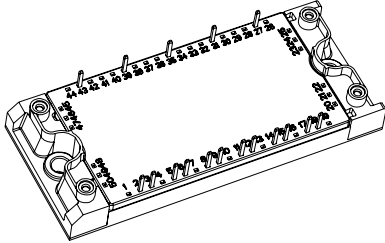


## IGBT Sixpack Module, 13 A


**ECONO2 6PACK**


PRODUCT SUMMARY	
$V_{CES}$	1200 V
$V_{CE(on)}$ (typical)	2.64 V
$t_{sc}$ at $T_J = 150\text{ }^\circ\text{C}$	> 10 $\mu\text{s}$
$I_C$ at $T_C = 80\text{ }^\circ\text{C}$	13 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	$I_C$	$T_C = 25\text{ }^\circ\text{C}$	20	A
		$T_C = 80\text{ }^\circ\text{C}$	13	
Pulsed collector current See fig. C.T.5	$I_{CM}$		40	
Clamped inductive load current	$I_{LM}$		40	
Diode continuous forward current	$I_F$	$T_C = 25\text{ }^\circ\text{C}$	20	
		$T_C = 80\text{ }^\circ\text{C}$	12	
Pulsed diode maximum forward current	$I_{FM}$		40	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Maximum power dissipation (IGBT and diode)	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	151	W
		$T_C = 80\text{ }^\circ\text{C}$	85	
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



<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)	-	0.87	-	V/°C
Collector to emitter voltage	$V_{CE(ON)}$	$I_C = 10\text{ A}, V_{GE} = 15\text{ V}$	-	2.64	2.85	V
		$I_C = 20\text{ A}, V_{GE} = 15\text{ V}$	-	3.59	3.94	
		$I_C = 10\text{ A}, V_{GE} = 15\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	3.17	3.46	
		$I_C = 20\text{ A}, V_{GE} = 15\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	4.48	4.97	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	4	-	6	
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)	-	-10.4	-	mV/°C
Zero gate voltage collector current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}$	-	-	100	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	750	-	
Diode forward voltage drop	$V_{FM}$	$I_F = 10\text{ A}$	-	2.00	2.28	V
		$I_F = 20\text{ A}$	-	2.48	2.90	
		$I_F = 10\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.16	2.51	
		$I_F = 20\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.87	3.42	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 200$	nA

<b>THERMAL AND MECHANICAL SPECIFICATIONS</b>					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Junction to case IGBT	$R_{thJC}$	-	-	1.42	°C/W
Junction to case diode		-	-	1.97	
Case to sink, flat, greased surface	$R_{thCS}$	-	0.05	-	
Mounting torque (M5)		2.7	-	3.3	Nm
Weight		-	170	-	g



<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)	$Q_G$	$I_C = 10\text{ A}$ $V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}$	-	48	75	nC
Gate to emitter charge (turn-on)	$Q_{GE}$		-	8	15	
Gate to collector charge (turn-on)	$Q_{GC}$		-	22	33	
Turn-on switching loss	$E_{ON}$	$I_C = 10\text{ A}$ , $V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}$ , $R_G = 22\text{ }\Omega$ , $L = 1\text{ mH}$ $T_J = 25\text{ }^\circ\text{C}$ <sup>(1)</sup>	-	0.84	1.26	mJ
Turn-off switching loss	$E_{OFF}$		-	0.36	0.54	
Total switching loss	$E_{TOT}$		-	1.20	1.81	
Turn-on switching loss	$E_{ON}$	$I_C = 10\text{ A}$ , $V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}$ , $R_G = 22\text{ }\Omega$ , $L = 1\text{ mH}$ $T_J = 125\text{ }^\circ\text{C}$ <sup>(1)</sup>	-	1.14	1.71	
Turn-off switching loss	$E_{OFF}$		-	0.64	0.96	
Total switching loss	$E_{TOT}$		-	1.78	2.67	
Turn-on delay time	$t_{d(ON)}$	$I_C = 10\text{ A}$ , $V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}$ , $R_G = 22\text{ }\Omega$ , $L = 1\text{ mH}$ $T_J = 125\text{ }^\circ\text{C}$	-	83	124	ns
Rise time	$t_r$		-	21	32	
Turn-off delay time	$t_{d(OFF)}$		-	115	172	
Fall time	$t_f$		-	279	420	
Input capacitance	$C_{ies}$	$V_{GE} = 0\text{ V}$ $V_{CC} = 30\text{ V}$ $f = 1\text{ MHz}$	-	750	1150	pF
Output capacitance	$C_{oes}$		-	190	290	
Reverse transfer capacitance	$C_{res}$		-	20	35	
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}$ , $I_C = 40\text{ A}$ $R_G = 22\text{ }\Omega$ , $V_{GE} = 15\text{ V to }0\text{ V}$	Fullsquare			
Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C}$ $V_{CC} = 960\text{ V}$ , $V_P = 1200\text{ V}$ $R_G = 22\text{ }\Omega$ , $V_{GE} = 15\text{ V to }0\text{ V}$	10	-	-	$\mu\text{s}$
Diode peak reverse recovery current	$I_{rr}$	$T_J = 125\text{ }^\circ\text{C}$ $V_{CC} = 600\text{ V}$ , $I_F = 10\text{ A}$ , $L = 1\text{ mH}$ $V_{GE} = 15\text{ V}$ , $R_G = 22\text{ }\Omega$	-	22	-	A

