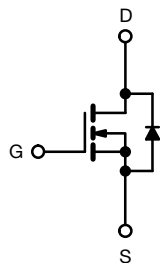
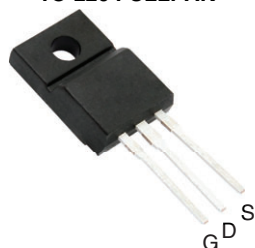


Power MOSFET

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)	$V_{GS} = 10\text{ V}$	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 $T_C = 25\text{ }^\circ\text{C}$, unless otherwise noted

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	V_{DS}	650	V
Gate-source voltage	V_{GS}	± 30	
Continuous drain current ^a	I_D	5.1	A
Continuous drain current		3.2	
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	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 $T_J = 25\text{ }^\circ\text{C}$, $L = 24\text{ mH}$, $R_G = 25\text{ }\Omega$, $I_{AS} = 5.2\text{ A}$ (see fig. 12)
- $I_{SD} \leq 5.2\text{ A}$, $dI/dt \leq 90\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{DS}$, $T_J \leq 150\text{ }^\circ\text{C}$
- 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-ssource breakdown voltage	V _{DS}	V _{GS} = 0 V, I _D = 250 μA		650	-	-	V
V _{DS} temperature coefficient	ΔV _{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	-	pF
Effective output capacitance	C _{Oss} eff.		V _{DS} = 520 V, f = 1.0 MHz	-	48	-	
			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 $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\text{ }\%$
c. $C_{oss\text{ eff.}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from $0\text{ }\%$ to $80\text{ }\%$ V_{DS}
d. $t = 60\text{ s}$, $f = 60\text{ Hz}$



TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted

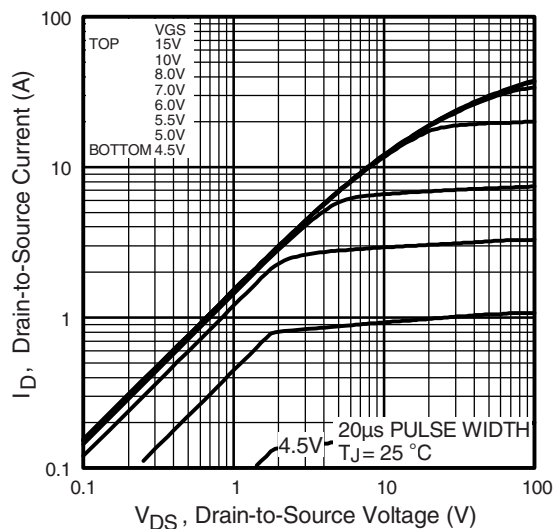


Fig. 1 - Typical Output Characteristics

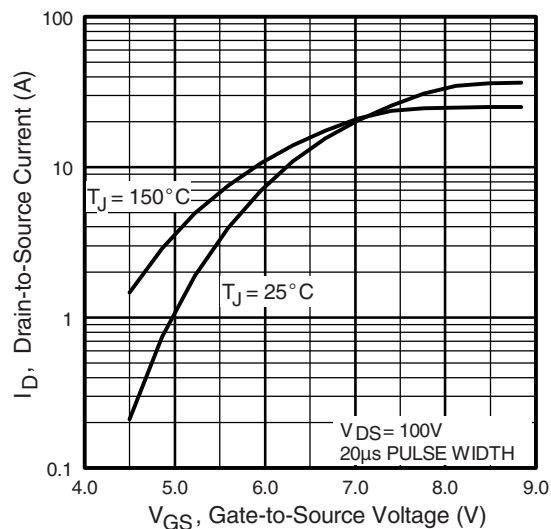


Fig. 3 - Typical Transfer Characteristics

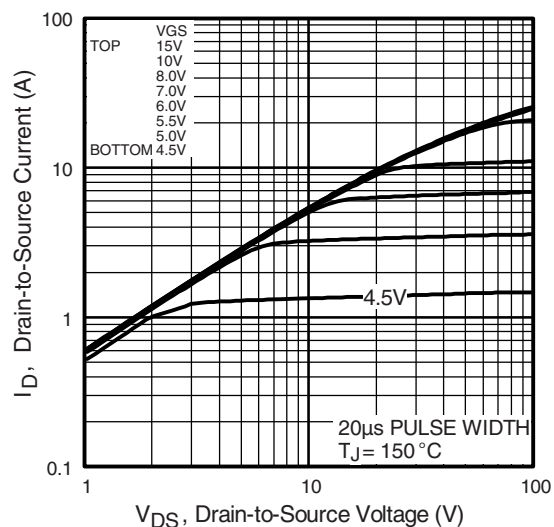


