

Power MOSFET

TO-220AB


N-Channel MOSFET

FEATURES

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



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

APPLICATIONS

- Switch mode power supply (SMPS)
- Uninterruptible power supplies
- High speed power switching

PRODUCT SUMMARY

V_{DS} (V)	500	
$R_{DS(on)}$ (Ω)	$V_{GS} = 10$ V	0.450
Q_g max. (nC)	81	
Q_{gs} (nC)	20	
Q_{gd} (nC)	36	
Configuration	Single	

ORDERING INFORMATION

Package	TO-220AB
Lead (Pb)-free	IRFB13N50APbF


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

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	V_{DS}	500	V
Gate-source voltage	V_{GS}	± 30	V
Continuous drain current	V_{GS} at 10 V	$T_C = 25$ °C	14
		$T_C = 100$ °C	9.1
Pulsed drain current ^a	I_{DM}	56	A
Linear derating factor		2.0	W/°C
Single pulse avalanche energy ^b	E_{AS}	560	mJ
Repetitive avalanche current ^a	I_{AR}	14	A
Repetitive avalanche energy ^a	E_{AR}	25	mJ
Maximum power dissipation	$T_C = 25$ °C	P_D	250
Peak diode recovery dV/dt ^c	dV/dt	9.2	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	6-32 or M3 screw	10	lbf · in
		1.1	N · m

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Starting $T_J = 25$ °C, $L = 5.7$ mH, $R_g = 25$ Ω , $I_{AS} = 14$ A, $dV/dt = 7.6$ V/ns (see fig. 12a)
- $I_{SD} \leq 14$ A, $dI/dt \leq 250$ A/ μ s, $V_{DD} \leq V_{DS}$, $T_J \leq 150$ °C
- 1.6 mm from case

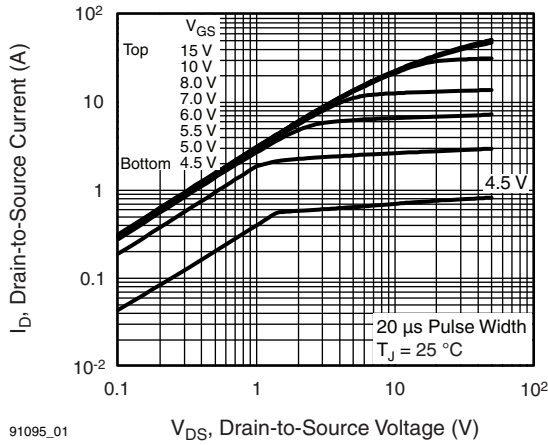
THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	R_{thJA}	-	62	°C/W
Case-to-sink, flat, greased surface	R_{thCS}	0.50	-	
Maximum junction-to-case (drain)	R_{thJC}	-	0.50	

