

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 m Ω

Phase Control Thyristor

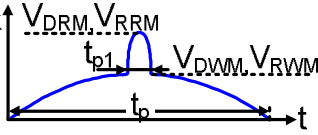
5STP 42U6500

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 $T_{vj} = 5 \dots 125$ °C, Note 1	6500	V
Max repetitive peak forward and reverse blocking voltage	V_{DRM} , V_{RRM}	$f = 50$ Hz, $t_p = 10$ ms, $t_{p1} = 250$ μ s, $T_{vj} = 5 \dots 125$ °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/ μ s

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

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On-state

Maximum rated values ¹⁾

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

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
On-state voltage	V_T	$I_T = 3000\text{ A}$, $T_{vj} = 125\text{ °C}$		1.51	1.71	V
Threshold voltage	$V_{(T0)}$	$I_T = 2000\text{ A} - 6000\text{ A}$, $T_{vj} = 125\text{ °C}$			1.17	V
Slope resistance	r_T				0.181	mΩ
Holding current	I_H	$T_{vj} = 25\text{ °C}$			200	mA
		$T_{vj} = 125\text{ °C}$			100	mA
Latching current	I_L	$T_{vj} = 25\text{ °C}$			900	mA
		$T_{vj} = 125\text{ °C}$			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}	$T_{vj} = 125\text{ °C}$, $I_T = 3000\text{ A}$, $V_D \leq 0.67 \cdot V_{DRM}$, $I_{GM} = 2\text{ A}$, $t_r = 0.5\text{ }\mu\text{s}$			250	A/ μs
		Cont. $f = 50\text{ Hz}$			1000	A/ μs
Circuit-commutated turn-off time	t_q	$T_{vj} = 125\text{ °C}$, $I_T = 2000\text{ A}$, $V_R = 200\text{ V}$, $di_T/dt = -1.5\text{ A}/\mu\text{s}$, $V_D \leq 0.67 \cdot V_{DRM}$, $dV_D/dt = 20\text{ V}/\mu\text{s}$			970	μs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Reverse recovery charge	Q_{rr}	$T_{vj} = 125\text{ °C}$, $I_T = 2000\text{ A}$, $V_R = 200\text{ V}$, $di_T/dt = -1.5\text{ A}/\mu\text{s}$	4500	6860	7500	μAs
Reverse recovery current	I_{RM}		60	91	110	A
Gate turn-on delay time	t_{gd}	$T_{vj} = 25\text{ °C}$, $V_D = 0.4 \cdot V_{RM}$, $I_{GM} = 2\text{ A}$, $t_r = 0.5\text{ }\mu\text{s}$			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}	T _{vj} = 25 °C			2.6	V
Gate-trigger current	I _{GT}	T _{vj} = 25 °C			400	mA
Gate non-trigger voltage	V _{GD}	V _D = 0.4·V _{DRM} , T _{vjmax} = 125 °C			0.3	V
Gate non-trigger current	I _{GD}	V _D = 0.4·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), R_{th(j-c)} increases by 5% and R_{th(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

