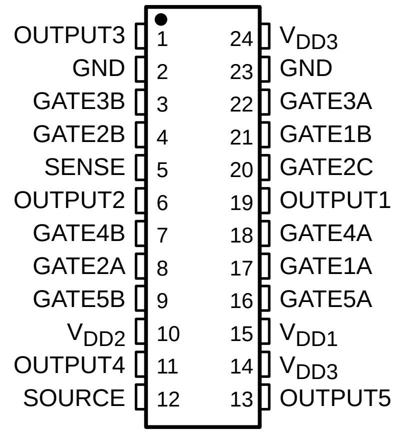
- **Low $r_{DS(on)}$:**
  0.1 Ω Typ (Full H-Bridge)
  0.4 Ω Typ (Triple Half H-Bridge)
- **Pulsed Current:**
  12 A Per Channel (Full H-Bridge)
  6 A Per Channel (Triple Half H-Bridge)
- **Matched Sense Transistor for Class A-B Linear Operation**
- **Fast Commutation Speed**

DW PACKAGE
(TOP VIEW)

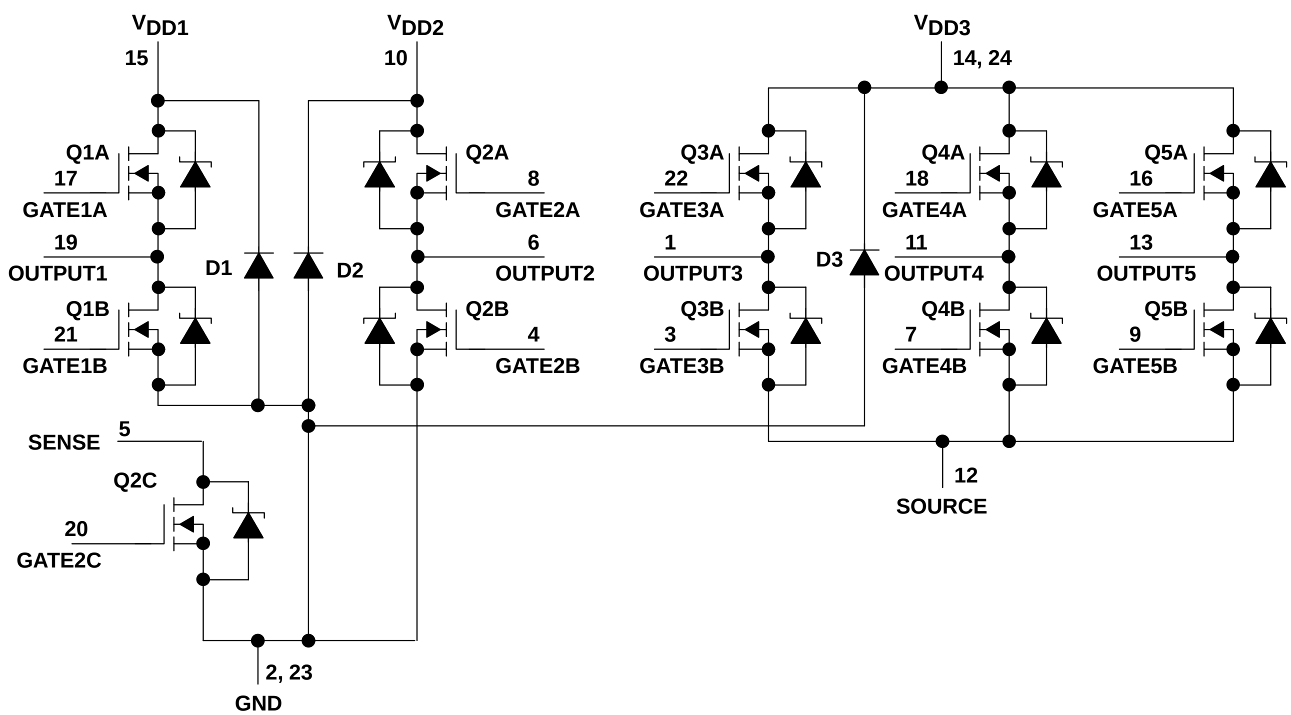


description

The TPIC1501A 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 TPIC1501A 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 2 and 23 must be externally connected.
B. Pins 14 and 24 must be externally connected.
C. No output may be taken greater than 0.5 V below GND.

absolute maximum ratings, T_C = 25°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)	±20 V
Gate-to-source voltage range, V_{GS} (Q2C)	–0.7 V to 6 V
Continuous drain current, each output (Q1A, Q1B, Q2A, Q2B)	3 A
Continuous drain current, each output (Q3A, Q3B, Q4A, Q4B, Q5A, Q5B)	1.5 A
Continuous drain current (Q2C)	15 mA
Continuous source-to-drain diode current (Q1A, Q1B, Q2A, Q2B)	3 A
Continuous source-to-drain diode current (Q3A, Q3B, Q4A, Q4B, Q5A, Q5B)	1.5 A
Continuous source-to-drain diode current (Q2C)	15 mA
Pulsed drain current, each output, I_{max} (Q1A, Q1B, Q2A, Q2B) (see Note 1 and Figure 24)	12 A
Pulsed drain current, each output, I_{max} (Q3A, Q3B, Q4A, Q4B, Q5A, Q5B) (see Note 1 and Figure 25)	6 A
Pulsed drain current, I_{max} (Q2C) (see Note 1)	60 mA
Continuous total power dissipation, T_C = 70°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, See Figure 5	V_{DS} = V_{GS},	1.4	1.7	2.1	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
$V_{DS(on)}$	Drain-to-source on-state voltage	I_D = 2 A, See Notes 3 and 4	V_{GS} = 10 V,		0.2	0.24	V
V_F	Forward on-state voltage, GND-to-V_{DD1}, GND-to-V_{DD2}	I_D = 3 A (D1, D2) See Notes 3 and 4			1.8		V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	I_S = 2 A, See Notes 3 and 4 and Figure 19	V_{GS} = 0,		0.85	1.05	V
		I_S = 3 A, See Notes 3 and 4 and Figure 19	V_{GS} = 0,		0.9	1.1	
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_{GSSR}	Reverse-gate current, drain short circuited to source	V_{SG} = 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 = 2 A, See Notes 3 and 4 and Figure 9	T_C = 25°C		0.1	0.12	Ω
			T_C = 125°C		0.14	0.18	
		V_{GS} = 10 V, I_D = 3 A, See Notes 3 and 4 and Figures 7 and 9	T_C = 25°C		0.1	0.12	
			T_C = 125°C		0.14	0.18	
g_{fs}	Forward transconductance	V_{DS} = 14 V, See Notes 3 and 4	I_D = 1 A,	1.5	2.5		S
		V_{DS} = 14 V, See Notes 3 and 4 and Figure 13	I_D = 1.5 A,	2	3.1		
C_{iss}	Short-circuit input capacitance, common source	V_{DS} = 14 V, f = 1 MHz,	V_{GS} = 0, See Figure 17		240		pF
C_{oss}	Short-circuit output capacitance, common source				170		
C_{rss}	Short-circuit reverse transfer capacitance, common source				130		
α_S	Sense-FET drain current ratio	V_{DS} = 6 V,	$I_{D(Q2C)}$ = 40 µA	75	130	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 = 1.5 A, V_{GS} = 0, V_{DS} = 14 V, di/dt = 100 A/µs, See Figures 1 and 23		70		ns
Q_{RR}	Total diode charge			90		nC
t_{rr}	Reverse-recovery time	I_S = 2 A, V_{GS} = 0, V_{DS} = 14 V, di/dt = 100 A/µs		75		ns
Q_{RR}	Total diode charge			110		nC

