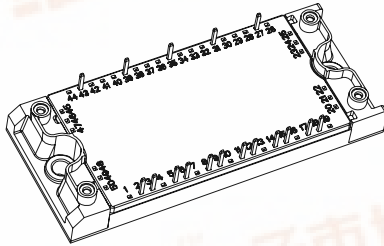


## IGBT Sixpack Module, 35 A


**ECONO2 6PACK**


PRODUCT SUMMARY	
$V_{CES}$	1200 V
$V_{CE(on)}$ (typical)	2.40 V
$t_{sc}$ at $T_J = 150\text{ }^\circ\text{C}$	> 10 $\mu\text{s}$
$I_C$ at $T_C = 80\text{ }^\circ\text{C}$	35 A

### FEATURES

- Low diode  $V_F$
- 10  $\mu\text{s}$  short circuit capability
- Square RBSOA
- Low  $V_{CE(on)}$  non punch through IGBT technology
- HEXFRED<sup>®</sup> antiparallel diode with ultrasoft reverse recovery characteristics
- Positive  $V_{CE(on)}$  temperature coefficient
- Ceramic DBC substrate
- Low stray inductance design
- Speed 8 to 60 kHz
- Totally lead (Pb)-free
- Designed and qualified for industrial market


**RoHS**  
COMPLIANT

### BENEFITS

- Benchmark efficiency for motor control
- Rugged transient performance
- Low EMI, requires less snubbing
- Direct mounting to heatsink
- PCB solderable terminals
- Low junction to case thermal resistance
- UL approved E78996 

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		1200	V
Continuous collector current	$I_C$	$T_C = 25\text{ }^\circ\text{C}$	50	A
		$T_C = 80\text{ }^\circ\text{C}$	35	
Pulsed collector current See fig. C.T.5	$I_{CM}$		100	
Clamped inductive load current	$I_{LM}$		100	
Diode continuous forward current	$I_F$	$T_C = 25\text{ }^\circ\text{C}$	50	
		$T_C = 80\text{ }^\circ\text{C}$	35	
Pulsed diode maximum forward current	$I_{FM}$		100	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Maximum power dissipation (IGBT and DIODE)	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	284	W
		$T_C = 80\text{ }^\circ\text{C}$	159	
Maximum operating junction temperature	$T_J$		150	$^\circ\text{C}$
Storage temperature range	$T_{Stg}$		- 40 to + 125	
Isolation voltage	$V_{ISOL}$		AC 2500 (minimum)	V

