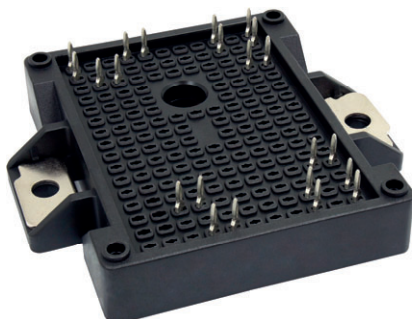


EMIPAK-2B PressFit Power Module

Double Interleaved Boost Converter, 15 A



EMIPAK-2B
(package example)

FEATURES

- Trench IGBT technology
- HEXFRED clamping diode technology
- Rectifier bypass diode
- PressFit pins technology
- Exposed Al_2O_3 substrate with low thermal resistance
- Integrated thermistor
- 10 μs short circuit capability
- Square RBSOA
- Low internal inductances
- Low switching loss
- PressFit pins locking technology. Patent # US.263.820 B2
- UL approved file E78996 
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



RoHS
COMPLIANT

PRODUCT SUMMARY

RECTIFIER BYPASS DIODE	
V_{RRM}	1200 V
V_{FM} typical at $I_F = 20$ A	1.04 V
I_F at $T_C = 80$ °C	62 A
PFC IGBT	
V_{CES}	1200 V
$V_{CE(ON)}$ typical at $I_C = 15$ A	2.61 V
I_C at $T_C = 80$ °C	15 A
Speed (max.)	20 kHz
Speed	8 kHz to 30 kHz
Package	EMIPAK-2B
Circuit	Double interleaved boost converter

DESCRIPTION

VS-ETL015Y120H is an integrated solution for a double interleaved boost converter. The EMIPAK-2B package is easy to use thanks to the PressFit pins and the exposed substrate provides improved thermal performance. The optimized layout also helps to minimize stray parameters, allowing for better EMI performance.

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Operating junction temperature	T_J		150	°C
Storage temperature range	T_{Stg}		-40 to +150	
RMS isolation voltage	V_{ISOL}	$T_J = 25$ °C, all terminals shorted, $f = 50$ Hz, $t = 1$ s	3500	V
DbpA - DbpB BYPASS DIODE				
Repetitive peak reverse voltage	V_{RRM}		1200	V
Continuous output current	I_F	$T_C = 25$ °C	94	A
		$T_C = 80$ °C	62	
		$T_{SINK} = 80$ °C	39	
Surge current (non- repetitive)	I_{FSM}	Rated V_{RRM} applied	250	
Power dissipation	P_D	$T_C = 25$ °C	167	W
		$T_C = 80$ °C	93	

PATENT(S): www.vishay.com/patents

This Vishay product is protected by one or more United States and International patents.

**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT				
Collector to emitter voltage	V _{CES}		1200	V
Gate to emitter voltage	V _{GES}		20	
Pulsed collector current	I _{CM}		40	A
Clamped inductive load current	I _{LM} ⁽¹⁾		40	
Continuous collector current	I _C	T _C = 25 °C	22	A
		T _C = 80 °C	15	
		T _{SINK} = 80 °C	11	
Power dissipation	P _D	T _C = 25 °C	89	W
		T _C = 80 °C	50	
Da1 - Da2 - Db1 - Db2 CLAMPING DIODE				
Repetitive peak reverse voltage	V _{RRM}		1200	V
Single pulse forward current	I _{FSM}	10 ms sine or 6 ms rectangular pulse, T _J = 25 °C	95	A
Diode continuous forward current	I _F	T _C = 25 °C	22	
		T _C = 80 °C	14	
		T _{SINK} = 80 °C	10	
Power dissipation	P _D	T _C = 25 °C	80	W
		T _C = 80 °C	45	
DTa1 - DTa2 - DTb1 - DTb2 AP DIODE				
Single pulse forward current	I _{FSM}	10 ms sine or 6 ms rectangular pulse, T _J = 25 °C	95	A
Diode continuous forward current	I _F	T _C = 25 °C	22	
		T _C = 80 °C	14	
		T _{SINK} = 80 °C	10	
Power dissipation	P _D	T _C = 25 °C	80	W
		T _C = 80 °C	45	

Notes

- Absolute Maximum Ratings indicate sustained limits beyond which damage to the device may occur.

⁽¹⁾ $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, $R_g = 4.7\text{ }\Omega$, $T_J = 150\text{ }^{\circ}\text{C}$

ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
DbpA - DbpB BYPASS DIODE						
Reverse leakage current	I _{RRM}	V _{RRM} = 1200 V	-	-	0.14	mA
		V _{RRM} = 1200 V, T _J = 150 °C	-	-	3.0	
Forward voltage drop	V _{FM}	I _F = 20 A	-	1.04	1.23	V
		I _F = 20 A, T _J = 150 °C	-	0.95	-	
Forward slope resistance	r _t	T _J = 150 °C	-	-	6.6	mΩ
Conduction threshold voltage	V _T		-	-	0.73	V
Ta1 - Ta2 -Tb1 - Tb2 PFC IGBT						
Collector to emitter breakdown voltage	BV _{CES}	V _{GE} = 0 V, I _C = 250 μA	1200	-	-	V
Collector to emitter voltage	V _{CE(ON)}	V _{GE} = 15 V, I _C = 15 A	-	2.61	3.03	
		V _{GE} = 15 V, I _C = 15 A, T _J = 125 °C	-	3.05	-	
Gate threshold voltage	V _{GE(th)}	V _{CE} = V _{GE} , I _C = 400 μA	4.5	5.8	8.1	
Temperature coefficient of threshold voltage	ΔV _{GE(th)} /ΔT _J	V _{CE} = V _{GE} , I _C = 1.0 mA (25 °C to 125 °C)	-	-14	-	mV/°C
Forward transconductance	g _{fe}	V _{CE} = 20 V, I _C = 15 A	-	8	-	S
Transfer characteristics	V _{GE}	V _{CE} = 20 V, I _C = 15 A	-	10	-	V
Zero gate voltage collector current	I _{CES}	V _{GE} = 0 V, V _{CE} = 1200 V	-	0.0003	0.075	mA
		V _{GE} = 0 V, V _{CE} = 1200 V, T _J = 125 °C	-	0.24	-	
Gate to emitter leakage current	I _{GES}	V _{GE} = ± 20 V, V _{CE} = 0 V	-	-	± 200	nA



