

$V_{DRM} = 6500 \text{ V}$
 $I_{T(AV)M} = 3780 \text{ A}$
 $I_{T(RMS)} = 5930 \text{ A}$
 $I_{TSM} = 75.0 \cdot 10^3 \text{ A}$
 $V_{T0} = 1.14 \text{ V}$
 $r_T = 0.255 \text{ m}\Omega$

Phase Control Thyristor

5STP 40N6500

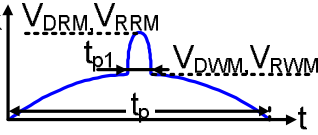
Preliminary

Doc. No. 5SYA1086-01 Feb. 21

- High forward and surge current rating
- Low on-state and switching losses
- Designed for industrial, Renewable, T&D and traction applications
- Optimum power handling capability
- Interdigitated amplifying gate

Blocking

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	5STP 40N6500	Unit
Max. surge peak forward and reverse blocking voltage	V_{DSM}, V_{RSM}	$t_p = 10 \text{ ms}, f = 5 \text{ Hz}$ $T_{vj} = 5 \dots 135 \text{ }^\circ\text{C}, \text{ Note 1}$	6500	V
Max repetitive peak forward and reverse blocking voltage	V_{DRM}, V_{RRM}	$f = 50 \text{ Hz}, t_p = 10 \text{ ms}, t_{p1} = 250 \text{ }\mu\text{s},$ $T_{vj} = 5 \dots 135 \text{ }^\circ\text{C}, \text{ Note 1}, \text{ Note 2}$	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 $0.67 \cdot V_{DRM}, T_{vj} = 135 \text{ }^\circ\text{C}$	4000	V/ μs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Forward leakage current	I_{DRM}	$V_{DRM}, T_{vj} = 135 \text{ }^\circ\text{C}$			500	mA
Reverse leakage current	I_{RRM}	$V_{RRM}, T_{vj} = 135 \text{ }^\circ\text{C}$			500	mA

Note 1: Voltage de-rating factor of 0.11% per $^\circ\text{C}$ is applicable for T_{vj} below $+5 \text{ }^\circ\text{C}$.

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		81	90	108	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				2.9	kg
Housing thickness	H	$F_M = 90 \text{ kN}, T_a = 25 \text{ }^\circ\text{C}$	34.94		35.46	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

On-state

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Average on-state current	$I_{T(AV)M}$	Half sine wave, $T_c = 70\text{ °C}$			3780	A
RMS on-state current	$I_{T(RMS)}$				5930	A
Peak non-repetitive surge current	I_{TSM}	$t_p = 10\text{ ms}$, $T_{vj} = 135\text{ °C}$, sine half wave, $V_D = V_R = 0\text{ V}$, after surge			$75.0 \cdot 10^3$	A
Limiting load integral	I^2t				$28.1 \cdot 10^6$	A^2s
Peak non-repetitive surge current	I_{TSM}	$t_p = 10\text{ ms}$, $T_{vj} = 135\text{ °C}$, sine half wave, $V_R = 0.6 \cdot V_{RRM}$, after surge			tbd	A
Limiting load integral	I^2t				tbd	A^2s

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
On-state voltage	V_T	$I_T = 3000\text{ A}$, $T_{vj} = 135\text{ °C}$		tbd	1.90	V
Threshold voltage	$V_{(TO)}$	$I_T = 1625\text{ A} - 5000\text{ A}$, $T_{vj} = 135\text{ °C}$			1.14	V
Slope resistance	r_T				0.255	$m\Omega$
Holding current	I_H	$T_{vj} = 25\text{ °C}$			125	mA
		$T_{vj} = 135\text{ °C}$			75	mA
Latching current	I_L	$T_{vj} = 25\text{ °C}$			700	mA
		$T_{vj} = 135\text{ °C}$			500	mA

