

VBM165R09S Datasheet

N-Channel 650V (D-S) Super Junction Power MOSFET

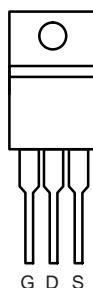
PRODUCT SUMMARY	
V_{DS} (V) at T_J max.	700
$R_{DS(on)}$ at 25 °C (Ω)	$V_{GS} = 10$ V 0.5
Q_g max. (nC)	25
Q_{gs} (nC)	2.0
Q_{gd} (nC)	2.7
Configuration	Single

FEATURES

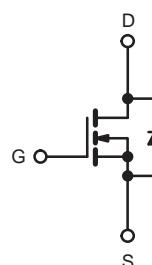
- Low figure-of-merit (FOM) $R_{on} \times Q_g$
- Low input capacitance (C_{iss})
- Reduced switching and conduction losses
- Ultra low gate charge (Q_g)
- Avalanche energy rated (UIS)



TO-220AB



Top View



N-Channel MOSFET

APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
 - High-intensity discharge (HID)
 - Fluorescent ballast lighting
- Industrial

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 ($T_J = 150$ °C)	V_{GS} at 10 V	I_D at $T_C = 25$ °C	9	A	
		I_D at $T_C = 100$ °C	6		
Pulsed Drain Current ^a		I_{DM}	21		
Linear Derating Factor			1.5	W/°C	
Single Pulse Avalanche Energy ^b		E_{AS}	186	mJ	
Maximum Power Dissipation		P_D	123	W	
Operating Junction and Storage Temperature Range		T_J, T_{stg}	-55 to +150	°C	
Drain-Source Voltage Slope	$T_J = 125$ °C	dV/dt	50	V/ns	
Reverse Diode dV/dt ^d			4.5		
Soldering Recommendations (Peak Temperature) ^c	for 10 s		300	°C	

Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$ V, starting $T_J = 25$ °C, $L = 28.2$ mH, $R_g = 25$ Ω, $I_{AS} = 3.5$ A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$, $dI/dt = 100$ A/μs, starting $T_J = 25$ °C.

THERMAL RESISTANCE RATINGS

PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	63	$^{\circ}\text{C}/\text{W}$
Maximum Junction-to-Case (Drain)	R_{thJC}	-	0.6	

