

TPIC5601 3-PHASE BRIDGE POWER DMOS ARRAY

SLIS022B – MARCH 1994 – REVISED OCTOBER 1995

- Low $r_{DS(on)}$. . . 0.3 Ω Typ
- High-Voltage Output . . . 60 V
- Pulsed Current . . . 8 A Per Channel
- Fast Commutation Speed

description

The TPIC5601 is a monolithic power DMOS array that consists of six electrically isolated N-channel enhancement-mode DMOS transistors, three of which are configured with a common source. The TPIC5601 is offered in a 20-pin wide-body surface-mount (DW) package.

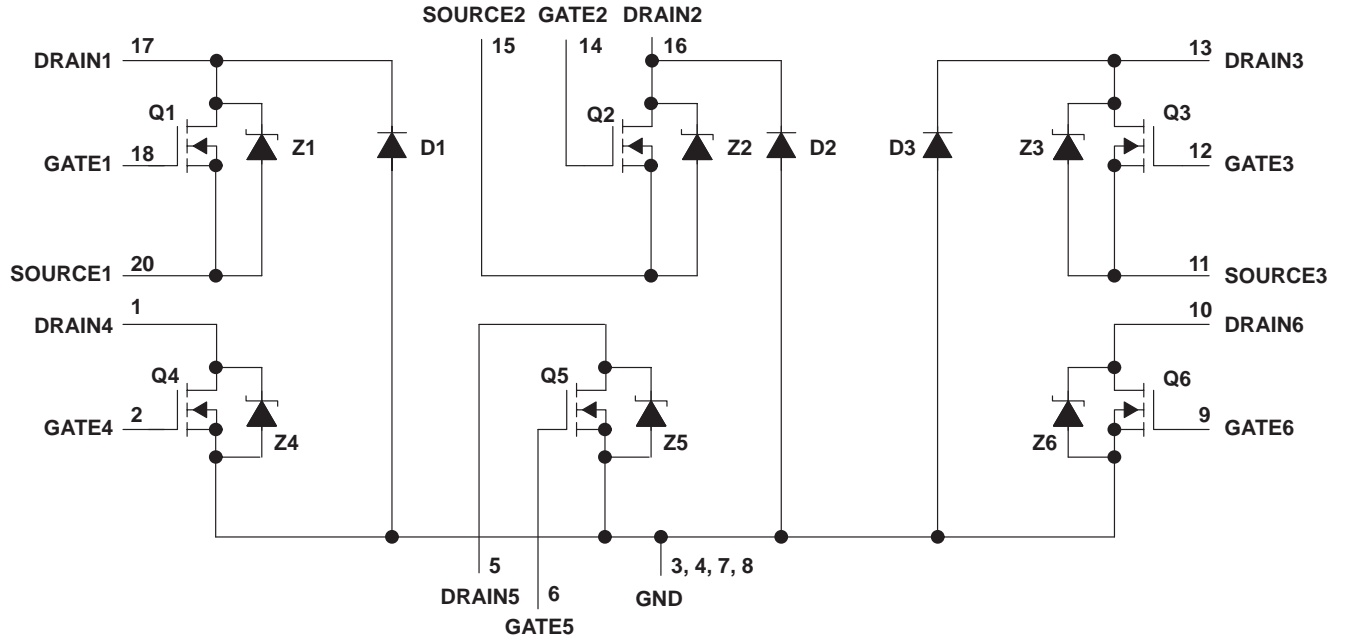
The TPIC5601 is characterized for operation over the case temperature range of -40°C to 125°C .

DW PACKAGE
(TOP VIEW)

DRAIN4	1	20	SOURCE1
GATE4	2	19	NC
GND	3	18	GATE1
GND	4	17	DRAIN1
DRAIN5	5	16	DRAIN2
GATE5	6	15	SOURCE2
GND	7	14	GATE2
GND	8	13	DRAIN3
GATE6	9	12	GATE3
DRAIN6	10	11	SOURCE3

NC – No internal connection

schematic



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.

TPIC5601

3-PHASE BRIDGE POWER DMOS ARRAY

SLIS022B – MARCH 1994 – REVISED OCTOBER 1995

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

Drain-to-source voltage, V_{DS}	60 V
Source-to-GND voltage (Q1, Q2, and Q3)	100 V
Drain-to-GND voltage (Q1, Q2, and Q3)	100 V
Drain-to-GND voltage (Q4, Q5, and Q6)	60 V
Gate-to-source voltage range, V_{GS}	± 20 V
Continuous drain current, each output, $T_C = 25^\circ\text{C}$	1.7 A
Continuous source-to-drain diode current	1.7 A
Pulsed drain current, I_D , each output, $T_C = 25^\circ\text{C}$ (see Note 1 and Figure 15)	8 A
Single-pulse avalanche energy, E_A , $T_C = 25^\circ\text{C}$ (see Figures 4 and 16)	36 mJ
Continuous total power dissipation	See Dissipation Rating Table
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%

DISSIPATION RATING TABLE

PACKAGE	$T_C \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_C = 25^\circ\text{C}$	$T_C = 125^\circ\text{C}$ POWER RATING
DW	1125 mW	9.0 mW/ $^\circ\text{C}$	225 mW

