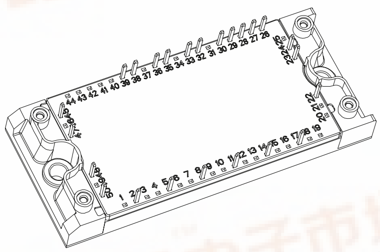
IGBT PIM Module, 21 A



ECONO2 PIM

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

Pb-free
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

PRODUCT SUMMARY	
V_{CES}	600 V
$V_{CE(on)}$ (typical)	1.89 V
t_{sc} at T_J = 150 °C	> 10 µs
I_C at T_C = 80 °C	21 A

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 °C		30	A
			T_C = 80 °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 °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 °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^2s
Brake	Collector to emitter voltage	V_{CES}			600	V
	Gate to emitter voltage	V_{GES}			± 20	
	Continuous collector current	I_C	T_C = 25 °C		20	A
			T_C = 80 °C		11	
	Pulsed collector current See fig. C.T.5	I_{CM}			40	A
	Power dissipation	P_D	One IGBT	25 °C	100	W
	Repetitive peak reverse voltage	V_{RRM}			600	V
	Maximum operating junction temperature	T_J			150	°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	$\Delta V_{(BR)CES}/\Delta T_J$	V_{GE} = 0 V, I_C = 1 mA (25 °C to 125 °C)	-	0.6	-	V/°C
	Collector to emitter voltage	$V_{CE(on)}$	I_C = 20 A, V_{GE} = 15 V	-	1.89	2.16	V
			I_C = 30 A, V_{GE} = 15 V	-	2.24	2.58	
			I_C = 20 A, V_{GE} = 15 V, T_J = 125 °C	-	2.16	2.65	
			I_C = 30 A, V_{GE} = 15 V, T_J = 125 °C	-	2.63	3.22	
	Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 250 µA	4	-	6	
	Threshold voltage temperature coefficient	$\Delta V_{GE(th)}/\Delta T_J$	V_{CE} = V_{GE}, I_C = 1 mA (25 °C to 125 °C)	-	- 9.6	-	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	-	500	-	
	Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V	-	-	± 200	nA
	Total gate charge (turn-on)	Q_G	I_C = 20 A V_{CC} = 300 V V_{GE} = 15 V	-	72	108	nC
	Gate to emitter charge (turn-on)	Q_{GE}		-	16	24	
	Gate to collector charge (turn-on)	Q_{GC}		-	24	36	
	Turn-on switching loss	E_{on}	I_C = 20 A, V_{CC} = 300 V V_{GE} = 15 V, R_G = 22 Ω L = 200 µH, T_J = 25 °C (1)	-	0.28	0.41	mJ
	Turn-off switching loss	E_{off}		-	0.17	0.25	
	Total switching loss	E_{tot}		-	0.44	0.67	
	Turn-on switching loss	E_{on}	I_C = 20 A, V_{CC} = 300 V V_{GE} = 15 V, R_G = 22 Ω L = 200 µH, T_J = 125 °C (1)	-	0.40	0.59	
	Turn-off switching loss	E_{off}		-	0.17	0.25	
	Total switching loss	E_{tot}		-	0.56	0.84	
	Turn-on delay time	$t_{d(on)}$	I_C = 20 A, V_{CC} = 300 V V_{GE} = 15 V, R_G = 22 Ω L = 200 µH, T_J = 125 °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 V V_{CC} = 30 V f = 1 MHz	-	1316	1974	pF
	Output capacitance	C_{oes}		-	335	502	
	Reverse transfer capacitance	C_{res}		-	40	60	
Inverter IGBT	Reverse bias safe operating area	RBSOA	T_J = 125 °C, I_C = 50 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 = 20 A, L = 200 µH R_G = 22 Ω, V_{GE} = 15 V	-	36	-	A
	Diode forward voltage drop	V_{FM}	I_F = 20 A	-	1.26	1.57	V
			I_F = 30 A	-	1.38	1.80	
			I_F = 20 A, T_J = 125 °C	-	1.21	1.52	
			I_F = 30 A, T_J = 125 °C	-	1.36	1.78	

ELECTRICAL SPECIFICATIONS (T_J = 25 °C unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Rectifier	Maximum forward voltage drop	V_{FM}	I_F = 20 A	-	-	1.18	V
	Maximum reverse leakage current	I_{RM}	T_J = 25 °C, V_R = 800 V	-	-	0.2	mA
			T_J = 150 °C, V_R = 800 V	-	-	1	
	Forward slope resistance	r_T	T_J = 150 °C	-	9.8	-	mΩ
	Conduction thresold voltage	$V_{F\ (TO)}$		-	0.75	-	V
Brake IGBT	Collector to emitter breakdown voltage	$BV_{(CES)}$	V_{GE} = 0 V, I_C = 500 µA	600	-	-	
	Temperature coefficient of breakdown voltage	$\Delta V_{(BR)CES}/\Delta T_J$	V_{GE} = 0 V, I_C = 1 mA (25 °C to 125 °C)	-	0.6	-	V/°C
	Collector to emitter voltage	$V_{CE(on)}$	I_C = 10 A, V_{GE} = 15 V	-	1.59	1.69	V
			I_C = 20 A, V_{GE} = 15 V	-	2.06	2.24	
			I_C = 10 A, V_{GE} = 15 V, T_J = 125 °C	-	1.79	2.37	
			I_C = 20 A, V_{GE} = 15 V, T_J = 125 °C	-	2.46	2.79	
	Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 250 µA	4	-	6	
	Threshold voltage temperature coefficient	$\Delta V_{GE(th)}/\Delta T_J$	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	-	300	-	
	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	-	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 A, V_{CC} = 300 V V_{GE} = 15 V, R_G = 22 Ω L = 500 µH, T_J = 25 °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 A, V_{CC} = 300 V V_{GE} = 15 V, R_G = 22 Ω L = 500 µH, T_J = 125 °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 A, V_{CC} = 300 V V_{GE} = 15 V, R_G = 22 Ω L = 500 µH, T_J = 125 °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 V V_{CC} = 30 V f = 1 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 °C, I_C = 20 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	10	-	-	µs

