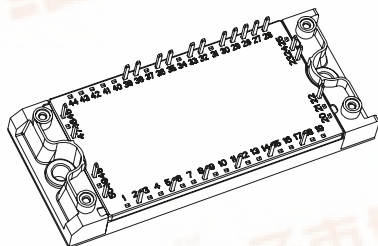


IGBT PIM Module, 12 A



ECONO2 PIM

PRODUCT SUMMARY

V_{CES}	600 V
$V_{CE(on)}$ (typical)	1.61 V
t_{sc} at $T_J = 150\text{ }^{\circ}\text{C}$	> 10 μs
I_C at $T_C = 80\text{ }^{\circ}\text{C}$	12 A

FEATURES

- Low $V_{CE(on)}$ non punch through IGBT technology
- Low diode V_F
- 10 μs 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

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	$T_C = 25\text{ }^{\circ}\text{C}$	20	A
			$T_C = 80\text{ }^{\circ}\text{C}$	12	
	Pulsed collector current See fig. C.T.5	I_{CM}		40	A
	Diode maximum forward current	I_{FM}	Pulsed	40	A
Input rectifier	Power dissipation	P_D	One IGBT $25\text{ }^{\circ}\text{C}$	100	W
	Repetitive peak reverse voltage	V_{RRM}		800	V
	Average output current	$I_{F(AV)}$	50/60 Hz sine pulse $80\text{ }^{\circ}\text{C}$	10	A
	Surge current (non-repetitive)	I_{FSM}	Rated V_{RRM} applied, 10 ms, sine pulse	310	
Brake	I^2t (non-repetitive)	I^2t		525	A^2s
	Collector to emitter voltage	V_{CES}		600	V
	Gate to emitter voltage	V_{GES}		± 20	
	Continuous collector current	I_C	$T_C = 25\text{ }^{\circ}\text{C}$	10	A
			$T_C = 80\text{ }^{\circ}\text{C}$	6	
	Pulsed collector current See fig. C.T.5	I_{CM}		20	A
	Power dissipation	P_D	One IGBT $25\text{ }^{\circ}\text{C}$	100	W
	Repetitive peak reverse voltage	V_{RRM}		600	V
	Maximum operating junction temperature	T_J		150	$^{\circ}\text{C}$
	Storage temperature range	T_{Stg}		- 40 to + 125	
	Isolation voltage	V_{ISOL}	AC (1 min)	2500	V

ELECTRICAL SPECIFICATIONS (T _J = 25 °C unless otherwise noted)							
	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Inverter IGBT	Collector to emitter breakdown voltage	BV _(CES)	V _{GE} = 0 V, I _C = 500 µA	600	-	-	V
	Temperature coefficient of breakdown voltage	ΔV _{(BR)CES} /ΔT _J	V _{GE} = 0 V, I _C = 1 mA (25 °C to 125 °C)	-	0.25	-	V/°C
	Collector to emitter voltage	V _{CE(on)}	I _C = 10 A, V _{GE} = 15 V	-	1.61	1.86	V
			I _C = 20 A, V _{GE} = 15 V	-	2.10	2.49	
			I _C = 10 A, V _{GE} = 15 V, T _J = 125 °C	-	1.79	1.97	
			I _C = 20 A, V _{GE} = 15 V, T _J = 125 °C	-	2.45	2.72	
	Gate threshold voltage	V _{GE(th)}	V _{CE} = V _{GE} , I _C = 250 µA	4	-	6	
	Threshold voltage temperature coefficient	ΔV _{GE(th)} /ΔT _J	V _{CE} = V _{GE} , I _C = 1 mA (25 °C to 125 °C)	-	- 9.1	-	mV/°C
	Zero gate voltage collector current	I _{CES}	V _{GE} = 0 V, V _{CE} = 600 V	-	-	100	µA
			V _{GE} = 0 V, V _{CE} = 600 V T _J = 125 °C	-	250	-	
	Gate to emitter leakage current	I _{GES}	V _{GE} = ± 20 V	-	-	± 200	nA
	Total gate charge (turn-on)	Q _G	I _C = 10 A V _{CC} = 300 V V _{GE} = 15 V	-	51	76	nC
	Gate to emitter charge (turn-on)	Q _{GE}		-	12	18	
	Gate to collector charge (turn-on)	Q _{GC}		-	19	28	
	Turn-on switching loss	E _{on}	I _C = 10 A, V _{CC} = 300 V V _{GE} = 15 V, R _G = 22 Ω L = 500 µH, T _J = 25 °C ⁽¹⁾	-	0.19	0.29	mJ
	Turn-off switching loss	E _{off}		-	0.11	0.17	
	Total switching loss	E _{tot}		-	0.30	0.45	
	Turn-on switching loss	E _{on}	I _C = 10 A, V _{CC} = 300 V V _{GE} = 15 V, R _G = 22 Ω L = 500 µH, T _J = 125 °C ⁽¹⁾	-	0.24	0.36	
	Turn-off switching loss	E _{off}		-	0.18	0.28	
	Total switching loss	E _{tot}		-	0.42	0.63	
	Turn-on delay time	t _{d(on)}	I _C = 10 A, V _{CC} = 300 V V _{GE} = 15 V, R _G = 22 Ω L = 500 µH, T _J = 125 °C	-	87	131	ns
	Rise time	t _r		-	17	26	
	Turn-off delay time	t _{d(off)}		-	116	174	
	Fall time	t _f		-	161	242	
	Input capacitance	C _{ies}	V _{GE} = 0 V	-	900	1350	pF
	Output capacitance	C _{oes}	V _{CC} = 30 V	-	263	395	
	Reverse transfer capacitance	C _{res}	f = 1 MHz	-	30	45	
Inverter IGBT	Reverse bias safe operating area	RBSOA	T _J = 125 °C, I _C = 40 A R _G = 22 Ω, V _{GE} = 15 V to 0	Fullsquare			
	Short circuit safe operating area	SCSOA	T _J = 150 °C V _{CC} = 300 V, V _P = 600 V R _G = 22 Ω, V _{GE} = 15 V to 0 V	10	-	-	µs
Inverter Diode	Diode peak reverse recovery current	I _{rr}	T _J = 125 °C V _{CC} = 300 V, I _F = 10 A, L = 500 µH R _G = 22 Ω, V _{GE} = 15 V	-	23	-	A
	Diode forward voltage drop	V _{FM}	I _F = 10 A	-	1.23	1.49	V
			I _F = 20 A	-	1.43	1.84	
			I _F = 10 A, T _J = 125 °C	-	1.18	1.44	
			I _F = 20 A, T _J = 125 °C	-	1.44	1.79	

