	I _S = 1 A, V _{GS} = 0, See Notes 3 and 4 and Figure 20	0.9	1.2		V
I _{DSS}	Zero-gate-voltage drain current	V _{DS} = 16 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} = 16 V, V _{DS} = 0	10	100		nA
I _{lkg}	Leakage current, V _{DD3} -to-GND, gate shorted to source	V _{DGND} = 16 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 = 1 A, See Notes 3 and 4 and Figure 10	T _C = 25°C	0.35	0.48	Ω
			T _C = 125°C	0.55	0.75	
g _{fs}	Forward transconductance	V _{DS} = 14 V, I _D = 500 mA, See Notes 3 and 4	0.4	0.72		S
C _{iss}	Short-circuit input capacitance, common source	V _{DS} = 14 V, f = 1 MHz, V _{GS} = 0, See Figure 18		70		pF
C _{oss}	Short-circuit output capacitance, common source			85		
C _{rss}	Short-circuit reverse transfer capacitance, common source			50		

NOTES: 3: Technique should limit T_J – T_C to 10°C maximum.

4: These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.



source-to-drain diode characteristics, Q3A, Q4A, Q5A, T_C = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{rr}	Reverse-recovery time	I _S = 500 mA, V _{GS} = 0, V _{DS} = 14 V, di/dt = 100 A/μs,		15		ns
Q _{RR}	Total diode charge	See Figures 2 and 23		10		nC

resistive-load switching characteristics, Q3A, Q3B, Q4A, Q4B, Q5A, Q5B, T_C = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{d(on)}	Turn-on delay time	V _{DD} = 14 V, R _L = 32 Ω, t _{en} = 10 ns, t _{dis} = 10 ns, See Figure 3		11		ns
t _{d(off)}	Turn-off delay time			16		
t _r	Rise time			3		
t _f	Fall time			4		
Q _g	Total gate charge	V _{DS} = 14 V, I _D = 500 mA, V _{GS} = 10 V, See Figure 4		1.7	2.1	nC
Q _{gs(th)}	Threshold gate-to-source charge			0.35	0.45	
Q _{gd}	Gate-to-drain charge			0.4	0.5	
L _(drain)	Internal drain inductance			7		nH
L _(source)	Internal source inductance			7		
r _(gate)	Internal gate resistance			10		Ω

thermal resistance

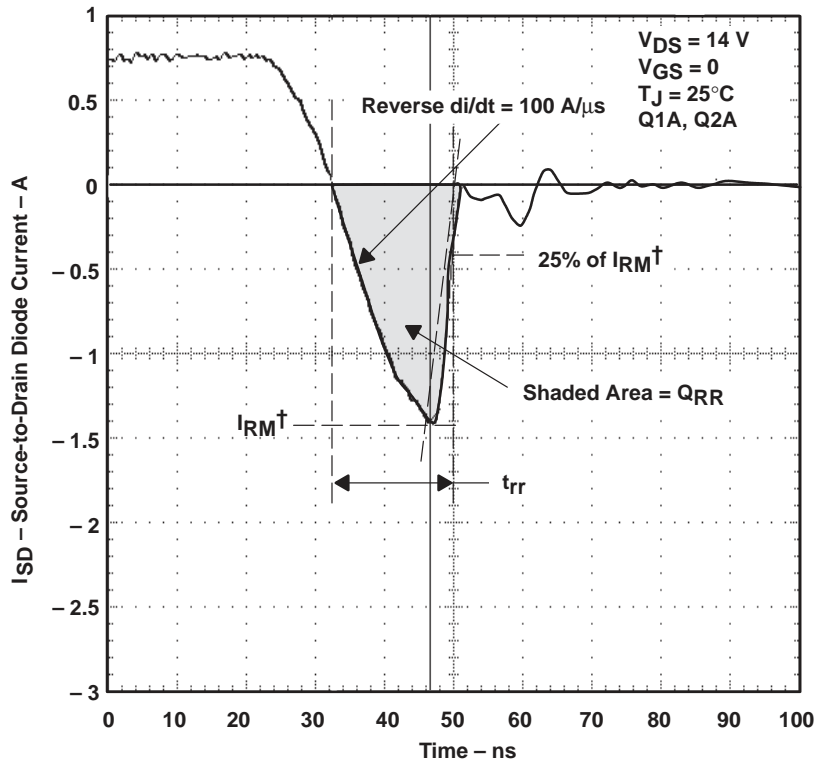
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
R _{θJA}	Junction-to-ambient thermal resistance	See Notes 5 and 8		90		°C/W
R _{θJB}	Junction-to-board thermal resistance	See Notes 6 and 8		52		
R _{θJP}	Junction-to-pin thermal resistance	See Notes 7 and 8		28		

- NOTES:
5. Package is mounted on a FR4 printed-circuit board with no heat sink.
 6. Package is mounted on a 24 in², 4-layer FR4 printed-circuit board.
 7. Package is mounted in intimate contact with infinite heat sink.
 8. All outputs have equal power.

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PARAMETER MEASUREMENT INFORMATION



