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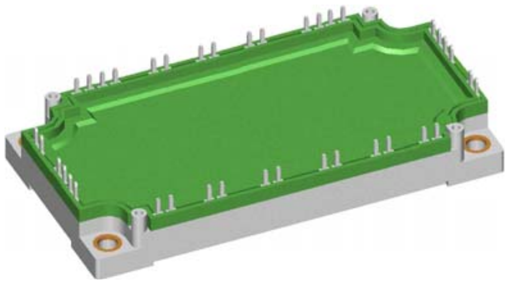
XPT IGBT Module

3~ Rectifier	Brake Chopper	3~ Inverter
V_{RRM} = 1600 V	V_{CES} = 1200 V	V_{CES} = 1200 V
I_{DAV} = 135 A	I_{C25} = 60 A	I_{C25} = 85 A
I_{TSM} = 700A	$V_{CE(sat)}$ = 1.8 V	$V_{CE(sat)}$ = 1.8 V

6-Pack + 3~ Rectifier Bridge, half-controlled (high-side) & Brake Unit + NTC

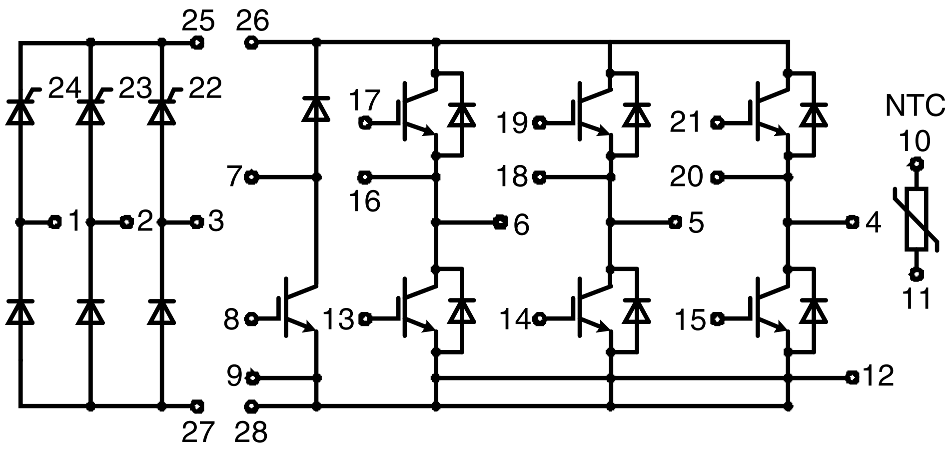
Part number

MIXA60WH1200TEH



Backside: isolated

UL E72873



Features / Advantages:

- Thyristor/Standard Rectifier for line frequency
- Easy paralleling due to the positive temperature coefficient of the on-state voltage
- Rugged XPT design (Xtreme light Punch Through) results in:
  - short circuit rated for 10 µsec.
  - very low gate charge
  - low EMI
  - square RBSOA @ 3x Ic
- Thin wafer technology combined with the XPT design results in a competitive low VCE(sat)
- SONIC™ diode
  - fast and soft reverse recovery
  - low operating forward voltage

Applications:

- AC motor drives
- Solar inverter
- Medical equipment
- Uninterruptible power supply
- Air-conditioning systems
- Welding equipment
- Switched-mode and resonant-mode power supplies
- Inductive heating, cookers
- Pumps, Fans

Package:

- Housing: E3-Pack
- International standard package
- RoHS compliant
- Isolation voltage: 3600 V~
- Advanced power cycling

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Rectifier

Symbol	Definition	Conditions		Ratings min.	typ.	max.	Unit
$V_{RSM/DSM}$	*max. non-repetitive reverse/forward blocking voltage*		T_{VJ} = 25°C			1700	V
$V_{RRM/DRM}$	*max. repetitive reverse/forward blocking voltage*		T_{VJ} = 25°C			1600	V
$I_{R/D}$	*reverse current, drain current*	$V_{R/D}$ = 1600 V	T_{VJ} = 25°C			100	µA
		$V_{R/D}$ = 1600 V	T_{VJ} = 150°C			20	mA
V_T	*forward voltage drop*	I_T = 80 A	T_{VJ} = 25°C			1.43	V
		I_T = 160 A				1.86	V
		I_T = 80 A	T_{VJ} = 125°C			1.42	V
		I_T = 160 A				1.97	V
I_{DAV}	*bridge output current*	T_C = 80°C 180° sine d = ⅓	T_{VJ} = 150°C			135	A
V_{T0}	*threshold voltage*	*for power loss calculation only*	T_{VJ} = 150°C			0.85	V
r_T	*slope resistance*	*for power loss calculation only*				7.1	mΩ
R_{thJC}	*thermal resistance junction to case*					0.65	K/W
R_{thCH}	*thermal resistance case to heatsink*				0.10		K/W
P_{tot}	*total power dissipation*		T_C = 25°C			190	W
I_{TSM}	*max. forward surge current*	t = 10 ms; (50 Hz), sine	T_{VJ} = 45°C			700	A
		t = 8,3 ms; (60 Hz), sine	V_R = 0 V			755	A
		t = 10 ms; (50 Hz), sine	T_{VJ} = 150°C			595	A
		t = 8,3 ms; (60 Hz), sine	V_R = 0 V			645	A
I^2t	*value for fusing*	t = 10 ms; (50 Hz), sine	T_{VJ} = 45°C			2.45	kA²s
		t = 8,3 ms; (60 Hz), sine	V_R = 0 V			2.37	kA²s
		t = 10 ms; (50 Hz), sine	T_{VJ} = 150°C			1.77	kA²s
		t = 8,3 ms; (60 Hz), sine	V_R = 0 V			1.73	kA²s
C_J	*junction capacitance*	V_R = 400 V f = 1 MHz	T_{VJ} = 25°C		32		pF
P_{GM}	*max. gate power dissipation*	t_P = 30 µs	T_C = 150°C			10	W
		t_P = 300 µs				5	W
P_{GAV}	*average gate power dissipation*					0.5	W
$(di/dt)_{cr}$	*critical rate of rise of current*	T_{VJ} = 125°C; f = 50 Hz t_P = 200 µs; di_G/dt = 0.45 A/µs	repetitive, I_T = 150 A			100	A/µs
		I_G = 0.45 A; V_D = ⅔ V_{DRM}	non-repet., I_T = 45 A			500	A/µs
$(dv/dt)_{cr}$	*critical rate of rise of voltage*	V_D = ⅔ V_{DRM} R_{GK} = ∞; method 1 (linear voltage rise)	T_{VJ} = 125 °C			1000	V/µs
V_{GT}	*gate trigger voltage*	V_D = 6 V	T_{VJ} = 25 °C			1.5	V
			T_{VJ} = -40 °C			1.6	V
I_{GT}	*gate trigger current*	V_D = 6 V	T_{VJ} = 25 °C			78	mA
			T_{VJ} = -40 °C			200	mA
V_{GD}	*gate non-trigger voltage*	V_D = ⅔ V_{DRM}	T_{VJ} = 125 °C			0.2	V
I_{GD}	*gate non-trigger current*					5	mA
I_L	*latching current*	t_p = 200 µs I_G = 10 A; di_G/dt = 0.45 A/µs	T_{VJ} = 25 °C			450	mA
I_H	*holding current*	V_D = 6 V R_{GK} = ∞	T_{VJ} = 25 °C			100	mA
t_{gd}	*gate controlled delay time*	V_D = ½ V_{DRM} I_G = 0.45 A; di_G/dt = 0.45 A/µs	T_{VJ} = 25 °C			2	µs
t_q	*turn-off time*	V_R = 100 V; I_T = 20 A; V_D = ⅔ V_{DRM} di/dt = 10 A/µs; dv/dt = 15 V/µs; t_p = 200 µs	T_{VJ} = 150 °C		150		µs