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	V_{DD} = 14 V, R_L = 9.3 Ω, t_{en} = 10 ns, t_{dis} = 10 ns, See Figure 3		20		ns
$t_{d(off)}$	Turn-off delay time			30		
t_r	Rise time			15		
t_f	Fall time			25		
Q_g	Total gate charge	V_{DS} = 14 V, I_D = 1.5 A, V_{GS} = 10 V, See Figure 4		5.6	7	nC
$Q_{gs(th)}$	Threshold gate-to-source charge			0.8	1	
Q_{gd}	Gate-to-drain charge			1.4	1.75	
$L_{(drain)}$	Internal drain inductance			5		nH
$L_{(source)}$	Internal source inductance			5		
$r_{(gate)}$	Internal gate resistance			0.25		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 V	20			V
$V_{GS(th)}$	Gate-to-source threshold voltage	I_D = 1 mA, See Figure 6	V_{DS} = V_{GS},	1.4	1.7	2.1	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 = 1.5 A, See Notes 3 and 4	V_{GS} = 10 V,		0.6	0.68	V
V_F	Forward on-state voltage, GND-to-V_{DD3}	I_D = 1.5 A (D3) See Notes 3 and 4			1.7		V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	I_S = 1.5 A, See Notes 3 and 4 and Figure 20	V_{GS} = 0,		1	1.2	V
		I_S = 2 A, See Notes 3 and 4 and Figure 20	V_{GS} = 0,		1.1	1.3	
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_{GSSR}	Reverse-gate current, drain short circuited to source	V_{SG} = 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 = 0.3 A, See Notes 3 and 4 and Figure 10	T_C = 25°C		0.35	0.39	Ω
			T_C = 125°C		0.5	0.56	
		V_{GS} = 10 V, I_D = 1.5 A, See Notes 3 and 4 and Figures 8 and 10	T_C = 25°C		0.4	0.45	
			T_C = 125°C		0.56	0.65	
g_{fs}	Forward transconductance	V_{DS} = 14 V, See Notes 3 and 4	I_D = 500 mA,	0.3	0.8		S
		V_{DS} = 14 V, See Notes 3 and 4 and Figure 14	I_D = 750 mA,	0.4	0.93		
C_{iss}	Short-circuit input capacitance, common source	V_{DS} = 14 V, f = 1 MHz,	V_{GS} = 0, See Figure 18		96		pF
C_{oss}	Short-circuit output capacitance, common source				98		
C_{rss}	Short-circuit reverse transfer capacitance, common source				65		

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 = 750 mA, V_{GS} = 0, V_{DS} = 14 V, di/dt = 100 A/µs, See Figures 2 and 23		60		ns
Q_{RR}	Total diode charge			55		nC
t_{rr}	Reverse-recovery time	I_S = 1.5 A, V_{GS} = 0, V_{DS} = 14 V, di/dt = 100 A/µs		120		ns
Q_{RR}	Total diode charge			150		nC

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

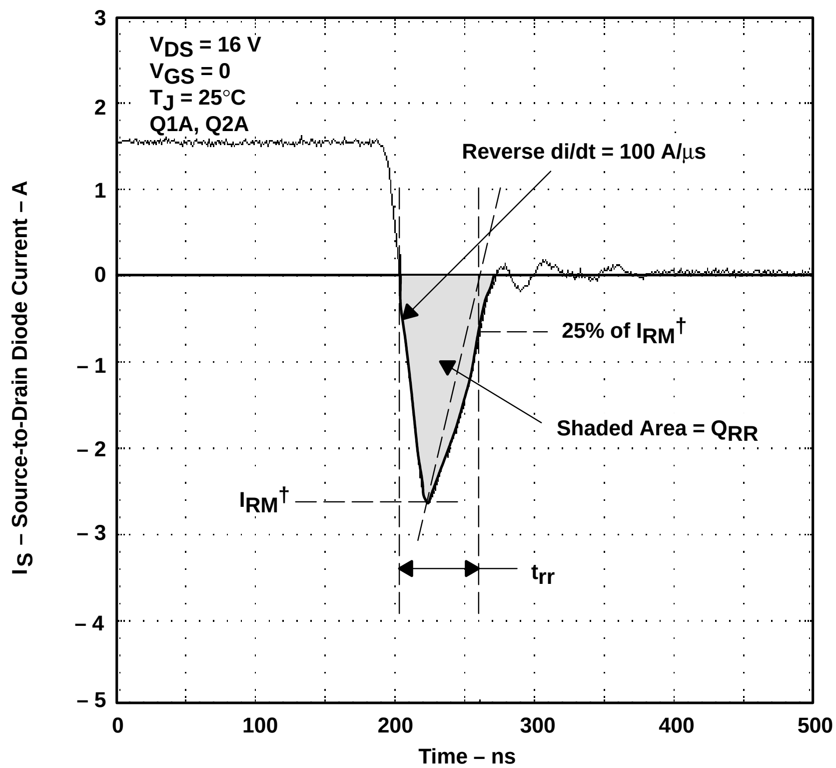
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(on)}$	Turn-on delay time	V_{DD} = 14 V, R_L = 18.7 Ω, t_{en} = 10 ns, t_{dis} = 10 ns, See Figure 3		18		ns
$t_{d(off)}$	Turn-off delay time			25		
t_r	Rise time			13		
t_f	Fall time			20		
Q_g	Total gate charge	V_{DS} = 14 V, I_D = 750 mA, V_{GS} = 10 V, See Figure 4		1.6	2	nC
$Q_{gs(th)}$	Threshold gate-to-source charge			0.26	0.32	
Q_{gd}	Gate-to-drain charge			0.42	0.52	
$L_{(drain)}$	Internal drain inductance			5		nH
$L_{(source)}$	Internal source inductance			5		
$r_{(gate)}$	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 5 and 8		90		°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	See Notes 6 and 8		38		
$R_{\theta JP}$	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 in^2, 4-layer FR4 printed-circuit board.
7. Package is mounted in intimate contact with infinite heat sink.
8. All outputs have equal power.