ELECTRICAL SPECIFICATIONS (T _J = 25 °C unless otherwise noted)						
Da1 - Da2 - Db1 - Db2 CLAMPING DIODE						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Cathode to anode blocking voltage	V _{BR}	I _R = 100 μA	1200	-	-	V
Forward voltage drop	V _{FM}	I _F = 10 A	-	2.09	2.77	
		I _F = 10 A, T _J = 125 °C	-	2.16	-	
Reverse leakage current	I _{RM}	V _R = 1200 V	-	0.0004	0.075	mA
		V _R = 1200 V, T _J = 125 °C	-	0.25	-	
DTa1 - DTa2 - DTb1 - DTb2 AP DIODE						
Forward voltage drop	V _{FM}	I _F = 20 A	-	2.59	3.25	V
		I _F = 20 A T _J = 125 °C	-	2.86	-	

SWITCHING CHARACTERISTICS ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
PFC IGBT (WITH FREEWHEELING CLAMPING DIODE)						
Total gate charge (turn-on)	Q_g	$I_C = 9\text{ A}$ $V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}$	-	45	-	nC
Gate to emitter charge (turn-on)	Q_{ge}		-	8.7	-	
Gate to collector charge (turn-on)	Q_{gc}		-	20	-	
Turn-on switching loss	E_{ON}	$I_C = 15\text{ A}$ $V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 4.7\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$ ⁽¹⁾	-	0.95	-	mJ
Turn-off switching loss	E_{OFF}		-	0.47	-	
Total switching loss	E_{TOT}		-	1.42	-	
Turn-on delay time	$t_{d(on)}$		-	23	-	ns
Rise time	t_r		-	22	-	
Turn-off delay time	$t_{d(off)}$		-	58	-	
Fall time	t_f		-	178	-	
Turn-on switching loss	E_{ON}	$I_C = 15\text{ A}$ $V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 4.7\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$ $T_J = 125\text{ }^{\circ}\text{C}$ ⁽¹⁾	-	1.18	-	mJ
Turn-off switching loss	E_{OFF}		-	0.72	-	
Total switching loss	E_{TOT}		-	1.89	-	
Turn-on delay time	$t_{d(on)}$		-	24	-	ns
Rise time	t_r		-	23	-	
Turn-off delay time	$t_{d(off)}$		-	60	-	
Fall time	t_f		-	219	-	
Input capacitance	C_{ies}	$V_{GE} = 0\text{ V}$ $V_{CC} = 30\text{ V}$ $f = 1\text{ MHz}$	-	1070	-	pF
Output capacitance	C_{oes}		-	63	-	
Reverse transfer capacitance	C_{res}		-	26	-	
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^{\circ}\text{C}, I_C = 40\text{ A}, V_{CC} = 600\text{ V}, V_P = 1200\text{ V}, R_g = 4.7\text{ }\Omega, V_{GE} = 15\text{ V to }0\text{ V}$	Fullsquare			
Short circuit safe operating area	SCSOA	$R_g = 22\text{ }\Omega, V_{CC} = 900\text{ V}, V_P = 1200\text{ V}, V_{GE} = 15\text{ V to }0$	-	-	10	μs
Da1 - Da2 - Db1 - Db2 CLAMPING DIODE						
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$ $I_F = 10\text{ A}$ $di/dt = 500\text{ A}/\mu\text{s}$	-	103	-	ns
Diode peak reverse current	I_{rr}		-	14	-	A
Diode recovery charge	Q_{rr}		-	711	-	nC
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$ $I_F = 10\text{ A}$ $di/dt = 500\text{ A}/\mu\text{s}, T_J = 125\text{ }^{\circ}\text{C}$	-	126	-	ns
Diode peak reverse current	I_{rr}		-	17	-	A
Diode recovery charge	Q_{rr}		-	1047	-	nC

**SWITCHING CHARACTERISTICS** ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
DTa1 - DTa2 - DTb1 - DTb2 AP DIODE						
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$ $I_F = 20\text{ A}$ $dI/dt = 500\text{ A}/\mu\text{s}$	-	127	-	ns
Diode peak reverse current	I_{rr}		-	16	-	A
Diode recovery charge	Q_{rr}		-	1020	-	nC
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$ $I_F = 20\text{ A}$ $dI/dt = 500\text{ A}/\mu\text{s}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	153	-	ns
Diode peak reverse current	I_{rr}		-	19	-	A
Diode recovery charge	Q_{rr}		-	1464	-	nC

Note

(1) Energy losses include "tail" and diode reverse recovery.

INTERNAL NTC - THERMISTOR SPECIFICATIONS

PARAMETER	SYMBOL	TEST CONDITIONS	VALUE	UNITS
Resistance	R_{25}	$T_C = 25\text{ }^{\circ}\text{C}$	5000	Ω
	R_{100}	$T_C = 100\text{ }^{\circ}\text{C}$	$493 \pm 5\%$	
B-value	$B_{25/50}$	$R_2 = R_{25} \exp. [B_{25/50} (1/T_2 - 1/(298.15\text{ K}))]$	$3375 \pm 5\%$	K
Maximum operating temperature			220	$^{\circ}\text{C}$
Dissipation constant			2	mW/ $^{\circ}\text{C}$
Thermal time constant			8	s

THERMAL AND MECHANICAL SPECIFICATIONS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
DbpA - DbpB Bypass diode - Junction to case thermal resistance (per diode)	R_{thJC}	-	-	0.75	$^{\circ}\text{C}/\text{W}$
Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT - Junction to case thermal resistance (per switch)		-	-	1.4	
Da1 - Da2 - Db1 - Db2 Clamping diode - Junction to case thermal resistance (per diode)		-	-	1.56	
DTa1 - DTa2 - DTb1 - DTb2 AP diode - Junction to case thermal resistance (per diode)		-	-	1.56	
DbpA - DbpB Bypass diode - Case to sink thermal resistance (per diode)	$R_{thCS}^{(1)}$	-	0.63	-	
Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT - Case to sink thermal resistance (per switch)		-	0.96	-	
Da1 - Da2 - Db1 - Db2 Clamping diode - Case to sink thermal resistance (per diode)		-	1.1	-	
DTa1 - DTa2 - DTb1 - DTb2 AP diode - Case to sink thermal resistance (per diode)		-	1.1	-	
Case to sink thermal resistance per module		-	0.1	-	
Mounting torque (M4)		2	-	3	Nm
Weight		-	45	-	g