# GB35XF120K



Vishay High Power Products IGBT Sixpack Module, 35 A

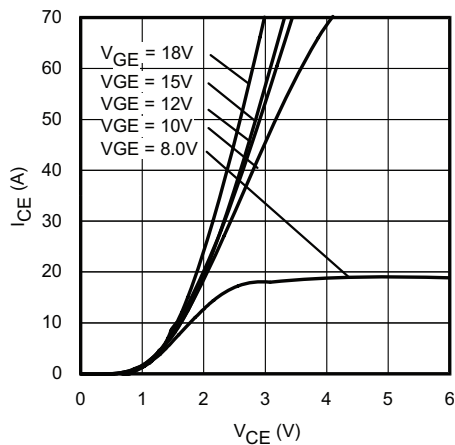
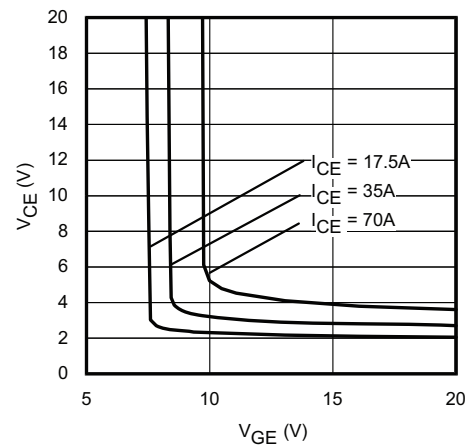
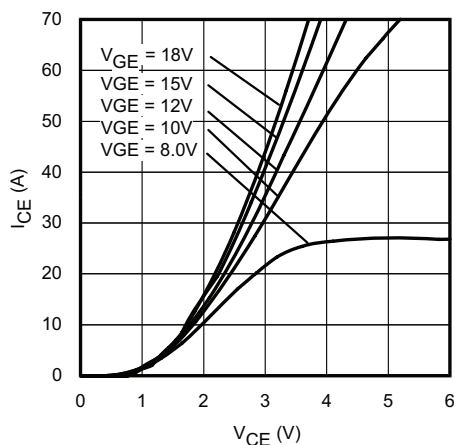
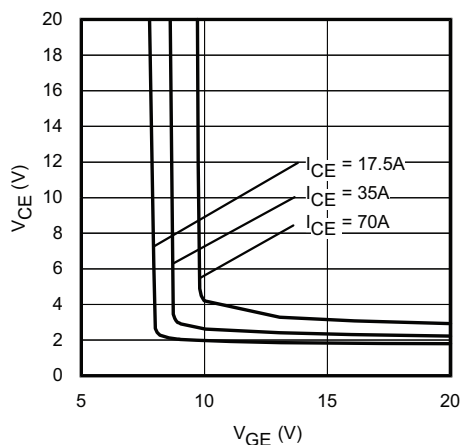
<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$BV_{(CES)}$	$V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$	1200	-	-	V
Temperature coefficient of breakdown voltage	$\Delta V_{(BR)CES}/\Delta T_J$	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$ (25 °C to 125 °C)	-	0.7	-	V/°C
Collector to emitter voltage	$V_{CE(ON)}$	$I_C = 35\text{ A}, V_{GE} = 15\text{ V}$	-	2.40	2.60	V
		$I_C = 50\text{ A}, V_{GE} = 15\text{ V}$	-	2.75	3.00	
		$I_C = 35\text{ A}, V_{GE} = 15\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	2.80	-	
		$I_C = 50\text{ A}, V_{GE} = 15\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	3.30	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	4.0	5.25	6.0	
Threshold voltage temperature coefficient	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$ (25 °C to 125 °C)	-	- 11	-	mV/°C
Zero gate voltage collector current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}$	-	-	100	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	500	-	
Diode forward voltage drop	$V_{FM}$	$I_F = 35\text{ A}$	-	1.90	2.35	V
		$I_F = 50\text{ A}$	-	2.15	2.65	
		$I_F = 35\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.00	-	
		$I_F = 50\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.35	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 200$	nA

<b>SWITCHING CHARACTERISTICS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Total gate charge (turn-on)	$Q_G$	$I_C = 35\text{ A}$	-	255	385	nC
Gate to emitter charge (turn-on)	$Q_{GE}$	$V_{CC} = 600\text{ V}$	-	25	40	
Gate to collector charge (turn-on)	$Q_{GC}$	$V_{GE} = 15\text{ V}$	-	125	90	
Turn-on switching loss	$E_{on}$	$I_C = 35\text{ A}, V_{CC} = 600\text{ V}$	-	2.70	4.08	mJ
Turn-off switching loss	$E_{off}$	$V_{GE} = 15\text{ V}, R_G = 10\text{ }\Omega, L = 400\text{ }\mu\text{H}$	-	2.50	3.78	
Total switching loss	$E_{tot}$	$T_J = 25\text{ }^\circ\text{C}$ <sup>(1)</sup>	-	5.20	7.85	
Turn-on switching loss	$E_{on}$	$I_C = 35\text{ A}, V_{CC} = 600\text{ V}$	-	3.75	5.45	
Turn-off switching loss	$E_{off}$	$V_{GE} = 15\text{ V}, R_G = 10\text{ }\Omega, L = 400\text{ }\mu\text{H}$	-	3.68	5.10	
Total switching loss	$E_{tot}$	$T_J = 125\text{ }^\circ\text{C}$ <sup>(1)</sup>	-	7.43	10.55	
Turn-on delay time	$t_{d(ON)}$	$I_C = 35\text{ A}, V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}, R_G = 10\text{ }\Omega, L = 400\text{ }\mu\text{H}$ $T_J = 125\text{ }^\circ\text{C}$	-	50	65	ns
Rise time	$t_r$		-	35	50	
Turn-off delay time	$t_{d(OFF)}$		-	415	560	
Fall time	$t_f$		-	230	300	
Input capacitance	$C_{ies}$	$V_{GE} = 0\text{ V}$	-	3475	-	pF
Output capacitance	$C_{oes}$	$V_{CC} = 30\text{ V}$	-	615	-	
Reverse transfer capacitance	$C_{res}$	$f = 1\text{ MHz}$	-	90	-	
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 100\text{ A}$ $R_G = 10\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}$	Fullsquare			
Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C}$ $V_{CC} = 900\text{ V}, V_P = 1200\text{ V}$ $R_G = 10\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}$	10	-	-	$\mu\text{s}$
Diode peak reverse recovery current	$I_{rr}$	$T_J = 125\text{ }^\circ\text{C}$ $V_{CC} = 600\text{ V}, I_F = 35\text{ A}, L = 400\text{ }\mu\text{H}$ $V_{GE} = 15\text{ V}, R_G = 10\text{ }\Omega$	-	73	-	A

