

### FEATURES

- Cu Base with Enhanced Al<sub>2</sub>O<sub>3</sub> Substrates
- 10μs Short Circuit Withstand

### APPLICATIONS

- Motor Drives
- Power Charging Equipment
- Solar Power
- High Reliability Inverters

The Powerline range of high power modules includes half bridge, chopper, dual, single and bi-directional switch configurations covering voltages from 1200V to 6500V and currents up to 2400A.

The TG450HF12M1-S3A00 is a half bridge 1200V, n-channel enhancement mode, insulated gate bipolar transistor (IGBT) module. The IGBT has a wide reverse bias safe operating area (RBSOA) plus 10μs short circuit withstand.

The module incorporates an electrically isolated base plate and low inductance construction enabling circuit designers to optimise circuit layouts and utilise grounded heat sinks for safety.

### ORDERING INFORMATION

Order As:

#### TG450HF12M1-S3A00

Note: When ordering, please use the complete part number

### KEY PARAMETERS

$V_{CES}$	<b>1200V</b>
$V_{CE(sat)}$ * (typ)	<b>1.65V</b>
$I_C$ (max)	<b>450A</b>
$I_{C(PK)}$ (max)	<b>900A</b>

\* Measured at the auxiliary terminals

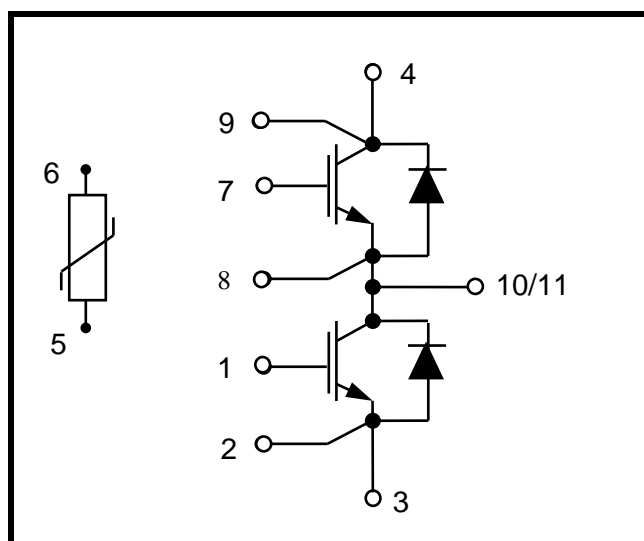


Fig. 1 Circuit configuration



Outline type code: M1

(See Fig. 15 for further information)

Fig. 2 Package

## ABSOLUTE MAXIMUM RATINGS

Stresses above those listed under 'Absolute Maximum Ratings' may cause permanent damage to the device. In extreme conditions, as with all semiconductors, this may include potentially hazardous rupture of the package. Appropriate safety precautions should always be followed. Exposure to Absolute Maximum Ratings may affect device reliability.

$T_{case} = 25^{\circ}\text{C}$  unless stated otherwise

Symbol	Parameter	Test Conditions	Max.	Units
$V_{CES}$	Collector-emitter voltage	$V_{GE} = 0\text{V}$ , $T_C = 25^{\circ}\text{C}$	1200	V
$V_{GES}$	Gate-emitter voltage	$T_C = 25^{\circ}\text{C}$	$\pm 20$	V
$I_C$	Continuous collector current	$T_C = 100^{\circ}\text{C}$	450	A
$I_{C(PK)}$	Peak collector current	$t_P = 1\text{ms}$ , $T_C = 133^{\circ}\text{C}$	900	A
$P_{max}$	Max. transistor power dissipation	$T_C = 25^{\circ}\text{C}$ , $T_{vj} = 175^{\circ}\text{C}$	2.8	kW
$I^2t$	Diode $I^2t$ value	$V_R = 0$ , $t_p = 10\text{ms}$ , $T_{vj} = 150^{\circ}\text{C}$	27.2	$\text{kA}^2\text{s}$
$V_{isol}$	Isolation voltage – per module	Commoned terminals to base plate. AC RMS, 1 min, 50Hz	2500	V

## THERMAL AND MECHANICAL RATINGS

Internal insulation material:	$\text{Al}_2\text{O}_3$
Baseplate material:	Cu
Creepage distance – Terminal to heatsink:	14.5mm
Creepage distance – Terminal to terminal:	13.0mm
Clearance – Terminal to heatsink:	12.5mm
Clearance – Terminal to terminal:	10mm
CTI (Comparative Tracking Index):	>200

