

# TPIC5424L H-BRIDGE LOGIC-LEVEL POWER DMOS ARRAY

SLIS026A – JUNE 1994 – REVISED NOVEMBER 1994

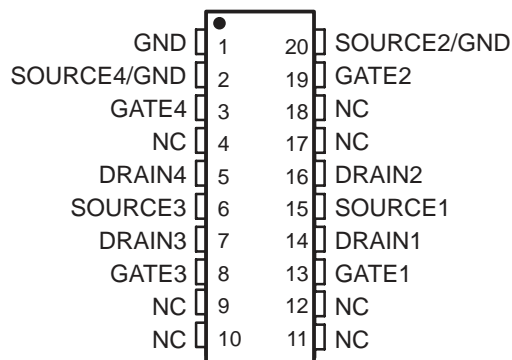
- Low  $r_{DS(on)}$  . . . 0.4  $\Omega$  Typ
- High-Voltage Output . . . 60 V
- Pulsed Current . . . 3 A Per Channel
- Fast Commutation Speed
- Direct Logic-Level Interface

## description

The TPIC5424L is a monolithic logic-level power DMOS array that consists of four electrically isolated N-channel enhancement-mode DMOS transistors, two of which are configured with a common source.

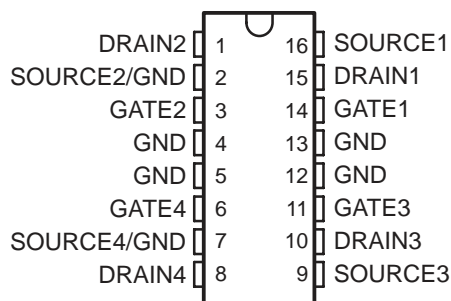
The TPIC5424L is offered in a 16-pin thermally enhanced dual-in-line (NE) package and a 20-pin wide-body surface-mount (DW) package. The TPIC5424L is characterized for operation over the case temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

DW PACKAGE  
(TOP VIEW)

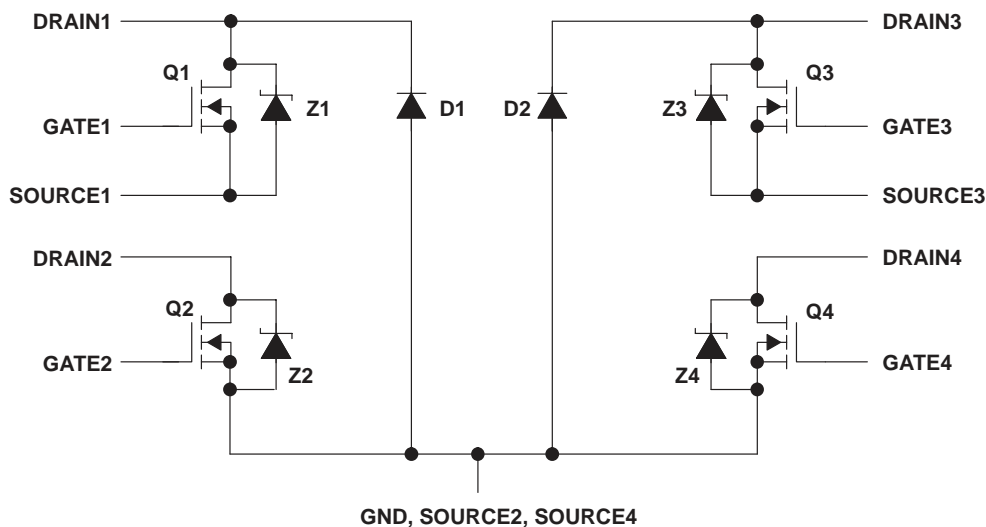


NC – No internal connection

NE PACKAGE  
(TOP VIEW)



## 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.



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# TPIC5424L

## H-BRIDGE LOGIC-LEVEL POWER DMOS ARRAY

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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 (Q1, Q3) .....	100 V
Drain-to-GND voltage (Q1, Q3) .....	100 V
Drain-to-GND voltage (Q2, Q4) .....	60 V
Gate-to-source voltage, $V_{GS}$ .....	$\pm 20$ V
Continuous drain current, each output, $T_C = 25^\circ\text{C}$ .....	1 A
Continuous source-to-drain diode current, $T_C = 25^\circ\text{C}$ .....	1 A
Pulsed drain current, each output, $I_{max}$ , $T_C = 25^\circ\text{C}$ (see Note 1 and Figure 15) .....	3 A
Single-pulse avalanche energy, $E_{AS}$ , $T_C = 25^\circ\text{C}$ (see Figure 4) .....	180 mJ
Continuous total dissipation .....	See Dissipation Rating Table
Operating virtual junction temperature range, $T_J$ .....	$-40^\circ\text{C}$ to $150^\circ\text{C}$
Operating case temperature range, $T_C$ .....	$-40^\circ\text{C}$ to $125^\circ\text{C}$
Storage temperature range .....	$-65^\circ\text{C}$ to $150^\circ\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds .....	$260^\circ\text{C}$

† 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 and 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	1389 mW	11.1 mW/ $^\circ\text{C}$	279 mW
NE	2075 mW	16.6 mW/ $^\circ\text{C}$	415 mW

# TPIC5424L

## H-BRIDGE LOGIC-LEVEL POWER DMOS ARRAY

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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	1.85	2.2	V
$V_{(BR)}$	Reverse drain-to-GND breakdown voltage (across D1, D2)	Drain-to-GND current = $250\ \mu\text{A}$		100			V
$V_{DS(on)}$	Drain-to-source on-state voltage	$I_D = 1\ \text{A}$ , See Notes 2 and 3	$V_{GS} = 5\ \text{V}$ ,		0.4	0.48	V
$V_{F(SD)}$	Forward on-state voltage, source-to-drain	$I_S = 1\ \text{A}$ , $V_{GS} = 0$ (Z1, Z2, Z3, Z4), See Notes 2 and 3 and Figure 12			1	1.2	V
$V_F$	Forward on-state voltage, GND-to-drain	$I_D = 1\ \text{A}$ (D1, D2), See Notes 2 and 3			4.6		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	$\mu\text{A}$
			$T_C = 125^\circ\text{C}$			0.5	
$I_{GSSF}$	Forward gate current, drain short circuited to source	$V_{GS} = 5\ \text{V}$ ,	$V_{DS} = 0$		10	100	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	$V_{DGND} = 48\ \text{V}$ (D1, D2)	$T_C = 25^\circ\text{C}$		0.05	1	$\mu\text{A}$
			$T_C = 125^\circ\text{C}$			0.5	
$r_{DS(on)}$	Static drain-to-source on-state resistance	$V_{GS} = 5\ \text{V}$ , $I_D = 1\ \text{A}$ , See Notes 2 and 3 and Figures 6 and 7	$T_C = 25^\circ\text{C}$		0.4	0.48	$\Omega$
			$T_C = 125^\circ\text{C}$			0.65	
$g_{fs}$	Forward transconductance	$V_{DS} = 15\ \text{V}$ , See Notes 2 and 3 and Figure 9	$I_D = 0.5\ \text{A}$ ,	1.25	1.39		S
$C_{iss}$	Short-circuit input capacitance, common source				220	275	pF
$C_{oss}$	Short-circuit output capacitance, common source	$V_{DS} = 25\ \text{V}$ , $f = 1\ \text{MHz}$ ,	$V_{GS} = 0$ , See Figure 11		120	150	
$C_{rss}$	Short-circuit reverse-transfer capacitance, common source				100	125	