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}	$I_F = 10\text{ A}$	-	-	1.04	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	$T_J = 150\text{ }^{\circ}\text{C}$	-	12.7	-	m Ω
	Conduction threshold voltage	$V_{F(TO)}$		-	0.70	-	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 $125\text{ }^{\circ}\text{C}$)	-	0.25	-	V/ $^{\circ}\text{C}$
	Collector to emitter voltage	$V_{CE(on)}$	$I_C = 5\text{ A}$, $V_{GE} = 15\text{ V}$	-	1.29	1.43	V
			$I_C = 10\text{ A}$, $V_{GE} = 15\text{ V}$	-	1.61	1.80	
			$I_C = 5\text{ A}$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.37	1.49	
			$I_C = 10\text{ A}$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.80	2.0	
	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
			$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$ $T_J = 125\text{ }^{\circ}\text{C}$	-	150	-	
	Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 200	nA
	Total gate charge (turn-on)	Q_G	$I_C = 5\text{ A}$ $V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}$	-	53	79	nC
	Gate to emitter charge (turn-on)	Q_{GE}		-	11	17	
	Gate to collector charge (turn-on)	Q_{GC}		-	18	27	
	Turn-on switching loss	E_{on}	$I_C = 5\text{ A}$, $V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}$, $R_G = 22\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$, $T_J = 25\text{ }^{\circ}\text{C}$ ⁽¹⁾	-	0.11	0.16	mJ
	Turn-off switching loss	E_{off}		-	0.10	0.14	
	Total switching loss	E_{tot}		-	0.20	0.30	
	Turn-on switching loss	E_{on}	$I_C = 5\text{ A}$, $V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}$, $R_G = 22\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$, $T_J = 125\text{ }^{\circ}\text{C}$ ⁽¹⁾	-	0.13	0.20	
	Turn-off switching loss	E_{off}		-	0.17	0.25	
	Total switching loss	E_{tot}		-	0.30	0.45	
	Turn-on delay time	$t_{d(on)}$	$I_C = 5\text{ A}$, $V_{CC} = 300\text{ V}$ $V_{GE} = 15\text{ V}$, $R_G = 22\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	86	129	ns
	Rise time	t_r		-	12	18	
	Turn-off delay time	$t_{d(off)}$		-	117	176	
	Fall time	t_f		-	184	276	
Brake IGBT	Input capacitance	C_{ies}	$V_{GE} = 0\text{ V}$ $V_{CC} = 30\text{ V}$ $f = 1\text{ MHz}$	-	900	1350	pF
	Output capacitance	C_{oes}		-	263	395	
	Reverse transfer capacitance	C_{res}		-	30	45	
	Reverse bias safe operating area	RB SOA	$T_J = 150\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$ $R_G = 22\text{ }\Omega$, $V_{GE} = 15\text{ V}$ to 0	Fullsquare			
	Short circuit safe operating area	SC SOA	$T_J = 150\text{ }^{\circ}\text{C}$ $V_{CC} = 300\text{ V}$, $V_P = 600\text{ V}$ $R_G = 22\text{ }\Omega$, $V_{GE} = 15\text{ V}$ 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}	$V_{CC} = 300\text{ V}$, $I_F = 5\text{ A}$, $L = 500\text{ }\mu\text{H}$ $V_{GE} = 15\text{ V}$ to 0, $R_G = 22\text{ }\Omega$	-	18	-	A
	Diode forward voltage drop	V_{FM}	$I_F = 5\text{ A}$	-	1.22	1.46	V
			$I_F = 10\text{ A}$	-	1.41	1.70	
			$I_F = 5\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.16	1.43	
			$I_F = 10\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.41	1.74	
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}	-	-	1.25	$^{\circ}\text{C}/\text{W}$
Junction to case inverter FRED thermal resistance		-	-	2.44	
Junction to case brake DIODE thermal resistance		-	-	3.08	
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

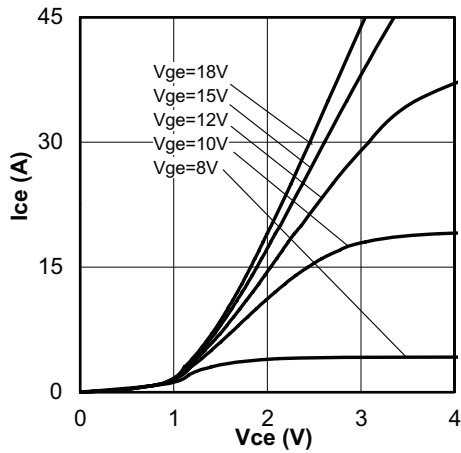


Fig. 1 - Typical IGBT Output Characteristics
 $T_J = 25\text{ }^{\circ}\text{C}$; $t_p = 80\text{ }\mu\text{s}$

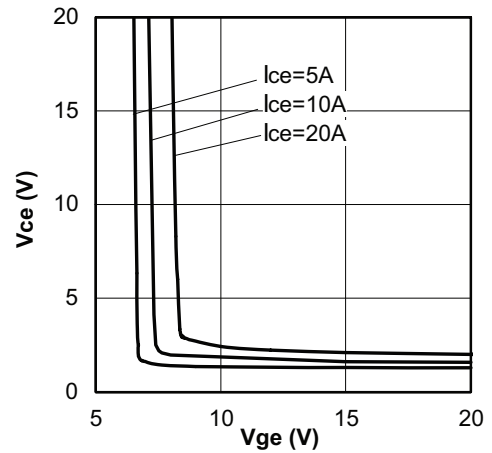


Fig. 4 - Typical V_{CE} vs. V_{GE}
 $T_J = 25\text{ }^{\circ}\text{C}$

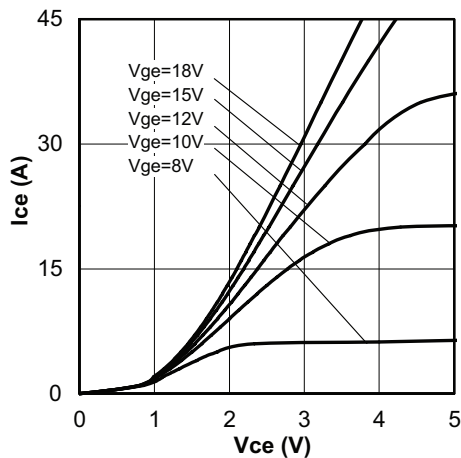


Fig. 2 - Typical IGBT Output Characteristics
 $T_J = 125\text{ }^{\circ}\text{C}$; $t_p = 80\text{ }\mu\text{s}$

