V_{DRM} = 6500 V
$I_{T(AV)M}$ = 4300 A
$I_{T(RMS)}$ = 6750 A
I_{TSM} = $86.0 \cdot 10^3$ A
V_{T0} = 1.17 V
r_T = 0.181 mΩ

Phase Control Thyristor

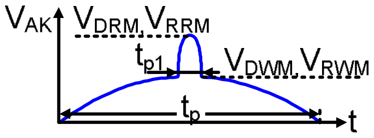
5STP 42U6500

Doc. No. 5SYA1043-08 May. 20

- **Patented free-floating silicon technology**
- **Low on-state and switching losses**
- **Designed for traction, energy and industrial applications**
- **Optimum power handling capability**
- **Interdigitated amplifying gate**

Blocking

Maximum rated values [1]

Parameter	**Symbol**	**Conditions**	**5STP 42U6500**	**Unit**
Max. surge peak forward and reverse blocking voltage	V_{DSM}, V_{RSM}	t_p = 10 ms, f = 5 Hz T_{vj} = 5…125 °C, Note 1	6500	V
Max repetitive peak forward and reverse blocking voltage	V_{DRM}, V_{RRM}	f = 50 Hz, t_p = 10 ms, t_{p1} = 250 µs, T_{vj} = 5…125 °C, Note 1, Note 2 	6500	V
Max crest working forward and reverse voltages	V_{DWM}, V_{RWM}		4340	V
Critical rate of rise of commutating voltage	dv/dt_{crit}	Exp. to $0.67 \cdot V_{DRM}$, T_{vj} = 125 °C	2000	V/µs

Characteristic values

Parameter	**Symbol**	**Conditions**	**min**	**typ**	**max**	**Unit**
Forward leakage current	I_{DRM}	V_{DRM}, T_{vj} = 125 °C			800	mA
Reverse leakage current	I_{RRM}	V_{RRM}, T_{vj} = 125 °C			800	mA

Note 1: Voltage de-rating factor of 0.11% per °C is applicable for T_{vj} below +5 °C.
Note 2: Recommended minimum ratio of V_{DRM} / V_{DWM} or V_{RRM} / V_{RWM} = 2. See App. Note 5SYA 2051.

Mechanical data

Maximum rated values [1]

Parameter	**Symbol**	**Conditions**	**min**	**typ**	**max**	**Unit**
Mounting force	F_M		90	135	160	kN
Acceleration	a	Device unclamped			50	m/s^2
Acceleration	a	Device clamped			100	m/s^2

Characteristic values

Parameter	**Symbol**	**Conditions**	**min**	**typ**	**max**	**Unit**
Weight	m				3.6	kg
Housing thickness	H	F_M = 135 kN, T_a = 25 °C	34.79		35.44	mm
Surface creepage distance	D_S		56			mm
Air strike distance	D_a		22			mm

1) Maximum rated values indicate limits beyond which damage to the device may occur

ABB Power Grids Switzerland Ltd, Semiconductors reserves the right to change specifications without notice.

On-state

Maximum rated values [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Average on-state current	$I_{T(AV)M}$	Half sine wave, Tc = 70 °C			4300	A
RMS on-state current	$I_{T(RMS)}$				6750	A
Peak non-repetitive surge current	I_{TSM}	t_p = 10 ms, T_{vj} = 125 °C, sine half wave, $V_D = V_R$= 0 V, after surge			$86.0 \cdot 10^3$	A
Limiting load integral	I^2t				$37.0 \cdot 10^6$	A^2s
Peak non-repetitive surge current	I_{TSM}	t_p = 10 ms, T_{vj} = 125 °C, sine half wave, $V_R = 0.6 \cdot V_{RRM}$, after surge			$64.0 \cdot 10^3$	A
Limiting load integral	I^2t				$20.5 \cdot 10^6$	A^2s

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
On-state voltage	V_T	I_T = 3000 A, T_{vj} = 125 °C		1.51	1.71	V
Threshold voltage	$V_{(T0)}$	I_T = 2000 A - 6000 A, T_{vj} = 125 °C			1.17	V
Slope resistance	r_T				0.181	mΩ
Holding current	I_H	T_{vj} = 25 °C			200	mA
		T_{vj} = 125 °C			100	mA
Latching current	I_L	T_{vj} = 25 °C			900	mA
		T_{vj} = 125 °C			700	mA

