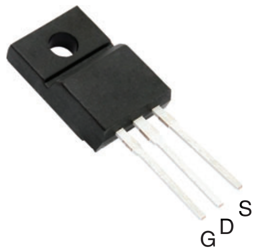
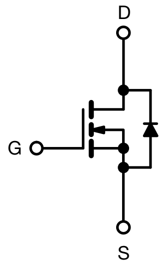
Power MOSFET

TO-220 FULLPAK





N-Channel MOSFET

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	

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

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

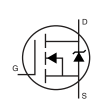
ABSOLUTE MAXIMUM RATINGS T_C = 25 °C, unless otherwise noted

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 °C	I_D	5.1	A
Continuous drain current		T_C = 100 °C		3.2	
Pulsed drain current [a]			I_{DM}	21	
Linear derating factor				0.48	W/°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 °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	°C
Soldering recommendations (peak temperature) [d]	For 10 s			300	
Mounting torque	M3 screw			0.6	Nm

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
b. Starting T_J = 25 °C, L = 24 mH, R_G = 25 Ω, I_{AS} = 5.2 A (see fig. 12)
c. $I_{SD} \leq 5.2$ A, dI/dt ≤ 90 A/μs, $V_{DD} \leq V_{DS}$, $T_J \leq 150$ °C
d. 1.6 mm from case
e. 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 °C, unless otherwise noted						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Static						
Drain-ssource breakdown voltage	V_{DS}	V_{GS} = 0 V, I_D = 250 μA	650	-	-	V
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = 1 mA [d]	-	670	-	mV/°C
Gate-source threshold voltage	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = 250 μA	2.0	-	4.0	V
Gate-source leakage	I_{GSS}	V_{GS} = ± 30 V	-	-	± 100	nA
Zero gate voltage drain current	I_{DSS}	V_{DS} = 650 V, V_{GS} = 0 V	-	-	25	μA
		V_{DS} = 520 V, V_{GS} = 0 V, T_J = 125 °C	-	-	250	
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS} = 10 V, I_D = 3.1 A [b]	-	-	0.93	Ω
Forward transconductance	g_{fs}	V_{DS} = 50 V, I_D = 3.1 A	3.9	-	-	S
Dynamic						
Input capacitance	C_{iss}	V_{GS} = 0 V, V_{DS} = 25 V, f = 1.0 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 V, V_{DS} = 1.0 V, f = 1.0 MHz	-	1912	-	
		V_{GS} = 0 V, V_{DS} = 520 V, f = 1.0 MHz	-	48	-	
Effective output capacitance	C_{oss} eff.	V_{GS} = 0 V, V_{DS} = 0 V to 520 V [c]	-	84	-	
Total gate charge	Q_g	V_{GS} = 10 V, I_D = 5.2 A, V_{DS} = 400 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 V, I_D = 5.2 A, R_G = 9.1 Ω, R_D = 62 Ω, 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 °C, I_S = 5.2 A, V_{GS} = 0 V [b]	-	-	1.5	V
Body diode reverse recovery time	t_{rr}	T_J = 25 °C, I_F = 5.2 A, dI/dt = 100 A/μs [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

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)