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	1.85	2.2	V
$V_{(BR)}$	Reverse drain-to-GND breakdown voltage (across D1, D2, and D3)	Drain-to-GND current = $250 \mu\text{A}$		100			V
$V_{DS(on)}$	Drain-to-source on-state voltage	$I_D = 1.7 \text{ A}$, See Notes 2 and 3	$V_{GS} = 10 \text{ V}$,		0.51	0.6	V
V_F	Forward on-state voltage, GND-to-drain	$I_D = 1.7 \text{ A}$ (D1, D2, D3), See Notes 2 and 3			7.5		V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	$I_S = 1.7 \text{ A}$, $V_{GS} = 0$ (Z1, Z2, Z3, Z4, Z5, Z6), See Notes 2 and 3			1	1.2	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	$V_{GS} = 16 \text{ V}$,	$V_{DS} = 0$		10	100	nA
I_{GSSR}	Reverse gate current, drain short circuited to source	$V_{SG} = 16 \text{ V}$,	$V_{DS} = 0$		10	100	nA
I_{lkg}	Leakage current, drain-to-GND	$V_R = 48 \text{ V}$	$T_C = 25^\circ\text{C}$	0.05	1		μA
			$T_C = 125^\circ\text{C}$	0.5	10		
$r_{DS(on)}$	Static drain-to-source on-state resistance	$V_{GS} = 10 \text{ V}$, $I_D = 1.7 \text{ A}$, See Notes 2 and 3 and Figures 6 and 7	$T_C = 25^\circ\text{C}$	0.3	0.35		Ω
			$T_C = 125^\circ\text{C}$	0.41	0.5		
g_{fs}	Forward transconductance	$V_{DS} = 15 \text{ V}$, See Notes 2 and 3	$I_D = 1 \text{ A}$,	1.2	1.75		S
C_{iss}	Short-circuit input capacitance, common source	$V_{DS} = 25 \text{ V}$, $f = 1 \text{ MHz}$		190		240	pF
C_{oss}	Short-circuit output capacitance, common source			100		125	
C_{rss}	Short-circuit reverse-transfer capacitance, common source			40		50	

NOTES: 2. Technique should limit $T_J - T_C$ to 10°C maximum, pulse duration $\leq 5 \text{ ms}$.
3. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{rr(SD)}$	Reverse-recovery time	$I_S = 1 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$,	$V_{GS} = 0$, $V_{DS} = 48 \text{ V}$, (Z1, Z2, Z3),		65		ns
Q_{RR}	Total diode charge	See Figure 1			0.12		μC
$t_{rr(SD)}$	Reverse-recovery time	$I_S = 1 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$,	$V_{GS} = 0$, $V_{DS} = 48 \text{ V}$, (Z4, Z5, Z6),		240		ns
Q_{RR}	Total diode charge	See Figure 1			0.9		μC

GND-to-drain diode characteristics, $T_C = 25^\circ\text{C}$ (see schematic, D1, D2, and D3)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{rr}	Reverse-recovery time	$I_F = 1 \text{ A}$,	$V_{DS} = 48 \text{ V}$,		260		ns
Q_{RR}	Total diode charge	$di/dt = 100 \text{ A}/\mu\text{s}$,	See Figure 1		2.2		μC

TPIC5601

3-PHASE BRIDGE POWER DMOS ARRAY

SLIS022B – MARCH 1994 – REVISED OCTOBER 1995

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

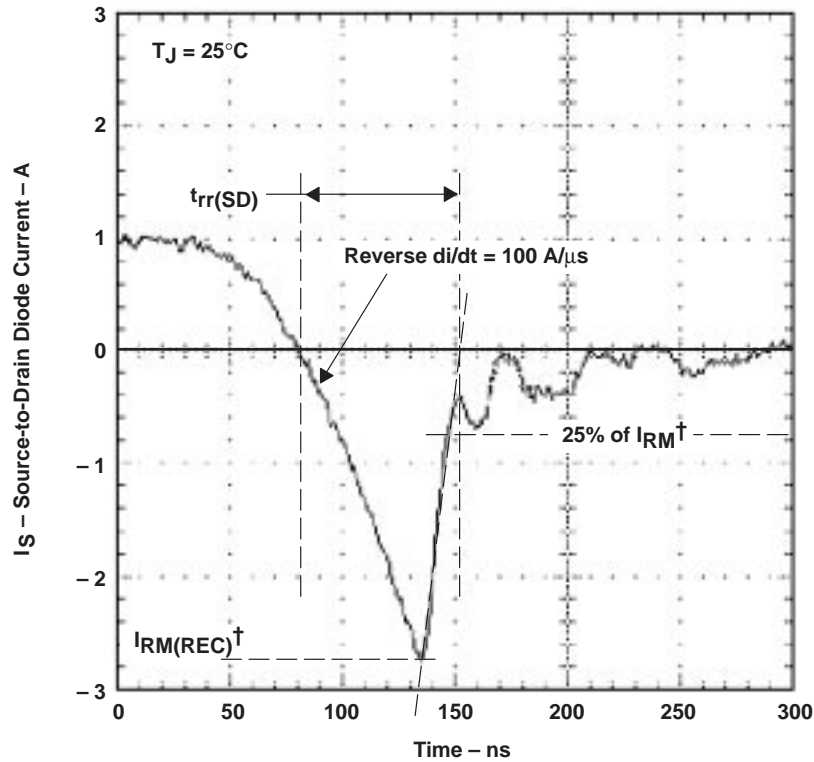
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 25\text{ V}$, $R_L = 25\ \Omega$, $t_{r1} = 10\text{ ns}$, See Figure 2		32	65	ns	
$t_{d(off)}$	Turn-off delay time			40	80		
t_{r2}	Rise time			15	30		
t_{f2}	Fall time			25	50		
Q_g	Total gate charge	$V_{DS} = 48\text{ V}$, See Figure 3	$I_D = 1\text{ A}$,	$V_{GS} = 10\text{ V}$,	5	6	nC
Q_{GS}	Threshold gate-to-source charge				0.5	0.6	
Q_{GD}	Gate-to-drain charge				1.9	2.3	
$L_{(drain)}$	Internal drain inductance			5		nH	
$L_{(source)}$	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	All outputs with equal power, See Note 4		90		$^\circ\text{C/W}$
$R_{\theta JP}$	Junction-to-pin thermal resistance			27		

NOTE 4: Package mounted on an FR4 printed-circuit board with no heat sink.

