

Data sheet 5SYA 1262-04 Mar. 23

5SHY 65L4522

Asymmetric Integrated Gate-Commutated Thyristor

- $V_{\text{DRM}} = 4500 \text{ V}$
- $I_{\text{TGQM}} = 6000 \text{ A}$
- $I_{\text{TSM}} = 38.6 \cdot 10^3 \text{ A}$
- $V_{\text{T0}} = 1.39 \text{ V}$
- $r_{\text{T}} = 0.390 \text{ m}\Omega$
- $V_{\text{DC}} = 2800 \text{ V}$
- High snubberless turn-off rating
- Optimized for high switching frequency
- High electromagnetic immunity
- Simple control interface with status feedback
- AC or DC supply voltage
- Option for series connection (contact factory)



Blocking

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Rep. peak off-state voltage	V_{DRM}	Gate Unit energized.			4500	V
Permanent DC voltage for 100 FIT failure rate of GCT	V_{DC}	Ambient cosmic radiation at sea level in open air. Gate Unit energized.			2800	V
Reverse voltage	V_{RRM}				17	V

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Rep. peak off-state current	I_{DRM}	$V_{\text{D}} = V_{\text{DRM}}$, Gate Unit energized.			50	mA

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

Mechanical data (see Fig. 12, 13)

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Mounting force	F_{m}		50	55	60	kN

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Pole-piece diameter	D_{p}	$\pm 0.1 \text{ mm}$		85		mm
Housing thickness	H	$F_{\text{m}} = 55 \text{ kN}$, $T_{\text{a}} = 25 \text{ }^{\circ}\text{C}$	25.3		25.8	mm
Weight (incl. Gate Unit)	m				2.9	kg
Surface creepage distance	D_{s}	Anode to Gate	33			mm
Air strike distance	D_{a}	Anode to Gate	10			mm
Length (incl. Gate Unit)	l	$\pm 1.0 \text{ mm}$		439		mm
Height (incl. Gate Unit)	h	$\pm 1.0 \text{ mm}$		41		mm
Width IGCT (incl. Gate Unit)	w	$\pm 1.0 \text{ mm}$		173		mm

GCT Data

On-state (see Fig. 3, 4, 5, 6, 15)

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Max. average on-state current	$I_{T(AV)M}$	Half sine wave, $T_c = 85\text{ °C}$, Double side cooled			2320	A
RMS on-state current	$I_{T(RMS)}$				3640	A
Peak non-repetitive surge current	I_{TSM}	$t_p = 3\text{ ms}$, $T_j = 140\text{ °C}$, sine half wave, $V_D = V_R = 0\text{ V}$, after surge			$52.9 \cdot 10^3$	A
Limiting load integral	I^2t				$4.20 \cdot 10^6$	A ² s
Peak non-repetitive surge current	I_{TSM}	$t_p = 10\text{ ms}$, $T_j = 140\text{ °C}$, sine half wave, $V_D = V_R = 0\text{ V}$, after surge			$38.6 \cdot 10^3$	A
Limiting load integral	I^2t				$7.45 \cdot 10^6$	A ² s
Stray inductance between GCT and antiparallel diode	L_D	Only relevant for applications with antiparallel diode to the IGCT			200	nH
Critical rate of rise of on-state current	$di_T/dt_{(cr)}$	For higher di_T/dt and current lower than 100 A an external retrigger pulse is required.			200	A/ μ s

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
On-state voltage	V_T	$I_T = 4000\text{ A}$, $T_j = 140\text{ °C}$	2.55	2.80	2.95	V
Threshold voltage	$V_{(T0)}$	$I_T = 1000\text{ A} - 5000\text{ A}$, $T_j = 140\text{ °C}$		1.36	1.39	V
Slope resistance	r_T			0.361	0.390	m Ω

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Turn-on switching (see Fig. 15, 16)

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Critical rate of rise of on-state current	$di_T/dt_{(cr)}$	$f = 0 \text{ Hz} - 500 \text{ Hz}$, $V_D = 2800 \text{ V}$, $T_{vj} = 0 \text{ }^\circ\text{C} - 140 \text{ }^\circ\text{C}$, $I_T = 6000 \text{ A}$, $I_{TM} \leq 9000 \text{ A}$			1900	A/ μs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Turn-on delay time	$t_{d(on)}$	$V_D = 2800 \text{ V}$, $T_{vj} = 140 \text{ }^\circ\text{C}$, $I_T = 4000 \text{ A}$,			4	μs
Turn-on delay time status feedback	$t_{d(on) \text{ SF}}$	$di_T/dt = V_D / L_i$, $L_i = 1.5 \text{ } \mu\text{H}$, $C_{CL} = 10 \text{ } \mu\text{F}$, $L_{CL} = 200 \text{ nH}$, $D_{FWD} = 5\text{SDF } 20\text{L}4520$			7	μs
Rise time	t_r	$D_{FWD} = 5\text{SDF } 20\text{L}4520$			3	μs
Turn-on energy per pulse	E_{on}	$D_{CL} = 5\text{SDF } 10\text{H}4503$			3	J