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Brake IGBT

Symbol	Definition	Conditions		min.	typ.	max.	Unit
V_{CES}	*collector emitter voltage*		T_{VJ} = 25°C			1200	V
V_{GES}	*max. DC gate voltage*					±20	V
V_{GEM}	*max. transient collector gate voltage*					±30	V
I_{C25}	*collector current*		T_C = 25°C			60	A
I_{C80}			T_C = 80°C			40	A
P_{tot}	*total power dissipation*		T_C = 25°C			195	W
$V_{CE(sat)}$	*collector emitter saturation voltage*	I_C = 35 A; V_{GE} = 15 V	T_{VJ} = 25°C		1.8	2.1	V
			T_{VJ} = 125°C		2.1		V
$V_{GE(th)}$	*gate emitter threshold voltage*	I_C = 1.5 mA; V_{GE} = V_{CE}	T_{VJ} = 25°C	5.4	5.9	6.5	V
I_{CES}	*collector emitter leakage current*	V_{CE} = V_{CES}; V_{GE} = 0 V	T_{VJ} = 25°C			2.1	mA
			T_{VJ} = 125°C		0.1		mA
I_{GES}	*gate emitter leakage current*	V_{GE} = ±20 V				500	nA
$Q_{G(on)}$	*total gate charge*	V_{CE} = 600 V; V_{GE} = 15 V; I_C = 35 A			106		nC
$t_{d(on)}$	*turn-on delay time*	inductive load V_{CE} = 600 V; I_C = 35 A V_{GE} = ±15 V; R_G = 27 Ω	T_{VJ} = 125°C		70		ns
t_r	*current rise time*				40		ns
$t_{d(off)}$	*turn-off delay time*				250		ns
t_f	*current fall time*				100		ns
E_{on}	*turn-on energy per pulse*				3.8		mJ
E_{off}	*turn-off energy per pulse*				4.1		mJ
RBSOA	*reverse bias safe operating area*	V_{GE} = ±15 V; R_G = 27 Ω	T_{VJ} = 125°C				
I_{CM}		V_{CEK} = 1200 V				105	A
SCSOA	*short circuit safe operating area*						
t_{SC}	*short circuit duration*	V_{CE} = 900 V; V_{GE} = ±15 V	T_{VJ} = 125°C			10	µs
I_{SC}	*short circuit current*	R_G = 27 Ω; non-repetitive			140		A
R_{thJC}	*thermal resistance junction to case*					0.64	K/W
R_{thCH}	*thermal resistance case to heatsink*				0.10		K/W

Brake Diode

Symbol	Definition	Conditions		min.	typ.	max.	Unit
V_{RRM}	*max. repetitive reverse voltage*		T_{VJ} = 25°C			1200	V
I_{F25}	*forward current*		T_C = 25°C			44	A
I_{F80}			T_C = 80°C			29	A
V_F	*forward voltage*	I_F = 30 A	T_{VJ} = 25°C			2.20	V
			T_{VJ} = 125°C			1.95	V
I_R	*reverse current*	V_R = V_{RRM}	T_{VJ} = 25°C			0.1	mA
			T_{VJ} = 125°C			0.15	mA
Q_{rr}	*reverse recovery charge*	V_R = 600 V $-di_F/dt$ = 600 A/µs I_F = 30 A	T_{VJ} = 125°C		3.5		µC
I_{RM}	*max. reverse recovery current*				30		A
t_{rr}	*reverse recovery time*				350		ns
E_{rec}	*reverse recovery energy*				0.9		mJ
R_{thJC}	*thermal resistance junction to case*					1.2	K/W
R_{thCH}	*thermal resistance case to heatsink*				0.10		K/W

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Inverter IGBT

Symbol	Definition	Conditions		min.	typ.	max.	Unit
V_{CES}	*collector emitter voltage*		T_{VJ} = 25°C			1200	V
V_{GES}	*max. DC gate voltage*					±20	V
V_{GEM}	*max. transient collector gate voltage*					±30	V
I_{C25}	*collector current*		T_C = 25°C			85	A
I_{C80}			T_C = 80°C			60	A
P_{tot}	*total power dissipation*		T_C = 25°C			290	W
$V_{CE(sat)}$	*collector emitter saturation voltage*	I_C = 55 A; V_{GE} = 15 V	T_{VJ} = 25°C		1.8	2.1	V
			T_{VJ} = 125°C		2.1		V
$V_{GE(th)}$	*gate emitter threshold voltage*	I_C = 2 mA; V_{GE} = V_{CE}	T_{VJ} = 25°C	5.4	5.9	6.5	V
I_{CES}	*collector emitter leakage current*	V_{CE} = V_{CES}; V_{GE} = 0 V	T_{VJ} = 25°C			0.5	mA
			T_{VJ} = 125°C		0.2		mA
I_{GES}	*gate emitter leakage current*	V_{GE} = ±20 V				500	nA
$Q_{G(on)}$	*total gate charge*	V_{CE} = 600 V; V_{GE} = 15 V; I_C = 55 A			165		nC
$t_{d(on)}$	*turn-on delay time*	inductive load V_{CE} = 600 V; I_C = 55 A V_{GE} = ±15 V; R_G = 15 Ω	T_{VJ} = 125°C		70		ns
t_r	*current rise time*				40		ns
$t_{d(off)}$	*turn-off delay time*				250		ns
t_f	*current fall time*				100		ns
E_{on}	*turn-on energy per pulse*				4.5		mJ
E_{off}	*turn-off energy per pulse*				5.5		mJ
RBSOA	*reverse bias safe operating area*	V_{GE} = ±15 V; R_G = 15 Ω	T_{VJ} = 125°C				
I_{CM}		V_{CEmax} = 1200 V				150	A
SCSOA	*short circuit safe operating area*	V_{CEmax} = 1200 V					
t_{SC}	*short circuit duration*	V_{CE} = 900 V; V_{GE} = ±15 V	T_{VJ} = 125°C			10	µs
I_{SC}	*short circuit current*	R_G = 15 Ω; non-repetitive			200		A
R_{thJC}	*thermal resistance junction to case*					0.43	K/W
R_{thCH}	*thermal resistance case to heatsink*				0.10		K/W

