

Power MOSFET

TO-220 FULLPAK


N-Channel MOSFET

FEATURES

- Low gate charge Q_g results in simple drive requirement
- Improved gate, avalanche and dynamic dV/dt ruggedness
- Fully characterized capacitance and avalanche voltage and current
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

APPLICATIONS

- Switch mode power supply (SMPS)
- Uninterruptible power supply
- High speed power switching
- High voltage isolation = 2.5 kV_{RMS} (t = 60 s, f = 60 Hz)

TYPICAL SMPS TOPOLOGIES

- Single transistor flyback
- Single transistor forward

PRODUCT SUMMARY		
V_{DS} (V)	650	
$R_{DS(on)}$ (Ω)	$V_{GS} = 10$ V	0.93
Q_g (Max.) (nC)	48	
Q_{gs} (nC)	12	
Q_{gd} (nC)	19	
Configuration	Single	

ORDERING INFORMATION	
Package	TO-220 FULLPAK
Lead (Pb)-free	IRFIB5N65APbF

ABSOLUTE MAXIMUM RATINGS $T_C = 25^\circ\text{C}$, unless otherwise noted				
PARAMETER	SYMBOL	LIMIT	UNIT	
Drain-source voltage	V_{DS}	650	V	
Gate-source voltage	V_{GS}	± 30		
Continuous drain current ^e	V_{GS} at 10 V	$T_C = 25^\circ\text{C}$	I_D	A
Continuous drain current		$T_C = 100^\circ\text{C}$		
Pulsed drain current ^a		I_{DM}	21	
Linear derating factor			0.48	W/ $^\circ\text{C}$
Single pulse avalanche energy ^b	E_{AS}	325	mJ	
Repetitive avalanche current ^a	I_{AR}	5.2	A	
Repetitive avalanche energy ^a	E_{AR}	6	mJ	
Maximum power dissipation	$T_C = 25^\circ\text{C}$	P_D	60	W
Peak diode recovery dV/dt ^c		dV/dt	2.8	V/ns
Operating junction and storage temperature range	T_J, T_{stg}	-55 to +150	$^\circ\text{C}$	
Soldering recommendations (peak temperature) ^d	For 10 s	300		
Mounting torque	M3 screw		0.6	Nm

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Starting $T_J = 25^\circ\text{C}$, $L = 24$ mH, $R_G = 25 \Omega$, $I_{AS} = 5.2$ A (see fig. 12)
- $I_{SD} \leq 5.2$ A, $dI/dt \leq 90$ A/ μs , $V_{DD} \leq V_{DS}$, $T_J \leq 150^\circ\text{C}$
- 1.6 mm from case
- Drain current limited by maximum junction temperature

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	R_{thJA}	-	65	°C/W
Maximum junction-to-case (drain)	R_{thJC}	-	2.1	

