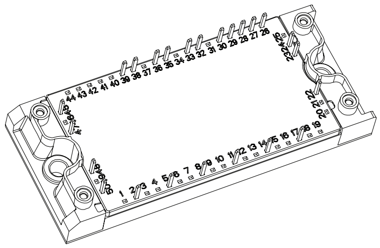
IGBT PIM Module, 15 A



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}	1200 V
$V_{CE(on)}$ (typical)	2.8 V
t_{sc} at T_J = 150 °C	> 10 µs
I_C at T_C = 80 °C	15 A

ABSOLUTE MAXIMUM RATINGS

	PARAMETER	SYMBOL	TEST CONDITIONS		MAX.	UNITS
Inverter	Collector to emitter voltage	V_{CES}			1200	V
	Gate to emitter voltage	V_{GES}			± 20	
	Continuous collector current	I_C	T_C = 25 °C		25	A
			T_C = 80 °C		15	
	Pulsed collector current See fig. C.T.5	I_{CM}			50	A
	Diode maximum forward current	I_{FM}	Pulsed		50	A
	Power dissipation	P_D	One IGBT	25 °C	125	W
Input rectifier	Repetitive peak reverse voltage	V_{RRM}			1600	V
	Average output current	$I_{F(AV)}$	50/60 Hz sine pulse	80 °C	15	A
	Surge current (non-repetitive)	I_{FSM}	Rated V_{RRM} applied, 10 ms, sine pulse		120	
	I^2t (non-repetitive)	I^2t			72	A^2s
Brake	Collector to emitter voltage	V_{CES}			1200	V
	Gate to emitter voltage	V_{GES}			± 20	
	Continuous collector current	I_C	T_C = 25 °C		25	A
			T_C = 80 °C		15	
	Pulsed collector current See fig. C.T.5	I_{CM}			50	A
	Power dissipation	P_D	One IGBT	25 °C	125	W
	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	1200	-	-	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)	-	1.1	-	V/°C
	Collector to emitter voltage	$V_{CE(on)}$	I_C = 15 A, V_{GE} = 15 V	-	2.8	3.2	V
			I_C = 25 A, V_{GE} = 15 V	-	3.6	4.0	
			I_C = 15 A, V_{GE} = 15 V, T_J = 125 °C	-	3.3	-	
			I_C = 25 A, V_{GE} = 15 V, T_J = 125 °C	-	4.2	-	
	Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 250 µA	4.0	5.0	6.0	
	Threshold voltage temperature coefficient	$\Delta V_{GE(th)}/\Delta T_J$	V_{CE} = V_{GE}, I_C = 1 mA (25 °C to 125 °C)	-	- 11	-	mV/°C
	Zero gate voltage collector current	I_{CES}	V_{GE} = 0 V, V_{CE} = 1200 V	-	-	100	µA
			V_{GE} = 0 V, V_{CE} = 1200 V T_J = 125 °C	-	370	-	
	Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V	-	-	± 200	nA
	Total gate charge (turn-on)	Q_G	I_C = 55 A V_{CC} = 400 V V_{GE} = 15 V	-	95	145	nC
	Gate to emitter charge (turn-on)	Q_{GE}		-	10	15	
	Gate to collector charge (turn-on)	Q_{GC}		-	45	70	
	Turn-on switching loss	E_{on}	I_C = 15 A, V_{CC} = 600 V V_{GE} = 15 V, R_G = 22 Ω, L = 400 µH, T_J = 25 °C [(1)]	-	1.30	2.30	mJ
	Turn-off switching loss	E_{off}		-	0.90	1.55	
	Total switching loss	E_{tot}		-	2.20	3.85	
	Turn-on switching loss	E_{on}	I_C = 15 A, V_{CC} = 600 V V_{GE} = 15 V, R_G = 22 Ω, L = 400 µH, T_J = 125 °C [(1)]	-	1.70	2.85	
	Turn-off switching loss	E_{off}		-	1.25	1.90	
	Total switching loss	E_{tot}		-	2.95	4.75	
	Turn-on delay time	$t_{d(on)}$	I_C = 15 A, V_{CC} = 600 V V_{GE} = 15 V, R_G = 22 Ω, L = 400 µH, T_J = 125 °C	-	50	65	ns
	Rise time	t_r		-	50	70	
	Turn-off delay time	$t_{d(off)}$		-	300	540	
	Fall time	t_f		-	220	286	
	Input capacitance	C_{ies}	V_{GE} = 0 V V_{CC} = 30 V f = 1 MHz	-	1285	-	pF
	Output capacitance	C_{oes}		-	280	-	
	Reverse transfer capacitance	C_{res}		-	35	-	
Inverter IGBT	Reverse bias safe operating area	RBSOA	T_J = 150 °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} = 900 V, V_P = 1200 V R_G = 22 Ω, V_{GE} = 15 V to 0 V	10	-	-	µs
Free-wheeling Diode	Diode peak reverse recovery current	I_{rr}	T_J = 125 °C V_{CC} = 600 V, I_F = 25 A, L = 400 µH R_G = 22 Ω, V_{GE} = 15 V	-	22	-	A
	Diode forward voltage drop	V_{FM}	I_F = 15 A	-	2.15	2.55	V
			I_F = 25 A	-	2.60	3.05	
			I_F = 15 A, T_J = 125 °C	-	2.30	-	
			I_F = 25 A, T_J = 125 °C	-	2.90	-	