Switching

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Critical rate of rise of on-state current	di/dt_{crit}	$T_{vj} = 135\text{ °C}$, $I_T = 3000\text{ A}$, $V_D \leq 0.67 \cdot V_{DRM}$, $I_{GM} = 2\text{ A}$, $t_r = 0.5\text{ }\mu s$			200	$A/\mu s$
		Cont. $f = 50\text{ Hz}$			1000	$A/\mu s$
Circuit-commutated turn-off time	t_q	$T_{vj} = 135\text{ °C}$, $I_T = 2000\text{ A}$, $V_R = 200\text{ V}$, $di_T/dt = -1.5\text{ A}/\mu s$, $V_D \leq 0.67 \cdot V_{DRM}$, $dV_D/dt = 20\text{ V}/\mu s$			800	μs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Reverse recovery charge	Q_{rr}	$T_{vj} = 135\text{ °C}$, $I_T = 2000\text{ A}$, $V_R = 200\text{ V}$, $di_T/dt = -1.5\text{ A}/\mu s$	3500	tbd	5800	μAs
Reverse recovery current	I_{RM}		60	tbd	90	A
Gate turn-on delay time	t_{gd}	$T_{vj} = 25\text{ °C}$, $V_D = 0.4 \cdot V_{RM}$, $I_{GM} = 2\text{ A}$, $t_r = 0.5\text{ }\mu s$			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} = 135 °C			0.3	V
Gate non-trigger current	I _{GD}	V _D = 0.4 · V _{DRM} , T _{vjmax} = 135 °C			10	mA

Thermal

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Operating junction temperature range	T _{vj}				135	°C
Storage temperature range	T _{stg}		-40		140	°C

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Thermal resistance junction to case	R _{th(j-c)}	Double-side cooled F _m = 81... 108 kN			4.8	K/kW
	R _{th(j-c)A}	Anode-side cooled F _m = 81... 108 kN			8.5	K/kW
	R _{th(j-c)C}	Cathode-side cooled F _m = 81... 108 kN			11.0	K/kW
Thermal resistance case to heatsink	R _{th(c-h)}	Double-side cooled F _m = 81... 108 kN			1	K/kW
	R _{th(c-h)}	Single-side cooled F _m = 81... 108 kN			2	K/kW

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)	3.278	0.918	0.477	0.127
τ _i (s)	1.0287	0.1161	0.0192	0.0038

