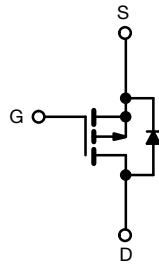
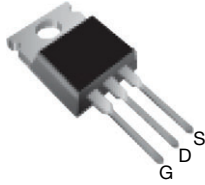


Power MOSFET

TO-220AB


P-Channel MOSFET

FEATURES

- Dynamic dV/dt rating
- P-channel
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


 Available
RoHS*
 Available

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

DESCRIPTION

The power MOSFETs technology is the key to Vishay's advanced line of Power MOSFET transistors. The efficient geometry and unique processing of the Power MOSFETs design achieve very low on-state resistance combined with high transconductance and extreme device ruggedness.

The TO-220AB package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

PRODUCT SUMMARY

V_{DS} (V)	-200	
$R_{DS(on)}$ (Ω)	$V_{GS} = -10$ V	3.0
Q_g max. (nC)	11	
Q_{gs} (nC)	7.0	
Q_{gd} (nC)	4.0	
Configuration	Single	

ORDERING INFORMATION

Package	TO-220AB
Lead (Pb)-free	IRF9610PbF
Lead (Pb)-free and halogen-free	IRF9610PbF-BE3

ABSOLUTE MAXIMUM RATINGS ($T_C = 25^\circ\text{C}$, unless otherwise noted)

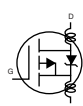
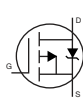
PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	V_{DS}	-200	V
Gate-source voltage	V_{GS}	± 20	
Continuous drain current	V_{GS} at 10 V	$T_C = 25^\circ\text{C}$	A
		$T_C = 100^\circ\text{C}$	
Pulsed drain current ^a	I_{DM}	-7.0	
Linear derating factor		0.16	W/ $^\circ\text{C}$
Single pulse avalanche energy ^b	P_D	20	W
Repetitive avalanche current ^a	I_{LM}	-7.0	A
Repetitive avalanche energy ^a	dV/dt	-5.0	V/ns
Maximum power dissipation	T_J, T_{stg}	-55 to +150	$^\circ\text{C}$
Peak diode recovery dV/dt ^c			
Operating junction and storage temperature range		10	lbf · in
Soldering recommendations (peak temperature) ^d	For 10 s	1.1	N · m

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 5)
- Not applicable
- $I_{SD} \leq -1.8$ A, $dI/dt \leq 70$ A/ μs , $V_{DD} \leq V_{DS}$, $T_J \leq 150^\circ\text{C}$
- 1.6 mm from case



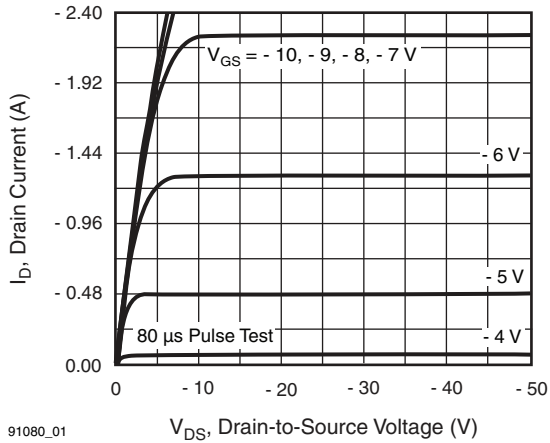
THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	R_{thJA}	-	62	°C/W
Case-to-sink, flat, greased surface	R_{thCS}	0.50	-	
Maximum junction-to-case (drain)	R_{thJC}	-	6.4	

SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Static						
Drain-source breakdown voltage	V_{DS}	$V_{GS} = 0\text{ V}$, $I_D = -250\text{ }\mu\text{A}$	-200	-	-	V
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$, $I_D = -1\text{ mA}$	-	-0.23	-	V/°C
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$, $I_D = -250\text{ }\mu\text{A}$	-2.0	-	-4.0	V
Gate-source leakage	I_{GSS}	$V_{GS} = \pm 20\text{ V}$	-	-	± 100	nA
Zero gate voltage drain current	I_{DSS}	$V_{DS} = -200\text{ V}$, $V_{GS} = 0\text{ V}$	-	-	-100	μA
		$V_{DS} = -160\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$	-	-	-500	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$, $I_D = -0.90\text{ A}^b$	-	-	3.0	Ω
Forward transconductance	g_{fs}	$V_{DS} = -50\text{ V}$, $I_D = -0.90\text{ A}^b$	0.90	-	-	S
Dynamic						
Input capacitance	C_{iss}	$V_{GS} = 0\text{ V}$, $V_{DS} = -25\text{ V}$, $f = 1.0\text{ MHz}$, see fig. 10	-	170	-	pF
Output capacitance	C_{oss}		-	50	-	
Reverse transfer capacitance	C_{rss}		-	15	-	
Total gate charge	Q_g	$V_{GS} = -10\text{ V}$, $I_D = -3.5\text{ A}$, $V_{DS} = -160\text{ V}$, see fig. 11 and 18 ^b	-	-	11	nC
Gate-source charge	Q_{gs}		-	-	7.0	
Gate-drain charge	Q_{gd}		-	-	4.0	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = -100\text{ V}$, $I_D = -0.90\text{ A}$, $R_g = 50\text{ }\Omega$, $R_D = 110\text{ }\Omega$, see fig. 17 ^b	-	8.0	-	ns
Rise time	t_r		-	15	-	
Turn-off delay time	$t_{d(off)}$		-	10	-	
Fall time	t_f		-	8.0	-	
Gate input resistance	R_g	$f = 1\text{ MHz}$, open drain	2.5	-	14.3	Ω
Internal drain inductance	L_D	Between lead, 6 mm (0.25") from package and center of die contact 	-	4.5	-	nH
Internal source inductance	L_S		-	7.5	-	
Drain-Source Body Diode Characteristics						
Continuous source-drain diode current	I_S	MOSFET symbol showing the integral reverse p - n junction diode 	-	-	-1.8	A
Pulsed diode forward current ^a	I_{SM}		-	-	-7.0	
Body diode voltage	V_{SD}	$T_J = 25\text{ }^\circ\text{C}$, $I_S = -1.8\text{ A}$, $V_{GS} = 0\text{ V}^b$	-	-	-5.8	V
Body diode reverse recovery time	t_{rr}	$T_J = 25\text{ }^\circ\text{C}$, $I_F = -1.8\text{ A}$, $dI/dt = 100\text{ A}/\mu\text{s}^b$	-	240	360	ns
Body diode reverse recovery charge	Q_{rr}		-	1.7	2.6	μC
Forward turn-on time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)				

Notes

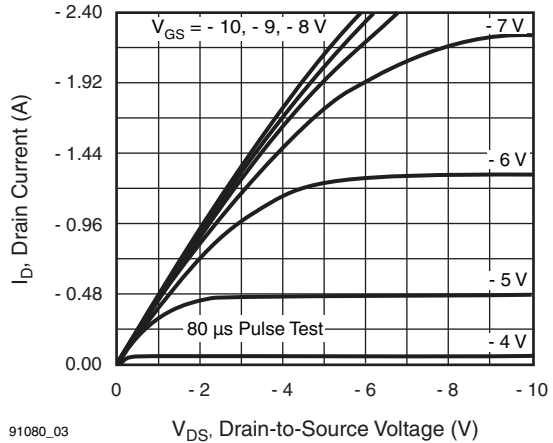
- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 5)
- b. Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