- NOTES: 2. Technique should limit  $T_J - T_C$  to  $10^\circ\text{C}$  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	$I_S = 0.5\ \text{A}$ , $V_{GS} = 0$ , See Figures 1 and 14	$V_{DS} = 48\ \text{V}$ , $di/dt = 100\ \text{A}/\mu\text{s}$ ,	Z1 and Z3	55		ns
				Z2 and Z4	150		
				D1 and D2	200		
$Q_{RR}$	Total diode charge		Z1 and Z3	0.06		$\mu\text{C}$	
			Z2 and Z4	0.3			
			D1 and D2	0.7			



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

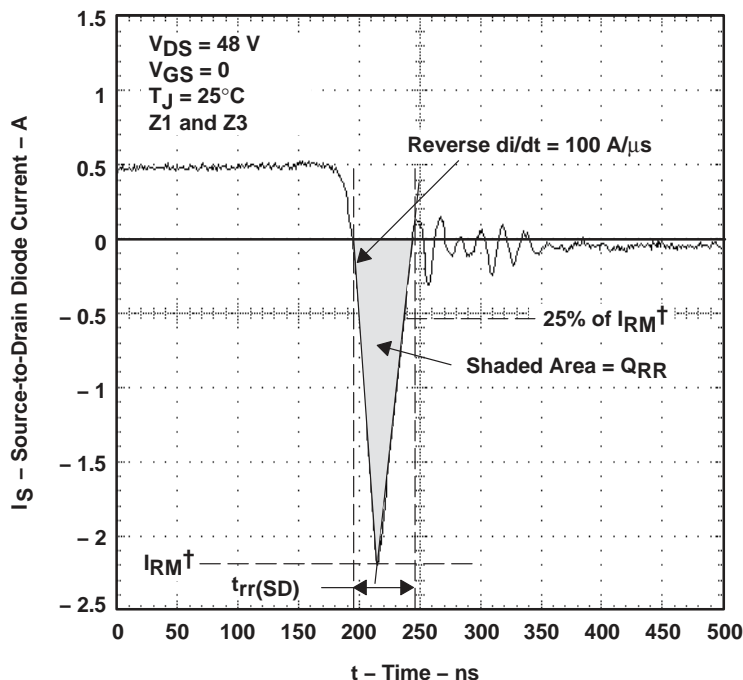
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 25\text{ V},$ $R_L = 25\ \Omega,$ $t_{en} = 10\text{ ns},$ $t_{dis} = 10\text{ ns},$ See Figure 2		34	68	ns
$t_{d(off)}$	Turn-off delay time			40	82	
$t_r$	Rise time			21	42	
$t_f$	Fall time			25	50	
$Q_g$	Total gate charge	$V_{DS} = 48\text{ V},$ See Figure 3 $I_D = 1\text{ A},$ $V_{GS} = 10\text{ V},$		3.9	5	nC
$Q_{gs(th)}$	Threshold gate-to-source charge			0.55	0.8	
$Q_{gd}$	Gate-to-drain charge			2.5	3.6	
$L_D$	Internal drain inductance			5		nH
$L_S$	Internal source inductance			5		
$R_g$	Internal gate resistance			0.25		$\Omega$

## thermal resistance

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance (see Note 4)	DW package		90		$^\circ\text{C/W}$
		NE package		60		
$R_{\theta JP}$	Junction-to-pin thermal resistance	DW package		30		$^\circ\text{C/W}$
		NE package		25		

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

## PARAMETER MEASUREMENT INFORMATION



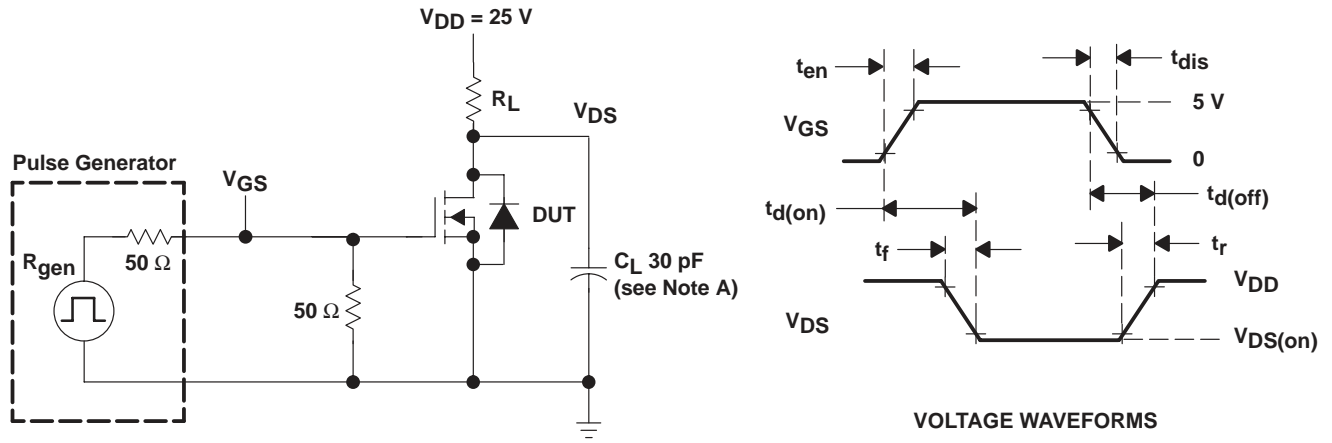
$^\dagger I_{RM}$  = maximum recovery current

NOTE A. The above waveform is representative of Z2, Z4, D1, and D2 in shape only.