Fig. 2 - Typical Output Characteristics

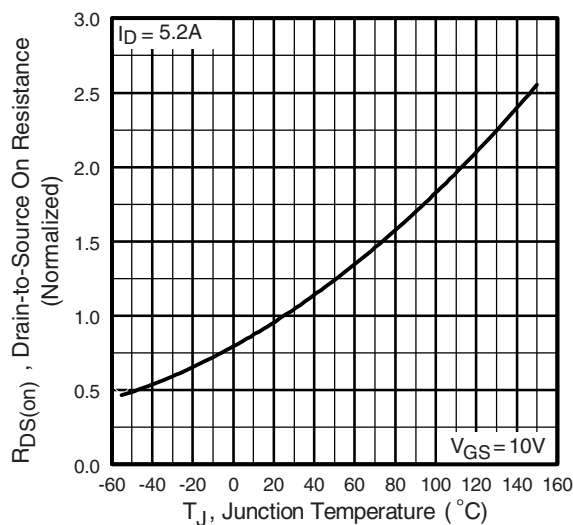
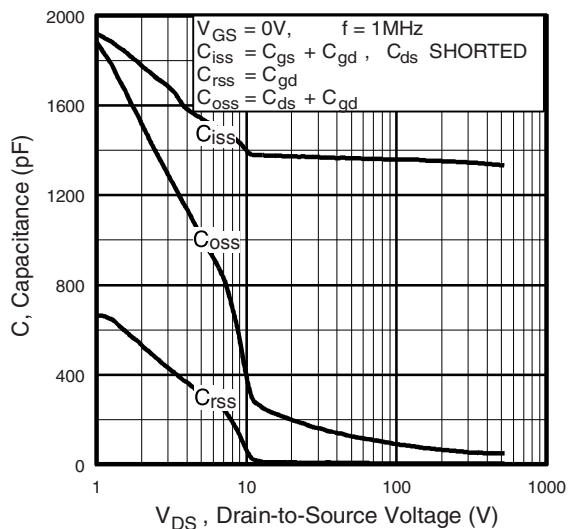
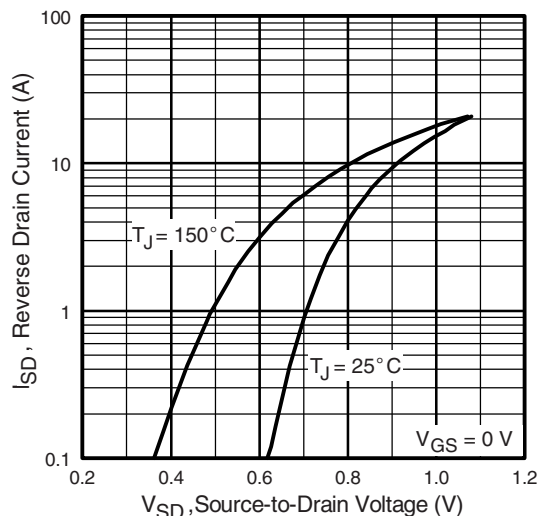
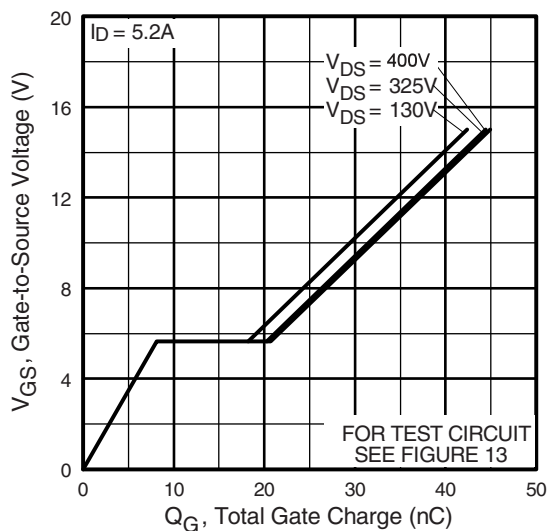
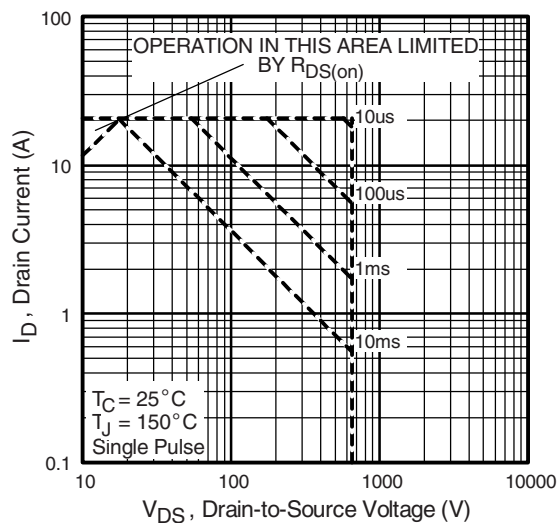