Turn-off switching (see Fig. 2, 7, 8, 9, 11, 15, 16)

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Controllable turn-off current (non repetitive)	I_{TGQM}	$T_{vj} = 0 \text{ }^\circ\text{C} - 140 \text{ }^\circ\text{C}$ $V_D = 2800 \text{ V}$, $V_{DM} \leq V_{DRM}$, $R_S = 0.65 \text{ } \Omega$, $C_{CL} = 10 \text{ } \mu\text{F}$, $L_{CL} \leq 200 \text{ nH}$, $D_{FWD} = 5\text{SDF } 20\text{L}4520$ $D_{CL} = 5\text{SDF } 10\text{H}4503$			6000	A

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Turn-off delay time	$t_{d(off)}$	$T_{vj} = 140 \text{ }^\circ\text{C}$, $I_{TQG} = 4000 \text{ A}$,			8	μs
Turn-off delay time status feedback	$t_{d(off) \text{ SF}}$	$V_D = 2800 \text{ V}$, $V_{DM} \leq V_{DRM}$, $L_i = 1.5 \text{ } \mu\text{H}$,			7	μs
Turn-off energy per pulse	E_{off}	$R_S = 0.65 \text{ } \Omega$, $C_{CL} = 10 \text{ } \mu\text{F}$, $L_{CL} = 200 \text{ nH}$, $D_{FWD} = 5\text{SDF } 20\text{L}4520$ $D_{CL} = 5\text{SDF } 10\text{H}4503$		17.4	19...21.5	J

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

Gate Unit Data

Power supply (see Fig. 2, 10, 11, 13, 14)

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Gate Unit voltage (Connector X1)	V _{Gin RMS}	AC square wave amplitude (15 kHz - 100kHz) or DC voltage. No galvanic isolation to power circuit.	28		40	V
Min. current needed to power up the Gate Unit	I _{Gin Min}	Rectified average current see application note 5SYA 2031	2			A
Gate Unit power consumption	P _{Gin Max}				130	W
Characteristic values						
Parameter	Symbol	Conditions	min	typ	max	Unit
Internal current limitation	I _{Gin Max}	Rectified average current limited by the Gate Unit			8	A

Optical control input/output ²⁾

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Min. on-time	t _{on}		40			µs
Min. off-time	t _{off}		40			µs
Characteristic values						
Parameter	Symbol	Conditions	min	typ	max	Unit
Optical input power	P _{on CS}	CS: Command signal SF: Status feedback Valid for 1mm plastic optical fiber (POF)	-15		-1	dBm
Optical noise power	P _{off CS}				-45	dBm
Optical output power	P _{on SF}		-19		-1	dBm
Optical noise power	P _{off SF}				-50	dBm
Pulse width threshold	t _{GLTCH}	Max. pulse width without response			400	ns
External retrigger pulse width	t _{retrig}		700		1100	ns

Connectors ²⁾ (see Fig. 12, 13, 14)

Parameter	Symbol	Description
Gate Unit power connector	X1	AMP: MTA-156, Part Number 641210-5 ³⁾
LWL receiver for command signal	CS	Avago, Type HFBR-2521Z ⁴⁾
LWL transmitter for status feedback	SF	Avago, Type HFBR-1528Z ⁴⁾

Visual feedback

Parameter	Symbol	Description	Color
Gate OFF	LED1	"Light" when GCT is off	(green)
Gate ON	LED2	"Light" when gate-current is flowing	(yellow)
Fault	LED3	"Light" when not ready / failure	(red)
Power supply voltage OK	LED4	"Light" when power supply is within specified range	(green)

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

2) Do not disconnect or connect fiber optic cables while light is on.

3) AMP, www.amp.com

4) Avago Technologies, www.avagotech.com

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Thermal

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Junction operating temperature	T _{vj}		0		140	°C
Storage temperature range	T _{stg}		0		60	°C
Ambient operational temperature	T _a		0		50	°C
Characteristic values						
Parameter	Symbol	Conditions	min	typ	max	Unit
Thermal resistance junction-to-case of GCT	R _{th(j-c)}	Double side cooled F _m = 50 ... 60 kN			6.8	K/kW
	R _{th(j-c)A}	Anode side cooled F _m = 50 ... 60 kN			11.3	K/kW
	R _{th(j-c)C}	Cathode side cooled F _m = 50 ... 60 kN			17.1	K/kW
Thermal resistance case-to- heatsink of GCT	R _{th(c-h)}	Double side cooled F _m = 50 ... 60 kN			2.4	K/kW