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

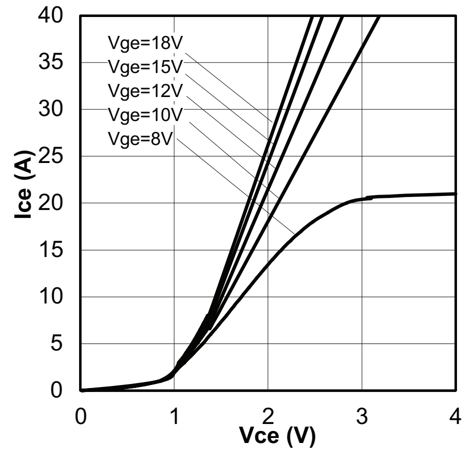


Fig. 1 - Typical IGBT Output Characteristics
T_J = 25 °C; t_p = 80 µs

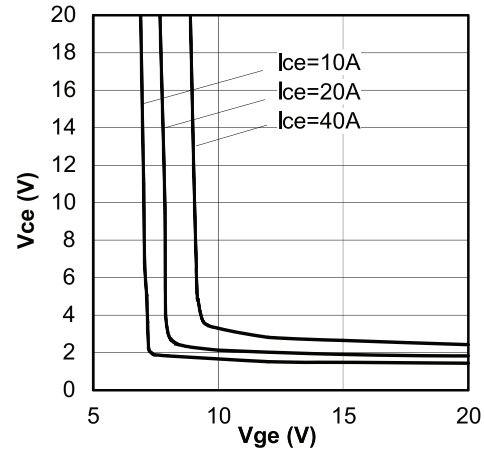


Fig. 4 - Typical V_{CE} vs. V_{GE}
T_J = 25 °C

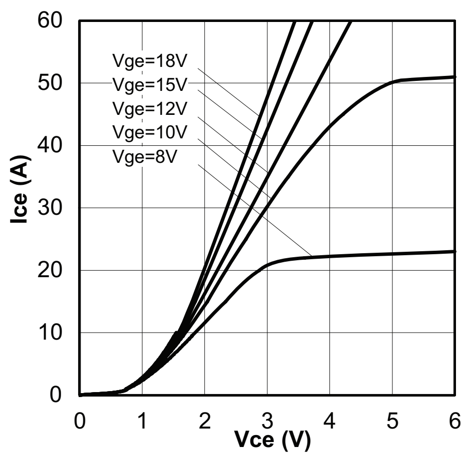


Fig. 2 - Typical IGBT Output Characteristics
T_J = 125 °C, t_p = 80 µs

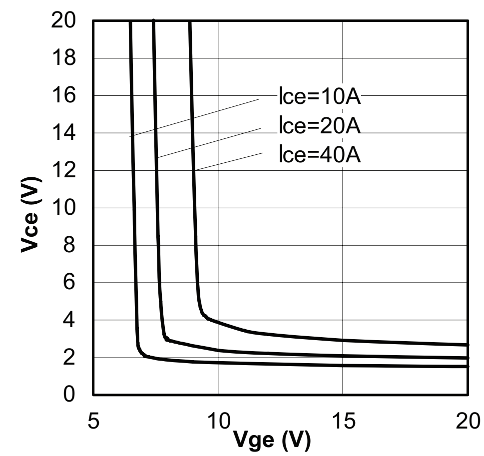


Fig. 5 - Typical V_{CE} vs. V_{GE}
T_J = 125 °C

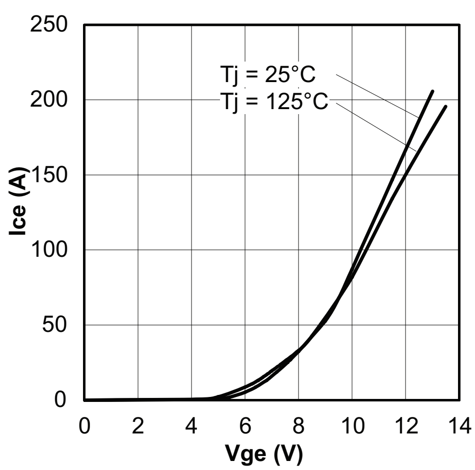


Fig. 3 - Typical Transfer Characteristics
V_{CE} = 50 V; t_p = 10 µs

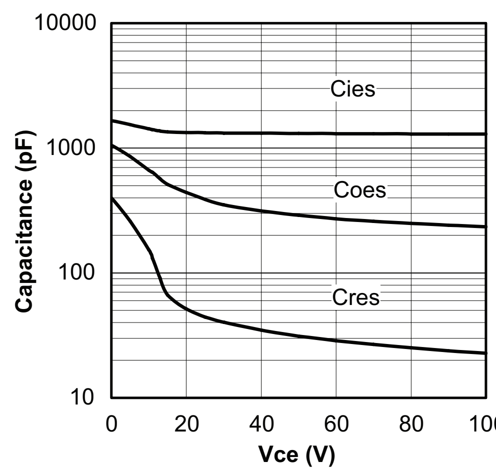


Fig. 6 - Typical Capacitance vs. V_{CE}
V_{GE} = 0 V; f = 1 MHz

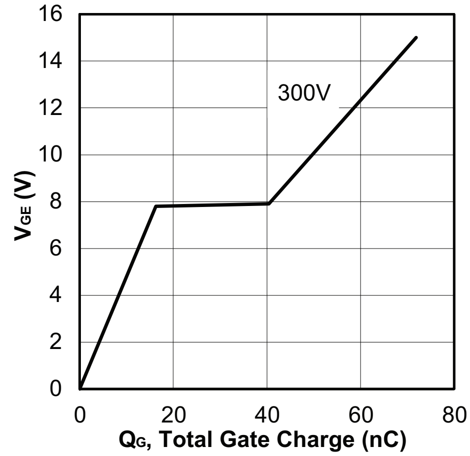


Fig. 7 - Typical Gate Charge vs. V_{GE}
I_{CE} = 20 A

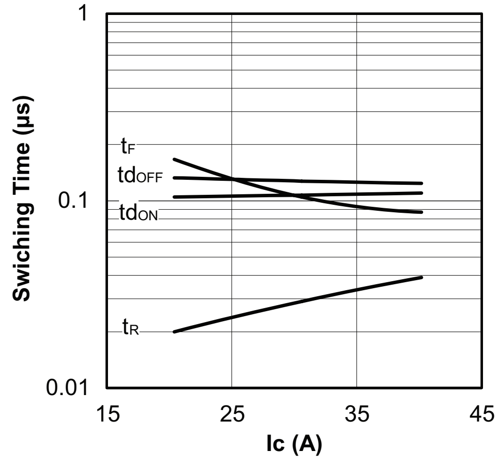


Fig. 10 - Typical Switching Time vs. I_C
T_J = 125 °C; L = 200 µH; V_{CE} = 300 V; R_G = 22 Ω; V_{GE} = 15 V

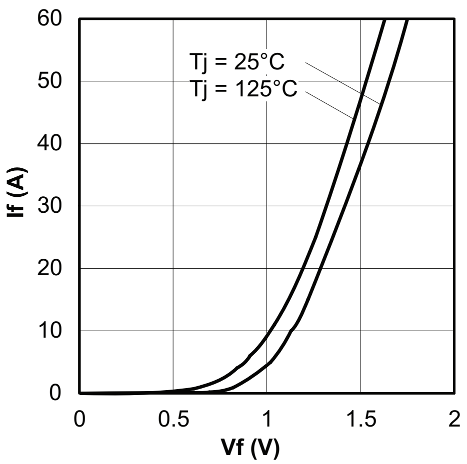


Fig. 8 - Typical Diode Forward Characteristics
t_p = 80 µs

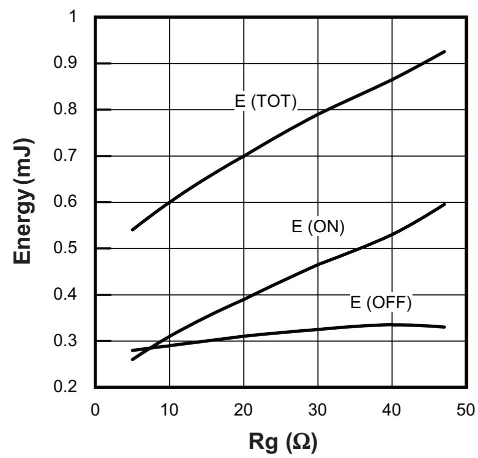


Fig. 11 - Typical Energy Loss vs. R_G
T_J = 125 °C; L = 200 µH; V_{CE} = 300 V; I_{CE} = 20 A; V_{GE} = 15 V

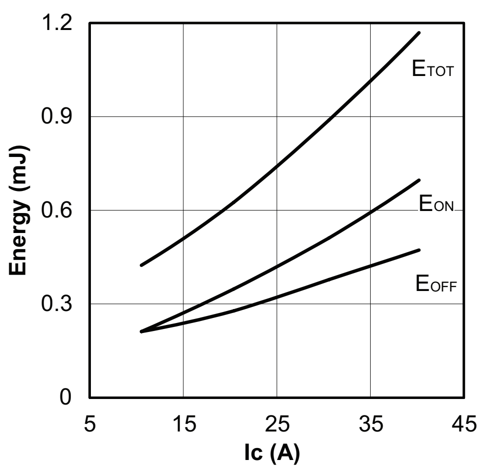


Fig. 9 - Typical Energy Loss vs. I_C
T_J = 125 °C; L = 200 µH; V_{CE} = 300 V; R_G = 22 Ω; V_{GE} = 15 V

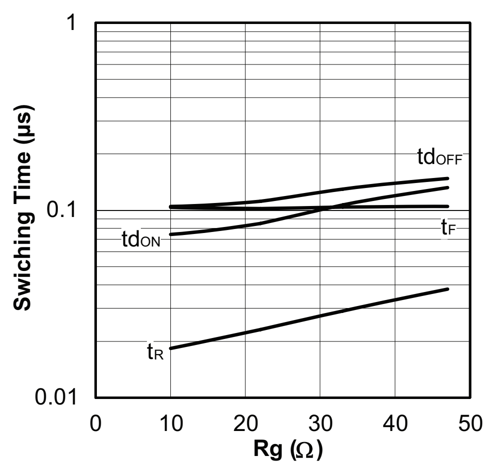


Fig. 12 - Typical Switching Time vs. R_G
T_J = 125 °C; L = 200 µH; V_{CE} = 300 V; I_{CE} = 20 A; V_{GE} = 15 V