Switching

Maximum rated values [1)]

Parameter	Symbol	Conditions		min	typ	max	Unit
Critical rate of rise of on-state current	di/dt_{crit}	T_{vj} = 125 °C, I_T = 3000 A, $V_D \leq 0.67 \cdot V_{DRM}$, I_{GM} = 2 A, t_r = 0.5 µs	Cont. f = 50 Hz			250	A/µs
			Cont. f = 1 Hz			1000	A/µs
Circuit-commutated turn-off time	t_q	T_{vj} = 125 °C, I_T = 2000 A, V_R = 200 V, di_T/dt = -1.5 A/µs, $V_D \leq 0.67 \cdot V_{DRM}$, dv_D/dt = 20 V/µs				970	µs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Reverse recovery charge	Q_{rr}	T_{vj} = 125 °C, I_T = 2000 A, V_R = 200 V, di_T/dt = -1.5 A/µs	4500	6860	7500	µAs
Reverse recovery current	I_{RM}		60	91	110	A
Gate turn-on delay time	t_{gd}	T_{vj} = 25 °C, $V_D = 0.4 \cdot V_{RM}$, I_{GM} = 2 A, t_r = 0.5 µs			3	µs

Triggering

Maximum rated values [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Peak forward gate voltage	V_{FGM}				12	V
Peak forward gate current	I_{FGM}				10	A
Peak reverse gate voltage	V_{RGM}				10	V
Average gate power loss	$P_{G(AV)}$		see Fig. 7			W

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Gate-trigger voltage	V_{GT}	Tvj = 25 °C			2.6	V
Gate-trigger current	I_{GT}	Tvj = 25 °C			400	mA
Gate non-trigger voltage	V_{GD}	$V_D = 0.4 \cdot V_{DRM}$, $T_{vjmax} = 125$ °C			0.3	V
Gate non-trigger current	I_{GD}	$V_D = 0.4 \cdot V_{DRM}$, $T_{vjmax} = 125$ °C			10	mA

Thermal

Maximum rated values [1)]

Parameter	Symbol	Conditions	min	typ	max	Unit
Operating junction temperature range	T_{vj}				125	°C
Storage temperature range	T_{stg}		-40		140	°C

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Thermal resistance junction to case, Note 3	$R_{th(j-c)}$	Double-side cooled F_m = 120... 160 kN			4	K/kW
	$R_{th(j-c)A}$	Anode-side cooled F_m = 120... 160 kN			8	K/kW
	$R_{th(j-c)C}$	Cathode-side cooled F_m = 120... 160 kN			8	K/kW
Thermal resistance case to heatsink, Note 3	$R_{th(c-h)}$	Double-side cooled F_m = 120... 160 kN			0.8	K/kW
	$R_{th(c-h)}$	Single-side cooled F_m = 120... 160 kN			1.6	K/kW

Note 3: Recommended mounting force 120... 160kN.
For lower mounting force (90... 120kN), Rth(j-c) increases by 5% and Rth(c-h) increases by 30%.

Analytical function for transient thermal impedance:

$$Z_{th(j-c)}(t) = \sum_{i=1}^{n} R_i (1 - e^{-t/\tau_i})$$

i	1	2	3	4
R_i(K/kW)	2.736	0.813	0.338	0.113
τ_i(s)	0.9484	0.1155	0.0131	0.0036

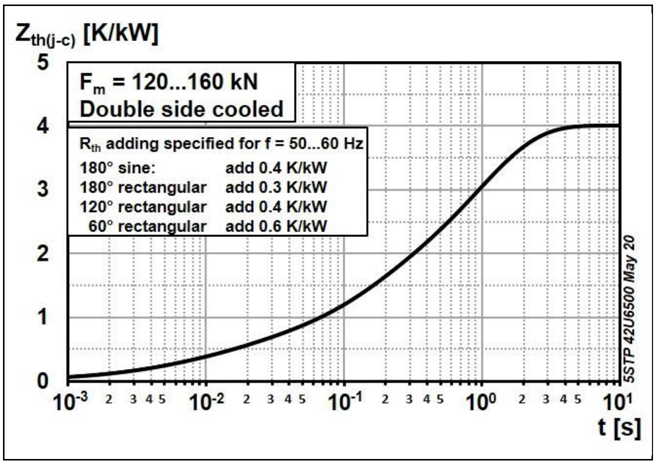


Fig. 1 Transient thermal impedance (junction-to-case) vs. time

Max. on-state characteristic model:

$$V_{T25} = A_{Tvj} + B_{Tvj} \cdot I_T + C_{Tvj} \cdot \ln(I_T + 1) + D_{Tvj} \cdot \sqrt{I_T}$$