[†] I_{RM} = maximum recovery current

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

PARAMETER MEASUREMENT INFORMATION

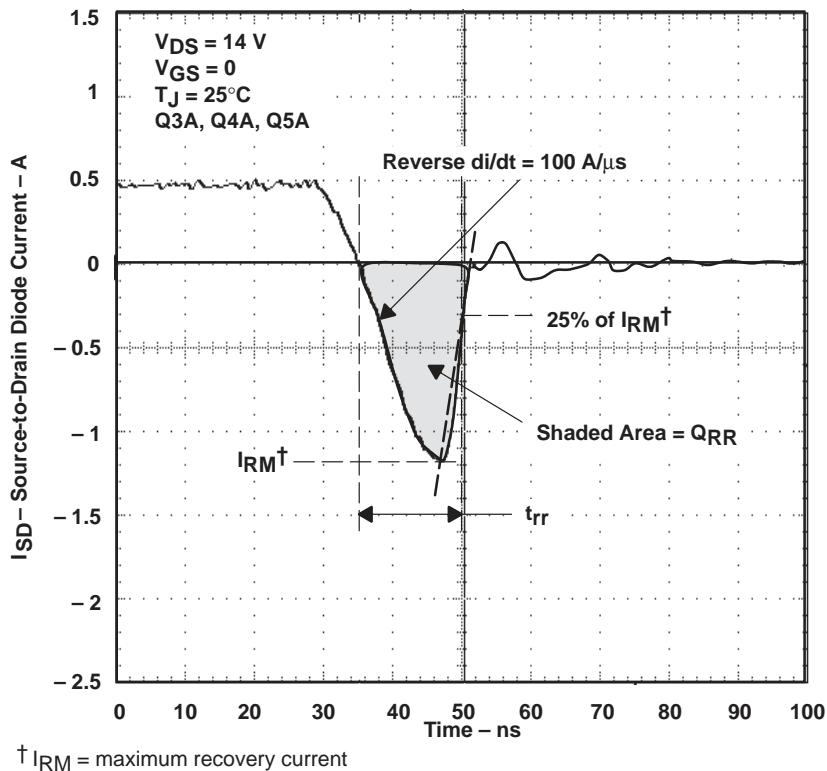
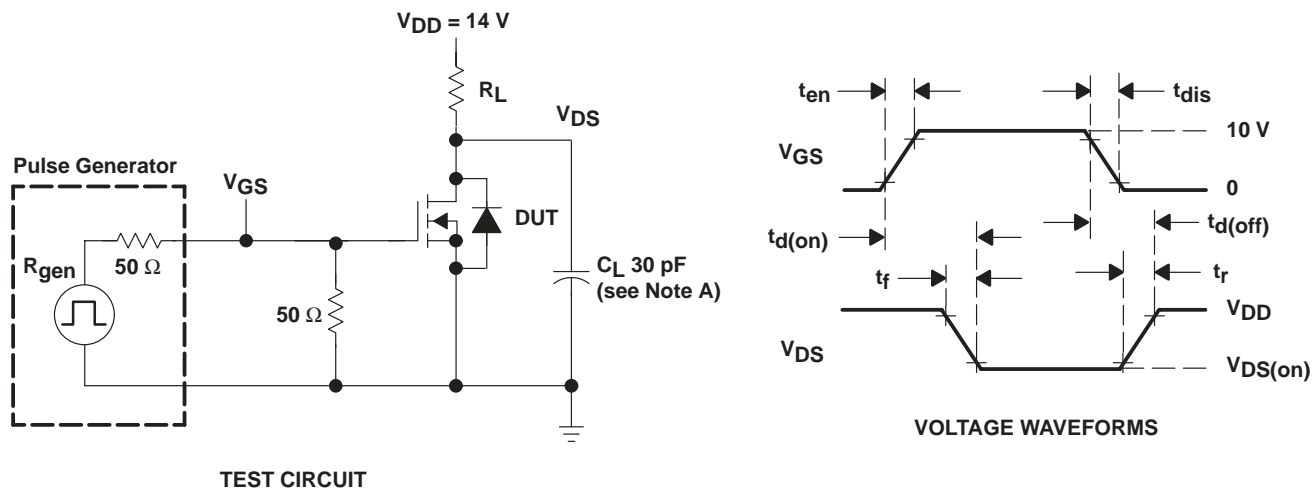


Figure 2. Reverse-Recovery-Current Waveform of Source-to-Drain Diodes



TEST CIRCUIT

NOTE A: C_L includes probe and jig capacitance.

Figure 3. Resistive-Switching Test Circuit and Voltage Waveforms

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PARAMETER MEASUREMENT INFORMATION

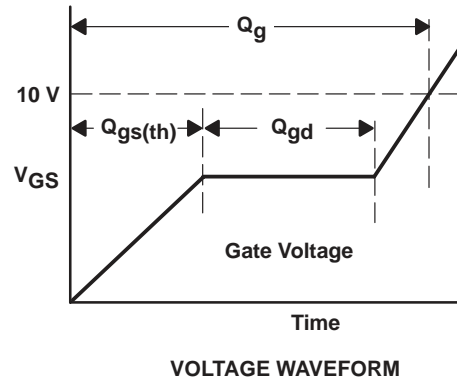
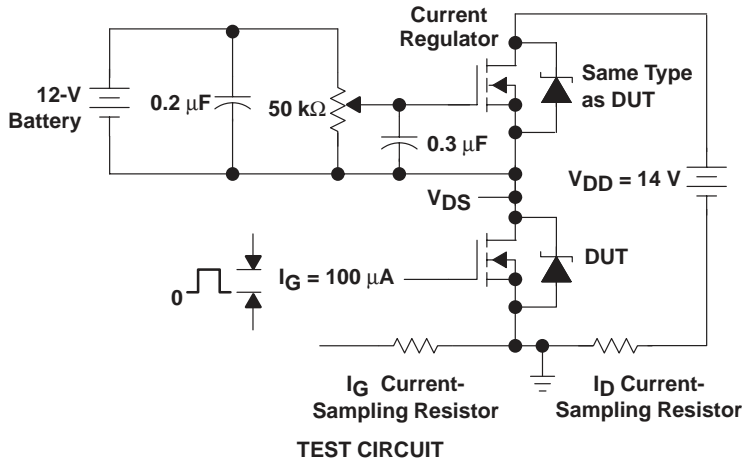