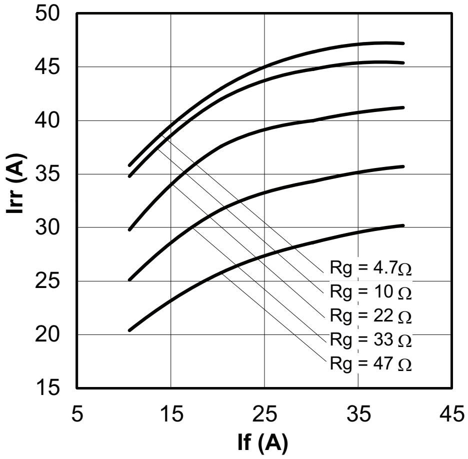


Fig. 13 - Typical Diode I_{RR} vs. I_F
T_J = 125 °C

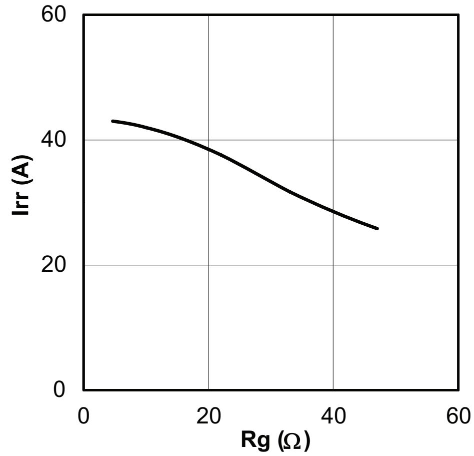


Fig. 14 - Typical Diode I_{RR} vs. R_G
T_J = 125 °C; I_F = 20 A

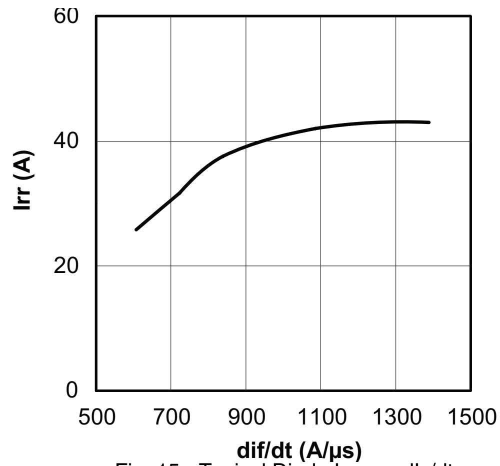


Fig. 15 - Typical Diode I_{RR} vs. dI_F/dt
V_{CC} = 300 V; V_{GE} = 15 V; I_{CE} = 20 A; T_J = 125 °C

THERMISTOR

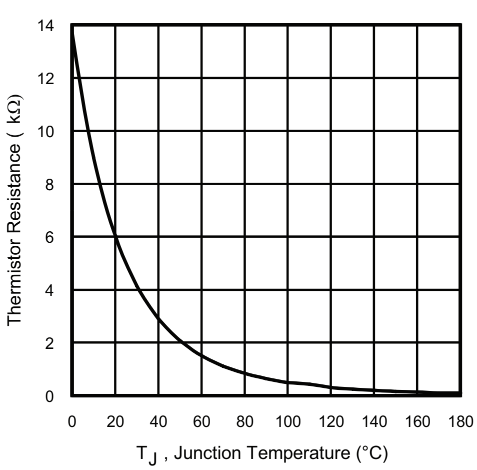


Fig. 16 - Thermistor Resistance vs. Temperature

INPUT RECTIFIER

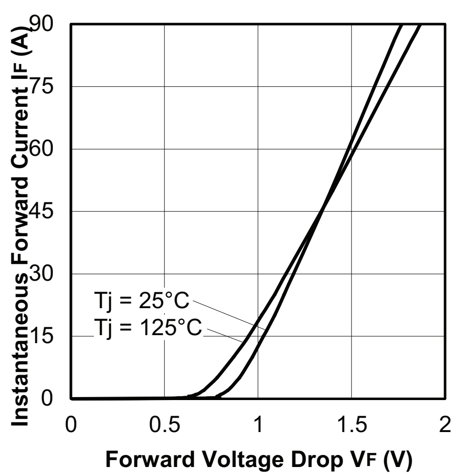


Fig. 17 - Typical Diode Forward Characteristics
t_p = 80 µs

INVERTER

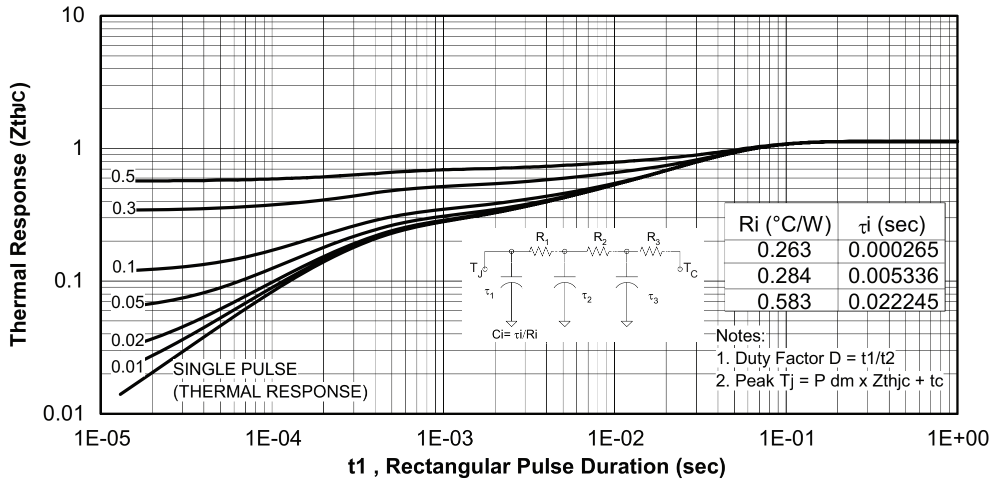


Fig. 18 - Maximum Transient Thermal Impedance, Junction to Case (Inverter IGBT)