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



PARAMETER MEASUREMENT INFORMATION



NOTE A:  $C_L$  includes probe and jig capacitance.

Figure 2. Resistive-Switching Test Circuit and Voltage Waveforms

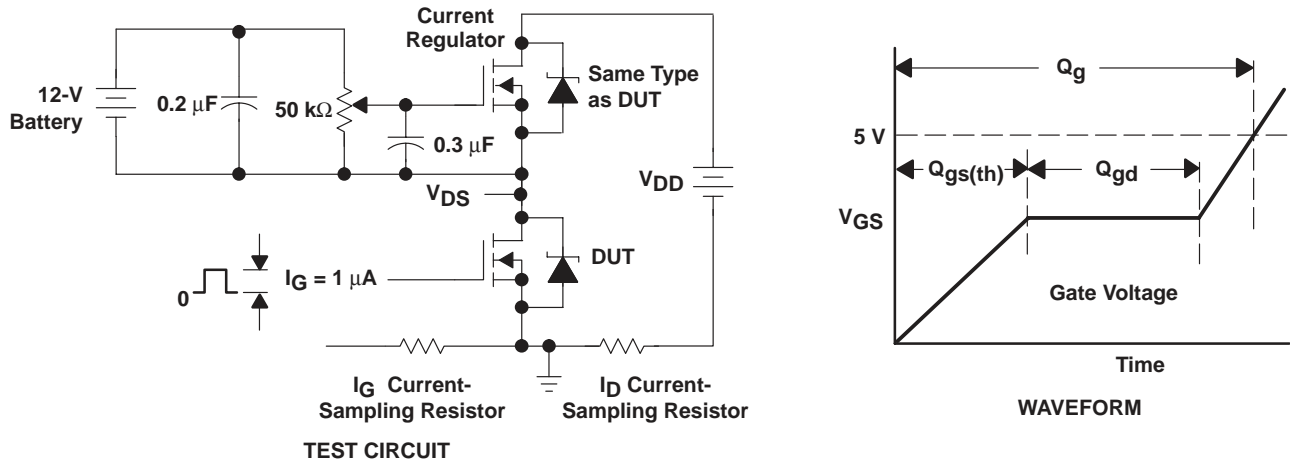
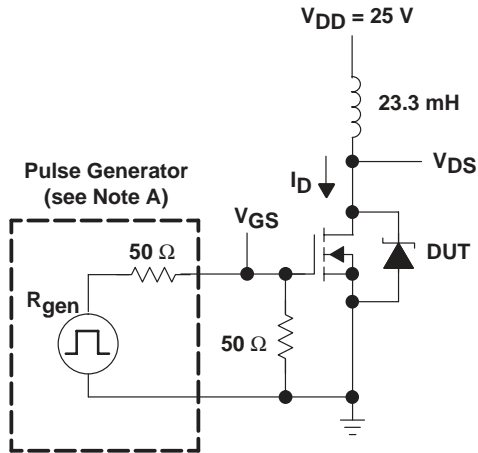


Figure 3. Gate-Charge Test Circuit and Waveform

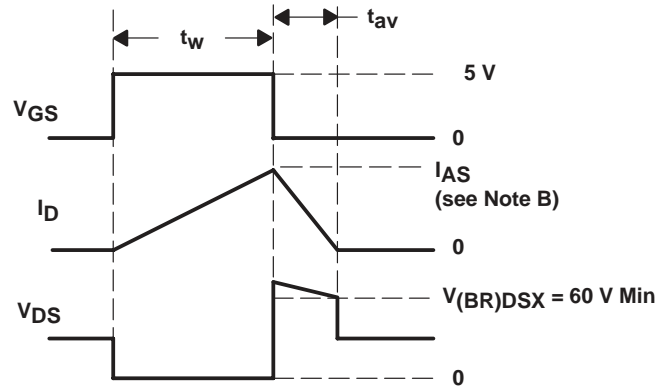
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## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

- NOTES: A. The pulse generator has the following characteristics:  $t_r \leq 10$  ns,  $t_f \leq 10$  ns,  $Z_O = 50 \Omega$ .  
 B. Input pulse duration ( $t_w$ ) is increased until peak current  $I_{AS} = 3$  A.

$$\text{Energy test level is defined as } E_{AS} = \frac{I_{AS} \times V_{(BR)DSX} \times t_{av}}{2} = 180 \text{ mJ.}$$