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 = 15 A	-	-	1.3	V
	Maximum reverse leakage current	I_{RM}	T_J = 25 °C, V_R = 1600 V	-	-	0.05	mA
			T_J = 150 °C, V_R = 1600 V	-	-	1.0	
	Forward slope resistance	r_T	T_J = 150 °C	-	-	16.4	mΩ
	Conduction thresold voltage	$V_{F\ (TO)}$		-	-	0.77	V
Brake IGBT	Collector to emitter breakdown voltage	$BV_{(CES)}$	V_{GE} = 0 V, I_C = 500 µA	1200	-	-	
	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)	-	1.1	-	V/°C
	Collector to emitter voltage	$V_{CE(on)}$	I_C = 15 A, V_{GE} = 15 V	-	2.8	3.2	V
			I_C = 25 A, V_{GE} = 15 V	-	3.6	4.0	
			I_C = 15 A, V_{GE} = 15 V, T_J = 125 °C	-	3.3	-	
			I_C = 25 A, V_{GE} = 15 V, T_J = 125 °C	-	4.2	-	
	Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, I_C = 250 µA	4.0	5.0	6.0	
	Threshold voltage temperature coefficient	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}$, I_C = 1 mA (25 °C to 125 °C)	-	- 11	-	mV/°C
	Zero gate voltage collector current	I_{CES}	V_{GE} = 0 V, V_{CE} = 1200 V	-	-	100	µA
			V_{GE} = 0 V, V_{CE} = 1200 V T_J = 125 °C	-	370	-	
	Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V	-	-	± 200	nA
	Total gate charge (turn-on)	Q_G	I_C = 55 A V_{CC} = 400 V V_{GE} = 15 V	-	95	145	nC
	Gate to emitter charge (turn-on)	Q_{GE}		-	10	15	
	Gate to collector charge (turn-on)	Q_{GC}		-	45	70	
	Turn-on switching loss	E_{on}	I_C = 15 A, V_{CC} = 600 V V_{GE} = 15 V, R_G = 22 Ω, L = 400 µH, T_J = 25 °C (1)	-	1.30	2.30	mJ
	Turn-off switching loss	E_{off}		-	0.90	1.55	
	Total switching loss	E_{tot}		-	2.20	3.85	
	Turn-on switching loss	E_{on}	I_C = 15 A, V_{CC} = 600 V V_{GE} = 15 V, R_G = 22 Ω, L = 400 µH, T_J = 125 °C (1)	-	1.70	2.85	
	Turn-off switching loss	E_{off}		-	1.25	1.90	
	Total switching loss	E_{tot}		-	2.95	4.75	
	Turn-on delay time	$t_{d(on)}$	I_C = 15 A, V_{CC} = 600 V V_{GE} = 15 V, R_G = 22 Ω, L = 400 µH, T_J = 125 °C	-	50	65	ns
	Rise time	t_r		-	50	70	
	Turn-off delay time	$t_{d(off)}$		-	300	540	
	Fall time	t_f		-	220	286	
Brake IGBT	Input capacitance	C_{ies}	V_{GE} = 0 V V_{CC} = 30 V f = 1 MHz	-	1285	-	pF
	Output capacitance	C_{oes}		-	280	-	
	Reverse transfer capacitance	C_{res}		-	35	-	
	Reverse bias safe operating area	RBSOA	T_J = 150 °C, I_C = 50 A R_G = 22 Ω, V_{GE} = 15 V to 0 V	Fullsquare			
	Short circuit safe operating area	SCSOA	T_J = 150 °C V_{CC} = 900 V, V_P = 1200 V R_G = 22 Ω, V_{GE} = 15 V to 0 V	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}	T_J = 125 °C V_{CC} = 600 V, I_F = 25 A, L = 400 µH R_G = 22 Ω, V_{GE} = 15 V	-	22	-	A
	Diode forward voltage drop	V_{FM}	I_F = 15 A	-	2.15	2.55	V
			I_F = 25 A	-	2.60	3.05	
			I_F = 15 A, T_J = 125 °C	-	2.30	-	
			I_F = 25 A, T_J = 125 °C	-	2.90	-	
NTC	Resistance	R	T_J = 25 °C	4538	5000	5495	Ω
			T_J = 100 °C	468.6	493.3	518	
	B value	B	T_J = 25 °C/50 °C	3307	3375	3443	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}	-	-	1.0	°C/W
Junction to case inverter FRED thermal resistance		-	-	1.6	
Junction to case brake DIODE thermal resistance		-	-	1.6	
Junction to case brake IGBT thermal resistance		-	-	1.0	
Junction to case input rectifier thermal resistance		-	-	1.0	
Case to sink, flat, greased surface	R_{thCS}	-	0.05	-	
Mounting torque (M5)		2.7	-	3.3	Nm
Weight		-	170	-	g