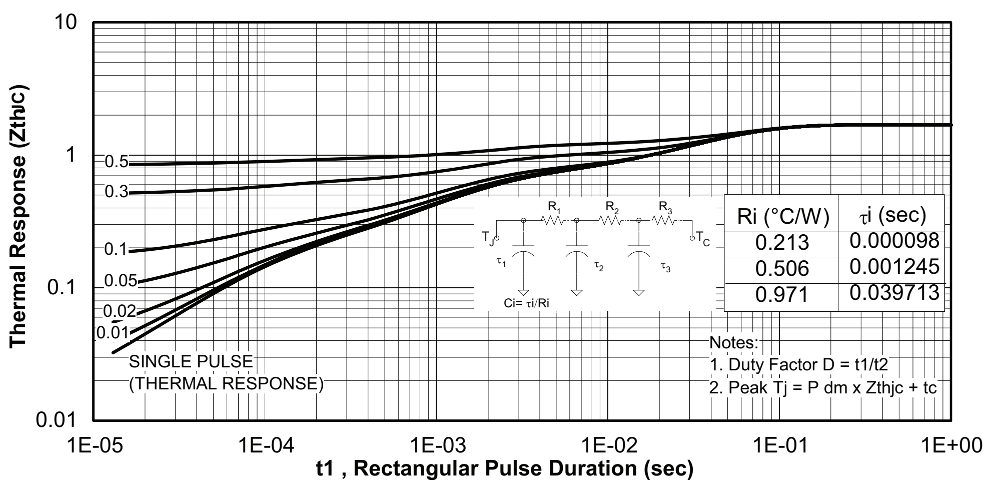


Fig. 19 - Maximum Transient Thermal Impedance, Junction to Case (Diode)