SPECIFICATIONS (T_J = 25 °C, unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-Source Breakdown Voltage	V_{DS}	$V_{GS} = 0 \text{ V}$, $I_D = 250 \mu\text{A}$		650	-	-	V
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, $I_D = 1 \text{ mA}$		-	0.65	-	V/°C
Gate-Source Threshold Voltage (N)	$V_{GS(th)}$	$V_{DS} = V_{GS}$, $I_D = 250 \mu\text{A}$		2	-	4	V
Gate-Source Leakage	I_{GSS}	$V_{GS} = \pm 20 \text{ V}$		-	-	± 100	nA
		$V_{GS} = \pm 30 \text{ V}$		-	-	± 1	μA
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 600 \text{ V}$, $V_{GS} = 0 \text{ V}$		-	-	1	μA
		$V_{DS} = 520 \text{ V}$, $V_{GS} = 0 \text{ V}$, $T_J = 125 \text{ }^{\circ}\text{C}$		-	-	10	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10 \text{ V}$	$I_D = 4 \text{ A}$	-	0.50	-	Ω
Forward Transconductance	g_{fs}	$V_{DS} = 30 \text{ V}$, $I_D = 4 \text{ A}$		-	16	-	S
Dynamic							
Input Capacitance	C_{iss}	$V_{GS} = 0 \text{ V}$, $V_{DS} = 100 \text{ V}$, $f = 1 \text{ MHz}$		-	360	-	pF
Output Capacitance	C_{oss}			-	25	-	
Reverse Transfer Capacitance	C_{rss}			-	12	-	
Effective Output Capacitance, Energy Related ^a	$C_{o(er)}$	$V_{DS} = 0 \text{ V to } 520 \text{ V}$, $V_{GS} = 0 \text{ V}$		-	45	-	nC
Effective Output Capacitance, Time Related ^b	$C_{o(tr)}$			-	62	-	
Total Gate Charge	Q_g			-	25		
Gate-Source Charge	Q_{gs}	$V_{GS} = 10 \text{ V}$	$I_D = 4 \text{ A}$, $V_{DS} = 520 \text{ V}$	-	2.0	-	ns
Gate-Drain Charge	Q_{gd}			-	2.7	-	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 520 \text{ V}$, $I_D = 4 \text{ A}$, $V_{GS} = 10 \text{ V}$, $R_g = 9.1 \Omega$		-	25	-	ns
Rise Time	t_r			-	55	-	
Turn-Off Delay Time	$t_{d(off)}$			-	70	-	
Fall Time	t_f			-	40	-	
Gate Input Resistance	R_g	$f = 1 \text{ MHz}$, open drain		-	3.5	-	Ω
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p-n junction diode		-	-	7	A
Pulsed Diode Forward Current	I_{SM}			-	-	18	
Diode Forward Voltage	V_{SD}	$T_J = 25 \text{ }^{\circ}\text{C}$, $I_S = 4 \text{ A}$, $V_{GS} = 0 \text{ V}$		-	-	1.5	V
Reverse Recovery Time	t_{rr}	$T_J = 25 \text{ }^{\circ}\text{C}$, $I_F = I_S = 4 \text{ A}$, $dl/dt = 100 \text{ A}/\mu\text{s}$, $V_R = 400 \text{ V}$		-	190	-	ns
Reverse Recovery Charge	Q_{rr}			-	2.3	-	μC
Reverse Recovery Current	I_{RRM}			-	10	-	A

Notes

a. $C_{oss(er)}$ is a fixed capacitance that gives the same energy as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS} .
 b. $C_{oss(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS} .

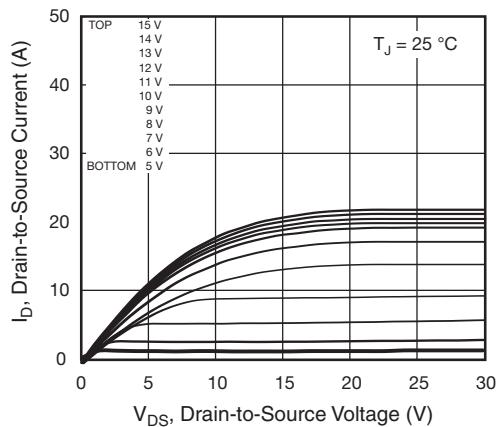
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)