For technical questions, contact: ind-modules@vishay.com

INVERTER

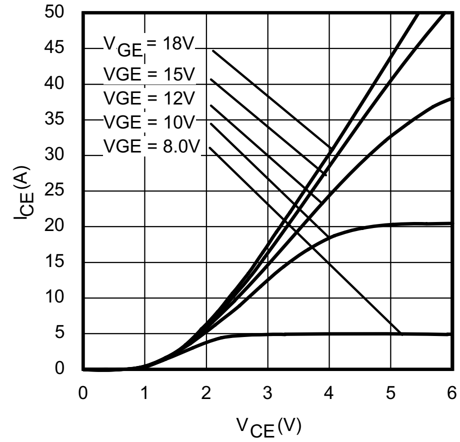


Fig. 1 - Typical IGBT Output Characteristics
T_J = 25 °C; t_p = 80 µs

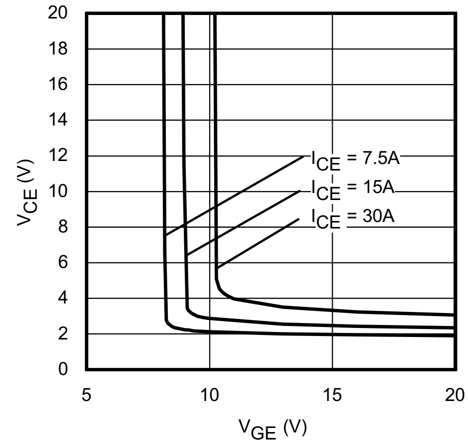


Fig. 4 - Typical V_{CE} vs. V_{GE}
T_J = 25 °C

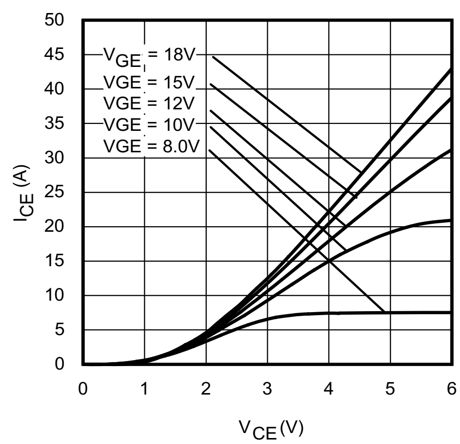


Fig. 2 - Typical IGBT Output Characteristics
T_J = 125 °C, t_p = 80 µs

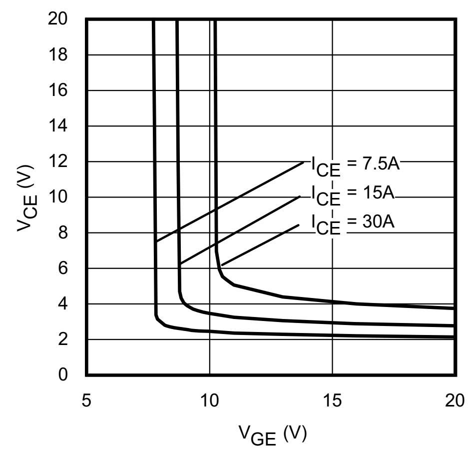


Fig. 5 - Typical V_{CE} vs. V_{GE}
T_J = 125 °C

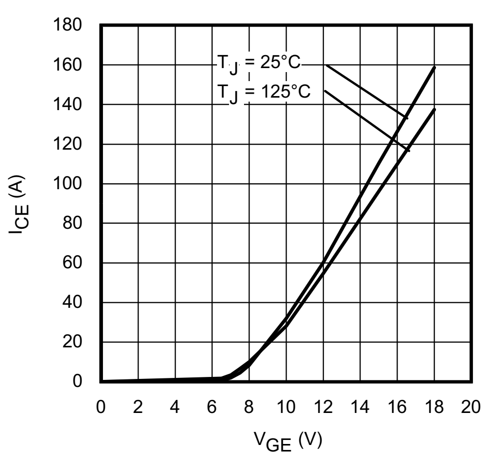


Fig. 3 - Typical Transfer Characteristics
V_{CE} = 50 V; t_p = 10 µs

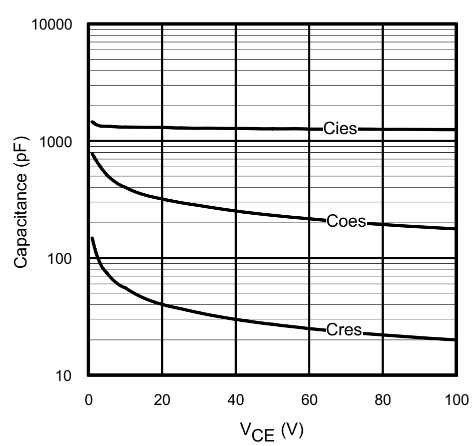


Fig. 6 - Typical Capacitance vs. V_{CE}
V_{GE} = 0 V; f = 1 MHz

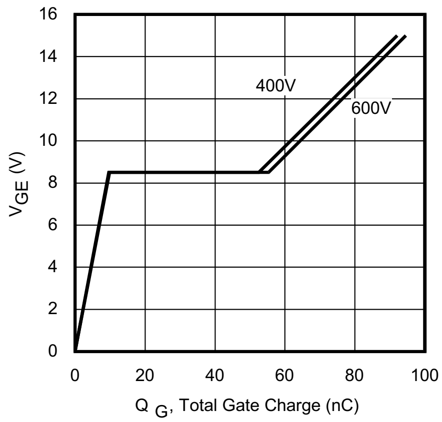


Fig. 7 - Typical Gate Charge vs. V_{GE}
I_{CE} = 15 A; L = 1.0 mH

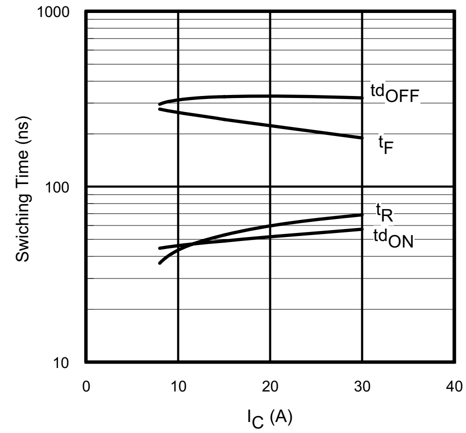


Fig. 10 - Typical Switching Time vs. I_C
T_J = 125 °C; L = 400 µH; V_{CE} = 600 V; R_G = 22 Ω; V_{GE} = 15 V

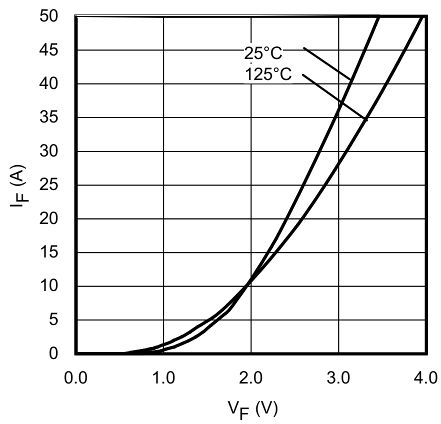


Fig. 8 - Typical Diode Forward Characteristics
t_p = 80 µs

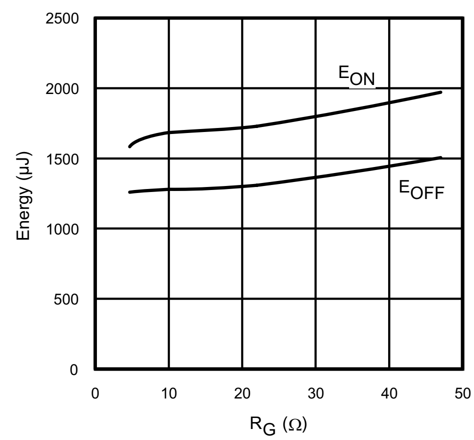


Fig. 11 - Typical Energy Loss vs. R_G
T_J = 125 °C; L = 400 µH; V_{CE} = 600 V; I_{CE} = 15 A; V_{GE} = 15 V