BRAKE

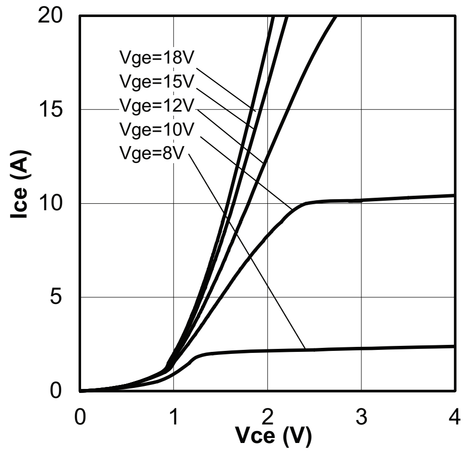


Fig. 20 - Typical IGBT Output Characteristics
T_J = 25 °C; t_p = 80 µs

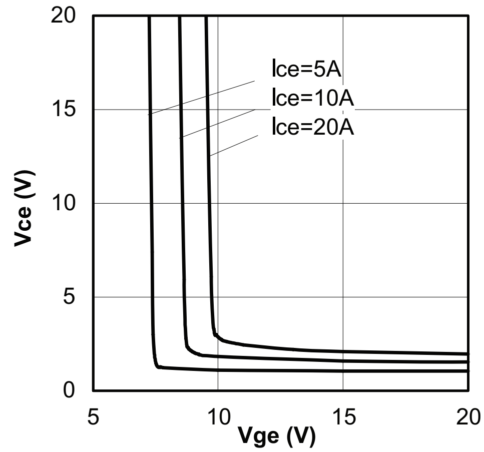


Fig. 23 - Typical V_{CE} vs. V_{GE}
T_J = 25 °C

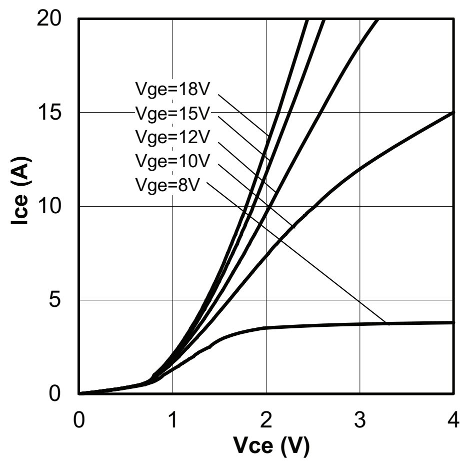


Fig. 21 - Typical IGBT Output Characteristics
T_J = 125 °C; t_p = 80 µs

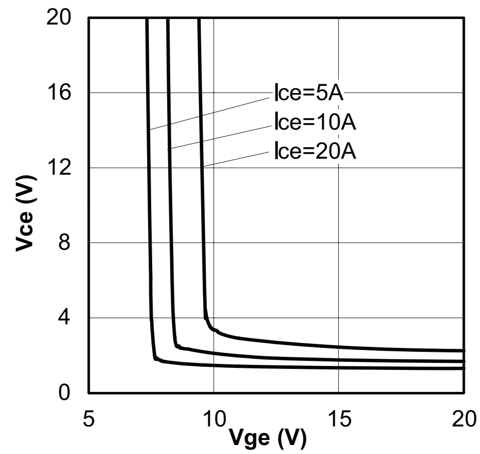


Fig. 24 - Typical V_{CE} vs. V_{GE}
T_J = 125 °C

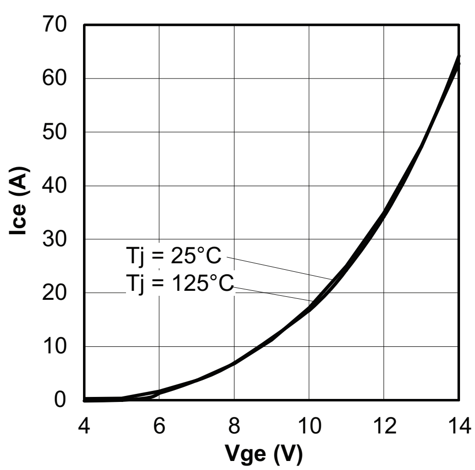


Fig. 22 - Typical Transfer Characteristics
V_{CE} = 50 V; t_p = 10 µs

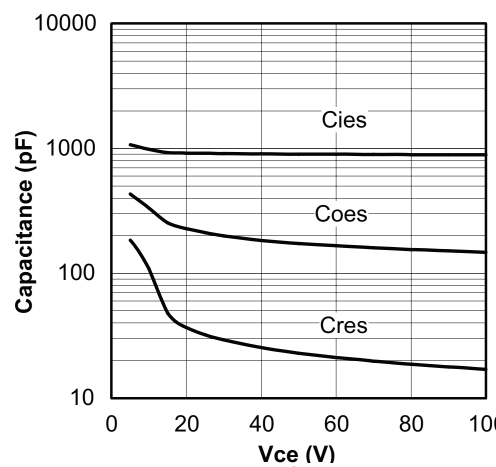


Fig. 25 - Typical Capacitance vs. V_{CE}
V_{GE} = 0 V; f = 1 MHz

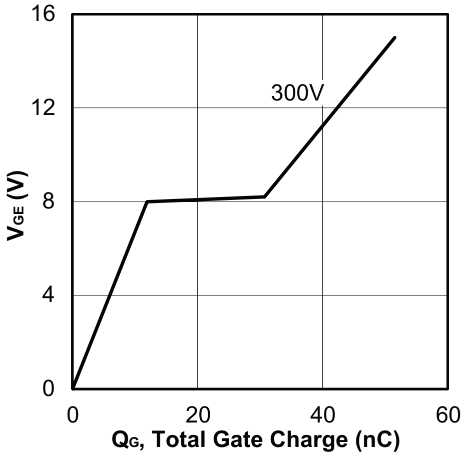


Fig. 26 - Typical Gate Charge vs. V_{GE}