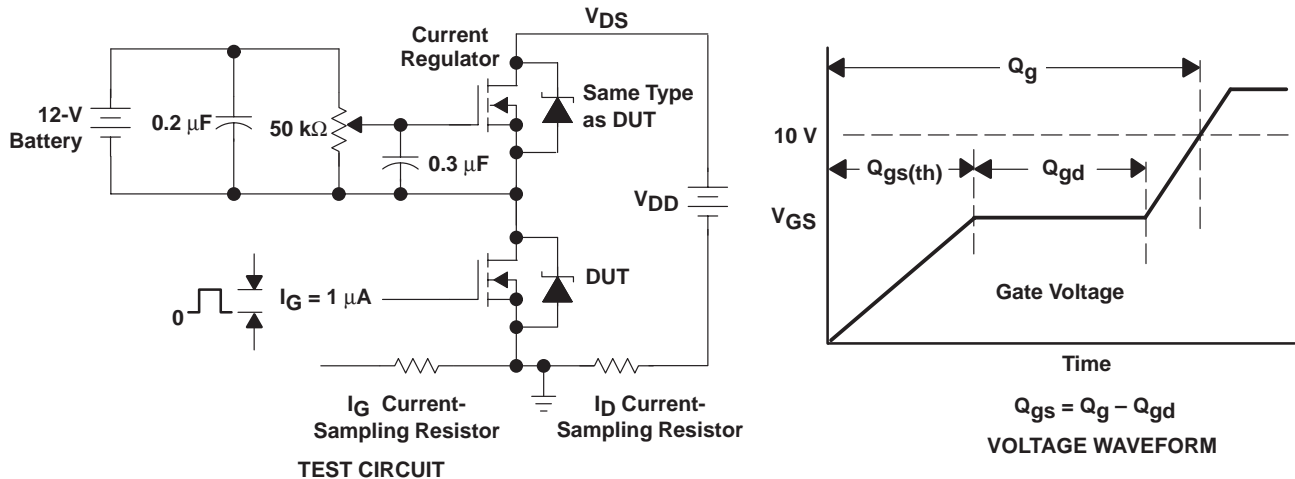
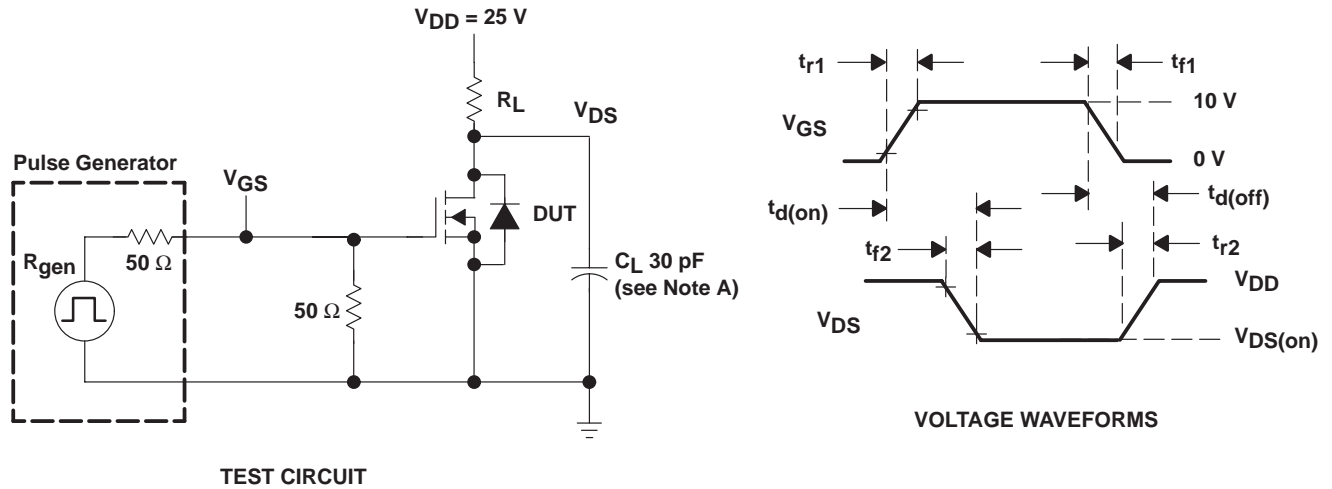
PARAMETER MEASUREMENT INFORMATION



