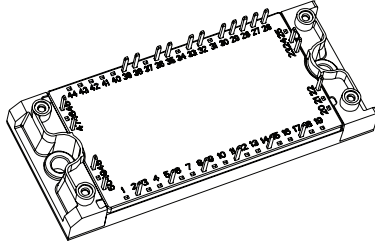


IGBT PIM Module, 21 A


ECONO2 PIM
FEATURES

- Low $V_{CE(on)}$ non punch through IGBT technology
- Low diode V_F
- 10 μ s short circuit capability
- Square RBSOA
- HEXFRED® 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

PRODUCT SUMMARY	
V_{CES}	600 V
$V_{CE(on)}$ (typical)	1.89 V
t_{sc} at $T_J = 150\text{ }^\circ\text{C}$	> 10 μ s
I_C at $T_C = 80\text{ }^\circ\text{C}$	21 A

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	
Inverter	Collector to emitter voltage	V_{CES}		600	V	
	Gate to emitter voltage	V_{GES}		± 20		
	Continuous collector current	I_C	$T_C = 25\text{ }^\circ\text{C}$	30	A	
			$T_C = 80\text{ }^\circ\text{C}$	21		
	Pulsed collector current See fig. C.T.5	I_{CM}		60	A	
	Diode maximum forward current	I_{FM}	Pulsed	60	A	
	Power dissipation	P_D	One IGBT	25 $^\circ\text{C}$	110	W
Input Rectifier	Repetitive peak reverse voltage	V_{RRM}		800	V	
	Average output current	$I_{F(AV)}$	50/60 Hz sine pulse	80 $^\circ\text{C}$	20	A
	Surge current (non-repetitive)	I_{FSM}	Rated V_{RRM} applied, 10 ms, sine pulse	310		
	I^2t (non-repetitive)	I^2t		525	A ² s	
Brake	Collector to emitter voltage	V_{CES}		600	V	
	Gate to emitter voltage	V_{GES}		± 20		
	Continuous collector current	I_C	$T_C = 25\text{ }^\circ\text{C}$	20	A	
			$T_C = 80\text{ }^\circ\text{C}$	11		
	Pulsed collector current See fig. C.T.5	I_{CM}		40	A	
	Power dissipation	P_D	One IGBT	25 $^\circ\text{C}$	100	W
	Repetitive peak reverse voltage	V_{RRM}		600	V	
	Maximum operating junction temperature	T_J		150	$^\circ\text{C}$	
	Storage temperature range	T_{Sig}		- 40 to + 125		
	Isolation voltage	V_{ISOL}	AC (1 min)	2500		V

ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)							
	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Inverter IGBT	Collector to emitter breakdown voltage	$BV_{(CES)}$	$V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$	600	-	-	V
	Temperature coefficient of breakdown voltage	$\Delta V_{(BR)CES}/\Delta T_J$	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$ ($25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$)	-	0.6	-	$V/^\circ\text{C}$
	Collector to emitter voltage	$V_{CE(on)}$	$I_C = 20\text{ A}, V_{GE} = 15\text{ V}$	-	1.89	2.16	V
			$I_C = 30\text{ A}, V_{GE} = 15\text{ V}$	-	2.24	2.58	
			$I_C = 20\text{ A}, V_{GE} = 15\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	2.16	2.65	
			$I_C = 30\text{ A}, V_{GE} = 15\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	2.63	3.22	
	Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	4	-	6	
	Threshold voltage temperature coefficient	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$ ($25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$)	-	-9.6	-	$\text{mV}/^\circ\text{C}$
	Zero gate voltage collector current	I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$	-	-	100	μA
			$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$	-	500	-	
	Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 200	nA
	Total gate charge (turn-on)	Q_G	$I_C = 20\text{ A}$	-	72	108	nC
	Gate to emitter charge (turn-on)	Q_{GE}	$V_{CC} = 300\text{ V}$	-	16	24	
	Gate to collector charge (turn-on)	Q_{GC}	$V_{GE} = 15\text{ V}$	-	24	36	
	Turn-on switching loss	E_{on}	$I_C = 20\text{ A}, V_{CC} = 300\text{ V}$	-	0.28	0.41	mJ
	Turn-off switching loss	E_{off}	$V_{GE} = 15\text{ V}, R_G = 22\text{ }\Omega$ $L = 200\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}^{(1)}$	-	0.17	0.25	
	Total switching loss	E_{tot}		-	0.44	0.67	
	Turn-on switching loss	E_{on}	$I_C = 20\text{ A}, V_{CC} = 300\text{ V}$	-	0.40	0.59	
	Turn-off switching loss	E_{off}	$V_{GE} = 15\text{ V}, R_G = 22\text{ }\Omega$ $L = 200\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}^{(1)}$	-	0.17	0.25	
	Total switching loss	E_{tot}		-	0.56	0.84	
	Turn-on delay time	$t_{d(on)}$	$I_C = 20\text{ A}, V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}, R_G = 22\text{ }\Omega$ $L = 200\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	106	159	ns
	Rise time	t_r		-	25	38	
	Turn-off delay time	$t_{d(off)}$		-	128	192	
Fall time	t_f	-		110	165		
Input capacitance	C_{ies}	$V_{GE} = 0\text{ V}$	-	1316	1974	pF	
Output capacitance	C_{oes}	$V_{CC} = 30\text{ V}$	-	335	502		
Reverse transfer capacitance	C_{res}	$f = 1\text{ MHz}$	-	40	60		
Inverter IGBT	Reverse bias safe operating area	RBSOA	$T_J = 125\text{ }^\circ\text{C}, I_C = 50\text{ A}$ $R_G = 22\text{ }\Omega, V_{GE} = 15\text{ V to }0$	Fullsquare			
	Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C}$ $V_{CC} = 300\text{ V}, V_P = 600\text{ V}$ $R_G = 22\text{ }\Omega, V_{GE} = 15\text{ V to }0\text{ V}$	10	-	-	μs
Inverter Diode	Diode peak reverse recovery current	I_{rr}	$T_J = 125\text{ }^\circ\text{C}$ $V_{CC} = 300\text{ V}, I_F = 20\text{ A}, L = 200\text{ }\mu\text{H}$ $R_G = 22\text{ }\Omega, V_{GE} = 15\text{ V}$	-	36	-	A
	Diode forward voltage drop	V_{FM}	$I_F = 20\text{ A}$	-	1.26	1.57	V
			$I_F = 30\text{ A}$	-	1.38	1.80	
			$I_F = 20\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.21	1.52	
$I_F = 30\text{ A}, T_J = 125\text{ }^\circ\text{C}$			-	1.36	1.78		