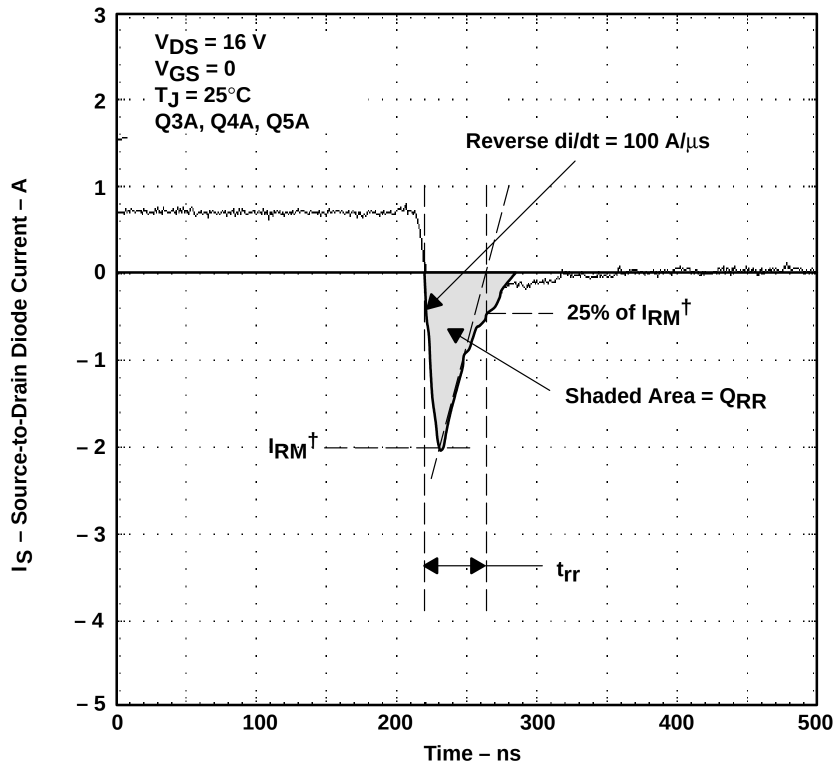
PARAMETER MEASUREMENT INFORMATION



† I_{RM} = maximum recovery current

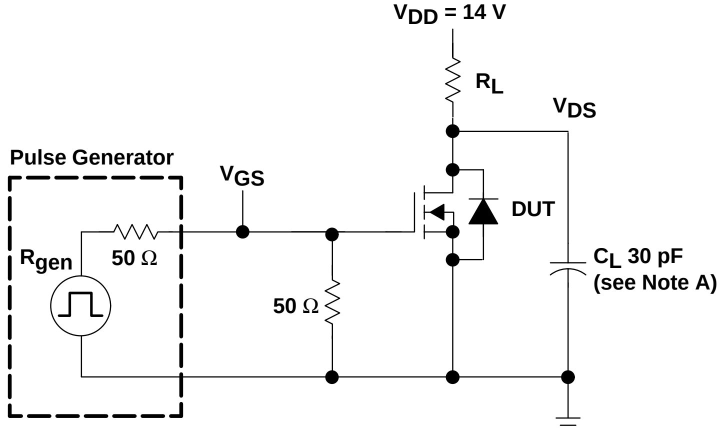
Figure 1. Reverse-Recovery-Current Waveform of Source-to-Drain Diodes

PARAMETER MEASUREMENT INFORMATION

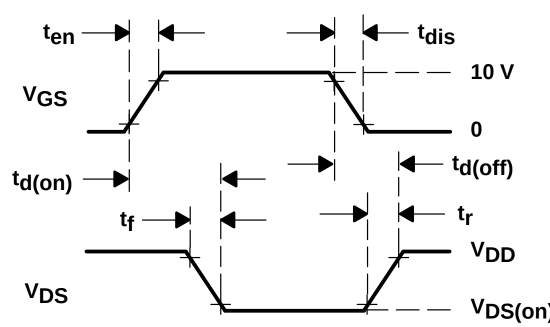


† I_{RM} = maximum recovery current

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



TEST CIRCUIT

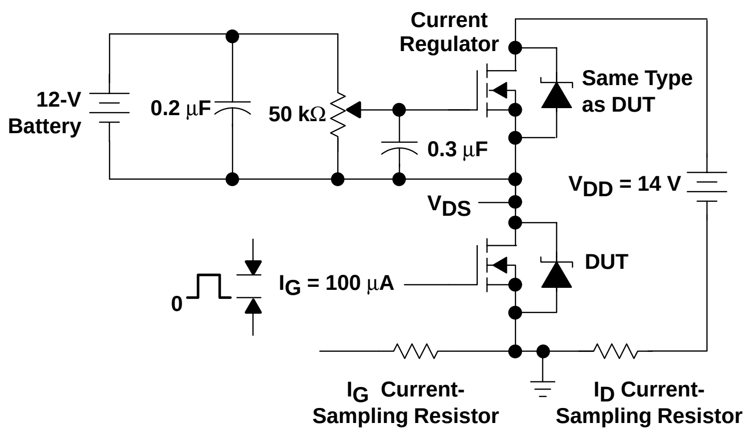


VOLTAGE WAVEFORMS

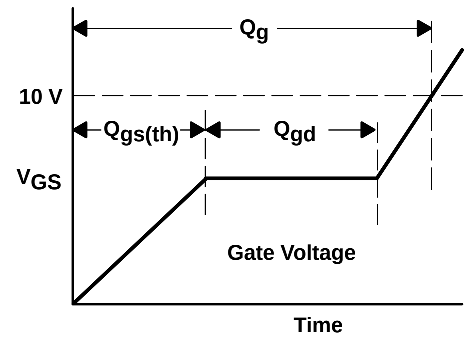
NOTE A: C_L includes probe and jig capacitance.

