AS ENERGI

Thyristor
AGF 4000-45-L-02

Key Parameters

V_{DRM}	=	4500	V
I_{TGQM}	=	4000	A
I_{TSM}	=	25×10^3	A
V_{T0}	=	1.2	V
r_T	=	0.65	mΩ
V_{Dclink}	=	2800	V

Features

- Patented free-floating silicon technology
- Low on-state and switching losses
- Annular gate electrode
- Industry standard housing
- Cosmic radiation withstand rating

Blocking

Symbols and parameters			Value			Unit
			min	typ	max	
V_{DRM}	Repetitive peak off-state voltage	$V_{GR} \geq 2$ V			4500	V
V_{RRM}	Repetitive peak reverse voltage				17	V
$V_{DC\text{-}link}$	Permanent DC voltage for 100 FIT failure rate	Ambient cosmic radiation at sea level in open air.			2800	V
I_{DRM}	Repetitive peak off-state current	$V_D = V_{DRM}$, $V_{GR} \geq 2$ V			100	mA
I_{RRM}	Repetitive peak reverse current	$V_R = V_{RRM}$, $R_{GK} = \infty$ Ω			50	mA

Mechanical data

Symbols and parameters			Value			Unit
			min	typ	max	
F_m	Mounting force		36	40	44	kN
D_p	Pole-piece diameter	± 0.1 mm		75		mm
H	Housing thickness		26.0		26.5	mm
m	Weight				1.5	kg
D_s	Surface creepage distance	Anode to Gate	33			mm
D_a	Air strike distance	Anode to Gate	14			mm

GTO Data

Symbols and parameters			Value			Unit
			min	typ	max	
$I_{T(AV)M}$	Max. average on-state current	Half sine wave, T_C = 85 °C			1180	A
$I_{T(RMS)}$	Max. RMS on-state current				1850	A
I_{TSM}	Max. peak non-repetitive surge current	t_p = 10 ms, T_{vj} = 125°C, sine wave After Surge: $V_D = V_R$ = 0 V			25×10^3	A
I^2t	Limiting load integral				3.1×10^6	A^2s
I_{TSM}	Max. peak non-repetitive surge current	t_p = 1 ms, T_{vj} = 125°C, sine wave After Surge: $V_D = V_R$ = 0 V			40×10^3	A
I^2t	Limiting load integral				800×10^3	A^2s
V_T	On-state voltage	I_T = 4000 A, T_{vj} = 125°C			3.8	V
$V_{(T0)}$	Threshold voltage	T_{vj} = 125°C I_T = 400...5000 A			1.2	V
r_T	Slope resistance				0.65	mΩ
I_H	Holding current	T_{vj} = 25°C			100	A

Turn-on switching

Symbols and parameters				Value			Unit
				min	typ	max	
di_T/dt_{cr}	Critical rate of rise of on state current	T_{vj} = 125°C, I_T = 4000 A, I_{GM} = 50 A, di_G/dt = 40 A/µs	f = 200 Hz			500	A/µs
di_T/dt_{cr}	Critical rate of rise of on state current		f = 1 Hz			1000	A/µs
t_{on}	Min. on-time	V_D = 0.5 V_{DRM}, T_{vj} = 125 °C I_T = 4000 A, di/dt = 300 A/µs, I_{GM} = 50 A, di_G/dt = 40 A/µs, C_S = 6 µF, R_S = 5 Ω		100			µs
t_d	Turn-on delay time					2.5	µs
t_r	Rise time					5	µs
E_{on}	Turn-on energy per pulse					3	J

Turn-off switching

Symbols and parameters			Value			Unit
			min	typ	max	
I_{TGQM}	Max. controllable turn-off current	$V_{DM} \leq V_{DRM}$, $di_{GQ}/dt = 40$ A/µs, $C_S = 6$ µF, $L_S \leq 0.2$ µH,			4000	A
t_{off}	Min. off-time	$V_D = 0.5\ V_{DRM}$, $T_{vj} = 125$ °C $V_{DM} \leq V_{DRM}$, $di_{GQ}/dt = 40$ A/µs, $I_{TGQ} = I_{TGQM}$, $R_S = 5\ \Omega$, $C_S = 6$ µF, $L_S = 0.2$ µH	100			µs
t_S	Storage time	$V_D = 0.5\ V_{DRM}$, $T_{vj} = 125$ °C $V_{DM} \leq V_{DRM}$, $di_{GQ}/dt = 40$ A/µs, $I_{TGQ} = I_{TGQM}$, $R_S = 5\ \Omega$, $C_S = 6$ µF, $L_S = 0.2$µH			25	µs
t_f	Fall time				3	µs
E_{off}	Turn-on energy per pulse				10	J
I_{GQM}	Peak turn-off gate current				1100	A