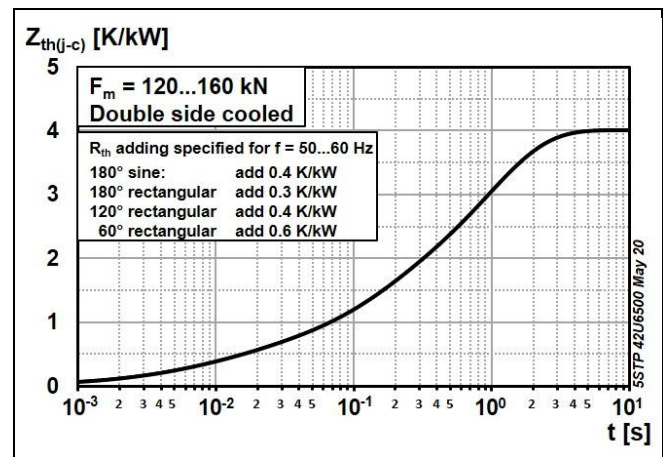


Fig. 1 Transient thermal impedance (junction-to-case) vs. time

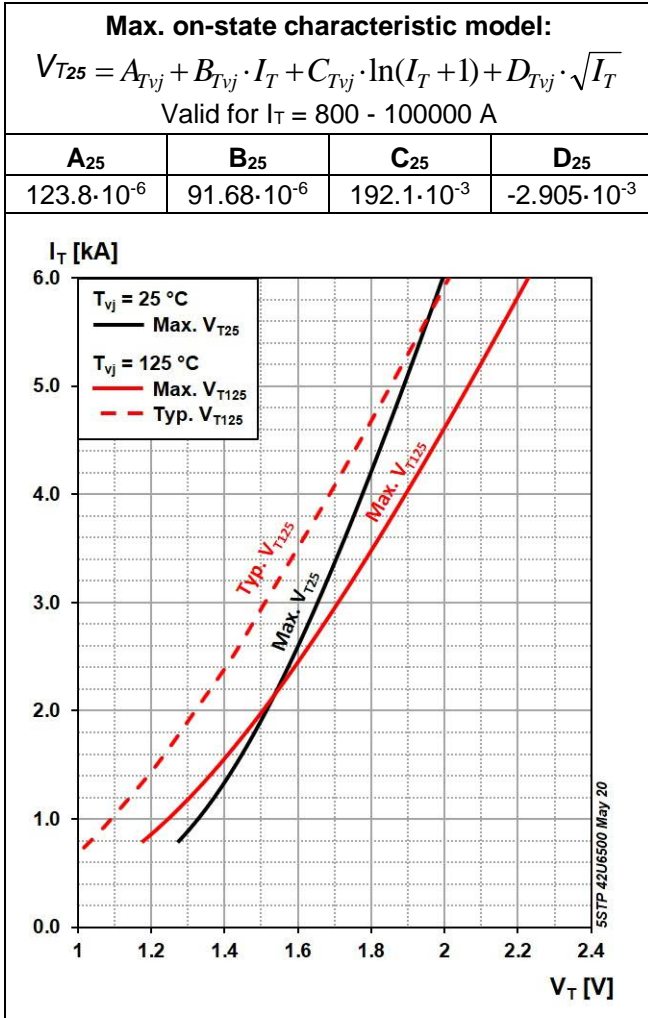


Fig. 2 On-state voltage characteristics

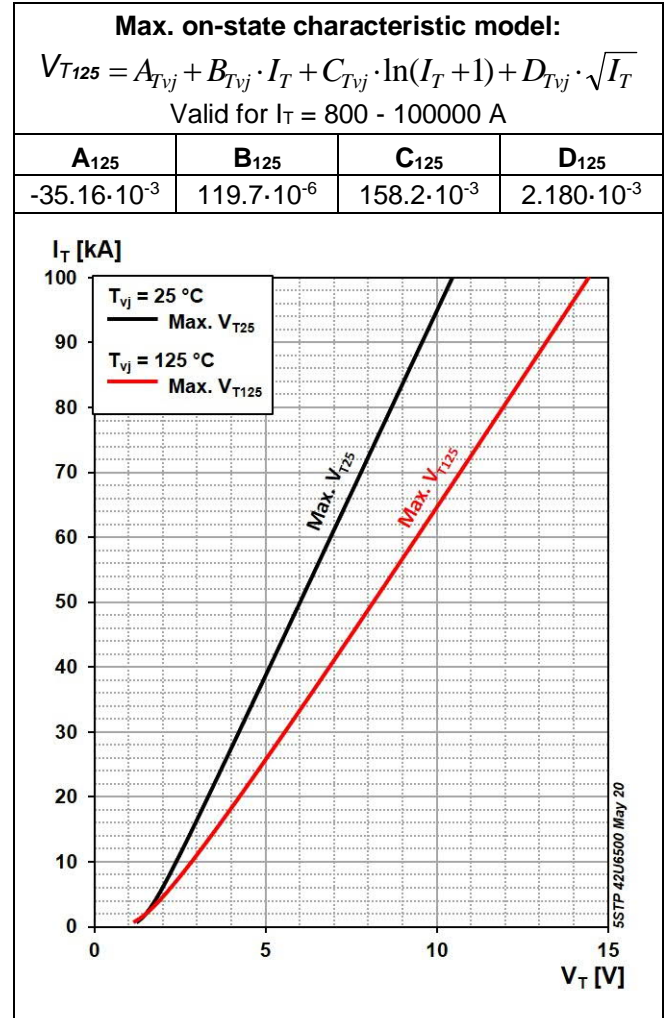


Fig. 3 On-state voltage characteristics