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}	$V_{GS} = 0\text{ V}$, $I_D = 250\text{ }\mu\text{A}$		650	-	-	V
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$, $I_D = 1\text{ mA}^d$		-	670	-	mV/°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}	$V_{GS} = \pm 30\text{ V}$		-	-	± 100	nA
Zero gate voltage drain current	I_{DSS}	$V_{DS} = 650\text{ V}$, $V_{GS} = 0\text{ V}$		-	-	25	μA
		$V_{DS} = 520\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$		-	-	250	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 3.1\text{ A}^b$	-	-	0.93	Ω
Forward transconductance	g_{fs}	$V_{DS} = 50\text{ V}$, $I_D = 3.1\text{ A}$		3.9	-	-	S
Dynamic							
Input capacitance	C_{iss}	$V_{GS} = 0\text{ V}$, $V_{DS} = 25\text{ V}$, $f = 1.0\text{ MHz}$, see fig. 5		-	1417	-	pF
Output capacitance	C_{oss}			-	177	-	
Reverse transfer capacitance	C_{rss}			-	7.0	-	
Output capacitance	C_{oss}	$V_{GS} = 0\text{ V}$	$V_{DS} = 1.0\text{ V}$, $f = 1.0\text{ MHz}$	-	1912	-	pF
			$V_{DS} = 520\text{ V}$, $f = 1.0\text{ MHz}$	-	48	-	
Effective output capacitance	$C_{oss\text{ eff.}}$		$V_{DS} = 0\text{ V to } 520\text{ V}^c$	-	84	-	
Total gate charge	Q_g	$V_{GS} = 10\text{ V}$	$I_D = 5.2\text{ A}$, $V_{DS} = 400\text{ V}$ see fig. 6 and 13 ^b	-	-	48	nC
Gate-source charge	Q_{gs}			-	-	12	
Gate-drain charge	Q_{gd}			-	-	19	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 325\text{ V}$, $I_D = 5.2\text{ A}$ $R_G = 9.1\text{ }\Omega$, $R_D = 62\text{ }\Omega$, see fig. 10 ^b		-	14	-	ns
Rise time	t_r			-	20	-	
Turn-off delay time	$t_{d(off)}$			-	34	-	
Fall time	t_f			-	18	-	
Drain-Source Body Diode Characteristics							
Continuous source-drain diode current	I_S	MOSFET symbol showing the integral reverse p - n junction diode		-	-	5.2	A
Pulsed diode forward current ^a	I_{SM}			-	-	21	
Body diode voltage	V_{SD}	$T_J = 25\text{ }^\circ\text{C}$, $I_S = 5.2\text{ A}$, $V_{GS} = 0\text{ V}^b$		-	-	1.5	V
Body diode reverse recovery time	t_{rr}	$T_J = 25\text{ }^\circ\text{C}$, $I_F = 5.2\text{ A}$, $dI/dt = 100\text{ A}/\mu\text{s}^b$		-	493	739	ns
Body diode reverse recovery charge	Q_{rr}			-	2.1	3.2	μC
Forward turn-on time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)					

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$
- $C_{oss\text{ eff.}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0% to 80% V_{DS}
- $t = 60\text{ s}$, $f = 60\text{ Hz}$



TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted

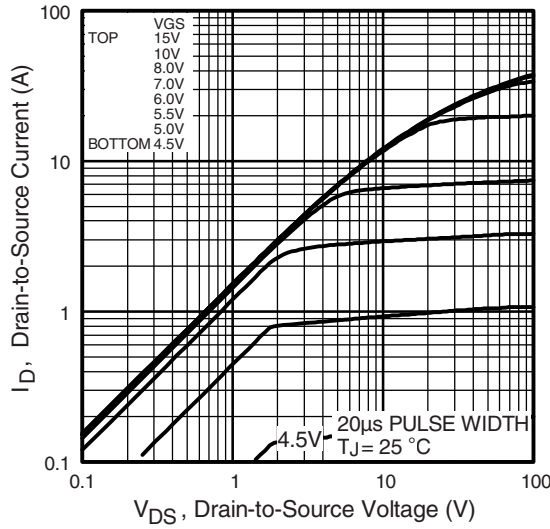


Fig. 1 - Typical Output Characteristics

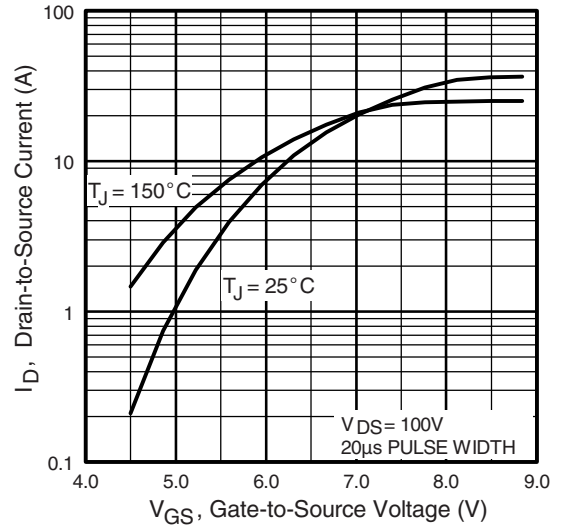


Fig. 3 - Typical Transfer Characteristics

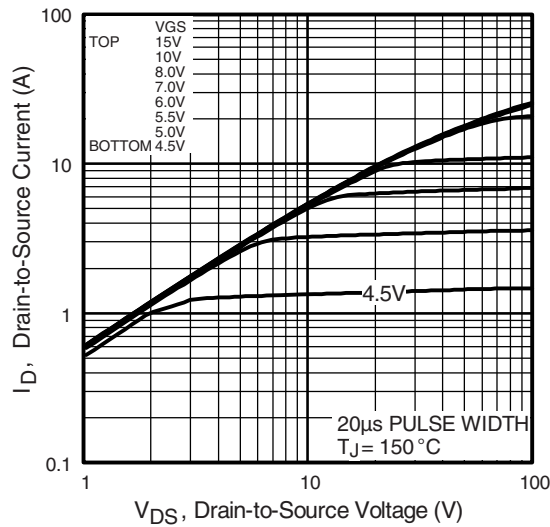


Fig. 2 - Typical Output Characteristics

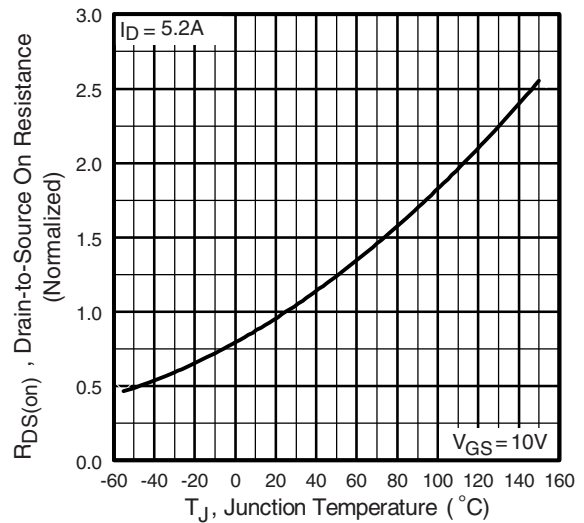


Fig. 4 - Normalized On-Resistance vs. Temperature

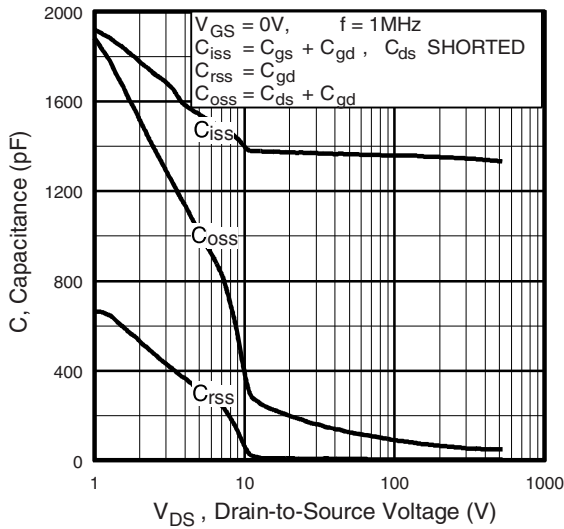


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

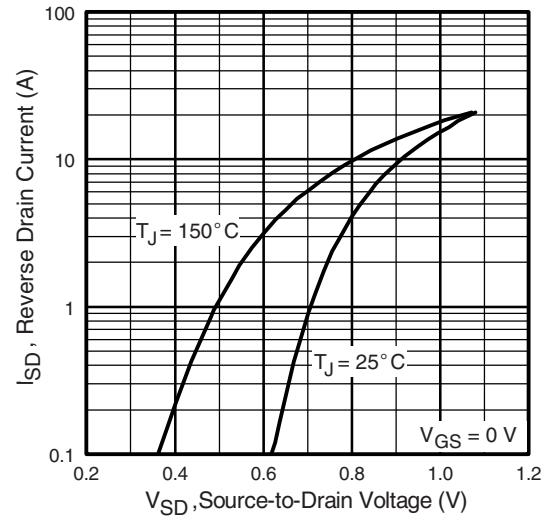


Fig. 7 - Typical Source-Drain Diode Forward Voltage

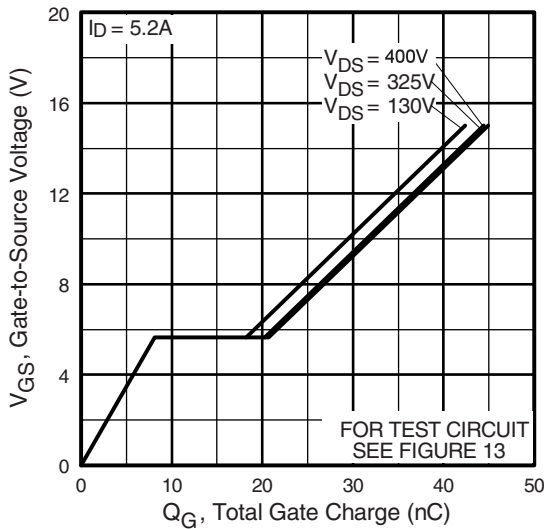