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}	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$		500	-	-	V		
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$, $I_D = 1\text{ mA}$		-	0.55	-	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}	$V_{GS} = \pm 30\text{ V}$		-	-	± 100	nA		
Zero gate voltage drain current	I_{DSS}	$V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$		-	-	25	μA		
		$V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$		-	-	250			
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 8.4\text{ A}^b$	-	-	0.450	Ω		
Forward transconductance	g_{fs}	$V_{DS} = 50\text{ V}, I_D = 8.4\text{ A}$		8.1	-	-	S		
Dynamic									
Input capacitance	C_{iss}	$V_{GS} = 0\text{ V}, V_{DS} = 25\text{ V}, f = 1.0\text{ MHz}$, see fig. 5		-	1910	-	μF		
Output capacitance	C_{oss}			-	290	-			
Reverse transfer capacitance	C_{rss}			-	11	-			
Output capacitance	C_{oss}	$V_{GS} = 0\text{ V}$	$V_{DS} = 1.0\text{ V}, f = 1.0\text{ MHz}$	-	2730	-	μF		
			$V_{DS} = 400\text{ V}, f = 1.0\text{ MHz}$	-	82	-			
Effective output capacitance	$C_{oss\text{ eff.}}$	$V_{DS} = 0\text{ V to } 400\text{ V}^c$		-	160	-			
Total gate charge	Q_g	$V_{GS} = 10\text{ V}$		-	-	81	nC		
Gate-source charge	Q_{gs}			$I_D = 14\text{ A}, V_{DS} = 400\text{ V}$, see fig. 6 and 13 ^b	-	-		20	
Gate-drain charge	Q_{gd}				-	-		36	
Turn-on delay time	$t_{d(on)}$	$V_{GS} = 10\text{ V}$		-	15	-	ns		
Rise time	t_r			$V_{DD} = 250\text{ V}, I_D = 14\text{ A}, R_g = 7.5\text{ }\Omega$, see fig. 10 ^b		-		39	-
Turn-off delay time	$t_{d(off)}$					-		39	-
Fall time	t_f					-		31	-
Gate input resistance	R_g	$f = 1\text{ MHz}$, open drain				0.5	-	2.1	Ω
Drain-Source Body Diode Characteristics									
Continuous source-drain diode current	I_S	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	14	A		
Pulsed diode forward current ^a	I_{SM}			-	-	56			
Body diode voltage	V_{SD}	$T_J = 25\text{ }^\circ\text{C}, I_S = 14\text{ A}, V_{GS} = 0\text{ V}^b$		-	-	1.5	V		
Body diode reverse recovery time	t_{rr}	$T_J = 25\text{ }^\circ\text{C}, I_F = 14\text{ A}, T_J = 125\text{ }^\circ\text{C}, dI/dt = 100\text{ A}/\mu\text{s}^b$		-	370	550	ns		
Body diode reverse recovery charge	Q_{rr}			-	4.4	6.5	μC		
Body diode reverse recovery current	I_{RRM}			-	21	31	A		
Forward turn-on time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)							

Notes

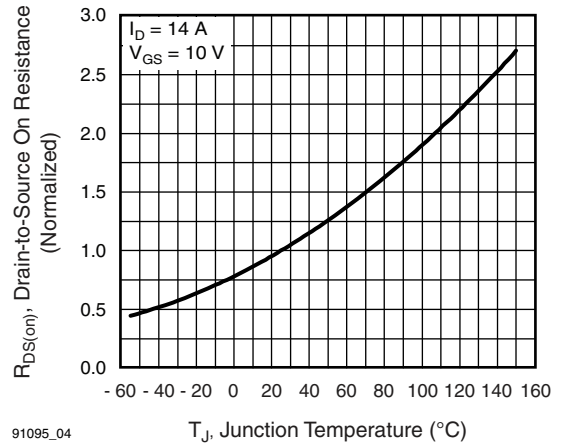
- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$
- $C_{oss\text{ eff.}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0% to 80% V_{DS}

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



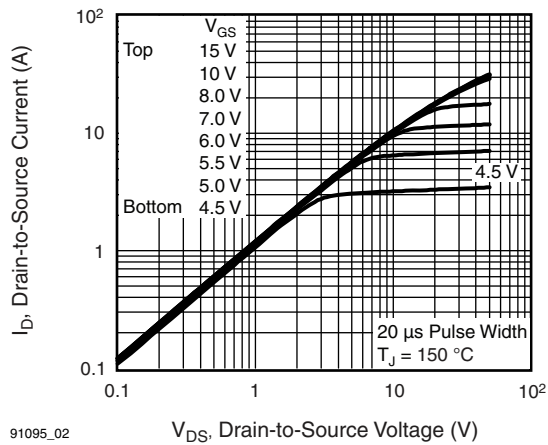
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Fig. 1 - Typical Output Characteristics



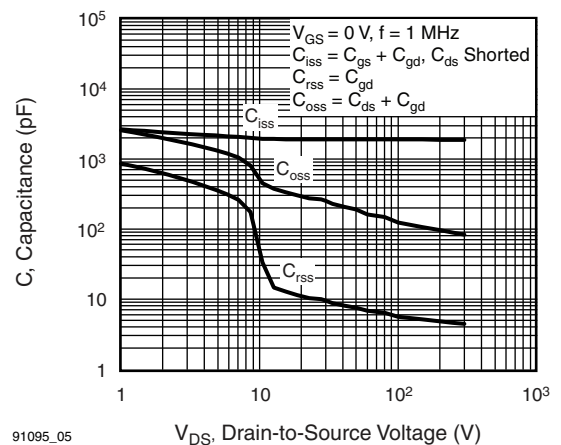
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Fig. 4 - Normalized On-Resistance vs. Temperature