Inverter Diode

Symbol	Definition	Conditions		min.	typ.	max.	Unit
V_{RRM}	*max. repetitive reverse voltage*		T_{VJ} = 25°C			1200	V
I_{F25}	*forward current*		T_C = 25°C			88	A
I_{F80}			T_C = 80°C			59	A
V_F	*forward voltage*	I_F = 60 A	T_{VJ} = 25°C			2.20	V
			T_{VJ} = 125°C		1.95		V
I_R	*reverse current*	V_R = V_{RRM}	T_{VJ} = 25°C			0.3	mA
			T_{VJ} = 125°C		1.2		mA
Q_{rr}	*reverse recovery charge*	V_R = 600 V $-di_F/dt$ = 1200 A/µs I_F = 60 A; V_{GE} = 0 V	T_{VJ} = 125°C		8		µC
I_{RM}	*max. reverse recovery current*				60		A
t_{rr}	*reverse recovery time*				350		ns
E_{rec}	*reverse recovery energy*				2.5		mJ
R_{thJC}	*thermal resistance junction to case*					0.6	K/W
R_{thCH}	*thermal resistance case to heatsink*				0.10		K/W

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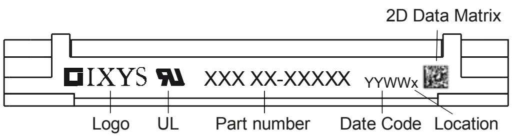
Package E3-Pack

Symbol	Definition	Conditions		Ratings min.	typ.	max.	Unit
I_{RMS}	*RMS current*	per terminal				300	A
T_{stg}	*storage temperature*			-40		125	°C
T_{VJ}	*virtual junction temperature*			-40		150	°C
Weight					270		g
M_D	*mounting torque*			3		6	Nm
V_{ISOL}	*isolation voltage*	t = 1 second	50/60 Hz, RMS; $I_{ISOL} \leq 1$ mA	3600			V
		t = 1 minute		3000			V
$d_{Spp/App}$	*creepage distance on surface | striking distance through air*		*terminal to terminal*	6.0			mm
$d_{Spb/Apb}$			*terminal to backside*	12.0			mm



Part number

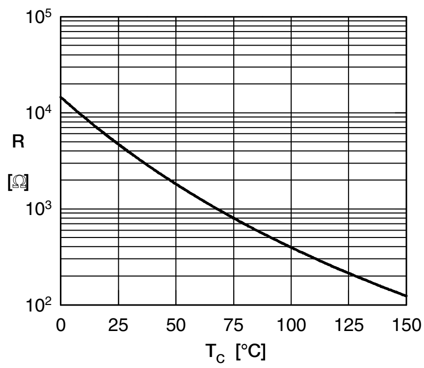
M = Module
I = IGBT
X = XPT IGBT
A = Gen 1 / std
60 = Current Rating [A]
WH = 6-Pack + 3~ Rectifier Bridge, half-controlled (high-side) & Brake Unit
1200 = Reverse Voltage [V]
T = Thermistor \ Temperature sensor
EH = E3-Pack

Ordering	Part Number	Marking on Product	Delivery Mode	Quantity	Code No.
Standard	MIXA60WH1200TEH	MIXA60WH1200TEH	Box	5	509622

Similar Part	Package	Voltage class
MIXA60WB1200TEH	E3-Pack	1200

Temperature Sensor NTC

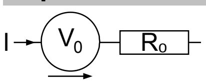
Symbol	Definition	Conditions	min.	typ.	max.	Unit
R_{25}	*resistance*	T_{VJ} = 25°	4.75	5	5.25	kΩ
$B_{25/50}$	*temperature coefficient*			3375		K