Note

(1) Mounting surface flat, smooth, and greased

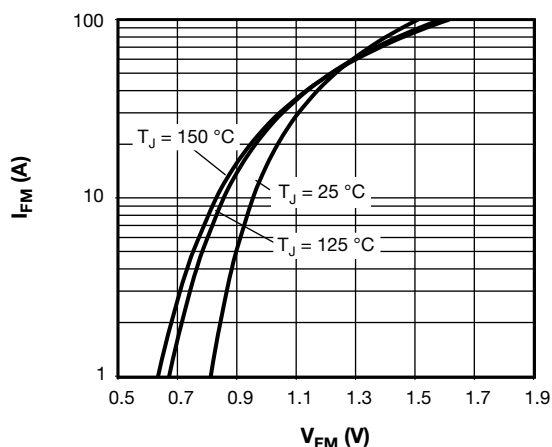


Fig. 1 - Typical DbpA -DbpB Bypass Diode Forward Characteristics

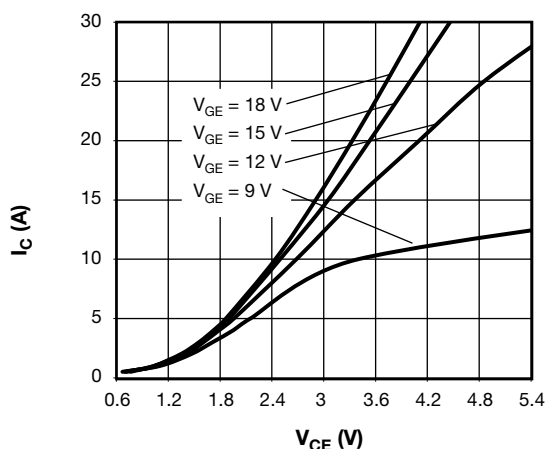
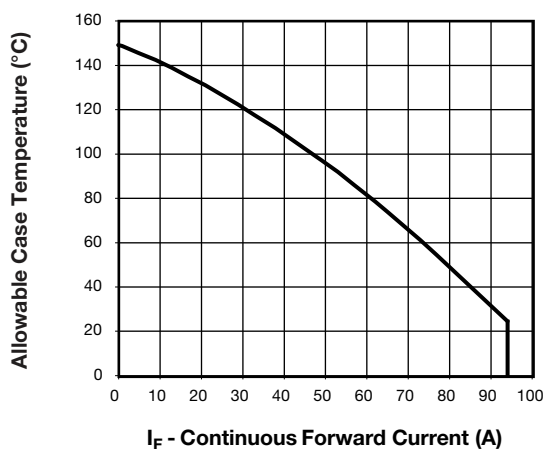
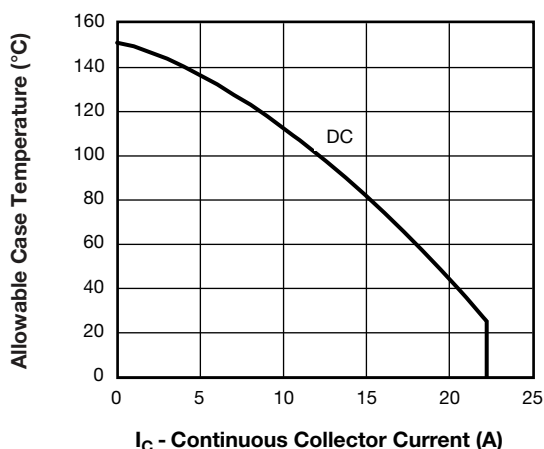


Fig. 4 - Typical Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT Output Characteristics, $T_J = 125\text{ °C}$



I_F - Continuous Forward Current (A)
Fig. 2 - Maximum DbpA -DbpB Bypass Diode Forward Current vs. Case Temperature



I_C - Continuous Collector Current (A)
Fig. 5 - Maximum Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT Continuous Collector Current vs. Case Temperature

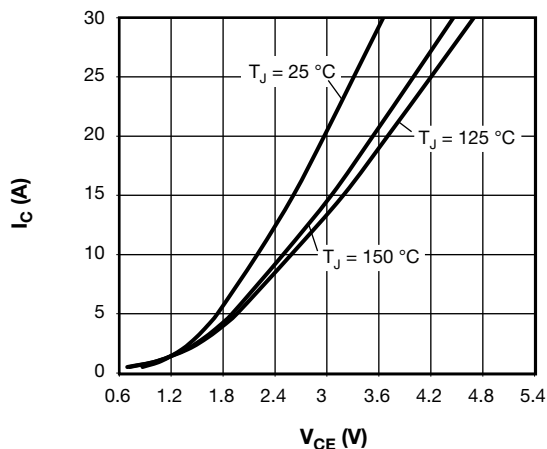


Fig. 3 - Typical Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT Output Characteristics, $V_{GE} = 15\text{ V}$

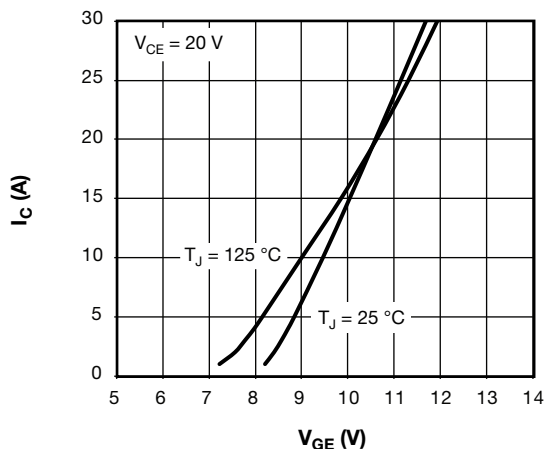


Fig. 6 - Typical Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT Transfer Characteristics