Figure 3. Resistive-Switching Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORM

Figure 4. Gate-Charge Test Circuit and Voltage Waveform

TYPICAL CHARACTERISTICS

GATE-TO-SOURCE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

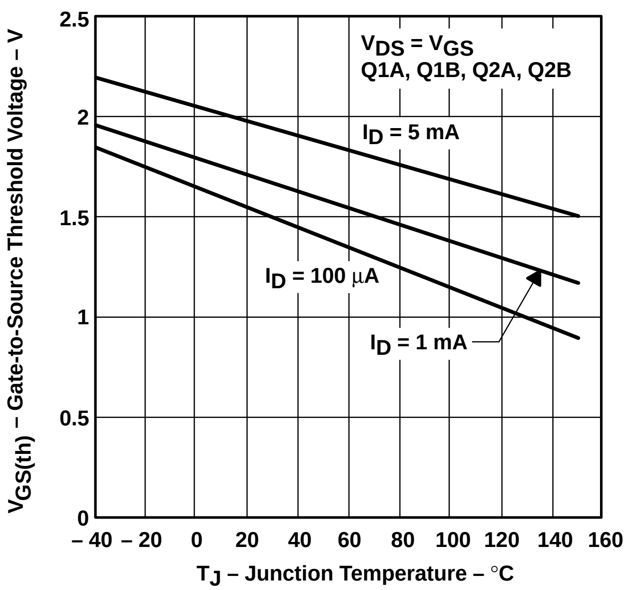


Figure 5

GATE-TO-SOURCE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

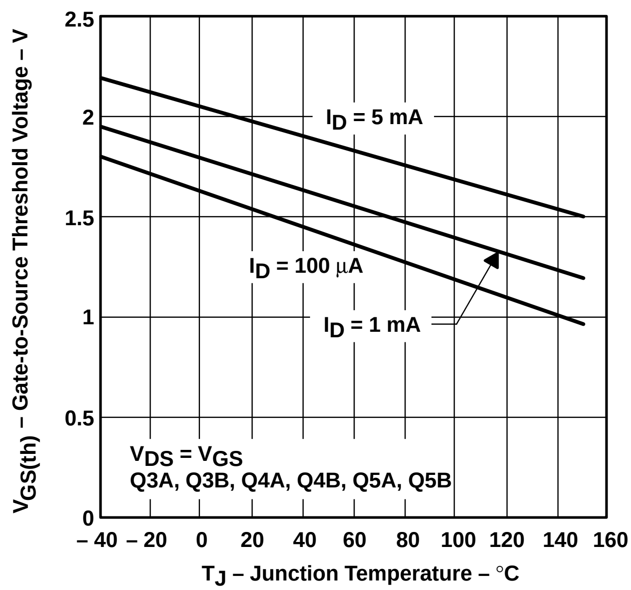


Figure 6

TYPICAL CHARACTERISTICS