Figure 4. Gate-Charge Test Circuit and Voltage Waveform

TYPICAL CHARACTERISTICS

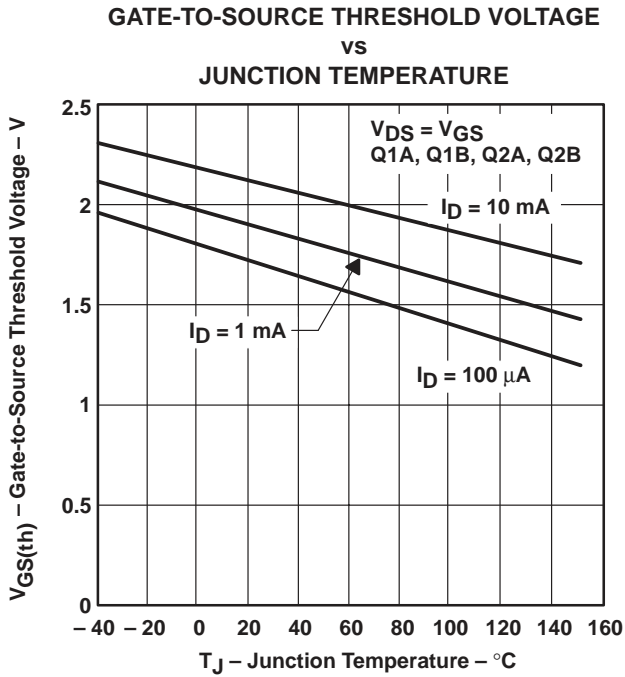


Figure 5

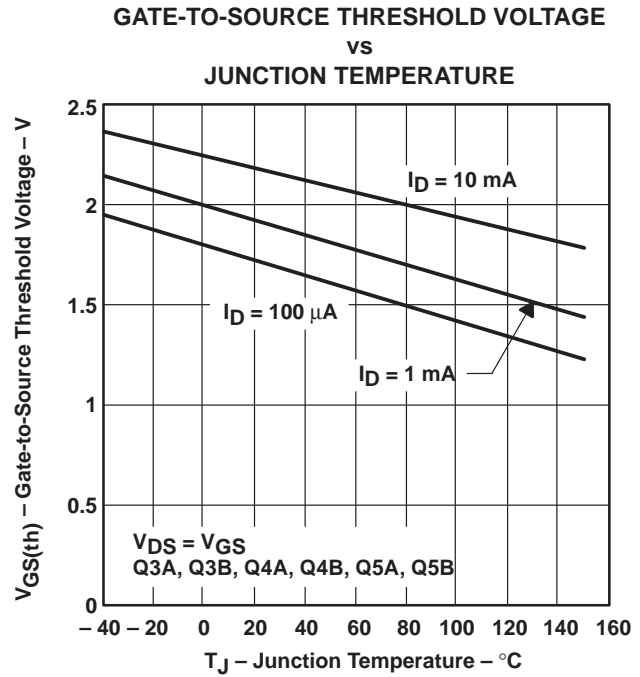


Figure 6

TYPICAL CHARACTERISTICS

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

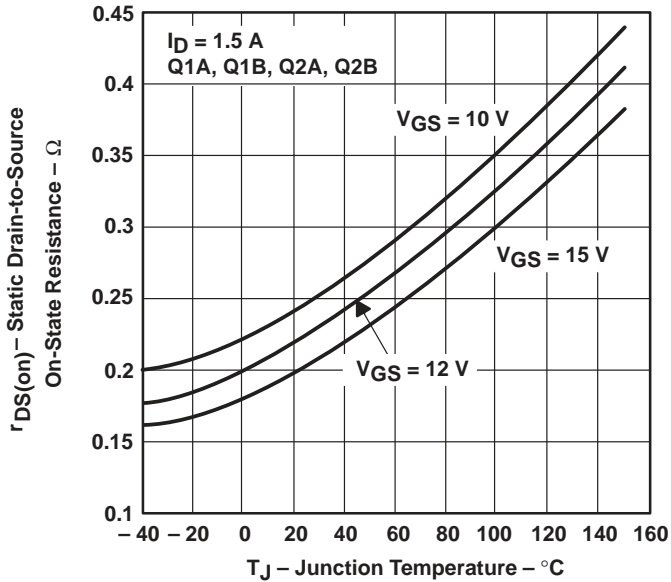


Figure 7

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

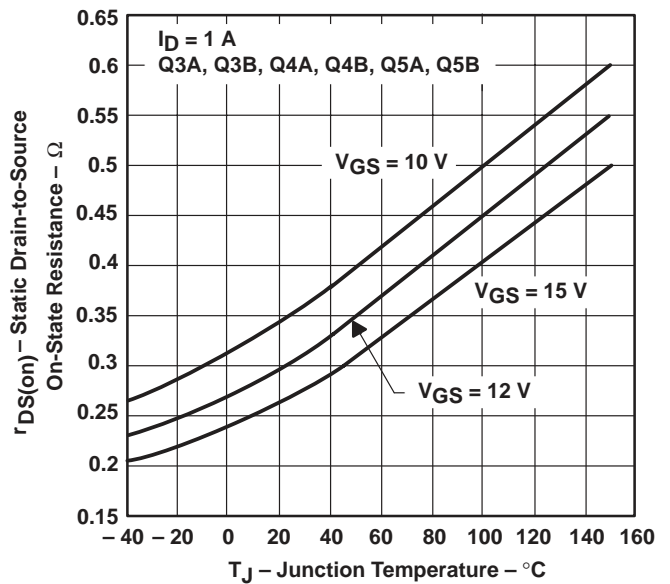


Figure 8

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

