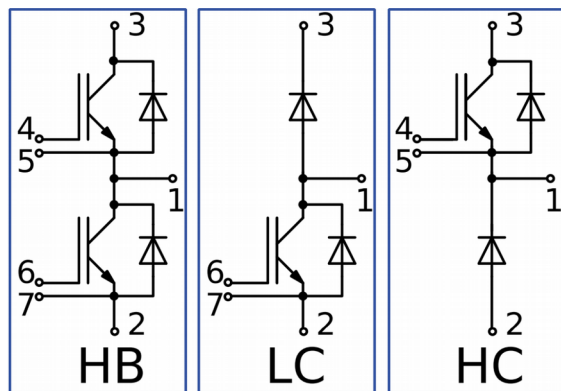
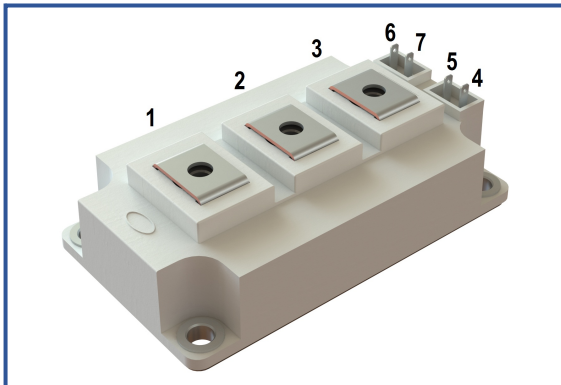


## Industry standard 62mm IGBT module

1200 V 400 A


**Chip features**

- IGBT chip
  - Trench FS — V-Series IGBT (Fuji 6<sup>th</sup> gen)
  - low  $V_{CE(sat)}$  value
  - 10  $\mu$ s short circuit of 150°C
  - square RBSOA of 2xI<sub>C</sub>
  - low EMI
- FRD chip
  - fast and soft reverse recovery
  - low voltage drop

**Design features**

- copper baseplate
- Al<sub>2</sub>O<sub>3</sub> DBC substrate
- ultrasonically welded power terminals
- Improved thermal cycling
- RoHS compliant

**Typical application**

- AC motor drives
- solar inverter
- air conditioning
- high power converters and UPS

**Maximum rated values**

Definition	Symbol	Conditions	Value	Unit
<b>IGBT</b>				
Collector-Emitter voltage	$V_{CES}$	$V_{GE} = 0$ .	1200	V
Collector current (nominal)	$I_{C\ nom}$		400	A
Collector current (maximum continuous)	$I_{C\ 25}$	$T_{vj\ (max)} = 175^{\circ}C; T_c = 25^{\circ}C$ .	504	A
	$I_{C\ 80}$	$T_{vj\ (max)} = 175^{\circ}C; T_c = 80^{\circ}C$ .	400	A
Repetitive peak collector current* <sup>1</sup>	$I_{CRM}$	$I_{CRM} = 3 \times I_{C\ nom}; t_p = 1\ ms$ .	1200	A
Short-circuit duration	$t_{psc}$	$T_{vj} = 25^{\circ}C; V_{GE} = \pm 15\ V; V_{CE} = 720\ V;$ $R_{G\ on} = R_{G\ off} = 2.2\ \Omega; I_{C\ max} < 1950\ A$ .	10	$\mu$ s
		$T_{vj} = 150^{\circ}C; V_{GE} = \pm 15\ V; V_{CE} = 720\ V;$ $R_{G\ on} = R_{G\ off} = 2.2\ \Omega; I_{C\ max} < 1900\ A$ .	10	
Gate-Emitter voltage	$V_{GES}$		$\pm 20$	V
Junction operating temperature	$T_{vj\ (op)}$		-40...+150	°C
<b>Inverse diode \ Freewheeling diode</b>				
Repetitive peak reverse voltage	$V_{RRM}$	$V_{GE} = 0\ V$ .	1200	V
Forward current (nominal)	$I_{F\ nom}$		400	A
Forward current (maximum continuous)	$I_{F\ 25}$	$T_{vj\ (max)} = 175^{\circ}C; T_c = 25^{\circ}C$ .	444	A
	$I_{F\ 80}$	$T_{vj\ (max)} = 175^{\circ}C; T_c = 80^{\circ}C$ .	332	A
Repetitive peak forward current* <sup>1</sup>	$I_{FRM}$	$I_{FRM} = 3 \times I_{F\ nom}; t_p = 1\ ms$ .	1200	A
Junction operating temperature	$T_{vj\ (op)}$		-40...+150	°C
<b>Module</b>				
Storage temperature	$T_{stg}$		-55...+50	°C
Isolation voltage	$V_{isol}$	AC sin 50 Hz; t = 1 min.	4000	V

\*1 Pulse width and repetition rate should be such that device junction temperature does not exceed maximum  $T_{vj}$  rating