Fig. 1 - Typical Output Characteristics

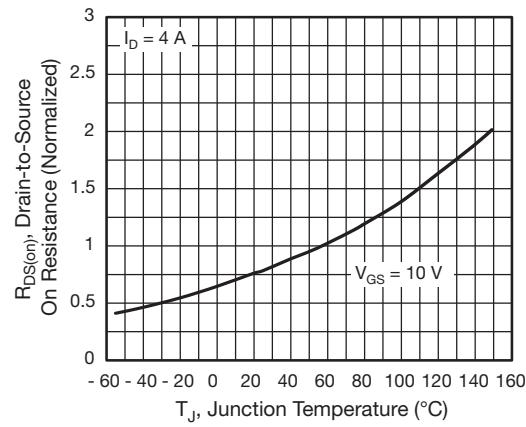


Fig. 4 - Normalized On-Resistance vs. Temperature

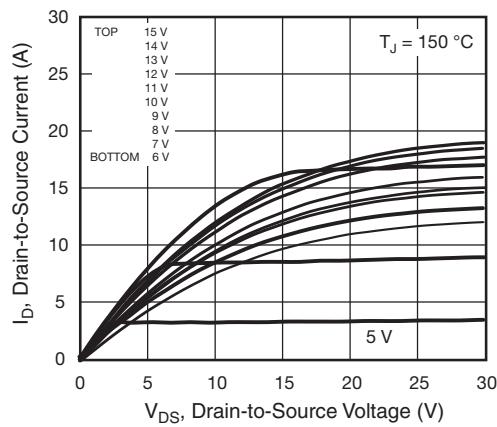


Fig. 2 - Typical Output Characteristics

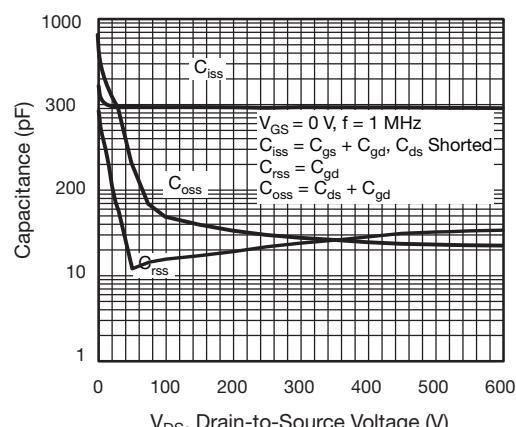


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

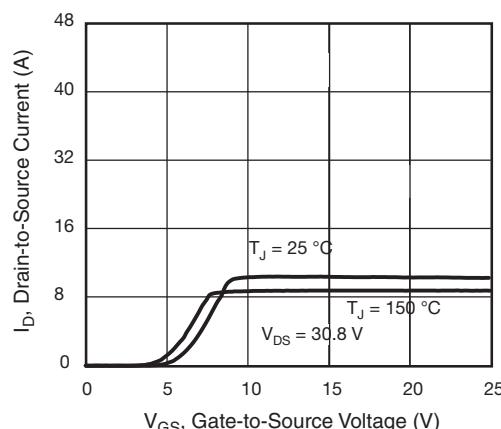


Fig. 3 - Typical Transfer Characteristics

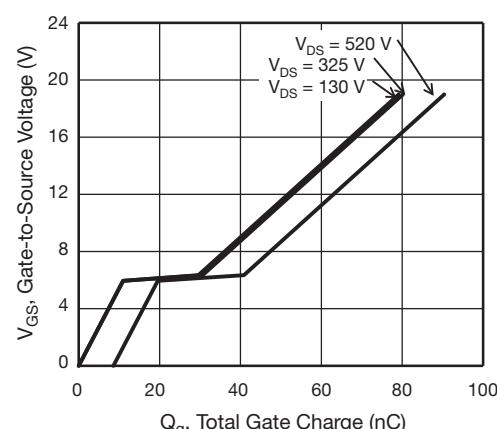


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