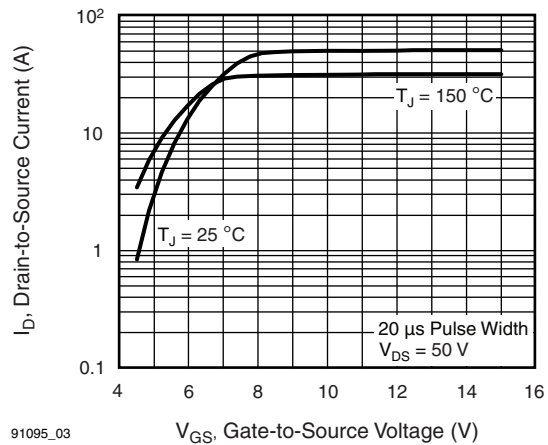
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Fig. 2 - Typical Output Characteristics



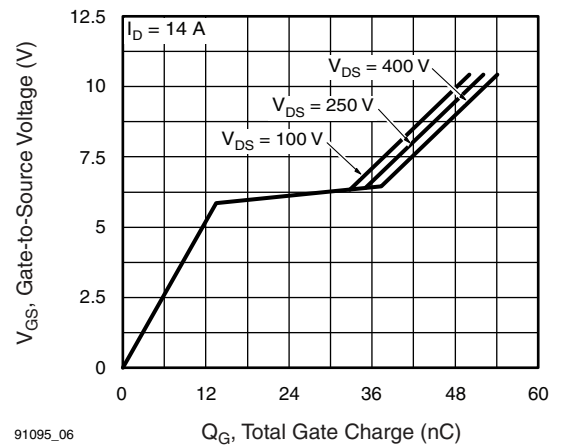
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Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



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Fig. 3 - Typical Transfer Characteristics