b. Pulse width ≤ 300 μs; duty cycle ≤ 2 %

c. C_{oss} 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}

d. t = 60 s, f = 60 Hz

TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted

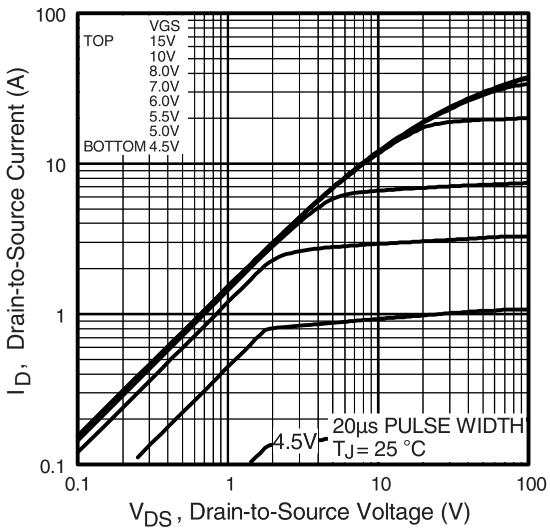


Fig. 1 - Typical Output Characteristics

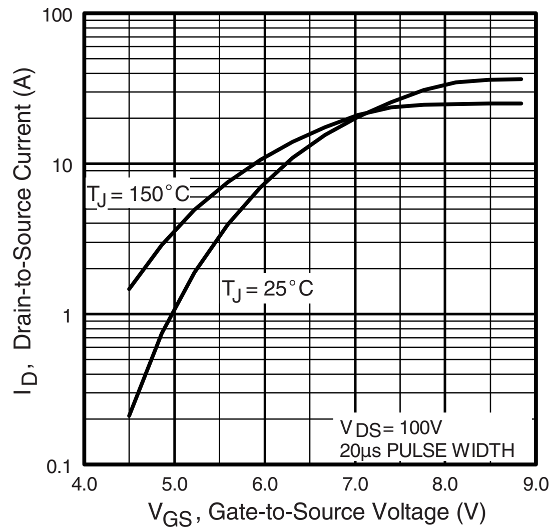


Fig. 3 - Typical Transfer Characteristics