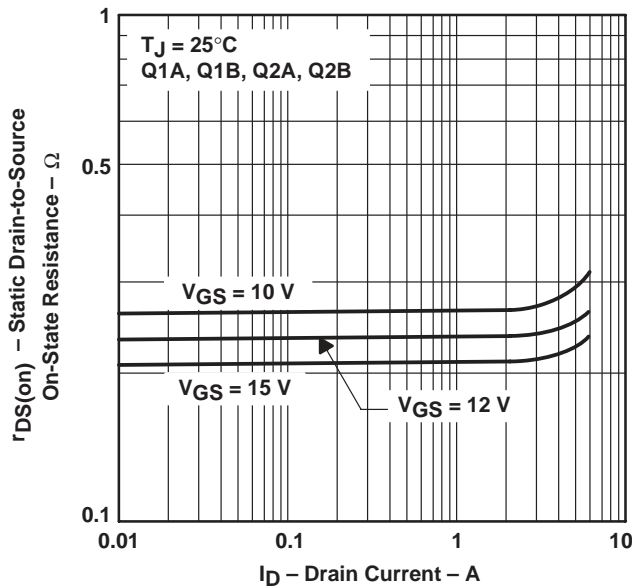


Figure 9

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

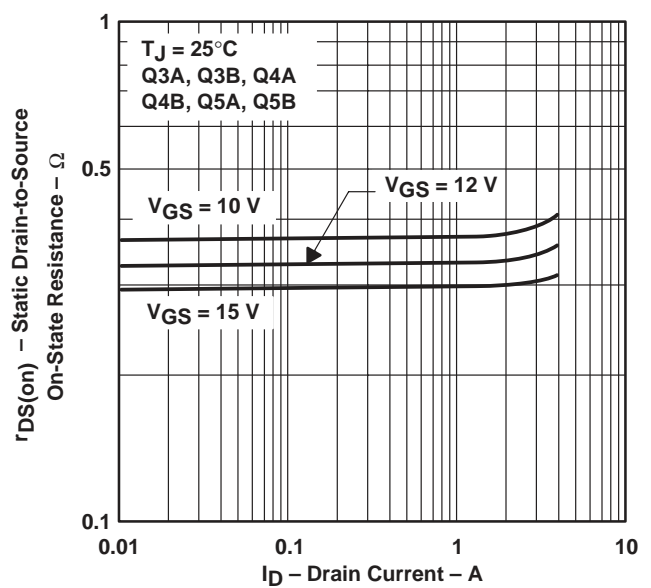


Figure 10

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TYPICAL CHARACTERISTICS

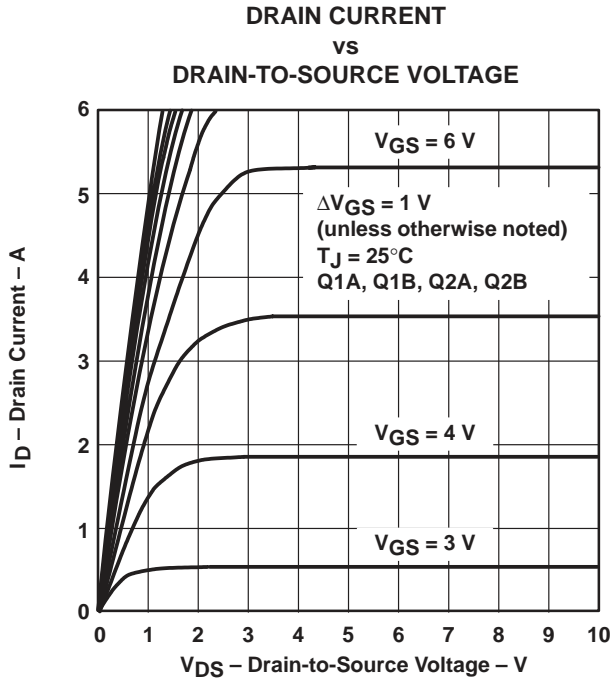


Figure 11

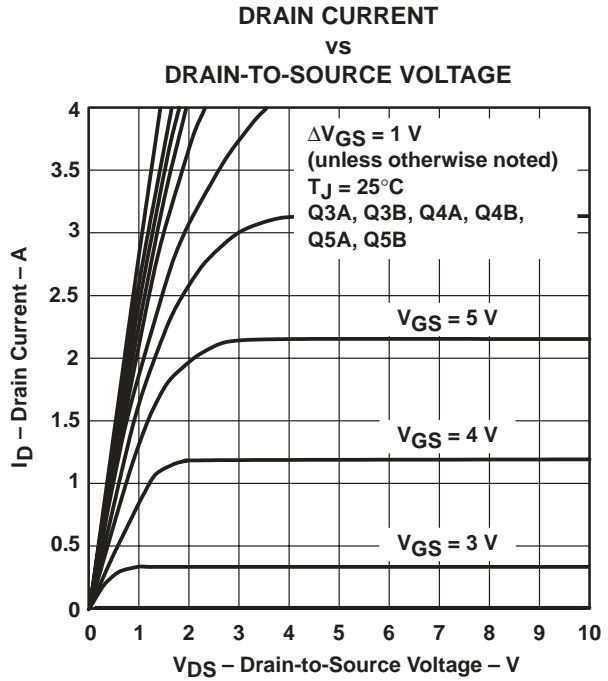


Figure 12

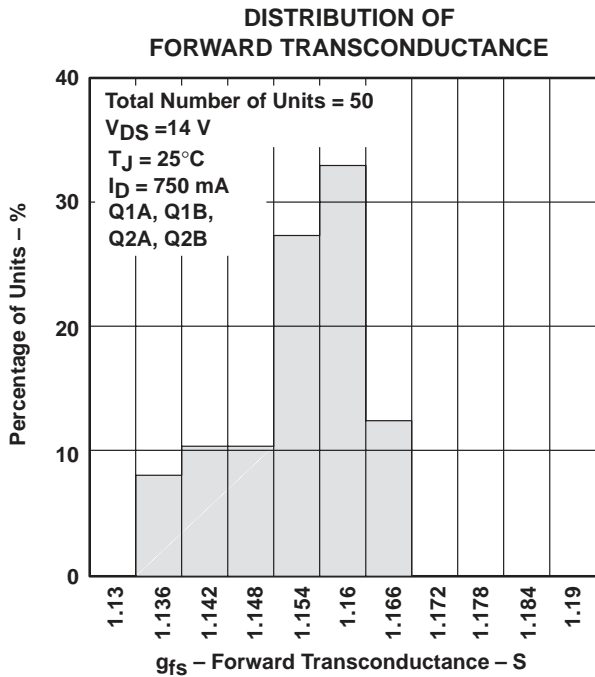


Figure 13

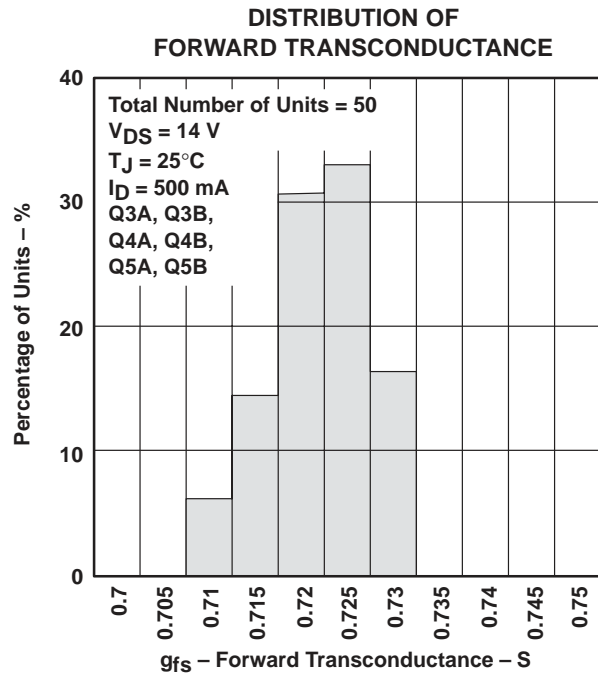