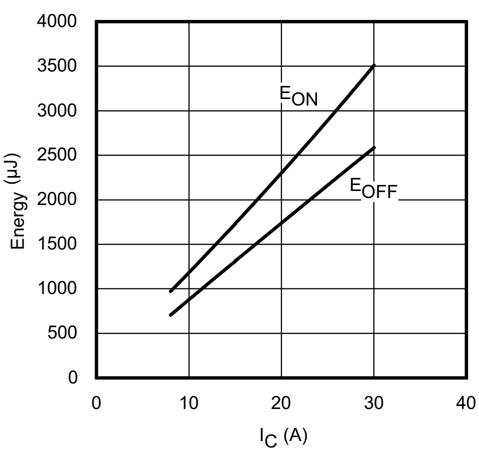


Fig. 9 - Typical Energy Loss vs. I_C
T_J = 125 °C; L = 400 µH; V_{CE} = 600 V; R_G = 22 Ω; V_{GE} = 15 V

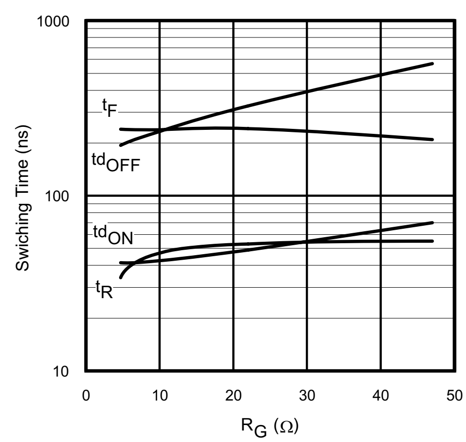


Fig. 12 - Typical Switching Time vs. R_G
T_J = 125 °C; L = 400 µH; V_{CE} = 600 V; I_{CE} = 15 A; V_{GE} = 15 V

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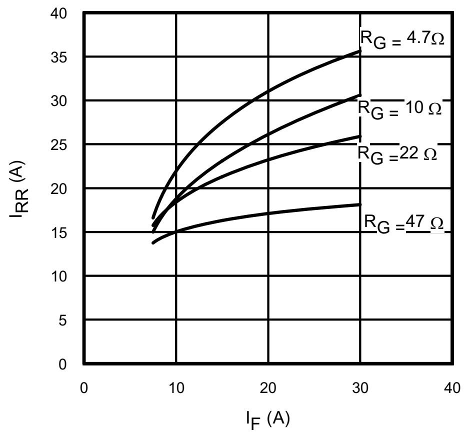

Fig. 13 - Typical Diode I_{RR} vs. I_F
T_J = 125 °C

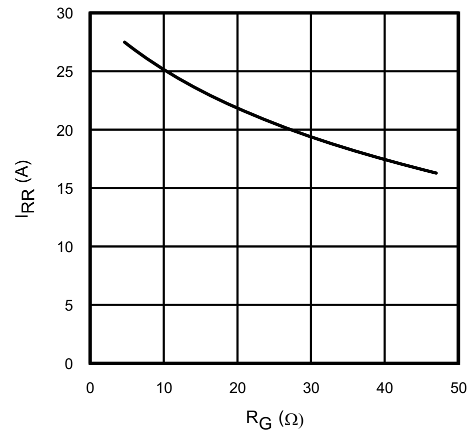

Fig. 14 - Typical Diode I_{RR} vs. R_G
T_J = 125 °C; I_F = 15 A

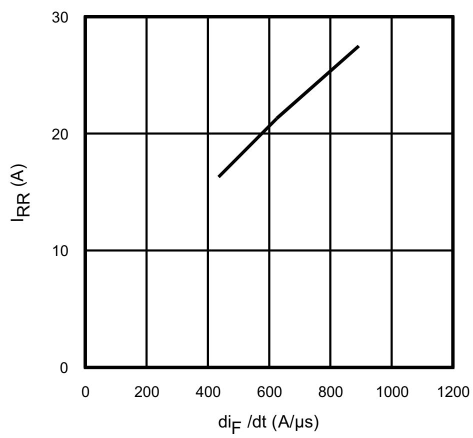

Fig. 15 - Typical Diode I_{RR} vs. dI_F/dt
V_{CC} = 600 V; V_{GE} = 15 V; I_{CE} = 15 A; T_J = 125 °C

THERMISTOR

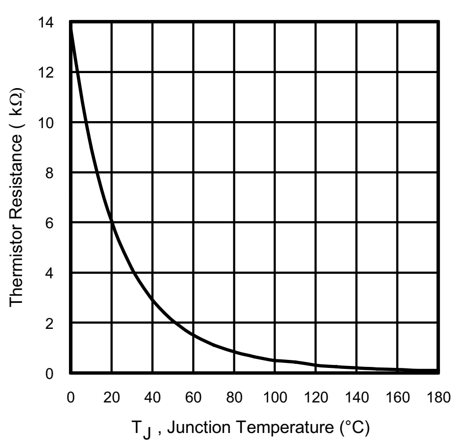

Fig. 16 - Thermistor Resistance vs. Temperature

INPUT RECTIFIER

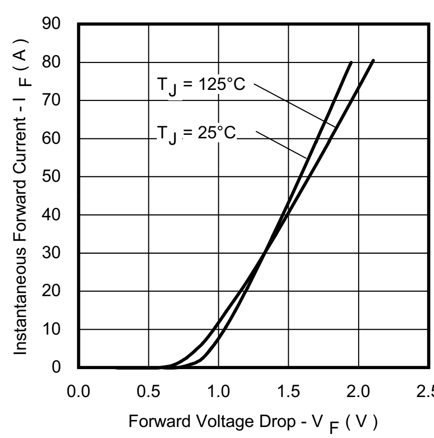

Fig. 17 - Typical Diode Forward Characteristics
t_p = 80 µs

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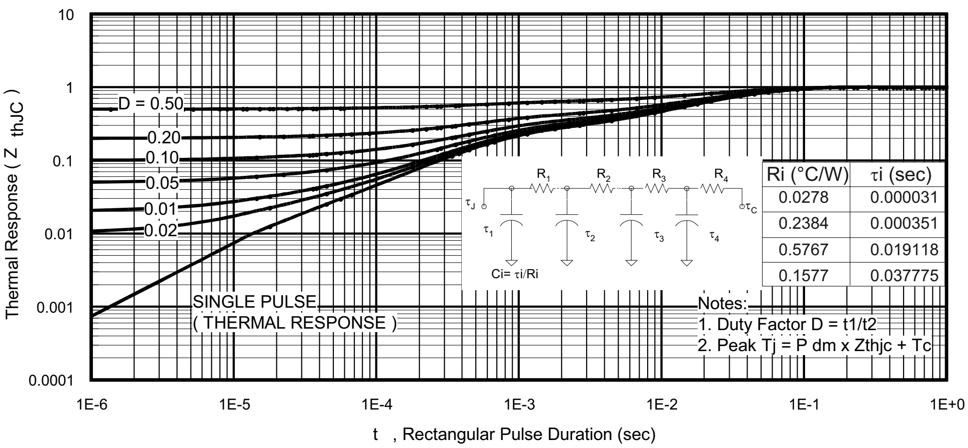