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Units
$R_{th(j-c)}$	Thermal resistance – IGBT	Continuous dissipation - junction to case	-	-	52	$^{\circ}\text{C}/\text{kW}$
$R_{th(j-c)}$	Thermal resistance – diode		-	-	86	$^{\circ}\text{C}/\text{kW}$
$R_{th(c-h)}$	Thermal resistance – case to heatsink (IGBT)	Mounting torque 3Nm (with mounting grease $1\text{W}/\text{m}^{\circ}\text{C}$ )	-	-	30	$^{\circ}\text{C}/\text{kW}$
$R_{th(c-h)}$	Thermal resistance – case to heatsink (Diode)		-	-	45	$^{\circ}\text{C}/\text{kW}$
$T_j$	Junction temperature	IGBT	-40	-	150	$^{\circ}\text{C}$
		Diode	-40	-	150	$^{\circ}\text{C}$
$T_{stg}$	Storage temperature range	-	-40	-	150	$^{\circ}\text{C}$
	Screw torque	Mounting – M5	3	-	6	Nm
		Electrical connections – M6	3	-	6	Nm

## ELECTRICAL CHARACTERISTICS

$T_{case} = 25^{\circ}\text{C}$  unless stated otherwise.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$I_{CES}$	Collector cut-off current	$V_{GE} = 0V, V_{CE} = V_{CES}$			1	mA
		$V_{GE} = 0V, V_{CE} = V_{CES}, T_C = 125^{\circ}\text{C}$			10	mA
		$V_{GE} = 0V, V_{CE} = V_{CES}, T_C = 150^{\circ}\text{C}$			20	mA
$I_{GES}$	Gate leakage current	$V_{GE} = \pm 20V, V_{CE} = 0V$			0.5	$\mu\text{A}$
$V_{GE(TH)}$	Gate threshold voltage	$I_C = 15\text{mA}, V_{GE} = V_{CE}$	5.0	6.0	7.0	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15V, I_C = 450A$		1.65	2.05	V
		$V_{GE} = 15V, I_C = 450A, T_j = 125^{\circ}\text{C}$		1.95	2.35	V
		$V_{GE} = 15V, I_C = 450A, T_j = 150^{\circ}\text{C}$		2.0	2.4	V
$I_F$	Diode forward current	DC		450		A
$I_{FM}$	Diode maximum forward current	$t_p = 1\text{ms}$		900		A
$V_F$	Diode forward voltage	$I_F = 450A$		1.65	2.05	V
		$I_F = 450A, T_j = 125^{\circ}\text{C}$		1.75	2.15	V
		$I_F = 450A, T_j = 150^{\circ}\text{C}$		1.75	2.15	V
$C_{ies}$	Input capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 100\text{kHz}$		62		nF
$Q_g$	Gate charge	$\pm 15V$		4.6		$\mu\text{C}$
$C_{res}$	Reverse transfer capacitance	$V_{CE} = 25V, V_{GE} = 0V, f = 1\text{MHz}$		0.82		nF
$L_M$	Module inductance			20		nH
$R_{INT}$	Internal transistor resistance			1.1		$\text{m}\Omega$
$SC_{Data}$	Short circuit current, $I_{SC}$	$T_j = 150^{\circ}\text{C}, V_{CC} = 800V$ $t_p \leq 10\mu\text{s}, V_{GE} \leq 15V$ $V_{CE(max)} = V_{CES} - L^* \times di/dt$ IEC 60747-9		1900		A

### Note:

\* L is the circuit inductance +  $L_M$

## NTC-Thermistor Data

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$R_{25}$	Rated resistance	$T_C = 25^{\circ}\text{C}$		5		k $\Omega$
$\Delta R/R$	Deviation of R100	$T_C = 100^{\circ}\text{C}, R_{100} = 493\Omega$	-5		5	%
$P_{25}$	Power dissipation	$T_C = 25^{\circ}\text{C}$			20	mW
$B_{25/50}$	B-value	$R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298.15K))]$		3375		K
$B_{25/80}$		$R_2 = R_{25} \exp [B_{25/80}(1/T_2 - 1/(298.15K))]$		3411		K
$B_{25/100}$		$R_2 = R_{25} \exp [B_{25/100}(1/T_2 - 1/(298.15K))]$		3433		K