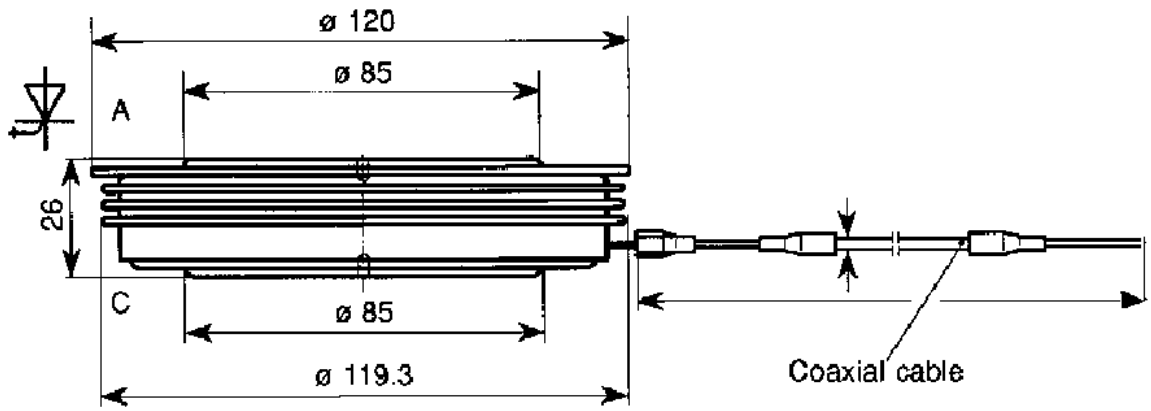
Gate

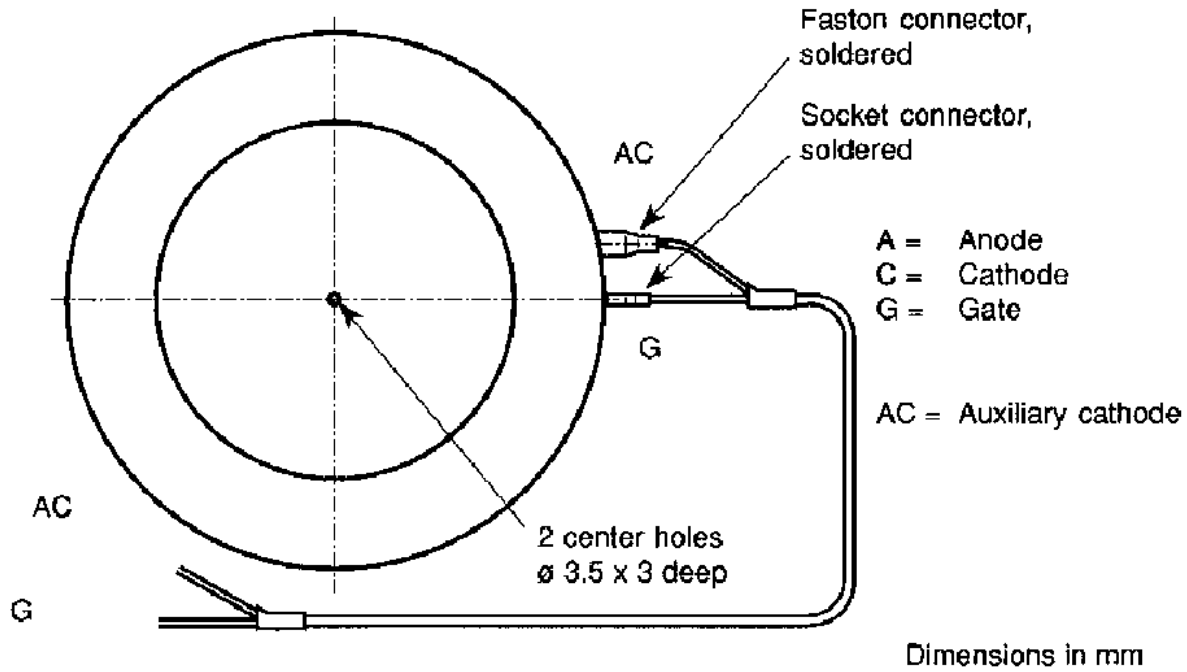
Symbols and parameters			Value			Unit
			min	typ	max	
V_{GRM}	Repetitive peak reverse voltage				17	V
I_{GRM}	Repetitive peak reverse current	$V_{GR} = V_{GRM}$			20	mA
V_{GT}	Gate trigger voltage	$T_{vj} = 25$°C, $V_D = 24$ V, $R_A = 0.1\ \Omega$		1.2		V
I_{GT}	Gate trigger current			4		A

Thermal

Symbols and parameters			Value	Unit
T_{vj}	Junction operating temperature		-40 ... 125	°C
T_{stg}	Storage temperature range		-40 ... 125	°C
$R_{th(j-c)}$	Thermal resistance junction to case	Double side cooled	11	K/kW
$R_{th(j-c)A}$		Anode side cooled	20	K/kW
$R_{th(j-c)C}$		Cathode side cooled	25	K/kW
$R_{th(c-h)}$	Thermal resistance case to heatsink (Double side cooled)	Single side cooled	6	K/kW
$R_{th(c-h)}$		Double side cooled	3	K/kW