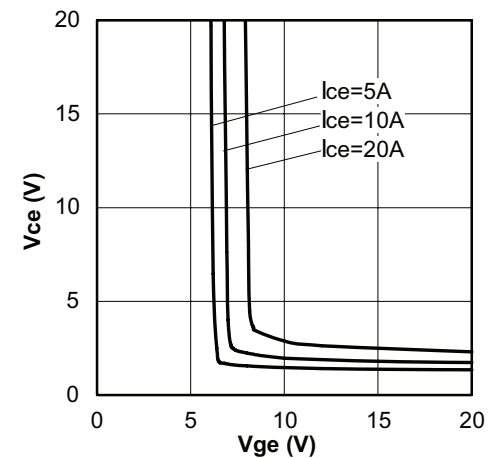


Fig. 5 - Typical V_{CE} vs. V_{GE}
 $T_J = 125\text{ }^{\circ}\text{C}$

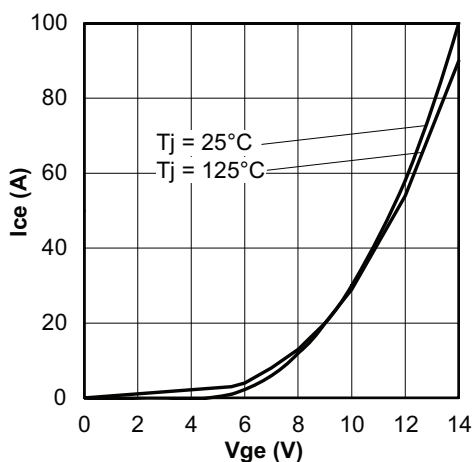


Fig. 3 - Typical Transfer Characteristics
 $V_{CE} = 50\text{ V}$; $t_p = 10\text{ }\mu\text{s}$

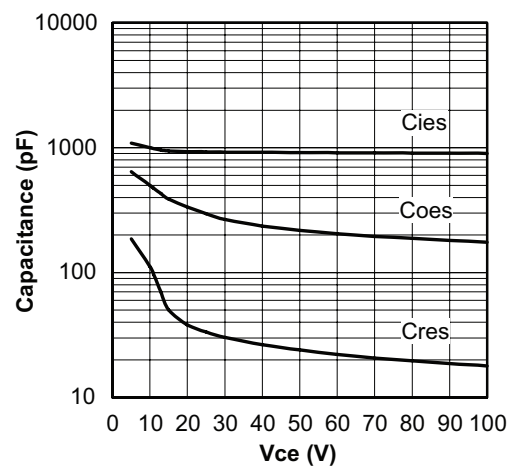


Fig. 6 - Typical Capacitance vs. V_{CE}
 $V_{GE} = 0\text{ V}$; $f = 1\text{ MHz}$

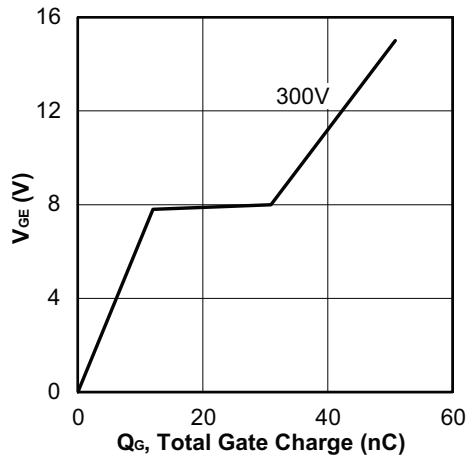


Fig. 7 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 10 \text{ A}$

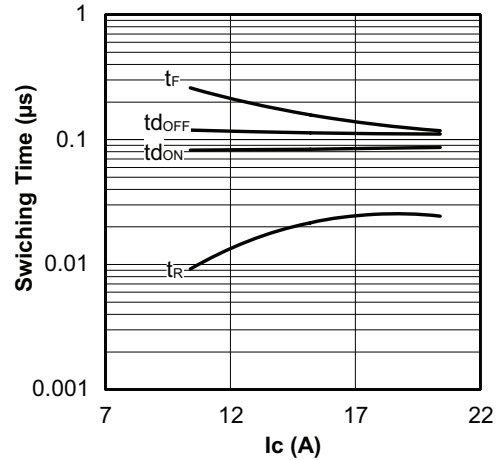


Fig. 10 - Typical Switching Time vs. I_C
 $T_J = 125^\circ\text{C}$; $L = 500 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $R_G = 22 \Omega$; $V_{GE} = 15 \text{ V}$

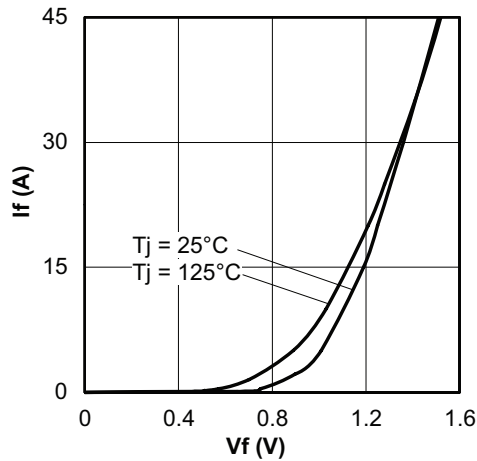


Fig. 8 - Typical Diode Forward Characteristics
 $t_p = 80 \mu\text{s}$

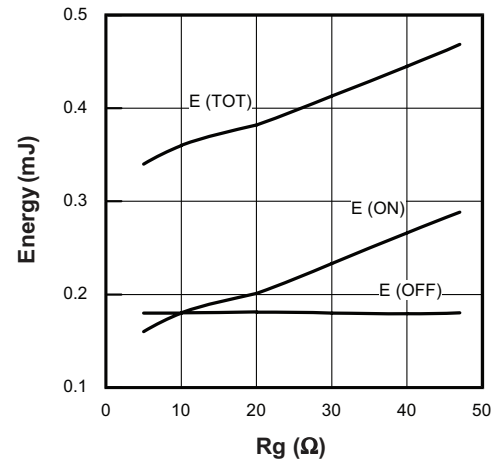


Fig. 11 - Typical Energy Loss vs. R_G
 $T_J = 125^\circ\text{C}$; $L = 500 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $I_{CE} = 10 \text{ A}$; $V_{GE} = 15 \text{ V}$