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

## TYPICAL CHARACTERISTICS

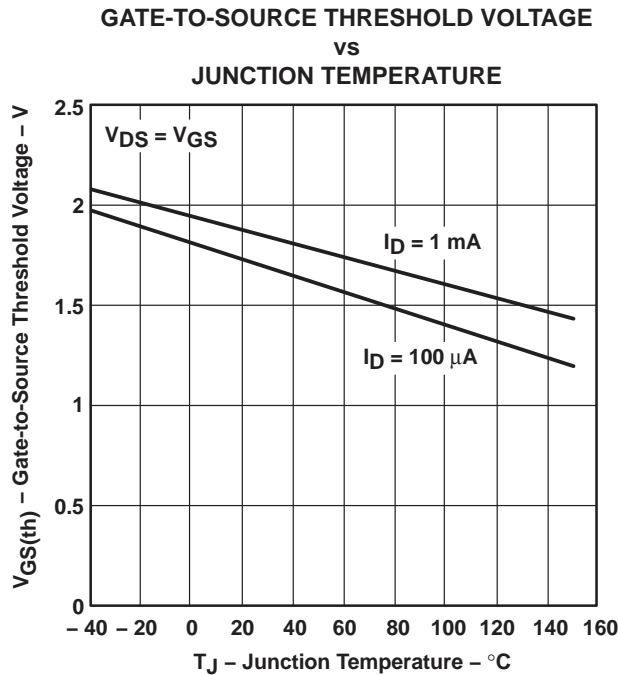


Figure 5

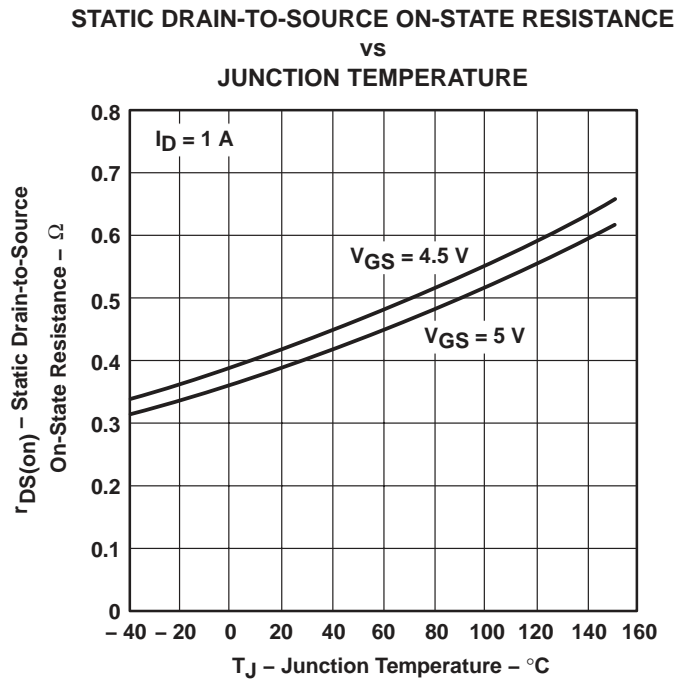


Figure 6



TYPICAL CHARACTERISTICS

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

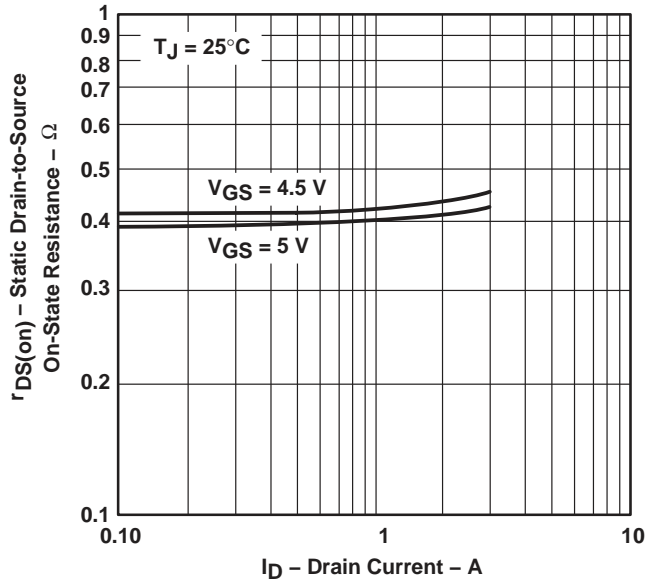


Figure 7

DRAIN CURRENT  
vs  
DRAIN-TO-SOURCE VOLTAGE

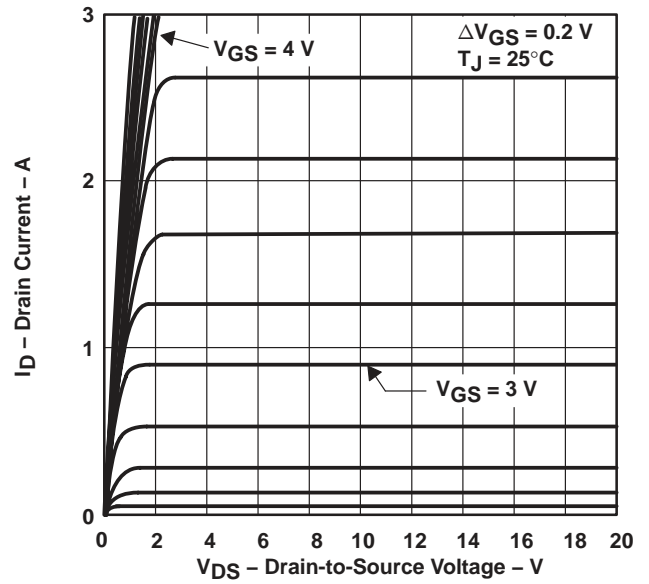


Figure 8

DISTRIBUTION OF  
FORWARD TRANSCONDUCTANCE