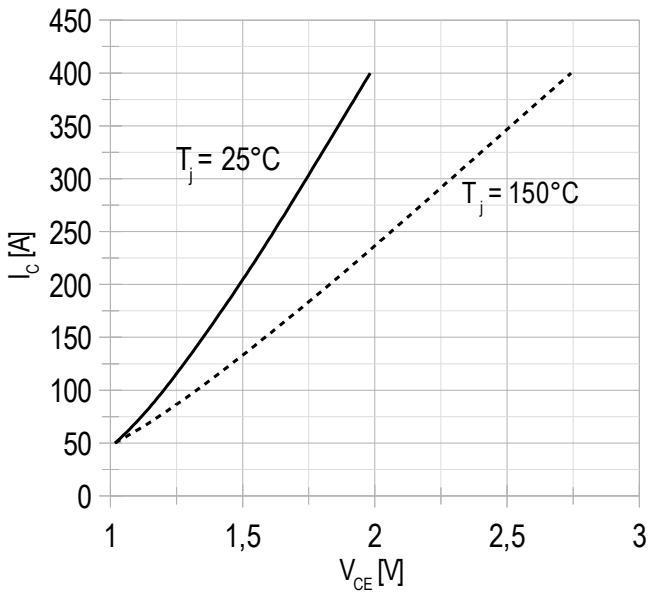
**Characteristics**

Definition	Symbol	Conditions	Value			Unit		
			min.	typ.	max.			
<b>IGBT</b>								
Collector-Emitter saturation voltage	$V_{CEsat}$	$V_{GE} = +15\text{ V}; I_C = 400\text{ A}; t_u = 1000\ \mu\text{s}.$	$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	1.93 2.54	1.97 2.72	2.12 3.00	V V	
Gate-Emitter threshold voltage	$V_{GE(th)}$	$I_C = 16\text{ mA}; V_{CE} = V_{GE}; T_{vj} = 25^\circ\text{C}; t_u = 2\text{ ms}.$		5.45	6.04	6.40	V	
Collector-Emitter cut-off current	$I_{CES}$	$V_{CE} = 1200\text{ V}; t_u = 10\text{ ms}; V_{GE} = 0.$	$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	45.5 1.99	63.2 2.11	300 5.0	$\mu\text{A}$ mA	
Gate-Emitter leakage current	$I_{GES}$	$V_{CE} = 0; V_{GE} = \pm 20\text{ V}; T_{vj} = 25^\circ\text{C}; t_u = 30\text{ ms}.$		9.92	11.9	400	nA	
Input capacitance	$C_{ies}$	$V_{CE} = 10\text{ V}; V_{GE} = 0\text{ V}; f = 1\text{ MHz}; T_{vj} = 25^\circ\text{C}.$		-	33.2	-	nF	
Output capacitance	$C_{oes}$			-	2.40	-	nF	
Reverse transfer capacitance	$C_{res}$			-	2.80	-	nF	
Total gate charge	$Q_G$	$I_C = 400\text{ A}; V_{CE} = 600\text{ V}; V_{GE} = -8 \div 15\text{ V}.$		-	3416	3654	nC	
Internal gate resistance	$R_{Gint}$	$T_{vj} = 25^\circ\text{C}.$		-	1.88	-	$\Omega$	
Turn-on delay time	$t_{d(on)}$	$V_{CE} = 600\text{ V}; V_{GE} = \pm 15\text{ V}; I_{Cmax} = 400\text{ A}; R_G = 2.2\ \Omega; L = 100\ \mu\text{H}.$	$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	348 440	387 457	470 590	ns	
Rise time	$t_{ri}$		$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	78 71	83 74	100 105	ns	
Turn-on energy	$E_{on}$		$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	16.8 23.2	21.0 27.9	28.0 47.0	mJ	
Turn-off delay time	$t_{d(off)}$		$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	650 640	666 650	770 890	ns	
Fall time	$t_{fi}$		$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	181 287	194 314	230 360	ns	
Turn-off energy	$E_{off}$		$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	40.8 52.1	41.3 53.9	46.0 60.0	mJ	
Collector-emitter threshold voltage	$V_{CE0}$		$V_{GE} = +15\text{ V}; T_{vj} = 150^\circ\text{C}; I_{CE1} = 100\text{ A}; I_{CE2} = 400\text{ A}; t_u = 1000\ \mu\text{s}.$		0.82	0.84	0.86	V
On-State slope resistance (IGBT)	$r_{CE0}$				4.27	4.69	5.30	m $\Omega$
Thermal resistance junction to case	$R_{th(j-c)}$		DC; $I_{CE} = 400 \pm 20\text{ A}; I_{test} = 1.0\text{ A}; V_{GE} = +15\text{ V}.$		-	0.073	0.092	K/W
<b>Inverse diode \ Freewheeling diode</b>								
Forward voltage drop	$V_F$	$I_F = 400\text{ A}; V_{GE} = 0; t_u = 500\ \mu\text{s}.$	$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	1.94 2.17	1.98 2.31	2.15 2.59	V V	
Reverse recovery time	$t_{rr}$	$V_{GE} = \pm 15\text{ V}; V_{CE} = 600\text{ V}; I_{Cmax} = 400\text{ A}; L = 100\ \mu\text{H}; R_{Gon} = 2.2\ \Omega.$	$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	136 207	142 221	170 270	ns ns	
Peak reverse recovery current	$I_{rrM}$		$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	260 320	276 340	310 390	A A	
Reverse recovered charge	$Q_{rr}$		$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	21.0 40.0	23.0 43.0	27.0 49.0	$\mu\text{C}$ $\mu\text{C}$	
Reverse recovery energy	$E_{rec}$		$T_{vj} = 25^\circ\text{C}$ $T_{vj} = 150^\circ\text{C}$	11.0 29.0	13.0 31.0	17.0 36.0	mJ mJ	
Threshold voltage	$V_{(T0)}$		$T_{vj} = 150^\circ\text{C}; V_{GE} = 0; I_{CE1} = 100\text{ A}; I_{CE2} = 400\text{ A}; t_u = 1000\ \mu\text{s}.$		0.81	0.82	0.85	V
Forward slope resistance	$r_T$				2.60	2.67	3.00	m $\Omega$
Thermal resistance junction to case	$R_{th(jc-D)}$	DC; $I_{CE} = 330 \pm 20\text{ A}; I_{test} = 1.0\text{ A}; V_{GE} = +15\text{ V}.$		-	0.131	0.150	K/W	

