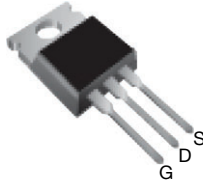


Power MOSFET

TO-220AB


P-Channel MOSFET

FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- P-channel
- 175 °C operating temperature
- Fast switching
- Ease of paralleling
- Simple drive requirements
- 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

DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

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)	-60	
$R_{DS(on)}$ (Ω)	$V_{GS} = -10$ V	0.28
Q_g max. (nC)	19	
Q_{gs} (nC)	5.4	
Q_{gd} (nC)	11	
Configuration	Single	

ORDERING INFORMATION

Package	TO-220AB
Lead (Pb)-free	IRF9Z24PbF
Lead (Pb)-free and halogen-free	IRF9Z24PbF-BE3

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



PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	V_{DS}	-60	V
Gate-source voltage	V_{GS}	± 20	
Continuous drain current	I_D	V_{GS} at 10 V $T_C = 25$ °C	-11
		$T_C = 100$ °C	-7.7
Pulsed drain current ^a	I_{DM}	-44	A
Linear derating factor		0.40	W/°C
Single pulse avalanche energy ^b	E_{AS}	240	mJ
Repetitive avalanche current ^a	I_{AR}	-11	A
Repetitive avalanche energy ^a	E_{AR}	6.0	mJ
Maximum power dissipation	P_D	60	W
Peak diode recovery dV/dt ^c	dV/dt	-4.5	V/ns
Operating junction and storage temperature range	T_J, T_{stg}	-55 to +175	°C
Soldering recommendations (peak temperature) ^d	For 10 s	300	
Mounting torque	6-32 or M3 screw	10	
		1.1	N · m

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = -25$ V, starting $T_J = 25$ °C, $L = 2.3$ mH, $R_g = 25$ Ω , $I_{AS} = -11$ A (see fig. 12)
- $I_{SD} \leq -11$ A, $di/dt \leq 140$ A/ μ s, $V_{DD} \leq V_{DS}$, $T_J \leq 175$ °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}	-	2.5	

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}	$V_{GS} = 0\text{ V}$, $I_D = -250\text{ }\mu\text{A}$		-60	-	-	V
V_{DS} temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$, $I_D = -1\text{ mA}$		-	-0.056	-	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}	$V_{DS} = -60\text{ V}$, $V_{GS} = 0\text{ V}$		-	-	-100	μA
		$V_{DS} = -48\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$		-	-	-500	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -6.6\text{ A}^b$	-	-	0.28	Ω
Forward transconductance	g_{fs}	$V_{DS} = -25\text{ V}$, $I_D = -6.6\text{ A}^b$		1.4	-	-	S
Dynamic							
Input capacitance	C_{iss}	$V_{GS} = 0\text{ V}$, $V_{DS} = -25\text{ V}$, $f = 1.0\text{ MHz}$, see fig. 5		-	570	-	μF
Output capacitance	C_{oss}			-	360	-	
Reverse transfer capacitance	C_{rss}			-	65	-	
Total gate charge	Q_g	$V_{GS} = -10\text{ V}$	$I_D = -11\text{ A}$, $V_{DS} = -48\text{ V}$, see fig. 6 and 13 ^b	-	-	19	nC
Gate-source charge	Q_{gs}			-	-	5.4	
Gate-drain charge	Q_{gd}			-	-	11	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = -30\text{ V}$, $I_D = -11\text{ A}$, $R_g = 18\text{ }\Omega$, $R_D = 2.5\text{ }\Omega$, see fig. 10 ^b		-	13	-	ns
Rise time	t_r			-	68	-	
Turn-off delay time	$t_{d(off)}$			-	15	-	
Fall time	t_f			-	29	-	
Gate input resistance	R_g	$f = 1\text{ MHz}$, open drain		0.5	-	3.5	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 		-	-	-11	A
Pulsed diode forward current ^a	I_{SM}			-	-	-44	
Body diode voltage	V_{SD}	$T_J = 25\text{ }^\circ\text{C}$, $I_S = -11\text{ A}$, $V_{GS} = 0\text{ V}^b$		-	-	-6.3	V
Body diode reverse recovery time	t_{rr}	$T_J = 25\text{ }^\circ\text{C}$, $I_F = -11\text{ A}$, $dI/dt = 100\text{ A}/\mu\text{s}^b$		-	100	200	ns
Body diode reverse recovery charge	Q_{rr}			-	0.32	0.64	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 $\leq 2\%$