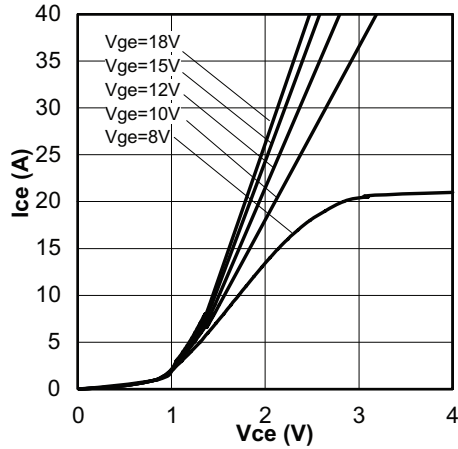
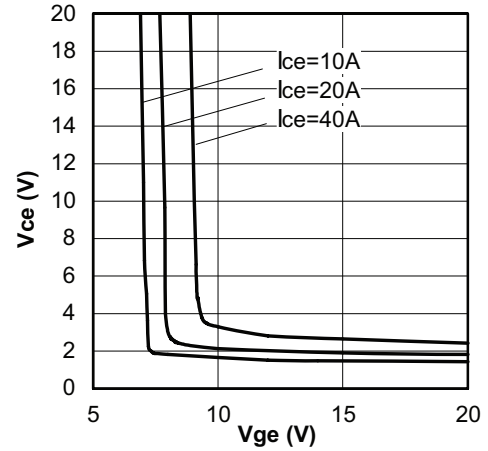
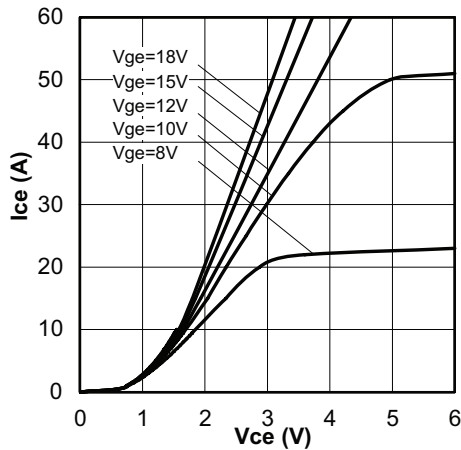
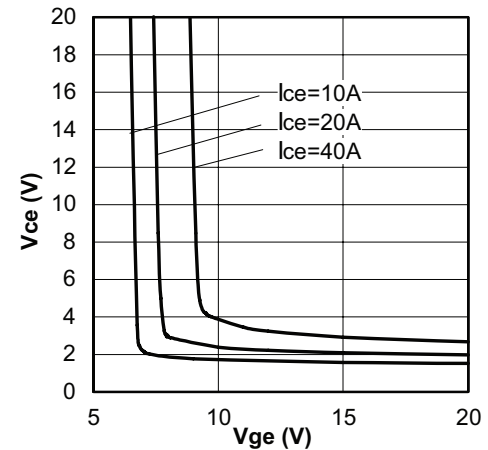
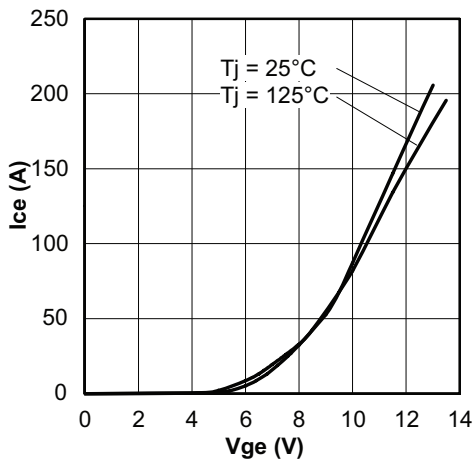
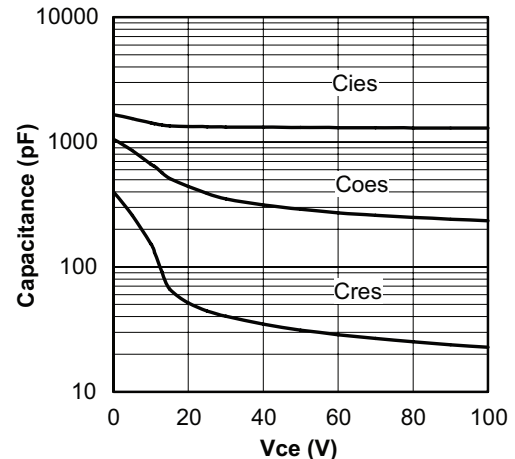
ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)							
	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Rectifier	Maximum forward voltage drop	V_{FM}	$I_F = 20\text{ A}$	-	-	1.18	V
	Maximum reverse leakage current	I_{RM}	$T_J = 25\text{ }^\circ\text{C}, V_R = 800\text{ V}$	-	-	0.2	mA
			$T_J = 150\text{ }^\circ\text{C}, V_R = 800\text{ V}$	-	-	1	
	Forward slope resistance	r_T	$T_J = 150\text{ }^\circ\text{C}$	-	9.8	-	m Ω
Conduction threshold voltage	$V_{F(TO)}$	-		0.75	-	V	
Brake IGBT	Collector to emitter breakdown voltage	$BV_{(CES)}$	$V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$	600	-	-	
	Temperature coefficient of breakdown voltage	$\Delta V_{(BR)CES}/\Delta T_J$	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$ ($25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$)	-	0.6	-	V/ $^\circ\text{C}$
	Collector to emitter voltage	$V_{CE(on)}$	$I_C = 10\text{ A}, V_{GE} = 15\text{ V}$	-	1.59	1.69	V
			$I_C = 20\text{ A}, V_{GE} = 15\text{ V}$	-	2.06	2.24	
			$I_C = 10\text{ A}, V_{GE} = 15\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	1.79	2.37	
			$I_C = 20\text{ A}, V_{GE} = 15\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	2.46	2.79	
	Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	4	-	6	
	Threshold voltage temperature coefficient	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$ ($25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$)	-	-9.1	-	mV/ $^\circ\text{C}$
	Zero gate voltage collector current	I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$	-	-	100	μA
			$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$	-	300	-	
	Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 200	nA
	Total gate charge (turn-on)	Q_G	$I_C = 10\text{ A}$ $V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}$	-	52	78	nC
	Gate to emitter charge (turn-on)	Q_{GE}		-	12	18	
	Gate to collector charge (turn-on)	Q_{GC}		-	19	29	
	Turn-on switching loss	E_{on}	$I_C = 10\text{ A}, V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}, R_G = 22\text{ }\Omega$ $L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}^{(1)}$	-	0.14	0.22	mJ
	Turn-off switching loss	E_{off}		-	0.11	0.16	
Total switching loss	E_{tot}	-		0.25	0.38		
Turn-on switching loss	E_{on}	$I_C = 10\text{ A}, V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}, R_G = 22\text{ }\Omega$ $L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}^{(1)}$		-	0.18	0.26	
Turn-off switching loss	E_{off}			-	0.20	0.29	
Total switching loss	E_{tot}			-	0.37	0.56	
Turn-on delay time	$t_{d(on)}$	$I_C = 10\text{ A}, V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}, R_G = 22\text{ }\Omega$ $L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	83	125	ns	
Rise time	t_r		-	18	27		
Turn-off delay time	$t_{d(off)}$		-	112	168		
Fall time	t_f		-	155	233		
Brake IGBT	Input capacitance	C_{ies}	$V_{GE} = 0\text{ V}$ $V_{CC} = 30\text{ V}$ $f = 1\text{ MHz}$	-	904	1356	pF
	Output capacitance	C_{oes}		-	201	302	
	Reverse transfer capacitance	C_{res}		-	29	44	
	Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 20\text{ A}$ $R_G = 22\text{ }\Omega, V_{GE} = 15\text{ V to }0$	Fullsquare			
	Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C}$ $V_{CC} = 300\text{ V}, V_P = 600\text{ V}$ $R_G = 22\text{ }\Omega, V_{GE} = 15\text{ V to }0$	10	-	-	μs

ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)							
	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Brake Diode	Diode peak reverse recovery current	I_{rr}	$V_{CC} = 300\text{ V}$, $I_F = 10\text{ A}$, $L = 500\text{ }\mu\text{H}$ $R_G = 22\text{ }\Omega$, $V_{GE} = 15\text{ V}$ to 0	-	-	-	A
	Diode forward voltage drop	V_{FM}	$I_F = 10\text{ A}$	-	1.31	1.51	V
			$I_F = 20\text{ A}$	-	1.57	1.84	
			$I_F = 10\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$	-	1.25	1.35	
			$I_F = 20\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$	-	1.58	1.69	
NTC	Resistance	R	$T_J = 25\text{ }^\circ\text{C}$	-	5000	-	Ω
			$T_J = 100\text{ }^\circ\text{C}$	-	4933	-	
	B value	B	$T_J = 25\text{ }^\circ\text{C}/50\text{ }^\circ\text{C}$	-	3375	-	K

Note

(1) Energy losses include “tail” and diode reverse recovery

THERMAL AND MECHANICAL SPECIFICATIONS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Junction to case inverter IGBT thermal resistance	R_{thJC}	-	-	1.13	$^\circ\text{C}/\text{W}$
Junction to case inverter FRED thermal resistance		-	-	1.69	
Junction to case brake DIODE thermal resistance		-	-	2.99	
Junction to case brake IGBT thermal resistance		-	-	1.25	
Junction to case input rectifier thermal resistance		-	-	1.03	
Case to sink, flat, greased surface	R_{thCS}	-	0.05	-	
Mounting torque (M5)		2.7	-	3.3	Nm
Weight		-	170	-	g

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}
 $T_J = 25^\circ\text{C}$

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

 Fig. 5 - Typical V_{CE} vs. V_{GE}
 $T_J = 125^\circ\text{C}$

 Fig. 3 - Typical Transfer Characteristics
 $V_{CE} = 50\ \text{V}$; $t_p = 10\ \mu\text{s}$

 Fig. 6 - Typical Capacitance vs. V_{CE}
 $V_{GE} = 0\ \text{V}$; $f = 1\ \text{MHz}$

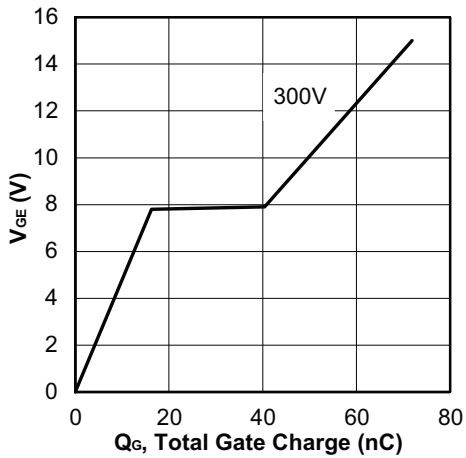


Fig. 7 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 20 \text{ A}$

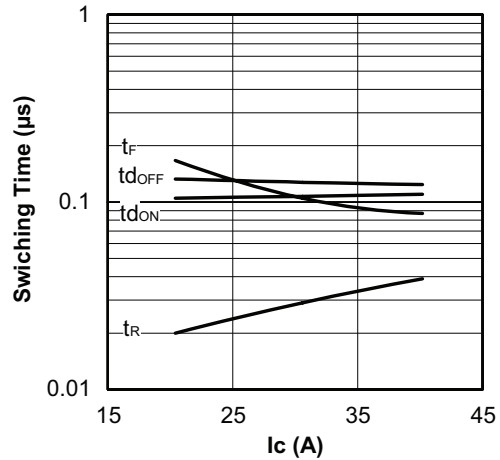


Fig. 10 - Typical Switching Time vs. I_C
 $T_J = 125^\circ\text{C}$; $L = 200 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $R_G = 22 \Omega$; $V_{GE} = 15 \text{ V}$

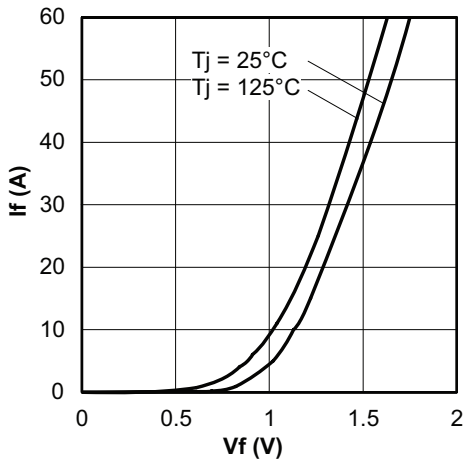


Fig. 8 - Typical Diode Forward Characteristics
 $t_p = 80 \mu\text{s}$

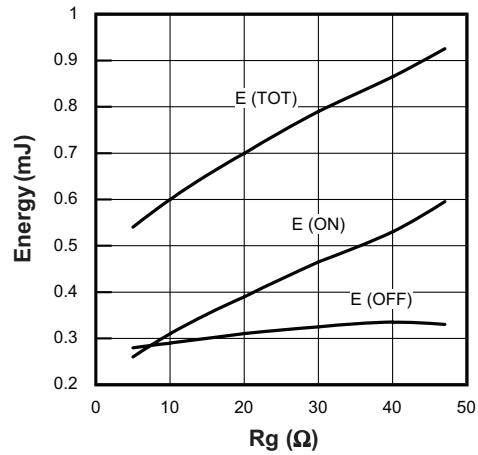


Fig. 11 - Typical Energy Loss vs. R_G
 $T_J = 125^\circ\text{C}$; $L = 200 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $I_{CE} = 20 \text{ A}$; $V_{GE} = 15 \text{ V}$