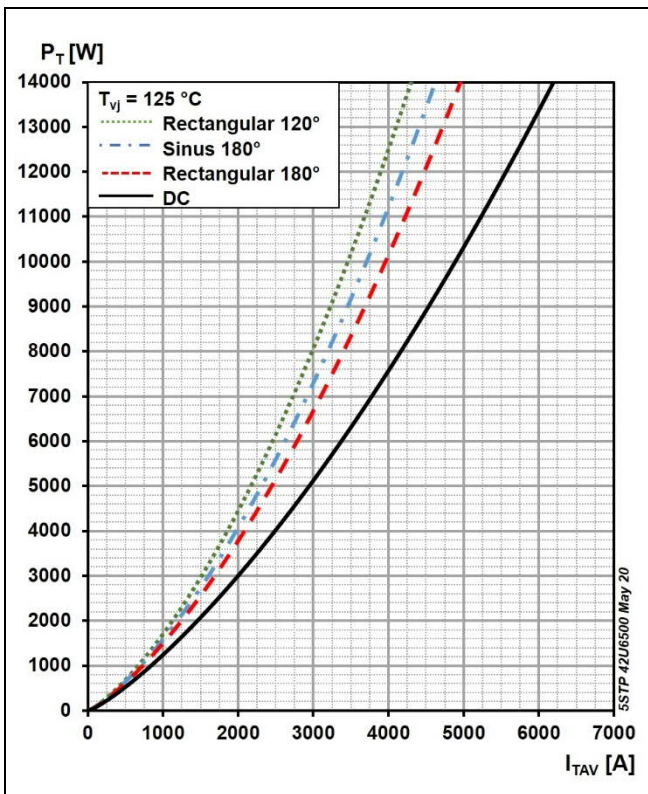


Fig. 4 On-state power dissipation vs. mean on-state current, turn-on losses excluded

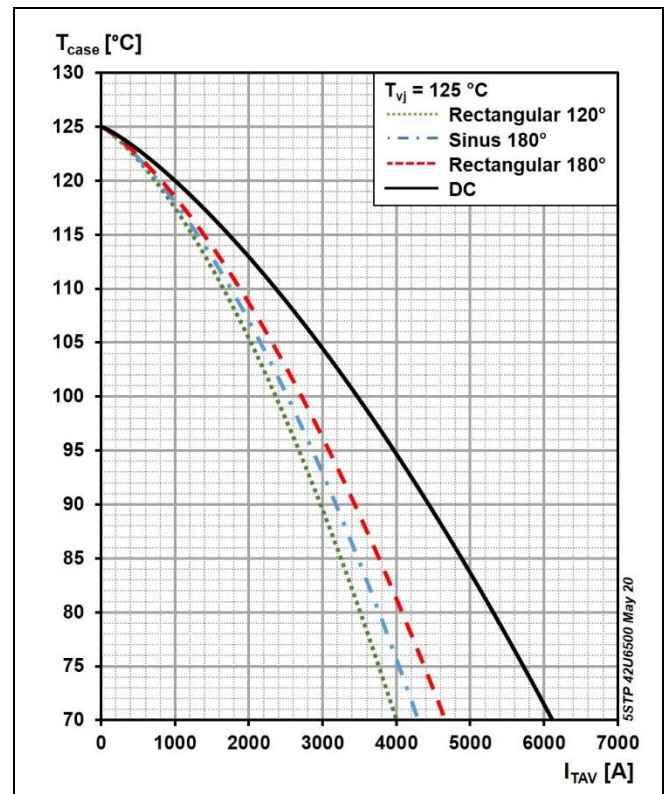


Fig. 5 Max. permissible case temperature vs. mean on-state current, switching losses ignored