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

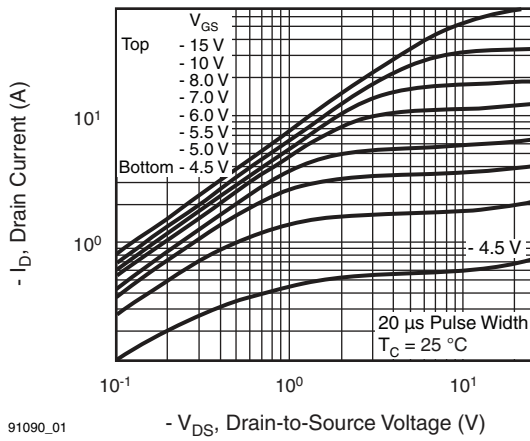


Fig. 1 - Typical Output Characteristics, $T_C = 25^\circ\text{C}$

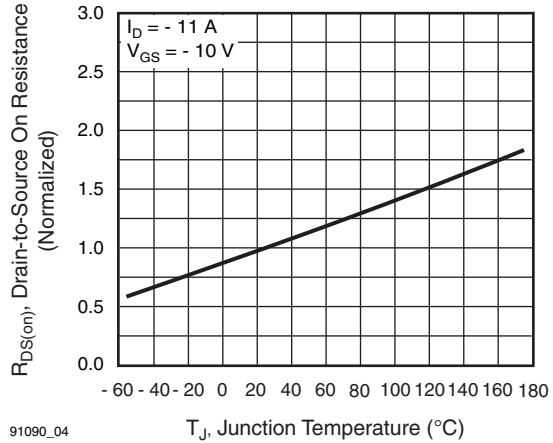


Fig. 4 - Normalized On-Resistance vs. Temperature

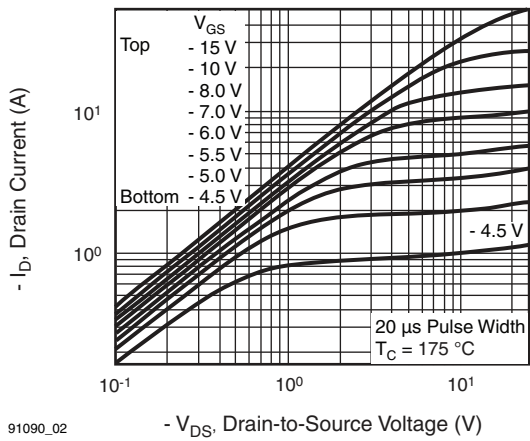


Fig. 2 - Typical Output Characteristics, $T_C = 175^\circ\text{C}$