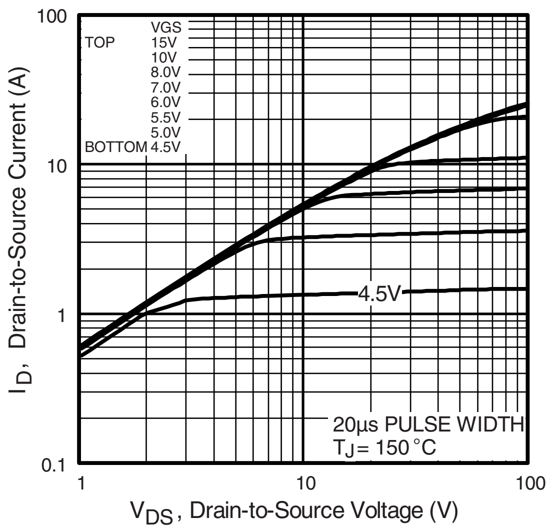


Fig. 2 - Typical Output Characteristics

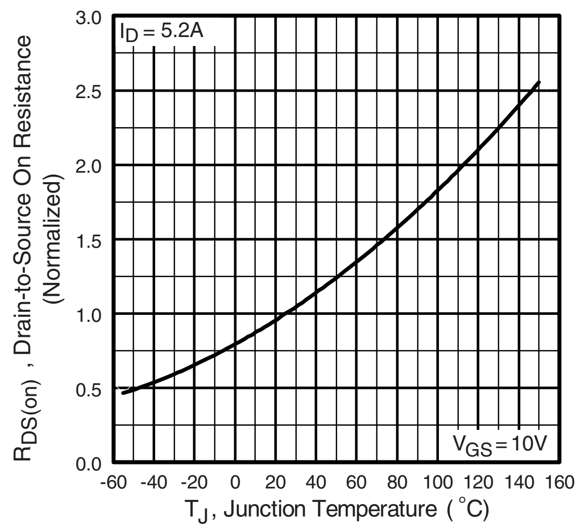


Fig. 4 - Normalized On-Resistance vs. Temperature

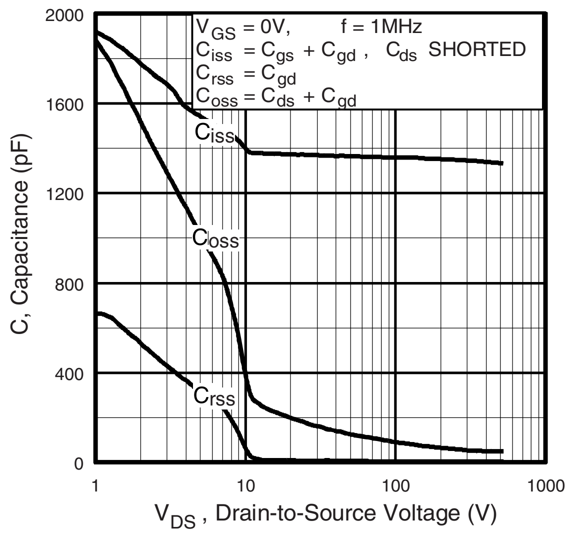


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

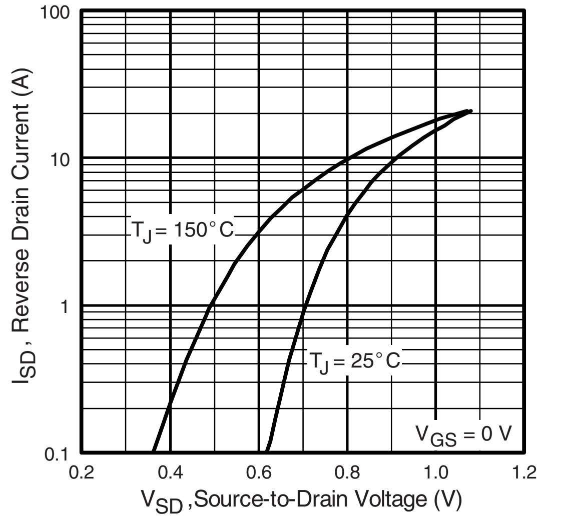


Fig. 7 - Typical Source-Drain Diode Forward Voltage