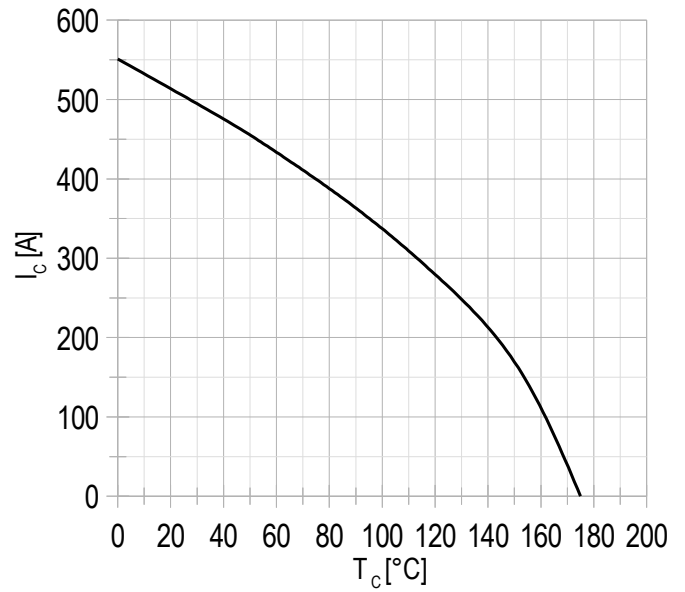
Module							
Pin resistance	$R_{Pxy}$	$T_{vj} = 25^{\circ}\text{C}.$	$R_{P12}$	-	0.28	0.50	m $\Omega$
			$R_{P13}$	-	0.38	0.50	
Parasitic inductance between terminals	$L_{Pxy}$	$T_{vj} = 25^{\circ}\text{C};$ $f = 1 \text{ MHz}.$	$L_{P12}$	-	33.4	35.0	nH
			$L_{P13}$	-	56.0	60.0	
Thermal resistance case to heatsink	$R_{thCH}$	per module			0.02	0.04	K/W
Mounting torque for screws to heatsink	$M_s$	to heatsink M6		3.00	-	5.00	N*m
Mounting torque for terminal screws	$M_t$	to terminals M5		2.25	2.50	2.75	N*m
Weight	$W$			-	320	340	g

**Notes:**

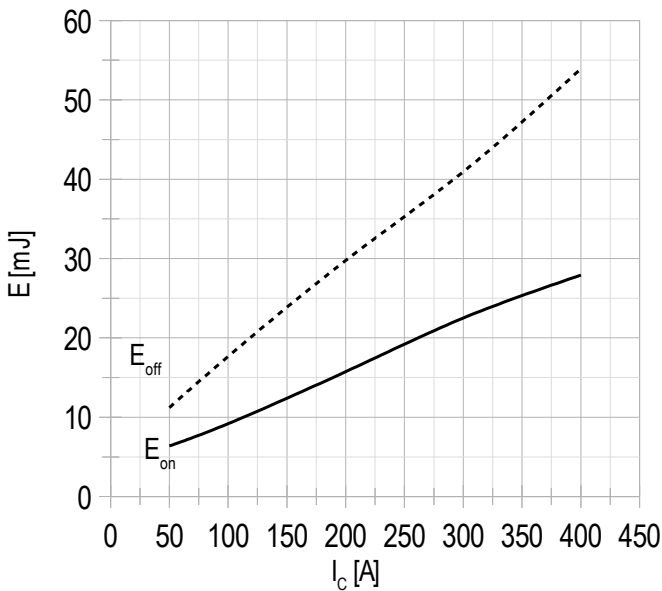
- Insulating material operating temperature 125°C max;
- Case temperature 125°C max;
- The recommended operating junction temperature  $T_{vj\ op} = -40 \div +150^{\circ}\text{C}.$

**Chart 1 – typ. output characteristic, IGBT.**


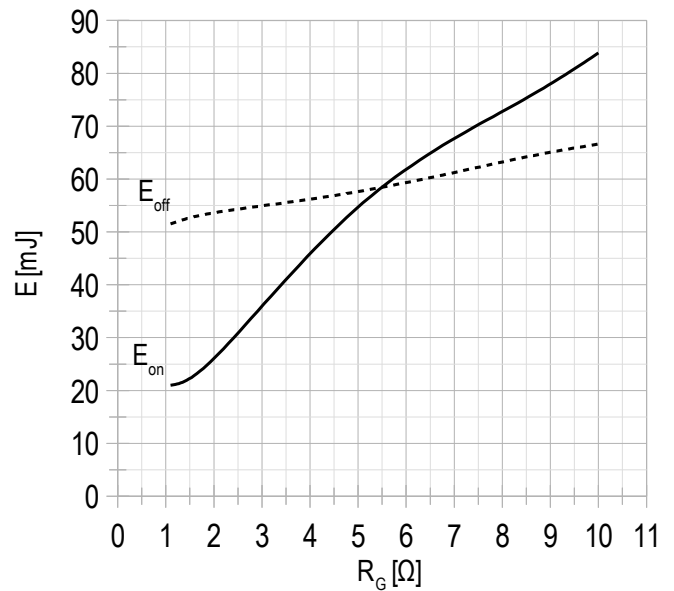
$V_{GE} = +15\text{ V}$ .