DIMENSIONS





Dimensions in mm

Analytical function for transient thermal impedance:

$$Z_{thJC}(t) = \sum_{i=1}^{n} R_i(1 - e^{-t/t_i})$$

i	1	2	3	4
R_i(K/kW)	7.766	1.728	1.064	0.450
τ_i(s)	0.5764	0.1258	0.0128	0.0031

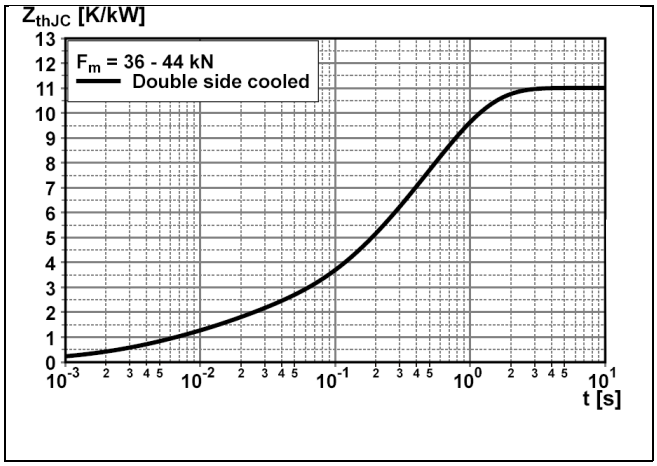


Fig. 1 Transient thermal impedance, junction to case.

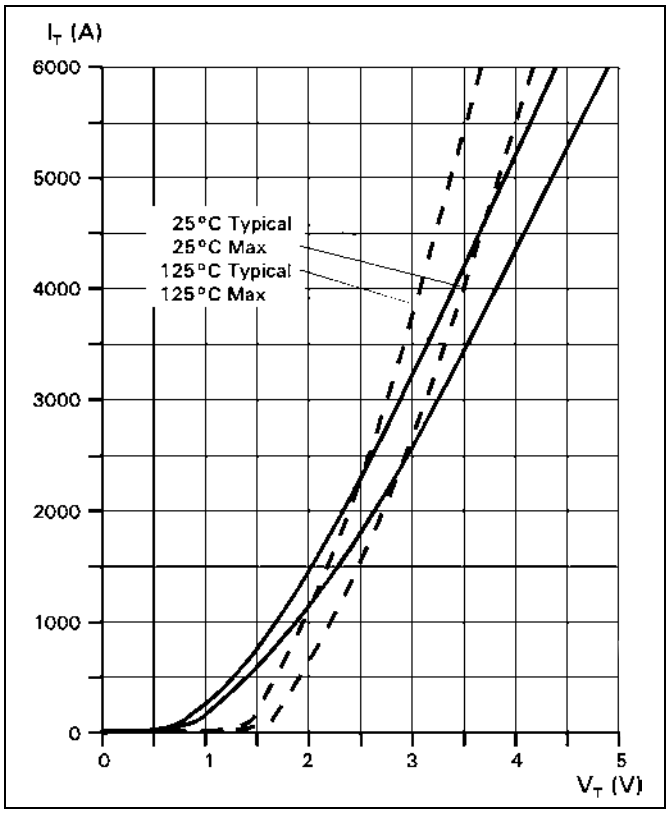


Fig. 2 On-state characteristics.

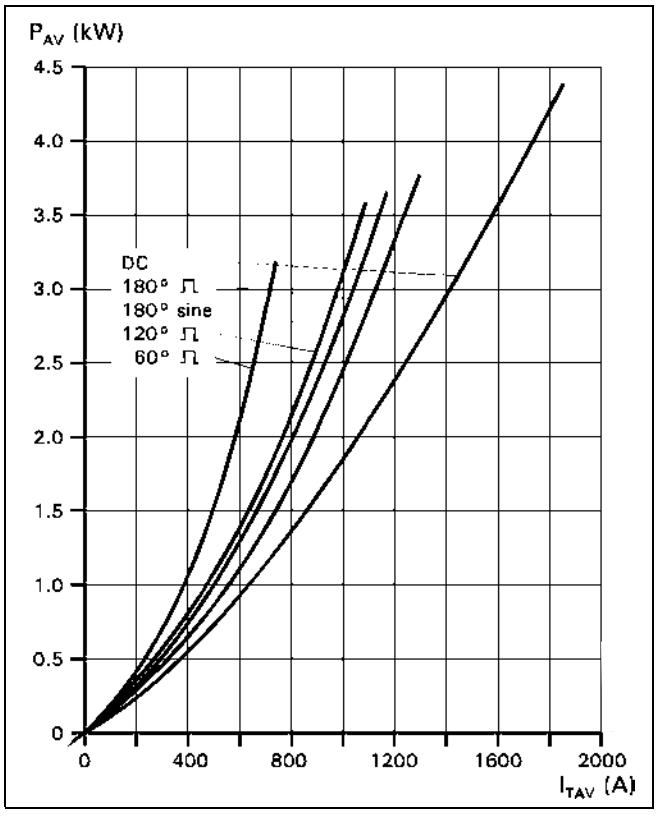


Fig. 3 Average on-state power dissipation vs. average on-state current.