Figure 14

TYPICAL CHARACTERISTICS

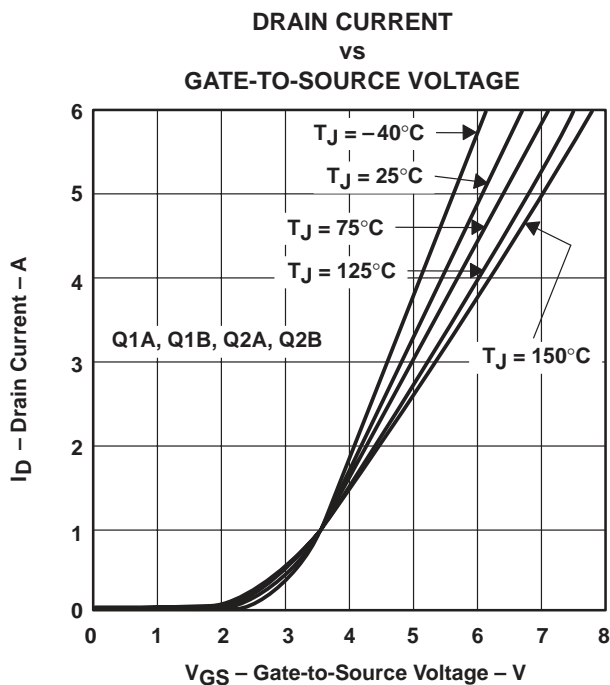


Figure 15

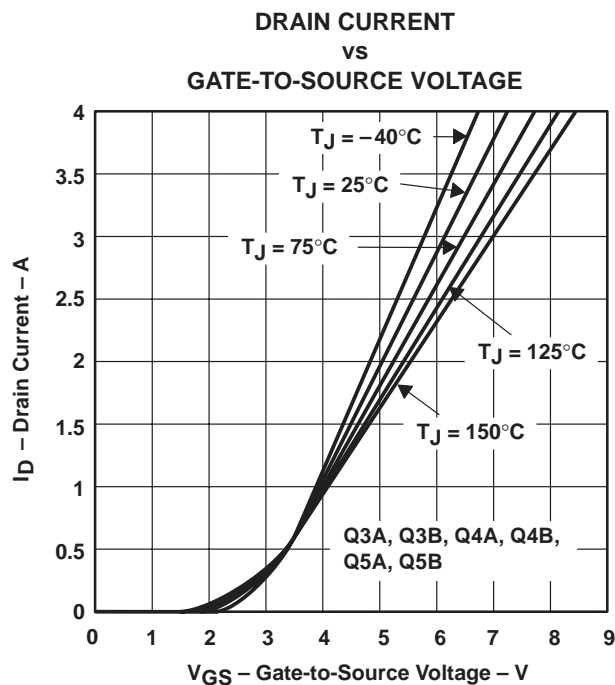


Figure 16

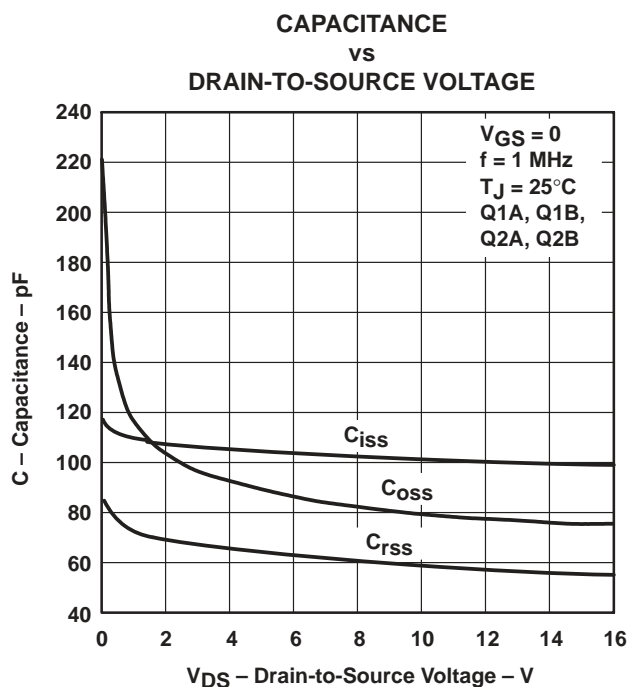


Figure 17

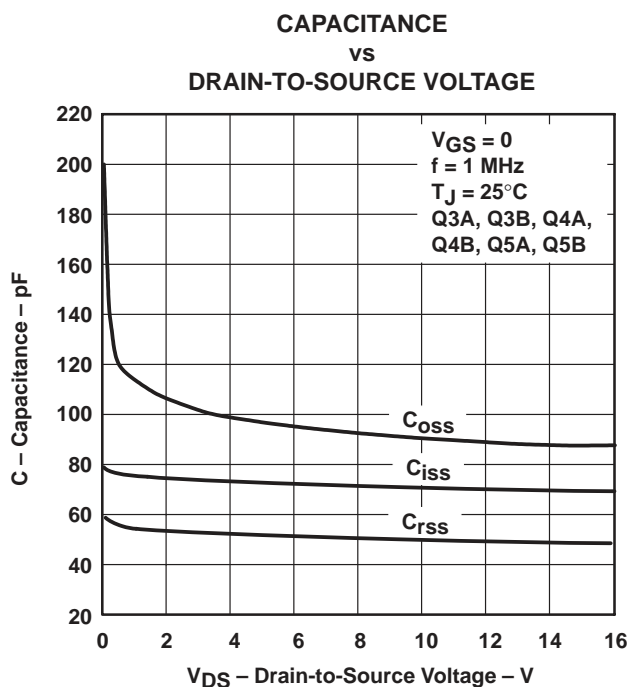


Figure 18

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TYPICAL CHARACTERISTICS

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

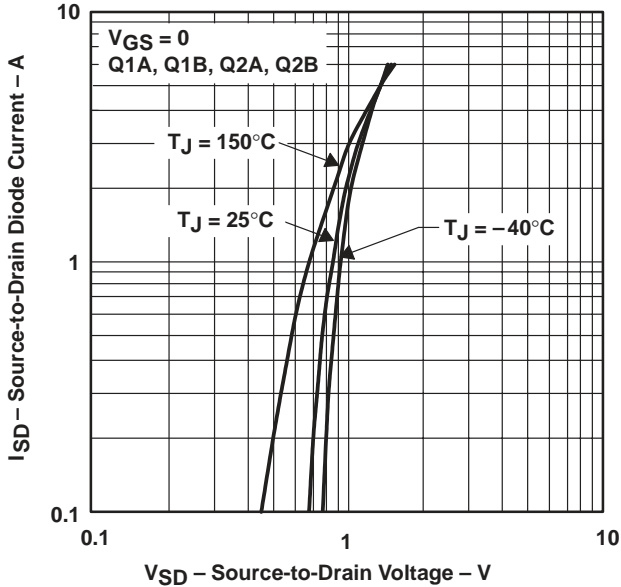


Figure 19