**Chart 2 – max. rated current vs temperature.**


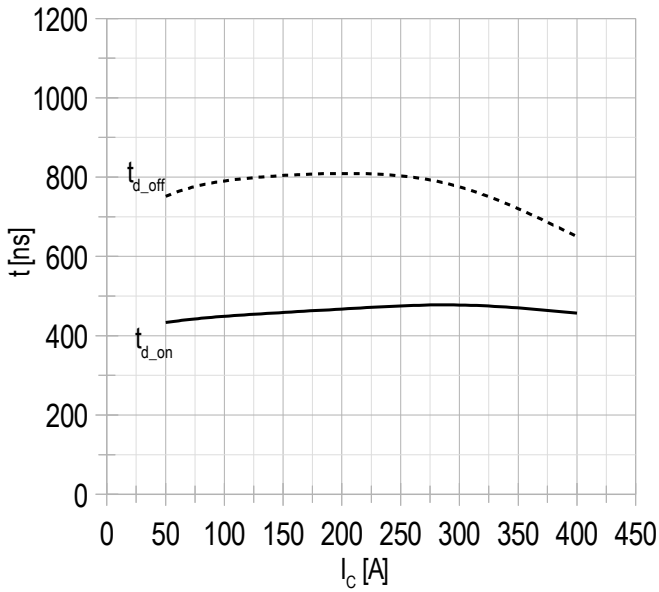
DC;  
 $V_{GE} = +15\text{ V}$ ;  
 $T_{vj(max)} = 150^\circ\text{C}$ .

**Chart 3 – typ. turn-on/-off energy vs rated current, IGBT.**


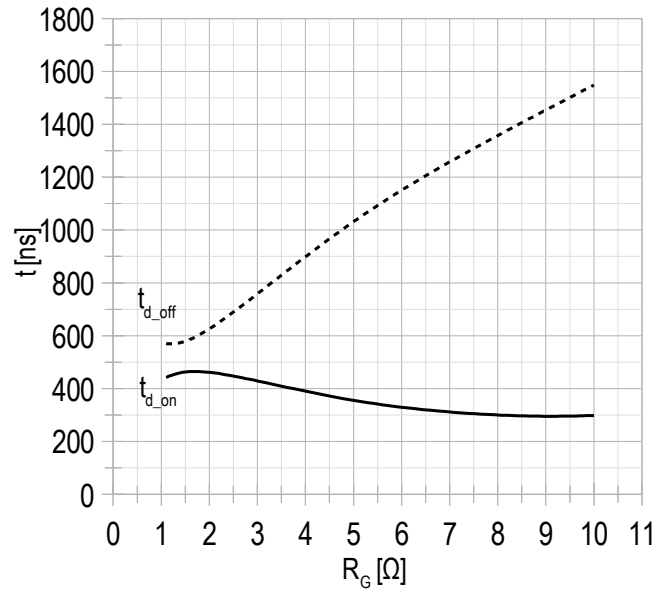
$V_{CE} = 600\text{ V}$ ;  
 $V_{GE} = \pm 15\text{ V}$ ;  
 $R_G = 2.2\ \Omega$ ;  
 $L = 100\ \mu\text{H}$ ;  
 $T_{vj(max)} = 150^\circ\text{C}$ .

**Chart 4 – typ. turn-on/-off energy vs gate resistance, IGBT.**


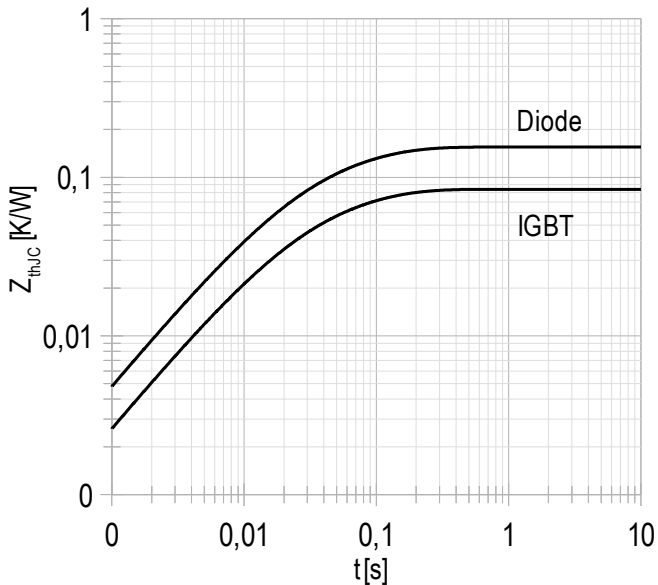
$V_{CE} = 600\text{ V}$ ;  
 $V_{GE} = \pm 15\text{ V}$ ;  
 $I_{c(max)} = 400\text{ A}$ ;  
 $L = 100\ \mu\text{H}$ ;  
 $T_{vj(max)} = 150^\circ\text{C}$ .