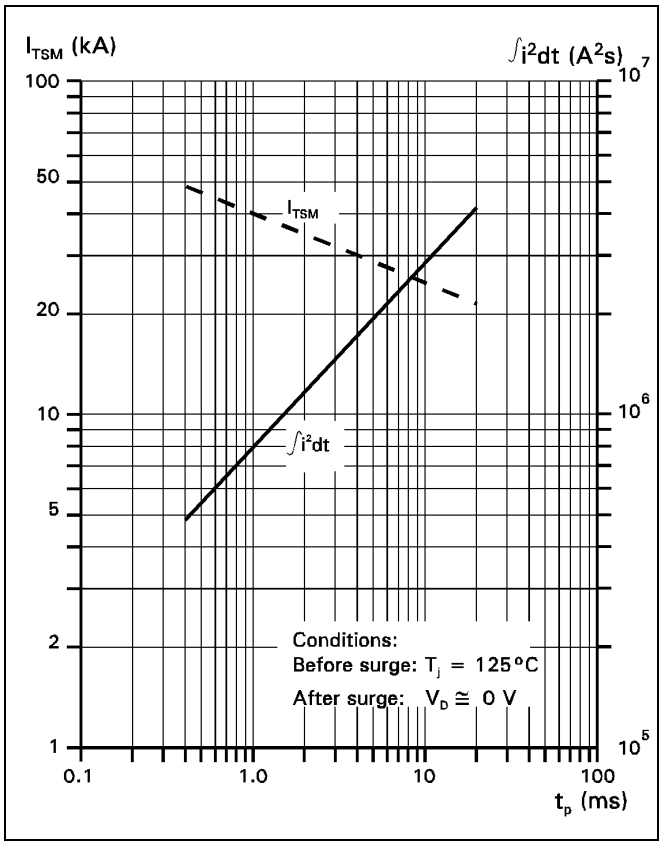


Fig. 4 Surge current and fusing integral vs. pulse width.

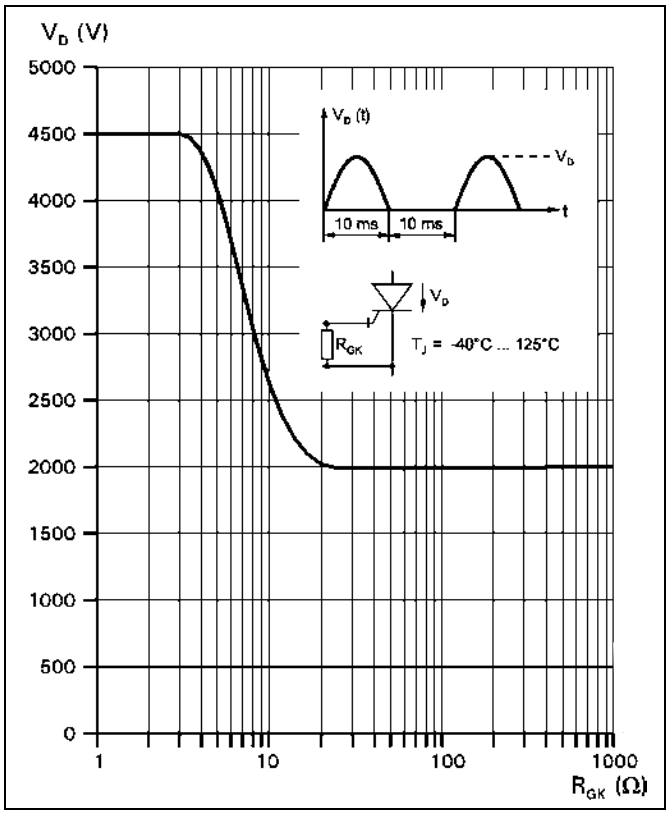


Fig. 5 Forward blocking voltage vs. gate-cathode resistance.

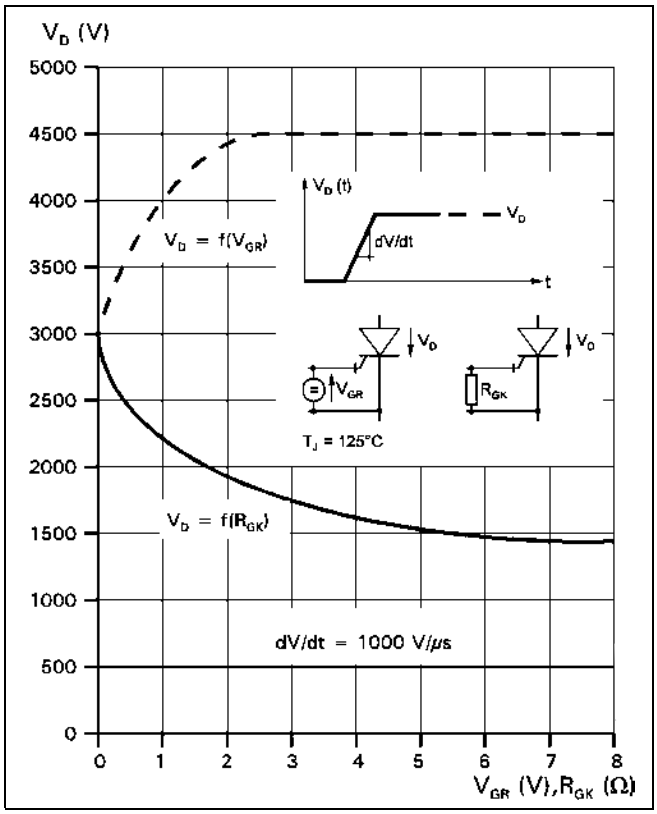


Fig. 6 Static dv/dt capability: Forward blocking voltage vs. neg. gate voltage or gate cathode resistance.