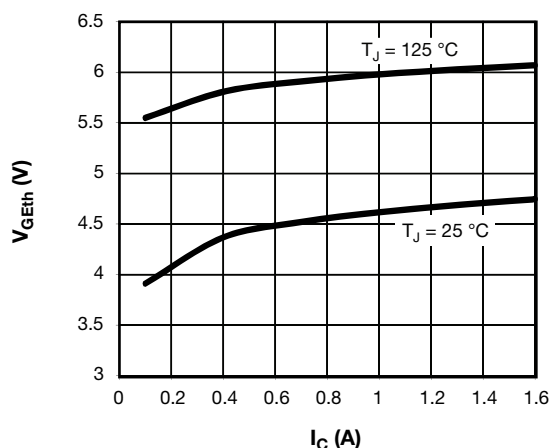


Fig. 7 - Typical Q1 - Q4 Trench IGBT Energy Loss vs. I_C
(with D5 - D6 Clamping Diode)
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 300\text{ V}$, $R_g = 4.7\text{ }\Omega$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$

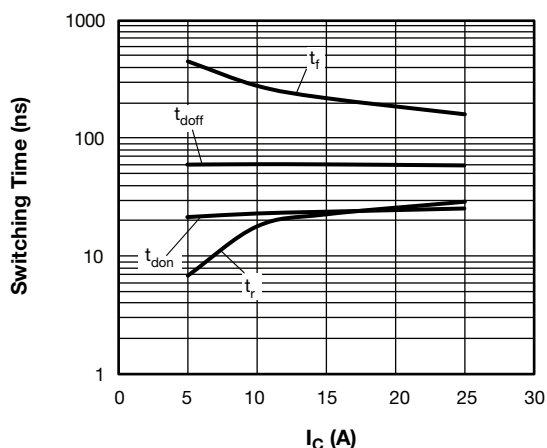


Fig. 10 - Typical PFC IGBT Switching Time vs. I_C
(with Freewheeling Clamping Diode)
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\text{ }\Omega$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$

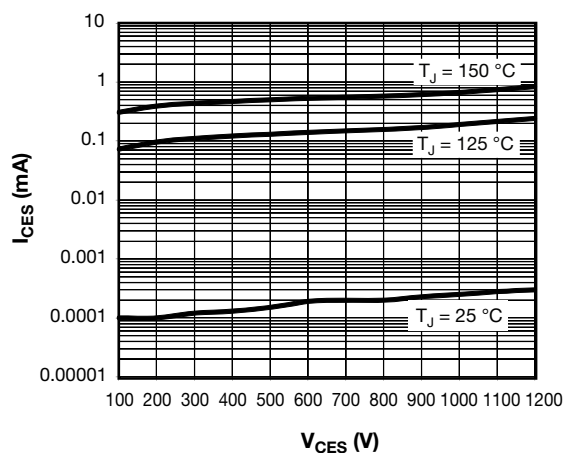


Fig. 8 - Typical Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT
Zero Gate Voltage Collector Current

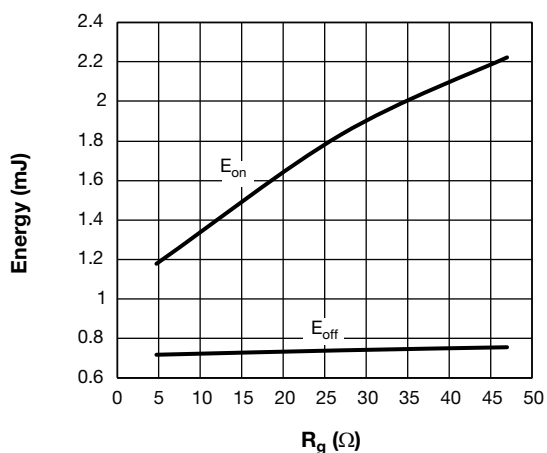


Fig. 11 - Typical PFC IGBT Energy Loss vs. R_g
(with Freewheeling Clamping Diode)
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 15\text{ A}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$

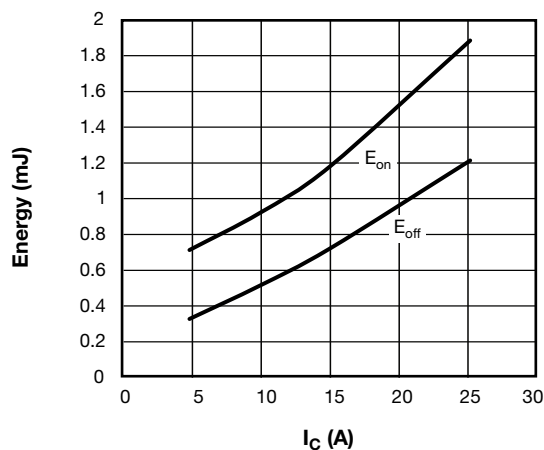


Fig. 9 - Typical PFC IGBT Energy Loss vs. I_C
(with Freewheeling Clamping Diode)
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\text{ }\Omega$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$

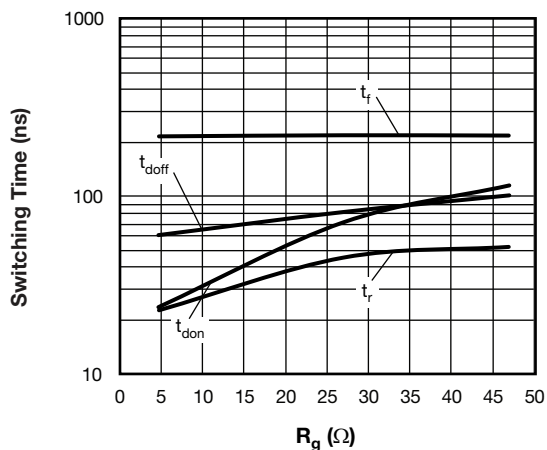


Fig. 12 - Typical PFC IGBT Switching Time vs. R_g
(with Freewheeling Clamping Diode)
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 15\text{ A}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$