Fig. 6 Recommended gate current waveform

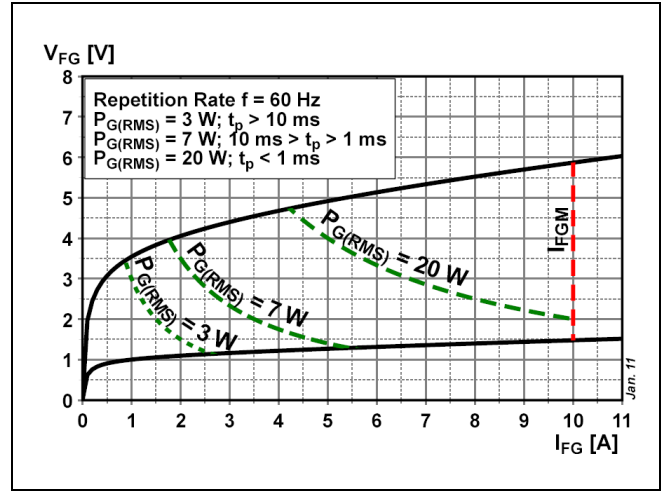


Fig. 7 Max. peak gate power loss

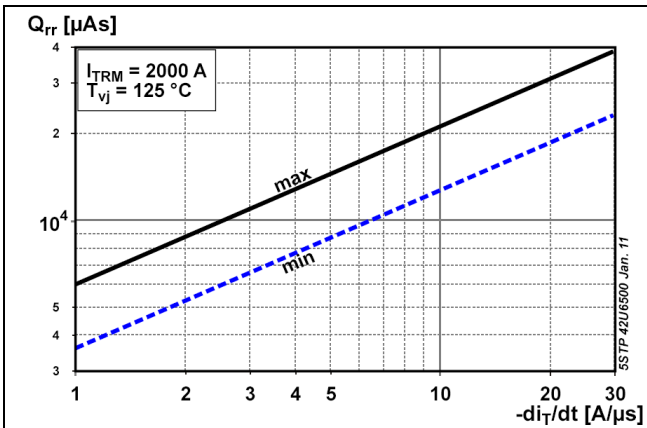


Fig. 8 Reverse recovery charge vs. decay rate of on-state current

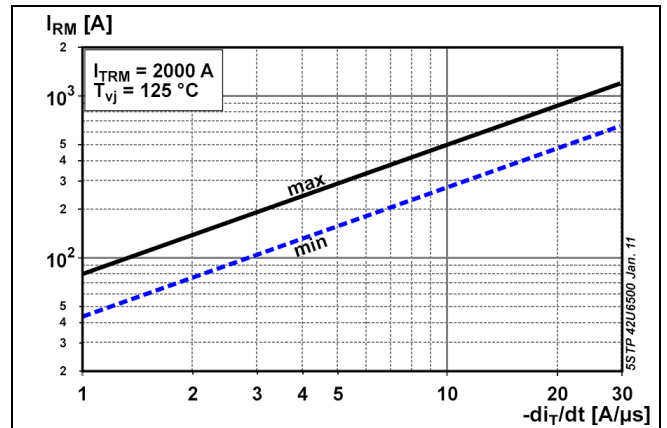


Fig. 9 Peak reverse recovery current vs. decay rate of on-state current