**Note**

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

THERMAL AND MECHANICAL SPECIFICATIONS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Junction to case IGBT	$R_{thJC}$	-	-	0.44	°C/W
Junction to case DIODE		-	-	0.80	
Case to sink, flat, greased surface MODULE	$R_{thCS}$	-	0.05	-	
Mounting torque (M5)		2.7	-	3.3	Nm
Weight		-	170	-	g


 Fig. 1 - Typical IGBT Output Characteristics  
 $T_J = 25\text{ °C}$ ;  $t_p = 80\ \mu\text{s}$ 

 Fig. 3 - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25\text{ °C}$ 

 Fig. 2 - Typical IGBT Output Characteristics  
 $T_J = 125\text{ °C}$ ;  $t_p = 80\ \mu\text{s}$ 

 Fig. 4 - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 125\text{ °C}$

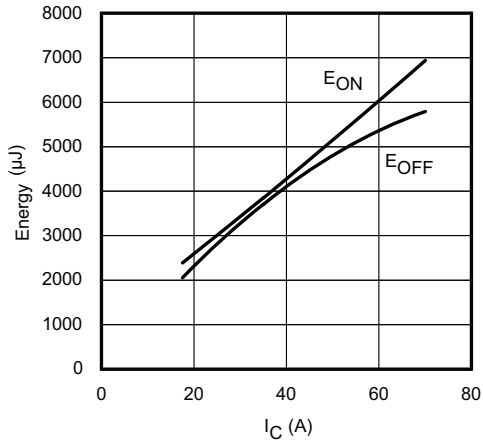


Fig. 5 - Typical Energy Loss vs.  $I_C$   
 $T_J = 125\text{ }^\circ\text{C}$ ;  $L = 400\text{ }\mu\text{H}$ ;  $V_{CE} = 600\text{ V}$   
 $R_G = 10\text{ }\Omega$ ;  $V_{GE} = 15\text{ V}$

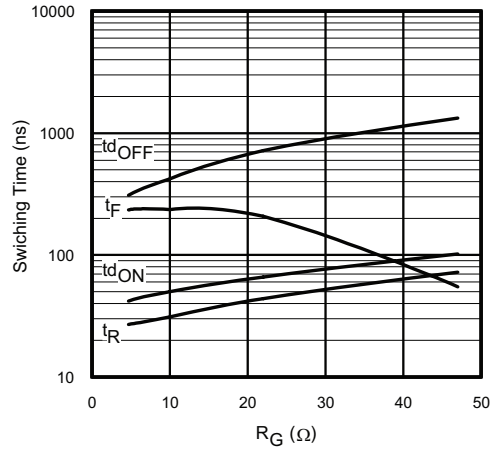


Fig. 8 - Typical Switching Time vs.  $R_G$   
 $T_J = 125\text{ }^\circ\text{C}$ ;  $L = 400\text{ }\mu\text{H}$ ;  $V_{CE} = 600\text{ V}$   
 $I_{CE} = 35\text{ A}$ ;  $V_{GE} = 15\text{ V}$

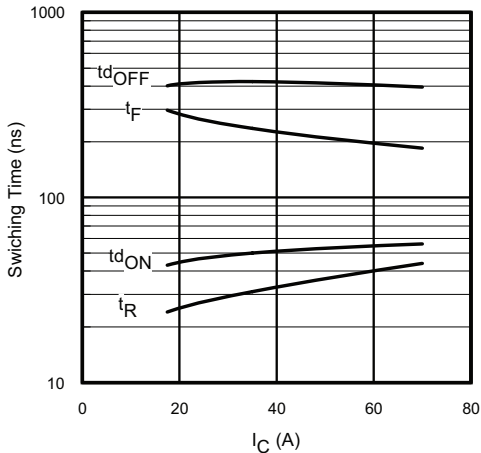


Fig. 6 - Typical Switching Time vs.  $I_C$   
 $T_J = 125\text{ }^\circ\text{C}$ ;  $L = 400\text{ }\mu\text{H}$ ;  $V_{CE} = 600\text{ V}$   
 $R_G = 10\text{ }\Omega$ ;  $V_{GE} = 15\text{ V}$