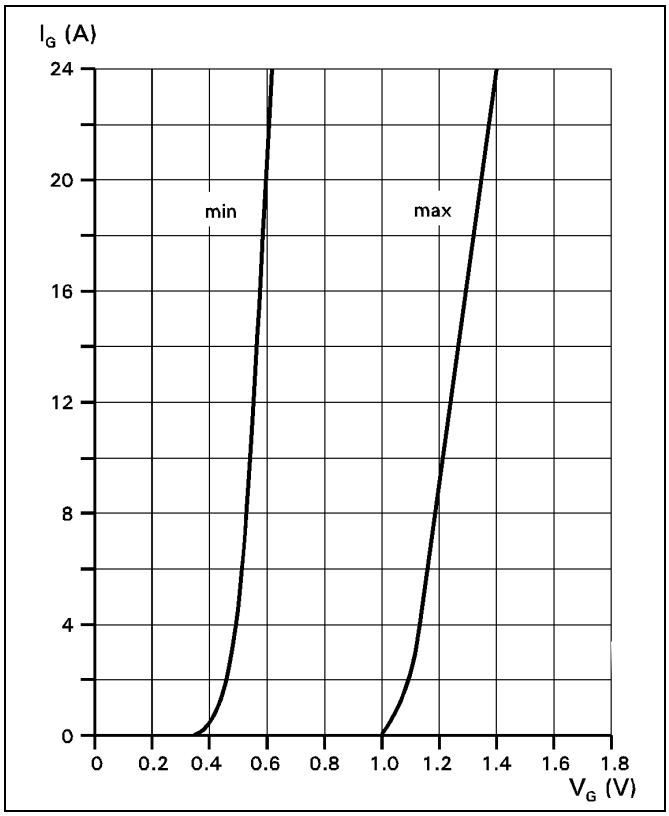


Fig. 7 Forward gate current vs. forard gate voltage.

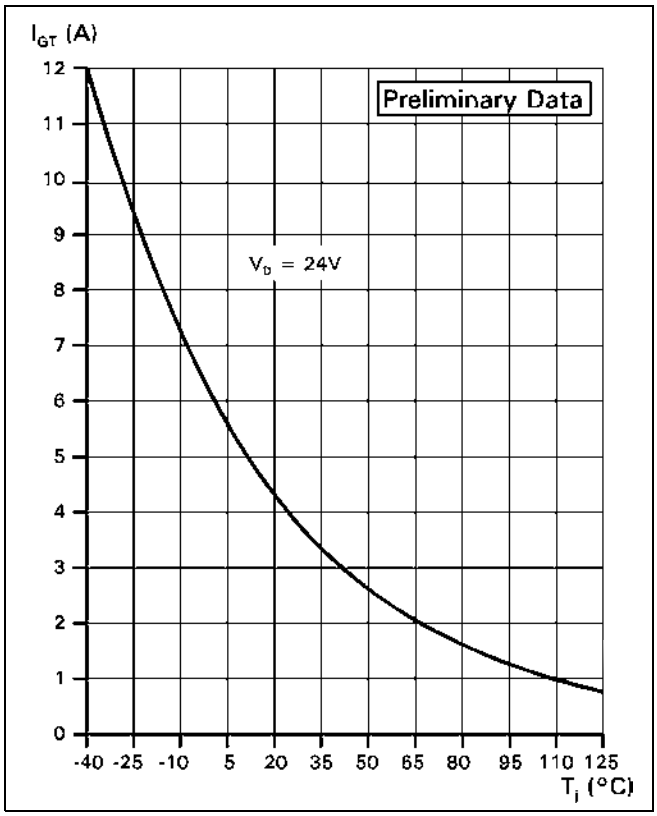


Fig. 8 Gate trigger current vs. junction temperature

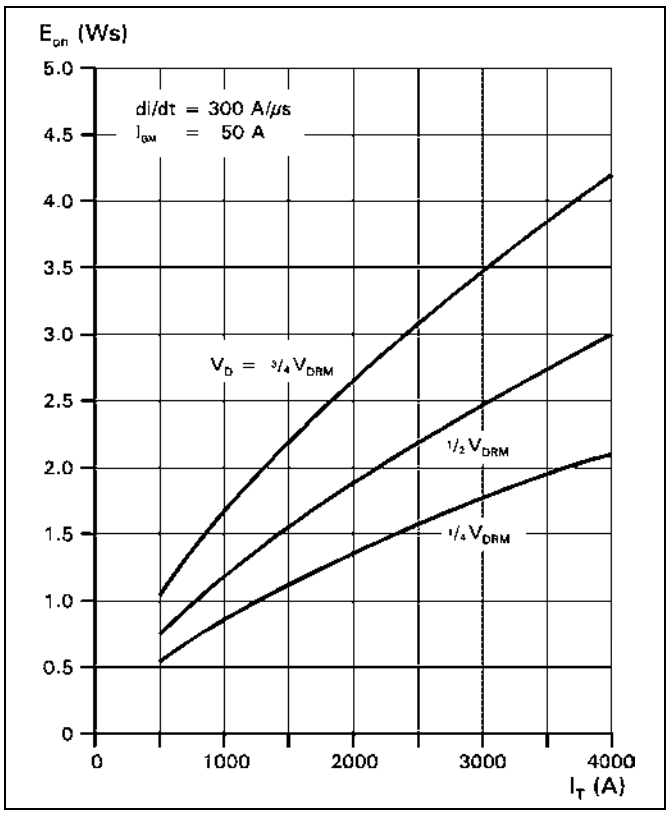


Fig. 9 Turn-on energy per pulse vs. on-state current and turn-on voltage.