Fig. 18 - Maximum Transient Thermal Impedance, Junction to Case (Inverter IGBT)

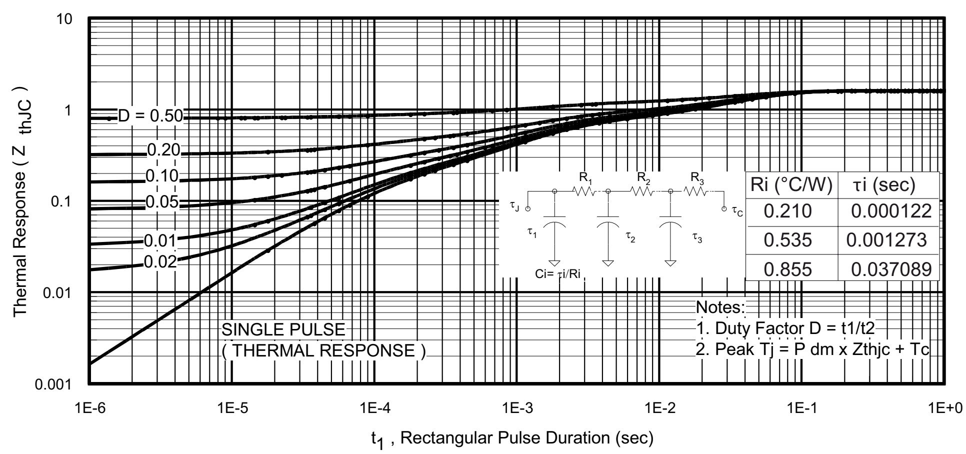


Fig. 19 - Maximum Transient Thermal Impedance, Junction to Case (Inverter FRED)