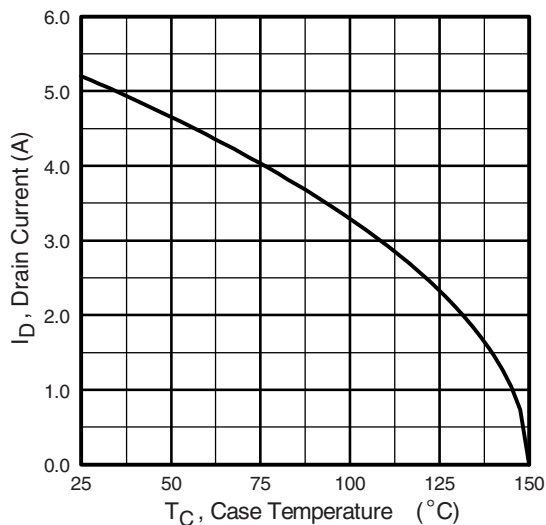
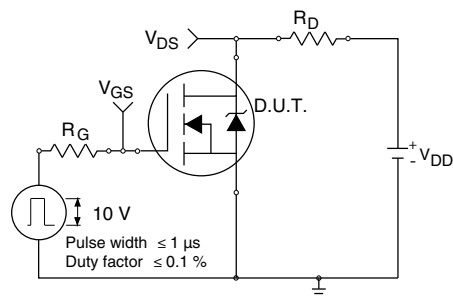
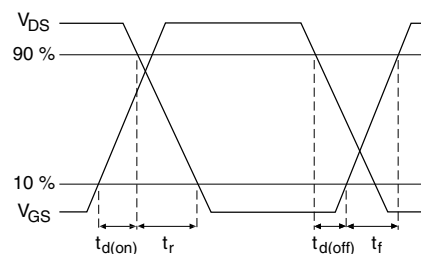
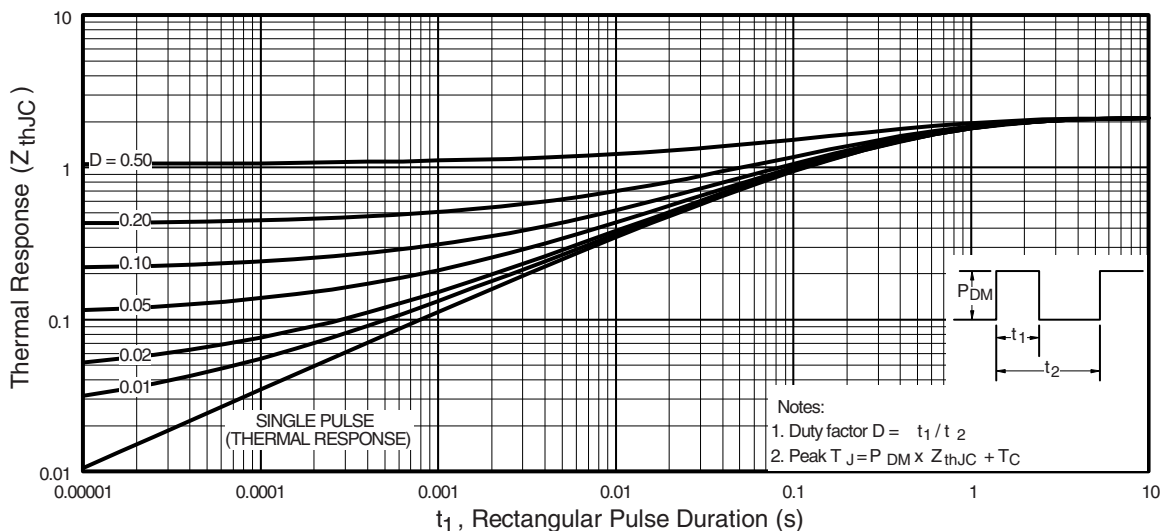
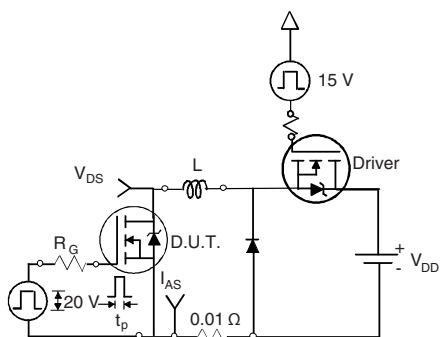
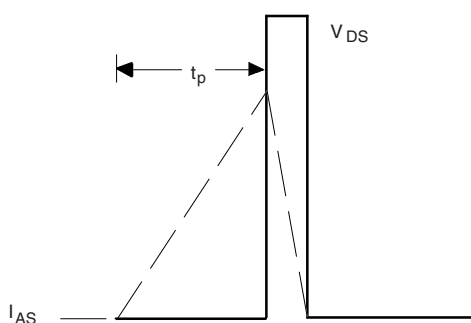