† $I_{RM(REC)}$ = maximum recovery current

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

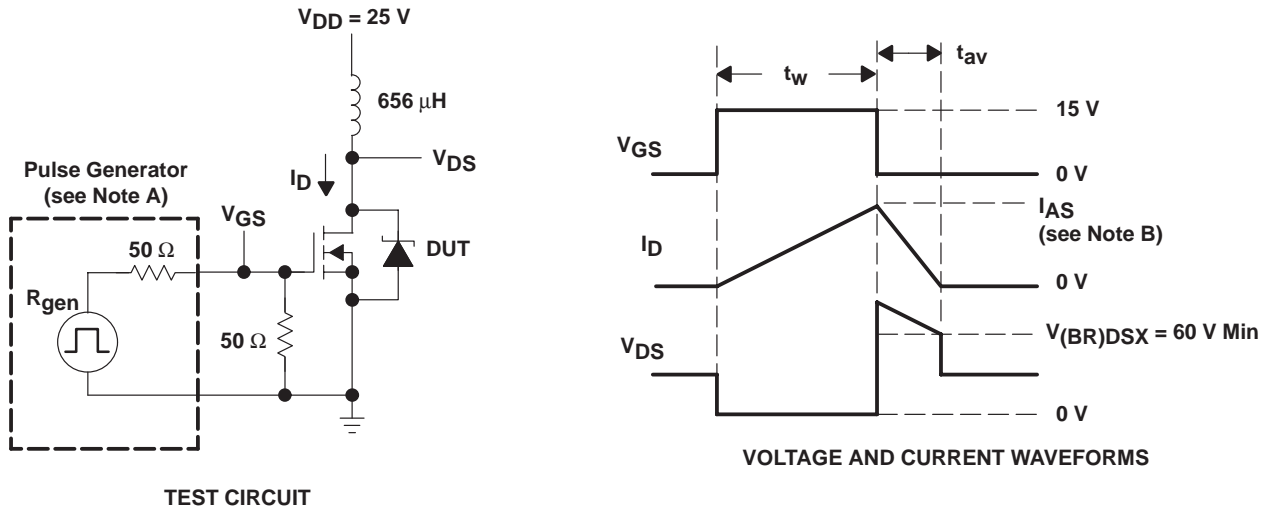
PARAMETER MEASUREMENT INFORMATION



TPIC5601 3-PHASE BRIDGE POWER DMOS ARRAY

SLIS022B – MARCH 1994 – REVISED OCTOBER 1995

PARAMETER MEASUREMENT INFORMATION



- 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 $I_{AS} = 8$ A.

Energy test level is defined as $E_{AS} = \frac{I_{AS} \times V_{(BR)DSX} \times t_{av}}{2} = 36$ mJ, where
 t_{av} = Avalanche time