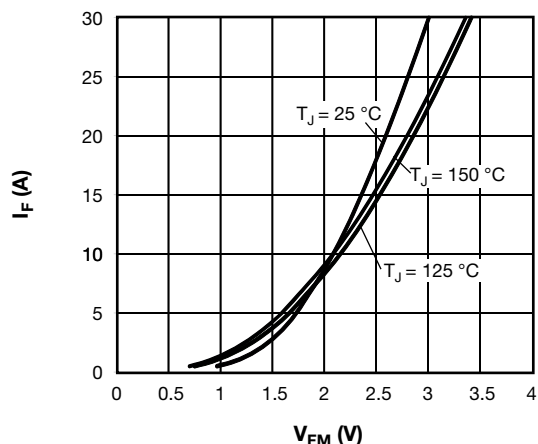


Fig. 13 - Typical Da1 - Da2 - Db1 - Db2 Clamping Diode Forward Characteristics

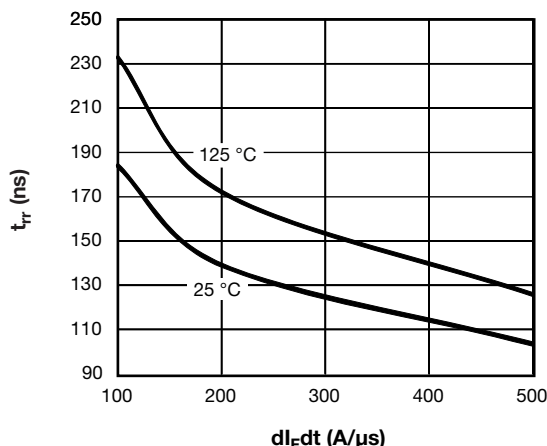


Fig. 16 - Typical Da1 - Da2 - Db1 - Db2 Clamping Diode Reverse Recovery Time vs. dI_F/dt , $V_{rr} = 400\text{ V}$, $I_F = 10\text{ A}$

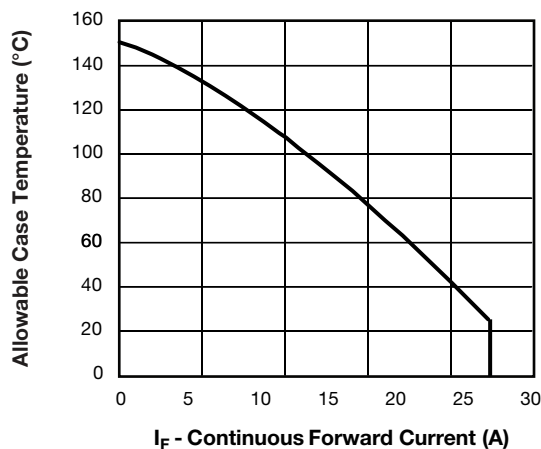


Fig. 14 - Maximum Da1 - Da2 - Db1 - Db2 Clamping Diode Forward Current vs. Case Temperature

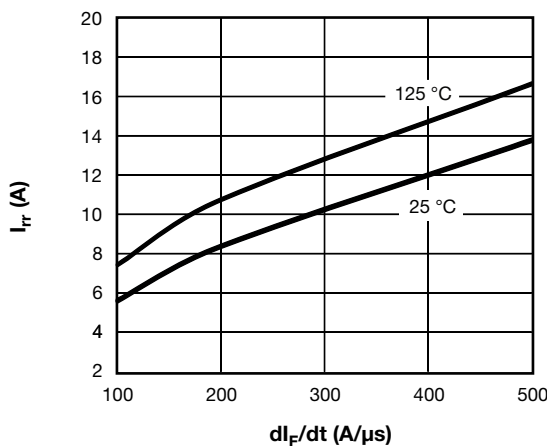


Fig. 17 - Typical Da1 - Da2 - Db1 - Db2 Clamping Diode Reverse Recovery Current vs. dI_F/dt , $V_{rr} = 400\text{ V}$, $I_F = 10\text{ A}$

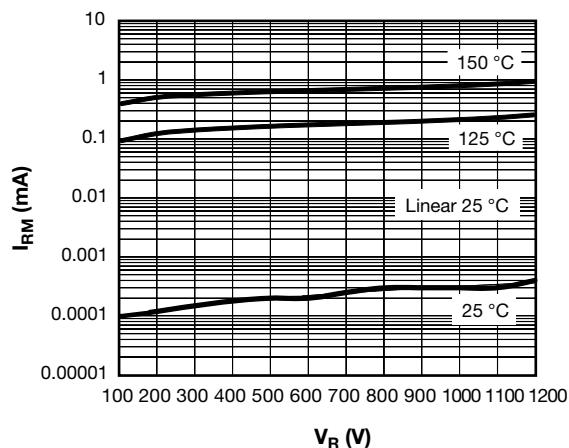


Fig. 15 - Typical Da1 - Da2 - Db1 - Db2 Clamping Diode Reverse Leakage Current

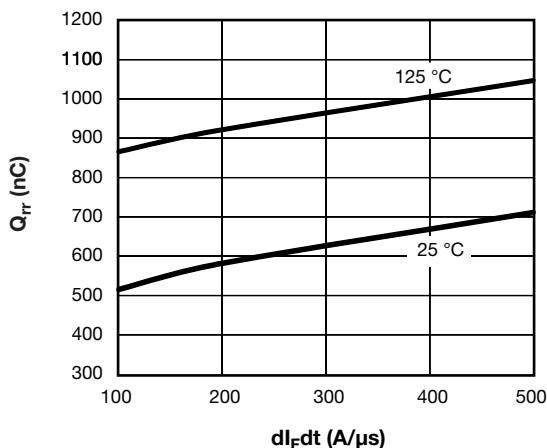


Fig. 18 - Typical Da1 - Da2 - Db1 - Db2 Clamping Diode Reverse Recovery Charge vs. dI_F/dt , $V_{rr} = 400\text{ V}$, $I_F = 10\text{ A}$

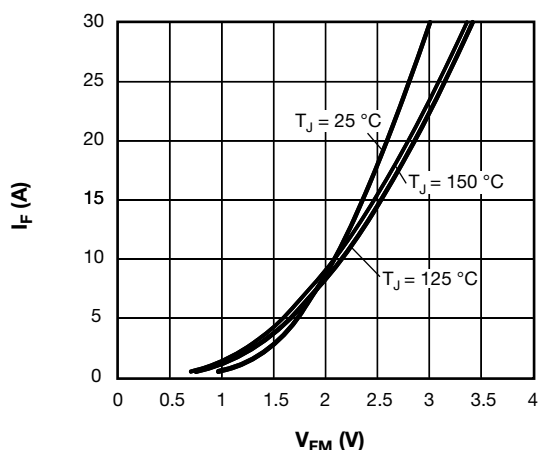


Fig. 19 - Typical DTa1 - DTa2 - DTb1 - DTb2 Antiparallel Diode Forward Characteristics