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

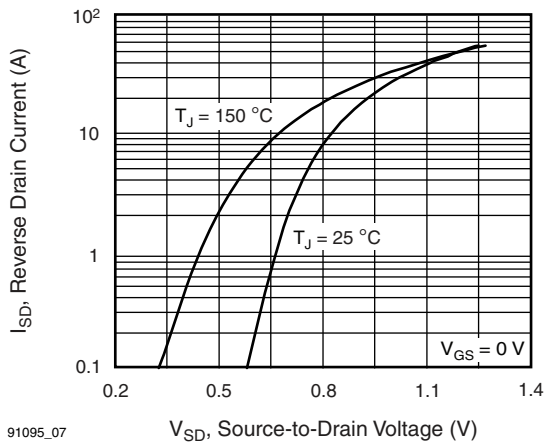


Fig. 7 - Typical Source-Drain Diode Forward Voltage

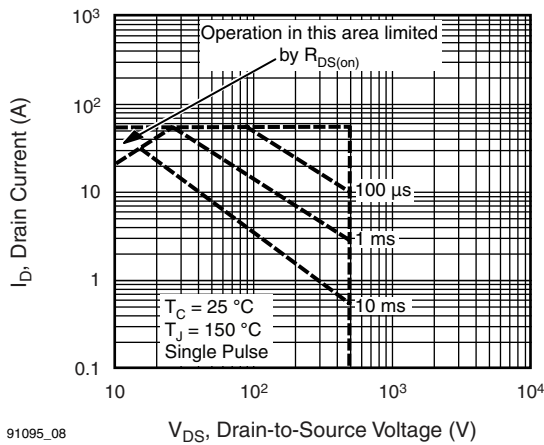


Fig. 8 - Maximum Safe Operating Area

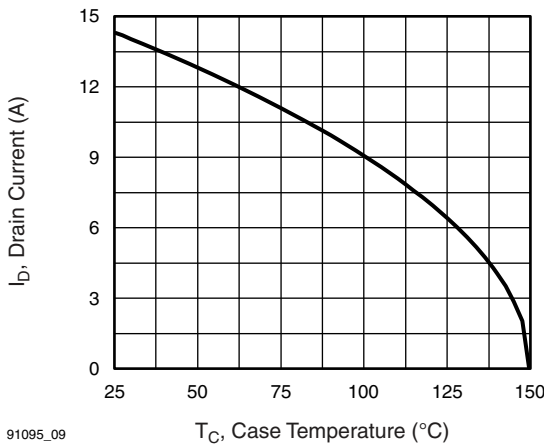


Fig. 9 - Maximum Drain Current vs. Case Temperature

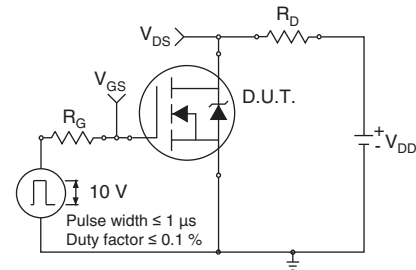


Fig. 10a - Switching Time Test Circuit

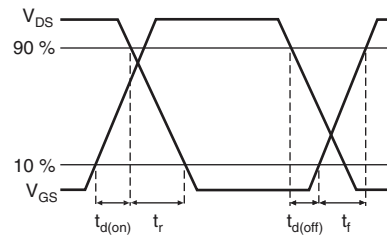


Fig. 10b - Switching Time Waveforms

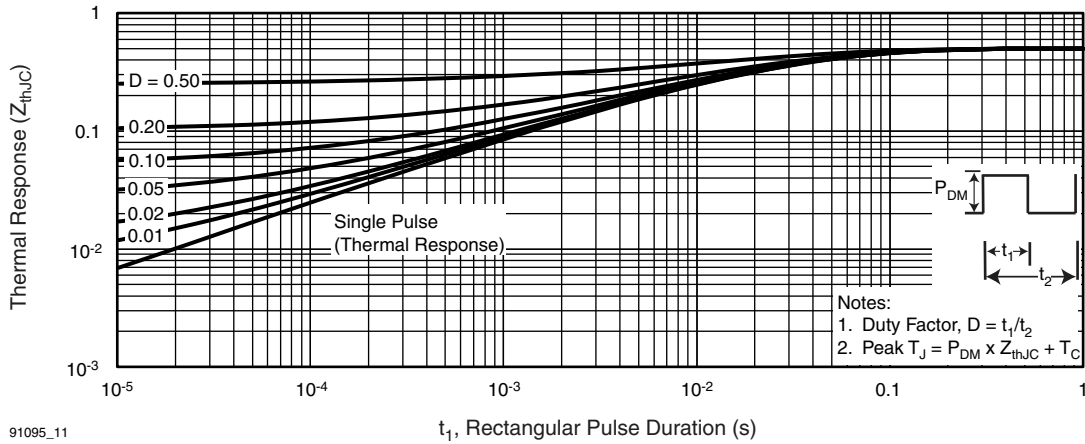


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

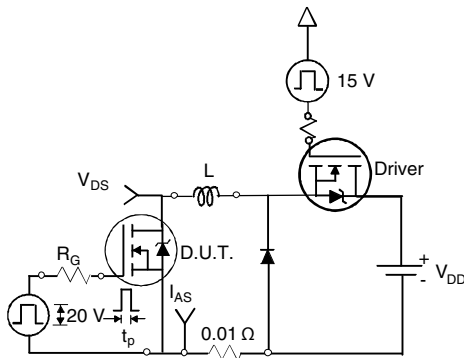


Fig. 12a - Unclamped Inductive Test Circuit