## ELECTRICAL CHARACTERISTICS

 $T_{\text{case}} = 25^{\circ}\text{C}$  unless stated otherwise

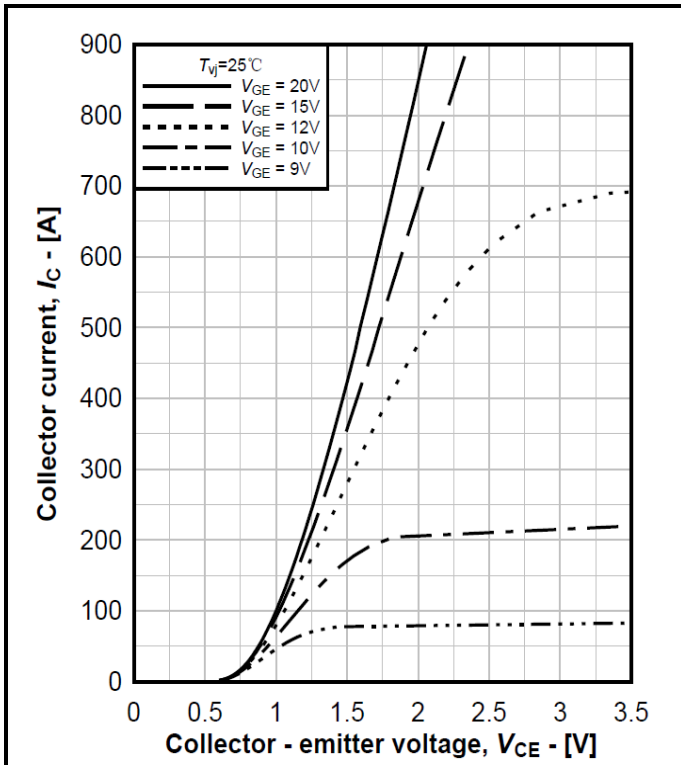
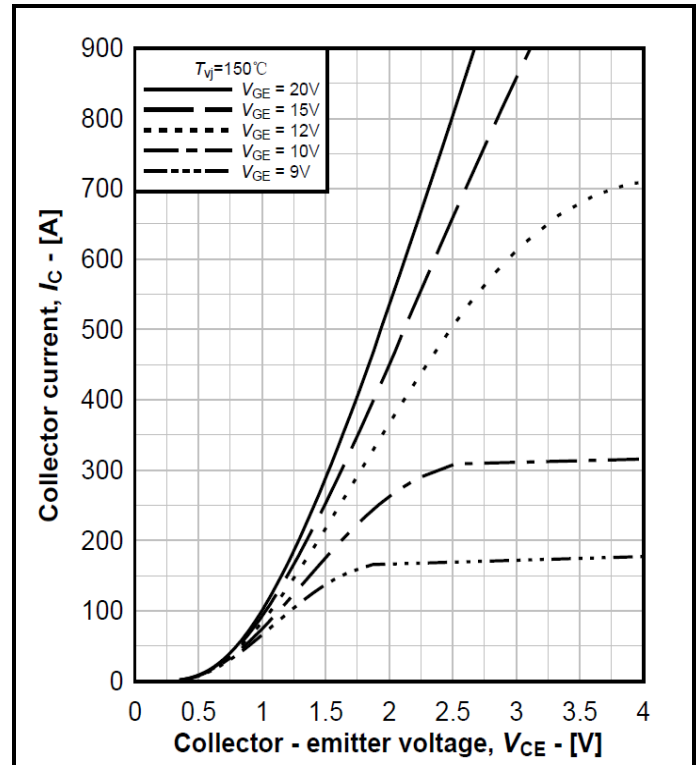
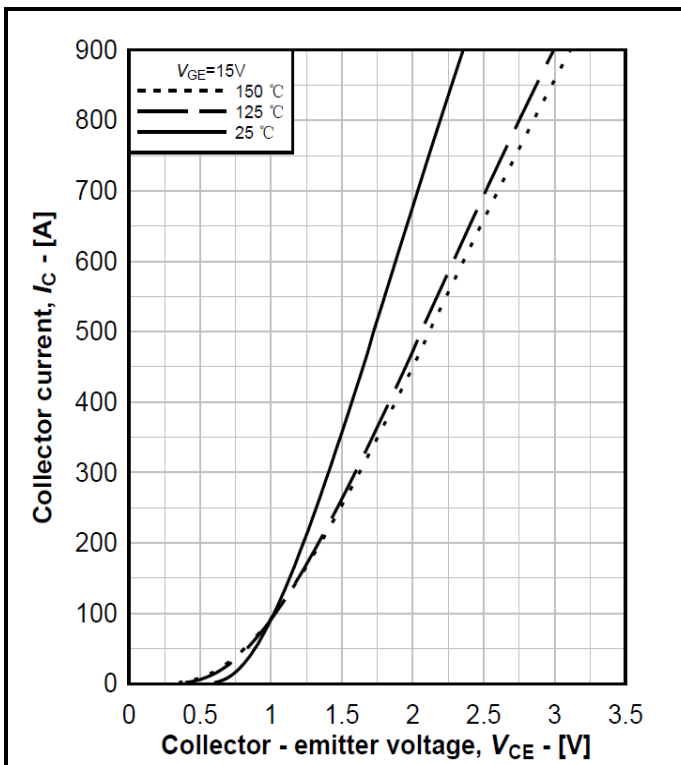
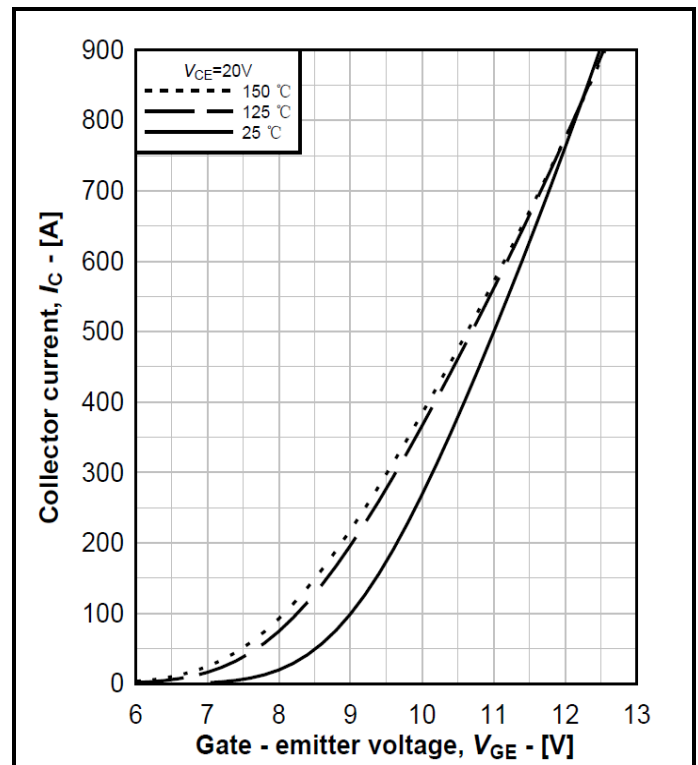
Symbol	Parameter	Test Conditions		Min	Typ.	Max	Units
t <sub>d(off)</sub>	Turn-off delay time	I <sub>C</sub> = 450A V <sub>CE</sub> = 600V V <sub>GE</sub> = ±15V R <sub>G(OFF)</sub> = 1.0Ω R <sub>G(ON)</sub> = 1.0Ω L <sub>S</sub> ~ 50nH	dv/dt = 4500V/μs		530		ns
t <sub>f</sub>	Fall time				260		ns
E <sub>OFF</sub>	Turn-off energy loss				52		mJ
t <sub>d(on)</sub>	Turn-on delay time		di/dt = 7000A/μs		220		ns
t <sub>r</sub>	Rise time				70		ns
E <sub>ON</sub>	Turn-on energy loss				8.3		mJ
Q <sub>rr</sub>	Diode reverse recovery charge	I <sub>F</sub> = 450A V <sub>CE</sub> = 600V di/dt = 7000A/μs			34		μC
I <sub>rr</sub>	Diode reverse recovery current				415		A
E <sub>rec</sub>	Diode reverse recovery energy				24		mJ