**Note**
<sup>(1)</sup> Energy losses include "tail" and diode reverse recovery

## INVERTER

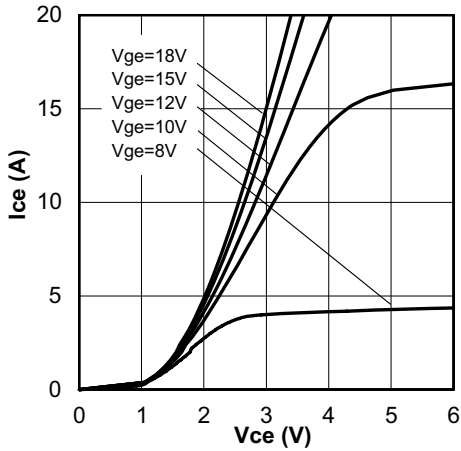


Fig. 1 - Typical IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 80 \mu\text{s}$

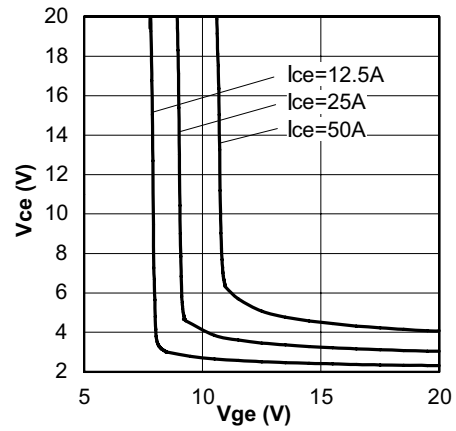


Fig. 4 - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 125^\circ\text{C}$

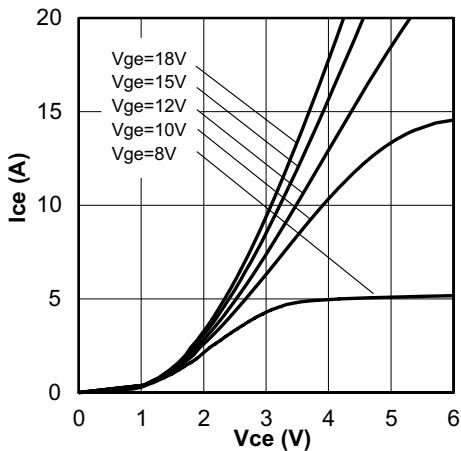


Fig. 2 - Typical IGBT Output Characteristics  
 $T_J = 125^\circ\text{C}$ ;  $t_p = 80 \mu\text{s}$

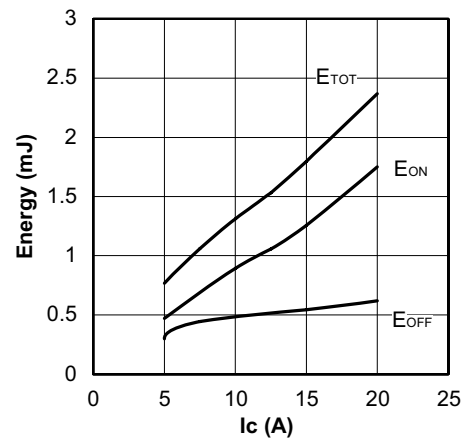


Fig. 5 - Typical Energy Loss vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ;  $L = 1 \text{ mH}$ ;  $V_{CE} = 600 \text{ V}$   
 $R_G = 22 \Omega$ ;  $V_{GE} = 15 \text{ V}$