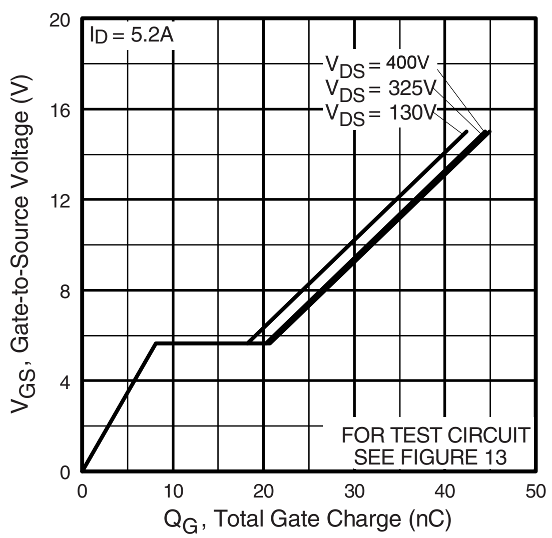


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

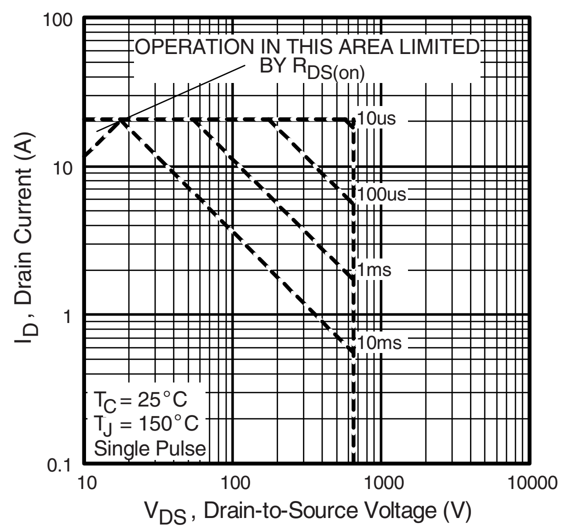


Fig. 8 - Maximum Safe Operating Area

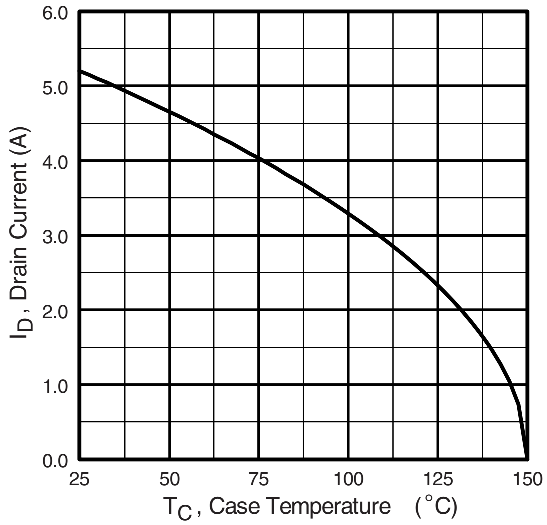


Fig. 9 - Maximum Drain Current vs. Case Temperature

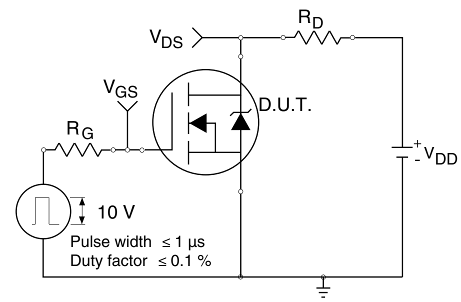


Fig. 10a - Switching Time Test Circuit