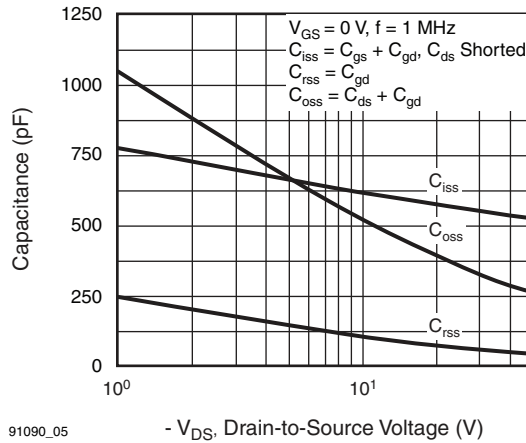


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

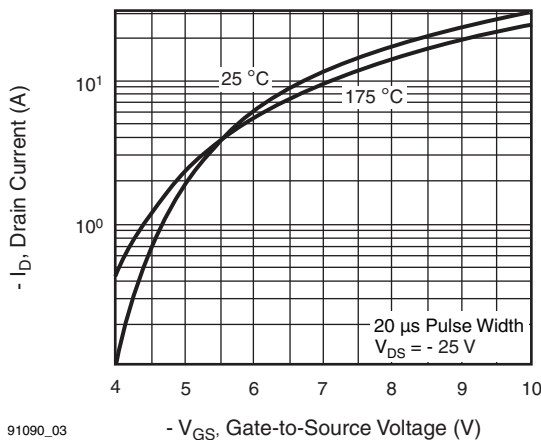


Fig. 3 - Typical Transfer Characteristics

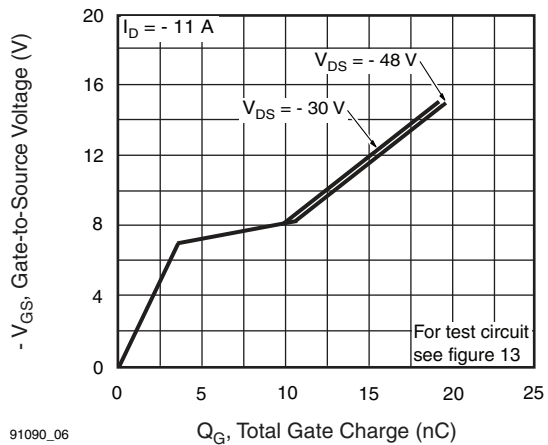
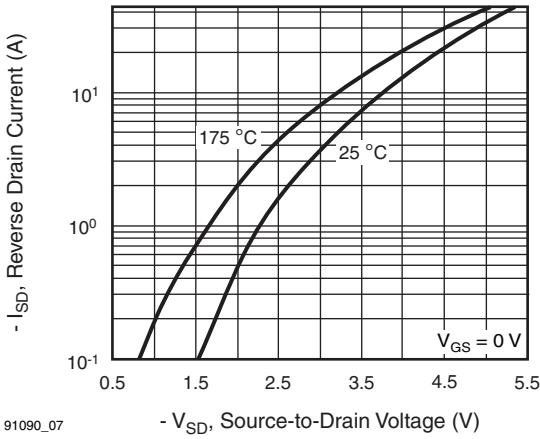
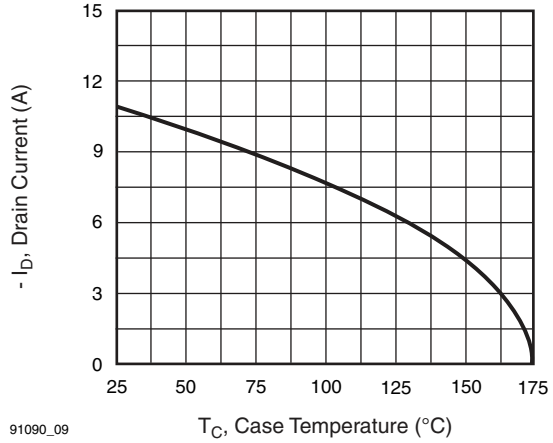