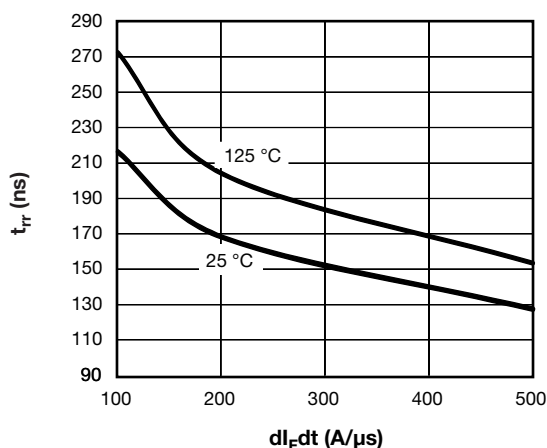


Fig. 21 - Typical DTa1 - DTa2 - DTb1 - DTb2 Antiparallel Diode Reverse Recovery Time vs. dI_F/dt
 $V_{rr} = 400\text{ V}$, $I_F = 20\text{ A}$

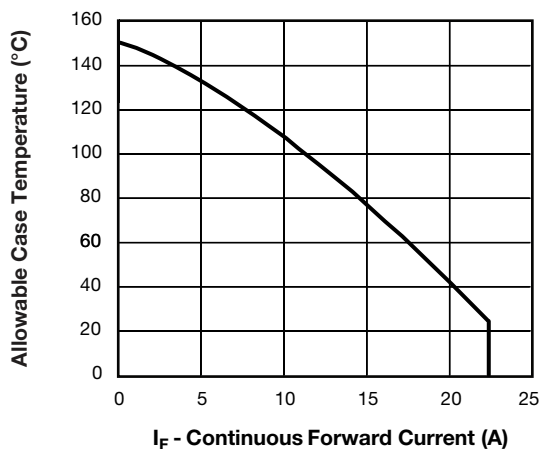


Fig. 20 - Maximum DTa1 - DTa2 - DTb1 - DTb2 Antiparallel Diode Forward Current vs. Case Temperature

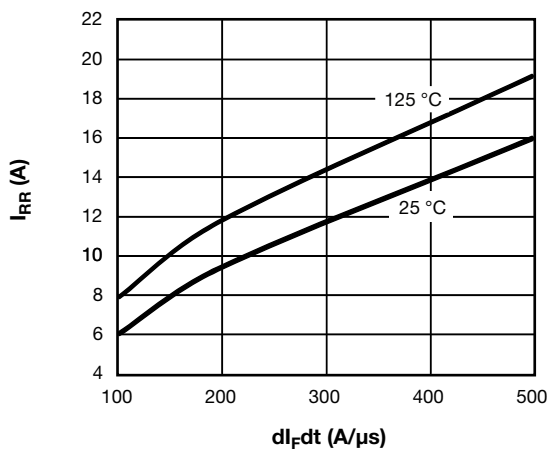


Fig. 22 - Typical DTa1 - DTa2 - DTb1 - DTb2 Antiparallel Diode Reverse Recovery Current vs. dI_F/dt
 $V_{rr} = 400\text{ V}$, $I_F = 10\text{ A}$

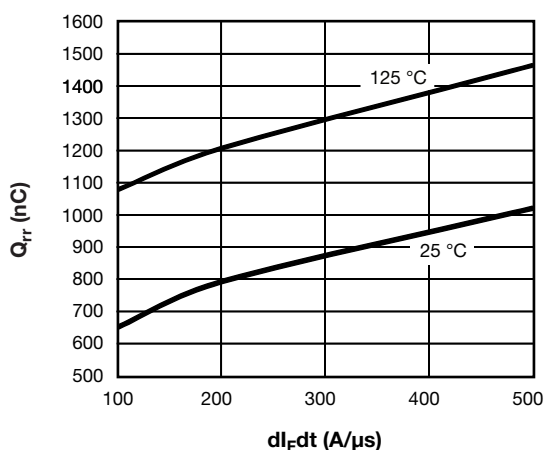


Fig. 23 - Typical DTa1 - DTa2 - DTb1 - DTb2 Antiparallel Diode Reverse Recovery Charge vs. dI_F/dt
 $V_{rr} = 400\text{ V}$, $I_F = 20\text{ A}$

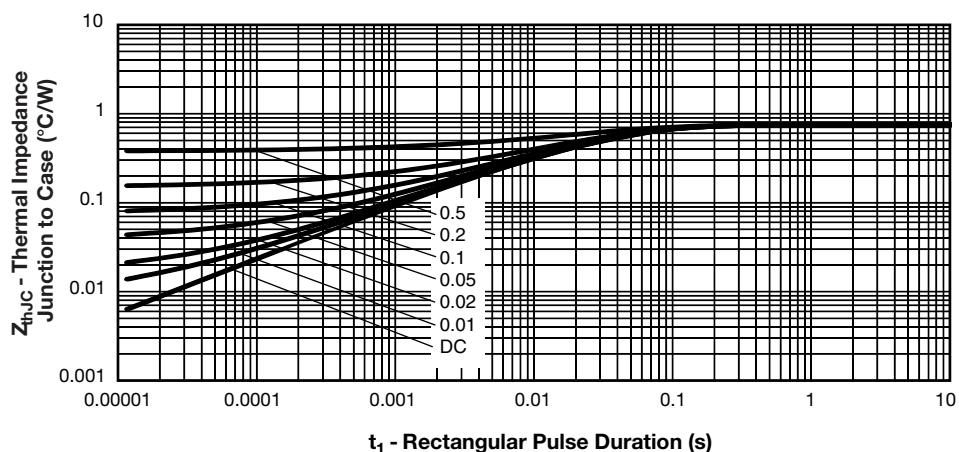


Fig. 24 - Maximum Thermal Impedance Z_{thJC} Characteristics (DbPa - DbpB Bypass Diode)