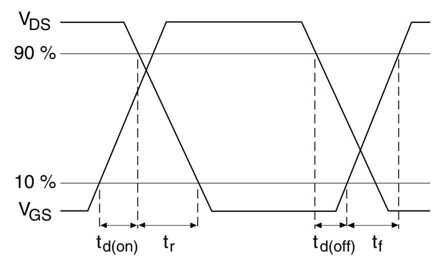


Fig. 10b - Switching Time Waveforms

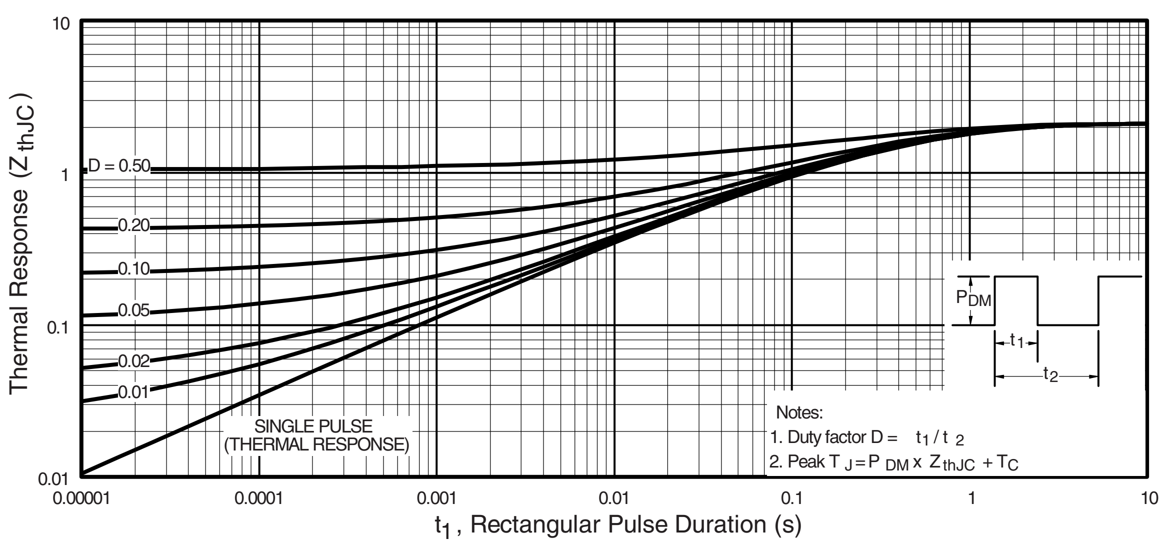


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

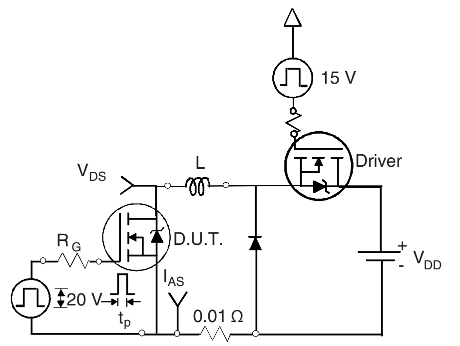


Fig. 12a - Unclamped Inductive Test Circuit

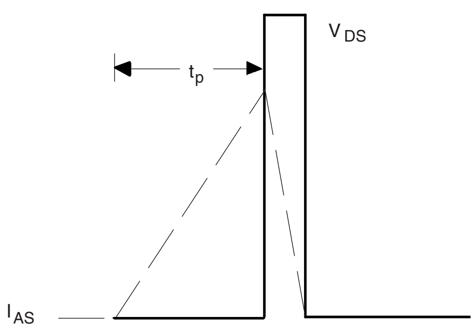


Fig. 12b - Unclamped Inductive Waveforms