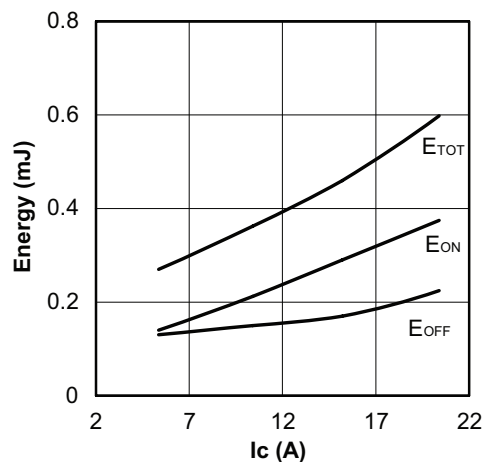


Fig. 9 - Typical Energy Loss vs. I_C
 $T_J = 125^\circ\text{C}$; $L = 500 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $R_G = 22 \Omega$; $V_{GE} = 15 \text{ V}$

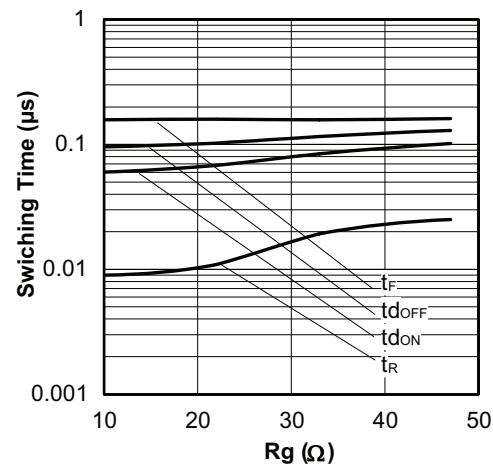


Fig. 12 - Typical Switching Time vs. R_G
 $T_J = 125^\circ\text{C}$; $L = 500 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $I_{CE} = 10 \text{ A}$; $V_{GE} = 15 \text{ V}$

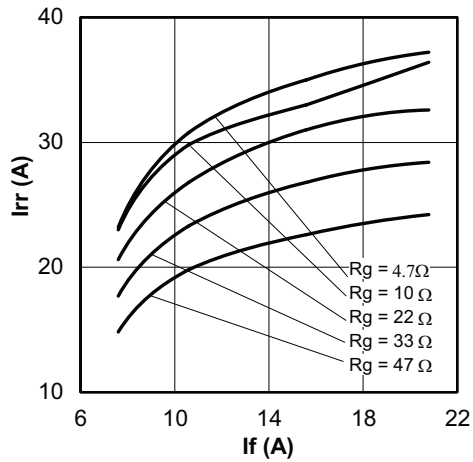


Fig. 13 - Typical Diode I_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

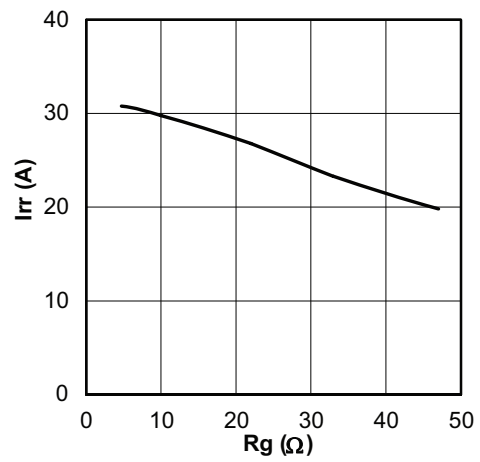


Fig. 14 - Typical Diode I_{RR} vs. R_G
 $T_J = 125^\circ\text{C}$; $I_F = 10\text{ A}$

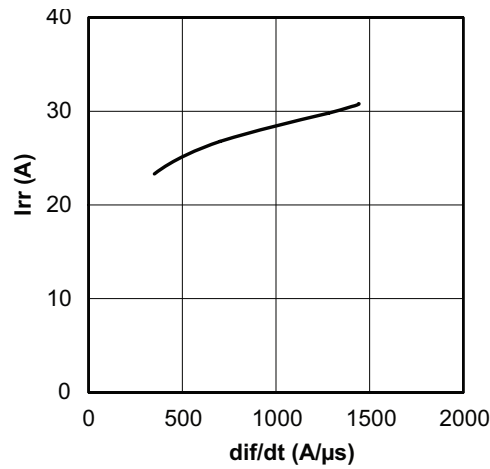


Fig. 15 - Typical Diode I_{RR} vs. dI_F/dt
 $V_{CC} = 300\text{ V}$; $V_{GE} = 15\text{ V}$; $I_F = 10\text{ A}$; $T_J = 125^\circ\text{C}$