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

TYPICAL CHARACTERISTICS

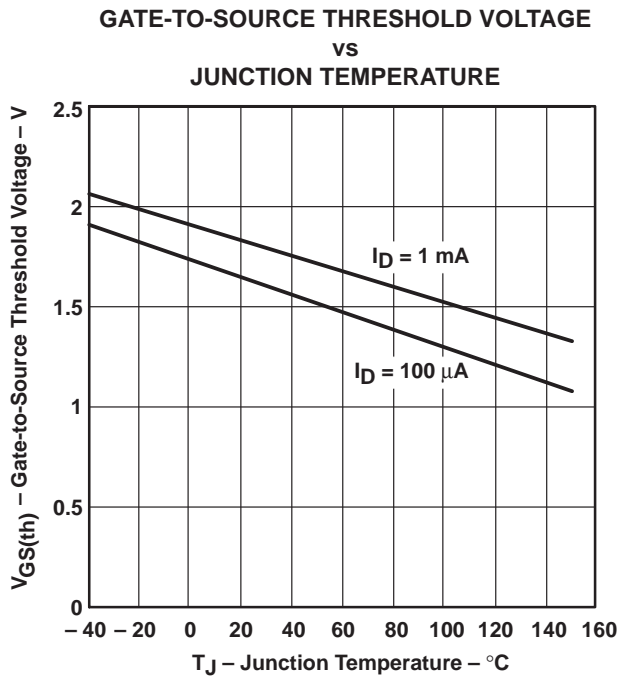


Figure 5

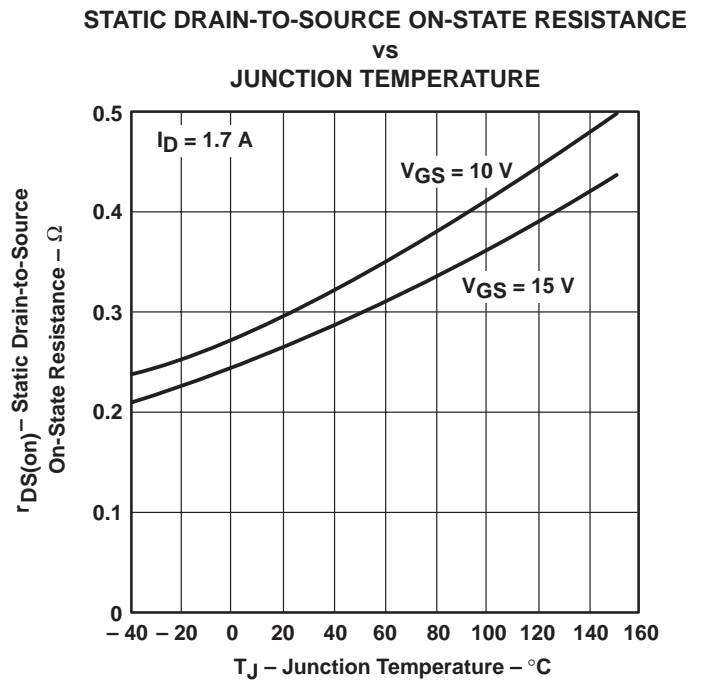


Figure 6



TYPICAL CHARACTERISTICS

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

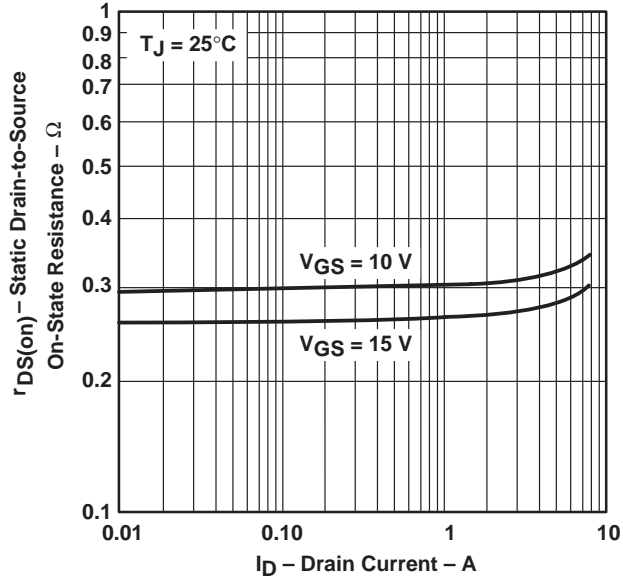


Figure 7

DRAIN CURRENT
vs
DRAIN-TO-SOURCE VOLTAGE

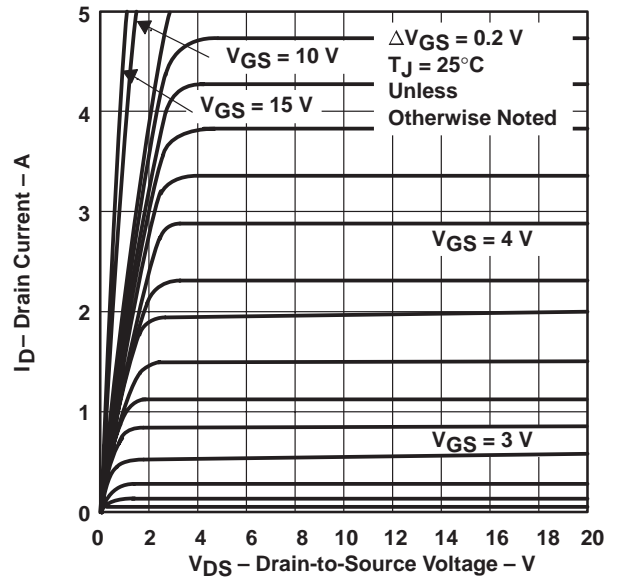


Figure 8

DISTRIBUTION OF
FORWARD TRANSCONDUCTANCE

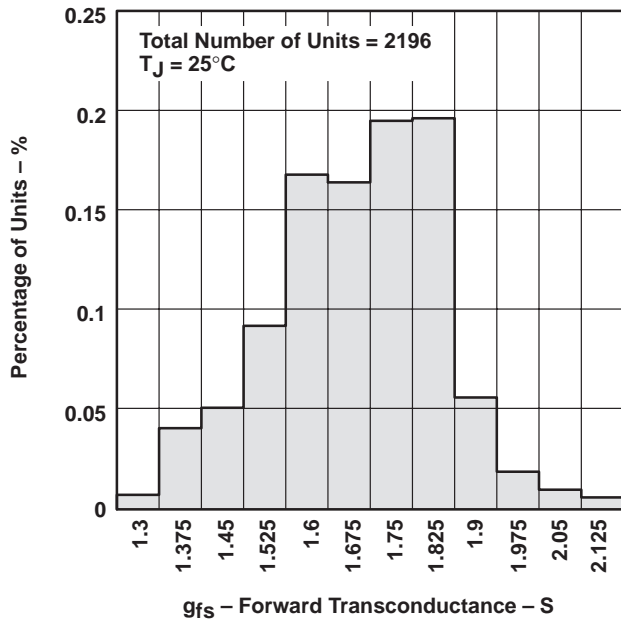


Figure 9

DRAIN CURRENT
vs
GATE-TO-SOURCE VOLTAGE

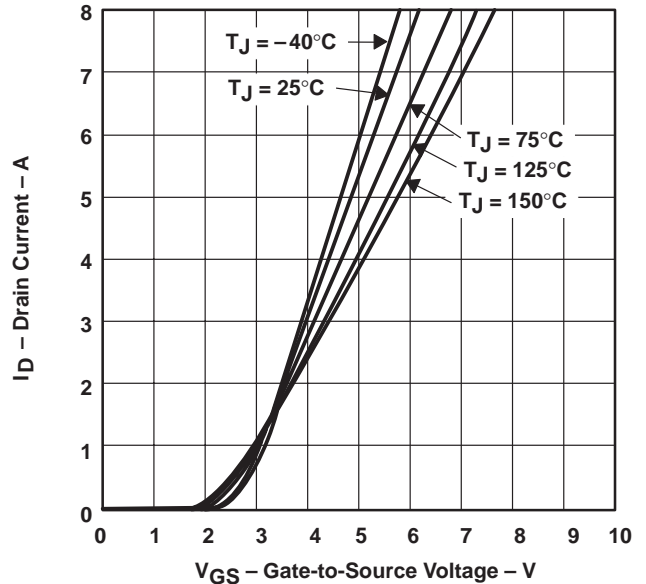


Figure 10

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SLIS022B – MARCH 1994 – REVISED OCTOBER 1995