Valid for I_T = 800 - 100000 A

A_{25}	B_{25}	C_{25}	D_{25}
$123.8 \cdot 10^{-6}$	$91.68 \cdot 10^{-6}$	$192.1 \cdot 10^{-3}$	$-2.905 \cdot 10^{-3}$

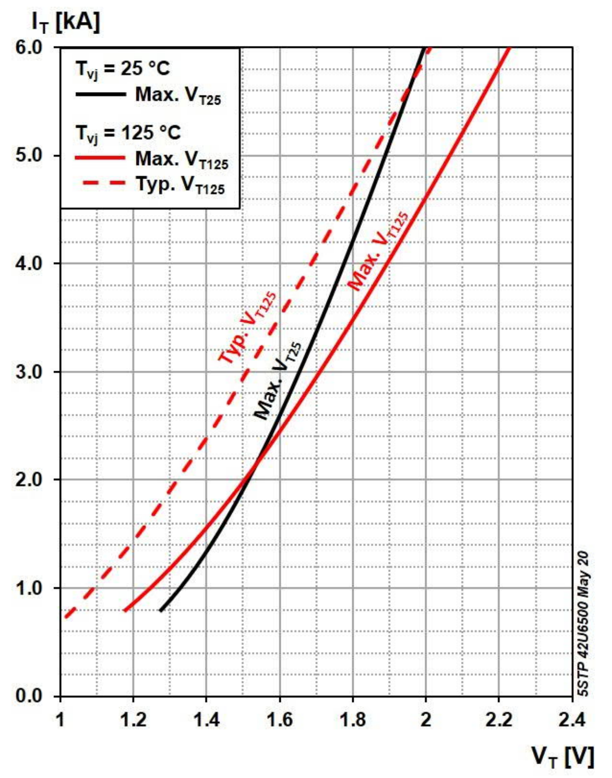


Fig. 2 On-state voltage characteristics

Max. on-state characteristic model:

$$V_{T125} = A_{Tvj} + B_{Tvj} \cdot I_T + C_{Tvj} \cdot \ln(I_T + 1) + D_{Tvj} \cdot \sqrt{I_T}$$

Valid for I_T = 800 - 100000 A

A_{125}	B_{125}	C_{125}	D_{125}
$-35.16 \cdot 10^{-3}$	$119.7 \cdot 10^{-6}$	$158.2 \cdot 10^{-3}$	$2.180 \cdot 10^{-3}$