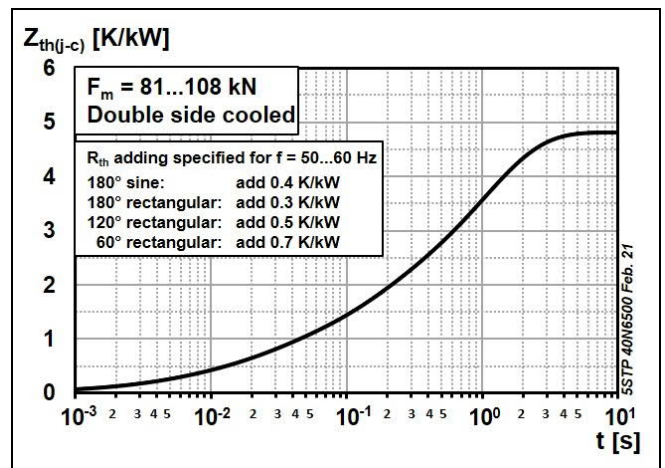


Fig. 1 Transient thermal impedance (junction-to-case) vs. time

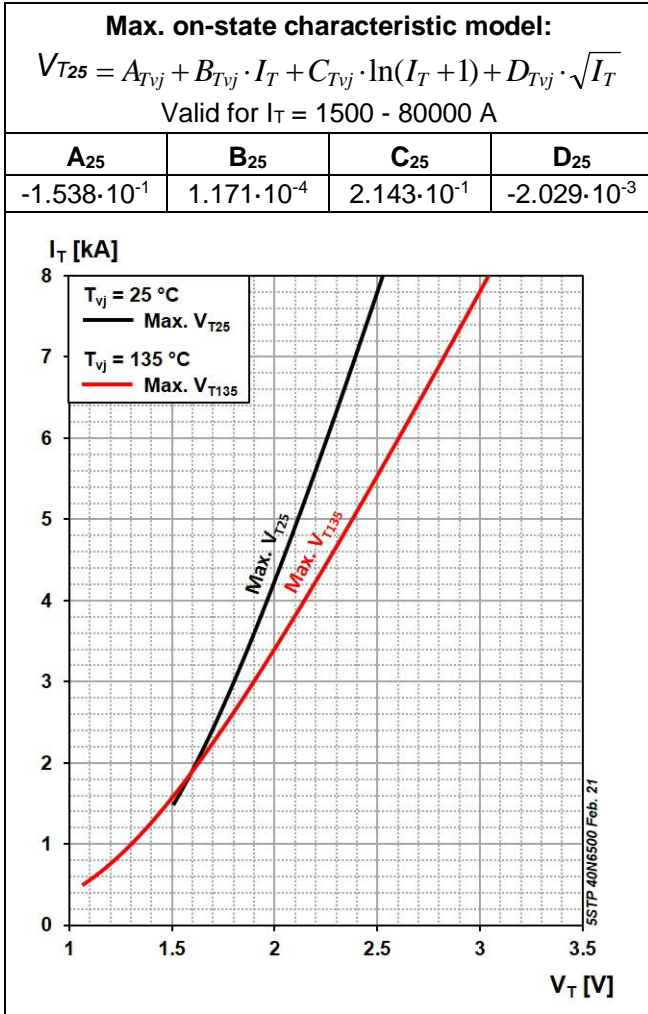


Fig. 2 On-state voltage characteristics

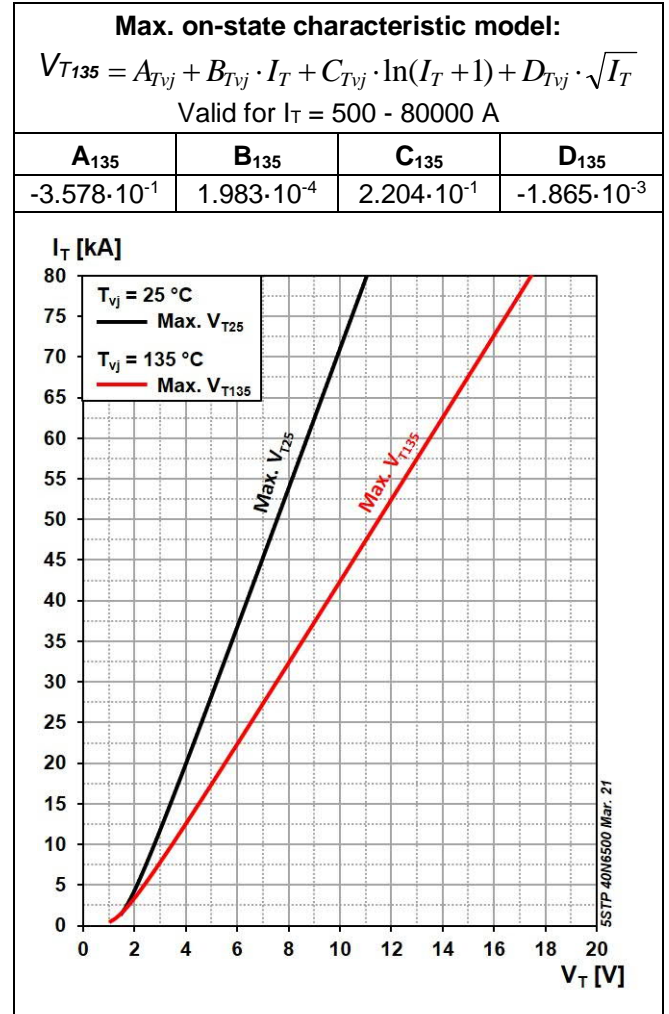


Fig. 3 On-state voltage characteristics