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage



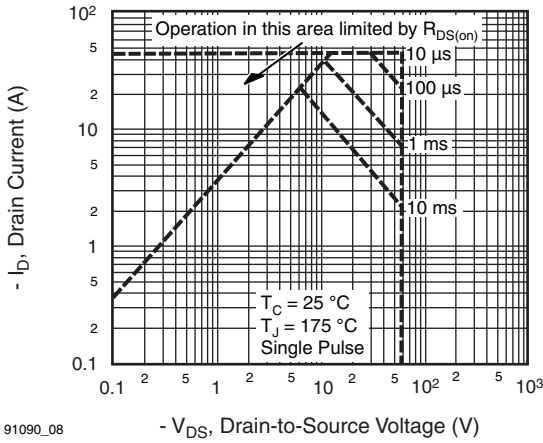
91090_07

Fig. 7 - Typical Source-Drain Diode Forward Voltage



91090_09

Fig. 9 - Maximum Drain Current vs. Case Temperature



91090_08

Fig. 8 - Maximum Safe Operating Area

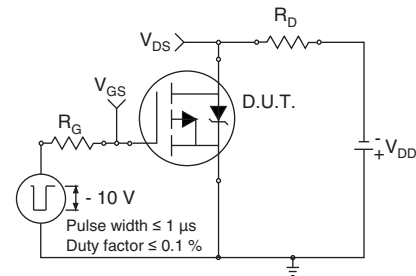


Fig. 10a - Switching Time Test Circuit

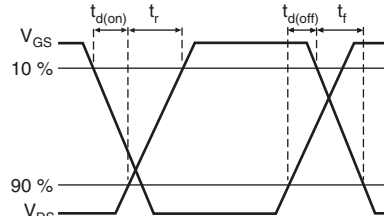
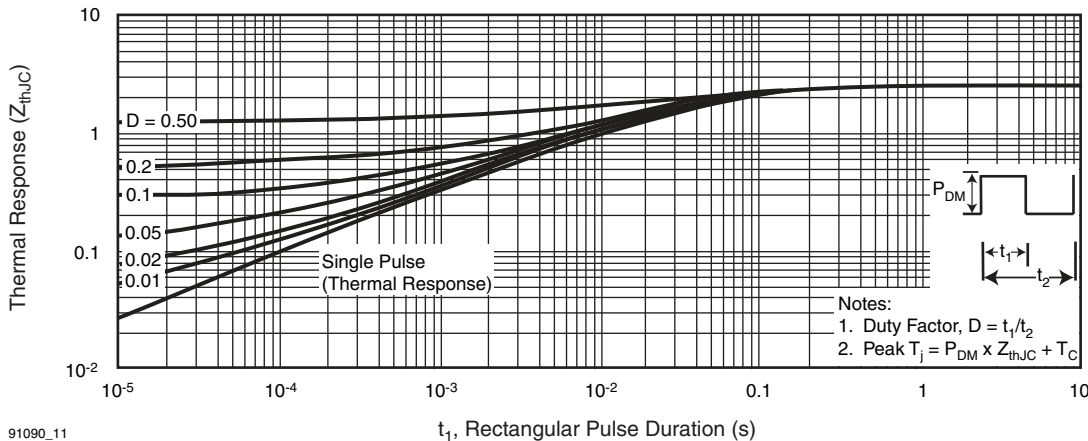