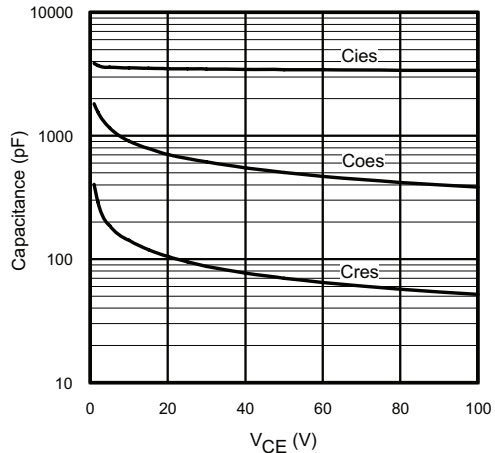


Fig. 9 - Typical Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0\text{ V}$ ;  $f = 1\text{ MHz}$

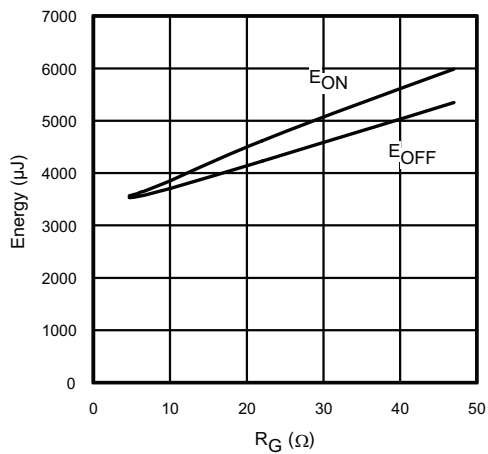


Fig. 7 - Typical Energy Loss vs.  $R_G$   
 $T_J = 125\text{ }^\circ\text{C}$ ;  $L = 400\text{ }\mu\text{H}$ ;  $V_{CE} = 600\text{ V}$   
 $I_{CE} = 35\text{ A}$ ;  $V_{GE} = 15\text{ V}$

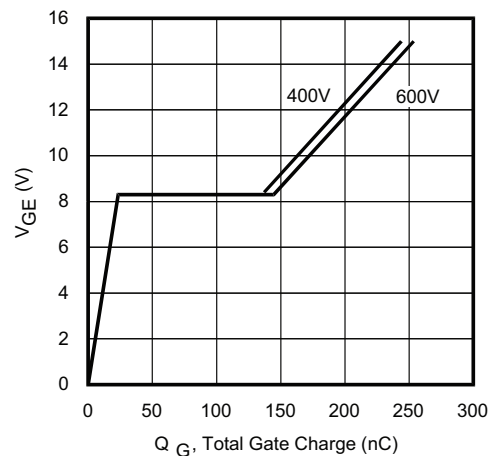


Fig. 10 - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 35\text{ A}$ ;  $L = 600\text{ }\mu\text{H}$