THERMISTOR

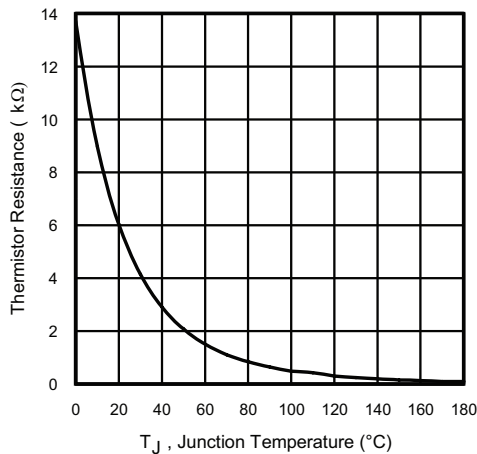


Fig. 16 - Thermistor Resistance vs. Temperature

INPUT RECTIFIER

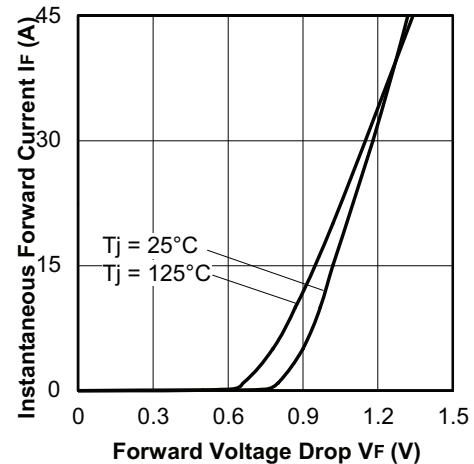


Fig. 17 - Typical Diode Forward Characteristics
 $t_p = 80\text{ }\mu\text{s}$

INVERTER

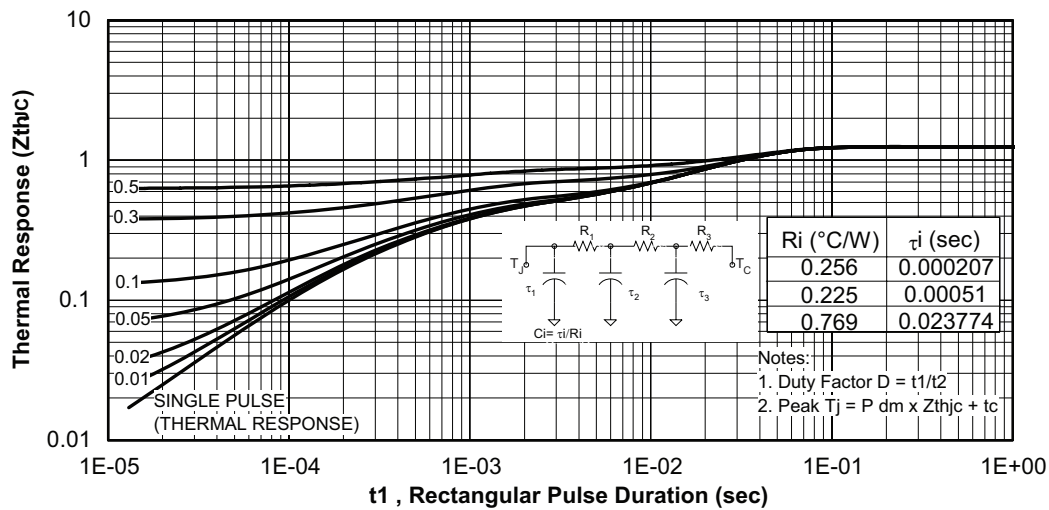


Fig. 18 - Maximum Transient Thermal Impedance, Junction to Case (Inverter IGBT)

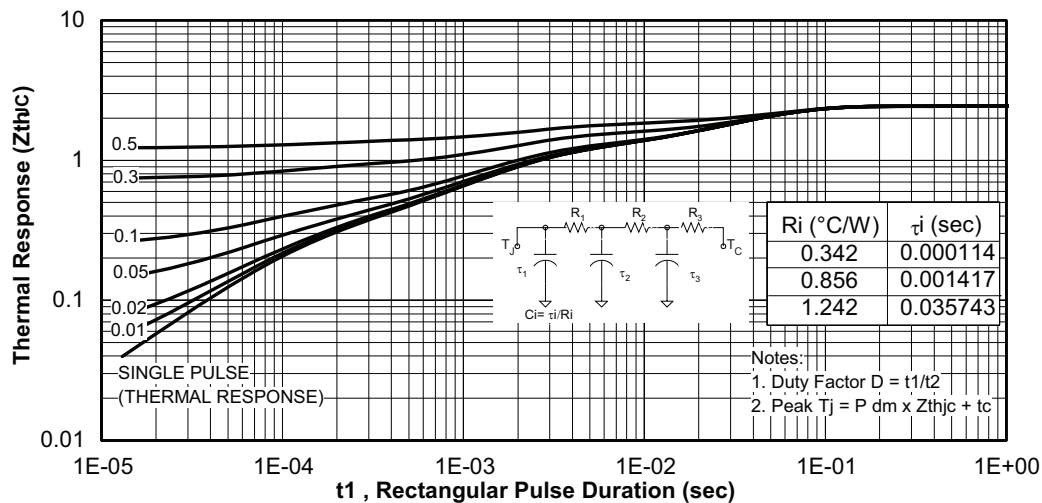


Fig. 19 - Maximum Transient Thermal Impedance, Junction to Case (Inverter FRED)

BRAKE

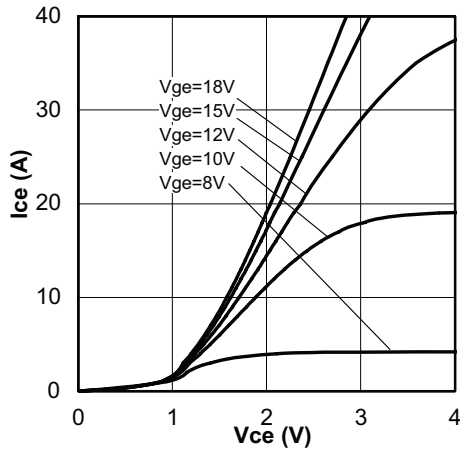


Fig. 20 - Typical IGBT Output Characteristics
 $T_J = 25\text{ °C}$; $t_p = 80\text{ μs}$

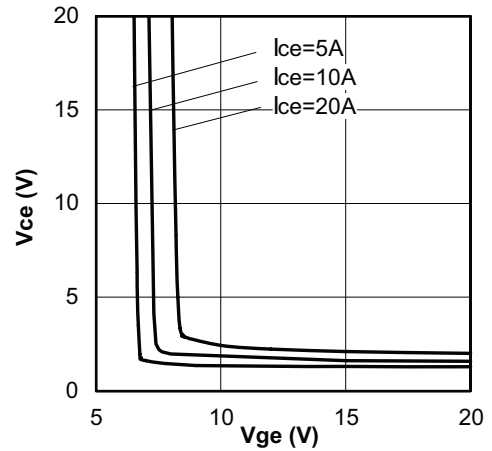


Fig. 23 - Typical V_{CE} vs. V_{GE}
 $T_J = 25\text{ °C}$

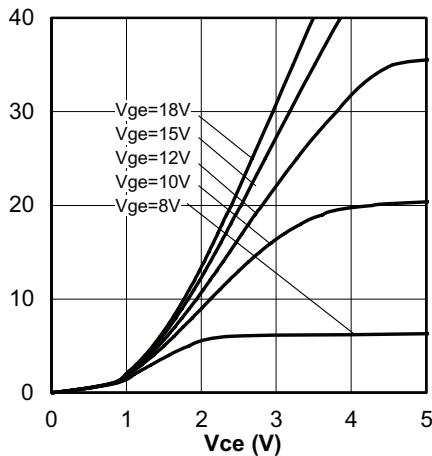


Fig. 21 - Typical IGBT Output Characteristics
 $T_J = 125\text{ °C}$; $t_p = 80\text{ μs}$