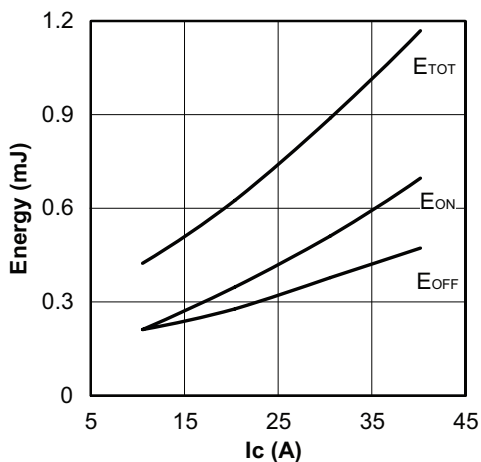


Fig. 9 - Typical Energy Loss vs. I_C
 $T_J = 125^\circ\text{C}$; $L = 200 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $R_G = 22 \Omega$; $V_{GE} = 15 \text{ V}$

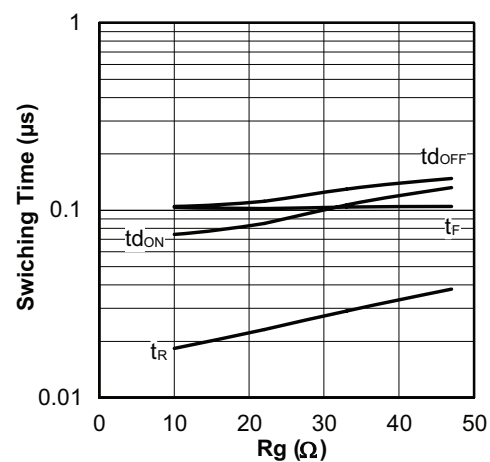


Fig. 12 - Typical Switching Time vs. R_G
 $T_J = 125^\circ\text{C}$; $L = 200 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $I_{CE} = 20 \text{ A}$; $V_{GE} = 15 \text{ V}$

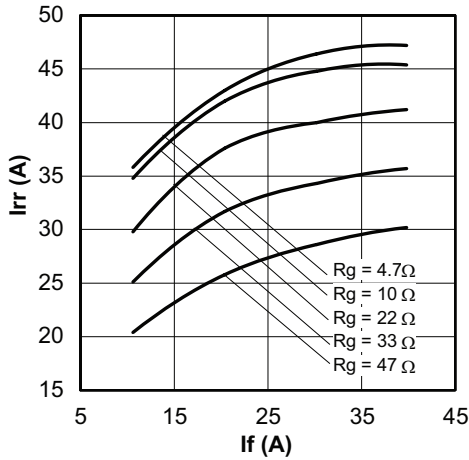


Fig. 13 - Typical Diode I_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

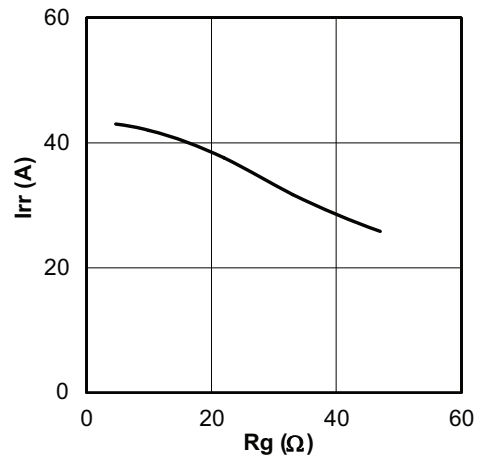


Fig. 14 - Typical Diode I_{RR} vs. R_G
 $T_J = 125^\circ\text{C}; I_F = 20\text{ A}$

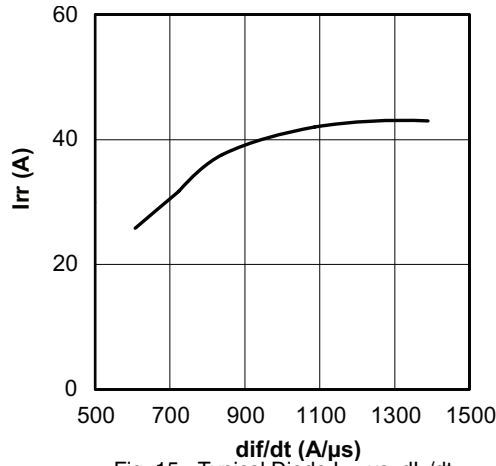


Fig. 15 - Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 300\text{ V}; V_{GE} = 15\text{ V}; I_{CE} = 20\text{ A}; T_J = 125^\circ\text{C}$