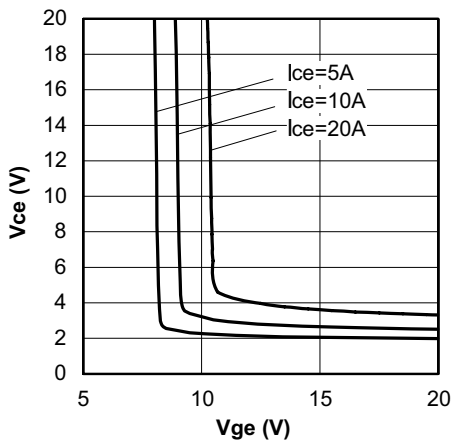


Fig. 3 - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$

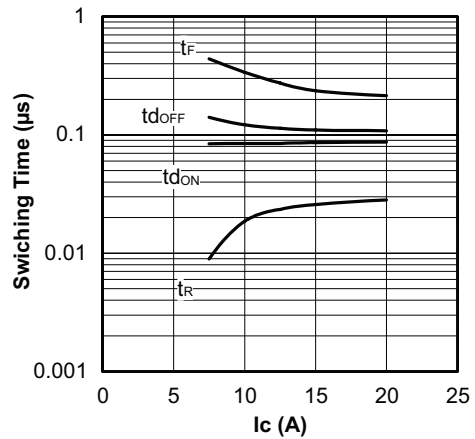


Fig. 6 - Typical Switching Time vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ;  $L = 1 \text{ mH}$ ;  $V_{CE} = 600 \text{ V}$   
 $R_G = 22 \Omega$ ;  $V_{GE} = 15 \text{ V}$

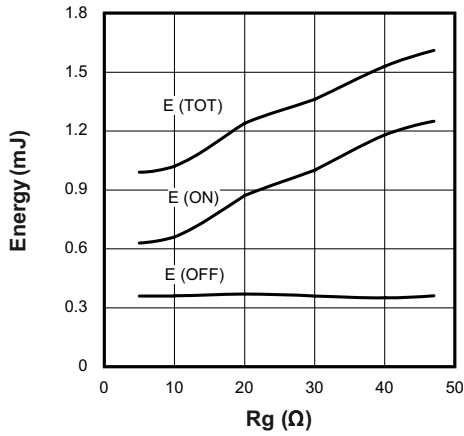


Fig. 7 - Typical Energy Loss vs.  $R_G$   
 $T_J = 125\text{ }^\circ\text{C}$ ;  $L = 1\text{ mH}$ ;  $V_{CE} = 600\text{ V}$   
 $I_{CE} = 10\text{ A}$ ;  $V_{GE} = 15\text{ V}$

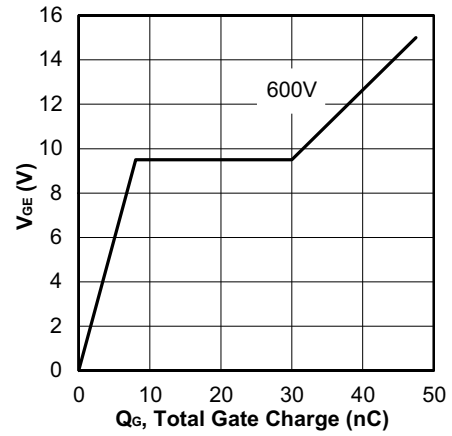


Fig. 10 - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 10\text{ A}$

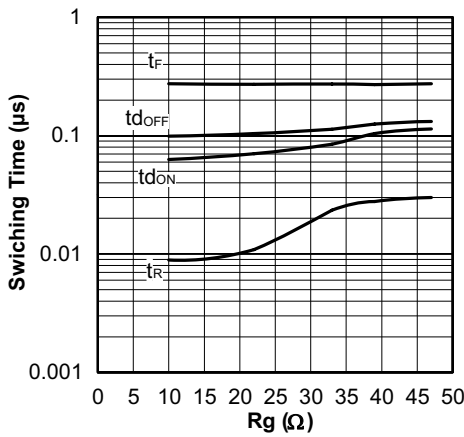


Fig. 8 - Typical Switching Time vs.  $R_G$   
 $T_J = 125\text{ }^\circ\text{C}$ ;  $L = 1\text{ mH}$ ;  $V_{CE} = 600\text{ V}$   
 $I_{CE} = 10\text{ A}$ ;  $V_{GE} = 15\text{ V}$