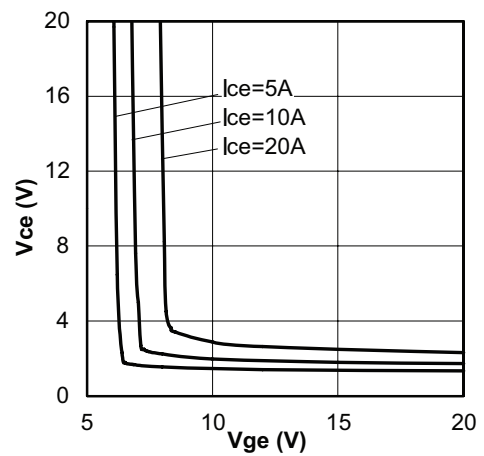


Fig. 24 - Typical V_{CE} vs. V_{GE}
 $T_J = 125\text{ °C}$

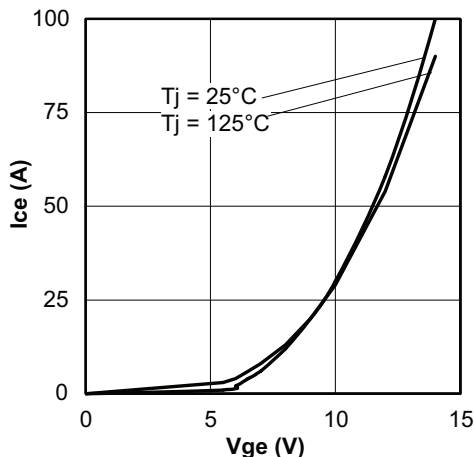


Fig. 22 - Typical Transfer Characteristics
 $V_{CE} = 50\text{ V}$; $t_p = 10\text{ μs}$

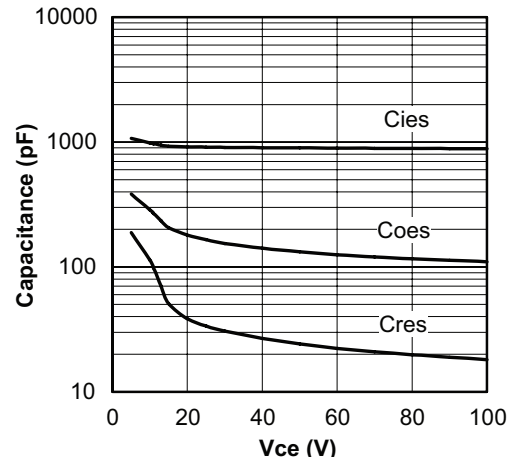


Fig. 25 - Typical Capacitance vs. V_{CE}
 $V_{GE} = 0\text{ V}$; $f = 1\text{ MHz}$

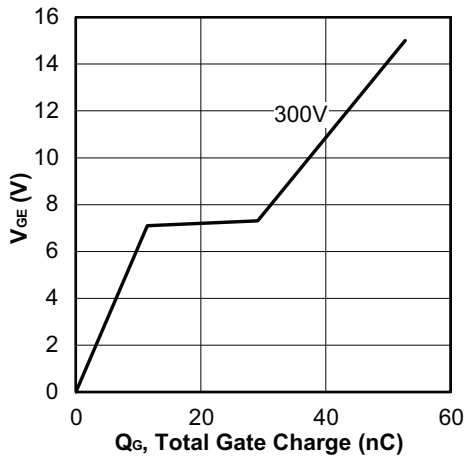


Fig. 26 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 5 \text{ A}$

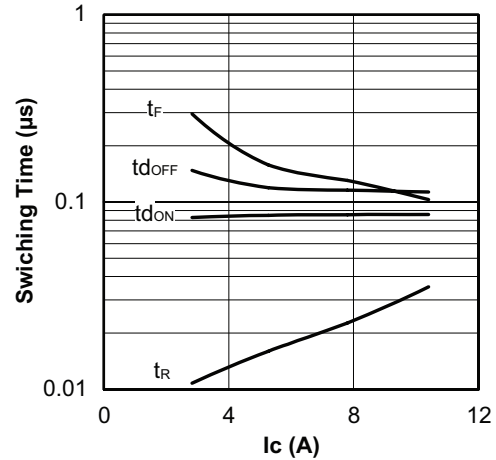


Fig. 29 - Typical Switching Time vs. I_C
 $T_J = 125^\circ\text{C}$; $L = 500 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $R_G = 22 \Omega$; $V_{GE} = 15 \text{ V}$

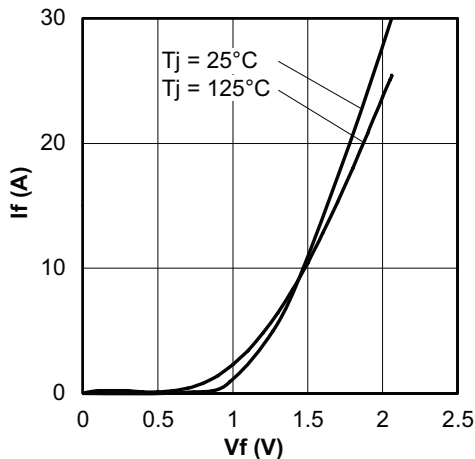


Fig. 27 - Typical Diode Forward Characteristics
 $t_p = 80 \mu\text{s}$

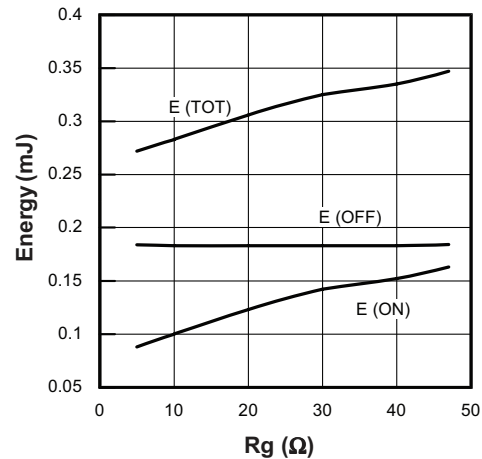


Fig. 30 - Typical Energy Loss vs. R_G
 $T_J = 125^\circ\text{C}$; $L = 500 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $I_{CE} = 5 \text{ A}$; $V_{GE} = 15 \text{ V}$

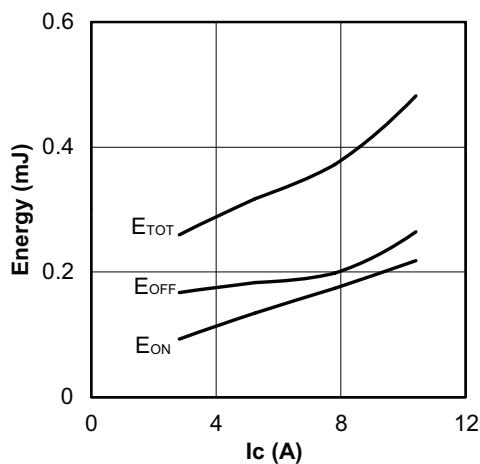


Fig. 28 - Typical Energy Loss vs. I_C
 $T_J = 125^\circ\text{C}$; $L = 500 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $R_G = 22 \Omega$; $V_{GE} = 15 \text{ V}$