I_{CE} = 10 A

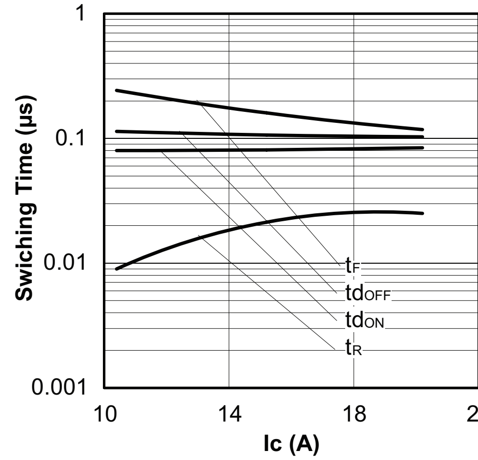


Fig. 29 - Typical Switching Time vs. I_C
T_J = 125 °C; L = 500 µH; V_{CE} = 300 V; R_G = 22 Ω; V_{GE} = 15 V

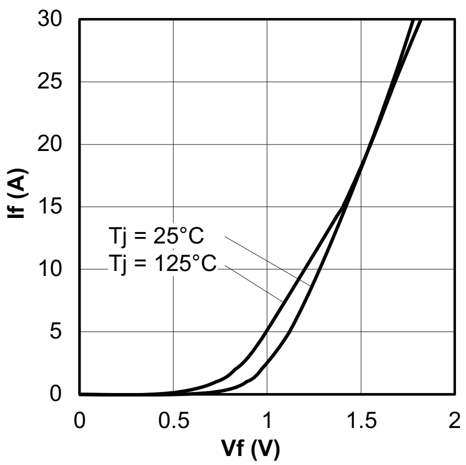


Fig. 27 - Typical Diode Forward Characteristics
t_p = 80 µs

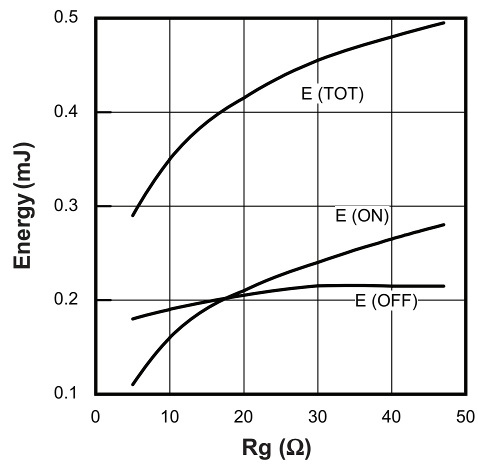


Fig. 30 - Typical Energy Loss vs. R_G
T_J = 125 °C; L = 500 µH; V_{CE} = 300 V; I_{CE} = 10 A; V_{GE} = 15 V

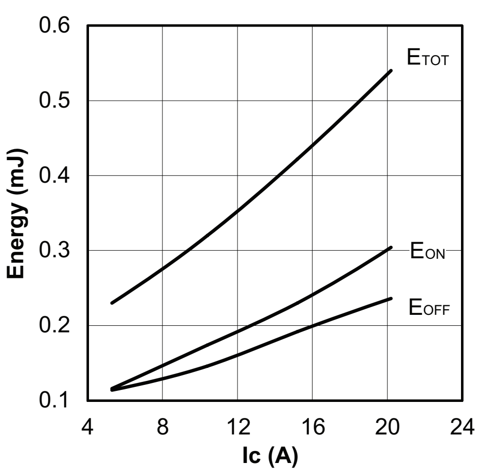


Fig. 28 - Typical Energy Loss vs. I_C
T_J = 125 °C; L = 500 µH; V_{CE} = 300 V; R_G = 22 Ω; V_{GE} = 15 V

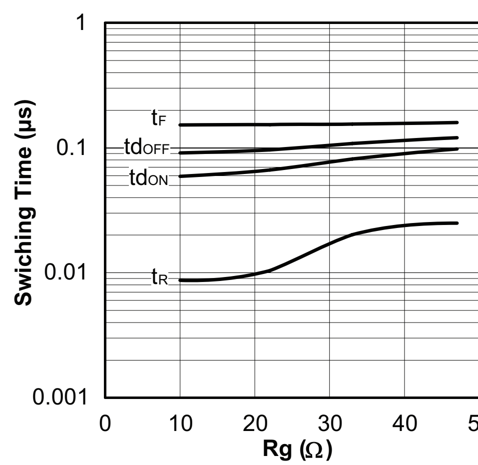


Fig. 31 - Typical Switching Time vs. R_G
T_J = 125 °C; L = 500 µH; V_{CE} = 300 V;I_{CE} = 10 A; V_{GE} = 15 V