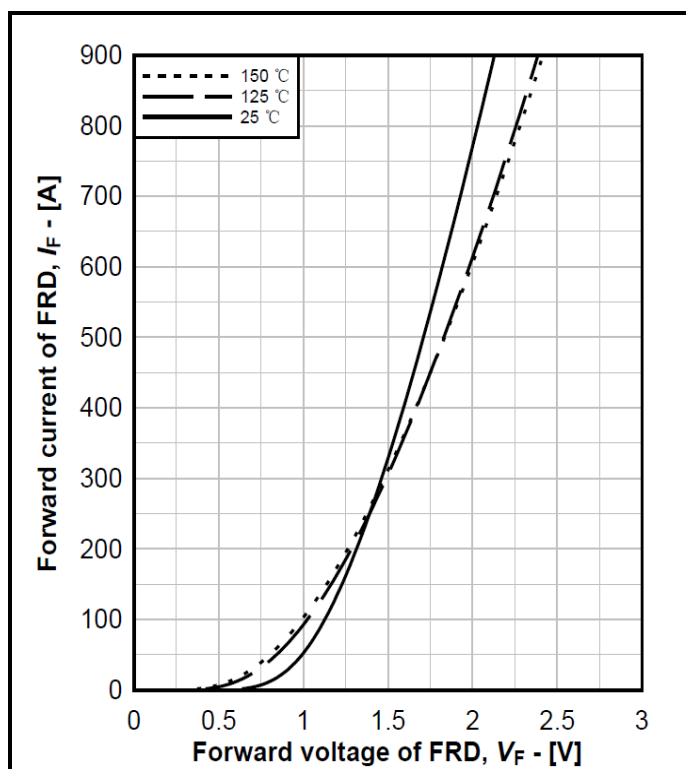
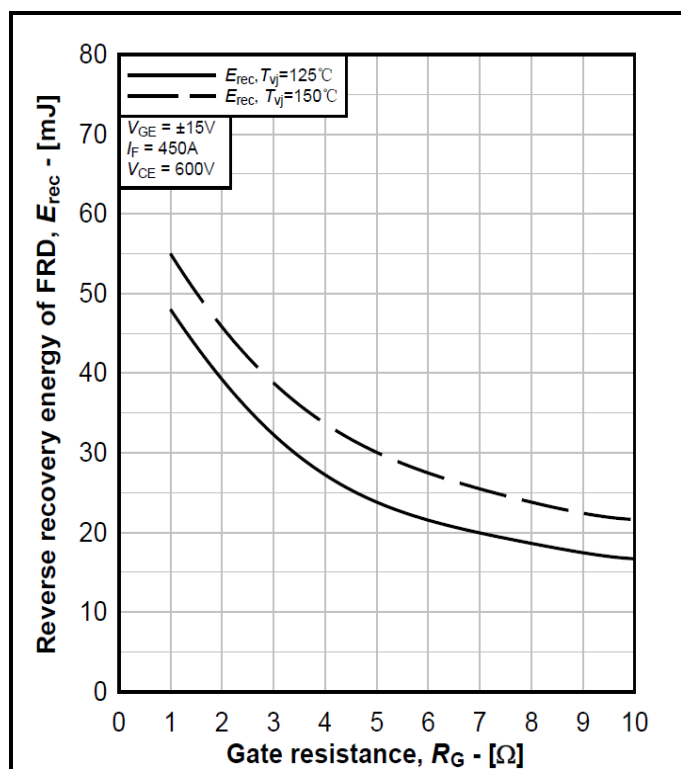
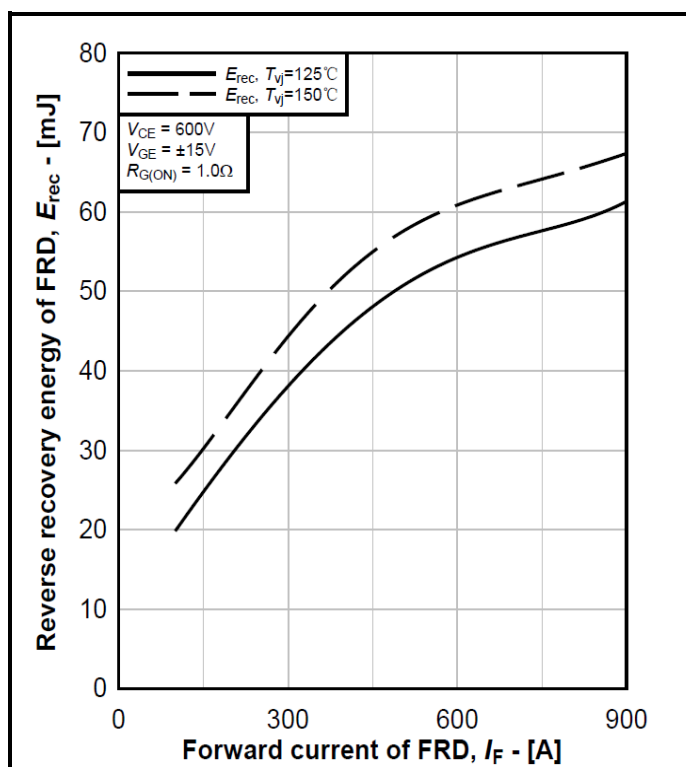
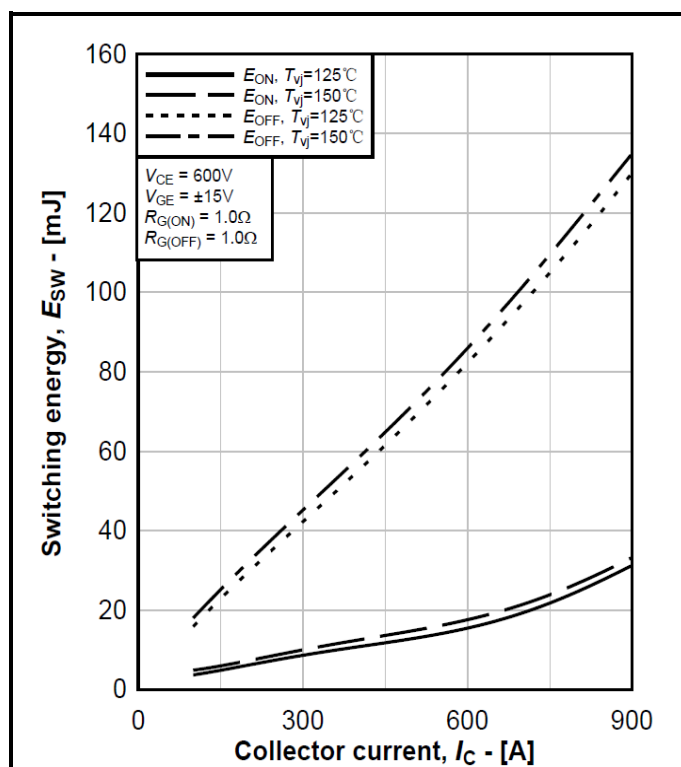
 $T_{\text{case}} = 125^{\circ}\text{C}$  unless stated otherwise