**Chart 5 – typ. switching times vs rated current, IGBT.**


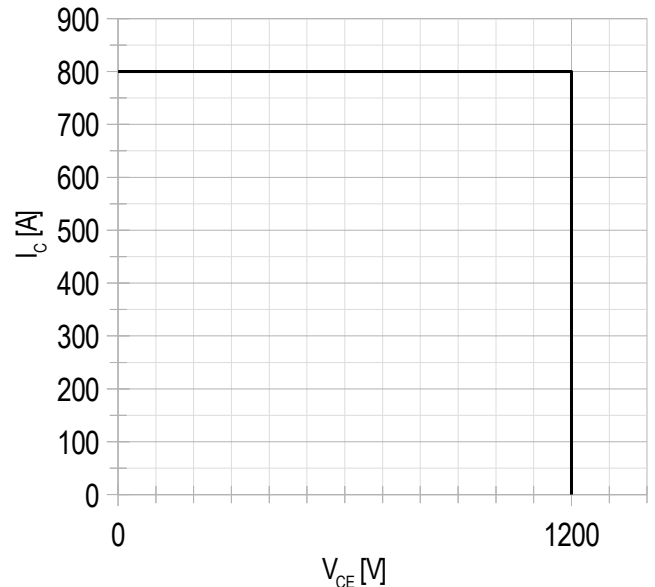
$V_{CE} = 600$  V;  
 $V_{GE} = \pm 15$  V;  
 $R_G = 2.2$   $\Omega$ ;  
 $L = 100$   $\mu$ H;  
 $T_{vj(max)} = 150^\circ$ C.

**Chart 6 – typ. switching times vs gate resistance, IGBT.**


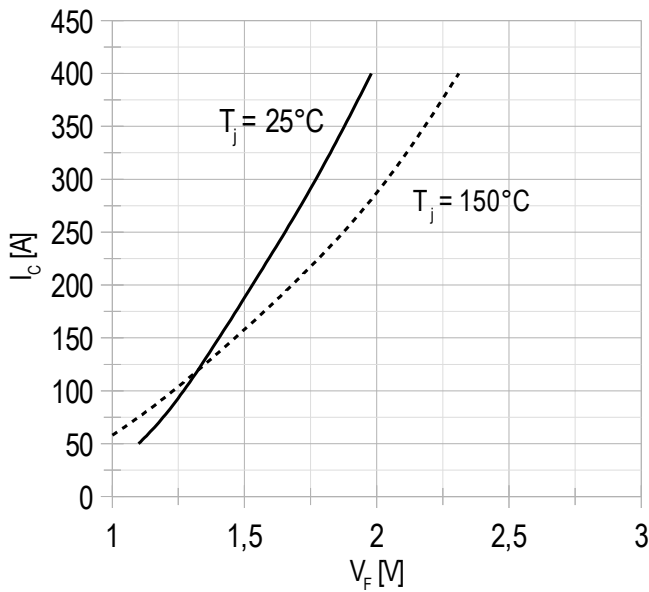
$V_{CE} = 600$  V;  
 $V_{GE} = \pm 15$  V;  
 $I_{Cmax} = 400$  A;  
 $L = 100$   $\mu$ H;  
 $T_{vj(max)} = 150^\circ$ C.

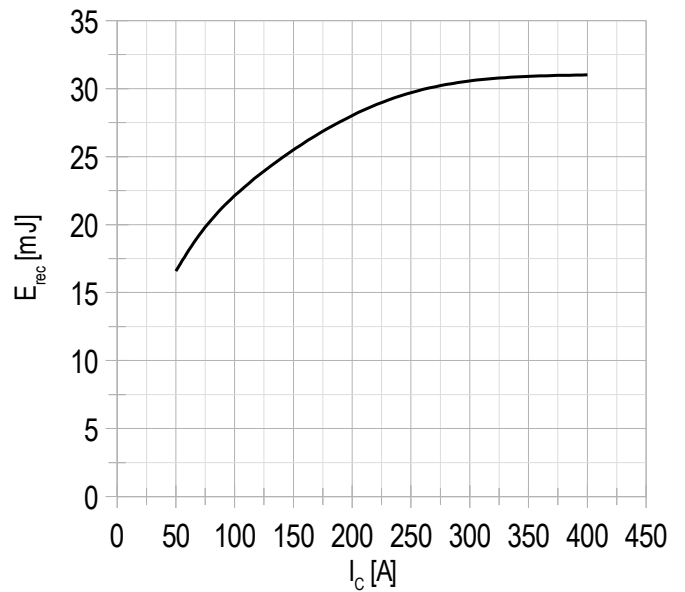
**Chart 7 – max. transient thermal impedance.**


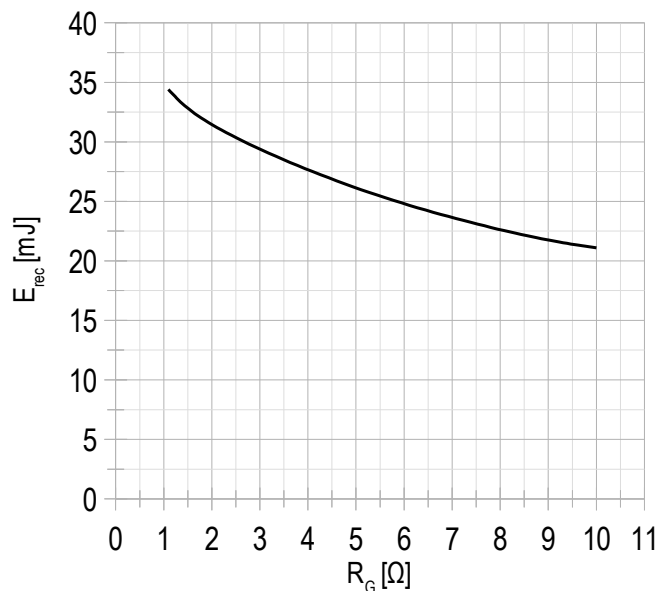
Single pulse;  
 $V_{GE} = +15$  V.