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

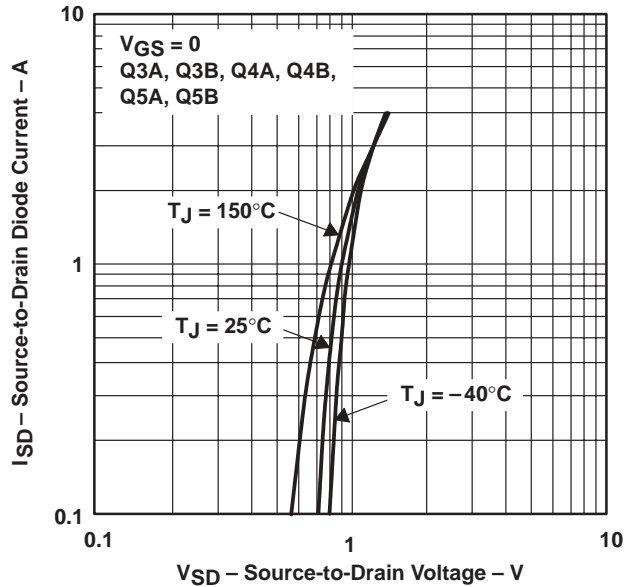


Figure 20

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

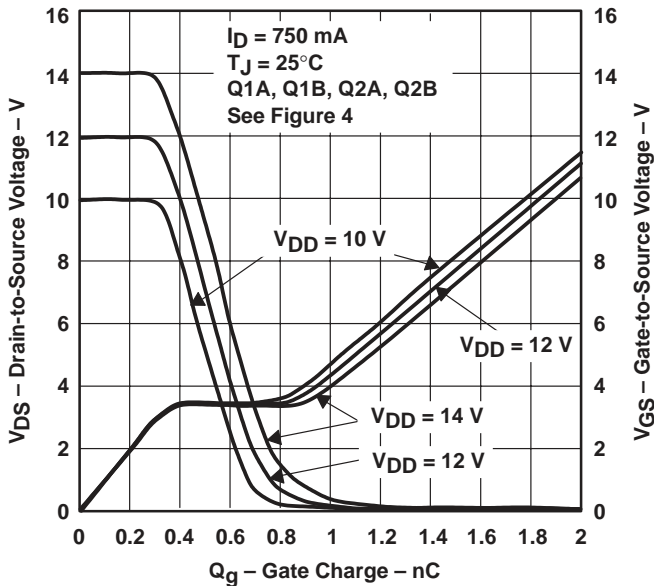


Figure 21

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

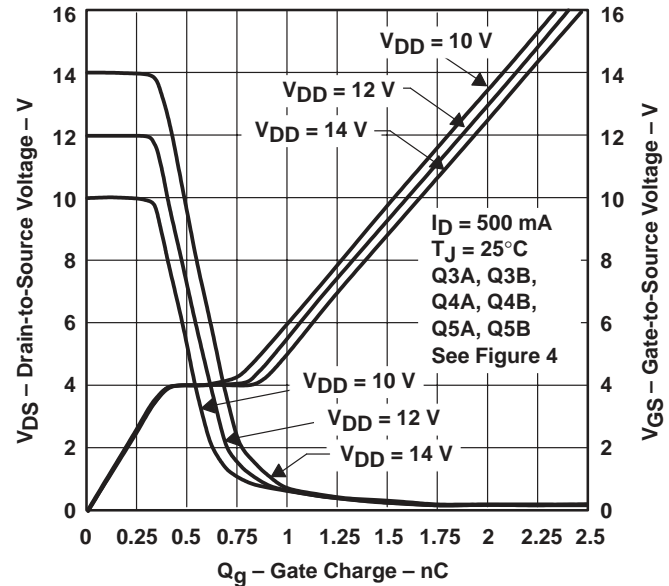


Figure 22



TYPICAL CHARACTERISTICS

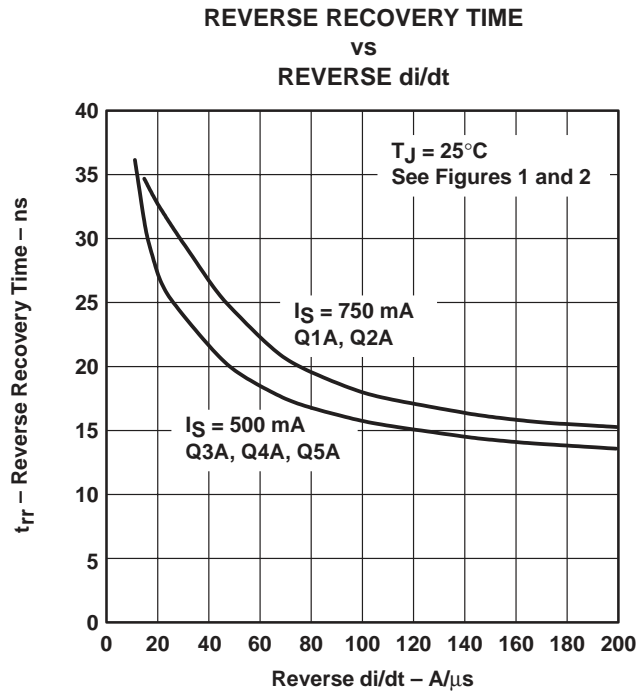


Figure 23

TPIC1505 QUAD AND HEX POWER DMOS ARRAY