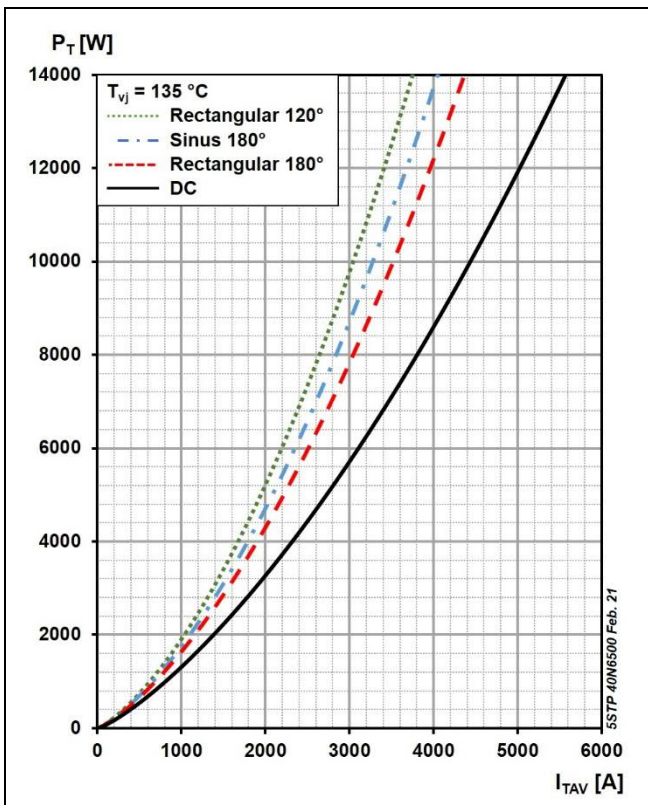


Fig. 4 On-state power dissipation vs. mean on-state current, turn-on losses excluded

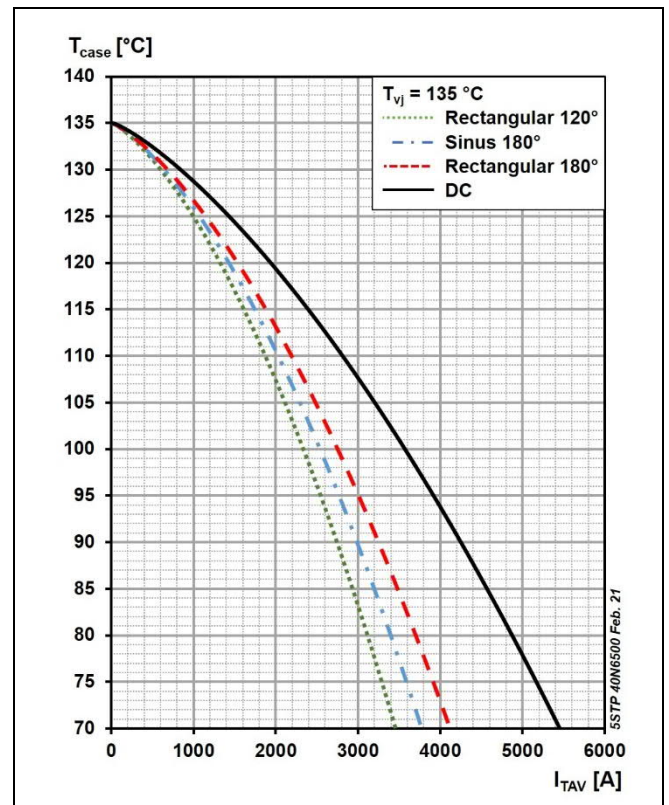


Fig. 5 Max. permissible case temperature vs. mean on-state current, switching losses ignored