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

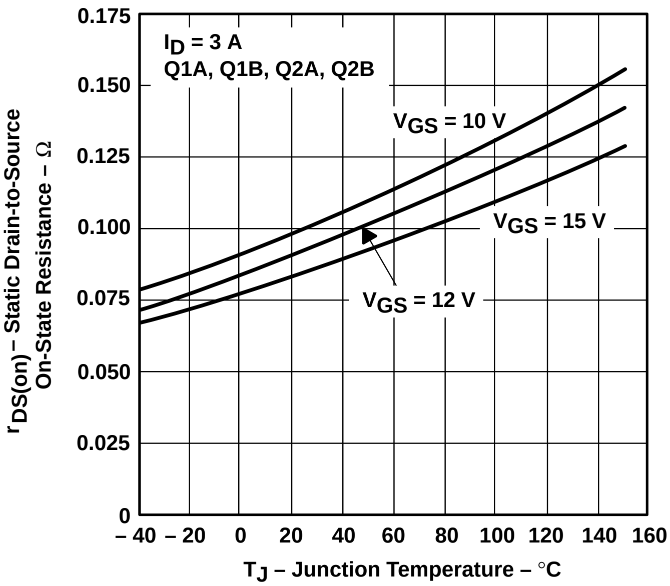


Figure 7

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

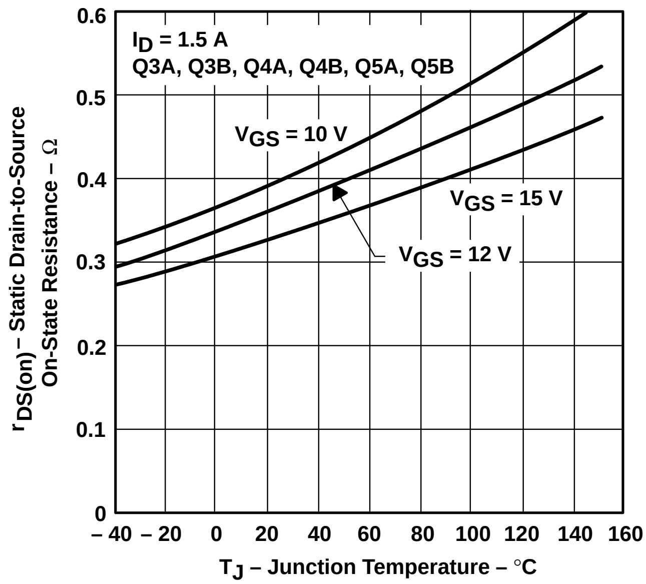


Figure 8

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

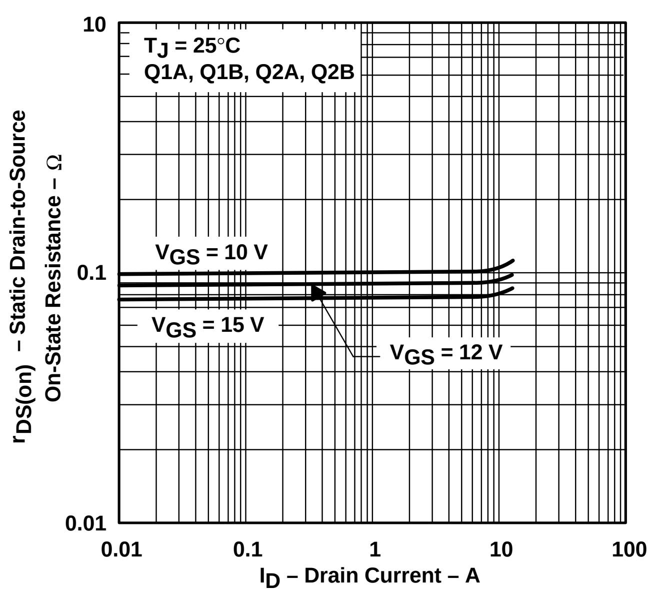


Figure 9

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

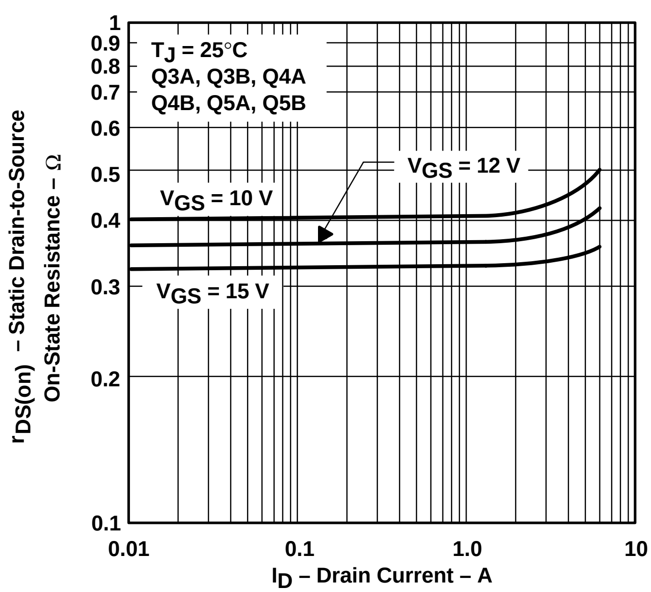


Figure 10

TYPICAL CHARACTERISTICS