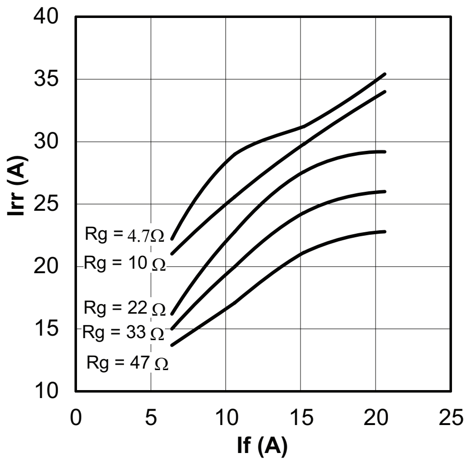


Fig. 32 - Typical Diode I_{RR} vs. I_F
T_J = 125 °C

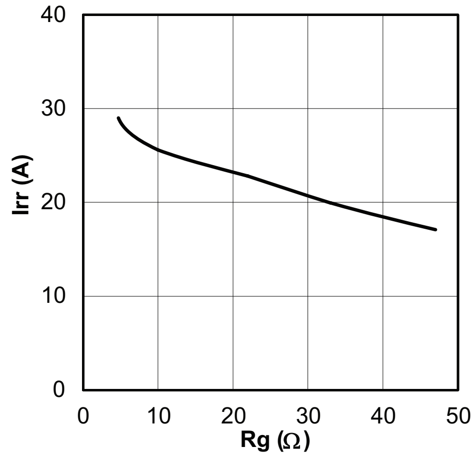


Fig. 33 - Typical Diode I_{RR} vs. R_G
T_J = 125 °C; I_F = 10 A

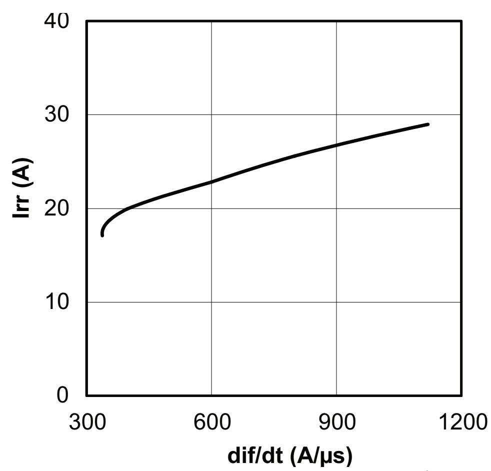


Fig. 34 -Typical Diode I_{RR} vs. dI_F/dt
V_{CC} = 300 V; V_{GE} = 15 V; I_{CE} = 10 A; T_J = 125 °C

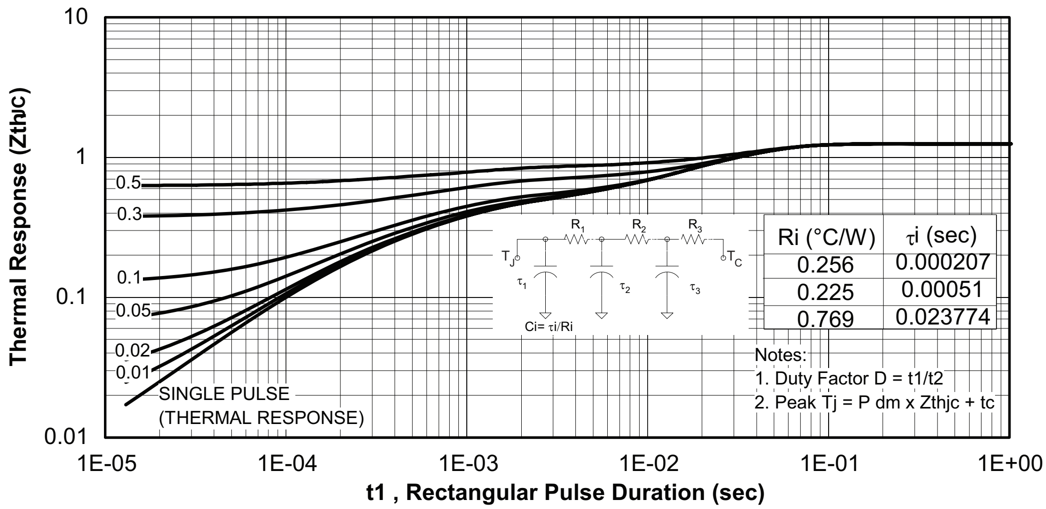


Fig. 35 - Maximum Transient Thermal Impedance, Junction to Case (Brake IGBT)

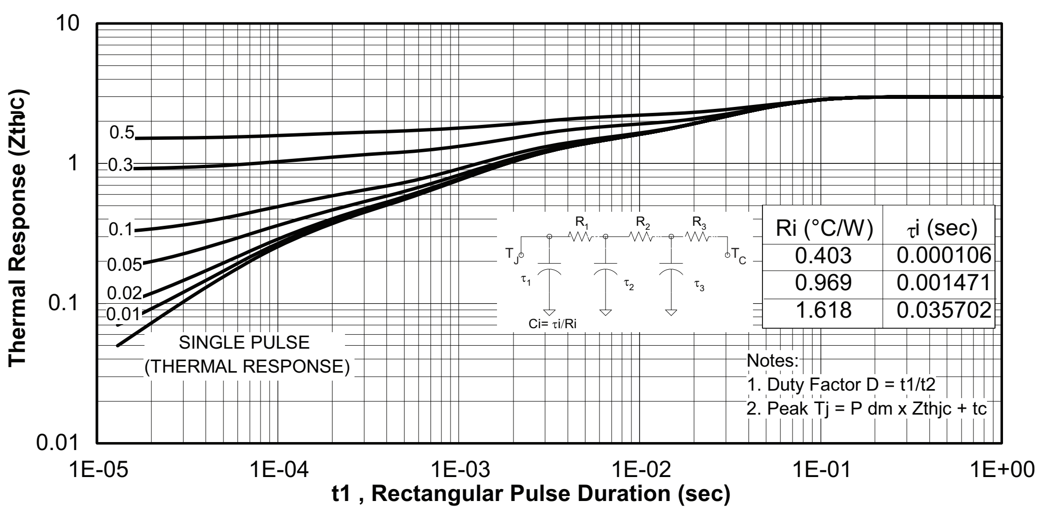


Fig. 36 - Maximum Transient Thermal Impedance, Junction to Case (Brake Diode)