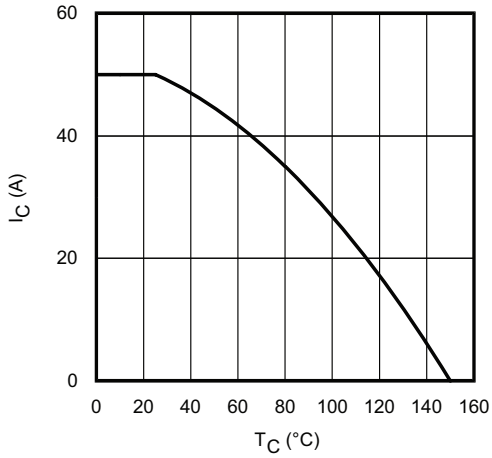


Fig. 11 - Maximum DC Collector Current vs. Case Temperature

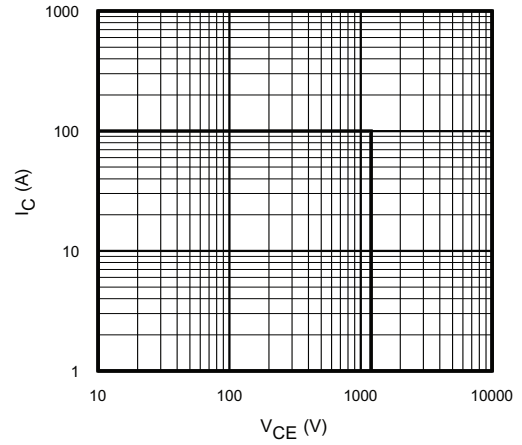


Fig. 14 - Reverse Bias SOA  
 $T_J = 150\text{ }^\circ\text{C}$ ;  $V_{GE} = 15\text{ V}$

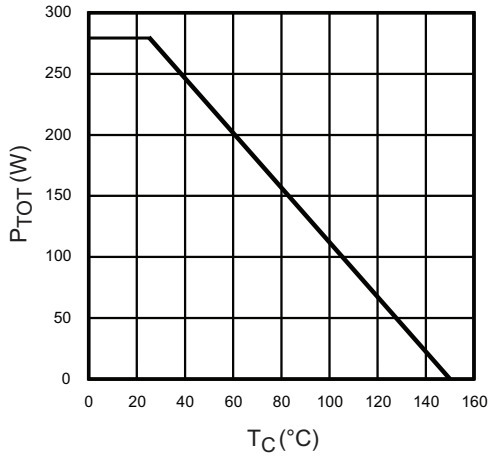


Fig. 12 - Power Dissipation vs. Case Temperature

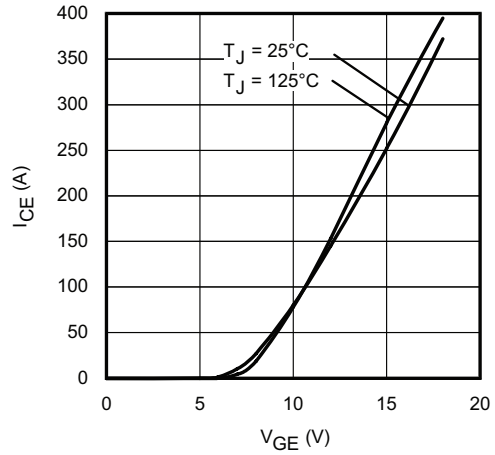


Fig. 15 - Typical Transfer Characteristics  
 $V_{CE} = 50\text{ V}$ ;  $t_p = 10\text{ }\mu\text{s}$

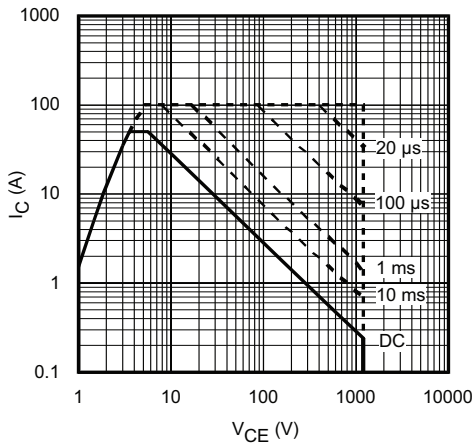


Fig. 13 - Forward SOA  
 $T_C = 25\text{ }^\circ\text{C}$ ;  $T_J \leq 150\text{ }^\circ\text{C}$