Typ. NTC resistance vs. temperature

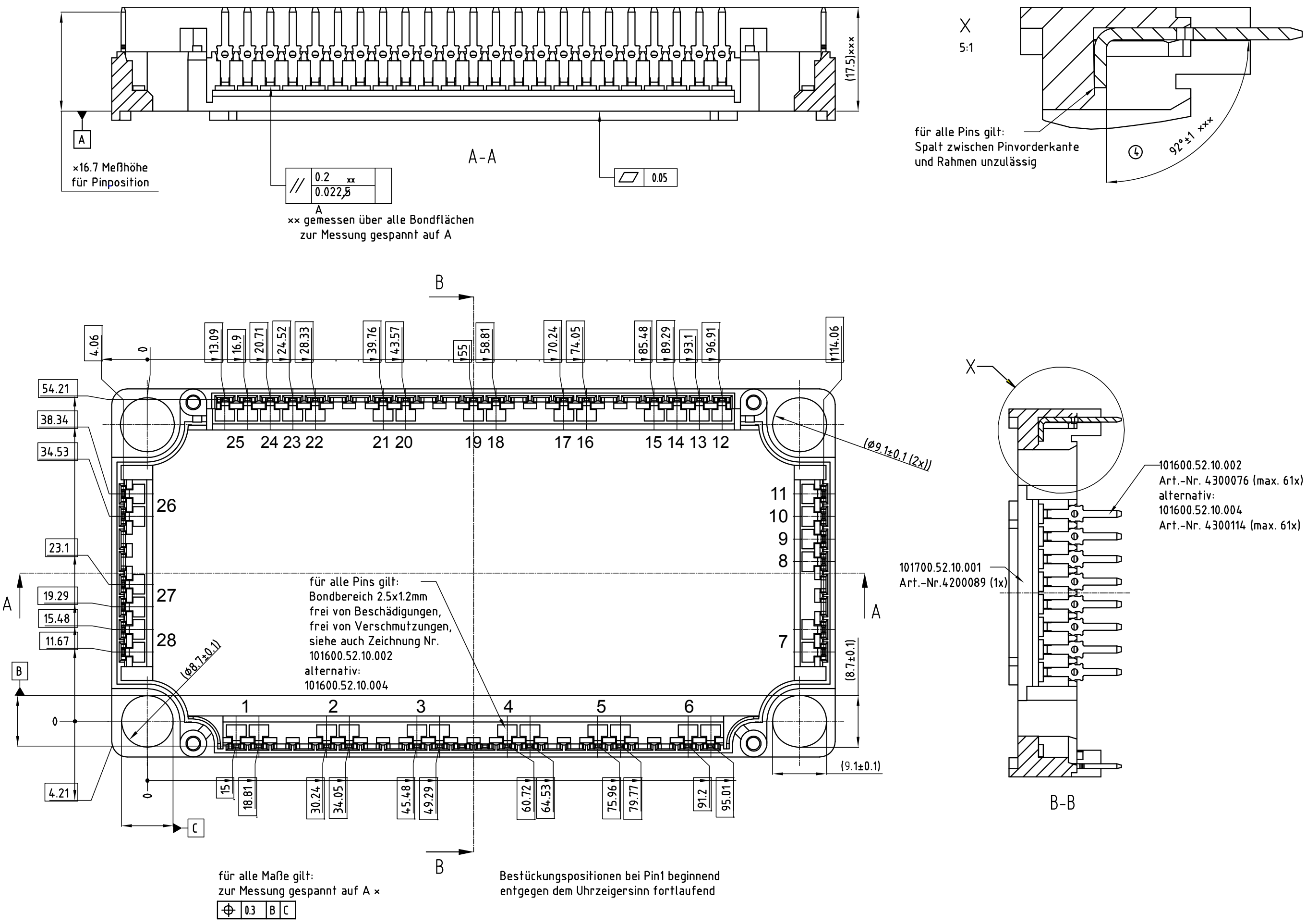
Equivalent Circuits for Simulation

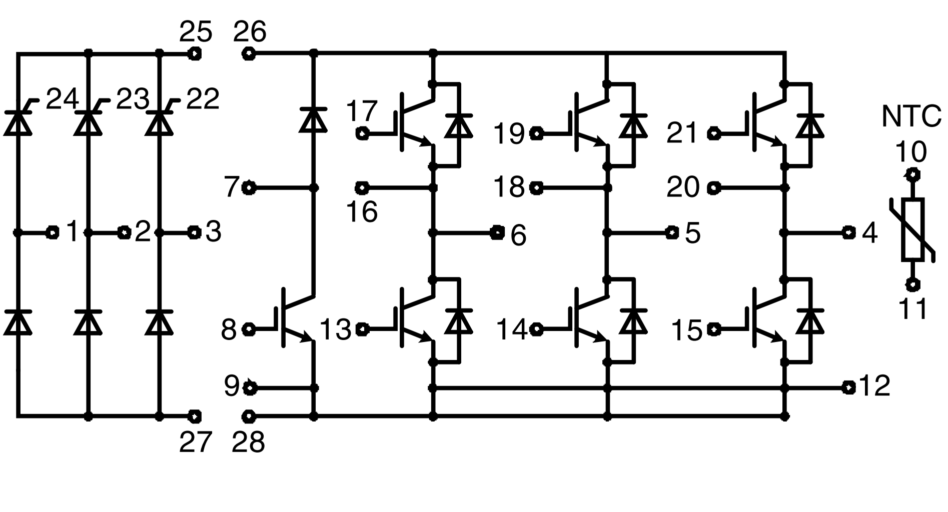
* on die level T_{VJ} = 150°C



		Rectifier	Brake IGBT	Brake Diode	Inverter IGBT	Inverter Diode	
$V_{0\,max}$	*threshold voltage*	0.85	1.1	1.2	1.1	1.22	V
$R_{0\,max}$	*slope resistance **	3.9	40	27	25.1	13	mΩ