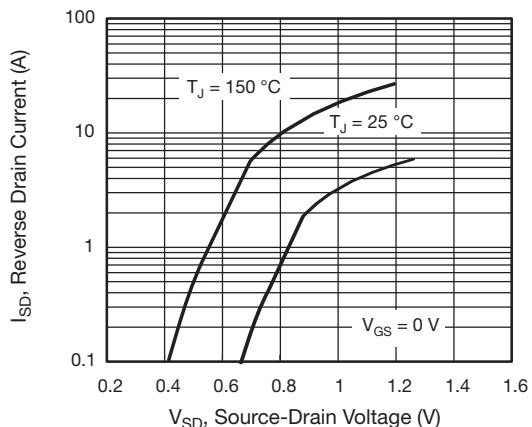


Fig. 7 - Typical Source-Drain Diode Forward Voltage

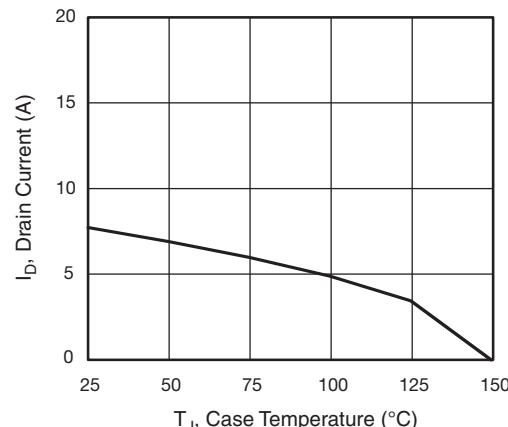


Fig. 9 - Maximum Drain Current vs. Case Temperature

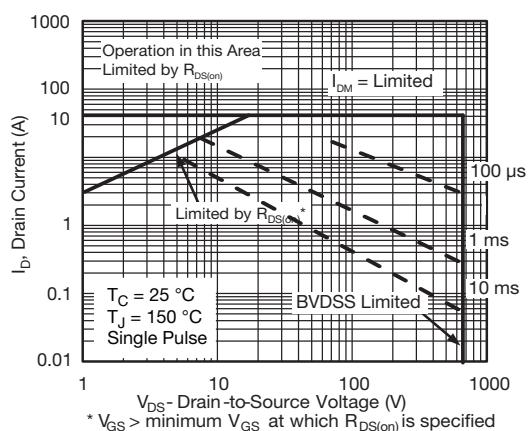


Fig. 8 - Maximum Safe Operating Area

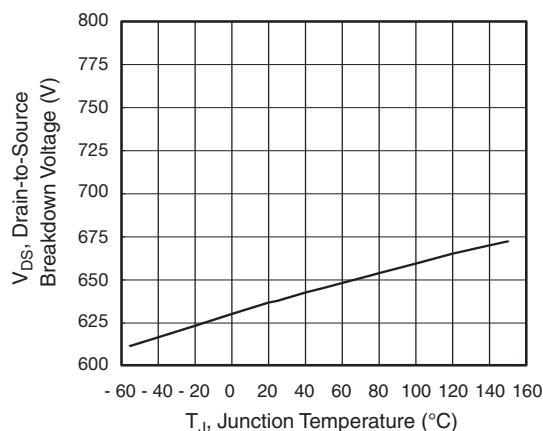


Fig. 10 - Temperature vs. Drain-to-Source Voltage

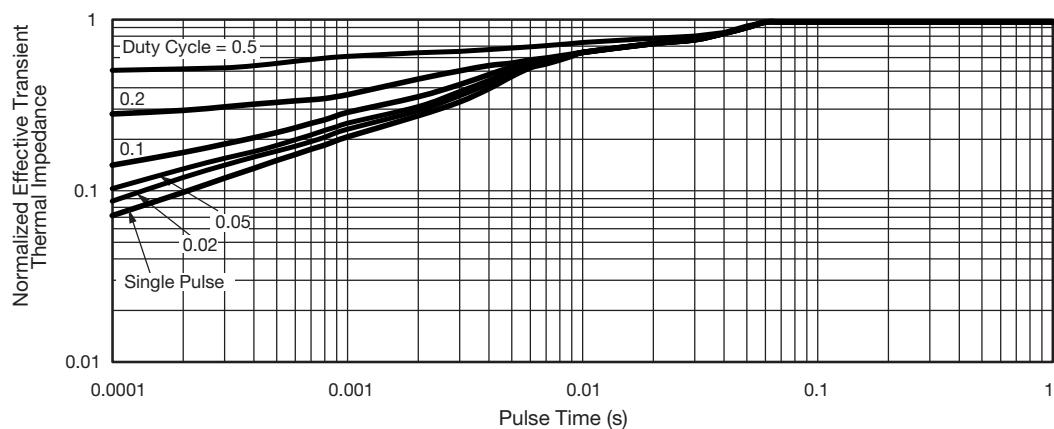


Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case

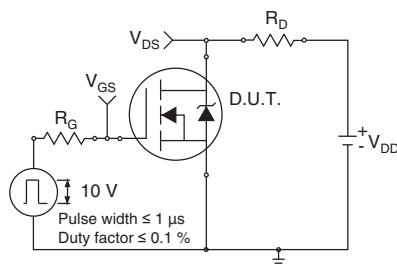