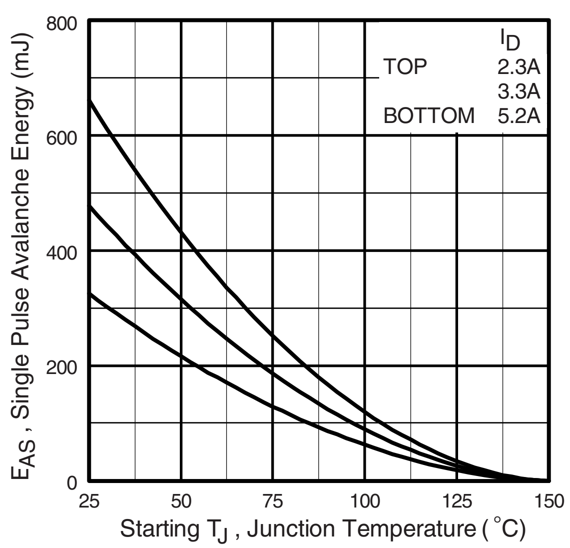


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

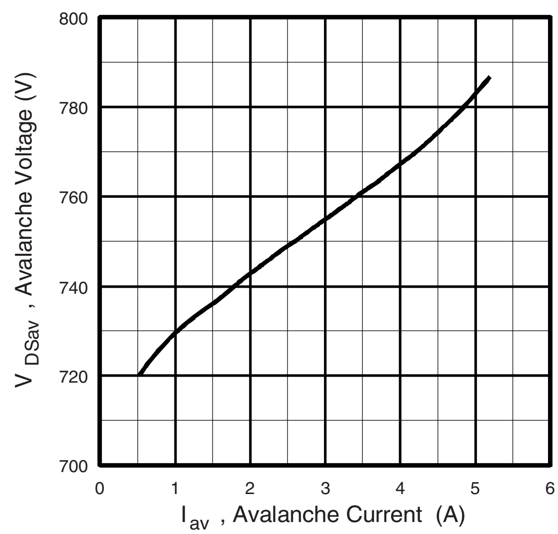


Fig. 12d - Typical Drain-to Source Voltage vs. Avalanche Current

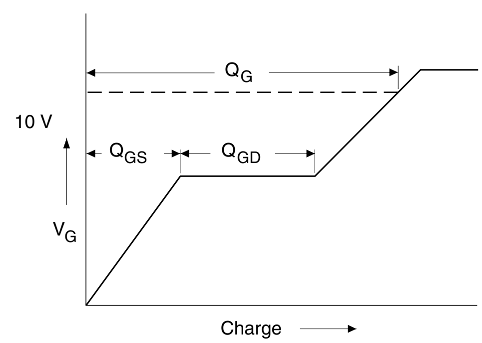


Fig. 13a - Basic Gate Charge Waveform

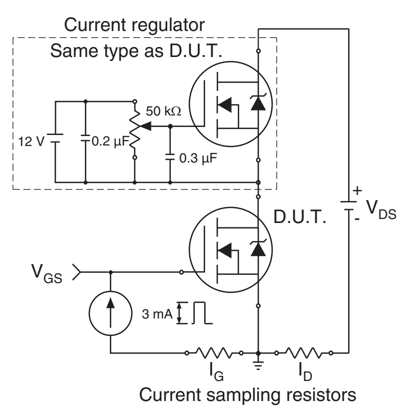
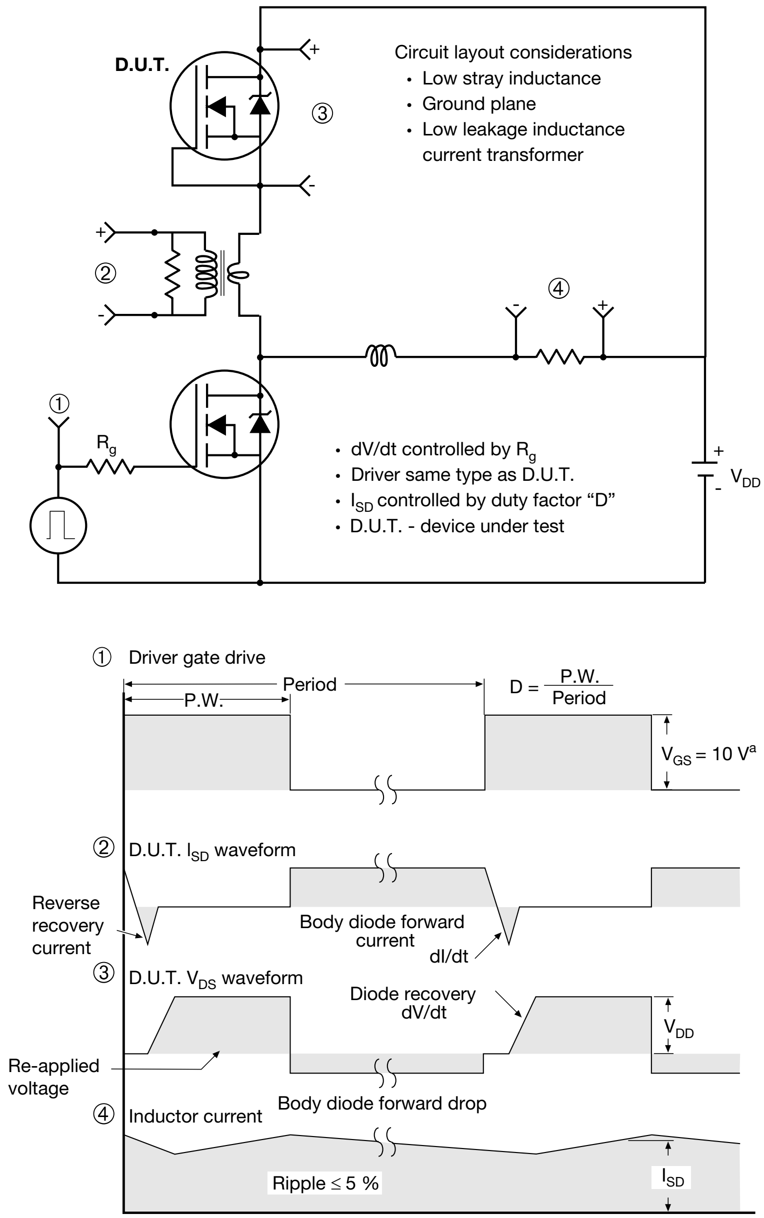