THERMISTOR

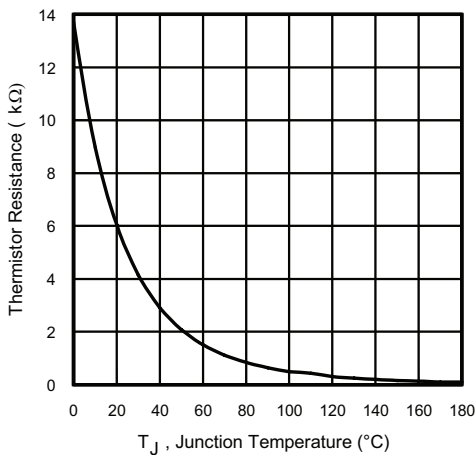


Fig. 16 - Thermistor Resistance vs. Temperature

INPUT RECTIFIER

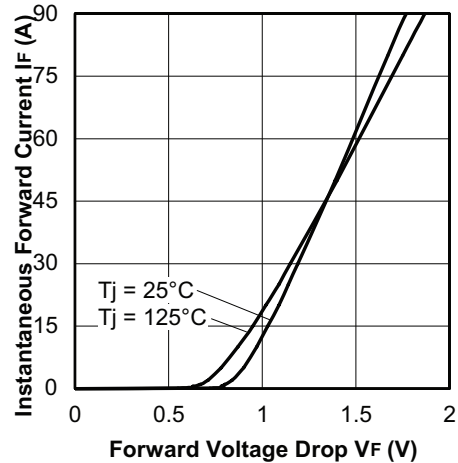


Fig. 17 - Typical Diode Forward Characteristics
 $t_p = 80\ \mu\text{s}$

INVERTER

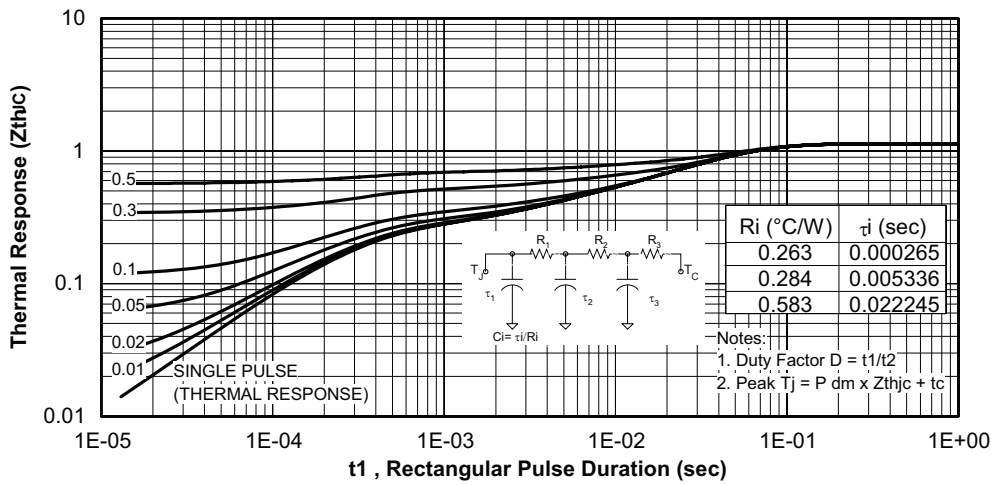


Fig. 18 - Maximum Transient Thermal Impedance, Junction to Case (Inverter IGBT)

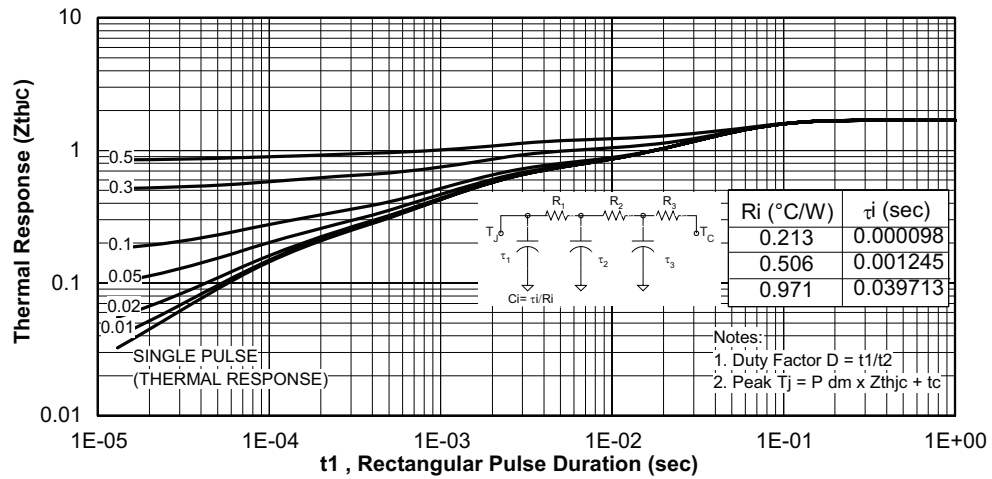
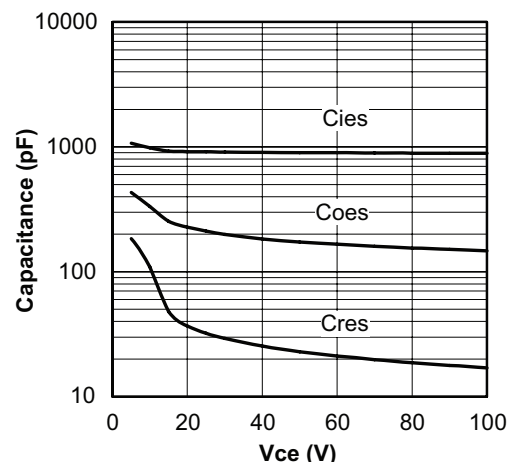
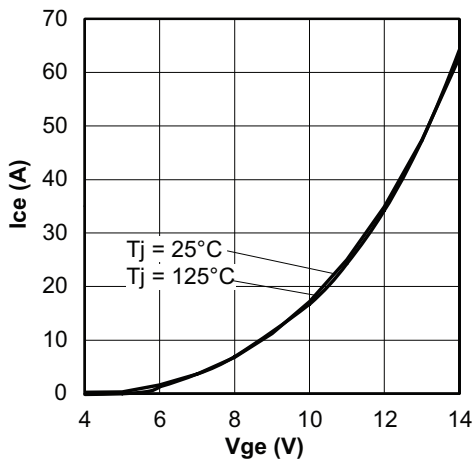
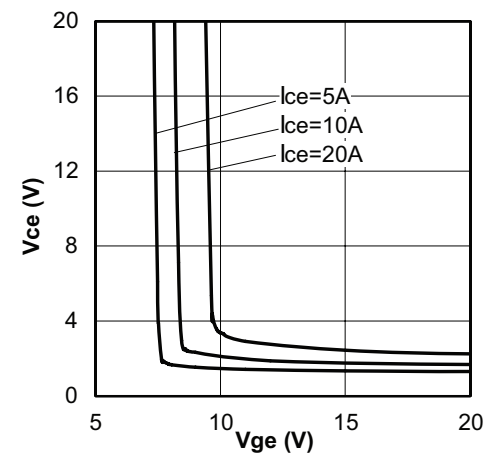
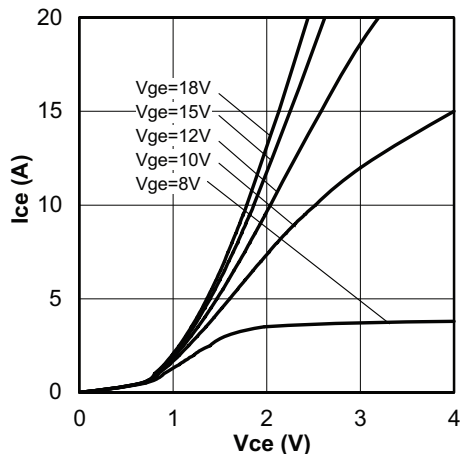
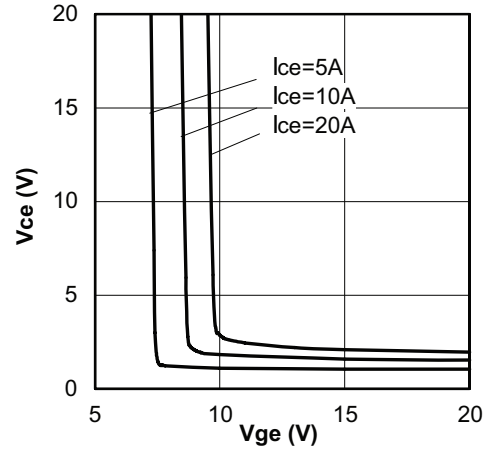
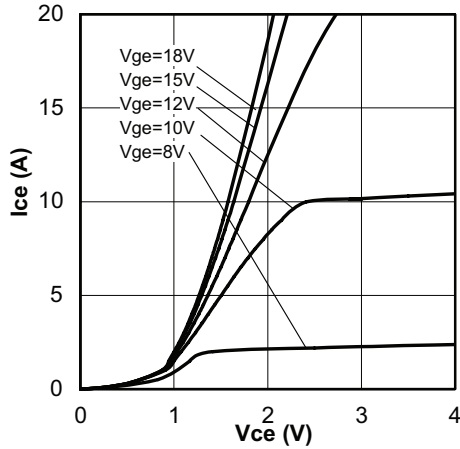