Fig. 10b - Switching Time Waveforms



91090_11

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

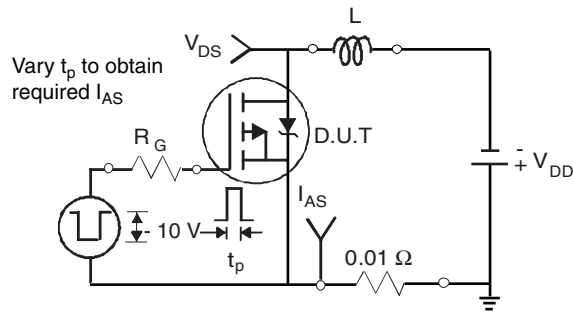


Fig. 12a - Unclamped Inductive Test Circuit

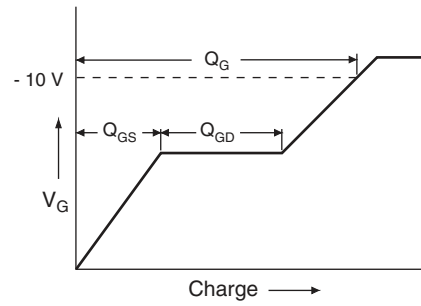


Fig. 13a - Basic Gate Charge Waveform

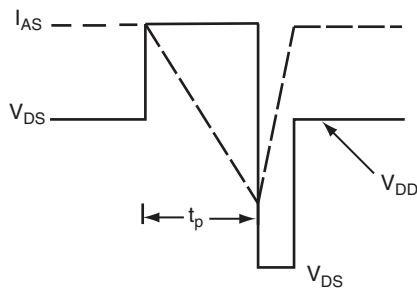


Fig. 12b - Unclamped Inductive Waveforms

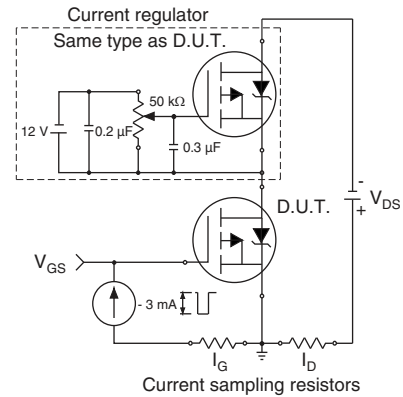


Fig 13b - Gate Charge Test Circuit

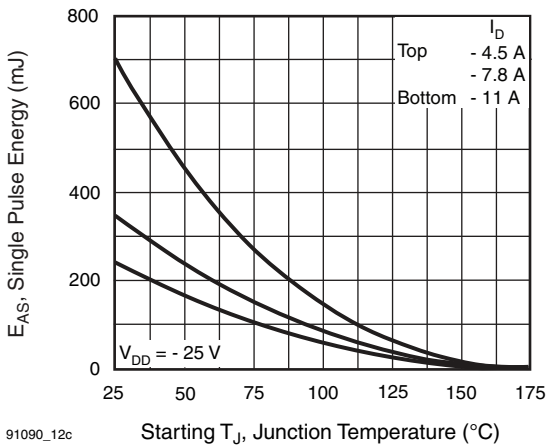
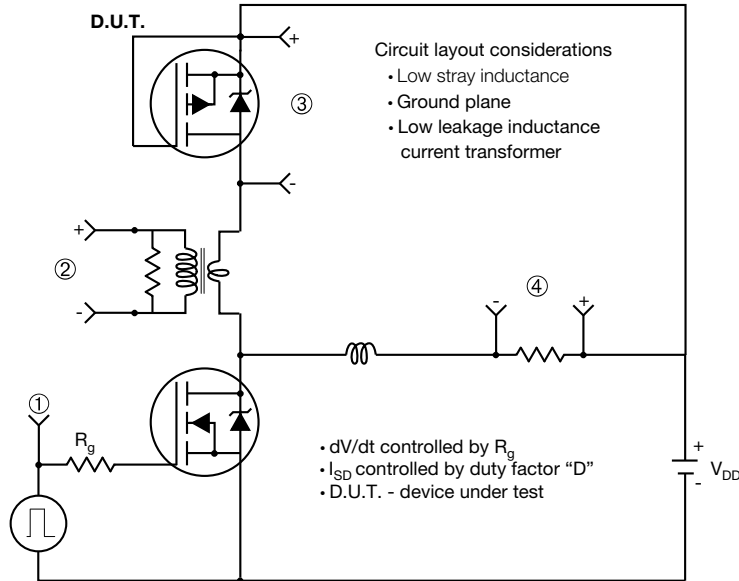


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

91090_12c

Peak Diode Recovery dV/dt Test Circuit



Note
• Compliment N-Channel of D.U.T. for driver



Note
a. $V_{GS} = -5 V$ for logic level and $-3 V$ drive devices

Fig. 14 - 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
$\varnothing P$	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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