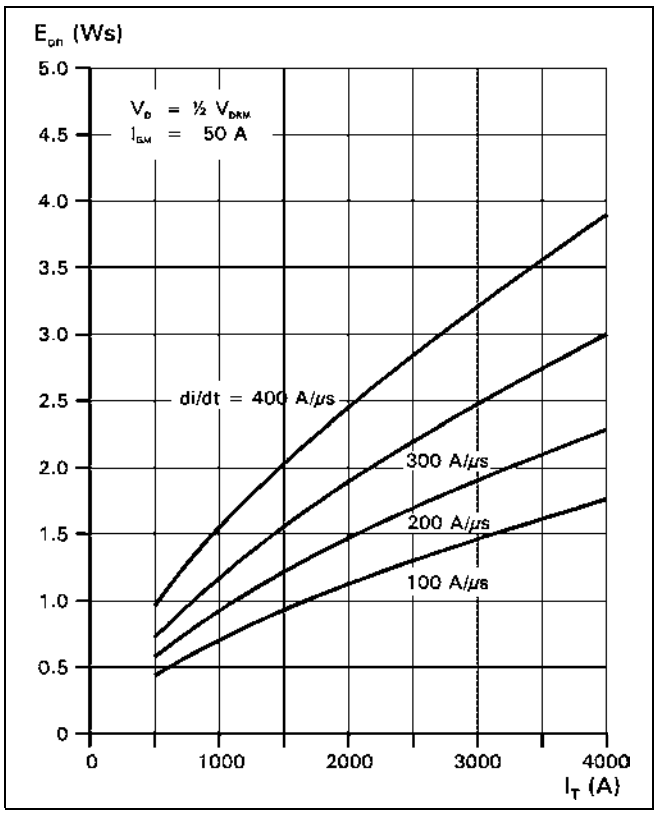


Fig. 10 Turn-on energy per pulse vs. on.-state current and current rise rate

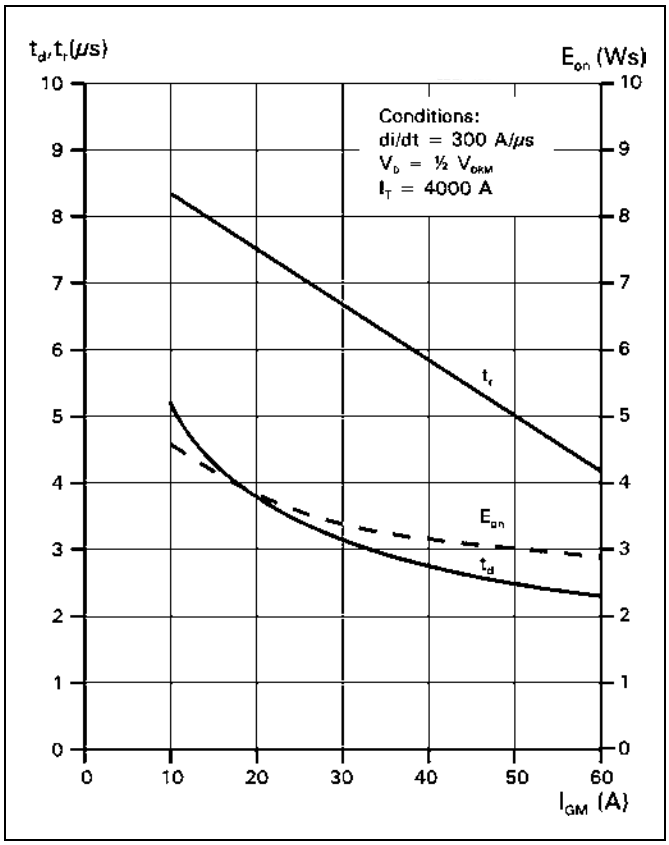


Fig. 11 Turn-on energy per pulse vs. on-state current and turn-on voltage.

Common Test conditions for figures 9, 10 and 11:

di_G/dt	= 40 A/µs
C_S	= 6 µF
R_S	= 5 Ω
Tj	= 125 °C

Definition of Turn-on energy:

$$E_{on} = \int_0^{20ms} V_D \cdot I_T dt \quad (t = 0, I_G = 0.1 \cdot I_{GM})$$

Common Test conditions for figures 12, 13 and 15:

Definition of Turn-off energy:

$$E_{off} = \int_0^{40ms} V_D \cdot I_T dt \quad (t = 0, I_T = 0.9 \cdot I_{TGQ})$$

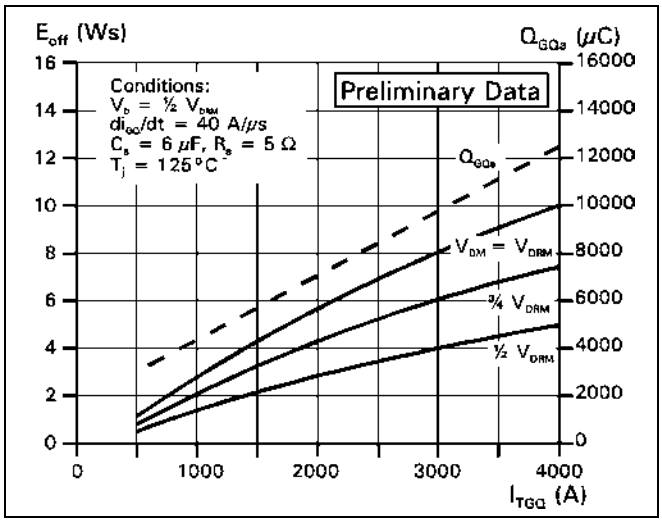


Fig. 12 Turn-off energy per pulse vs. turn-off current and peak turn-off voltage. Extracted gate charge vs. turn-off current.