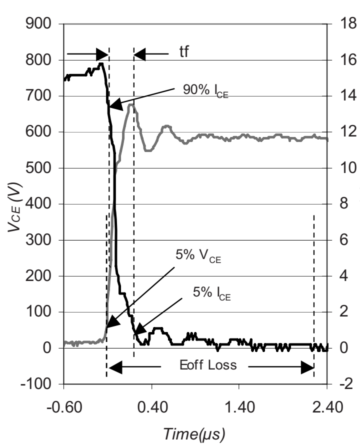


Fig. WF1 - Typical Turn-Off Loss Waveform at T_J = 125 °C using Fig. C.T.4

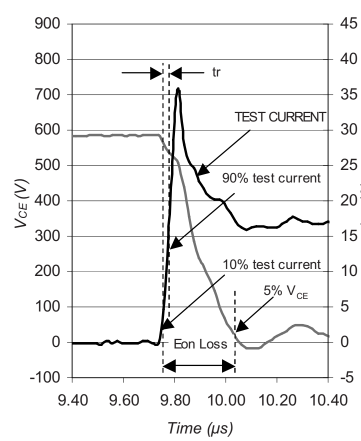


Fig. WF2 - Typical Turn-On Loss Waveform at T_J = 125 °C using Fig. C.T.4

BRAKE

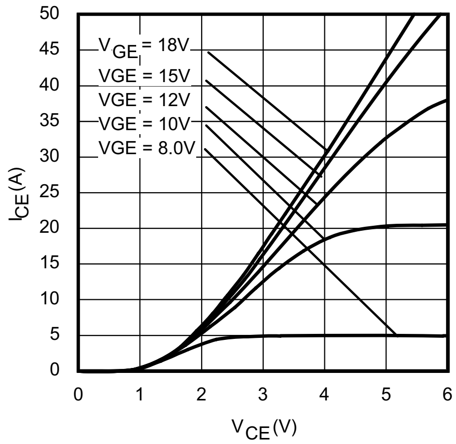


Fig. 20 - Typical IGBT Output Characteristics
T_J = 25 °C; t_p = 80 µs

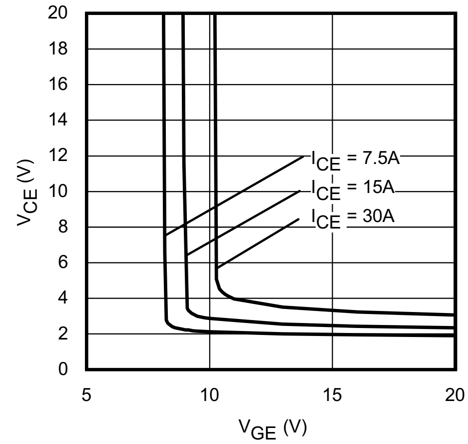


Fig. 23 - Typical V_{CE} vs. V_{GE}
T_J = 25 °C

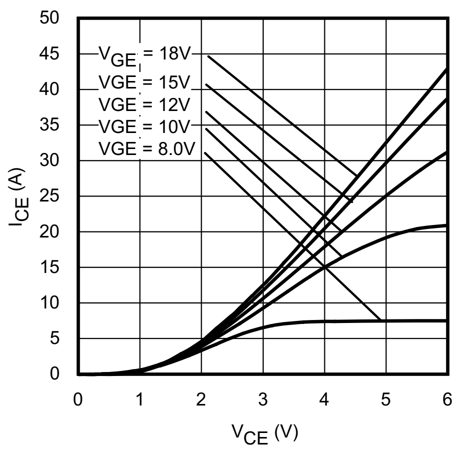


Fig. 21 - Typical IGBT Output Characteristics
T_J = 125 °C; t_p = 80 µs

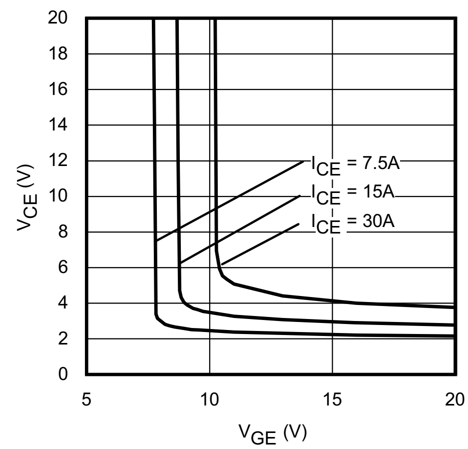


Fig. 24 - Typical V_{CE} vs. V_{GE}
T_J = 125 °C

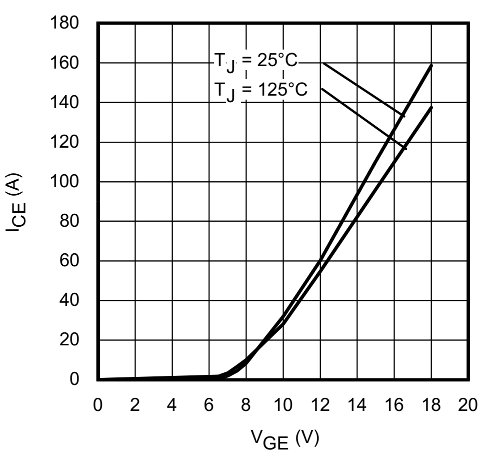


Fig. 22 - Typical Transfer Characteristics
V_{CE} = 50 V; t_p = 10 µs

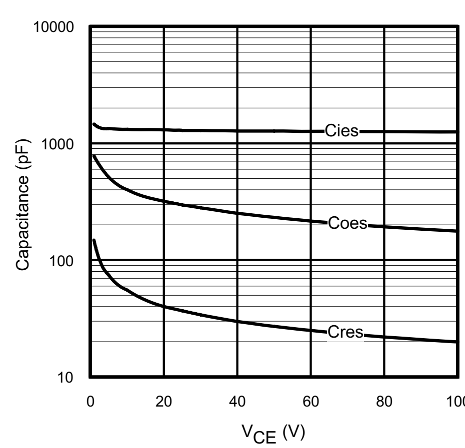


Fig. 25 - Typical Capacitance vs. V_{CE}
V_{GE} = 0 V; f = 1 MHz

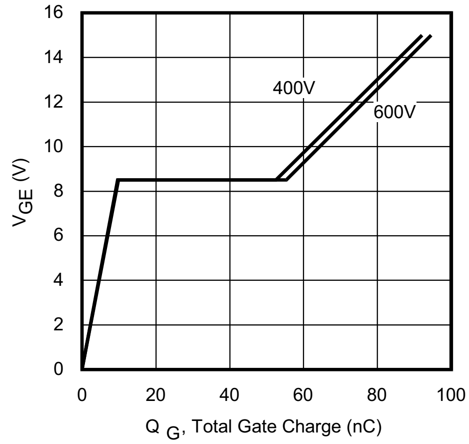


Fig. 26 - Typical Gate Charge vs. V_{GE}
I_{CE} = 15 A; L = 1.0 mH

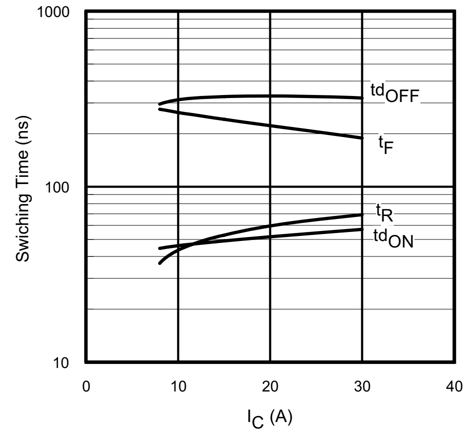


Fig. 29 - Typical Switching Time vs. I_C
T_J = 125 °C; L = 400 µH; V_{CE} = 600 V; R_G = 22 Ω; V_{GE} = 15 V

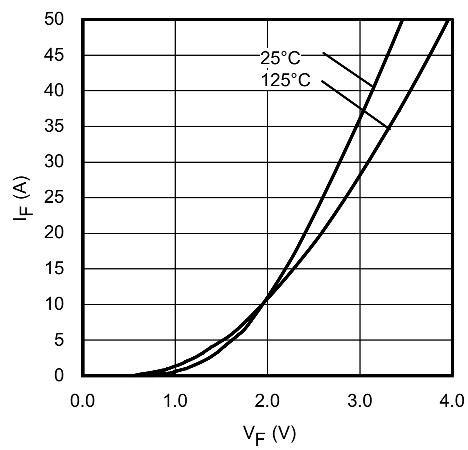


Fig. 27 - Typical Diode Forward Characteristics
t_p = 80 µs

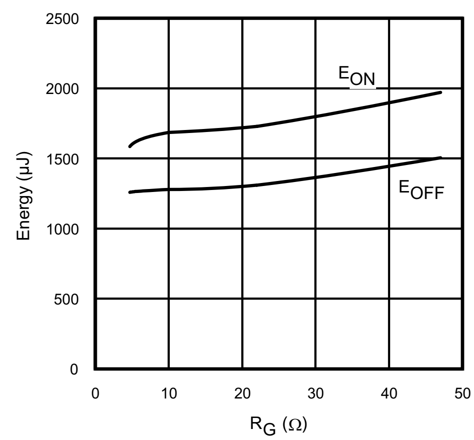


Fig. 30 - Typical Energy Loss vs. R_G
T_J = 125 °C; L = 400 µH; V_{CE} = 600 V; I_{CE} = 15 A; V_{GE} = 15 V

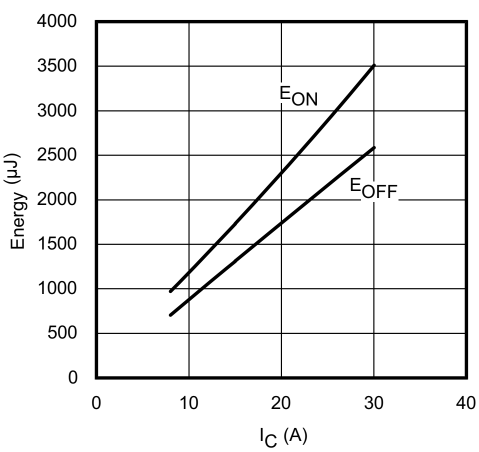


Fig. 28 - Typical Energy Loss vs. I_C
T_J = 125 °C; L = 400 µH; V_{CE} = 600 V; R_G = 22 Ω; V_{GE} = 15 V