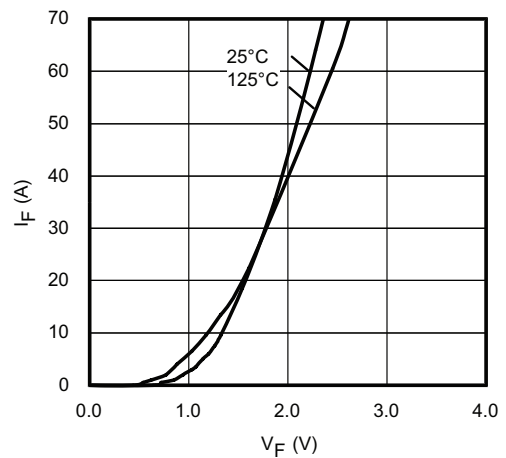


Fig. 16 - Typical Diode Forward Characteristics  
 $t_p = 80\text{ }\mu\text{s}$

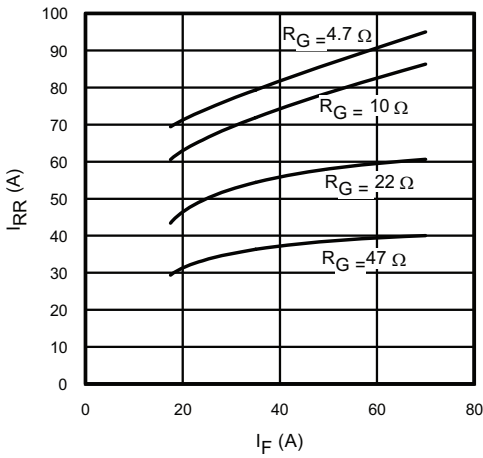


Fig. 17 - Typical Diode  $I_{RR}$  vs.  $I_F$   
 $T_J = 125^\circ\text{C}$

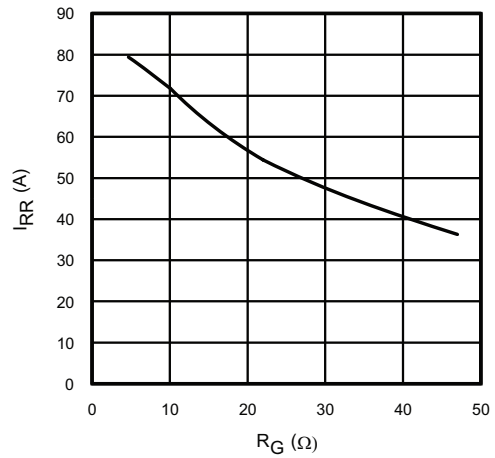


Fig. 18 - Typical Diode  $I_{RR}$  vs.  $R_G$   
 $T_J = 125^\circ\text{C}$ ;  $I_F = 35\text{ A}$

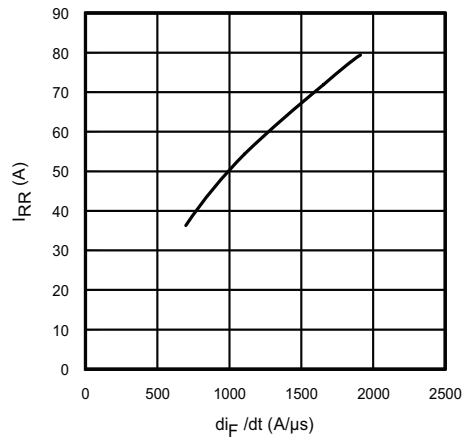


Fig. 19 - Typical Diode  $I_{RR}$  vs.  $di_F/dt$ ;  $V_{CC} = 600\text{ V}$ ;  
 $V_{GE} = 15\text{ V}$ ;  $I_{CE} = 35\text{ A}$ ;  $T_J = 125^\circ\text{C}$

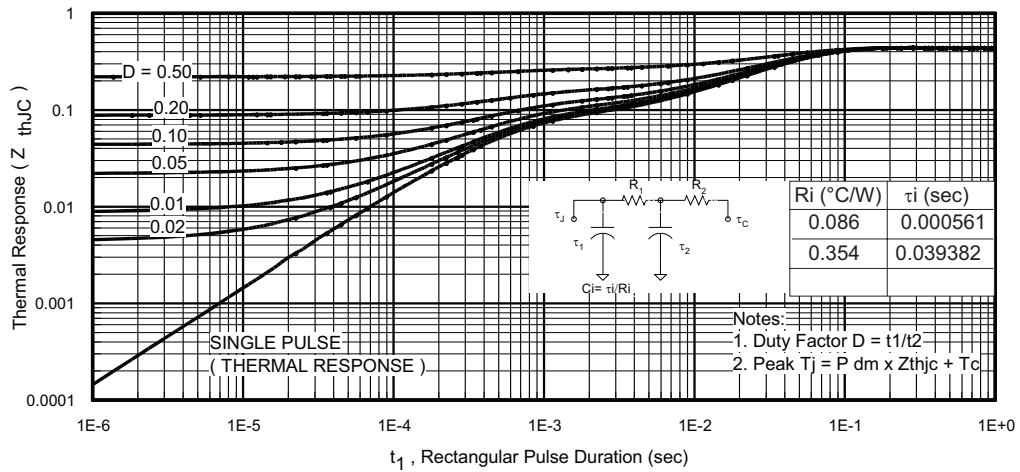


Fig. 20 - Maximum Transient Thermal Impedance, Junction to Case (IGBT)