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

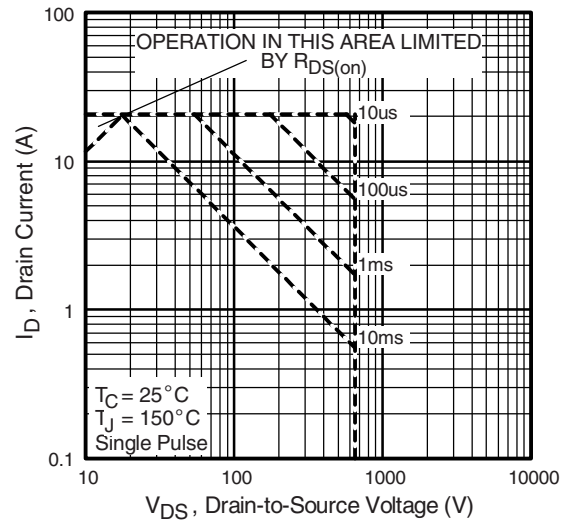


Fig. 8 - Maximum Safe Operating Area

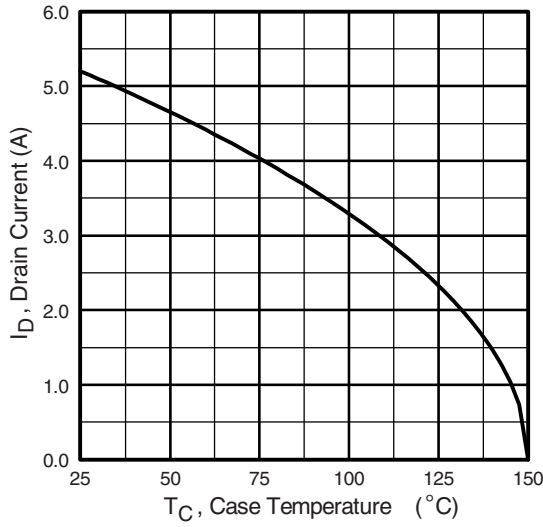


Fig. 9 - Maximum Drain Current vs. Case Temperature

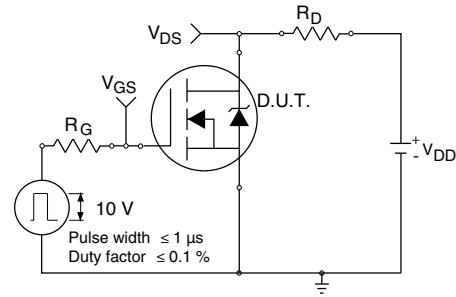


Fig. 10a - Switching Time Test Circuit

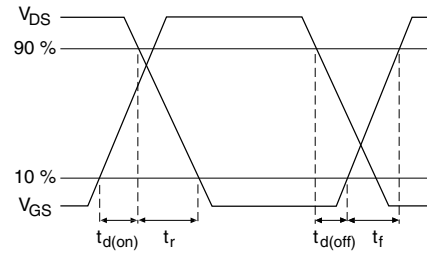


Fig. 10b - Switching Time Waveforms

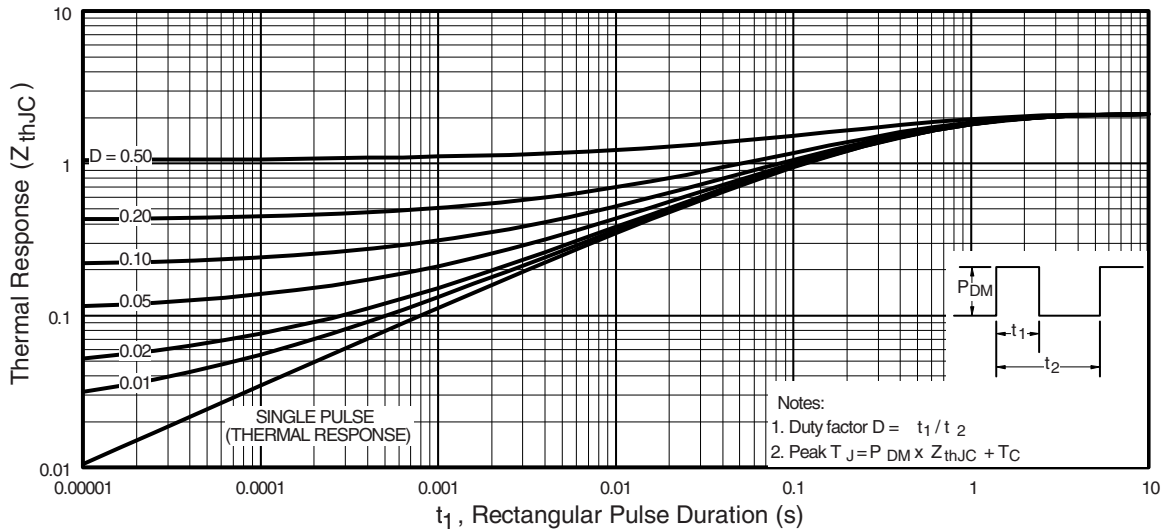


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

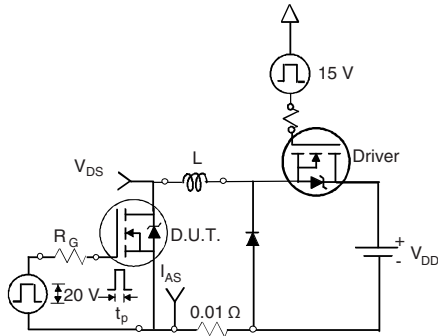


Fig. 12a - Unclamped Inductive Test Circuit

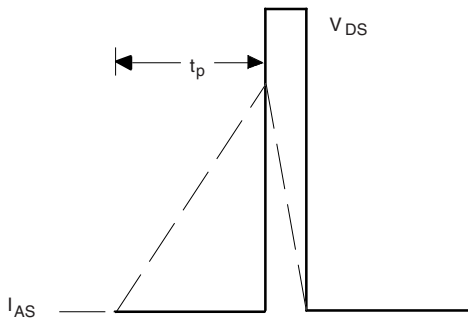