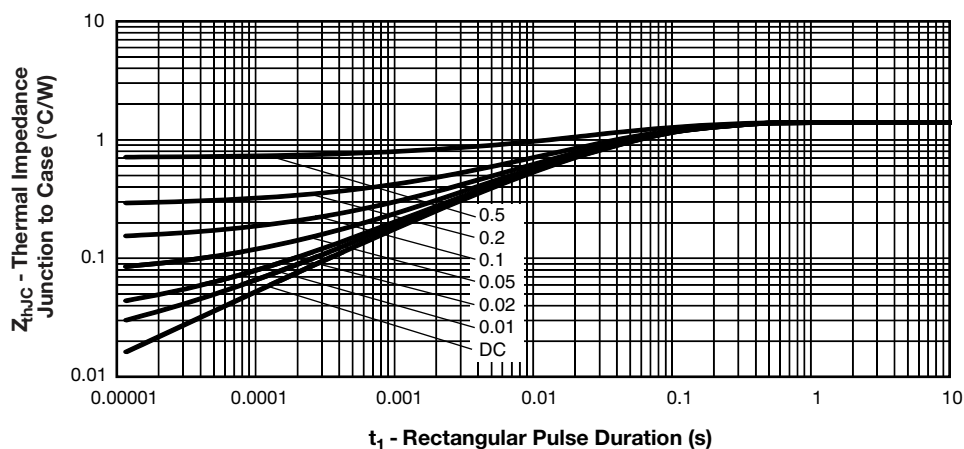


Fig. 25 - Maximum Thermal Impedance Z_{thJC} Characteristics (Ta1 - Ta2 - Tb1 - Tb2 PFC IGBT)

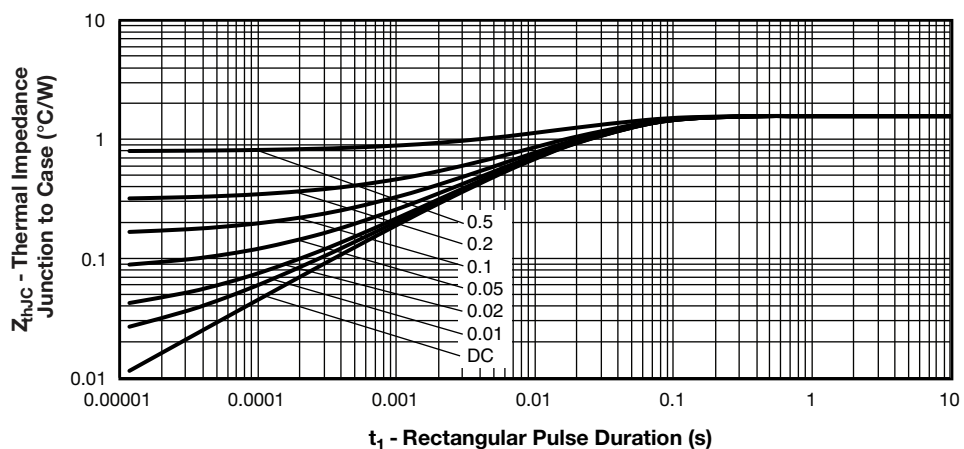


Fig. 26 - Maximum Thermal Impedance Z_{thJC} Characteristics (Da1 - Da2 - Db1 - Db2 Clamping diode)

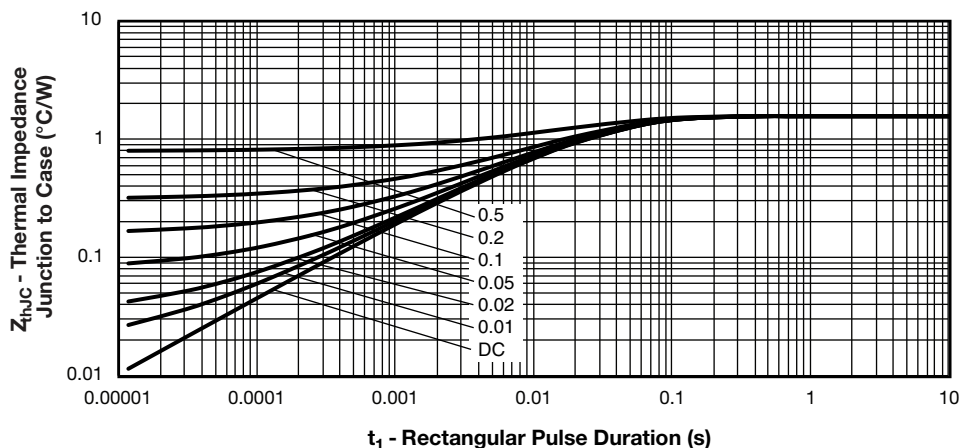


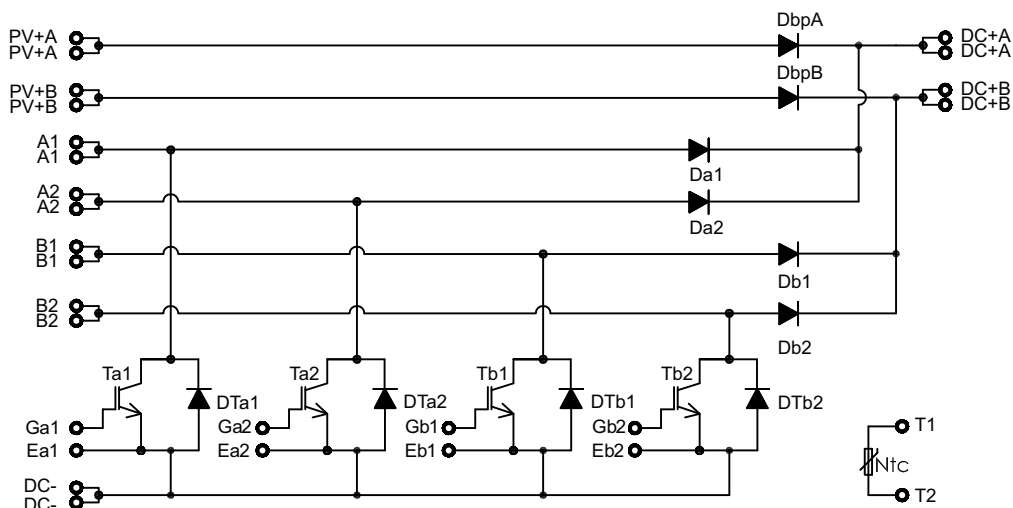
Fig. 27 - Maximum Thermal Impedance Z_{thJC} Characteristics (DTa1 - DTa2 - DTb1 - DTb2 Antiparallel Diode)