Outlines E3-Pack





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Rectifier

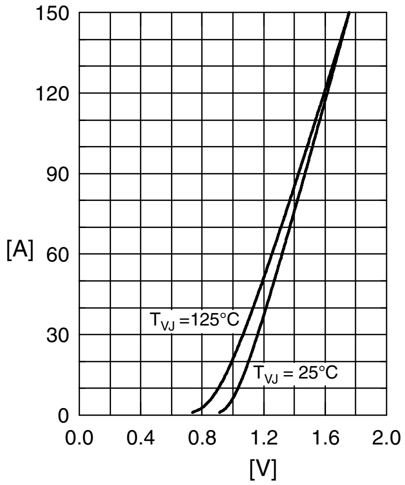


Fig.1 F orward current versus voltage drop per diode

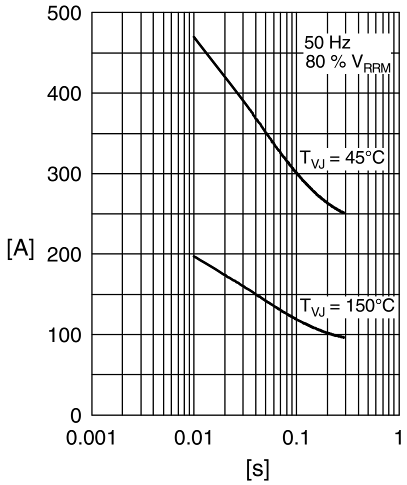


Fig.2 Surge overload current

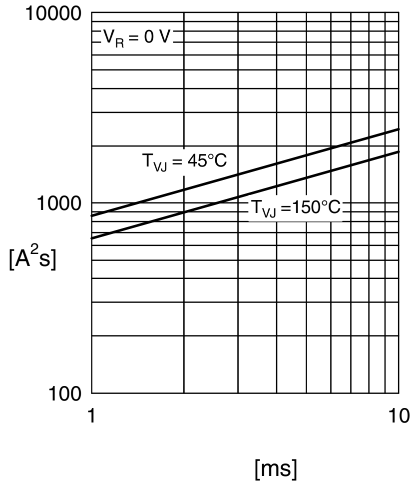


Fig.3 I^2t versus time per diode

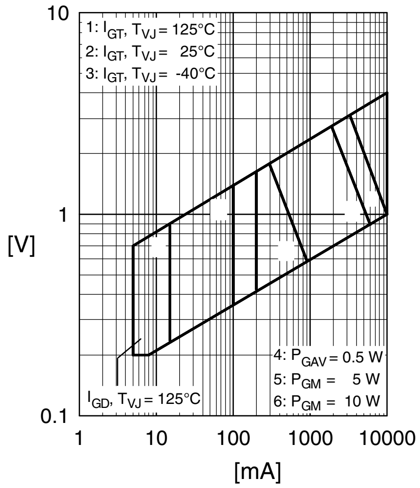


Fig. 4 Gate trigger characteristics

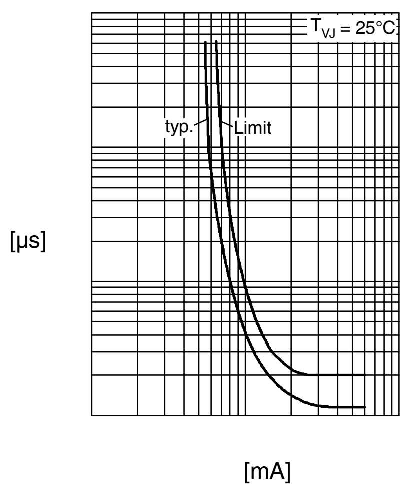


Fig. 5 Gate trigger delay time

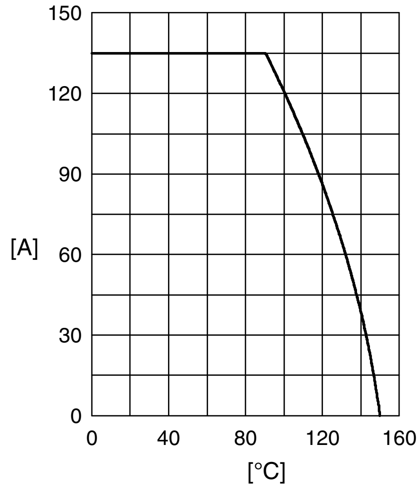


Fig. 6 Max. forward current versus case temperature

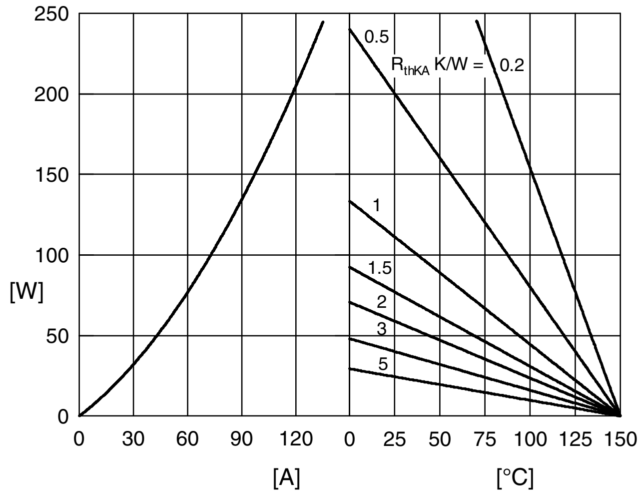


Fig.7 Power dissipation versus direct output current and ambient temperature, sine 180°