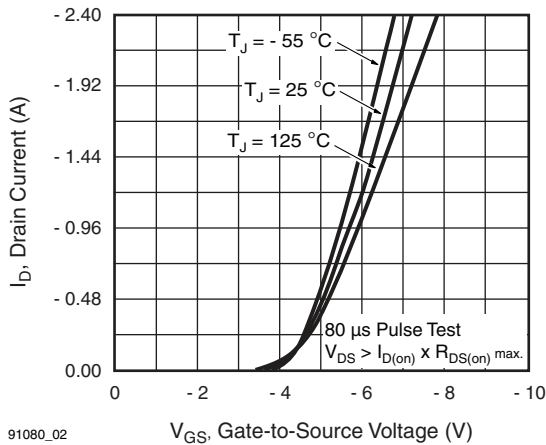
91080_01

Fig. 1 - Typical Output Characteristics



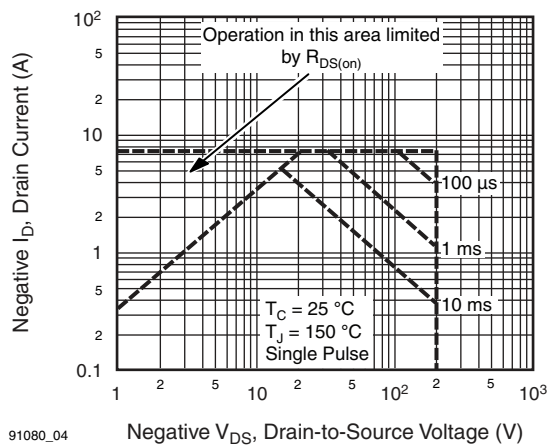
91080_03

Fig. 3 - Typical Saturation Characteristics



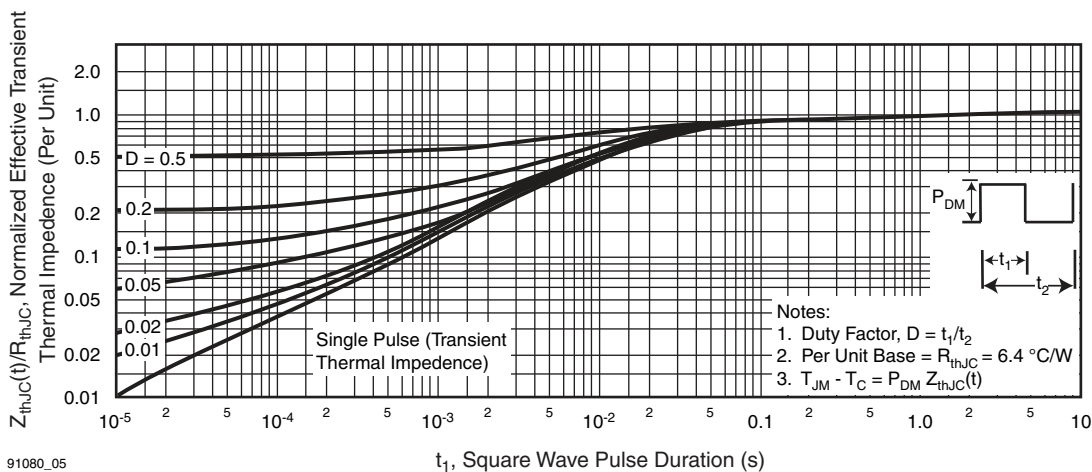
91080_02

Fig. 2 - Typical Transfer Characteristics



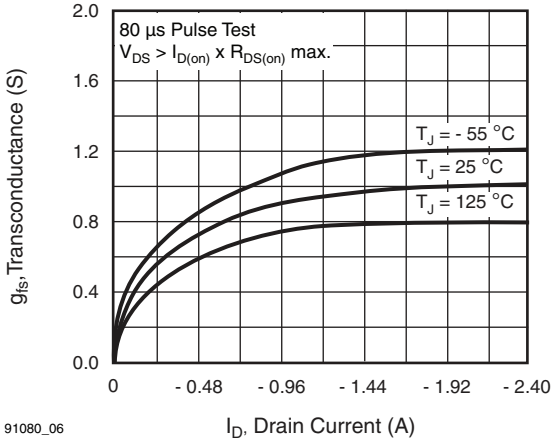
91080_04

Fig. 4 - Maximum Safe Operating Area



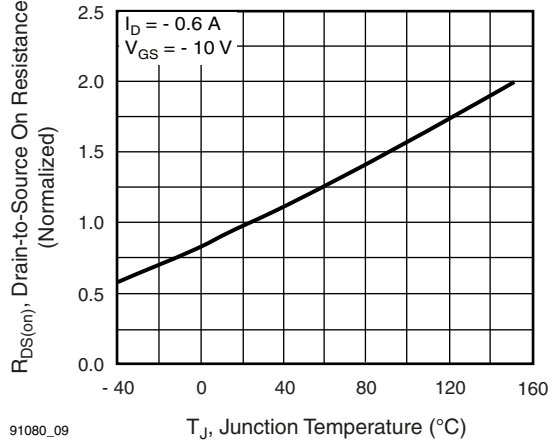
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Fig. 5 - Maximum Effective Transient Thermal Impedance, Junction-to-Case vs. Pulse Duration