Fig. 12 - Switching Time Test Circuit

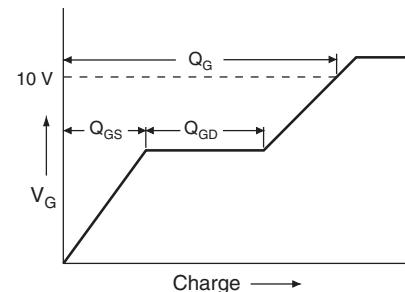


Fig. 16 - Basic Gate Charge Waveform

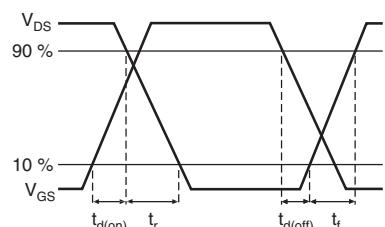


Fig. 13 - Switching Time Waveforms

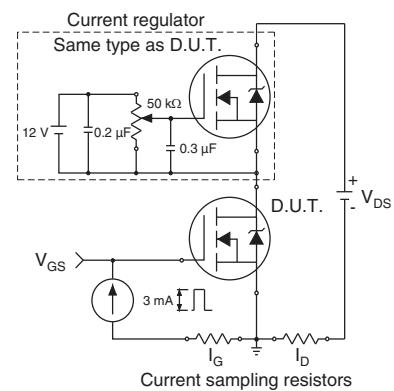


Fig. 17 - Gate Charge Test Circuit

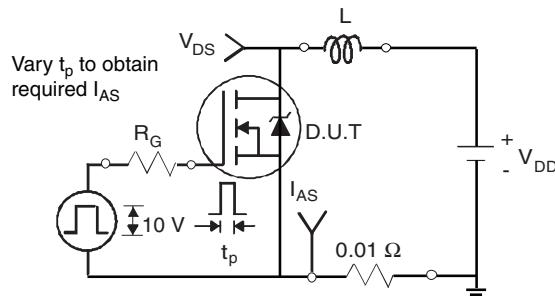


Fig. 14 - Unclamped Inductive Test Circuit

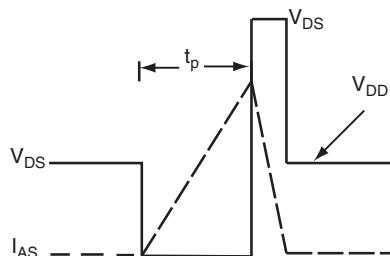
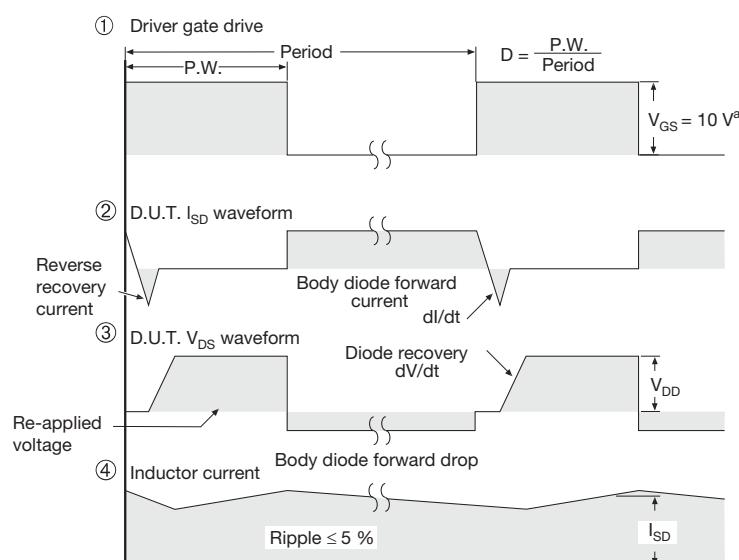
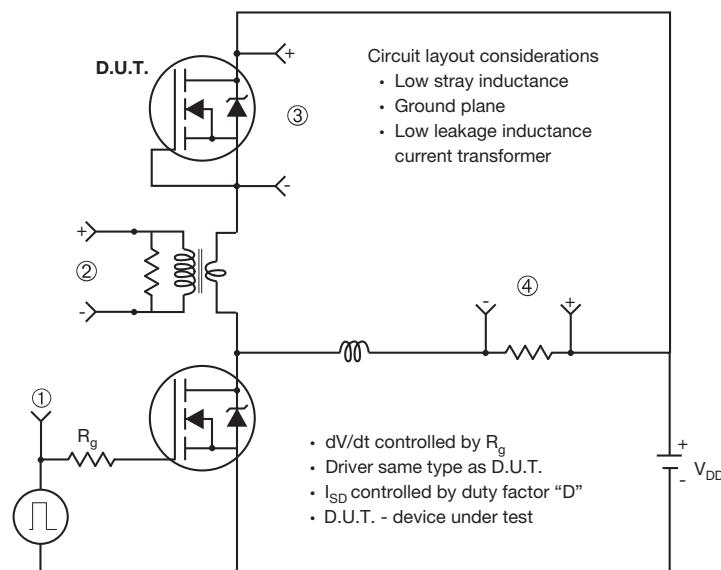