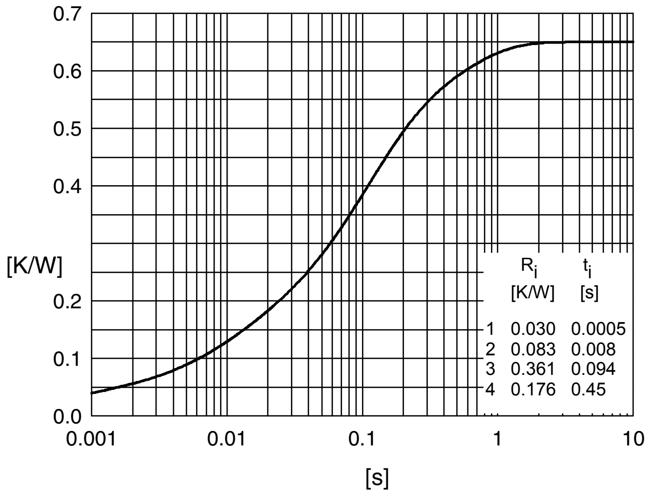


Fig. 8 Transient thermal impedance junction to case

Brake IGBT

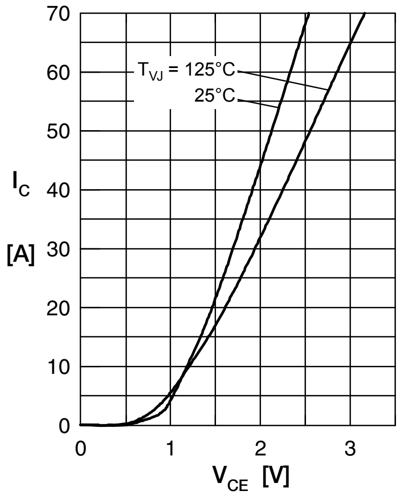


Fig. 1 Typ. output characteristics

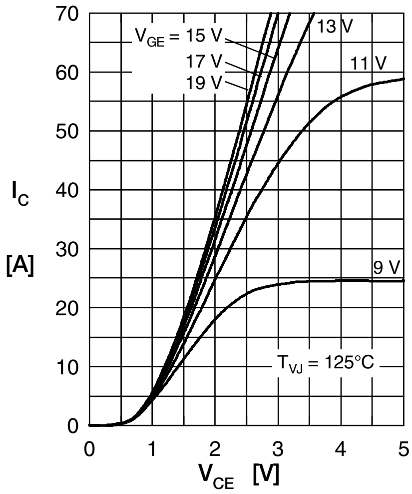


Fig. 2 Typ. output characteristics

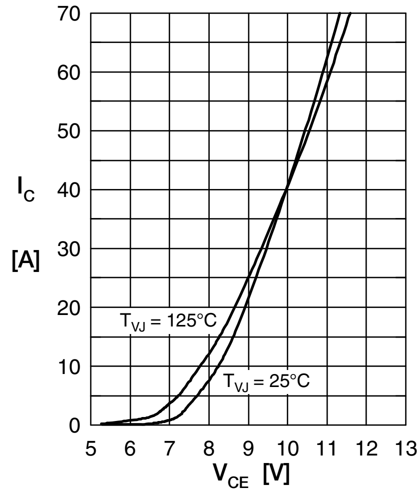


Fig. 3 Typ. transfer characteristics

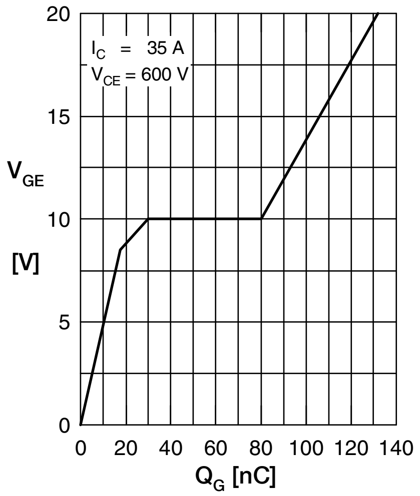


Fig. 4 Dynamic parameters Q_r, I_{RM} versus T_{VJ}

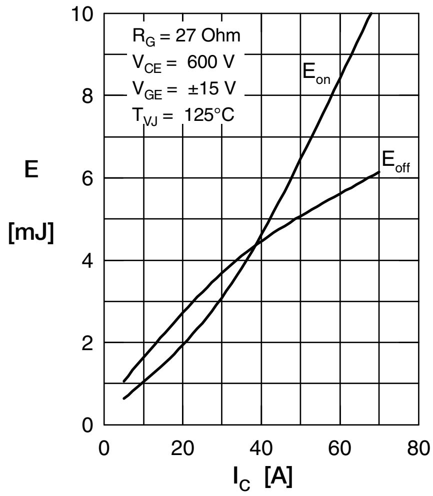


Fig. 5 Typ. recovery time t_{rr} versus $-di_F/dt$

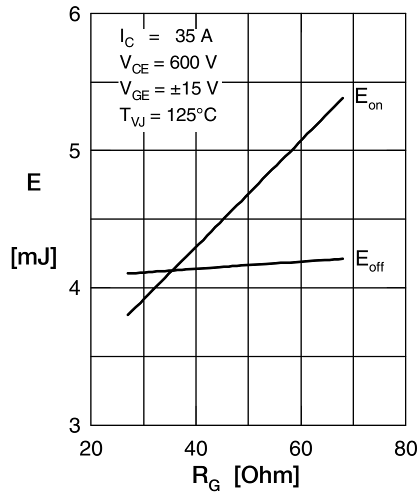
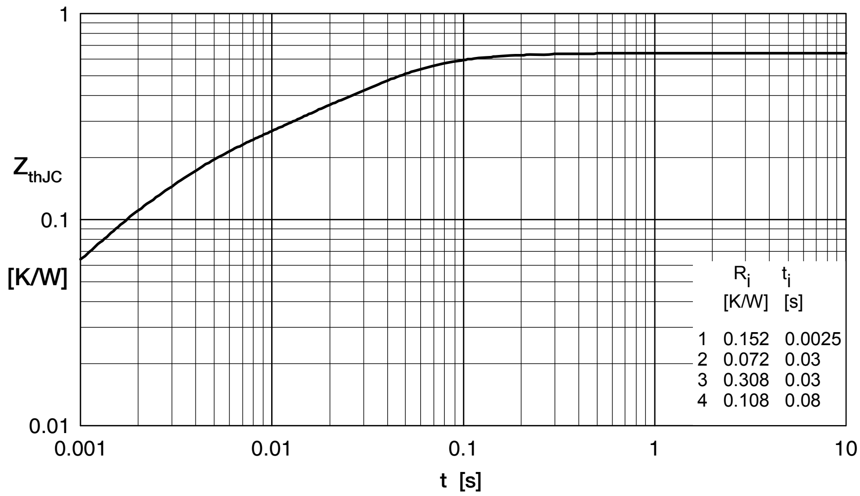