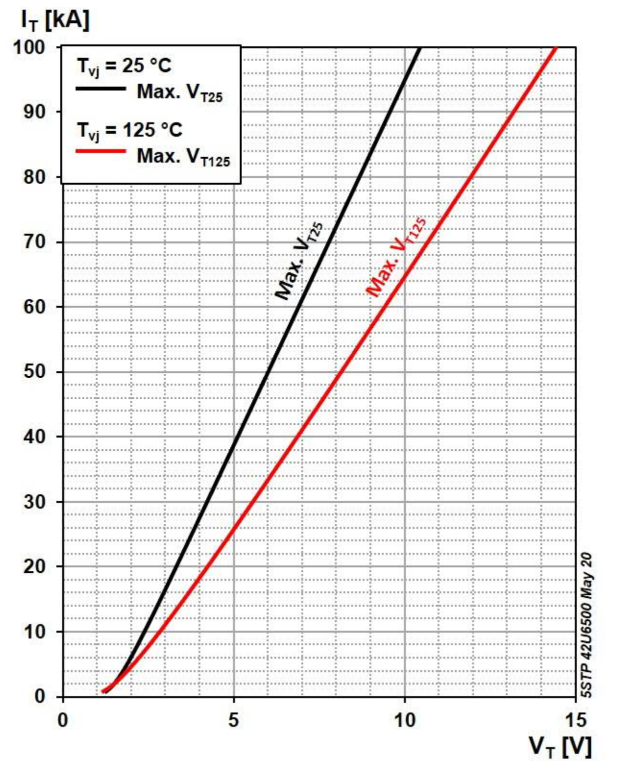


Fig. 3 On-state voltage characteristics

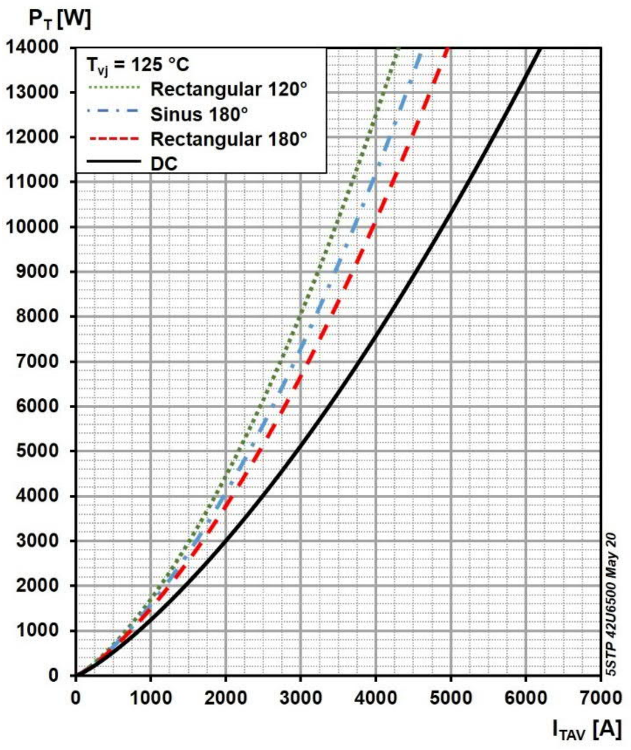


Fig. 4 On-state power dissipation vs. mean on-state current, turn-on losses excluded

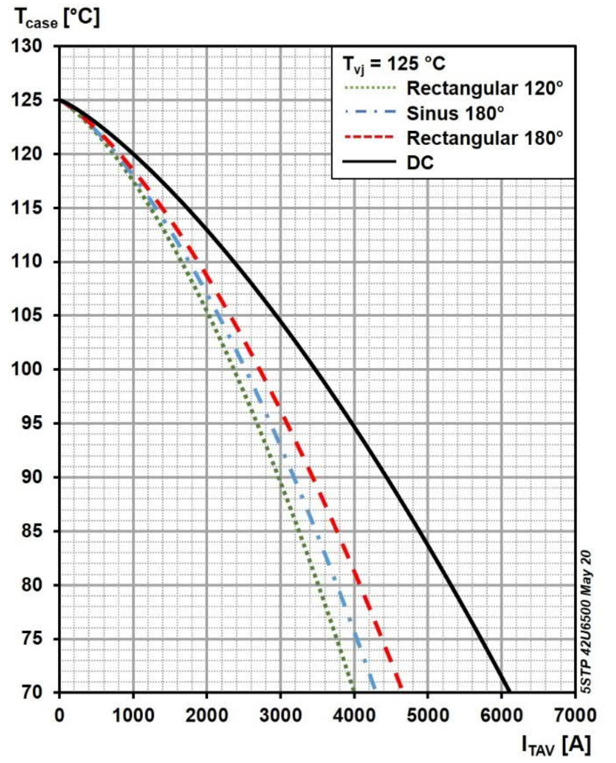


Fig. 5 Max. permissible case temperature vs. mean on-state current, switching losses ignored