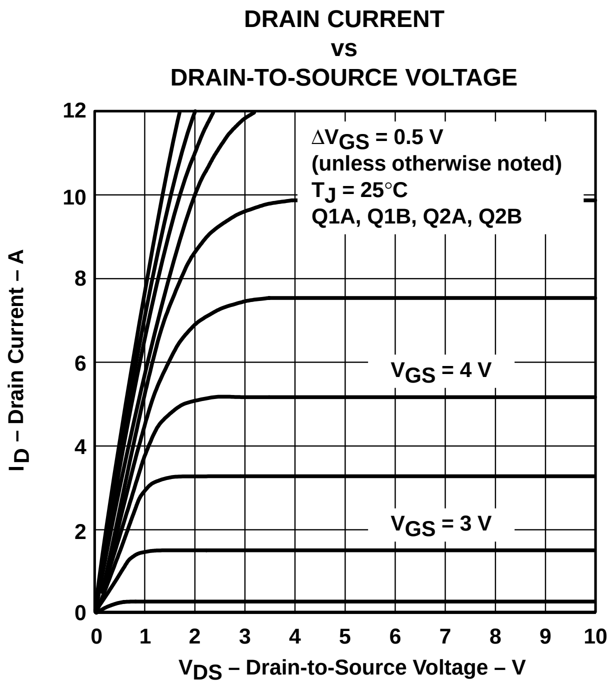


Figure 11

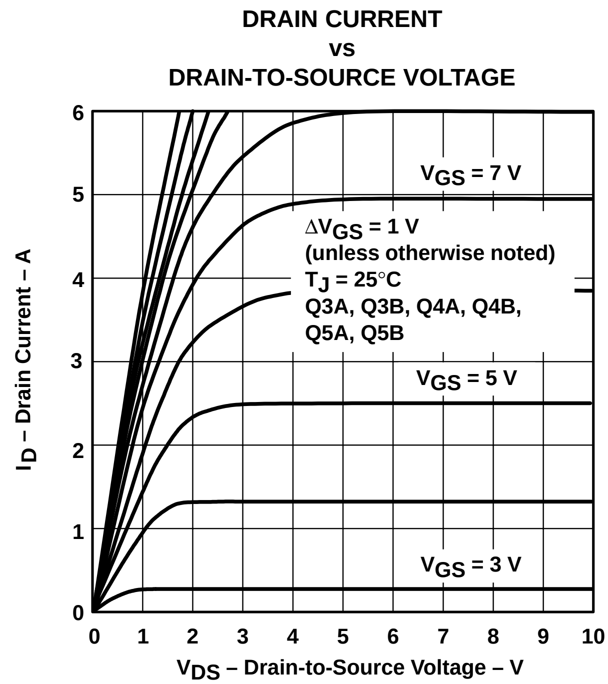


Figure 12

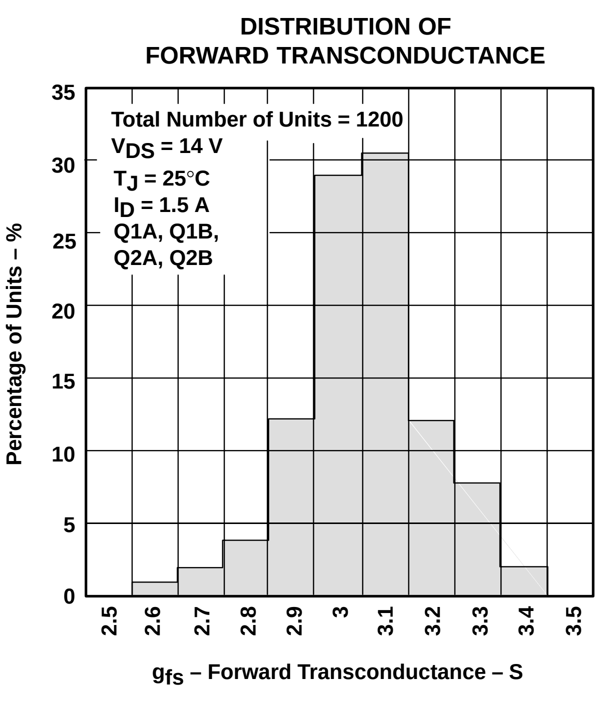


Figure 13

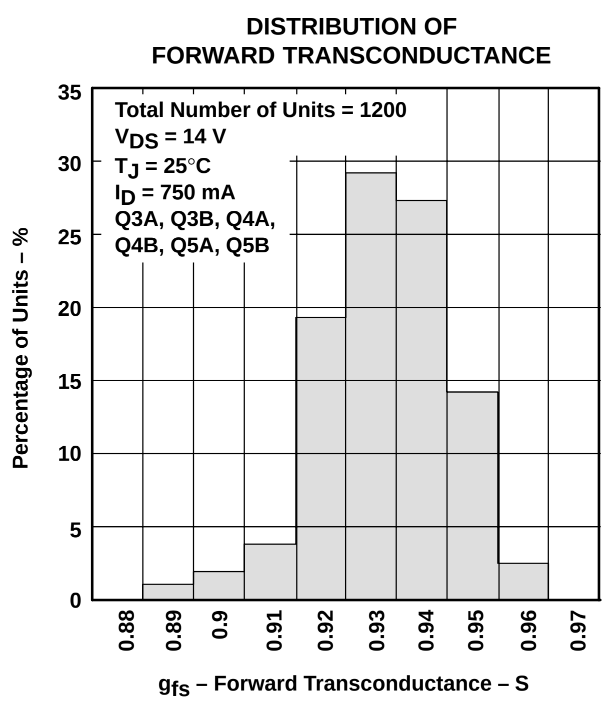


Figure 14

TYPICAL CHARACTERISTICS

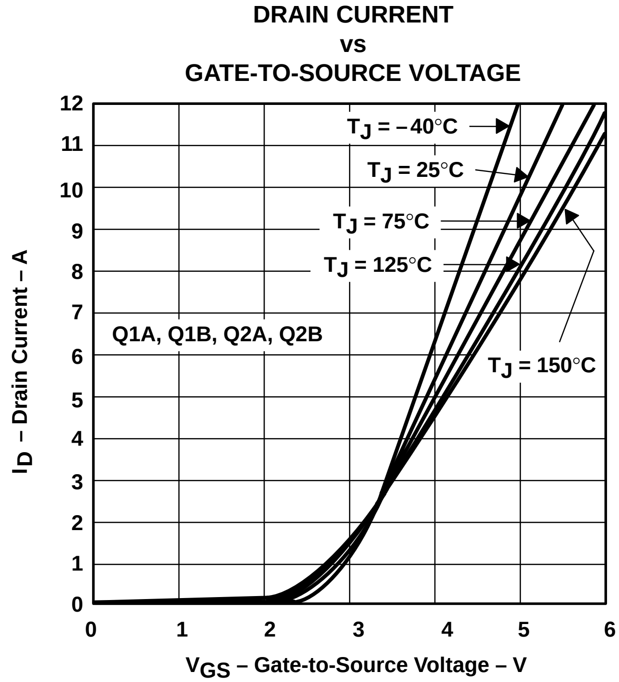


Figure 15

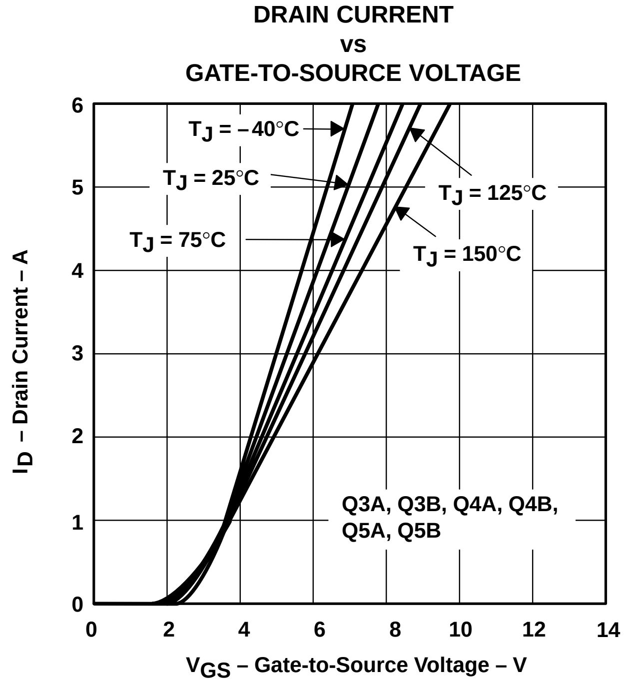


Figure 16

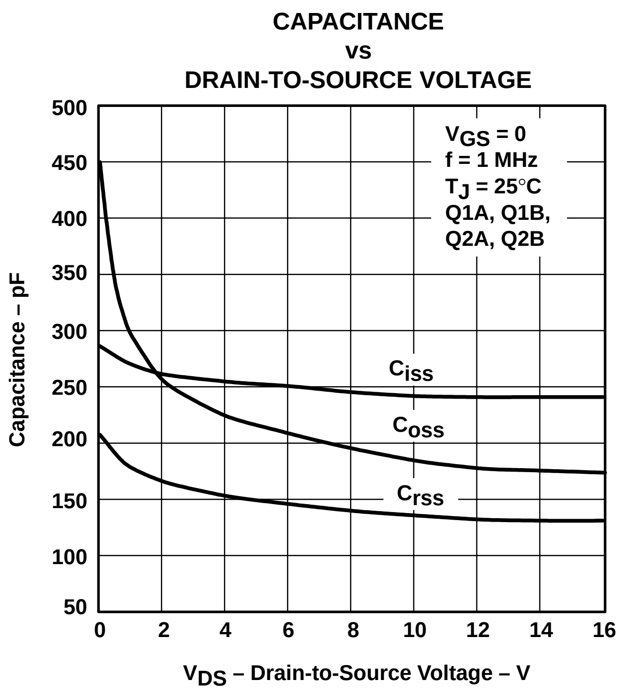


Figure 17

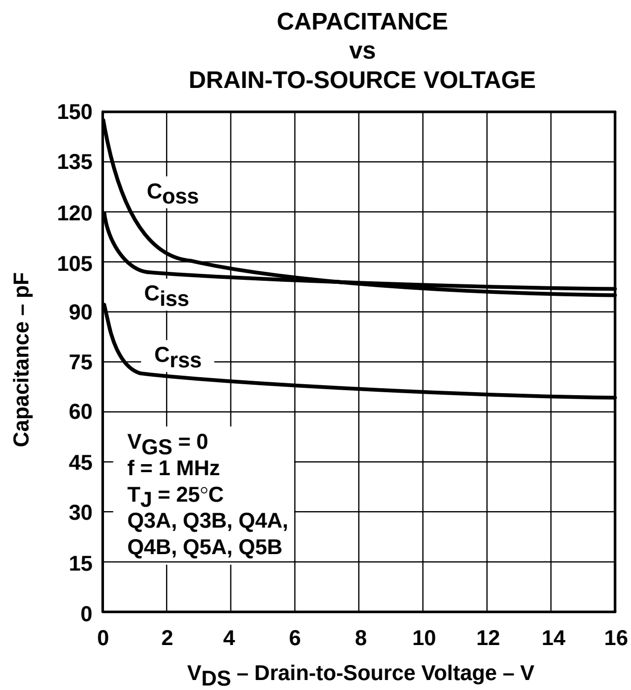