TYPICAL CHARACTERISTICS

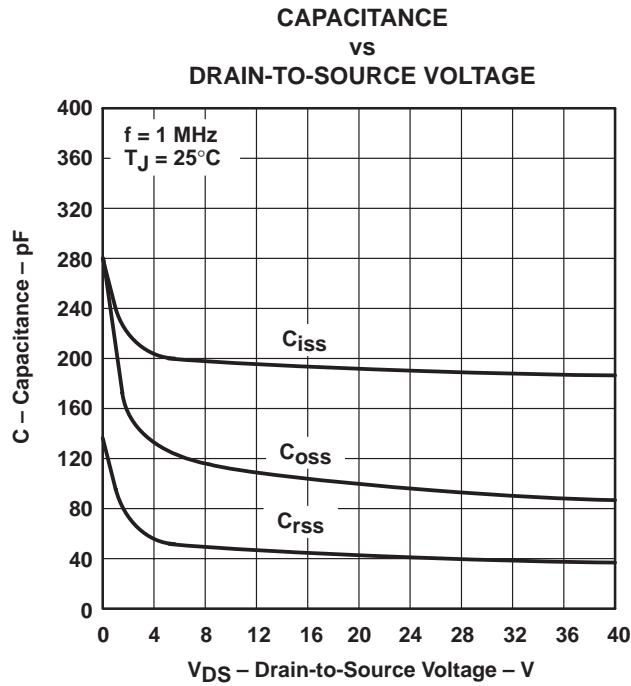


Figure 11

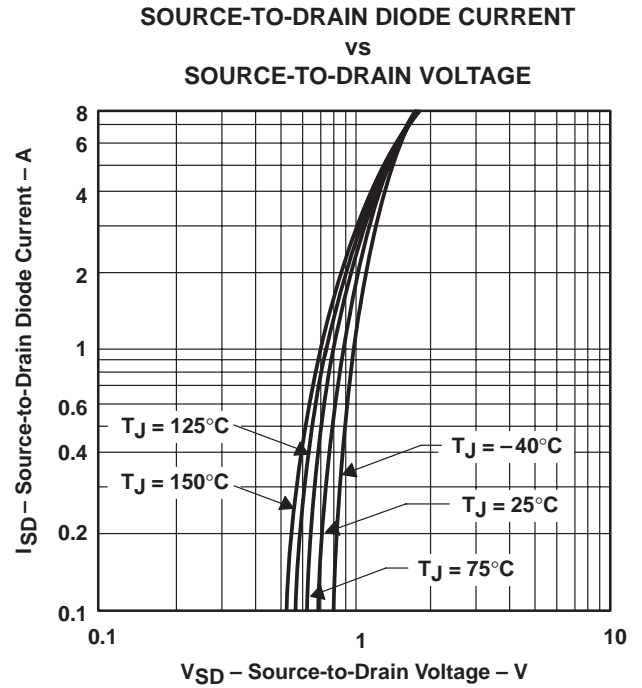


Figure 12

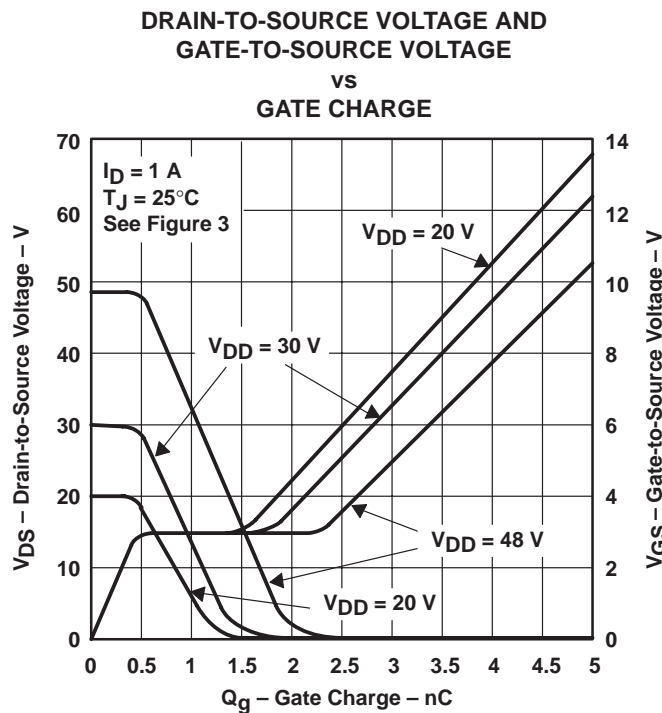


Figure 13

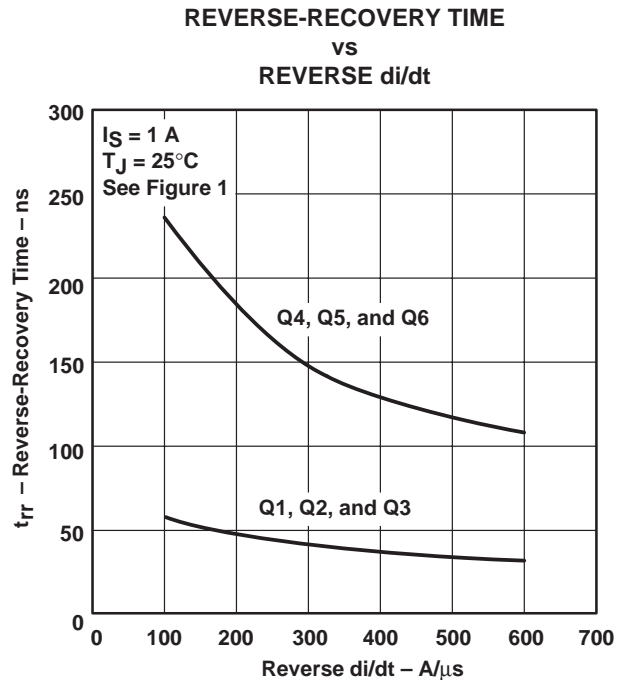
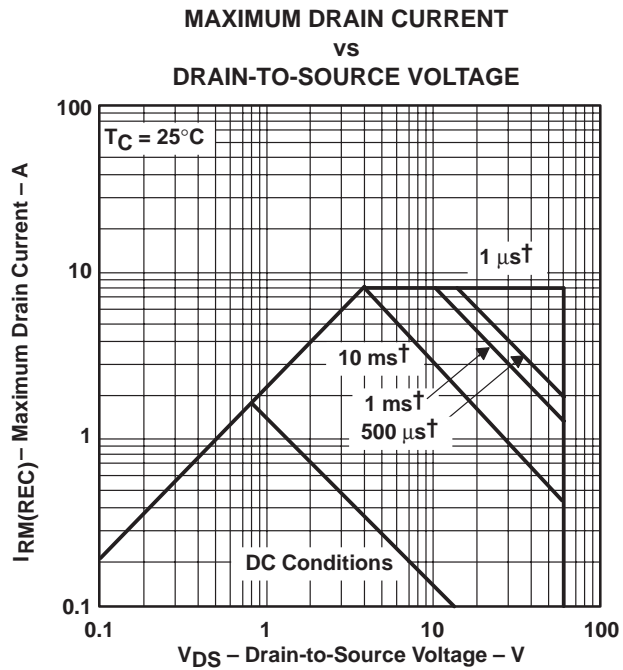