Fig. 19 - Maximum Transient Thermal Impedance, Junction to Case (Diode)

BRAKE


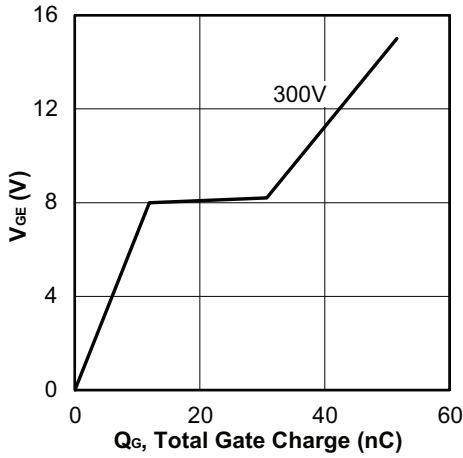


Fig. 26 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 10 \text{ A}$

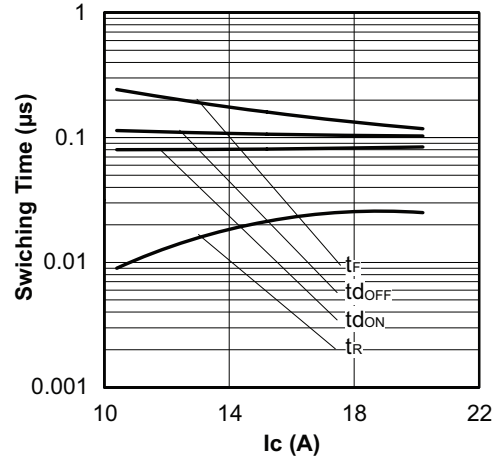


Fig. 29 - Typical Switching Time vs. I_C
 $T_J = 125 \text{ }^\circ\text{C}$; $L = 500 \text{ } \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $R_G = 22 \text{ } \Omega$; $V_{GE} = 15 \text{ V}$

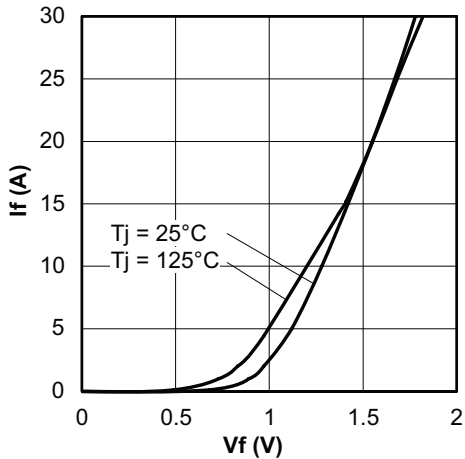


Fig. 27 - Typical Diode Forward Characteristics
 $t_p = 80 \text{ } \mu\text{s}$

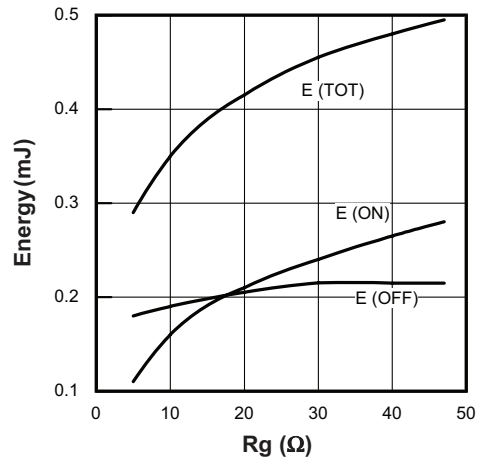


Fig. 30 - Typical Energy Loss vs. R_G
 $T_J = 125 \text{ }^\circ\text{C}$; $L = 500 \text{ } \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $I_{CE} = 10 \text{ A}$; $V_{GE} = 15 \text{ V}$

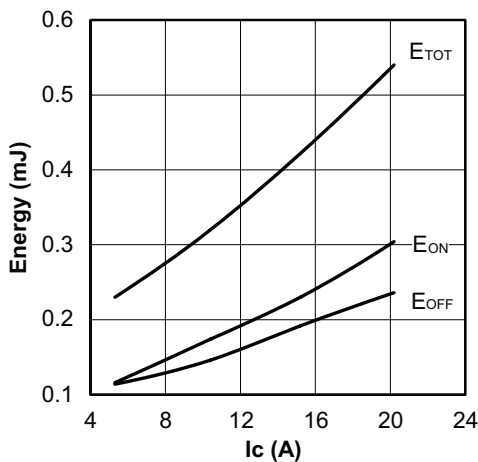


Fig. 28 - Typical Energy Loss vs. I_C
 $T_J = 125 \text{ }^\circ\text{C}$; $L = 500 \text{ } \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $R_G = 22 \text{ } \Omega$; $V_{GE} = 15 \text{ V}$