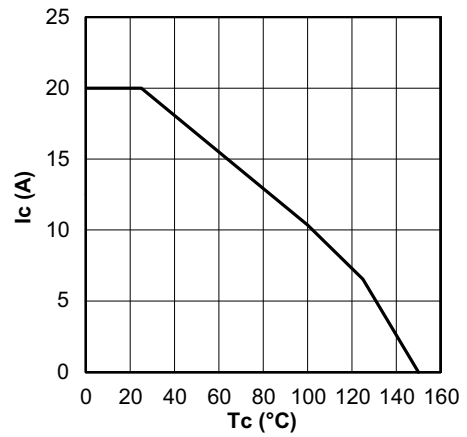


Fig. 11 - Maximum DC Collector Current vs. Case Temperature

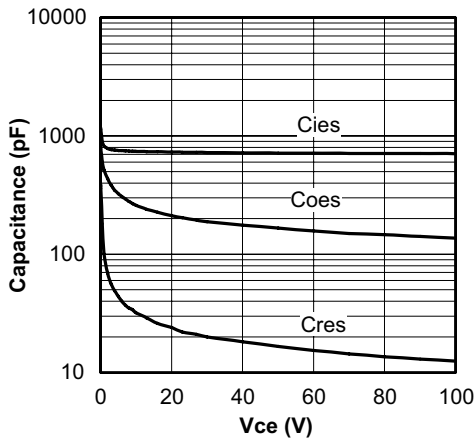


Fig. 9 - Typical Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0\text{ V}$ ;  $f = 1\text{ MHz}$

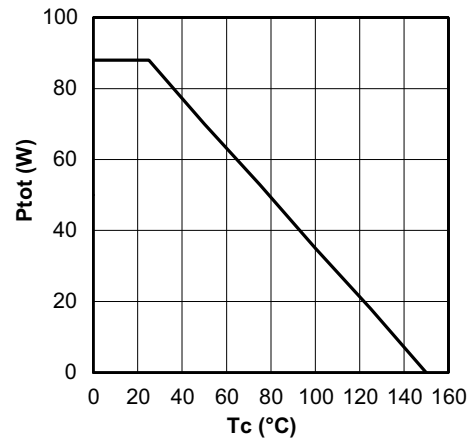


Fig. 12 - Power Dissipation vs. Case Temperature

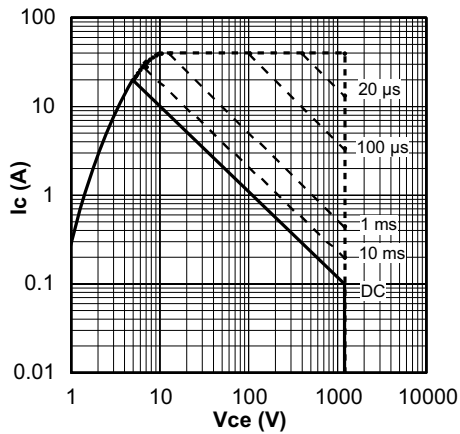


Fig. 13 - Forward SOA  
 $T_C = 25^\circ\text{C}$ ;  $T_J \leq 150^\circ\text{C}$