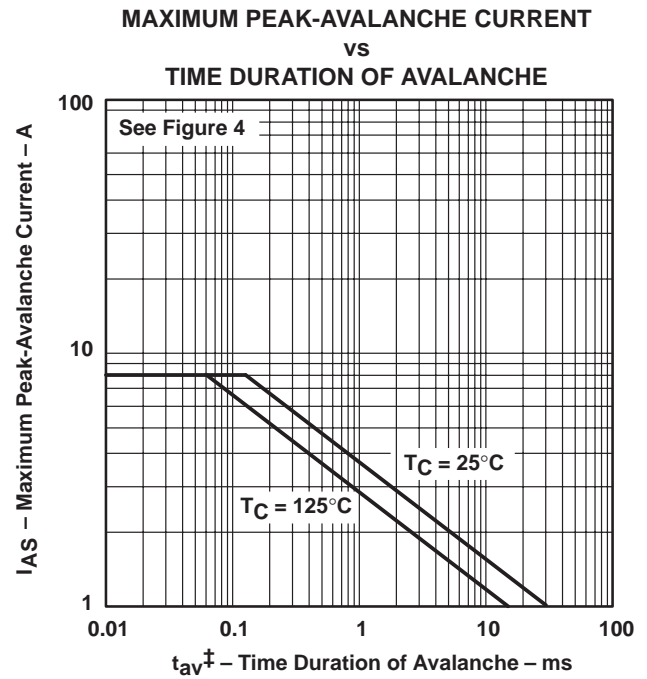
Figure 14

THERMAL INFORMATION



[†] Less than 0.1 duty cycle

Figure 15



[‡] Non-JEDEC symbol for avalanche time.