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



Note

a. V_{GS} = 5 V for logic level devices

Fig. 14 - For N-Channel

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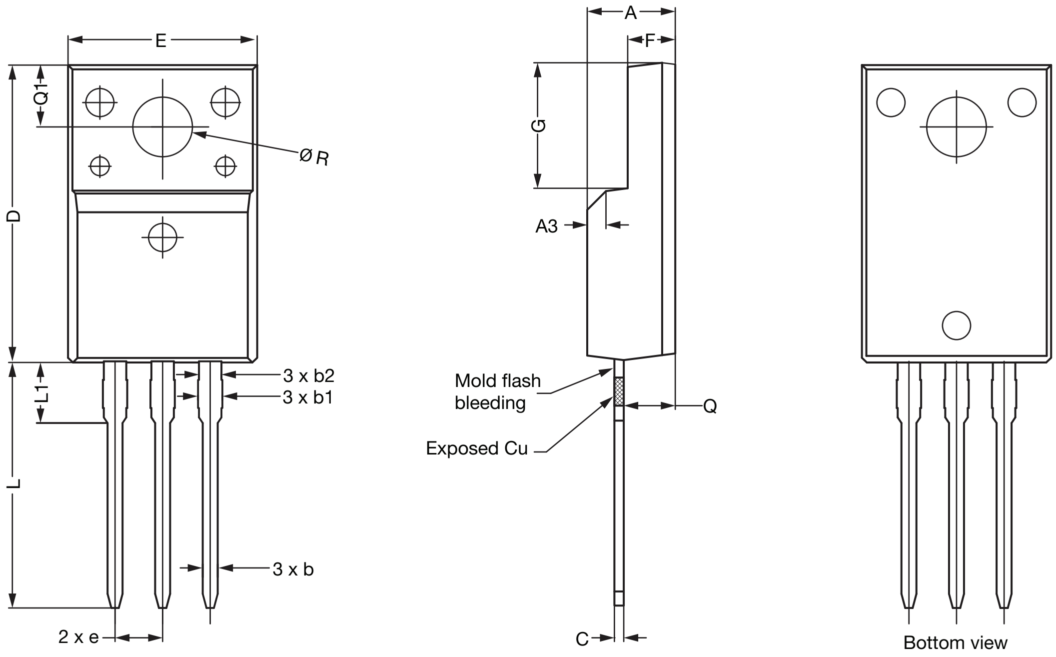
TO-220 FULLPAK (High Voltage)

OPTION 1: FACILITY CODE = 9

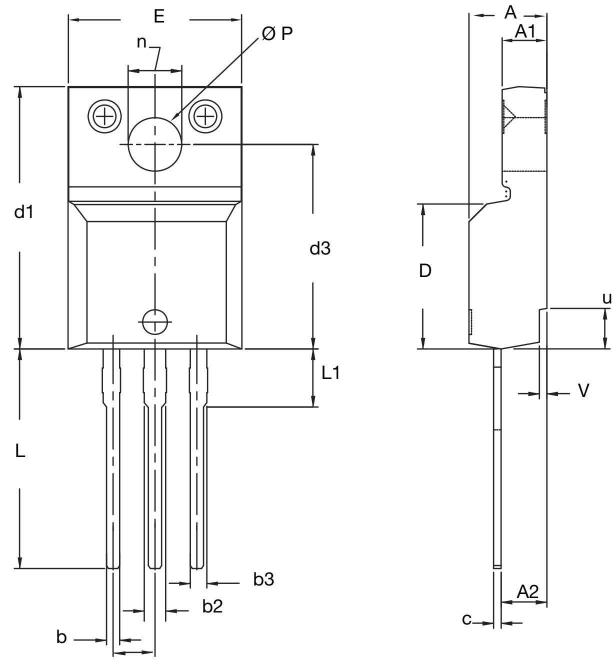


	MILLIMETERS		
DIM.	**MIN.**	**NOM.**	**MAX.**
A	4.60	4.70	4.80
b	0.70	0.80	0.91
b1	1.20	1.30	1.47
b2	1.10	1.20	1.30
C	0.45	0.50	0.63
D	15.80	15.87	15.97
e	2.54 BSC		
E	10.00	10.10	10.30
F	2.44	2.54	2.64
G	6.50	6.70	6.90
L	12.90	13.10	13.30
L1	3.13	3.23	3.33
Q	2.65	2.75	2.85
Q1	3.20	3.30	3.40
Ø R	3.08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



	MILLIMETERS		INCHES	
DIM.	**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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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

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