ORDERING INFORMATION TABLE

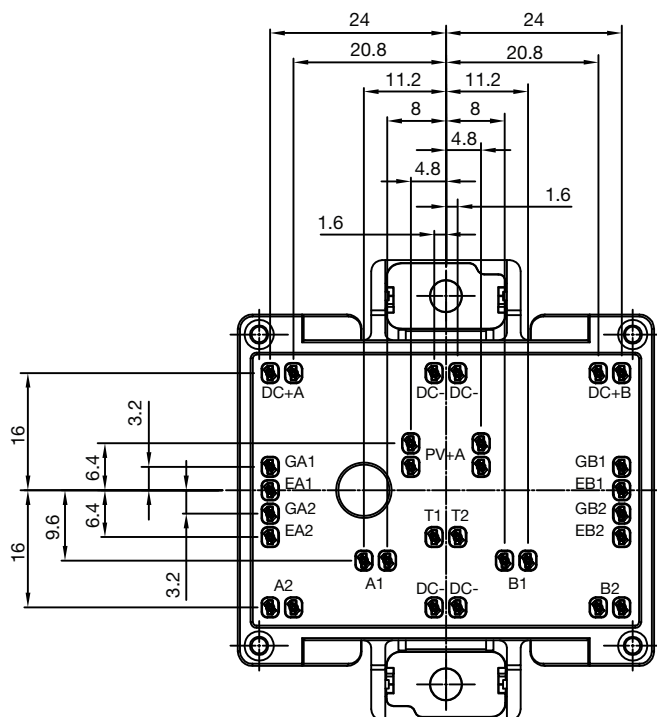
Device code	VS-	ET	L	015	Y	120	H
	①	②	③	④	⑤	⑥	⑦

- 1** - Vishay Semiconductors product
- 2** - Package indicator (ET = EMIPAK-2B)
- 3** - Circuit configuration (L = double interleaved boost converter)
- 4** - Current rating (015 = 15 A)
- 5** - Switch die technology (Y = trench IGBT)
- 6** - Voltage rating (120 = 1200 V)
- 7** - Diode die technology (H = HEXFRED diode)

CIRCUIT CONFIGURATION



PACKAGE



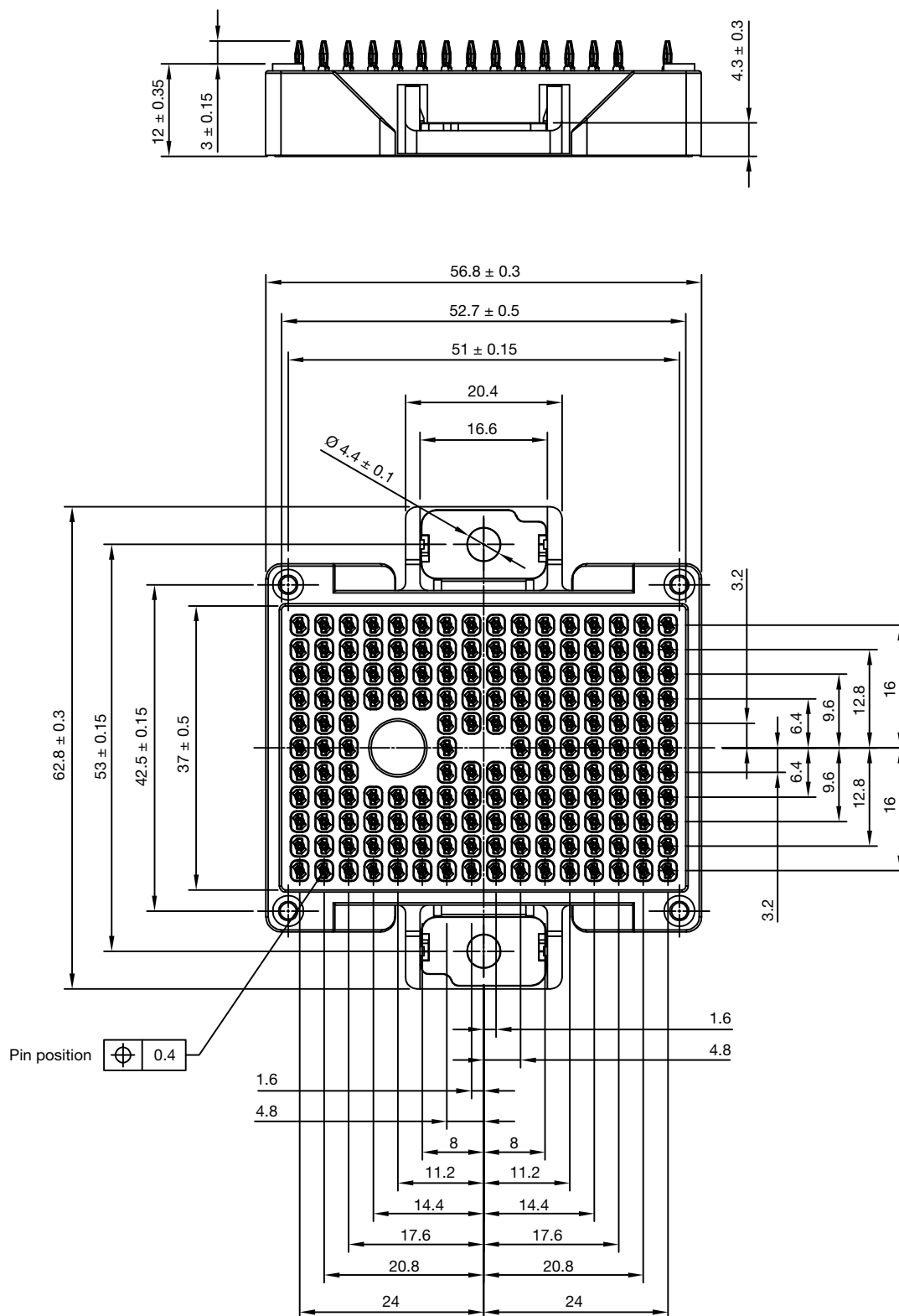
LINKS TO RELATED DOCUMENTS

LINKS TO RELATED DOCUMENTS	
Dimensions	www.vishay.com/doc?95559



EMIPAK-2B PressFit

DIMENSIONS in millimeters





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