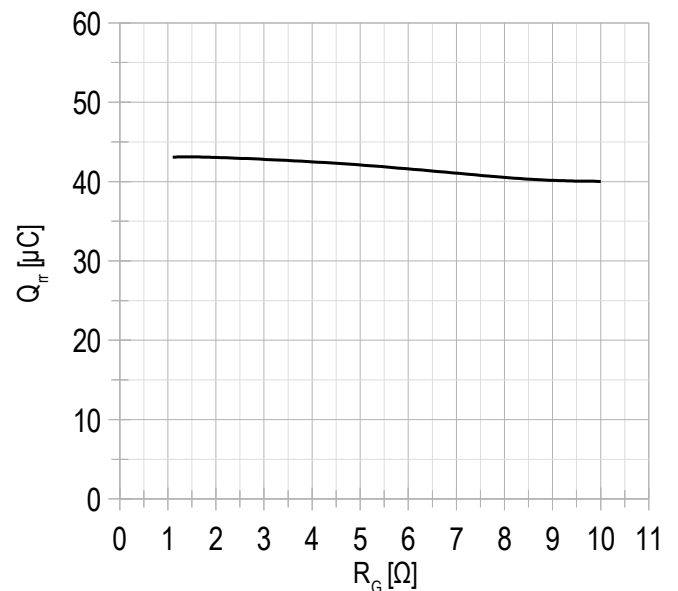
**Chart 8 – RBSOA.**


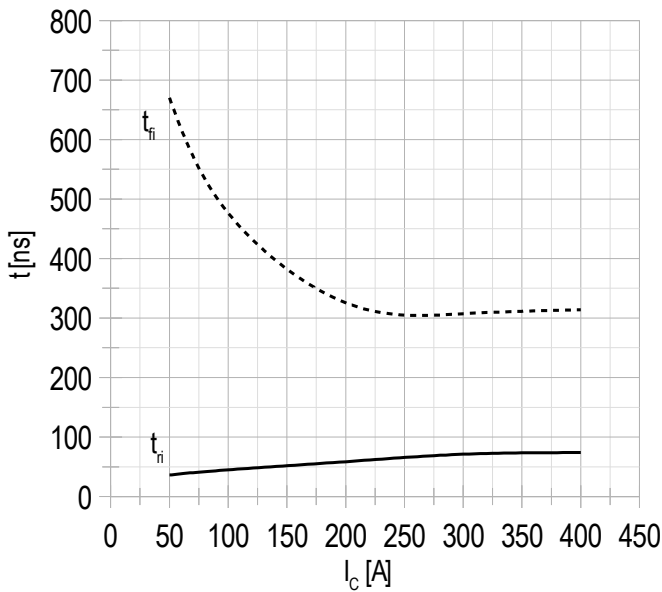
$V_{CEmax} = 1200$  V;  
 $V_{GE} = \pm 15$  V;  
 $I_{Cmax} = 2 \cdot I_{Cnom}$ ;  
 $R_G = 2.2$   $\Omega$ ;  
 $L = 30$   $\mu$ H.

**Chart 9 – typ. output characteristic, FRD.**

 $V_{GE} = +15\text{ V}$ .

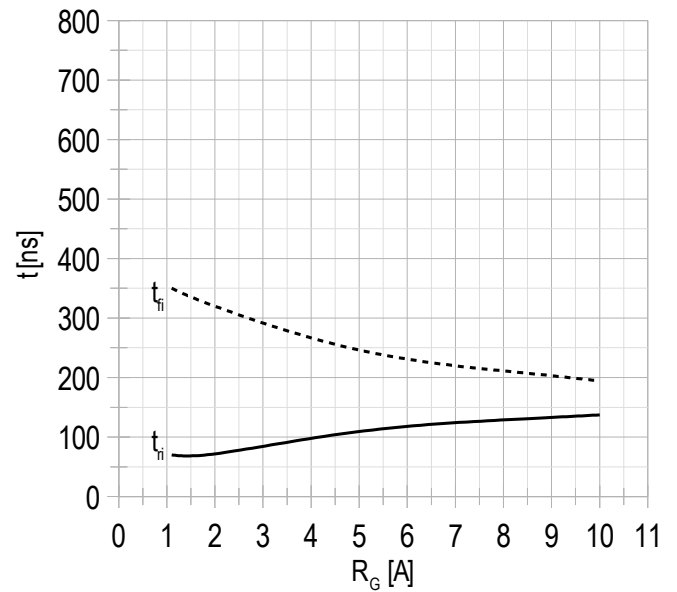
**Chart 10 – typ. switching losses vs rated current, FRD.**

 $V_{GE} = \pm 15\text{ V}$ ;  
 $V_{CE} = 600\text{ V}$ ;  
 $L = 100\ \mu\text{H}$ ;  
 $R_{G\ on} = 2.2\ \Omega$ ;  
 $T_{vj\ (max)} = 150^\circ\text{C}$ .