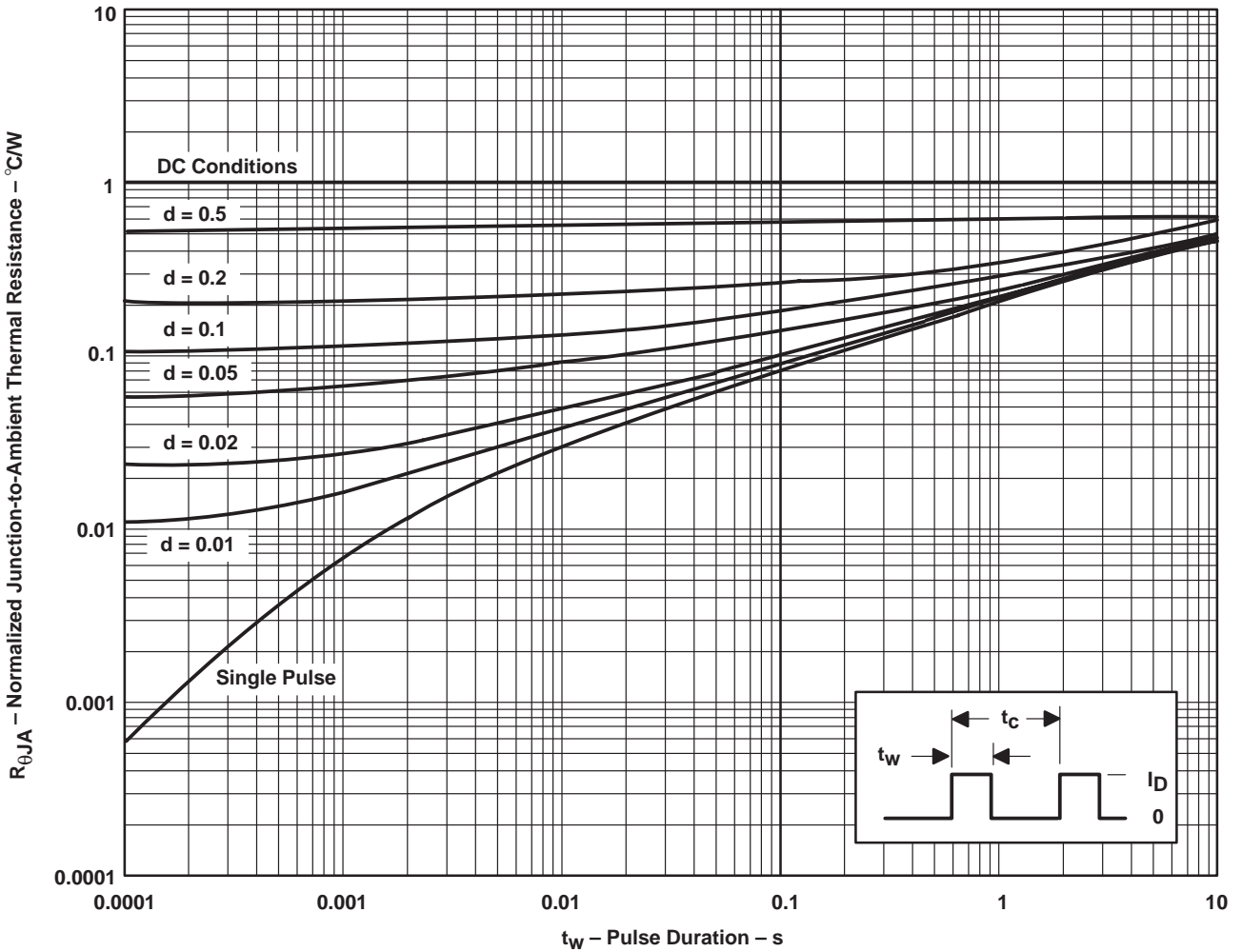
Figure 16

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SLIS022B – MARCH 1994 – REVISED OCTOBER 1995

THERMAL INFORMATION

DW PACKAGE† NORMALIZED JUNCTION-TO-AMBIENT THERMAL RESISTANCE VS PULSE DURATION



† Device mounted on FR4 printed-circuit board with no heatsink

NOTE A: $Z_{\theta A}(t) = r(t) R_{\theta JA}$
 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⁾
TPIC5601DW	OBSOLETE	SOIC	DW	20		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)

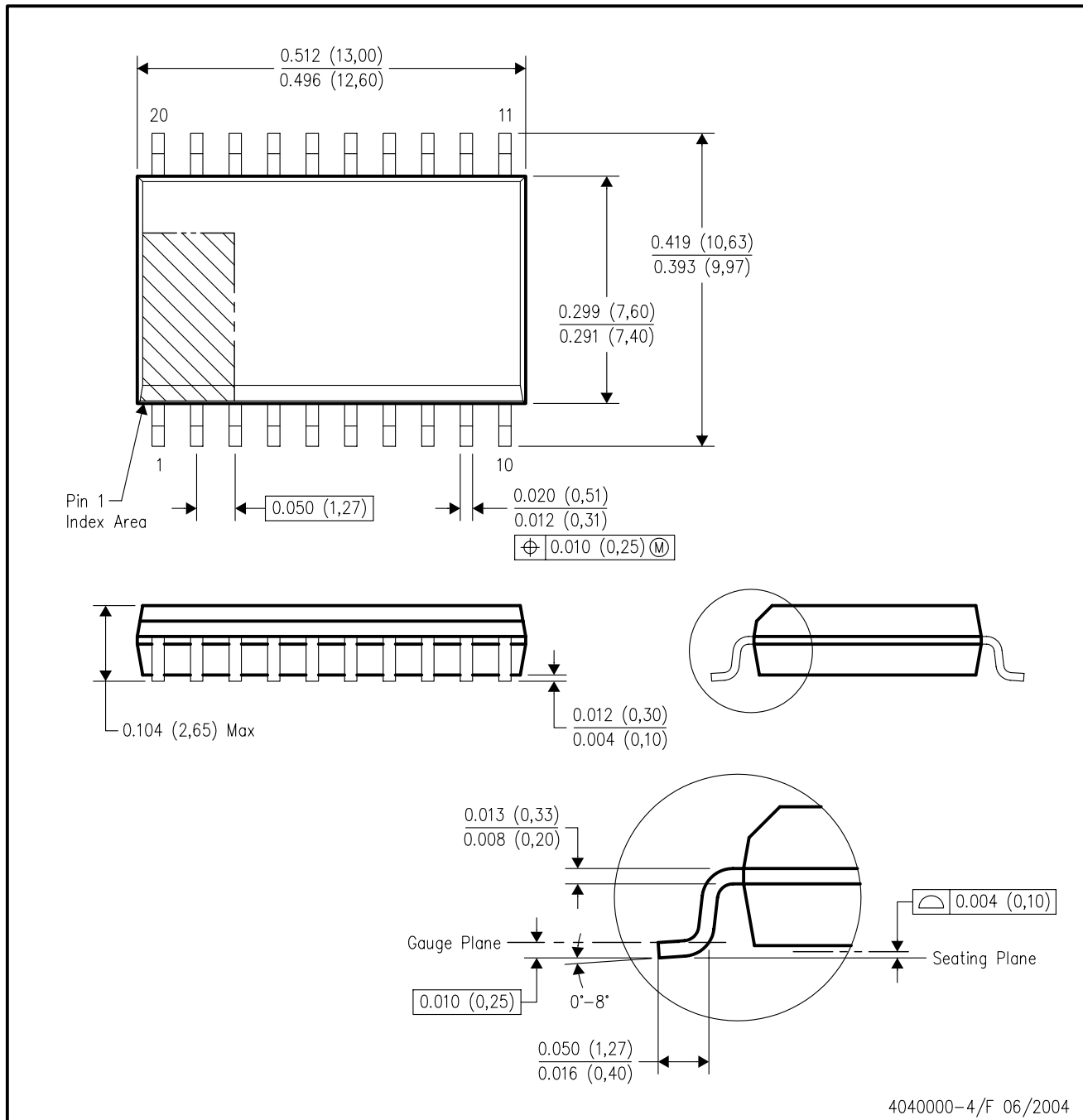
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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DW (R-PDSO-G20)

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 AC.

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