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THERMAL INFORMATION

MAXIMUM DRAIN CURRENT vs DRAIN-TO-SOURCE VOLTAGE

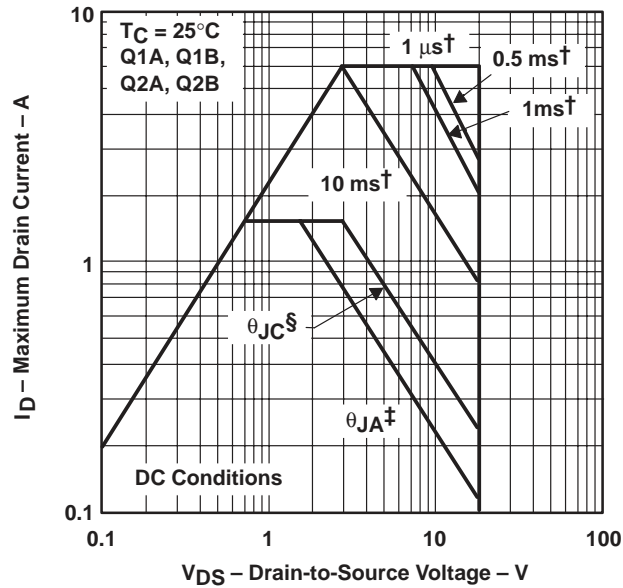


Figure 24

MAXIMUM DRAIN CURRENT vs DRAIN-TO-SOURCE VOLTAGE

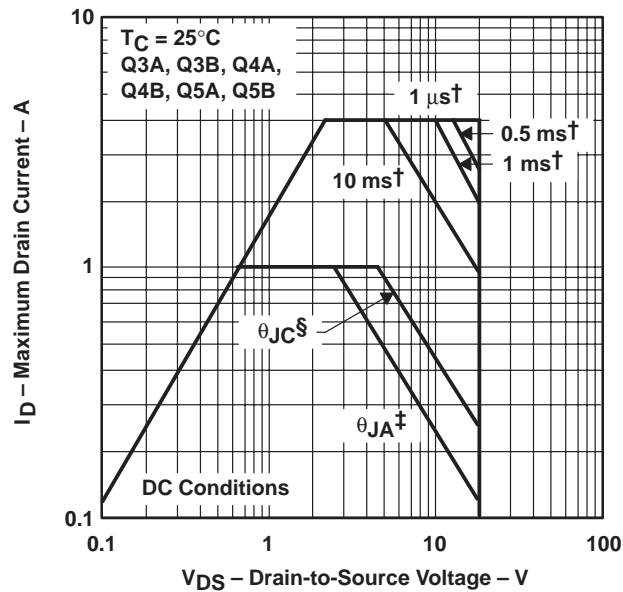


Figure 25

† Less than 10% duty cycle

‡ Device is mounted on a 24 in², 4 layer FR4 printed-circuit board.

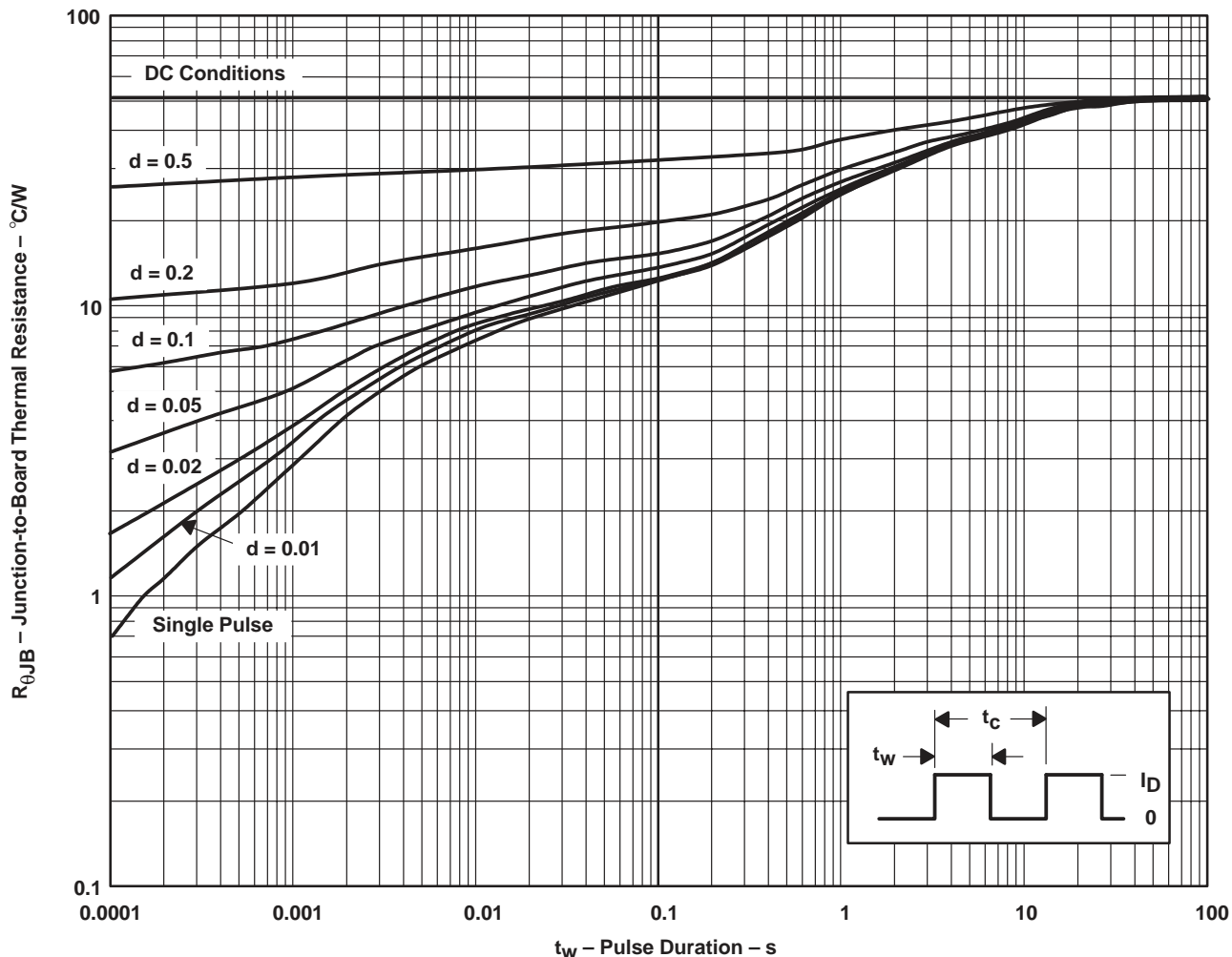
§ Device is mounted in intimate contact with infinite heat sink.