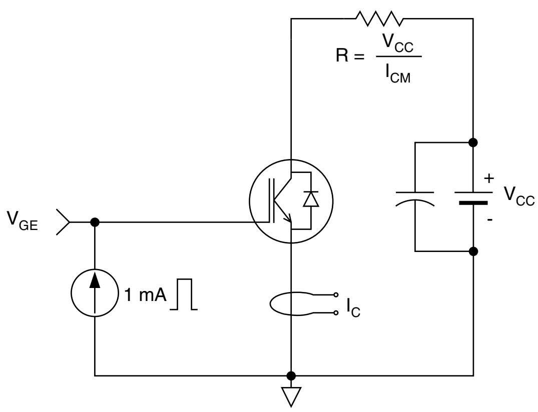


Fig. C.T.1 - Gate Charge Circuit (turn-off)

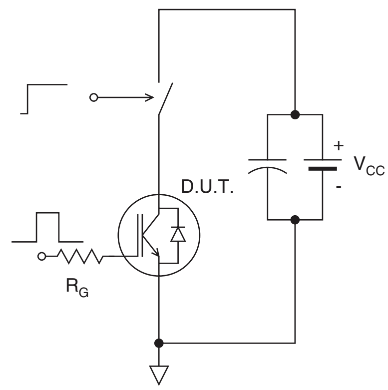


Fig. C.T.3 - S.C. SOA Circuit

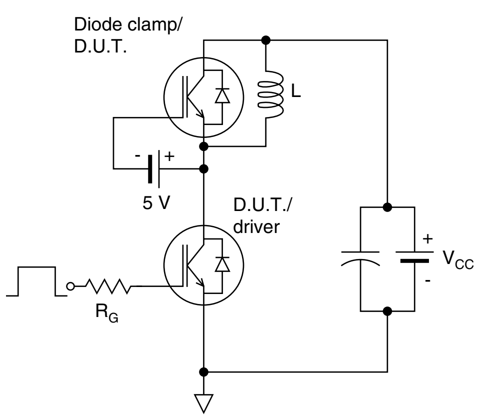


Fig. C.T.2 - RBSOA Circuit

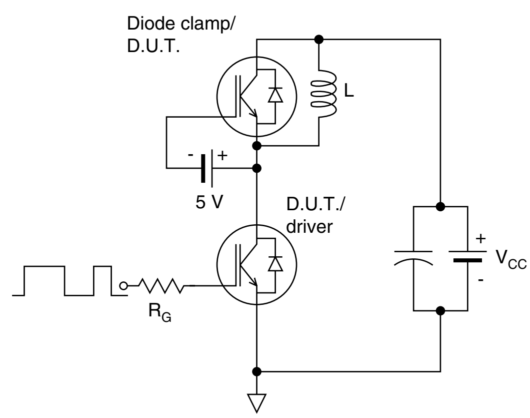


Fig. C.T.4 - Switching Loss Circuit

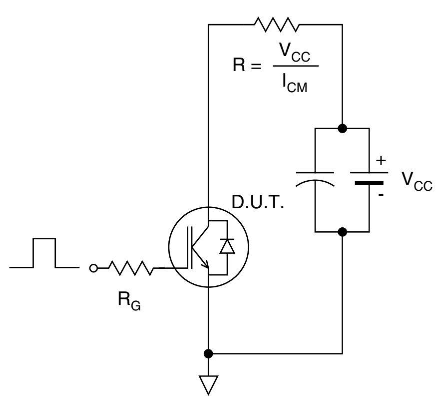


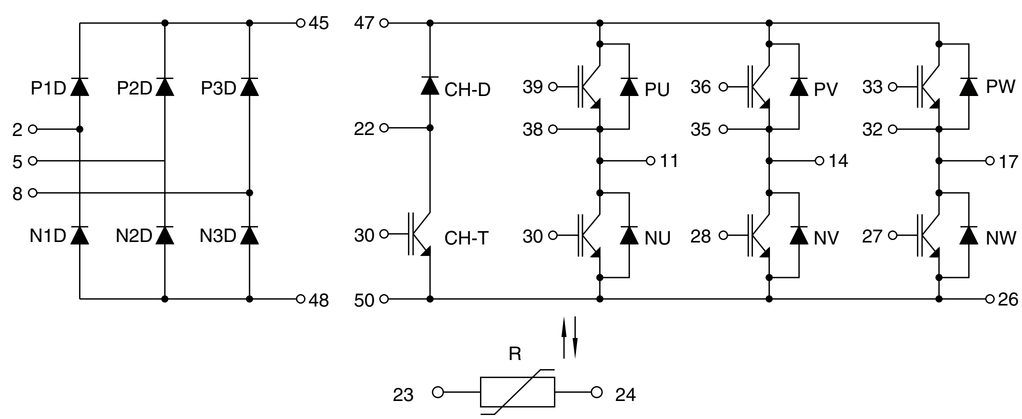
Fig. C.T.5 - Resistive Load Circuit

ORDERING INFORMATION TABLE

Device code	G	B	20	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 (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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