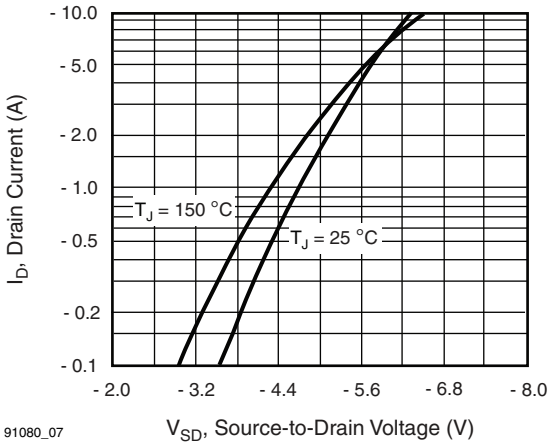
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Fig. 6 - Typical Transconductance vs. Drain Current



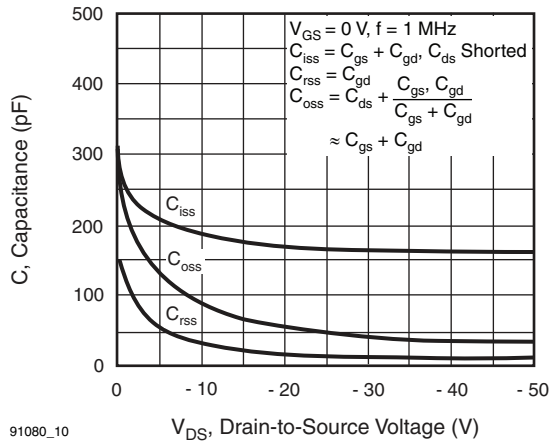
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Fig. 9 - Normalized On-Resistance vs. Temperature



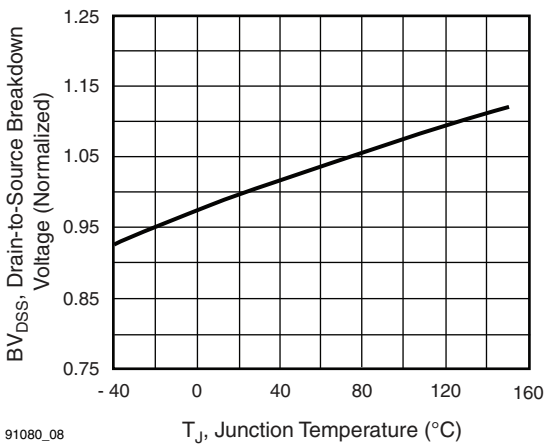
91080_07

Fig. 7 - Typical Source-Drain Diode Forward Voltage



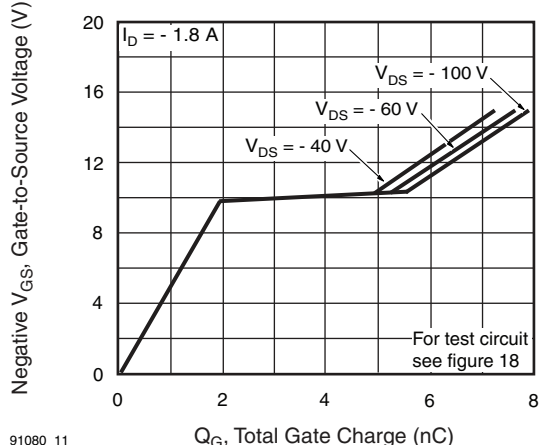
91080_10

Fig. 10 - Typical Capacitance vs. Drain-to-Source Voltage



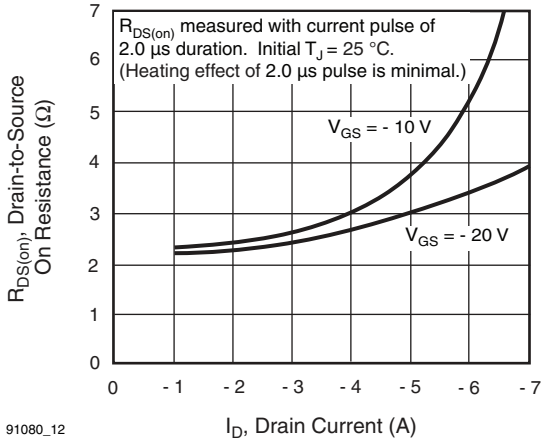
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Fig. 8 - Breakdown Voltage vs. Temperature