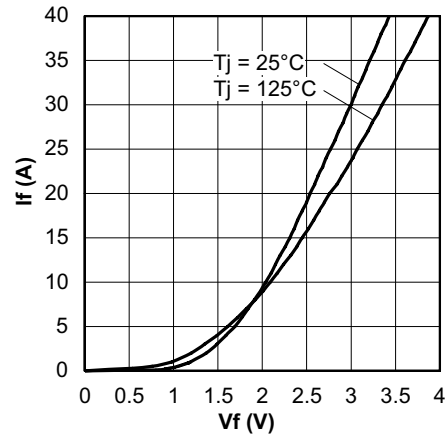


Fig. 16 - Typical Diode Forward Characteristics  
 $t_p = 80 \mu\text{s}$

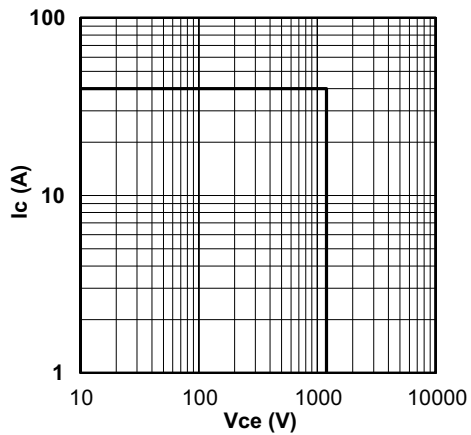


Fig. 14 - Reverse Bias SOA  
 $T_J = 150^\circ\text{C}$ ;  $V_{GE} = 15\text{ V}$

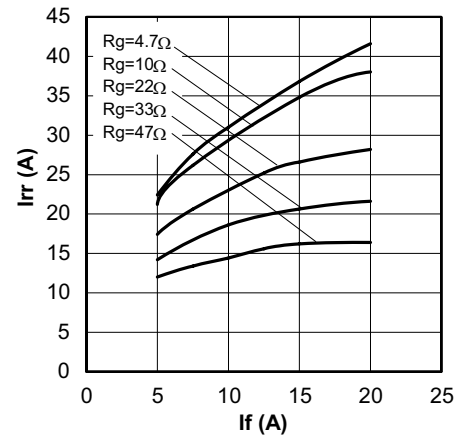


Fig. 17 - Typical Diode  $I_{RR}$  vs.  $I_F$   
 $T_J = 125^\circ\text{C}$

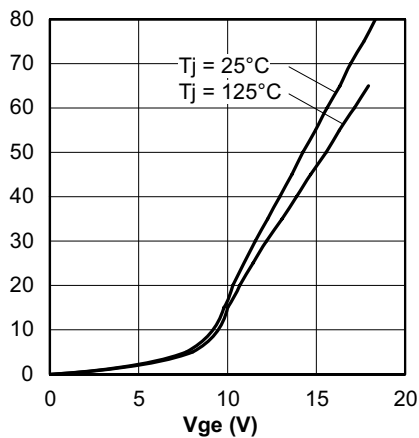


Fig. 15 - Typical Transfer Characteristics  
 $V_{CE} = 50\text{ V}$ ;  $t_p = 10 \mu\text{s}$

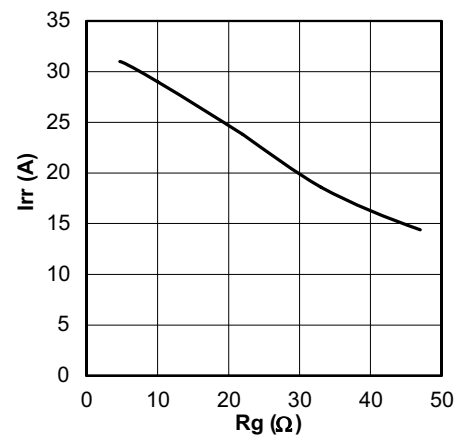


Fig. 18 - Typical Diode  $I_{RR}$  vs.  $R_G$   
 $T_J = 125^\circ\text{C}$ ;  $I_F = 10\text{ A}$

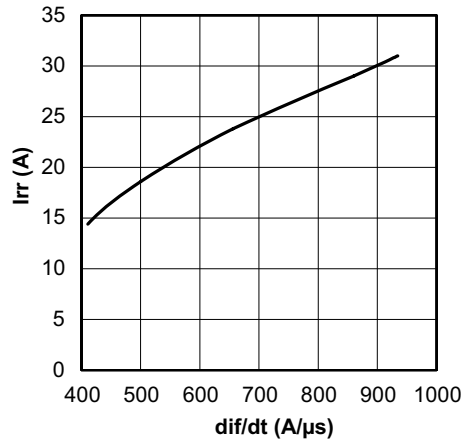


Fig. 19 - Typical Diode  $I_{RR}$  vs.  $di_F/dt$ ;  $V_{CC} = 600$  V;  
 $V_{GE} = 15$  V;  $I_{CE} = 10$  A;  $T_J = 125$  °C