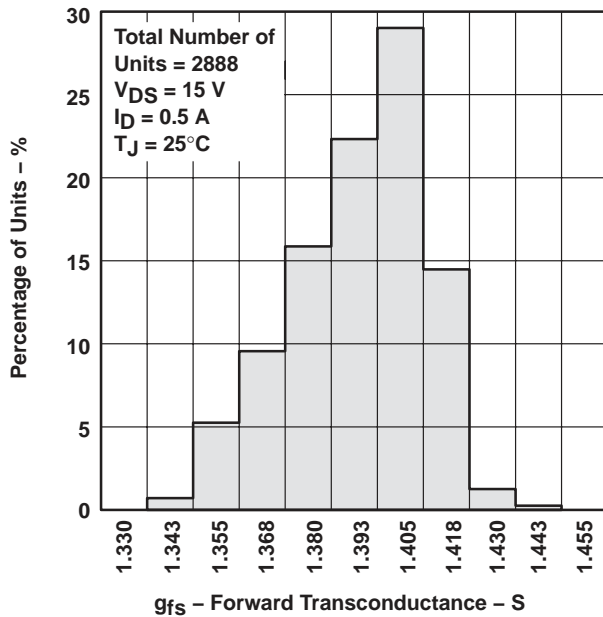


Figure 9

DRAIN CURRENT  
vs  
GATE-TO-SOURCE VOLTAGE

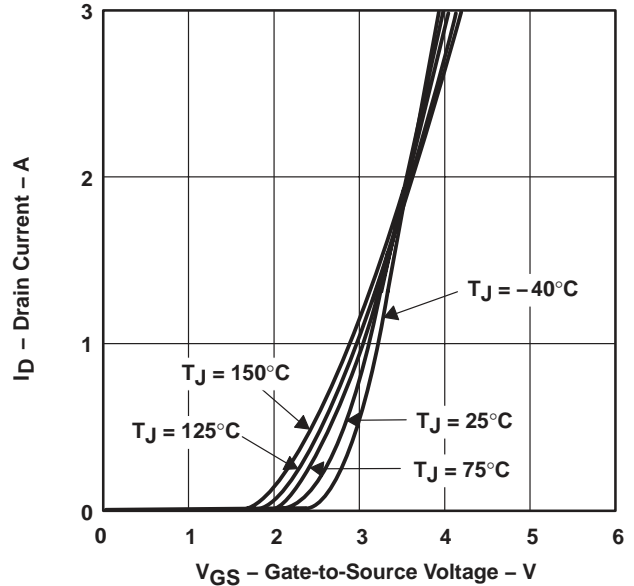


Figure 10

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## TYPICAL CHARACTERISTICS

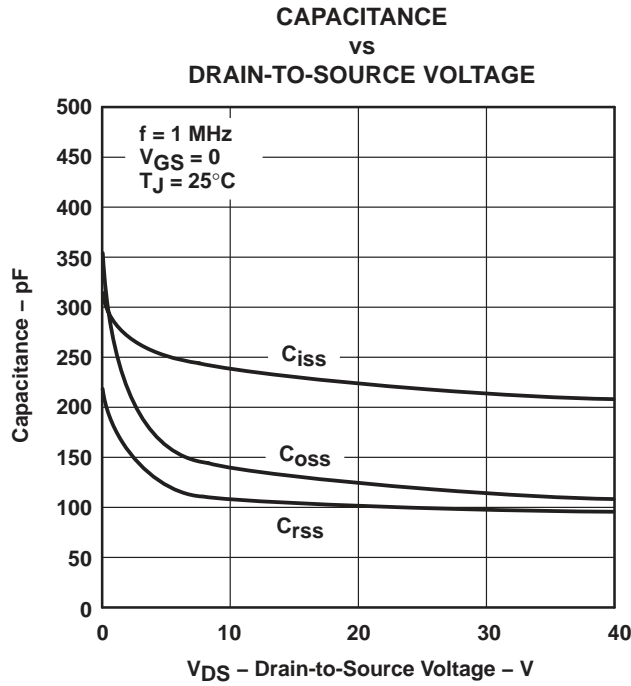


Figure 11

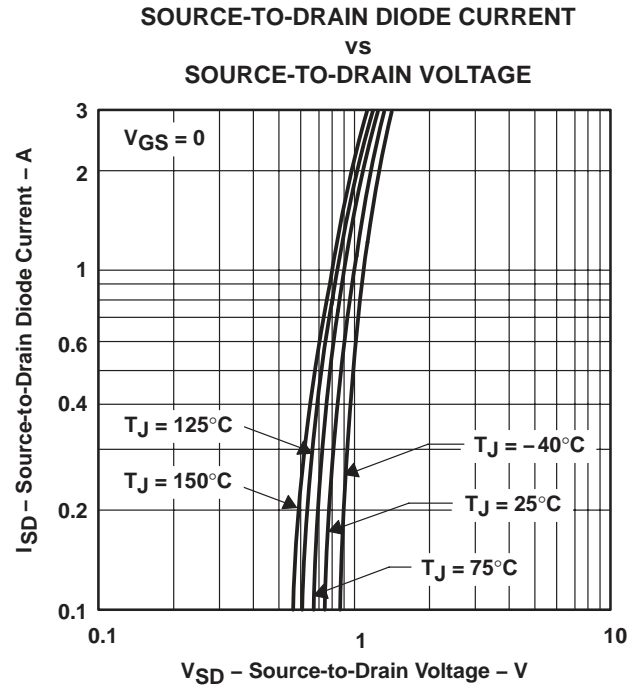


Figure 12

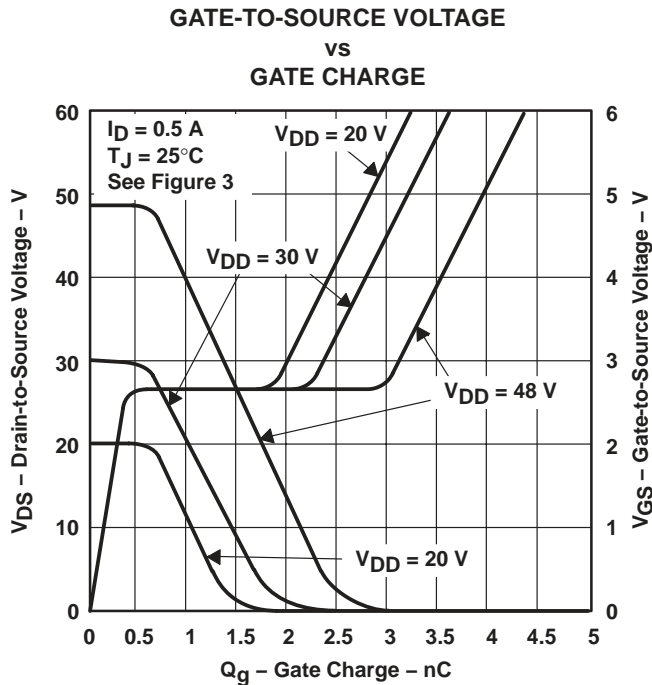


Figure 13

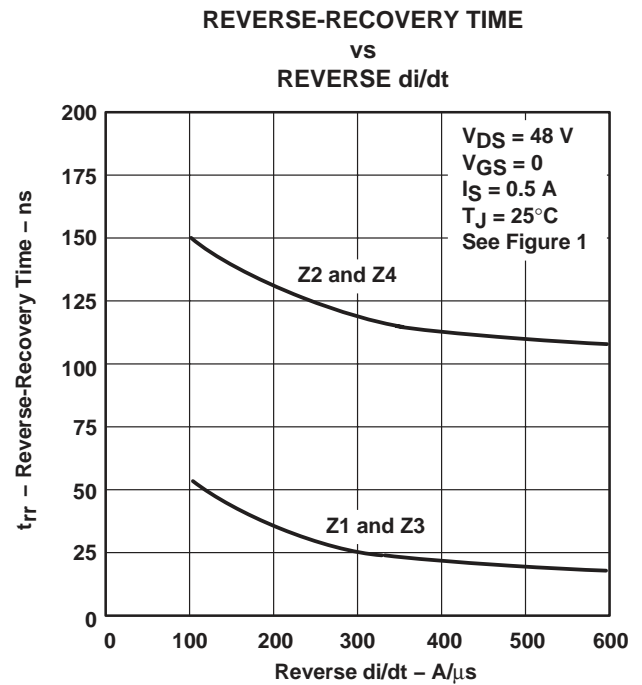
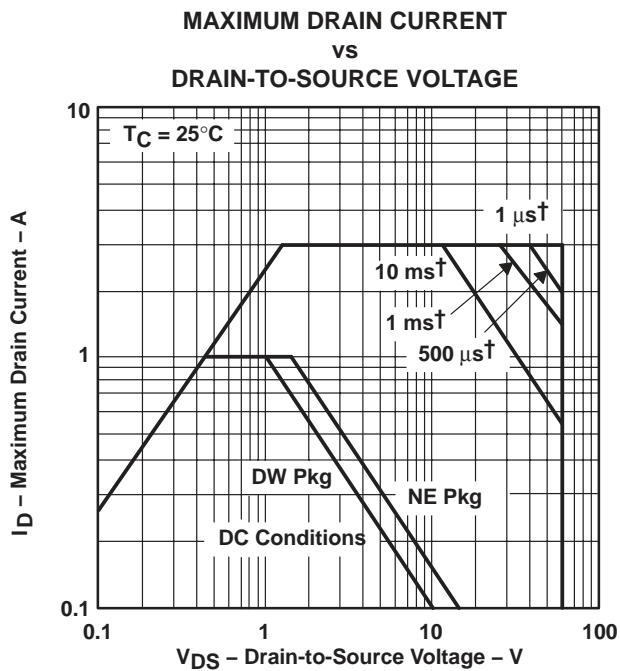