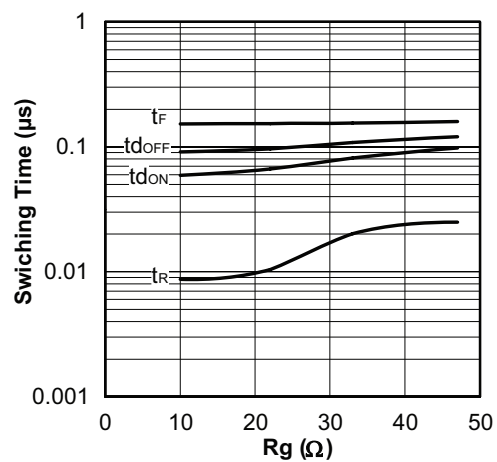


Fig. 31 - Typical Switching Time vs. R_G
 $T_J = 125 \text{ }^\circ\text{C}$; $L = 500 \text{ } \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $I_{CE} = 10 \text{ A}$; $V_{GE} = 15 \text{ V}$

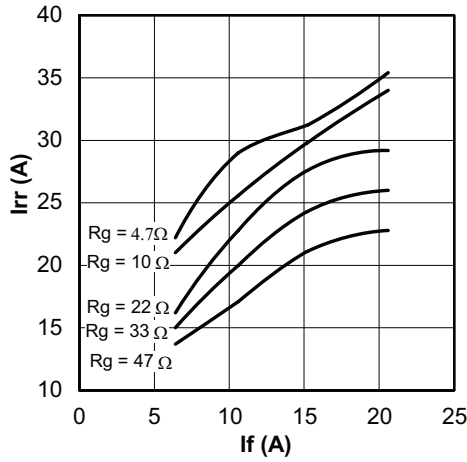


Fig. 32 - Typical Diode I_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

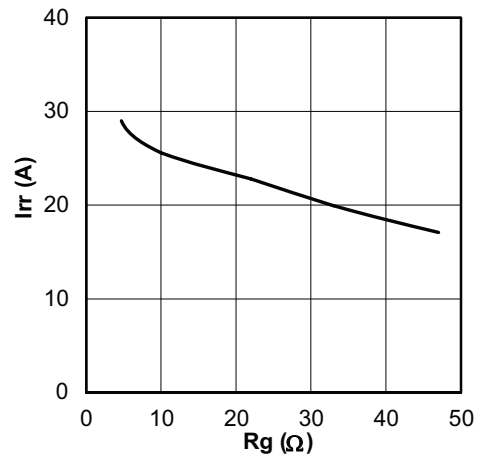


Fig. 33 - Typical Diode I_{RR} vs. R_G
 $T_J = 125^\circ\text{C}$; $I_F = 10\text{ A}$

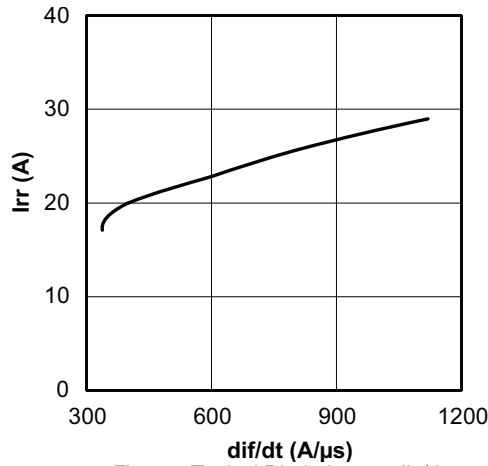


Fig. 34 - Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 300\text{ V}$; $V_{GE} = 15\text{ V}$; $I_{CE} = 10\text{ A}$; $T_J = 125^\circ\text{C}$

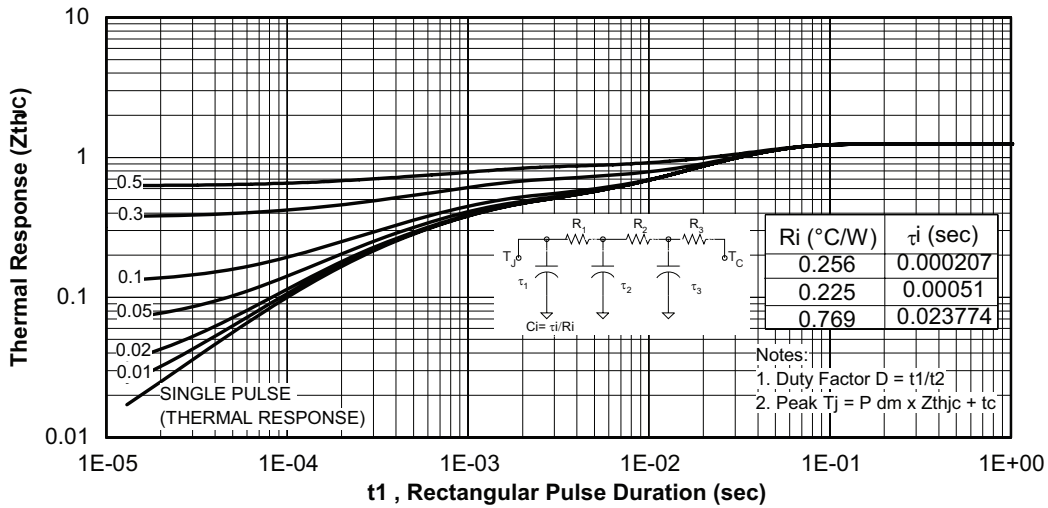


Fig. 35 - Maximum Transient Thermal Impedance, Junction to Case (Brake IGBT)

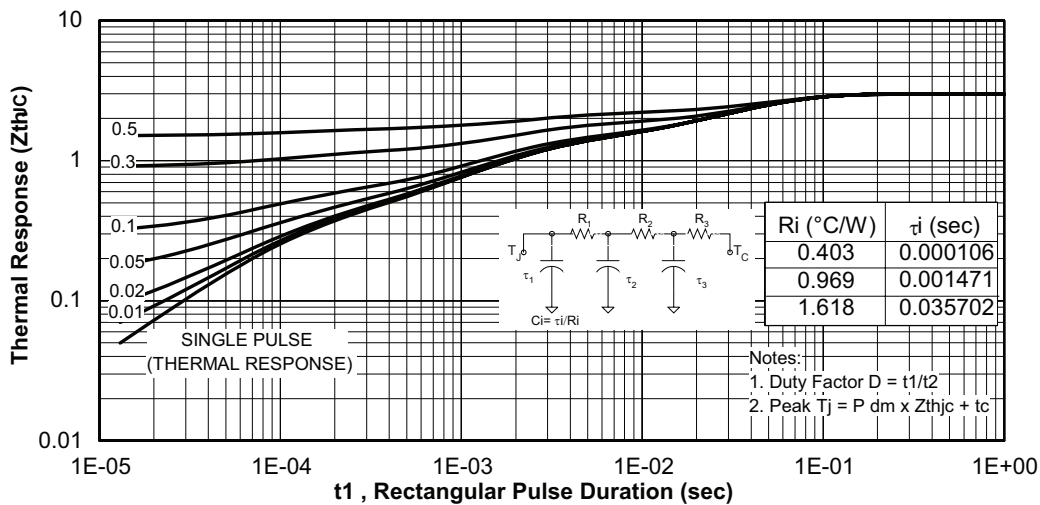


Fig. 36 - Maximum Transient Thermal Impedance, Junction to Case (Brake Diode)