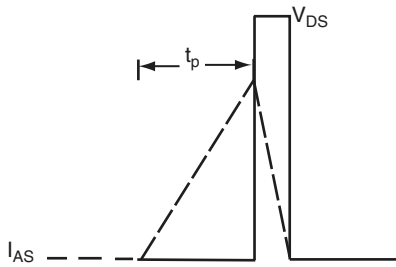


Fig. 12b - Unclamped Inductive Waveforms

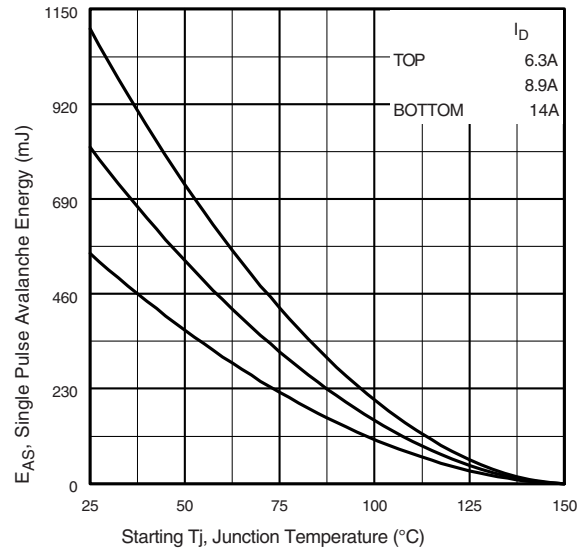


Fig. 12c - Maximum Avalanche Energy vs. Drain Current



Fig. 13a - Basic Gate Charge Waveform

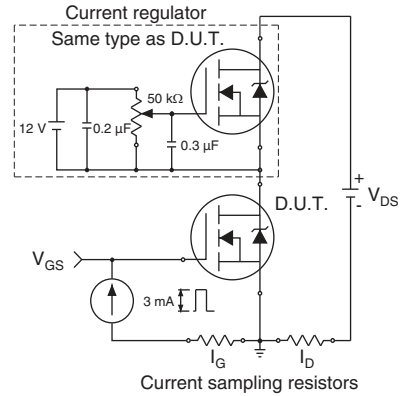
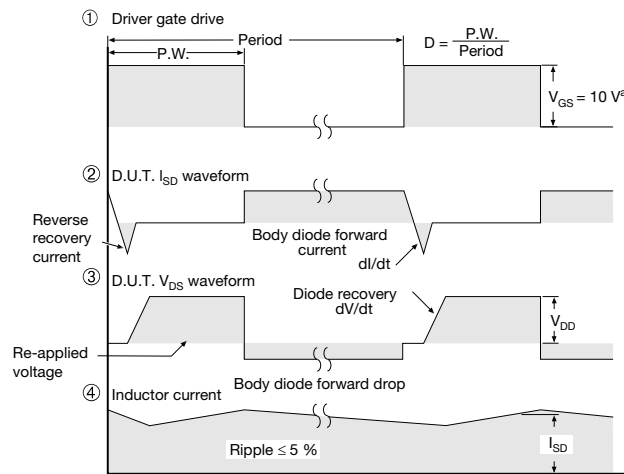
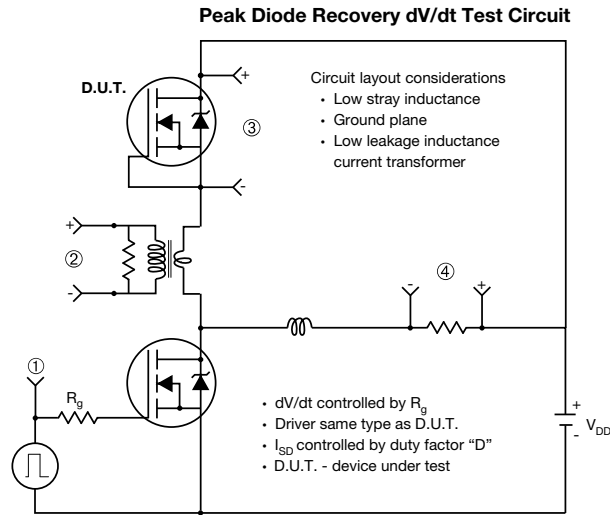


Fig. 13b - Gate Charge Test Circuit



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

Fig. 14 - For N-Channel

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TO-220-1



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
Ø P	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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