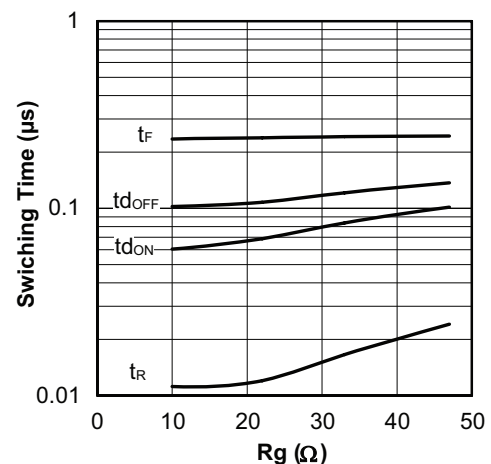


Fig. 31 - Typical Switching Time vs. R_G
 $T_J = 125^\circ\text{C}$; $L = 500 \mu\text{H}$; $V_{CE} = 300 \text{ V}$; $I_{CE} = 5 \text{ A}$; $V_{GE} = 15 \text{ V}$

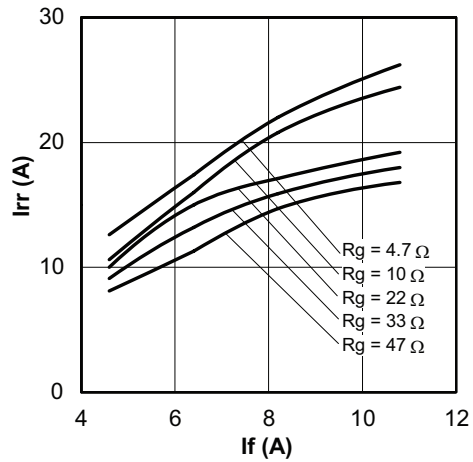


Fig. 32 - Typical Diode I_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

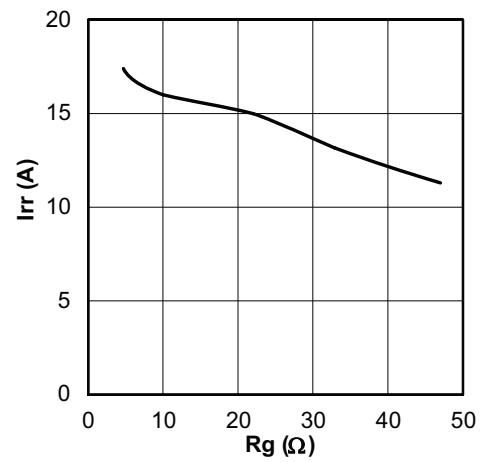


Fig. 33 - Typical Diode I_{RR} vs. R_G
 $T_J = 125^\circ\text{C}; I_F = 5\text{ A}$

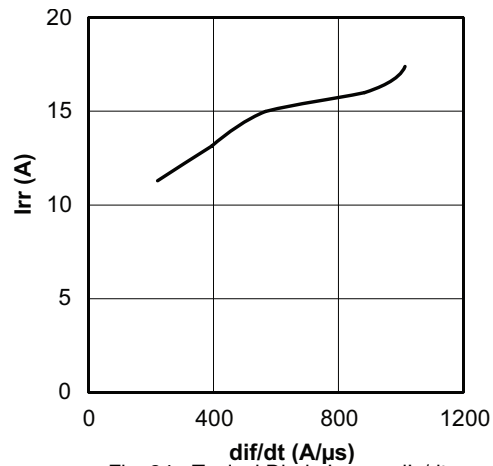


Fig. 34 - Typical Diode I_{RR} vs. dI_F/dt
 $V_{CC} = 300\text{ V}; V_{GE} = 15\text{ V}; I_{CE} = 5\text{ A}; T_J = 125^\circ\text{C}$

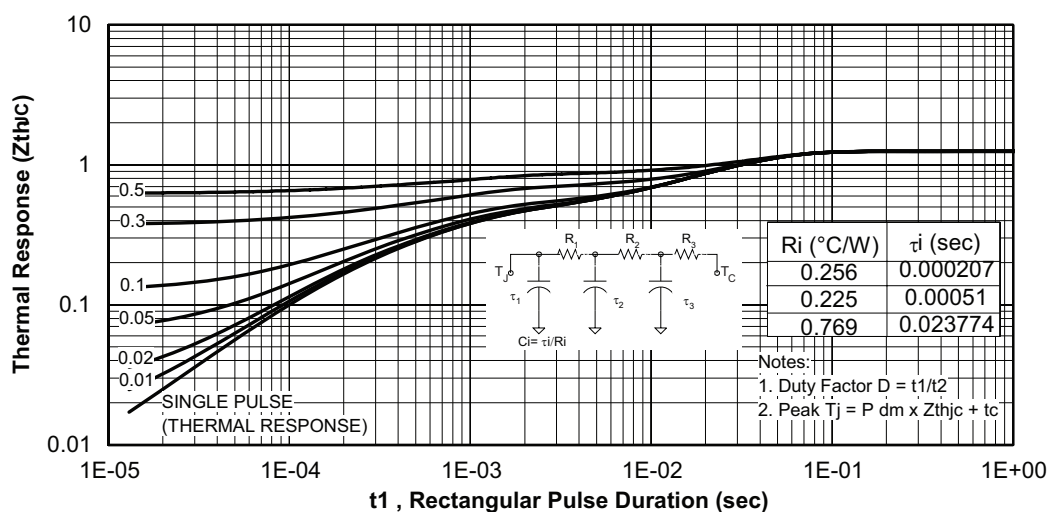


Fig. 35 - Maximum Transient Thermal Impedance, Junction to Case (Brake IGBT)