Symbol	Parameter	Test Conditions		Min	Typ.	Max	Units
t <sub>d(off)</sub>	Turn-off delay time	I <sub>C</sub> = 450A V <sub>CE</sub> = 600V V <sub>GE</sub> = ±15V R <sub>G(OFF)</sub> = 1.0Ω R <sub>G(ON)</sub> = 1.0Ω L <sub>S</sub> ~ 50nH	dv/dt = 4500V/μs		590		ns
t <sub>f</sub>	Fall time				320		ns
E <sub>OFF</sub>	Turn-off energy loss				62		mJ
t <sub>d(on)</sub>	Turn-on delay time		di/dt = 7000A/μs		224		ns
t <sub>r</sub>	Rise time				74		ns
E <sub>ON</sub>	Turn-on energy loss				12		mJ
Q <sub>rr</sub>	Diode reverse recovery charge	I <sub>F</sub> = 450A V <sub>CE</sub> = 600V di/dt = 7000A/μs			77		μC
I <sub>rr</sub>	Diode reverse recovery current				475		A
E <sub>rec</sub>	Diode reverse recovery energy				48		mJ

 $T_{\text{case}} = 150^{\circ}\text{C}$  unless stated otherwise

Symbol	Parameter	Test Conditions		Min	Typ.	Max	Units
t <sub>d(off)</sub>	Turn-off delay time	I <sub>C</sub> = 450A V <sub>CE</sub> = 600V V <sub>GE</sub> = ±15V R <sub>G(OFF)</sub> = 1.0Ω R <sub>G(ON)</sub> = 1.0Ω L <sub>S</sub> ~ 50nH	dv/dt = 4500V/μs		600		ns
t <sub>f</sub>	Fall time				330		ns
E <sub>OFF</sub>	Turn-off energy loss				65		mJ
t <sub>d(on)</sub>	Turn-on delay time		di/dt = 7000A/μs		226		ns
t <sub>r</sub>	Rise time				76		ns
E <sub>ON</sub>	Turn-on energy loss				13		mJ
Q <sub>rr</sub>	Diode reverse recovery charge	I <sub>F</sub> = 450A V <sub>CE</sub> = 600V di/dt = 7000A/μs			90		μC
I <sub>rr</sub>	Diode reverse recovery current				500		A
E <sub>rec</sub>	Diode reverse recovery energy				55		mJ