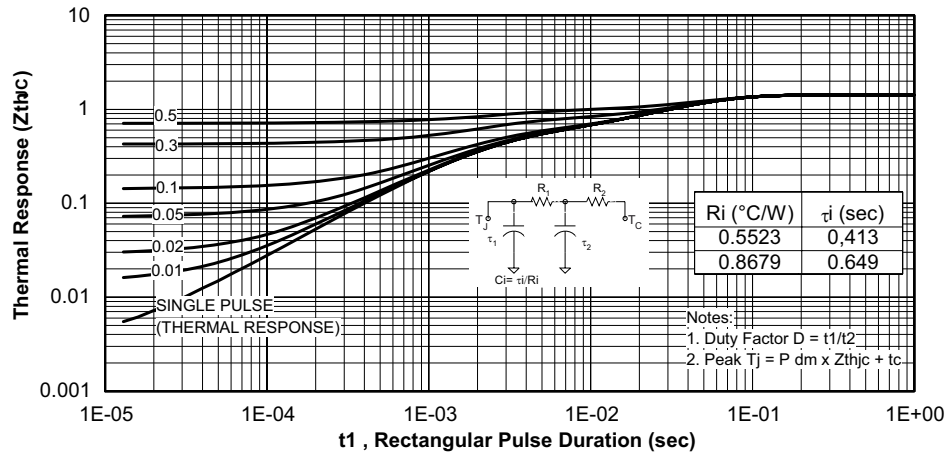


Fig. 20 - Maximum Transient Thermal Impedance, Junction to Case (IGBT)

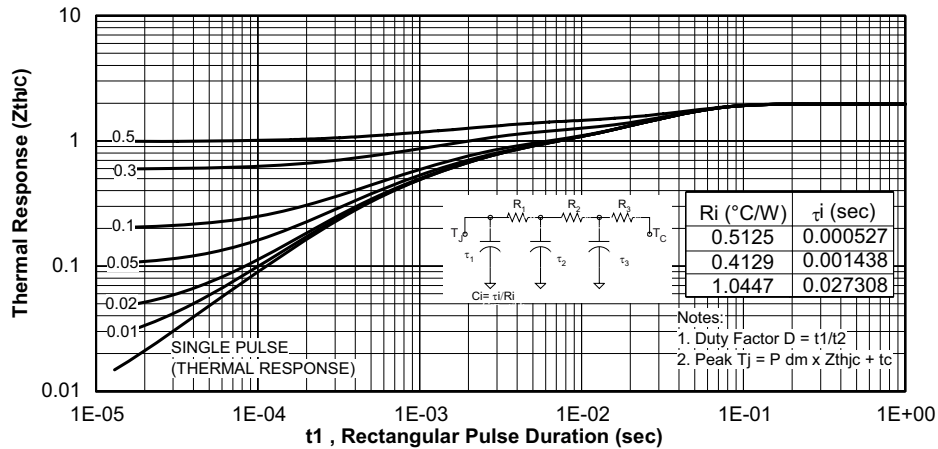


Fig. 21 - Maximum Transient Thermal Impedance, Junction to Case (Diode)

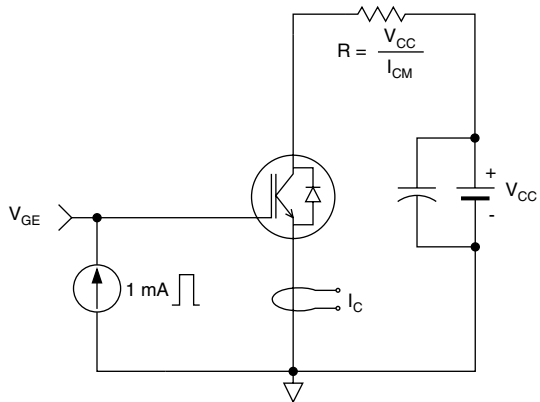


Fig. C.T.1 - Gate Charge Circuit (Turn-Off)