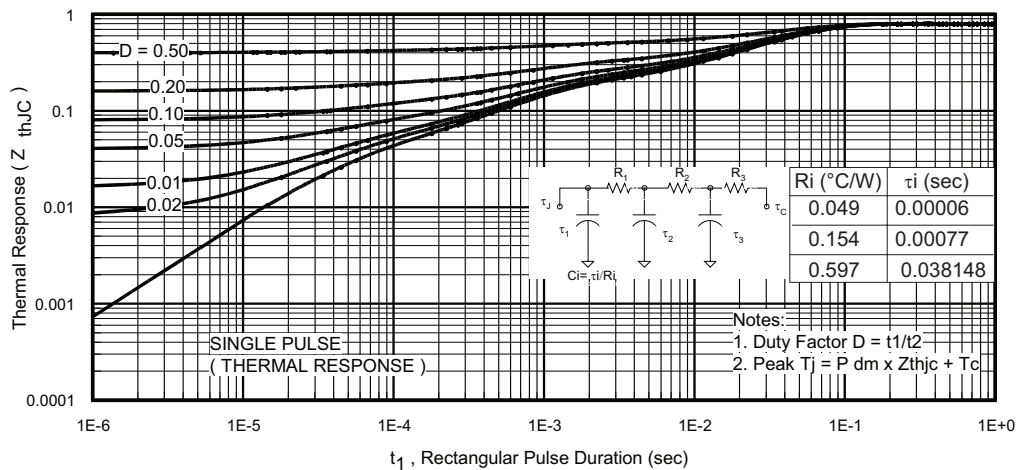


Fig. 21 - Maximum Transient Thermal Impedance, Junction to Case (DIODE)

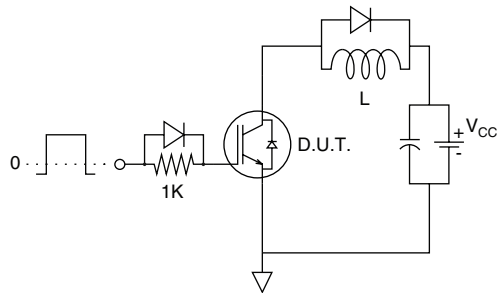


Fig. C.T.1 - Gate Charge Circuit (Turn-Off)