**Fig. 3 Typical IGBT output characteristics,  $I_C = f(V_{CE})$** 

**Fig. 4 Typical IGBT output characteristics,  $I_C = f(V_{CE})$** 

**Fig. 5 Typical IGBT output characteristics,  $I_C = f(V_{CE})$** 

**Fig. 6 Typical IGBT transfer characteristics,  $I_C = f(V_{GE})$**

Fig. 7 Diode typical forward characteristics,  $I_F = f(V_F)$ Fig. 8 Typical FRD  $E_{rec}$ ,  $E_{rec} = f(R_G)$ Fig. 9 Typical FRD  $E_{rec}$ ,  $E_{rec} = f(I_F)$ Fig. 10 Typical IGBT switching energy,  $E_{ON} = f(I_C)$ ,  $E_{OFF} = f(I_C)$

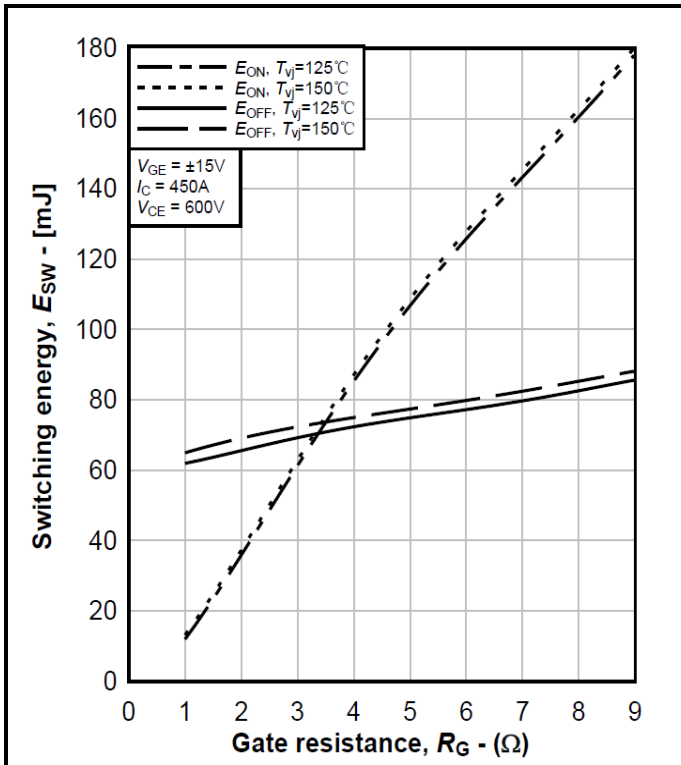


Fig. 11 Typical IGBT switching energy  
 $E_{ON} = f(R_G)$ ,  $E_{OFF} = f(R_G)$

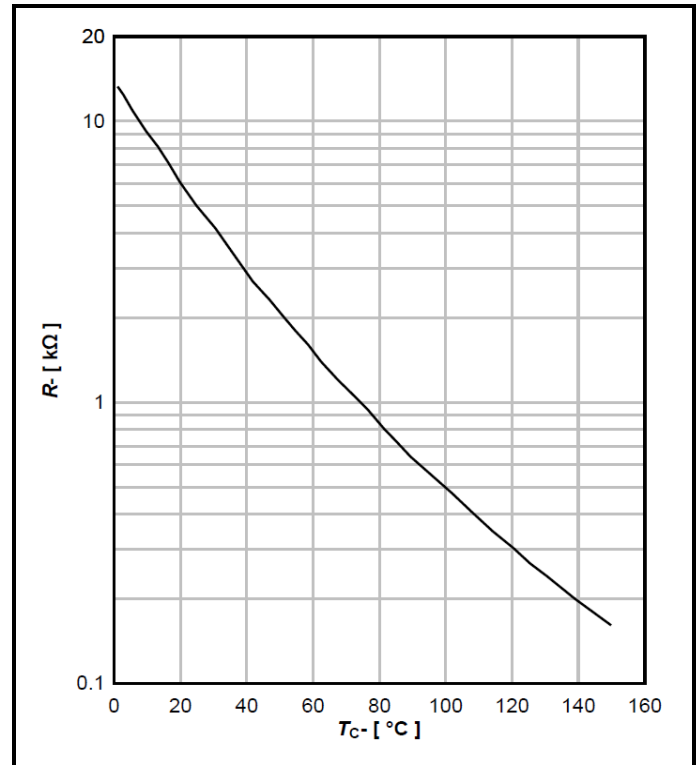


Fig. 12 Typical NTC thermistor characteristic,  $R = f(T_C)$

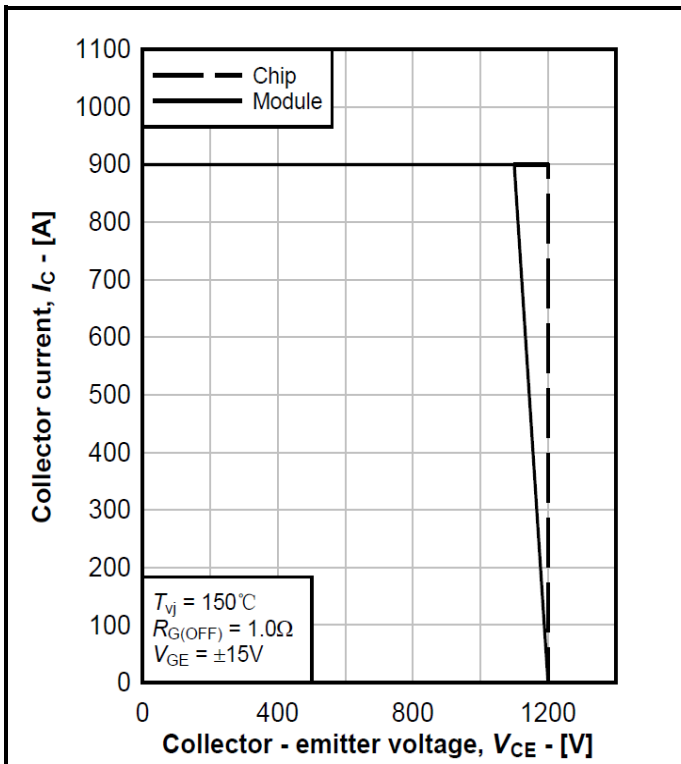


Fig. 13 Reverse bias safe operating area of IGBT,  
 $I_C = f(V_{CE})$

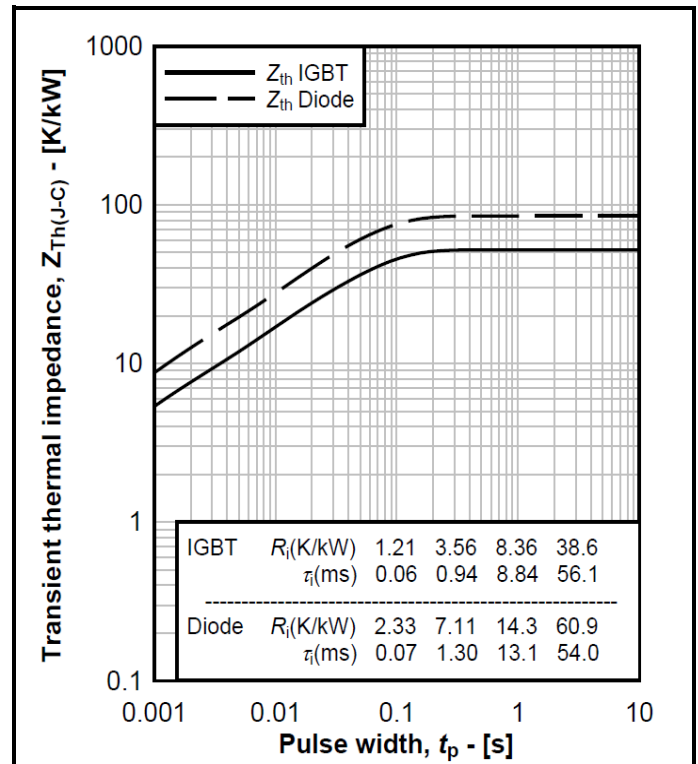


Fig. 14 Transient thermal impedance,  $Z_{th(J-C)} = f(t)$





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