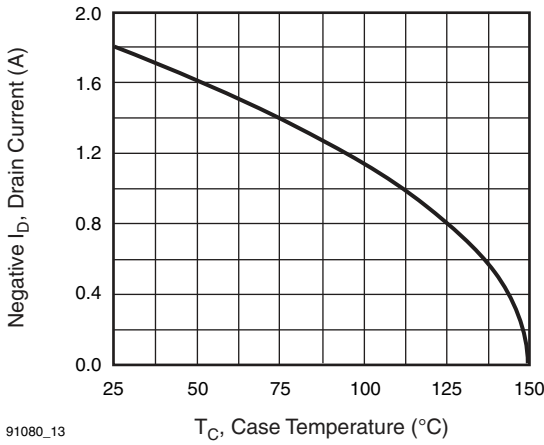
91080_11

Fig. 11 - Typical Gate Charge vs. Gate-to-Source Voltage



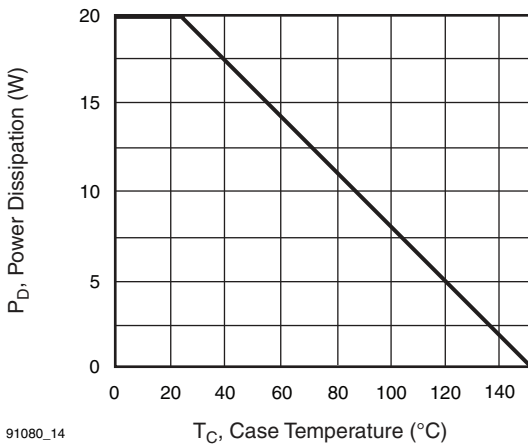
91080_12

Fig. 12 - Typical On-Resistance vs. Drain Current



91080_13

Fig. 13 - Maximum Drain Current vs. Case Temperature



91080_14

Fig. 14 - Power vs. Temperature Derating Curve

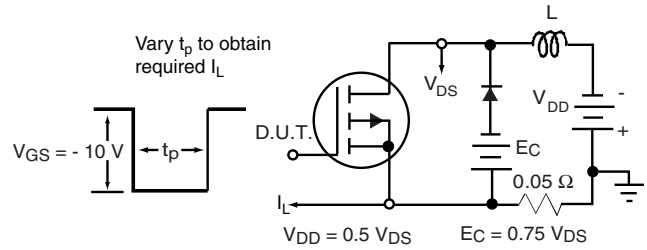


Fig. 15 - Clamped Inductive Test Circuit

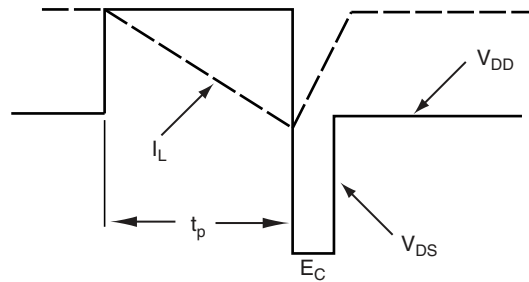


Fig. 16 - Clamped Inductive Waveforms

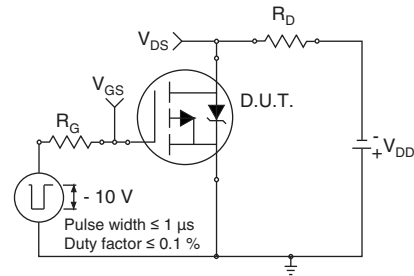


Fig. 17a - Switching Time Test Circuit

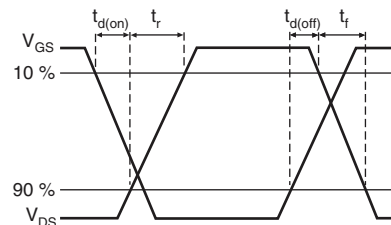


Fig. 17b - Switching Time Waveforms

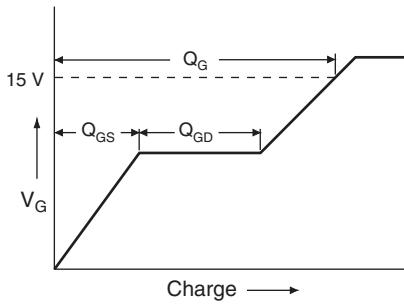


Fig. 18a - Basic Gate Charge Waveform

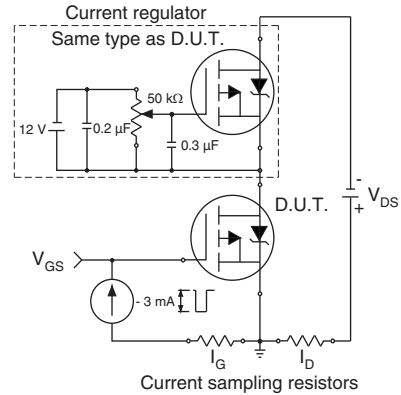