**Chart 11 – typ. switching losses vs gate resistance, FRD.**

 $V_{GE} = \pm 15\text{ V}$ ;  
 $V_{CE} = 600\text{ V}$ ;  
 $I_{C\ max} = 400\text{ A}$ ;  
 $L = 100\ \mu\text{H}$ ;  
 $T_{vj\ (max)} = 150^\circ\text{C}$ .

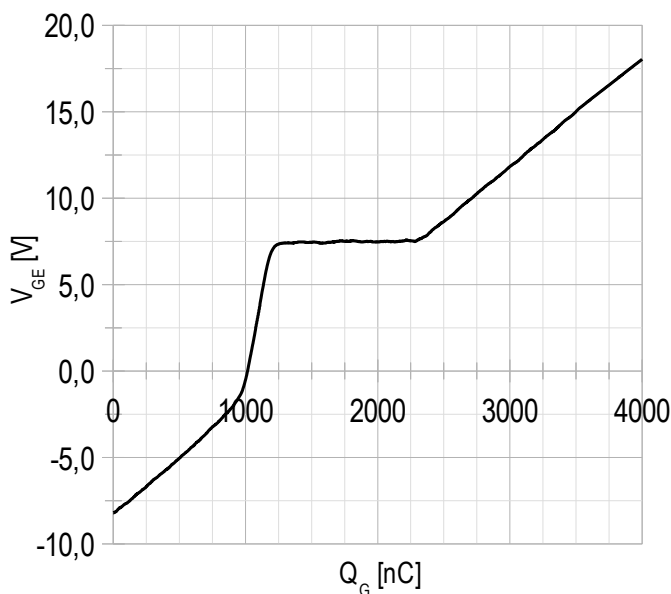
**Chart 12 – typ. reverse recovered charge vs gate resistance, FRD.**

 $V_{GE} = \pm 15\text{ V}$ ;  
 $V_{CE} = 600\text{ V}$ ;  
 $I_{C\ max} = 400\text{ A}$ ;  
 $L = 100\ \mu\text{H}$ ;  
 $T_{vj\ (max)} = 150^\circ\text{C}$ .

**Chart 13 – typ. switching times vs rated current, FRD.**


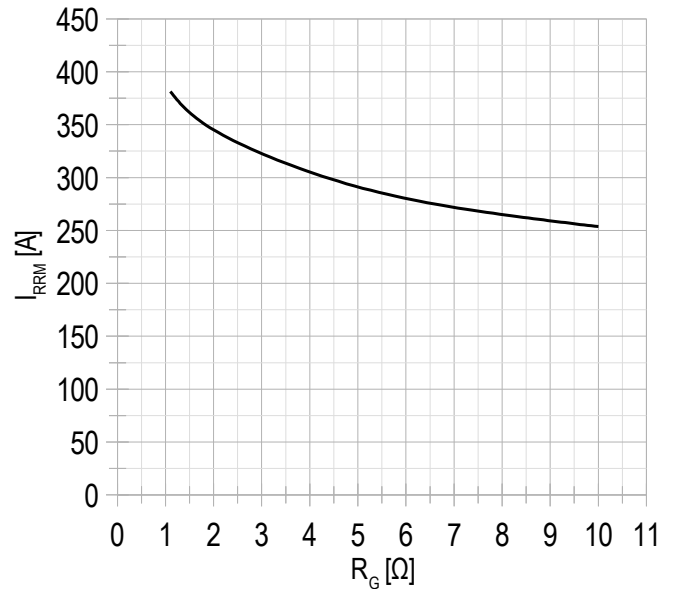
$V_{CE} = 600$  V;  
 $V_{GE} = \pm 15$  V;  
 $R_G = 2.2$   $\Omega$ ;  
 $L = 100$   $\mu$ H.  
 $T_{vj(max)} = 150^\circ$ C.

**Chart 14 – typ. switching times vs gate resistance, FRD.**


$V_{CE} = 600$  V;  
 $V_{GE} = \pm 15$  V;  
 $I_{Cmax} = 400$  A;  
 $L = 100$   $\mu$ H.  
 $T_{vj(max)} = 150^\circ$ C.

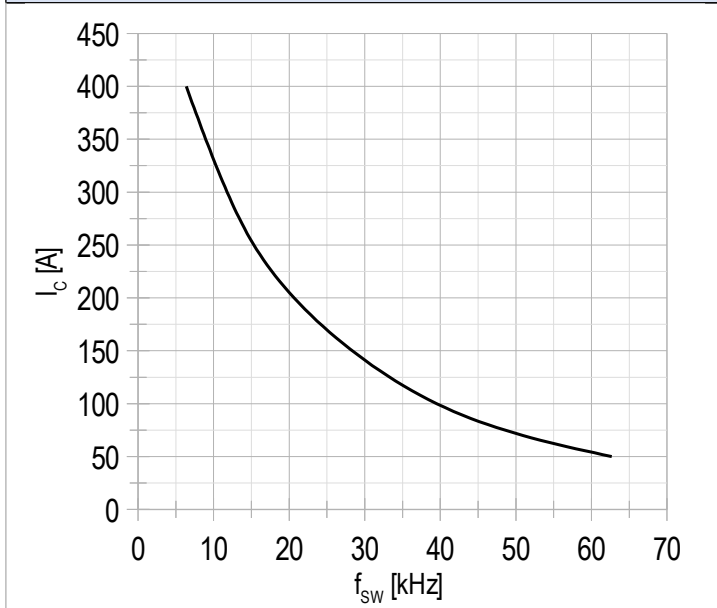
**Chart 15 – typ. gate charge characteristic.**


$I_c = 400$  A;  
 $V_{CE} = 600$  V;  
 $V_{GE} = -8 \div 15$  V.