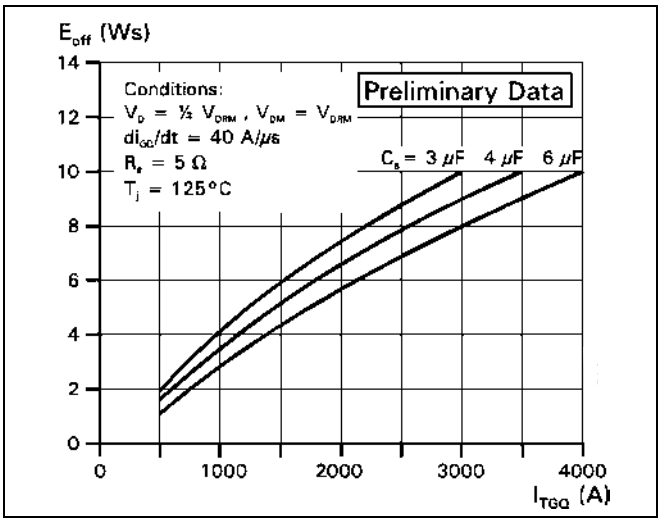


Fig. 13 Turn-off energy per pulse vs. turn-off current and snubber capacitance.

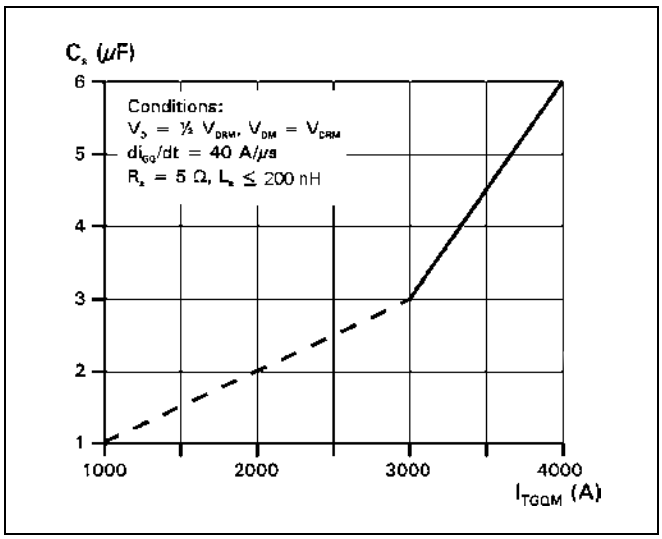


Fig. 14 Required snubber capacitor vs. max allowable turn-off current.

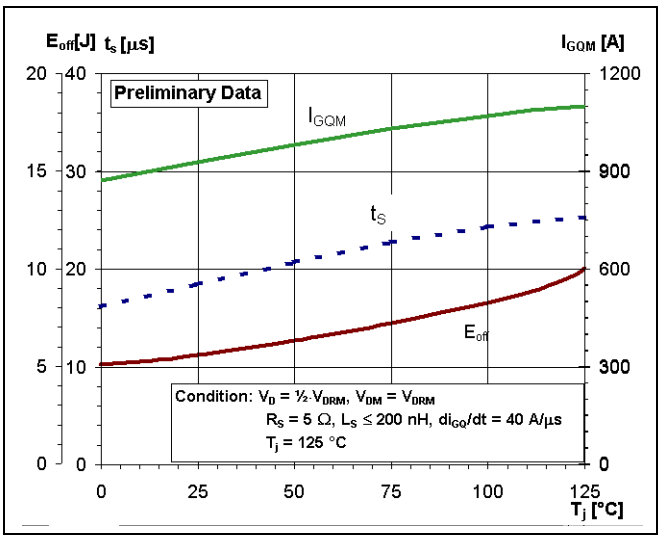


Fig. 15 Turn-off energy per pulse, storage time and peak turn-off gate current vs. junction temperature.

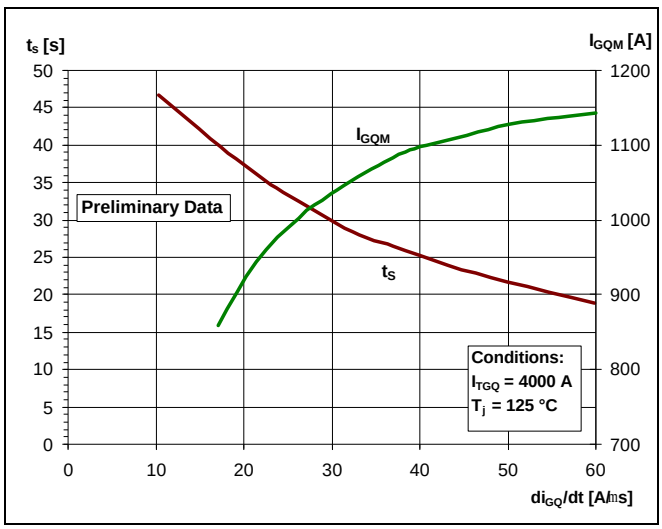


Fig. 16 Storage time and peak turn-off gate current vs. neg. gate current rise rate.