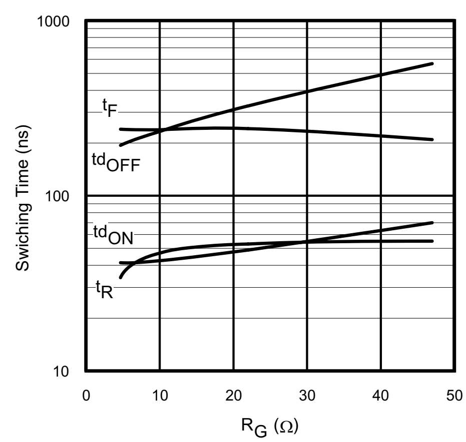


Fig. 31 - Typical Switching Time vs. R_G
T_J = 125 °C; L = 400 µH; V_{CE} = 600 V; I_{CE} = 15 A; V_{GE} = 15 V

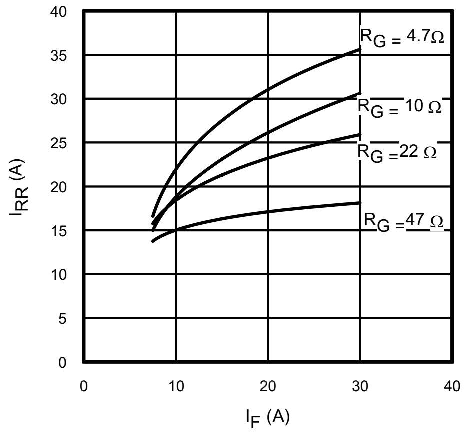


Fig. 32 - Typical Diode I_{RR} vs. I_F
T_J = 125 °C

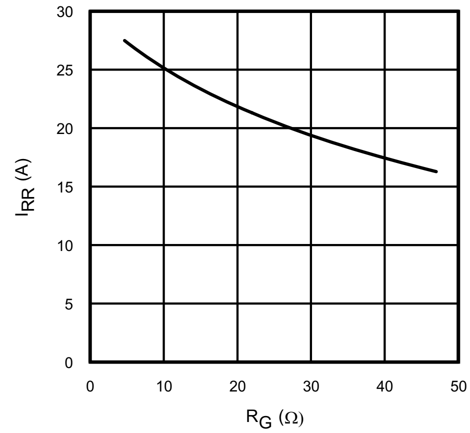


Fig. 33 - Typical Diode I_{RR} vs. R_G
T_J = 125 °C; I_F = 15 A

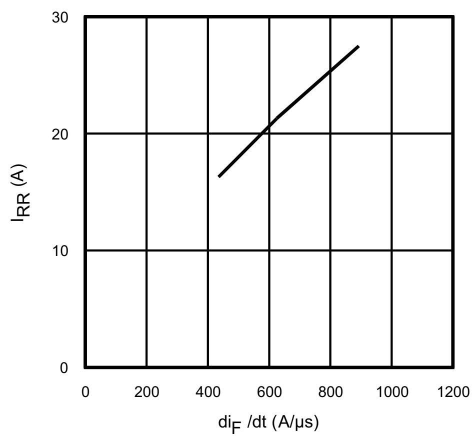
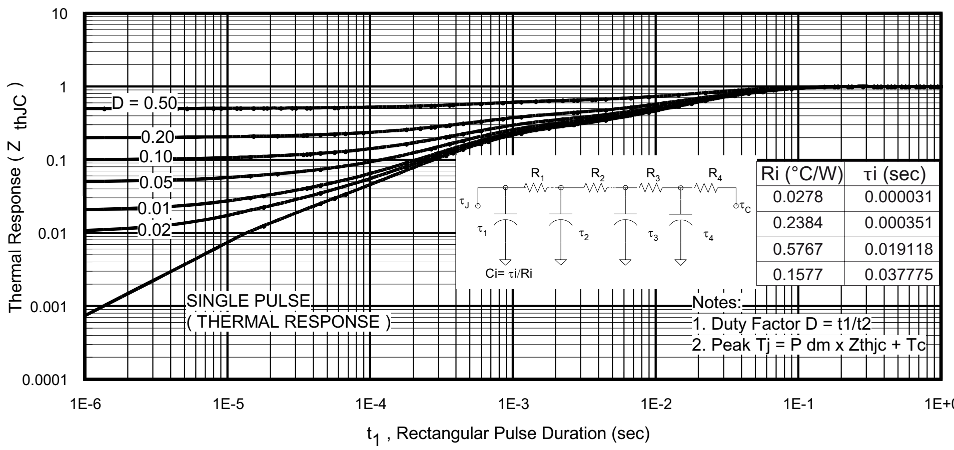
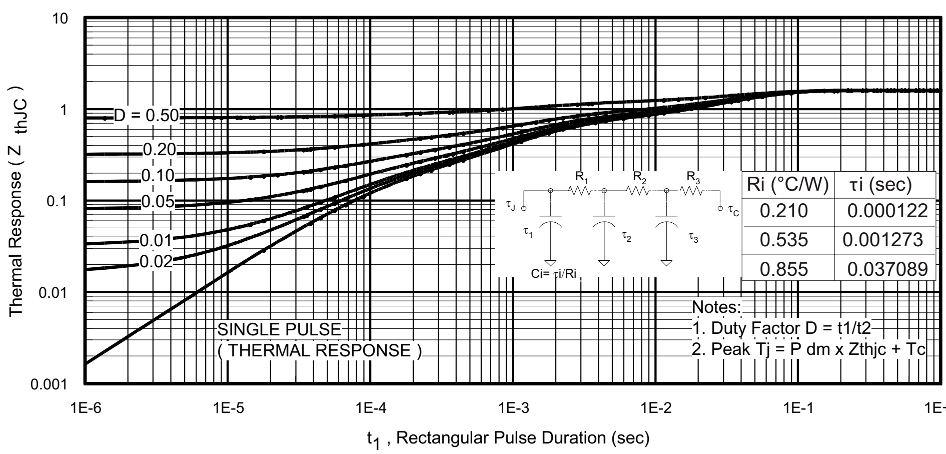