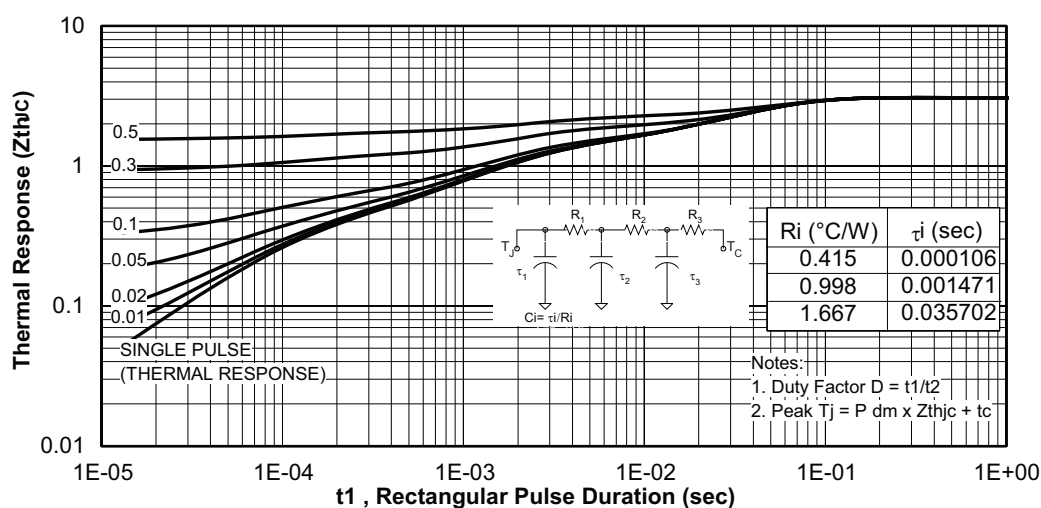


Fig. 36 - Maximum Transient Thermal Impedance, Junction to Case (Brake Diode)

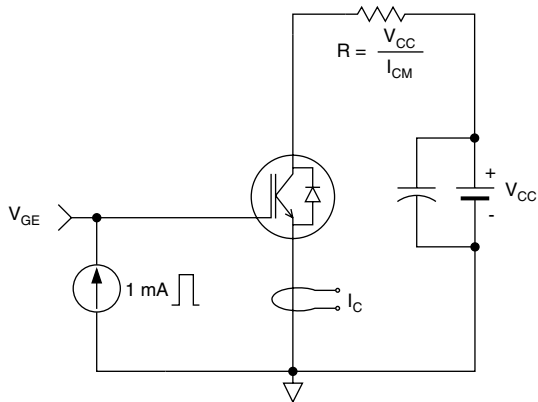


Fig. C.T.1 - Gate Charge Circuit (turn-off)

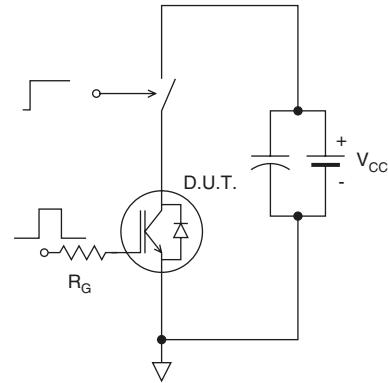


Fig. C.T.3 - S.C. SOA Circuit

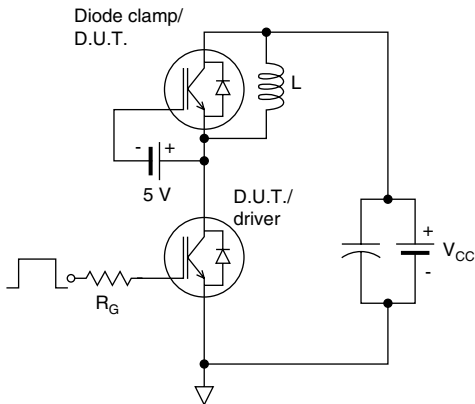


Fig. C.T.2 - RBSOA Circuit

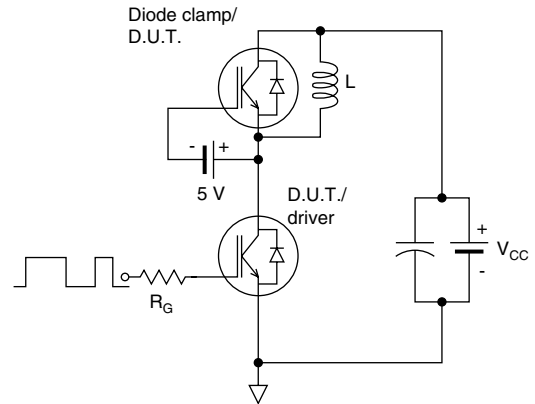


Fig. C.T.4 - Switching Loss Circuit

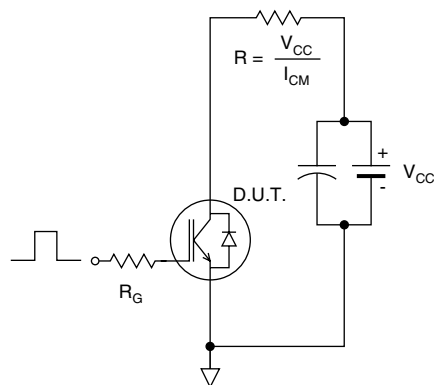


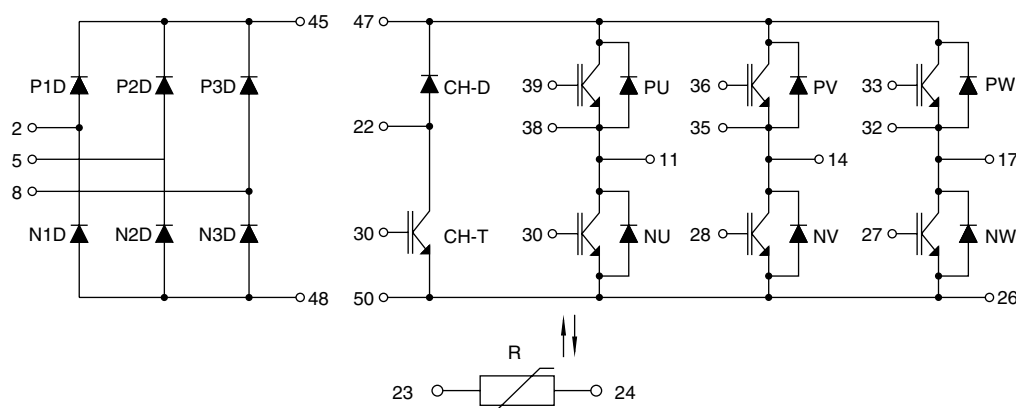
Fig. C.T.5 - Resistive Load Circuit

ORDERING INFORMATION TABLE

Device code	G	B	10	R	F	60	K
	1	2	3	4	5	6	7

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