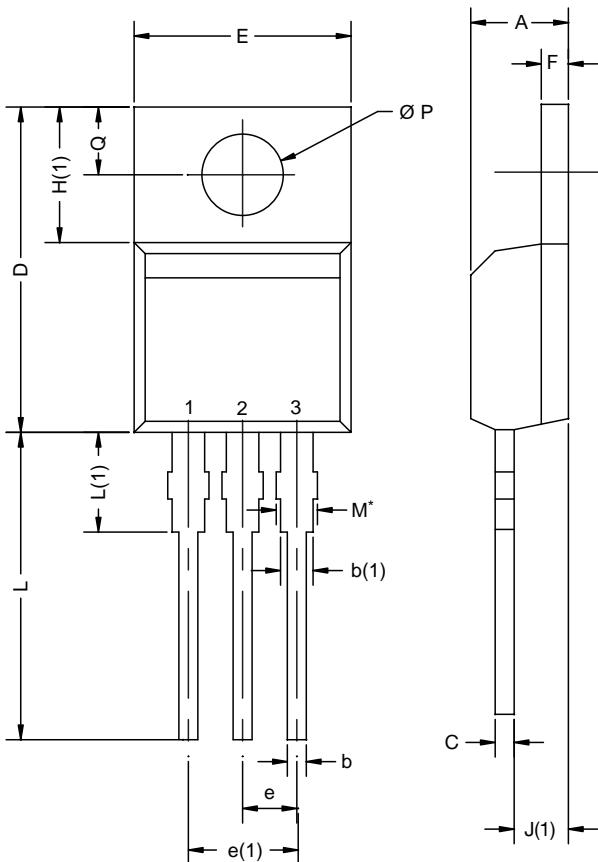
Fig. 15 - Unclamped Inductive Waveforms

Peak Diode Recovery dV/dt Test Circuit

Note

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

Fig. 18 - For N-Channel

TO-220AB



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.25	4.65	0.167	0.183
b	0.69	1.01	0.027	0.040
b(1)	1.20	1.73	0.047	0.068
c	0.36	0.61	0.014	0.024
D	14.85	15.49	0.585	0.610
E	10.04	10.51	0.395	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)	6.09	6.48	0.240	0.255
J(1)	2.41	2.92	0.095	0.115
L	13.35	14.02	0.526	0.552
L(1)	3.32	3.82	0.131	0.150
Ø P	3.54	3.94	0.139	0.155
Q	2.60	3.00	0.102	0.118

Notes

* M = 1.32 mm to 1.62 mm (dimension including protrusion)
Heatsink hole for HVM

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