Figure 14



THERMAL INFORMATION



† Less than 2% duty cycle

Figure 15

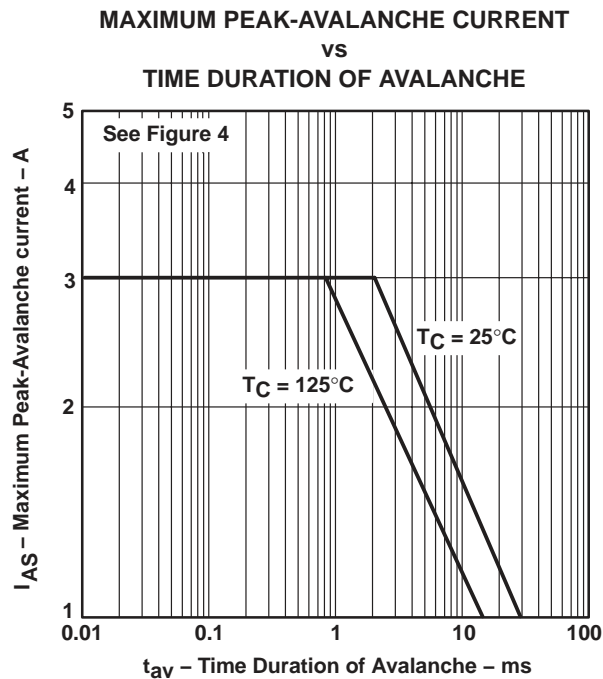


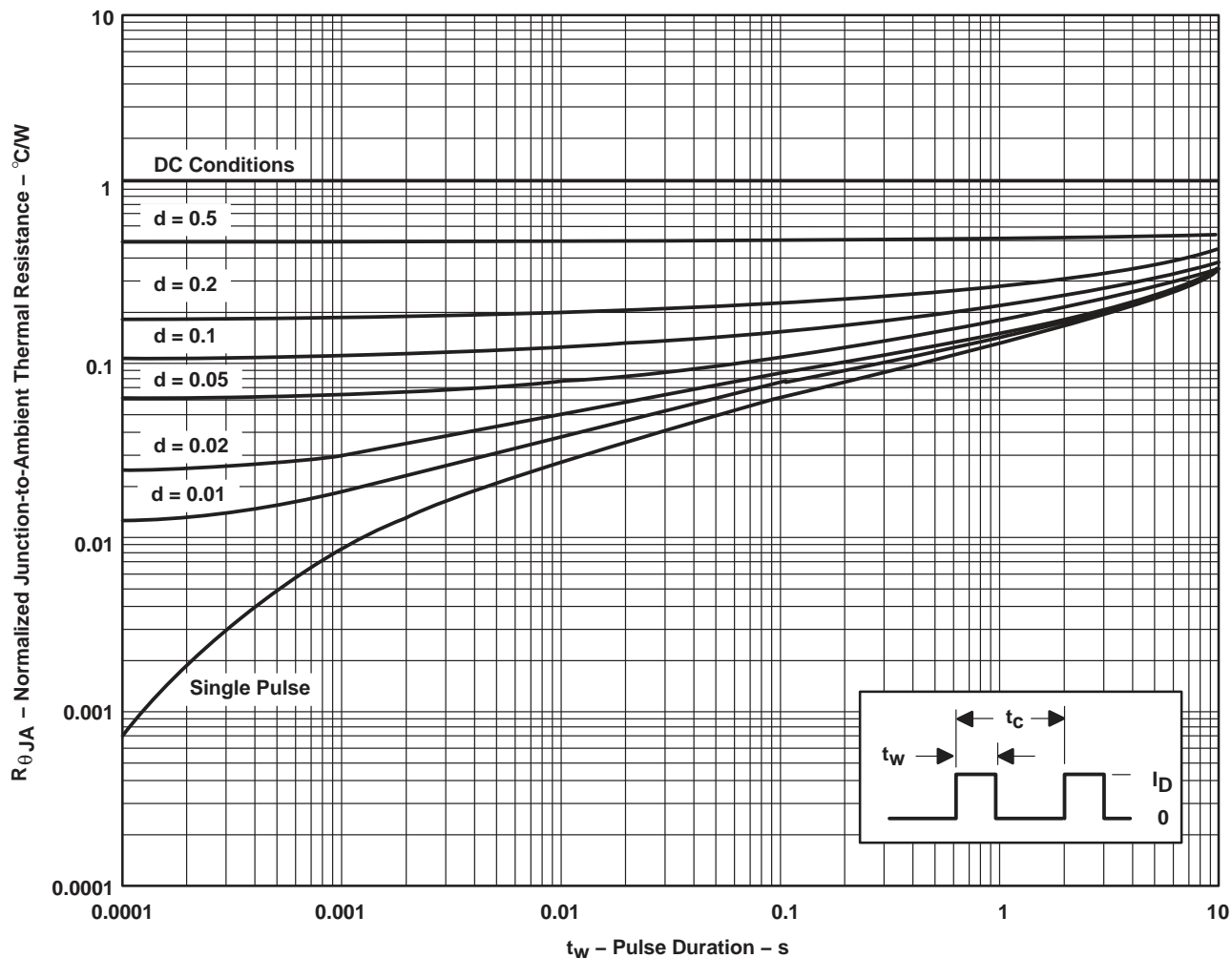
Figure 16

# TPIC5424L H-BRIDGE LOGIC-LEVEL POWER DMOS ARRAY

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## THERMAL INFORMATION

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



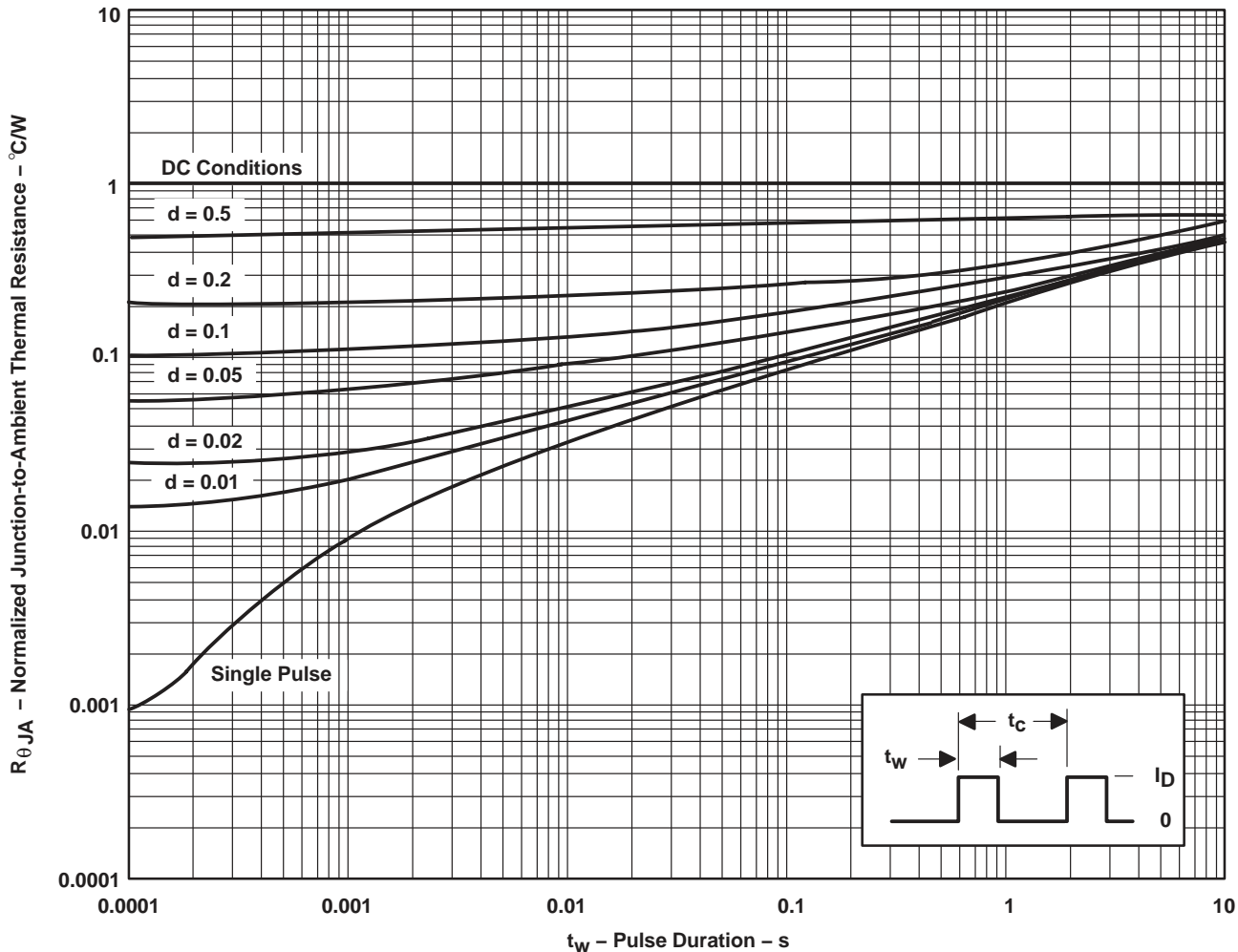
† Device mounted on FR4 printed-circuit board with no heat sink

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

Figure 17

THERMAL INFORMATION

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