Fig. 12b - Unclamped Inductive Waveforms

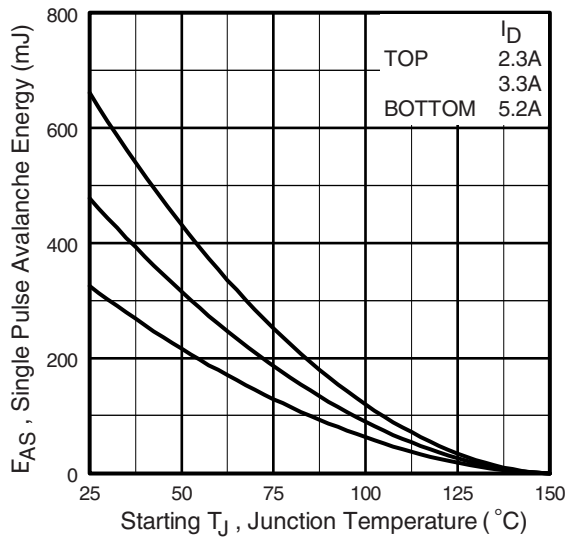


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

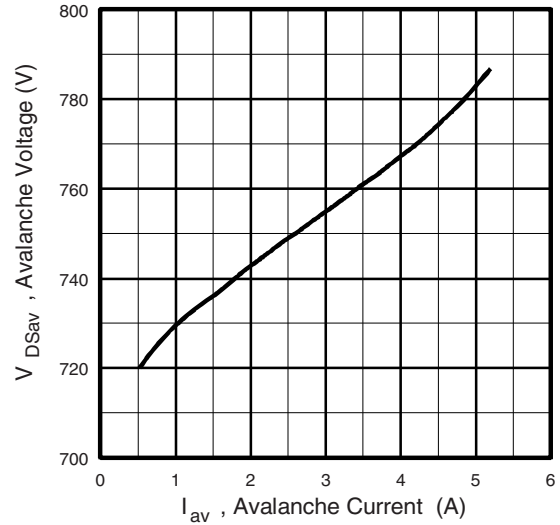


Fig. 12d - Typical Drain-to-Source Voltage vs. Avalanche Current

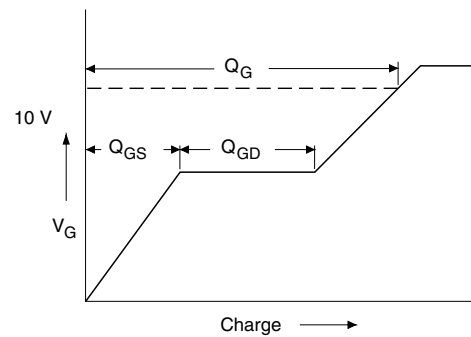


Fig. 13a - Basic Gate Charge Waveform

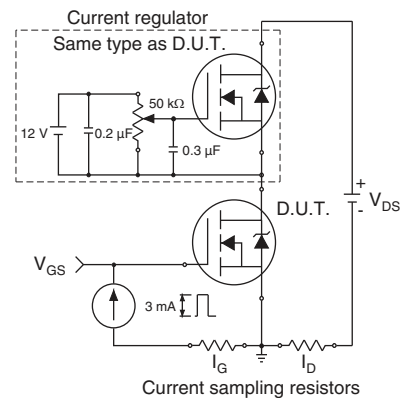
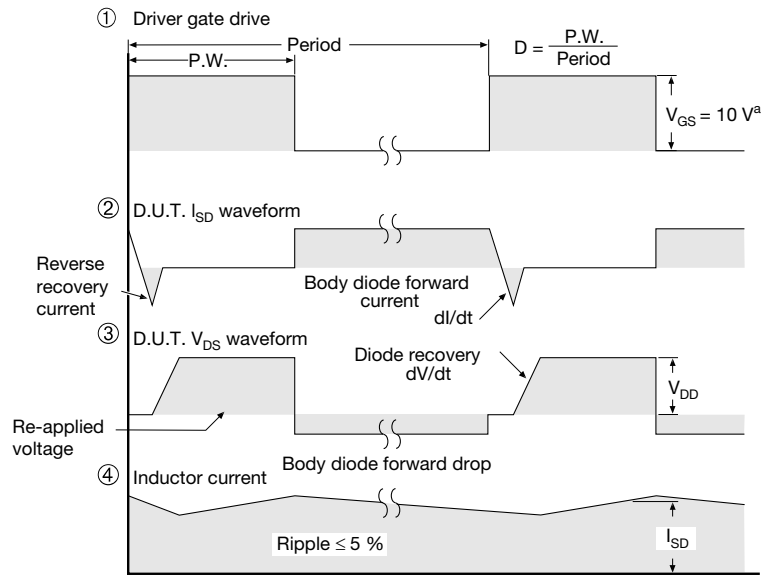
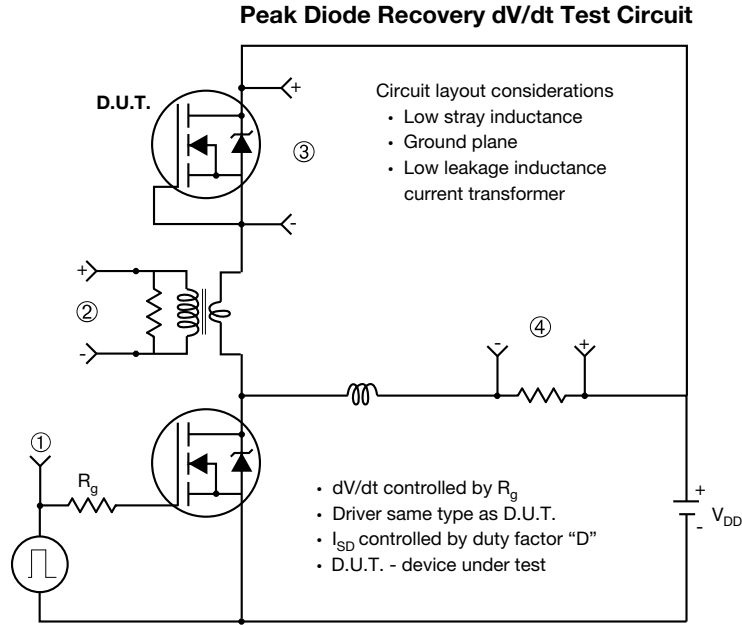


Fig. 13b - Gate Charge Test Circuit



Note
a. $V_{GS} = 5\text{ V}$ for logic level devices

Fig. 14 - For N-Channel