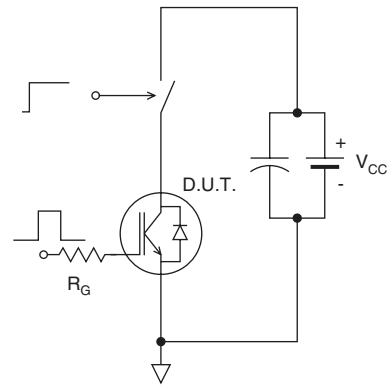


Fig. C.T.3 - S.C. SOA Circuit

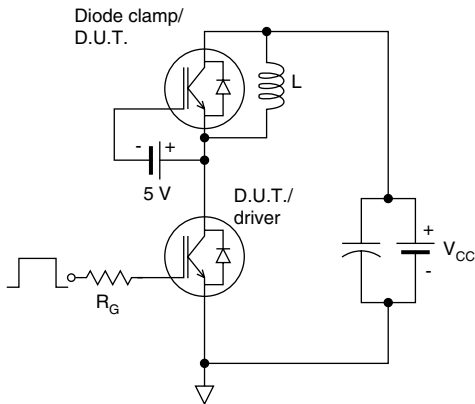


Fig. C.T.2 - RB SOA Circuit

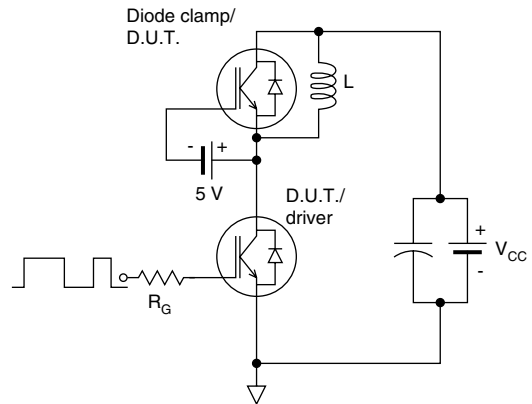


Fig. C.T.4 - Switching Loss Circuit

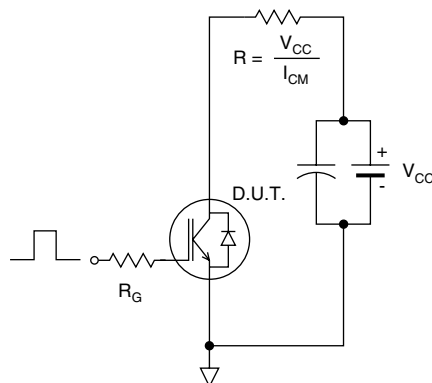
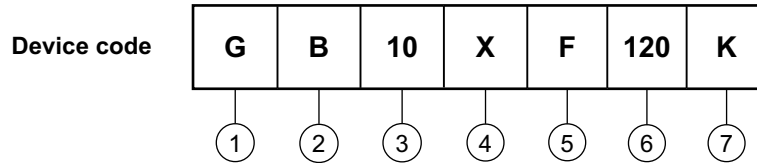
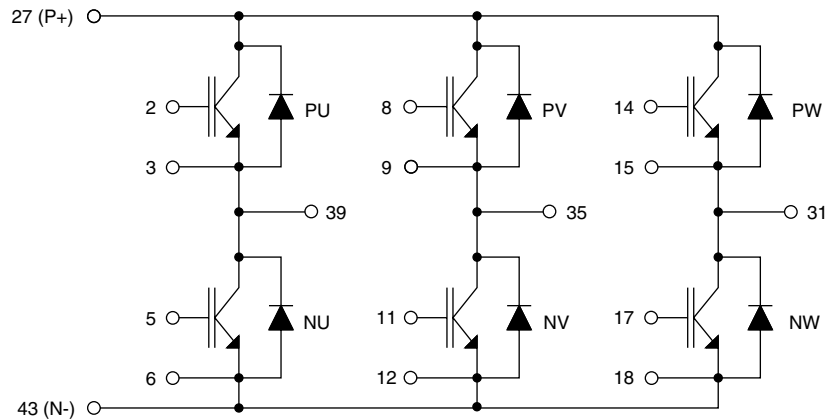


Fig. C.T.5 - Resistive Load Circuit



**ORDERING INFORMATION TABLE**


- 1** - Insulated Gate Bipolar Transistor (IGBT)
- 2** - IGBT Generation 5 NPT
- 3** - Current rating (10 = 10 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)

**CIRCUIT CONFIGURATION**


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



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