† Device mounted on FR4 printed-circuit board with no heat sink

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

Figure 18

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TPIC5424LDW	OBSOLETE	SOIC	DW	20		TBD	Call TI	Call TI
TPIC5424LNE	OBSOLETE	PDIP	NE	16		TBD	Call TI	Call TI

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

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

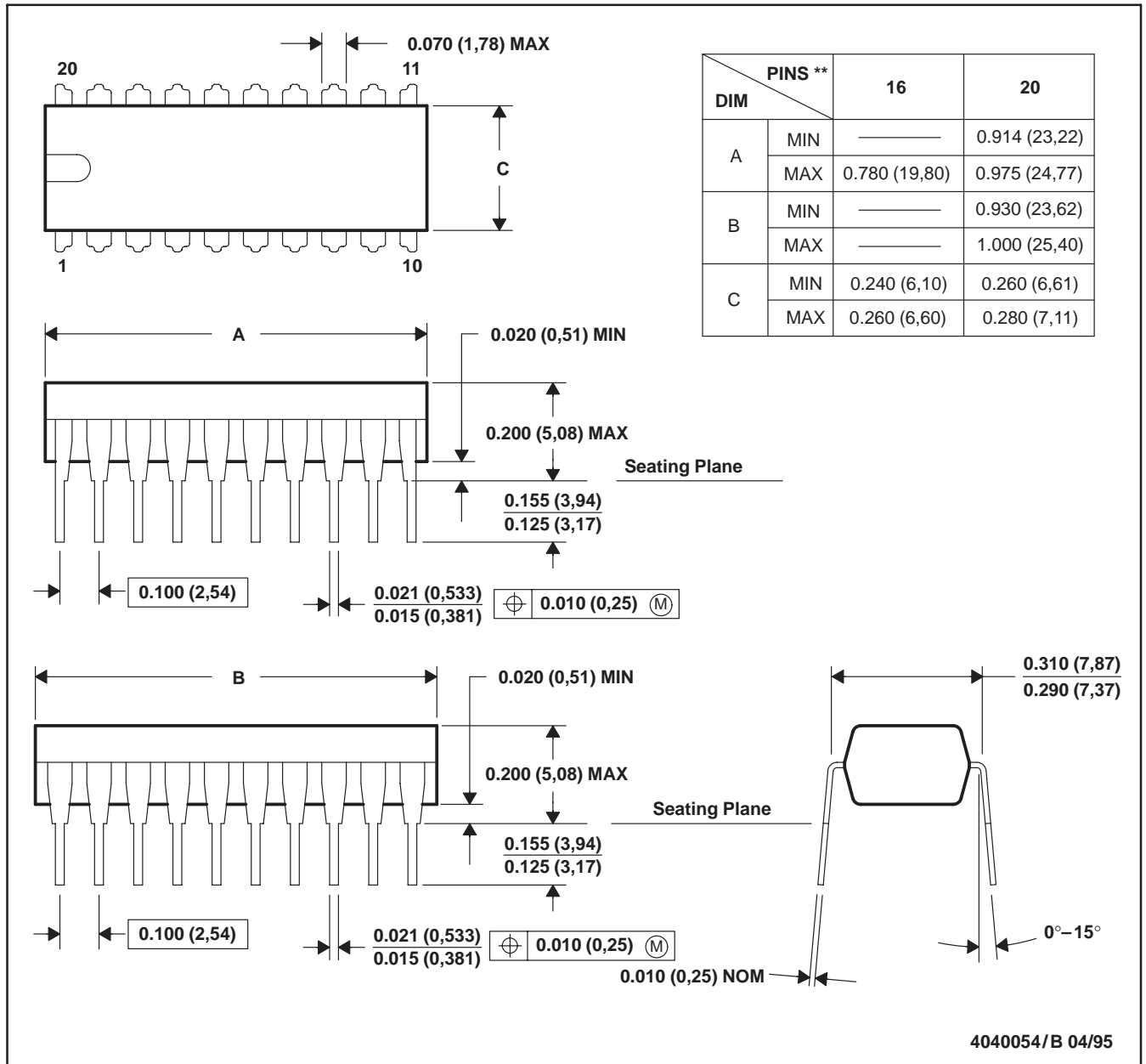
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NE (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