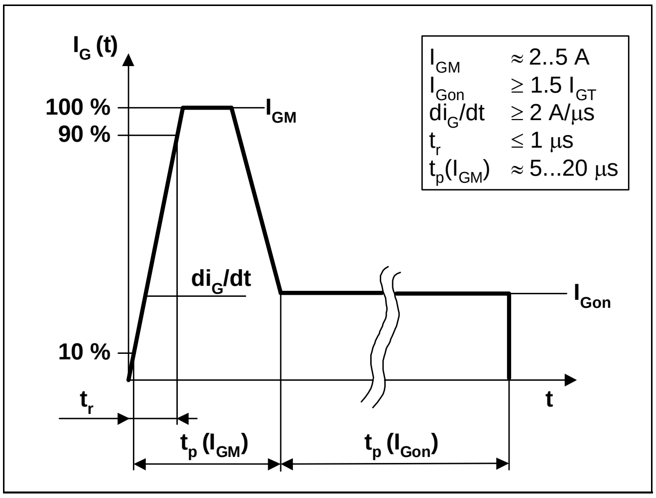


Fig. 6 Recommended gate current waveform

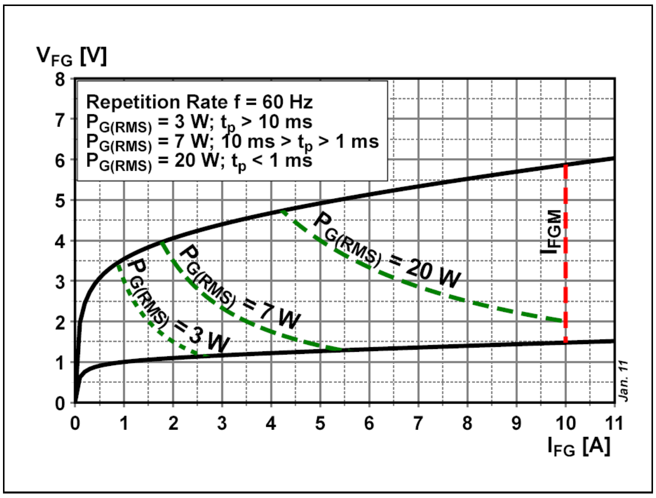


Fig. 7 Max. peak gate power loss

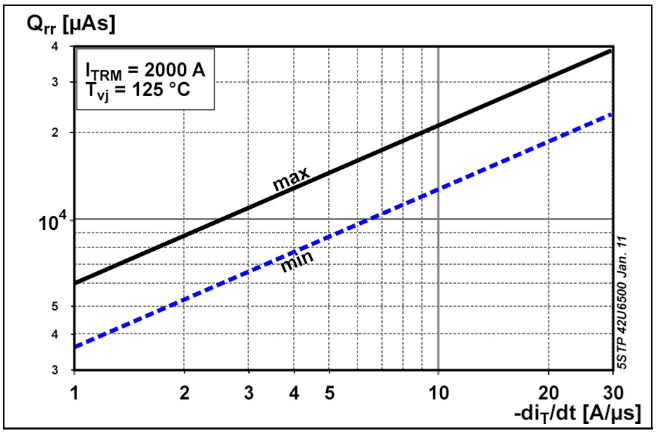


Fig. 8 Reverse recovery charge vs. decay rate of on-state current

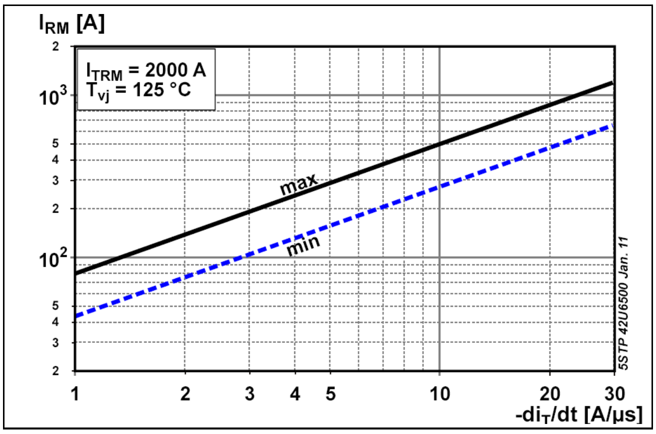


Fig. 9 Peak reverse recovery current vs. decay rate of on-state current

Turn-on and Turn-off losses

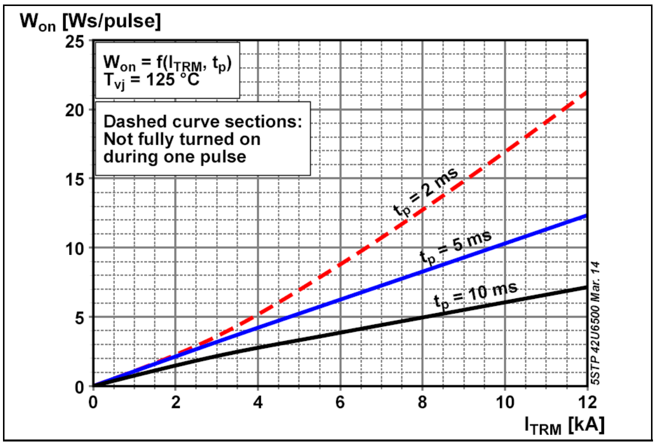


Fig. 10 Turn-on energy, half sinusoidal waves

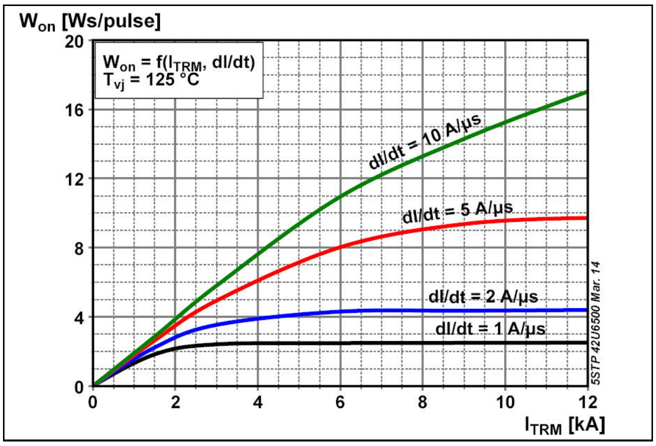


Fig. 11 Turn-on energy, rectangular waves

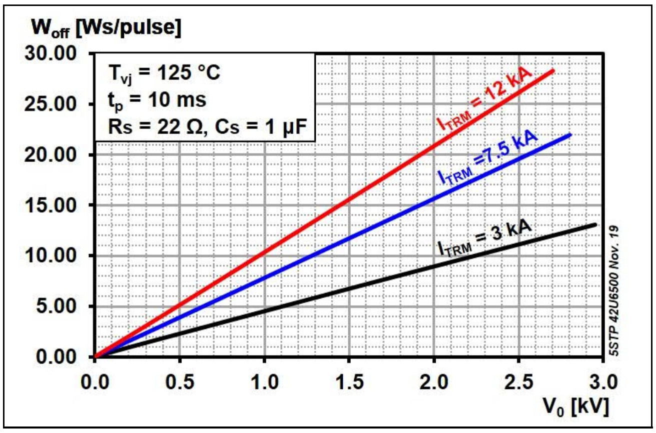


Fig. 12 Typical turn-off energy, half sinusoidal waves