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THERMAL INFORMATION

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



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

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 26

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TPIC1505DW	PREVIEW	SOIC	DW	24	25	TBD	Call TI	Call TI
TPIC1505DWR	PREVIEW	SOIC	DW	24	2000	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), Pb-Free (RoHS Exempt), 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.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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)

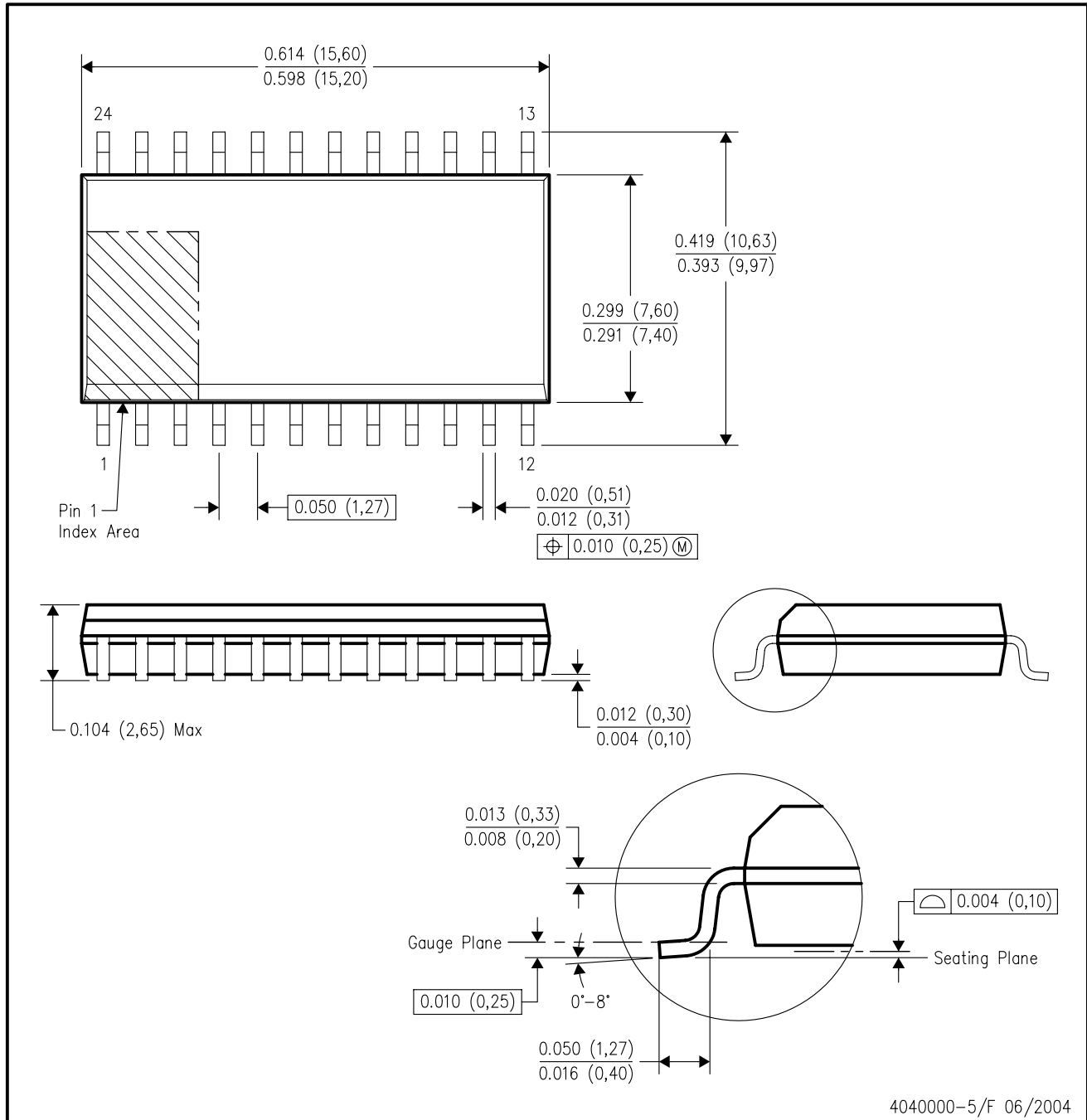
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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DW (R-PDSO-G24)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
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