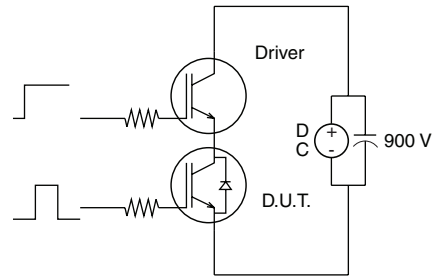


Fig. C.T.3 - S.C. SOA Circuit

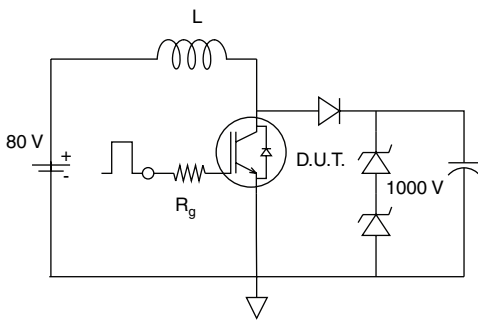


Fig. C.T.2 - RBSOA Circuit

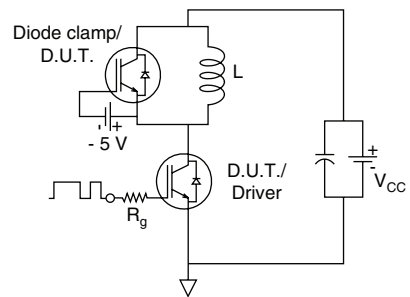


Fig. C.T.4 - Switching Loss Circuit

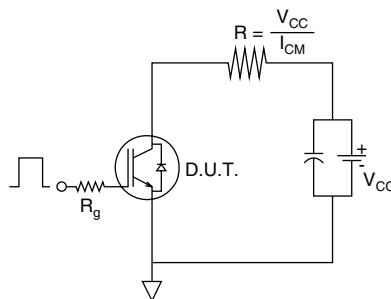


Fig. C.T.5 - Resistive Load Circuit



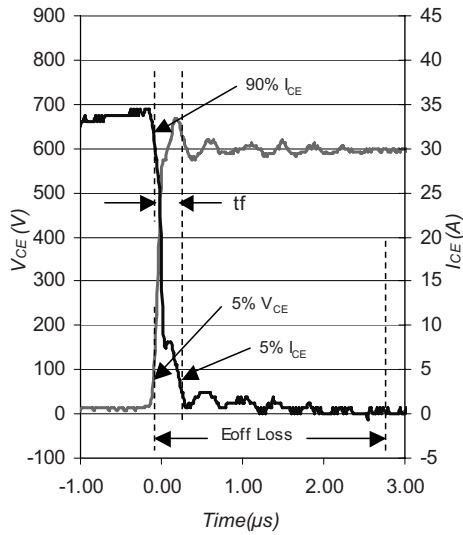


Fig. WF1 - Typical Turn-Off Loss Waveform at  $T_J = 125^\circ\text{C}$  using Fig. CT.4

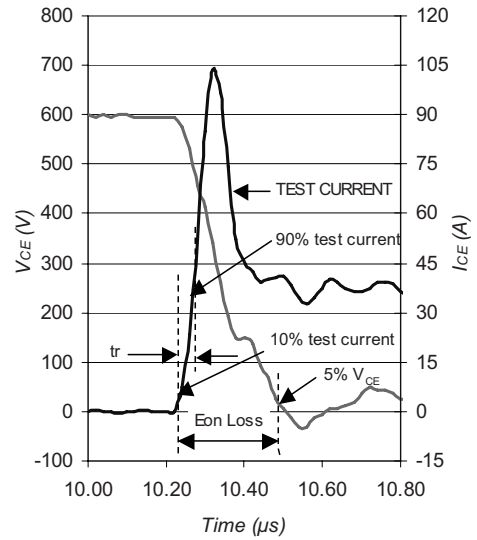


Fig. WF2 - Typical Turn-On Loss Waveform at  $T_J = 125^\circ\text{C}$  using Fig. CT.4

**ORDERING INFORMATION TABLE**

Device code	<b>G</b>	<b>B</b>	<b>35</b>	<b>X</b>	<b>F</b>	<b>120</b>	<b>K</b>
	①	②	③	④	⑤	⑥	⑦

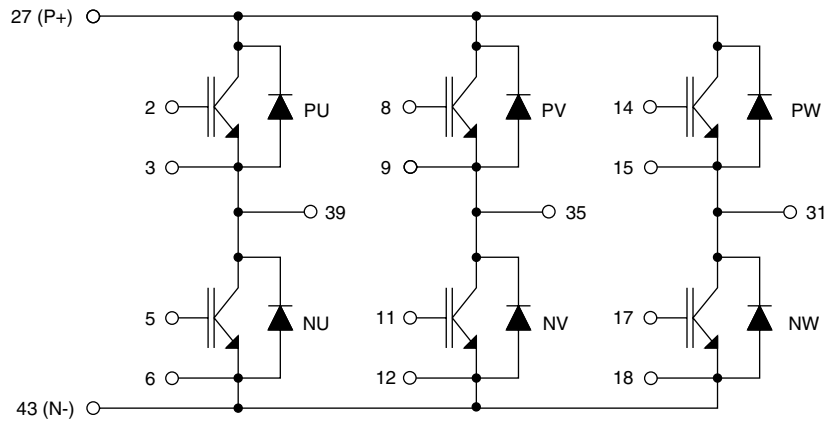
- 1** - Insulated Gate Bipolar Transistor (IGBT)
- 2** - IGBT Generation 5 NPT
- 3** - Current rating (35 = 35 A)
- 4** - Circuit configuration  
(X = Sixpack or three phase inverter)
- 5** - Package (F = ECONO2)
- 6** - Voltage rating (120 = 1200 V)
- 7** - Ultrafast (Speed 8 to 60 kHz)

# GB35XF120K



Vishay High Power Products IGBT Sixpack Module, 35 A

## CIRCUIT CONFIGURATION



LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95090">http://www.vishay.com/doc?95090</a>
Part marking information	<a href="http://www.vishay.com/doc?95089">http://www.vishay.com/doc?95089</a>

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