Figure 18

TYPICAL CHARACTERISTICS

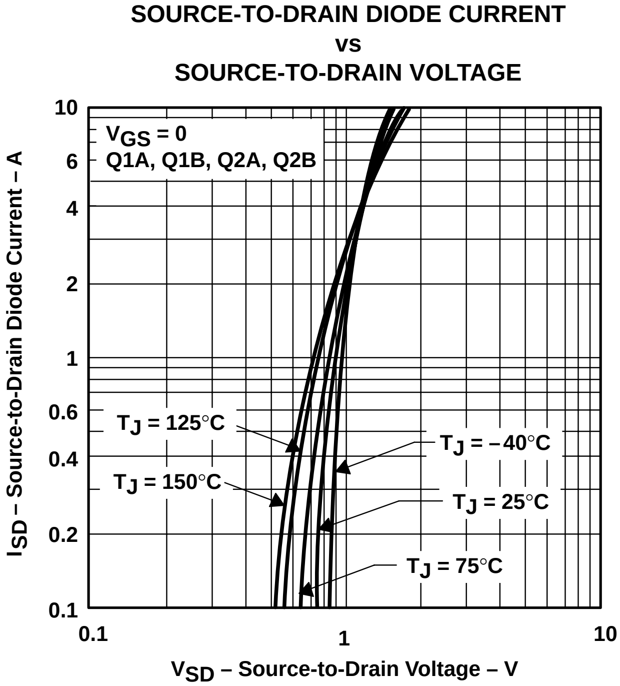


Figure 19

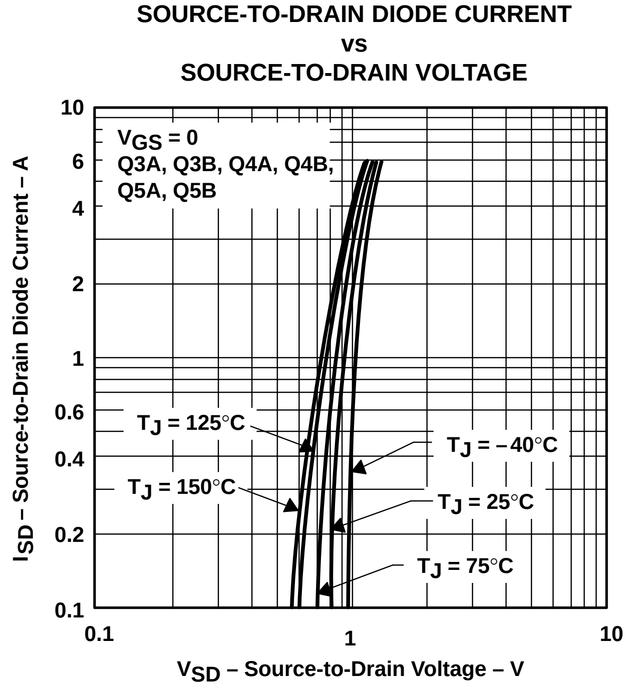


Figure 20

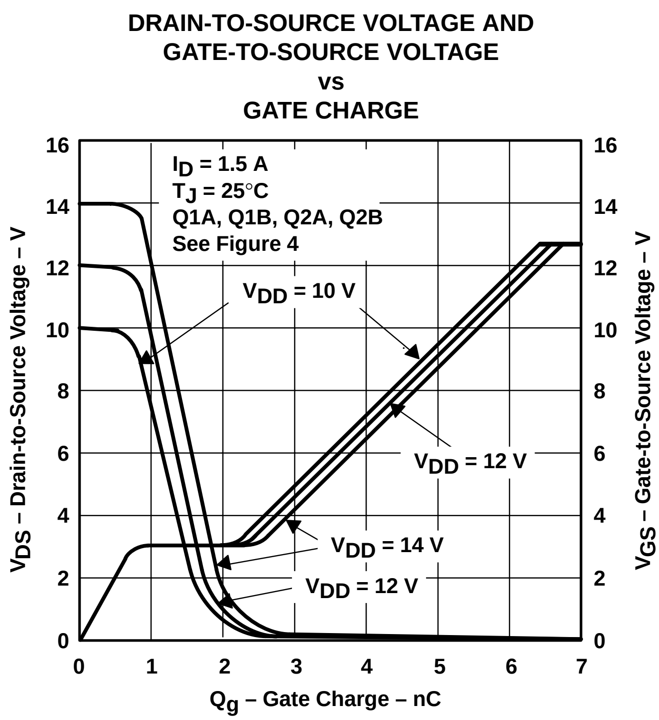


Figure 21

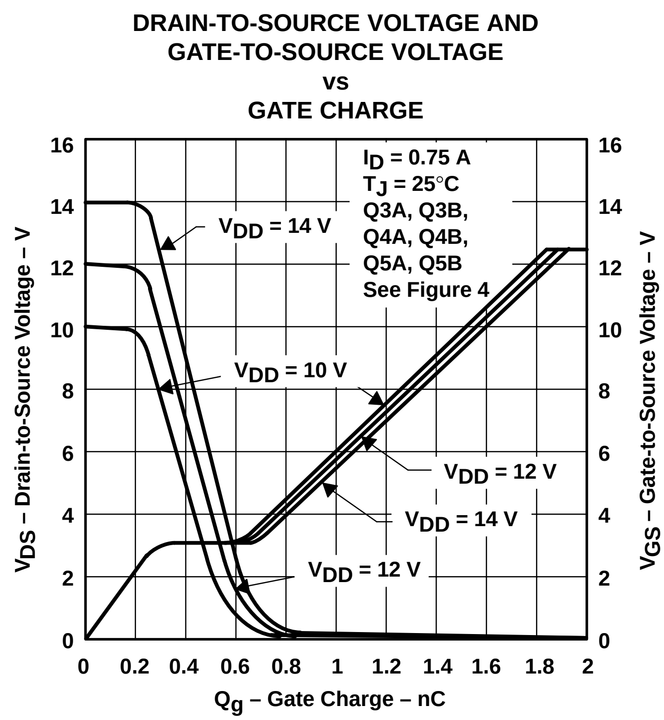


Figure 22

TYPICAL CHARACTERISTICS

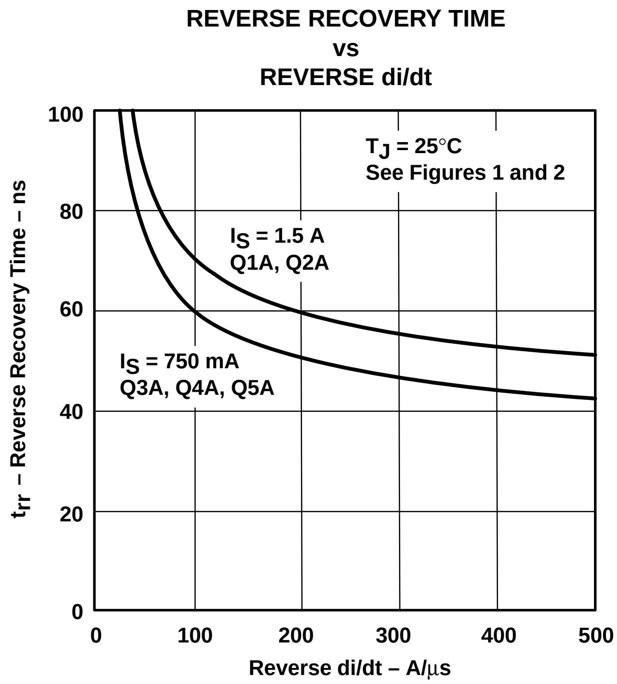


Figure 23

THERMAL INFORMATION

MAXIMUM DRAIN CURRENT vs DRAIN-TO-SOURCE VOLTAGE

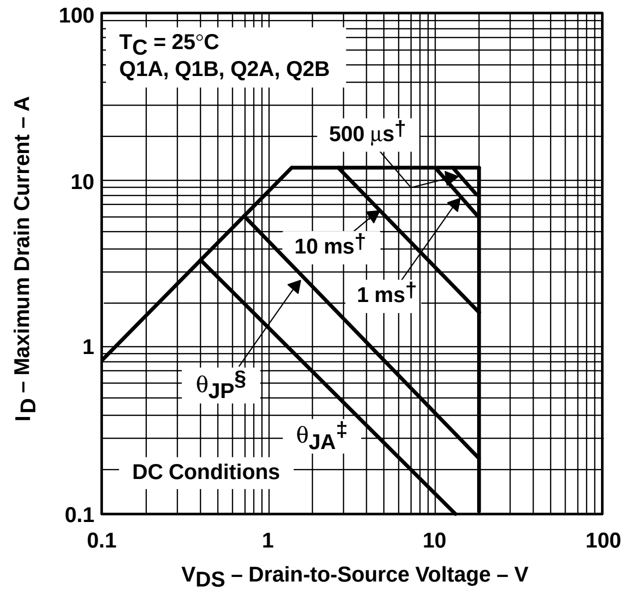