Fig. 6 Typ. peak forward voltage V_{FR} and t_{fr} versus di_F/dt



	R_i [K/W]	t_i [s]
1	0.152	0.0025
2	0.072	0.03
3	0.308	0.03
4	0.108	0.08

Fig. 7 Transient thermal impedance junction to case

Brake Diode

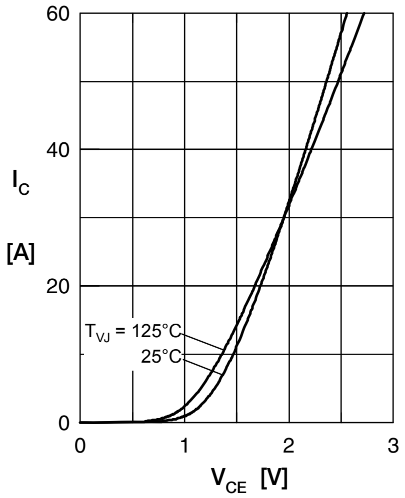


Fig. 1 Typ. Forward current versus V_F

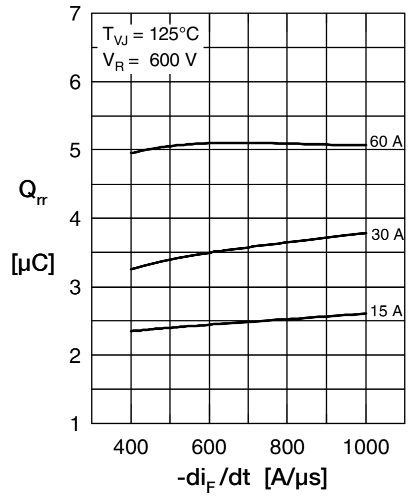


Fig. 2 Typ. reverse recovery charge Q_{rr} versus di/dt

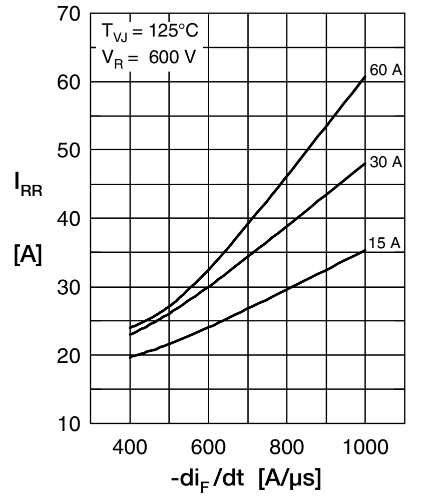


Fig. 3 Typ. peak reverse current I_{RM} versus di/dt

Fig. 4 Dynamic parameters Q_r, I_{RM} versus T_{VJ}

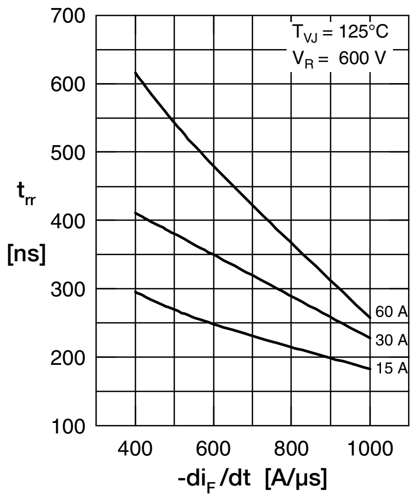


Fig. 5 Typ. recovery time t_{rr} versus $-di_F/dt$

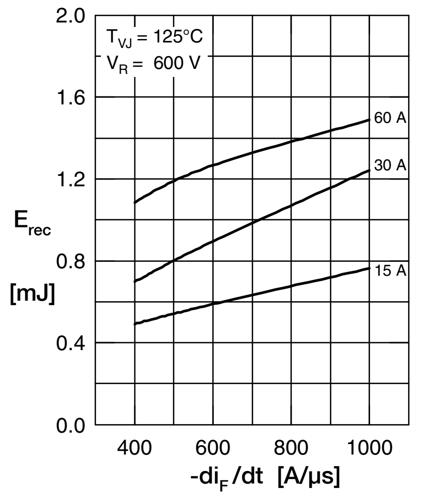


Fig. 6 Typ. recovery energy E_{rec} versus -di/dt

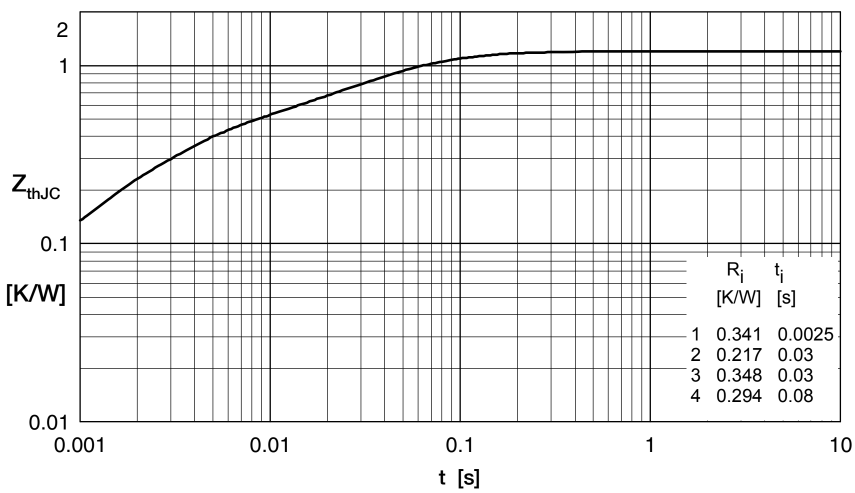


Fig. 7 Transient thermal impedance junction to case

Inverter IGBT

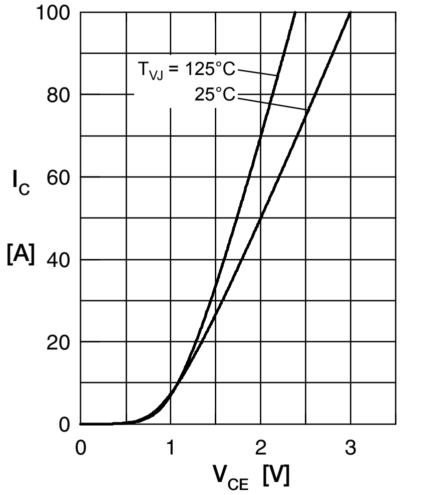


Fig. 1 Typ. output characteristics

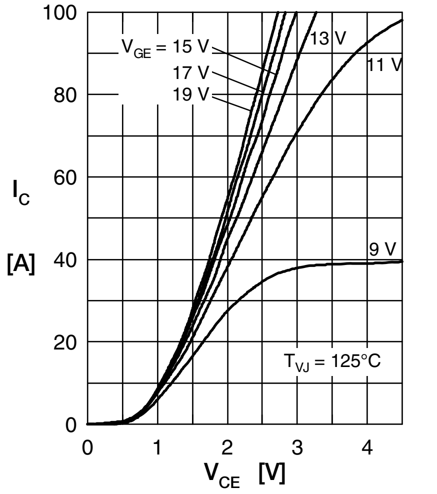


Fig. 2 Typ. output characteristics

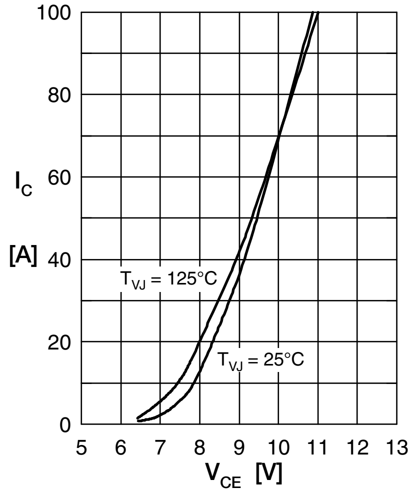