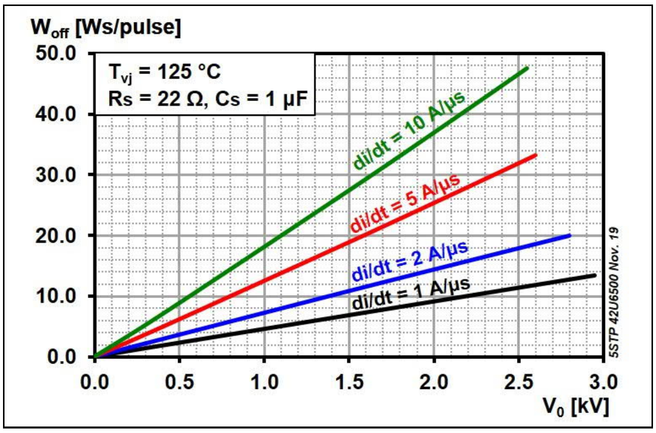


Fig. 13 Typical turn-off energy, rectangular waves

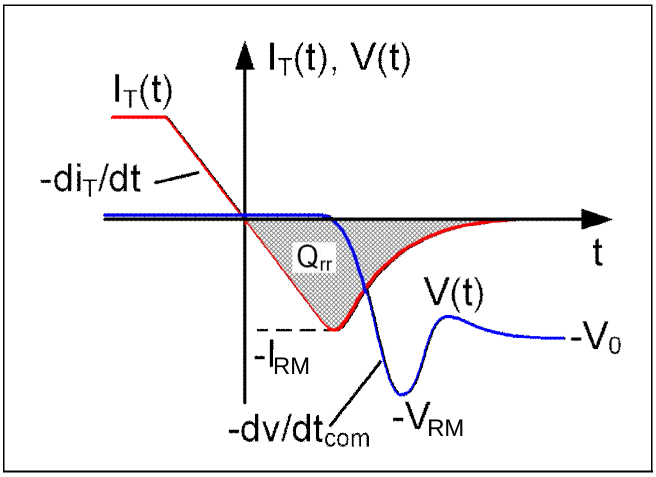


Fig. 14 Current and voltage waveforms at turn-off

Total power loss for repetitive waveforms:

$$P_{TOT} = P_T + W_{on} \cdot f + W_{off} \cdot f$$

where

$$P_T = \frac{1}{T}\int_0^T I_T \cdot V_T(I_T)\ dt$$

Fig. 15 Relationships for power loss

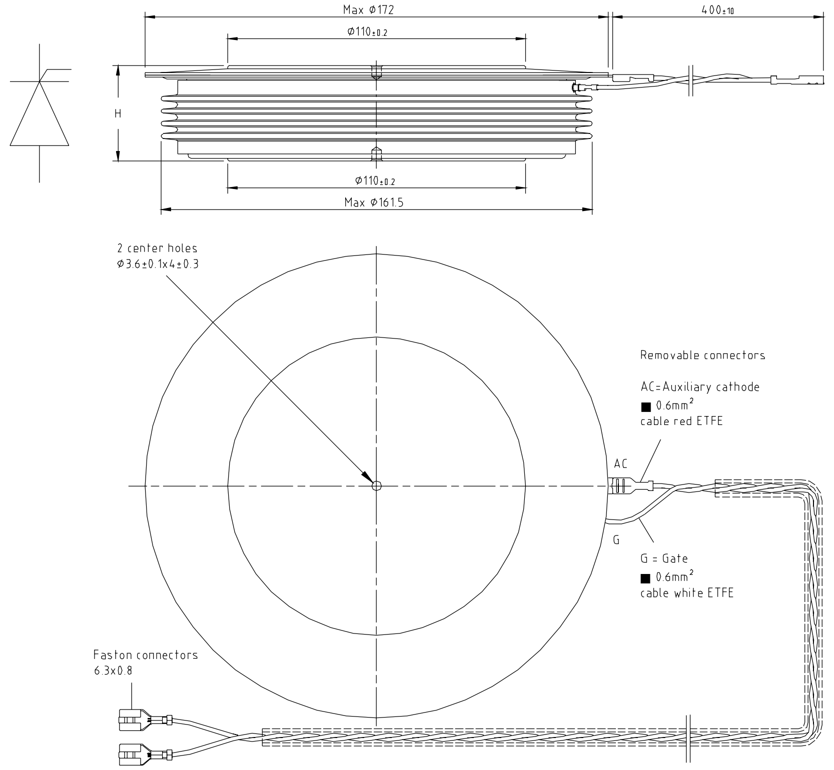


Fig. 16 Device Outline Drawing

Related documents:

5SYA 2020	Design of RC-Snubbers for Phase Control Applications
5SYA 2049	Voltage definitions for phase control and bi-directionally controlled thyristors
5SYA 2051	Voltage ratings of high power semiconductors
5SYA 2034	Gate-drive recommendations for phase control and bi-directionally controlled thyristors
5SYA 2036	Recommendations regarding mechanical clamping of Press-Pack High Power Semiconductors
5SYA 2102	Surge currents for Phase Control Thyristors
5SZK 9118	General Environmental Conditions for High Power Semiconductors

Please refer to http://www.abb.com/semiconductors for current version of documents.

ABB Power Grids Switzerland Ltd
Semiconductors
Fabrikstrasse 3
CH-5600 Lenzburg, Switzerland

Telephone +41 (0)58 586 1419
Fax +41 (0)58 586 1306
Email abbsem@ch.abb.com
Internet www.abb.com/semiconductors