Turn-on and Turn-off losses

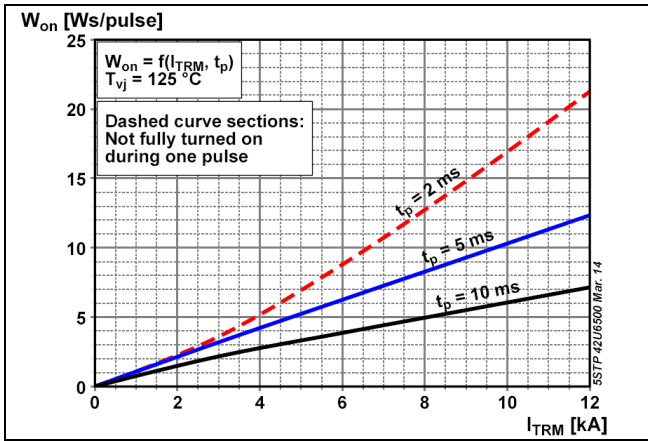


Fig. 10 Turn-on energy, half sinusoidal waves

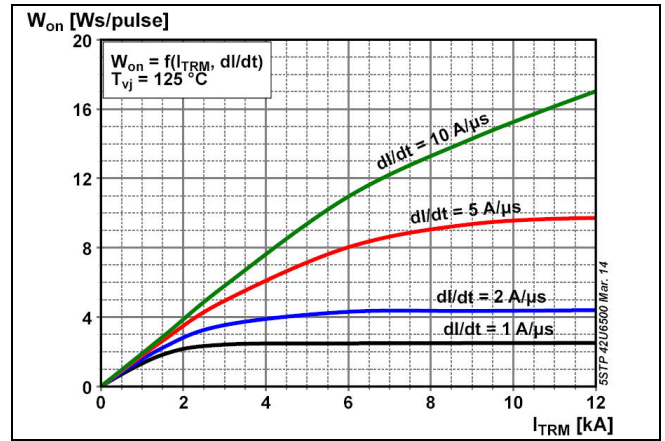


Fig. 11 Turn-on energy, rectangular waves

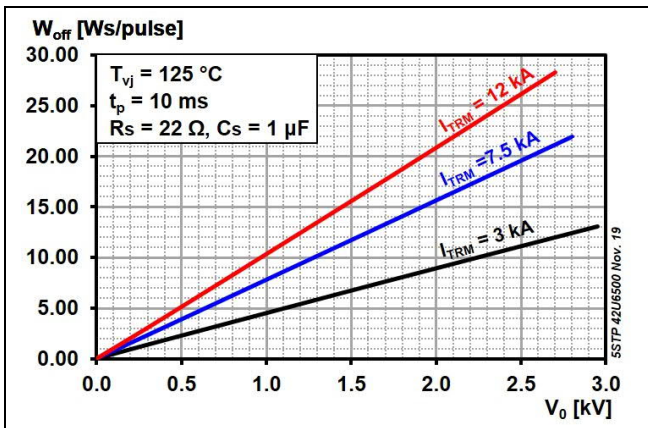


Fig. 12 Typical turn-off energy, half sinusoidal waves

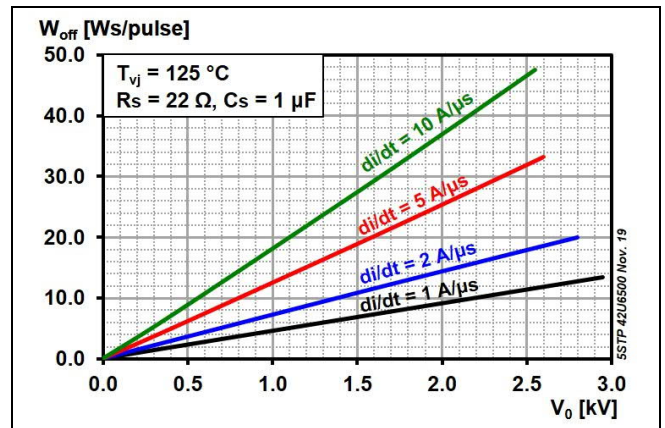