**Chart 16 – typ. reverse recovery current vs gate resistance FRD.**


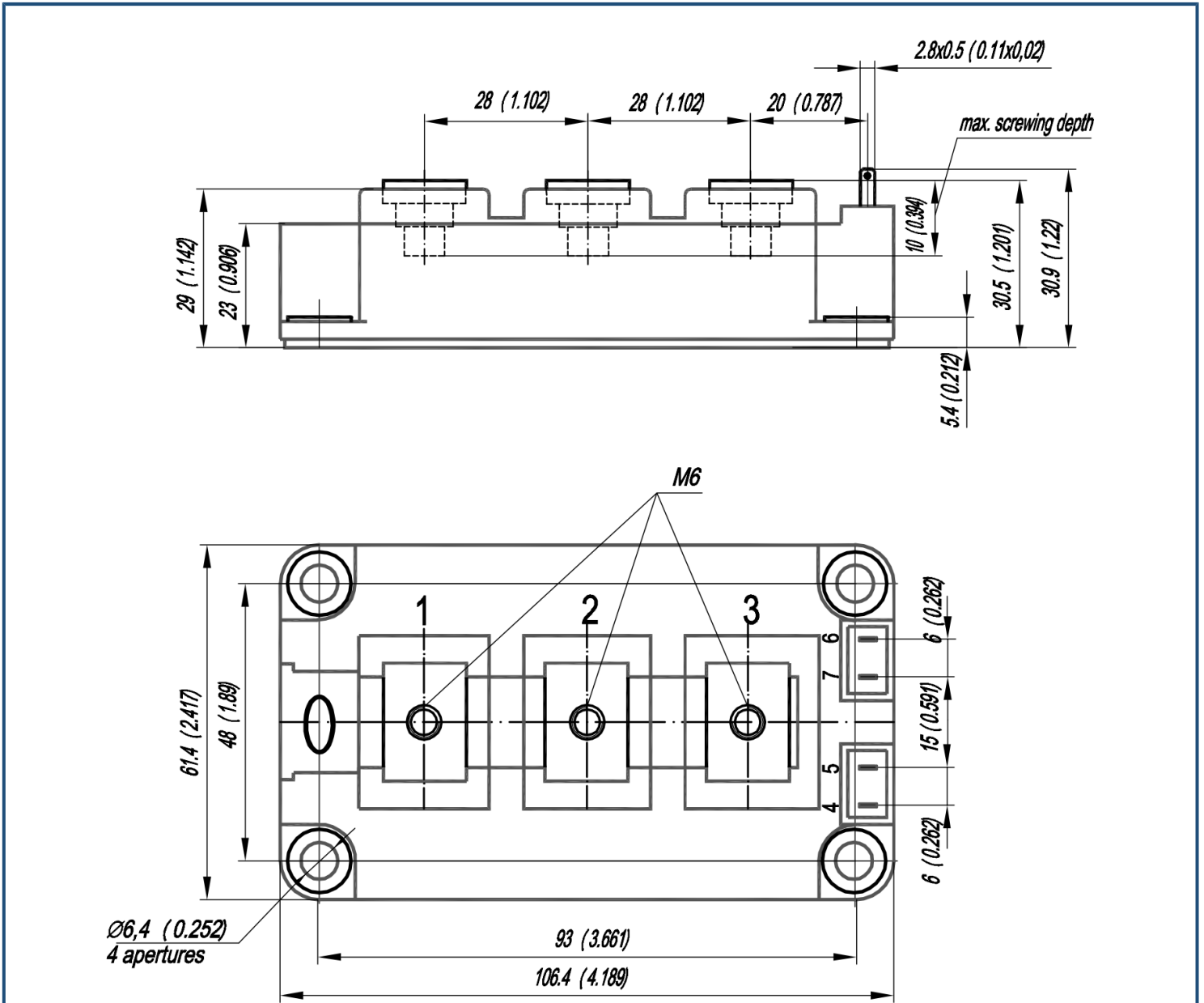
$V_{CE} = 600$  V;  
 $V_{GE} = \pm 15$  V;  
 $L = 100$   $\mu$ H.  
 $T_{vj(max)} = 150^\circ$ C.

Chart 17 – typ. rated current vs frequency.



Duty cycle 50%



**Overall dimensions: Package type – AA**

**Part numbering guide**

MIAA	-	HB	12	FA	-	400	N	
MIAA								IGBT module package type: FA
		HB						2 switches as Half-Bridge
		HC						1 switch as High-Side chopper
		LC						1 switch as Low-Side chopper
			12					Voltage rating ( $V_{CES}/100$ )
				FA				IGBT+FRD chipset modification
						400		Current Rating
							N	Climatic version: normal climate

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