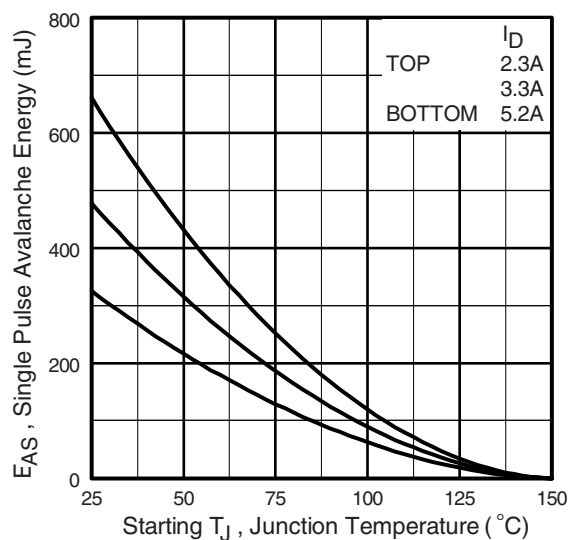
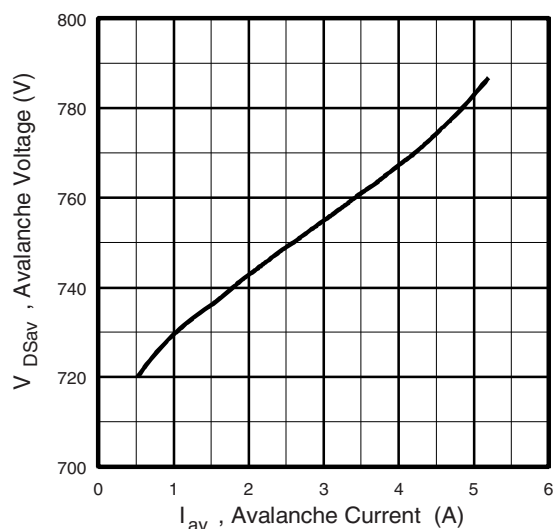
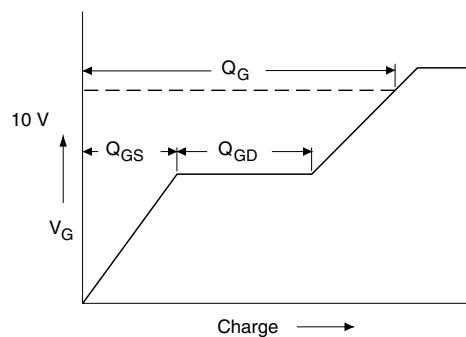
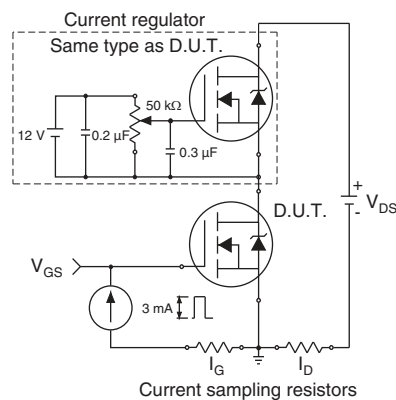
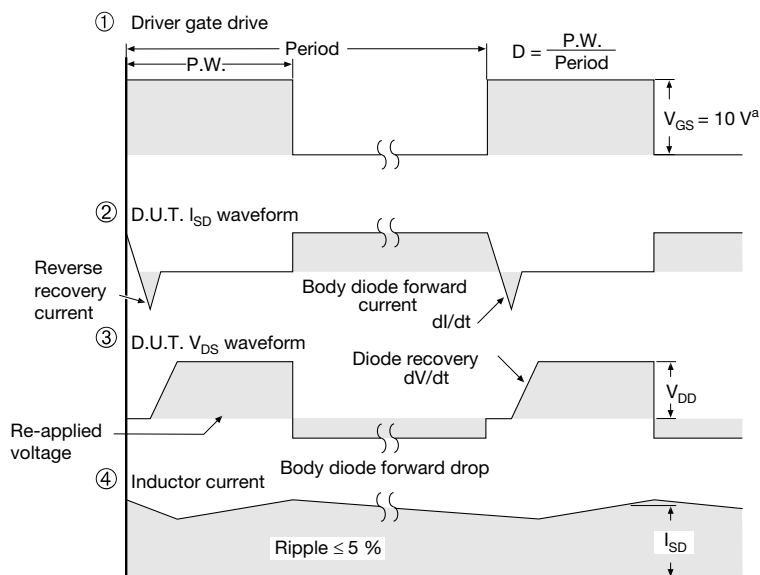
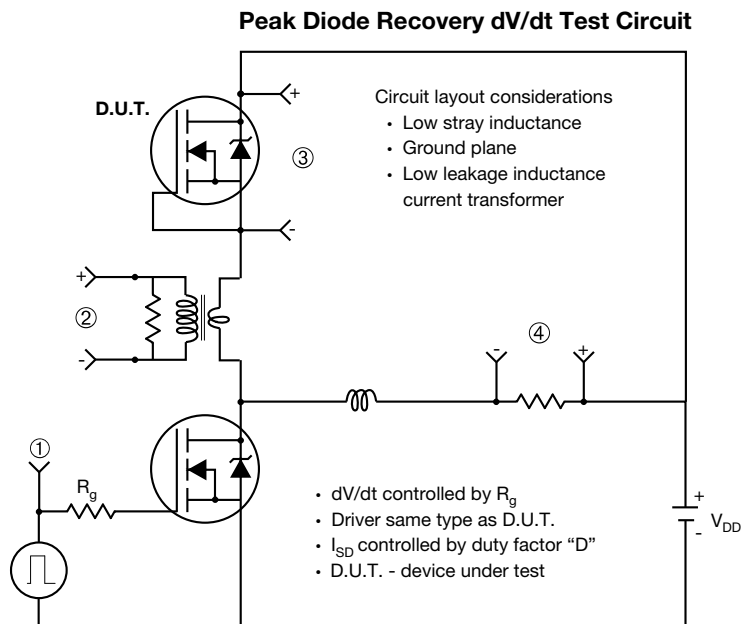