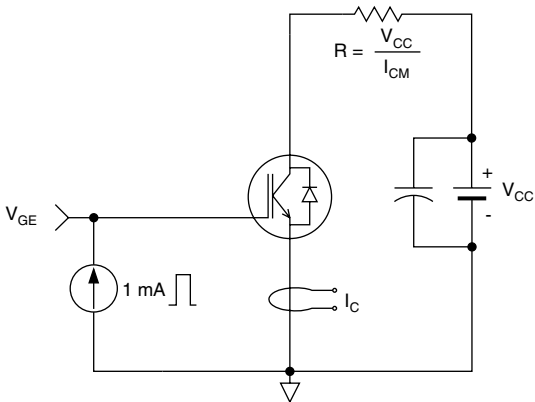


Fig. C.T.1 - Gate Charge Circuit (turn-off)

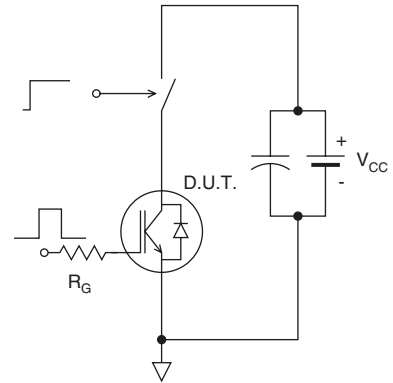


Fig. C.T.3 - S.C. SOA Circuit

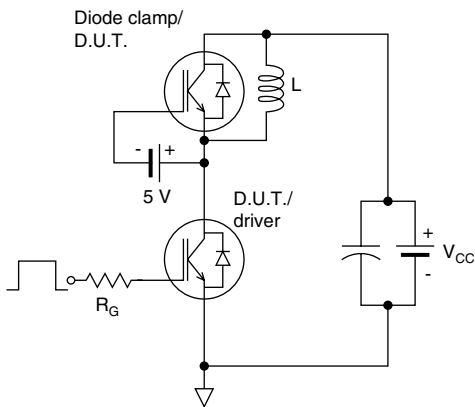


Fig. C.T.2 - RBSOA Circuit

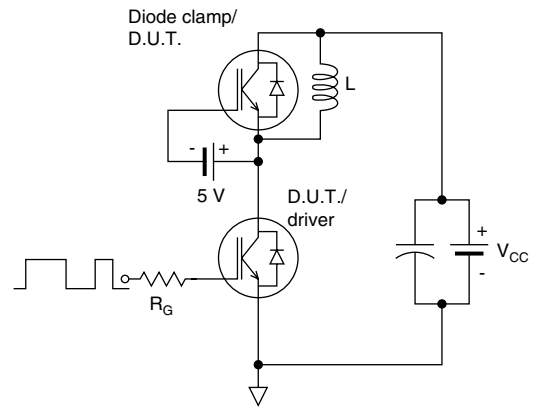


Fig. C.T.4 - Switching Loss Circuit

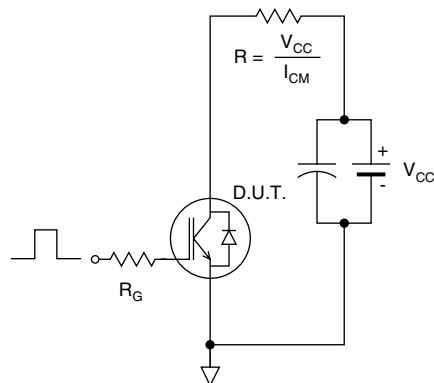
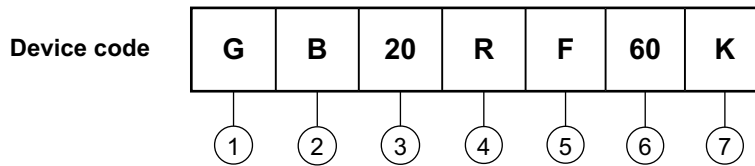


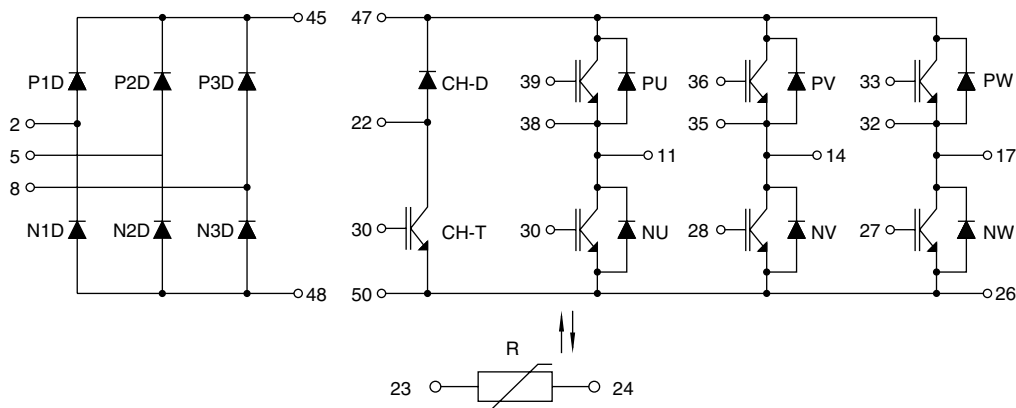
Fig. C.T.5 - Resistive Load Circuit

ORDERING INFORMATION TABLE



- 1** - Insulated Gate Bipolar Transistor (IGBT)
- 2** - B = IGBT Generation 5 NPT
- 3** - Current rating (20 = 20 A)
- 4** - Circuit configuration
(R = Three phase bridge-brake-inverter with thermistor)
- 5** - Package indicator (F = ECONO2)
- 6** - Voltage rating (60 = 600 V)
- 7** - Speed/type (K = Ultrafast IGBT/Speed 8 to 60 kHz)

CIRCUIT CONFIGURATION



LINKS TO RELATED DOCUMENTS

Dimensions	http://www.vishay.com/doc?95083
Part marking information	http://www.vishay.com/doc?95071



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