Fig. 6 Recommended gate current waveform

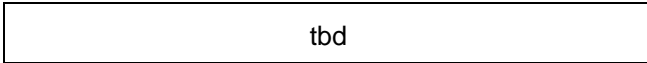


Fig. 8 Reverse recovery charge vs. decay rate of on-state current

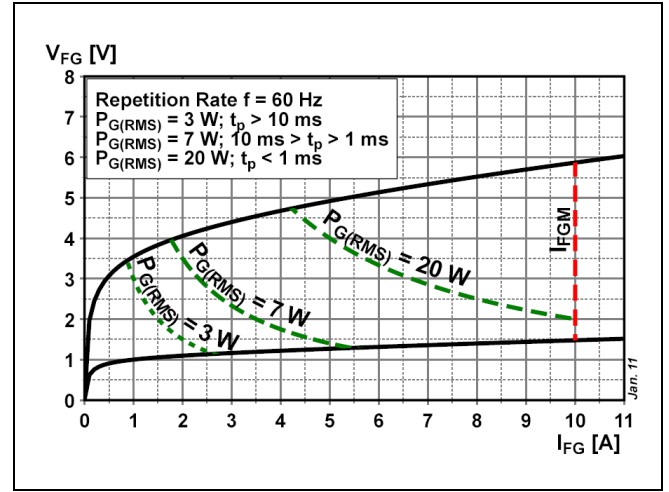


Fig. 7 Max. peak gate power loss

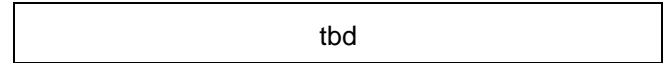


Fig. 9 Peak reverse recovery current vs. decay rate of on-state current

Turn-on and Turn-off losses

tbd

Fig. 10 Turn-on energy, half sinusoidal waves

tbd

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

tbd

Fig. 11 Turn-on energy, rectangular waves

tbd

Fig. 13 Typical turn-off energy, rectangular waves

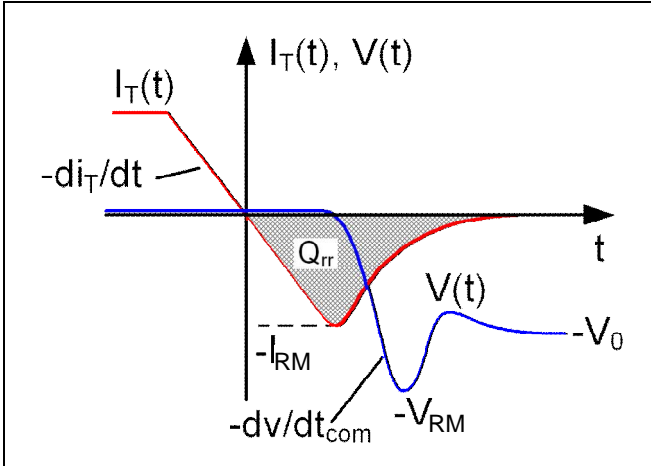


Fig. 14 Current and voltage waveforms at turn-off

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

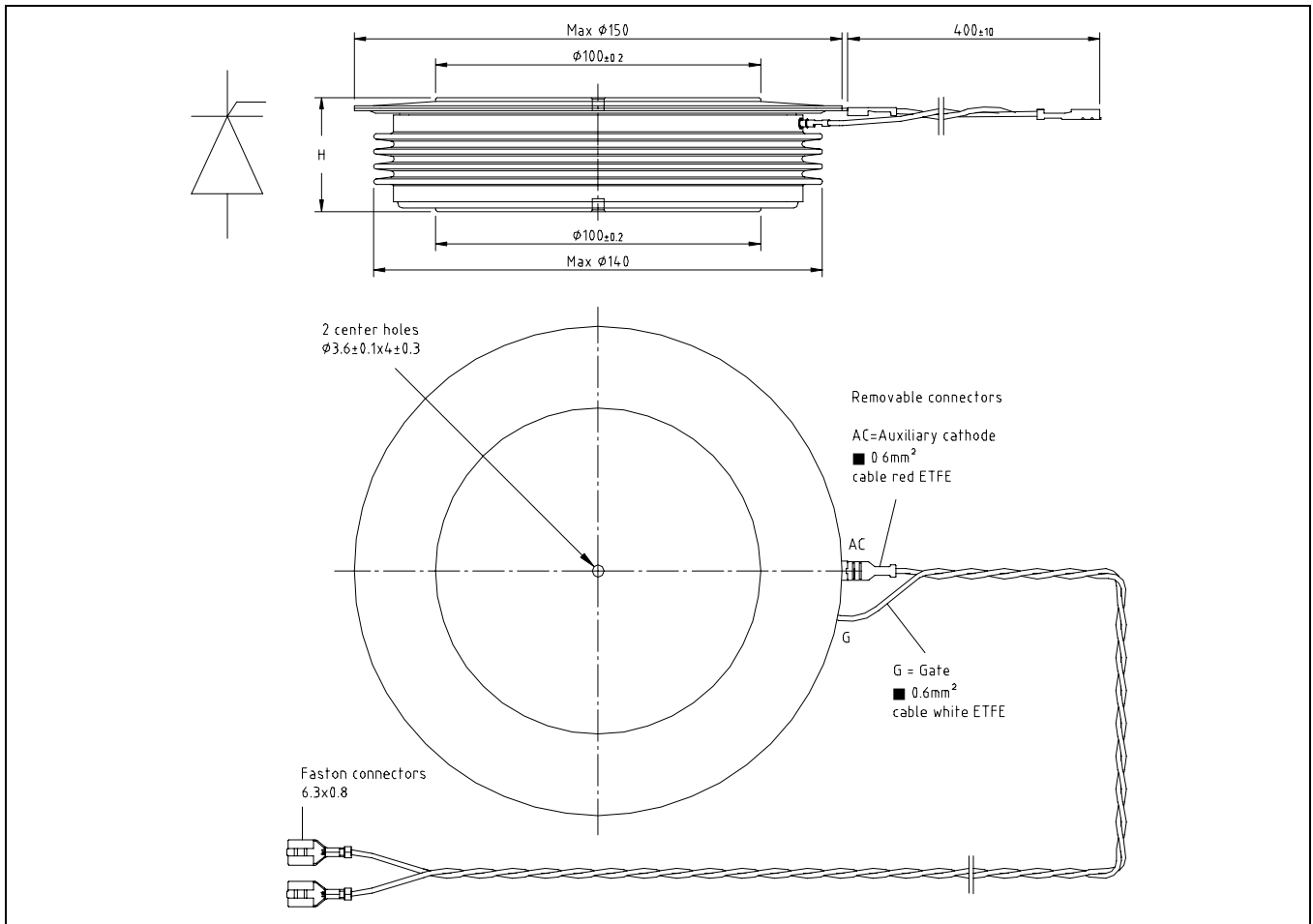


Fig. 16 Device Outline Drawing

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.hitachiabb-powergrids.com/semiconductors> for current version of documents.

We reserve all rights in this document and in the subject matter and illustrations contained therein. Any reproduction, disclosure to third parties or utilization of its contents – in whole or in parts – is forbidden without prior written consent. We reserve the right to change specifications without notice.

ABB is a registered trademark of ABB Asea Brown Boveri Ltd Manufactured by/for a Hitachi Power Grids company. Copyright 2021 Hitachi Powergrids. All rights reserved.

ABB Power Grids Switzerland Ltd Semiconductors

Hitachi ABB Joint Venture
Fabrikstrasse 3
CH-5600 Lenzburg
Switzerland

Tel: +41 (0)58 586 14 19
Fax : +41 (0)58 586 13 06
Email : abbsem@hitachi-powergrids.com
Internet www.hitachiabb-powergrids.com/semiconductors