Figure 24

MAXIMUM DRAIN CURRENT vs DRAIN-TO-SOURCE VOLTAGE

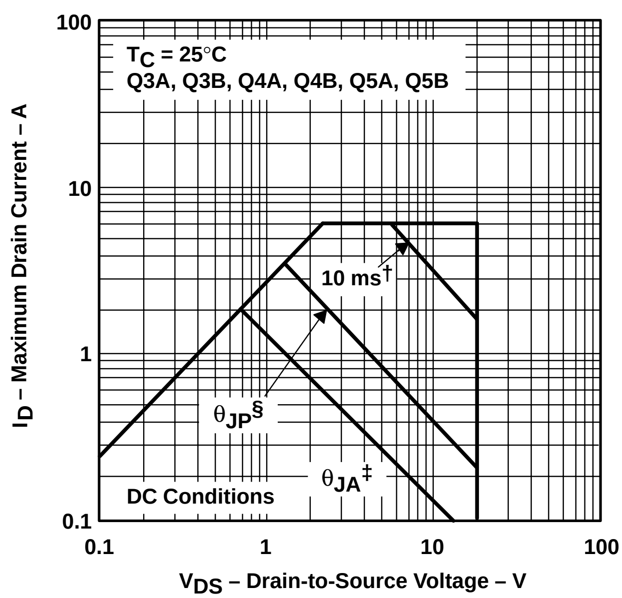
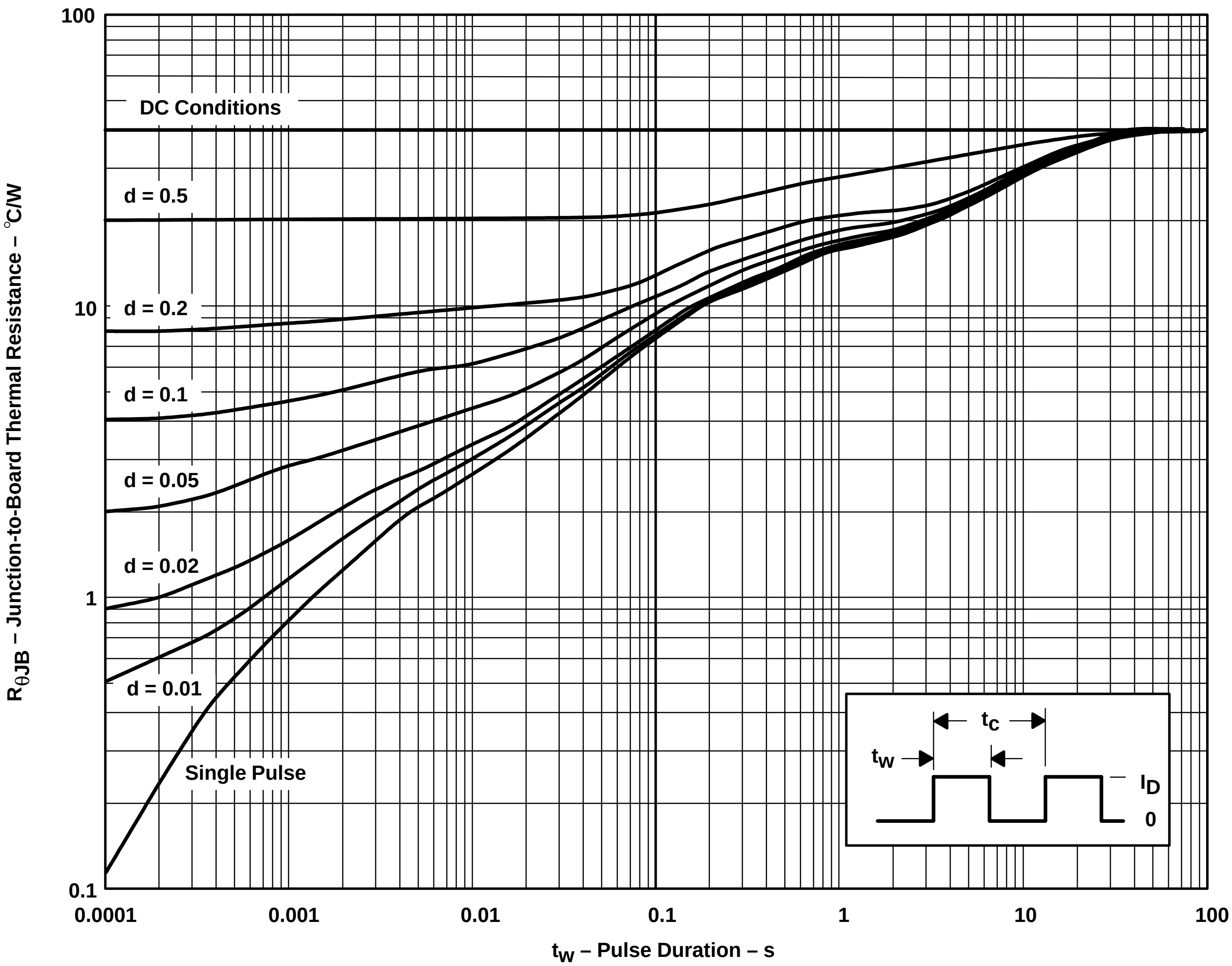


Figure 25

† Less than 10% duty cycle
‡ Device is mounted on a 24 in^2, 4 layer FR4 printed-circuit board.
§ Device is mounted in intimate contact with infinite heat sink.

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

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