Fig. 18b - Gate Charge Test Circuit

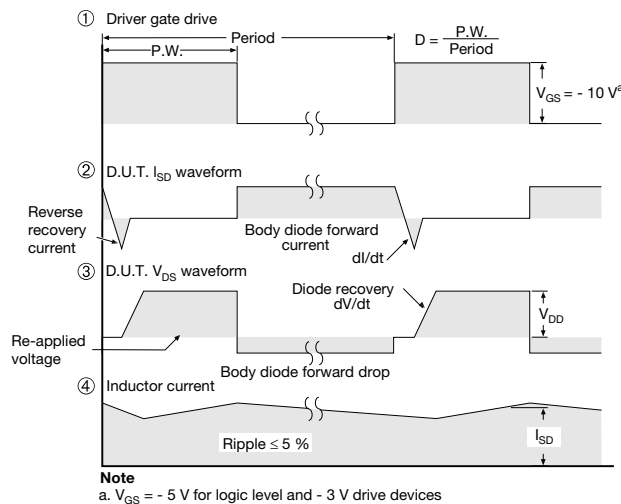
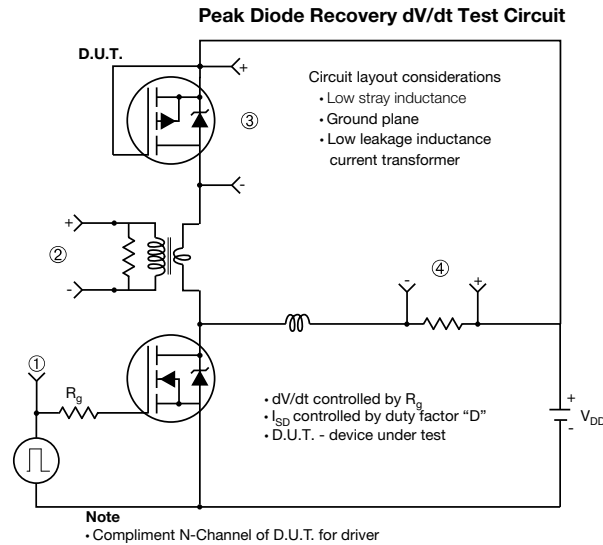


Fig. 19 - For P-Channel

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TO-220-1



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.24	4.65	0.167	0.183
b	0.69	1.02	0.027	0.040
b(1)	1.14	1.78	0.045	0.070
c	0.36	0.61	0.014	0.024
D	14.33	15.85	0.564	0.624
E	9.96	10.52	0.392	0.414
e	2.41	2.67	0.095	0.105
e(1)	4.88	5.28	0.192	0.208
F	1.14	1.40	0.045	0.055
H(1)	6.10	6.71	0.240	0.264
J(1)	2.41	2.92	0.095	0.115
L	13.36	14.40	0.526	0.567
L(1)	3.33	4.04	0.131	0.159
ØP	3.53	3.94	0.139	0.155
Q	2.54	3.00	0.100	0.118

ECN: E21-0621-Rev. D, 04-Nov-2021
DWG: 6031

Note

- M* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM



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