20 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001 (16 pin only)

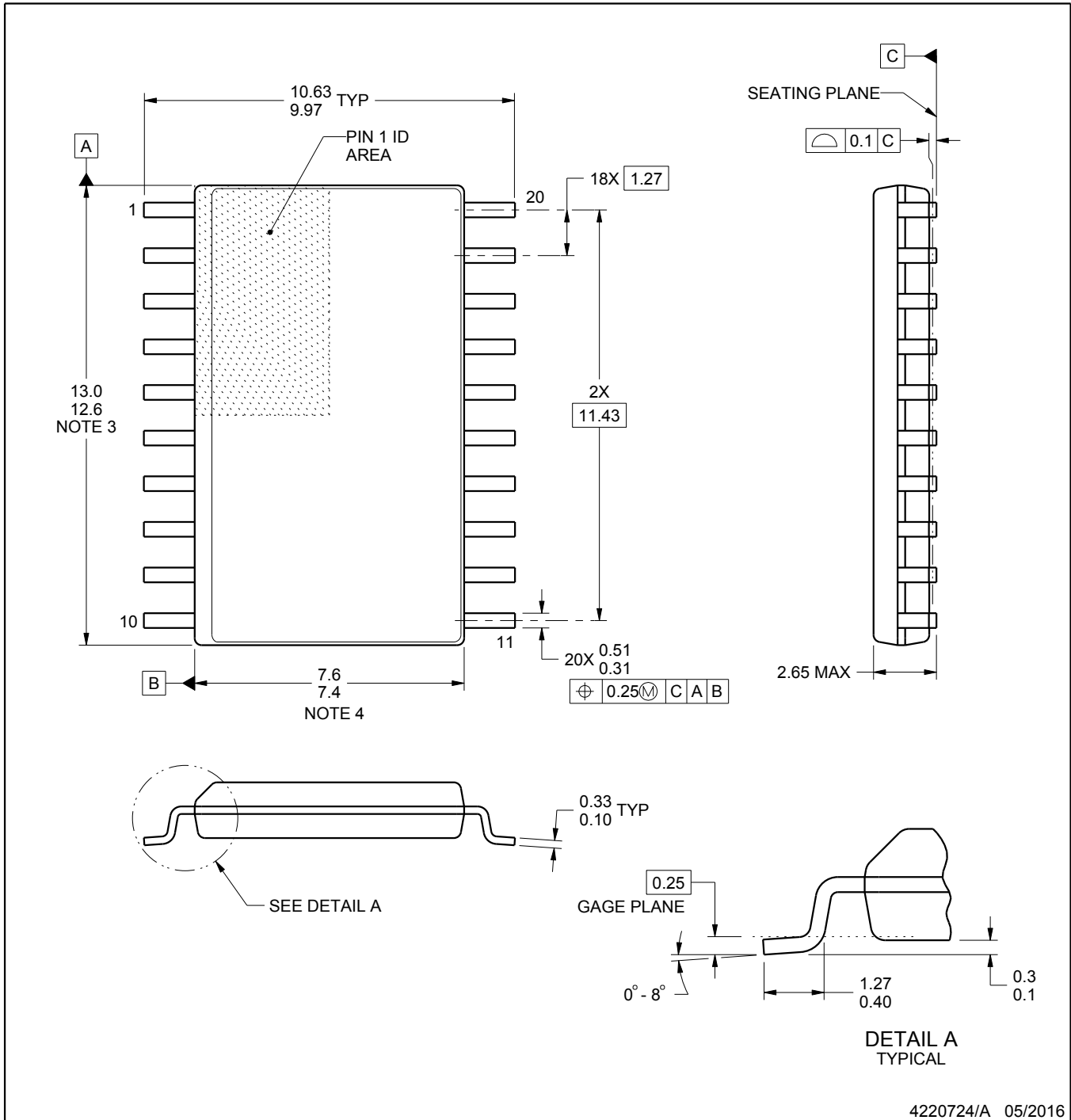
# DW0020A



# PACKAGE OUTLINE

## SOIC - 2.65 mm max height

SOIC



4220724/A 05/2016

**NOTES:**

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm per side.
5. Reference JEDEC registration MS-013.

# EXAMPLE BOARD LAYOUT

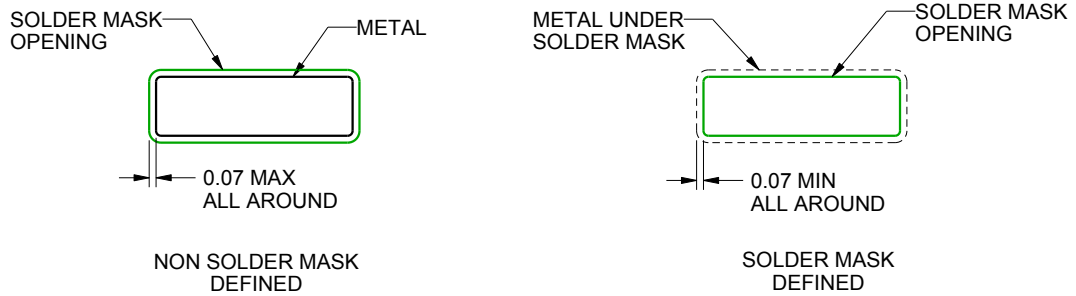
DW0020A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE  
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DW0020A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:6X

4220724/A 05/2016

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.



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Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
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