Fig. 4 - Normalized On-Resistance vs. Temperature


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

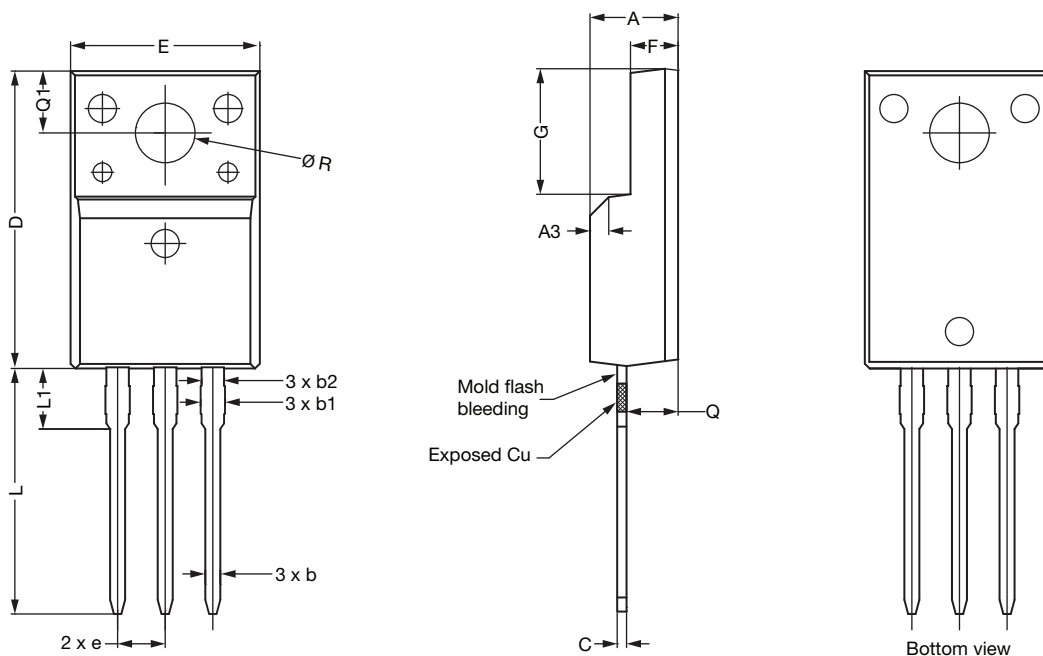
Fig. 14 - For N-Channel

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TO-220 FULLPAK (High Voltage)

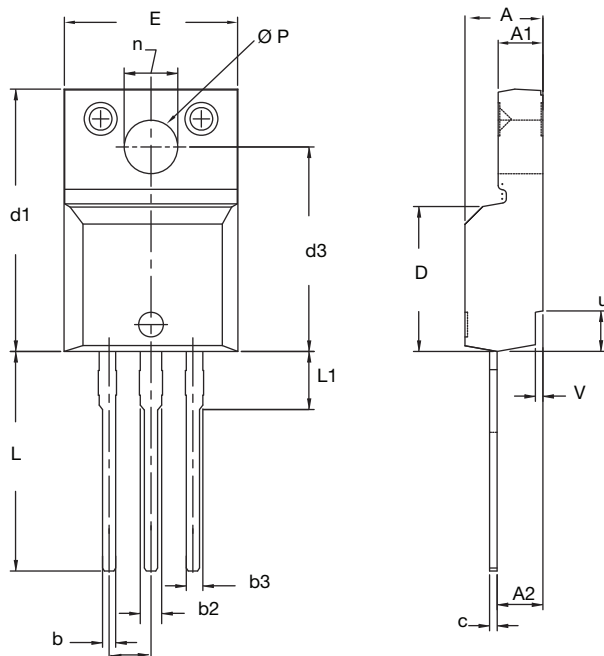
OPTION 1: FACILITY CODE = 9



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
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**

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

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 $C_{pk} > 1.33$
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