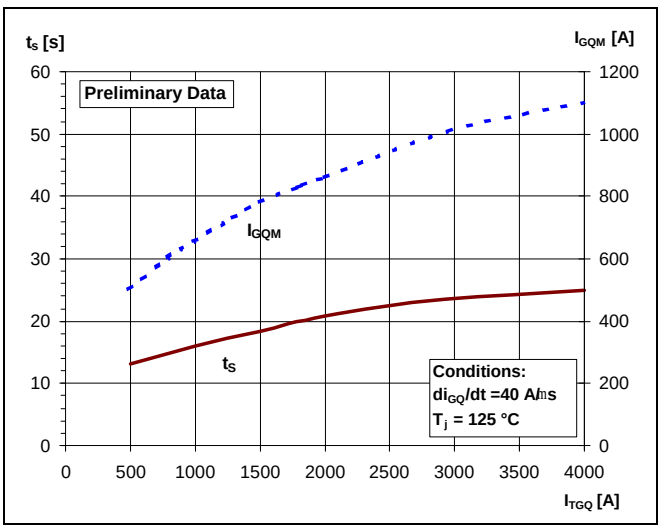


Fig. 17 Storage time and peak turn-off gate current vs. turn-off current.

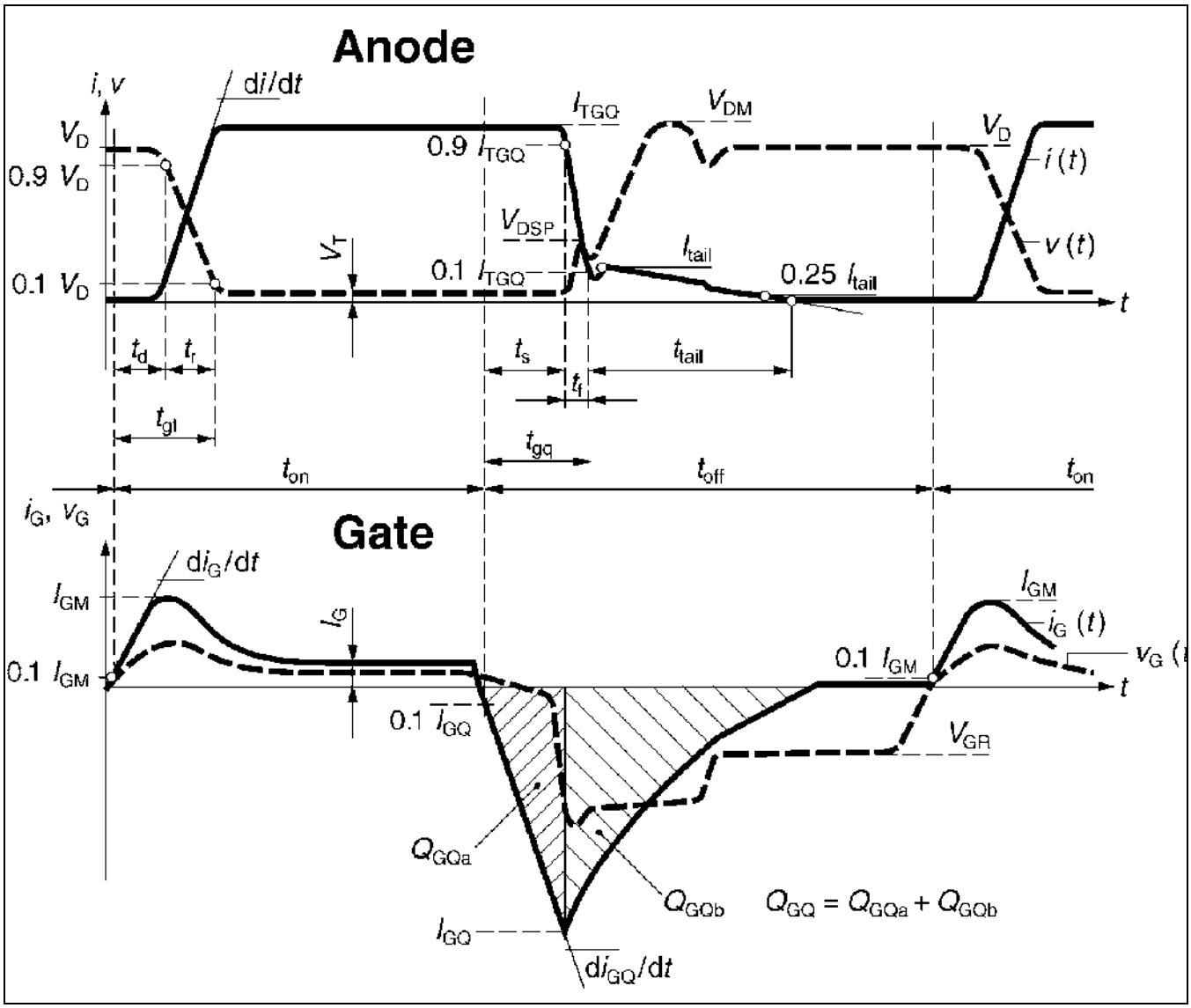


Fig. 18 General current and voltage waveforms with GTO-specific symbols.