Fig. 34 - Typical Diode I_{RR} vs. dI_F/dt
V_{CC} = 600 V; V_{GE} = 15 V; I_{CE} = 15 A; T_J = 125 °C



Ri (°C/W)	τi (sec)
0.0278	0.000031
0.2384	0.000351
0.5767	0.019118
0.1577	0.037775

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



Ri (°C/W)	τi (sec)
0.210	0.000122
0.535	0.001273
0.855	0.037089

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

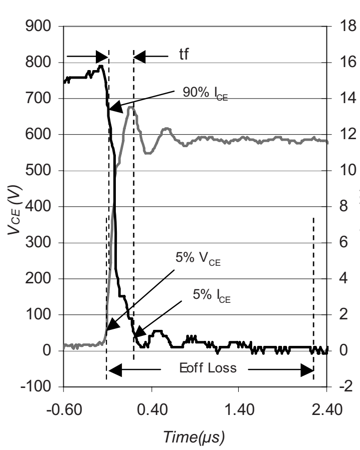


Fig. WF3 - Typical Turn-Off Loss Waveform
at T_J = 125 °C using Fig. C.T.4

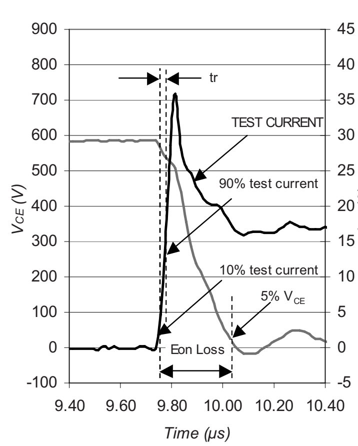


Fig. WF4 - Typical Turn-On Loss Waveform
at T_J = 125 °C using Fig. C.T.4

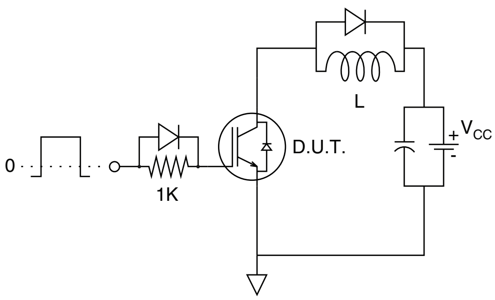


Fig. C.T.1 - Gate Charge Circuit (Turn-Off)

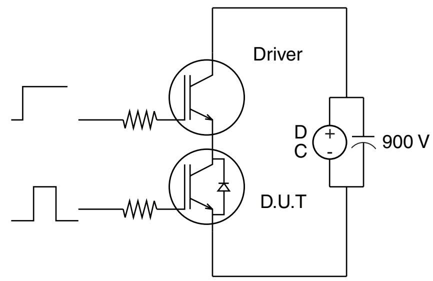


Fig. C.T.3 - S.C. SOA Circuit

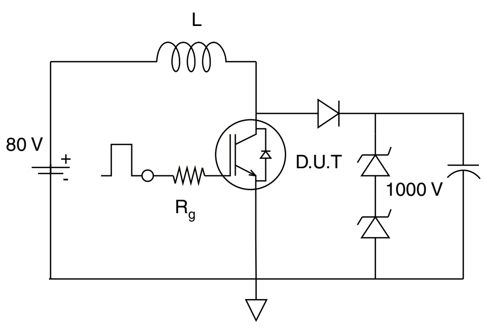


Fig. C.T.2 - RBSOA Circuit

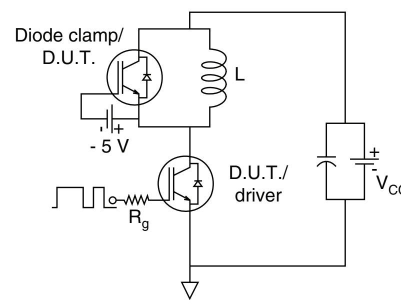


Fig. C.T.4 - Switching Loss Circuit

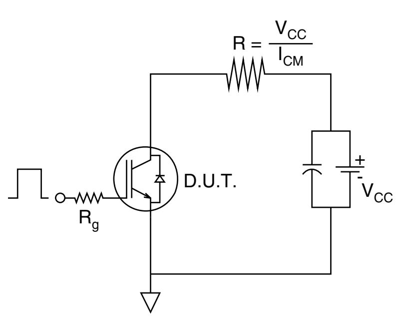


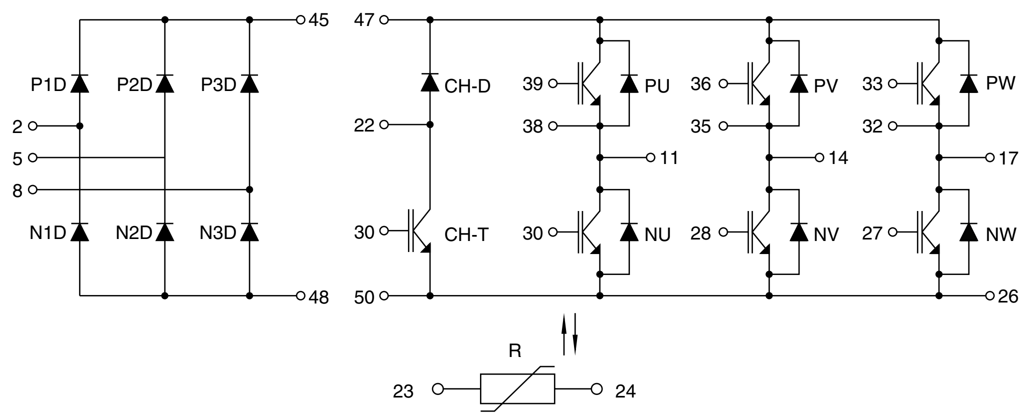
Fig. C.T.5 - Resistive Load Circuit

ORDERING INFORMATION TABLE

Device code	G	B	15	R	F	120	K
	1	2	3	4	5	6	7

1 - Insulated Gate Bipolar Transistor (IGBT)
2 - IGBT Generation 5 NPT
3 - Current rating (15 = 15 A)
4 - Circuit configuration
(R = Three phase bridge-brake-inverter with thermistor)
5 - Package (F = ECONO2)
6 - Voltage rating (120 = 1200 V)
7 - Ultrafast (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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