Fig. 3 Typ. transfer characteristics

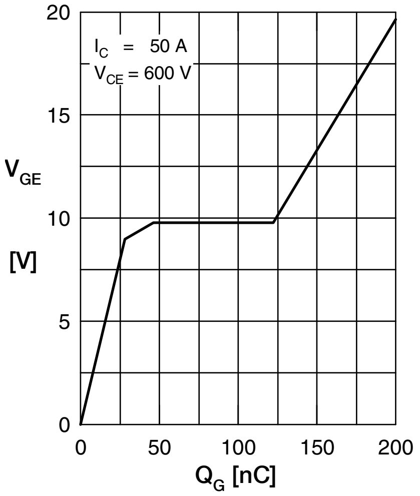


Fig. 4 Dynamic parameters Q_r, I_{RM} versus T_{VJ}

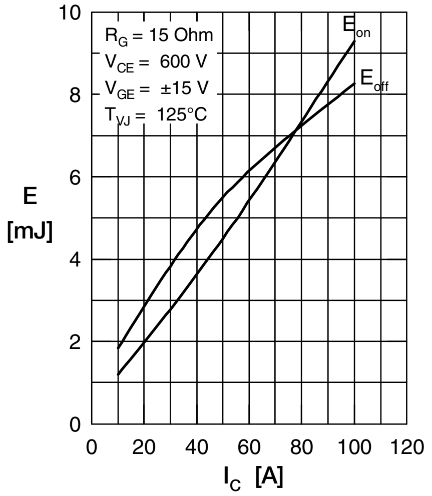


Fig. 5 Typ. recovery time t_{rr} versus $-di_F/dt$

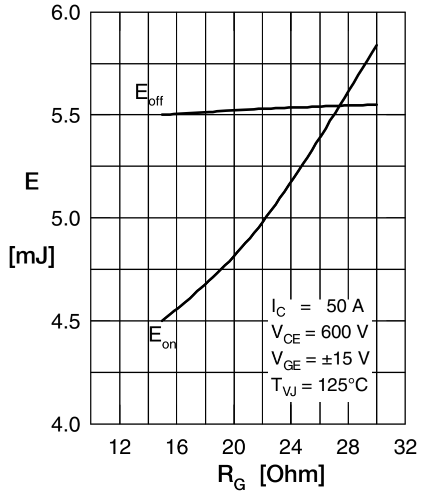


Fig. 6 Typ. peak forward voltage V_{FR} and t_{fr} versus di_F/dt

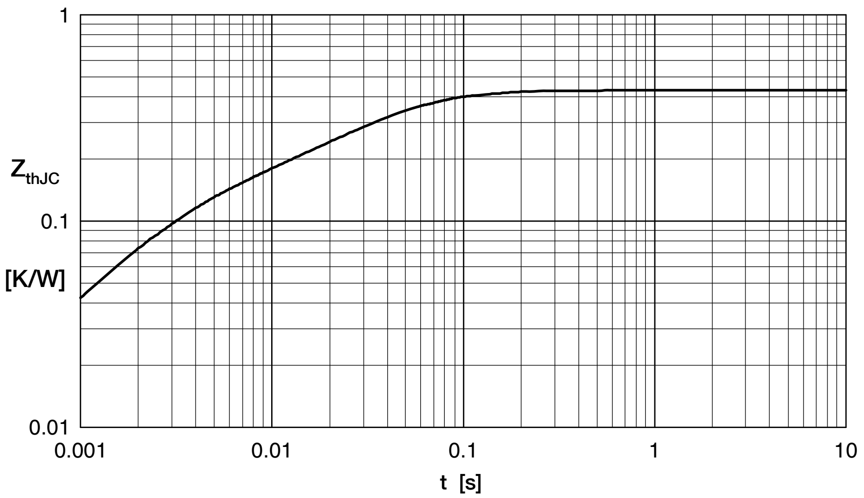


Fig. 7 Transient thermal impedance junction to case

preliminary

Inverter Diode

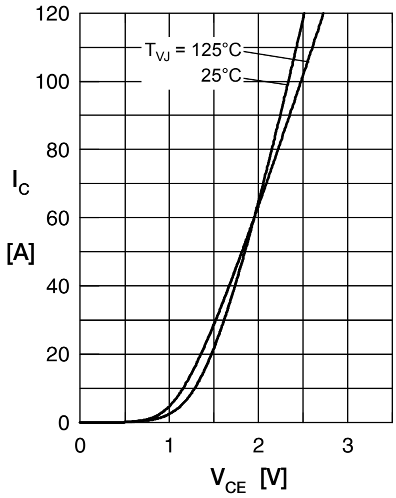


Fig. 1 Typ. Forward current versus V_F

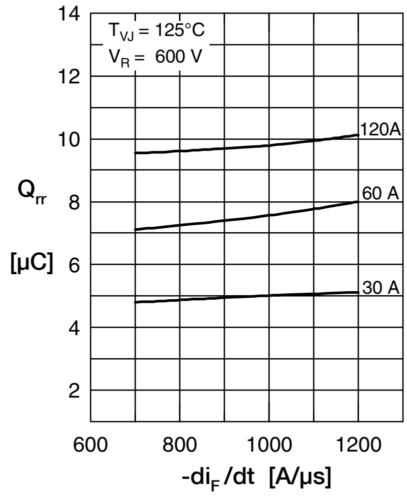


Fig. 2 Typ. reverse recovery charge Q_{rr} versus di/dt

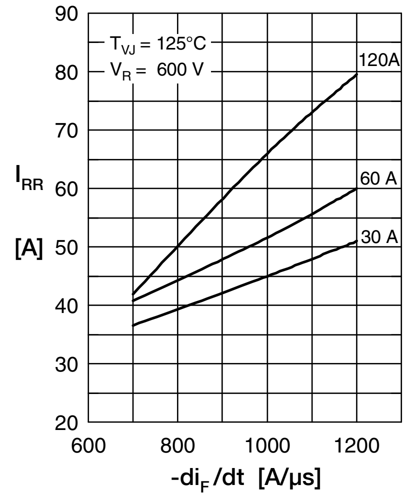


Fig. 3 Typ. peak reverse current I_{RM} versus di/dt

Fig. 4 Dynamic parameters Q_r, I_{RM} versus T_{VJ}

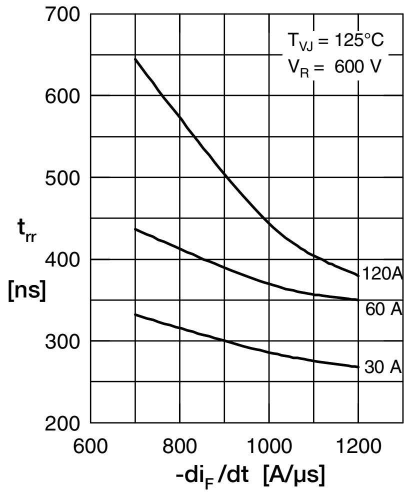


Fig. 5 Typ. recovery time t_{rr} versus $-di_F/dt$

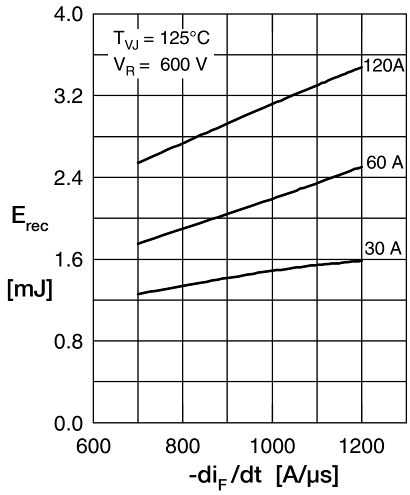


Fig. 6 Typ. recovery energy E_{rec} versus -di/dt

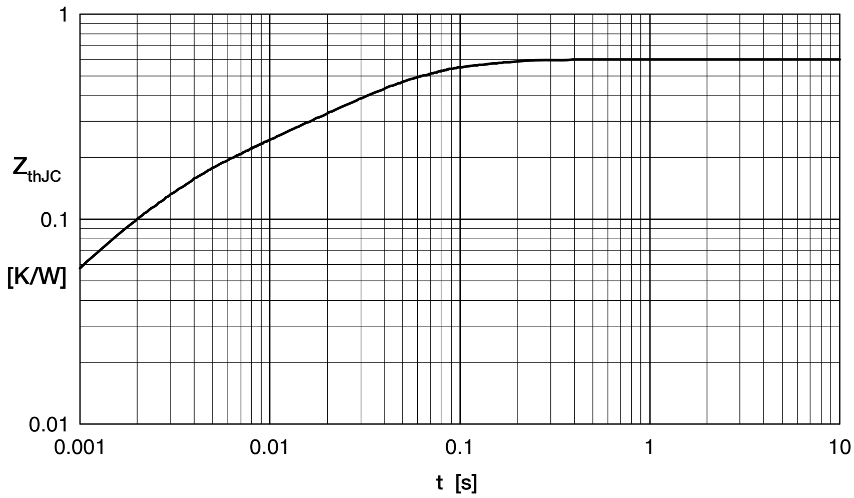


Fig. 7 Transient thermal impedance junction to case