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TO-220 FULLPAK (High Voltage)

OPTION 1: FACILITY CODE = 9



DIM.	MILLIMETERS		
	MIN.	NOM.	MAX.
A	4.60	4.70	4.80
b	0.70	0.80	0.91
b1	1.20	1.30	1.47
b2	1.10	1.20	1.30
C	0.45	0.50	0.63
D	15.80	15.87	15.97
e	2.54 BSC		
E	10.00	10.10	10.30
F	2.44	2.54	2.64
G	6.50	6.70	6.90
L	12.90	13.10	13.30
L1	3.13	3.23	3.33
Q	2.65	2.75	2.85
Q1	3.20	3.30	3.40
$\varnothing R$	3.08	3.18	3.28

Notes

1. To be used only for process drawing
2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
6. Facility code will be the 1st character located at the 2nd row of the unit marking



OPTION 2: FACILITY CODE = Y



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.570	4.830	0.180	0.190
A1	2.570	2.830	0.101	0.111
A2	2.510	2.850	0.099	0.112
b	0.622	0.890	0.024	0.035
b2	1.229	1.400	0.048	0.055
b3	1.229	1.400	0.048	0.055
c	0.440	0.629	0.017	0.025
D	8.650	9.800	0.341	0.386
d1	15.88	16.120	0.622	0.635
d3	12.300	12.920	0.484	0.509
E	10.360	10.630	0.408	0.419
e	2.54 BSC		0.100 BSC	
L	13.200	13.730	0.520	0.541
L1	3.100	3.500	0.122	0.138
n	6.050	6.150	0.238	0.242
Ø P	3.050	3.450	0.120	0.136
u	2.400	2.500	0.094	0.098
V	0.400	0.500	0.016	0.020

ECN: E19-0180-Rev. D, 08-Apr-2019
DWG: 5972

Notes

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