Fig. 13 Typical turn-off energy, rectangular waves

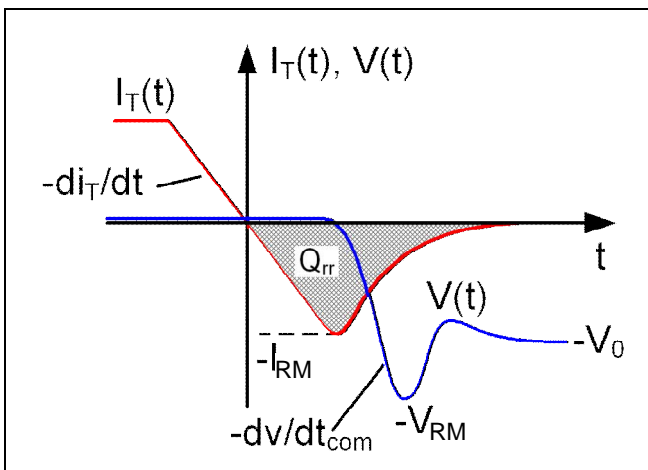


Fig. 14 Current and voltage waveforms at turn-off

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

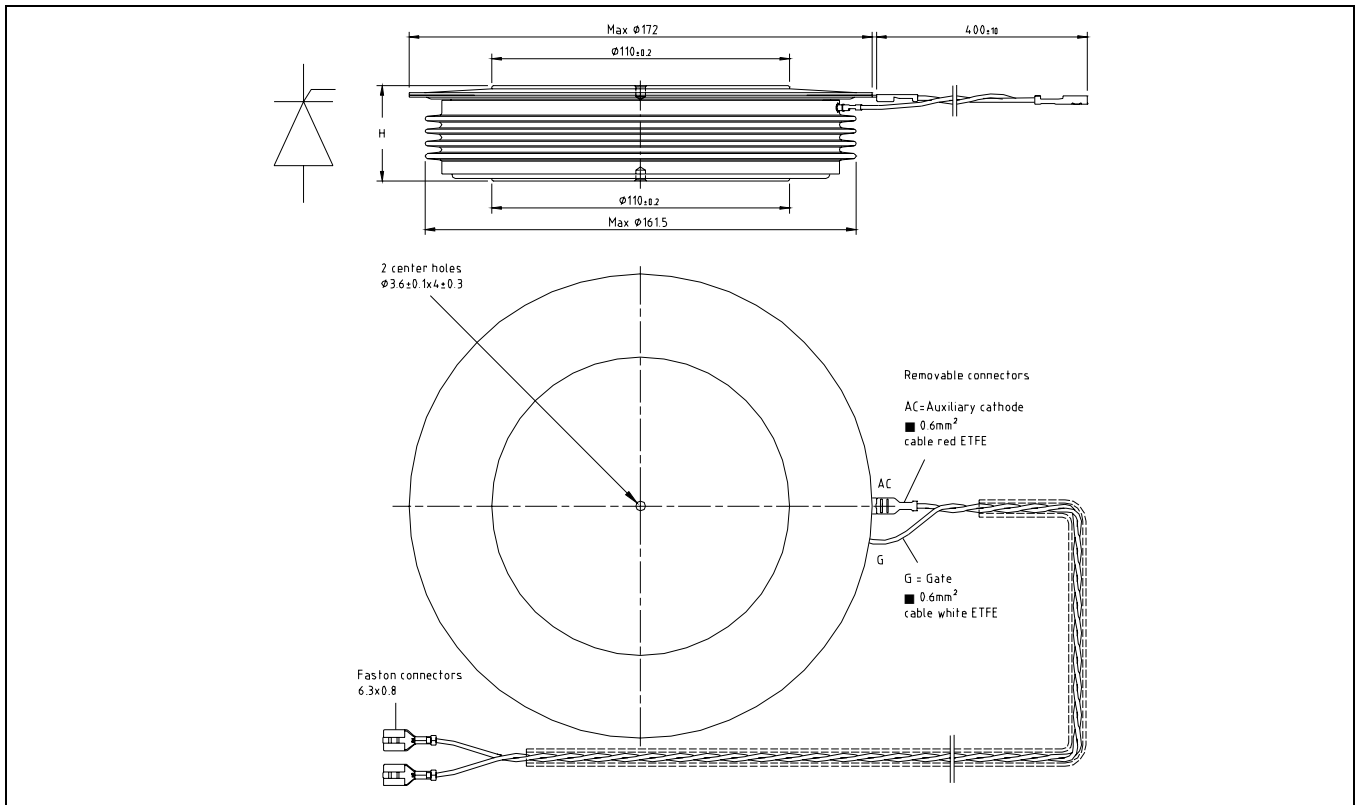


Fig. 16 Device Outline Drawing

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

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