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

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)	3.45	2.26	0.97	0.10
τ _i (s)	0.6050	0.1010	0.0052	0.0006

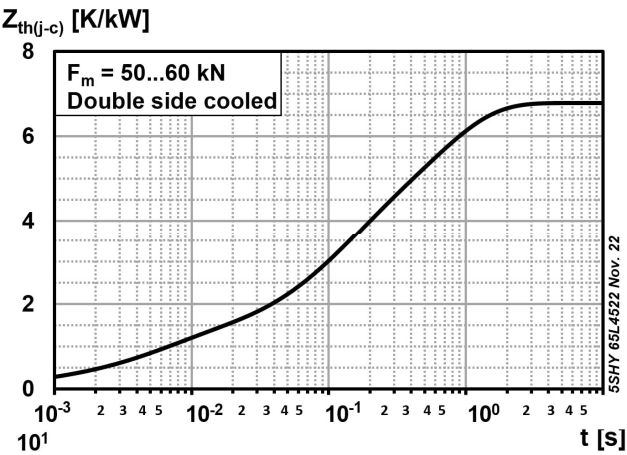


Fig. 1 Transient thermal impedance (junction-to-case) vs. time (max. values)

Max. Turn-off current for Lifetime operation

- calculated lifetime of on-board capacitors 20 years
- with slightly forced air cooling (air velocity > 0.5 m/s)
- strong air cooling allows for increased ambient temperature

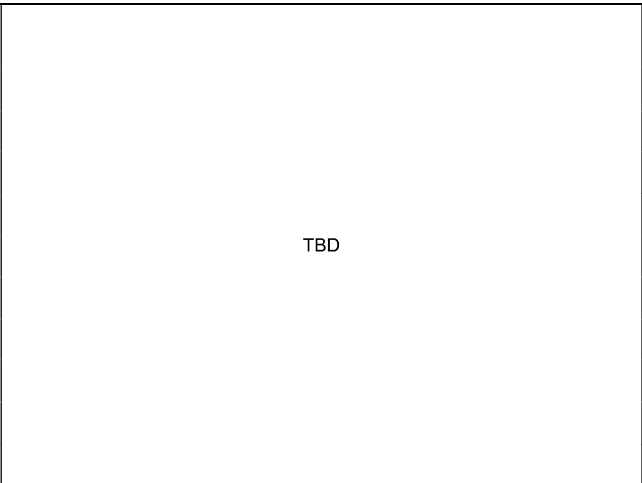


Fig. 2 Max. turn-off current vs. frequency for lifetime operation

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 $I_T = 400 - 30000$ A				
	A ₂₅	B ₂₅	C ₂₅	D ₂₅
Max.	-36.22·10 ⁻³	214.9·10 ⁻⁶	279·10 ⁻³	-5.014·10 ⁻³
Typ.	265·10 ⁻³	192.9·10 ⁻⁶	202.8·10 ⁻³	-1.763·10 ⁻³

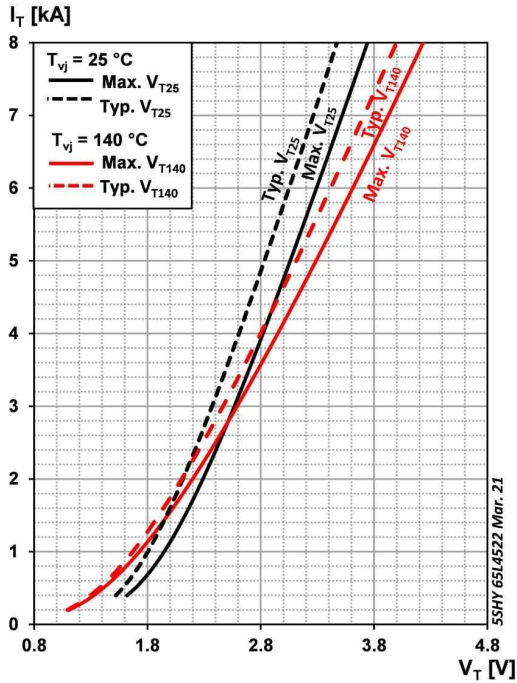


Fig. 3 GCT on-state voltage characteristics

Max. on-state characteristic model:				
$V_{T140} = A_{Tvj} + B_{Tvj} \cdot I_T + C_{Tvj} \cdot \ln(I_T + 1) + D_{Tvj} \cdot \sqrt{I_T}$				
Valid for $I_F = 200 - 40000$ A				
	A ₁₄₀	B ₁₄₀	C ₁₄₀	D ₁₄₀
Max.	36.30·10 ⁻³	230.2·10 ⁻⁶	168.8·10 ⁻³	9.374·10 ⁻³
Typ.	26.56·10 ⁻³	227.3·10 ⁻⁶	175.6·10 ⁻³	6.425·10 ⁻³

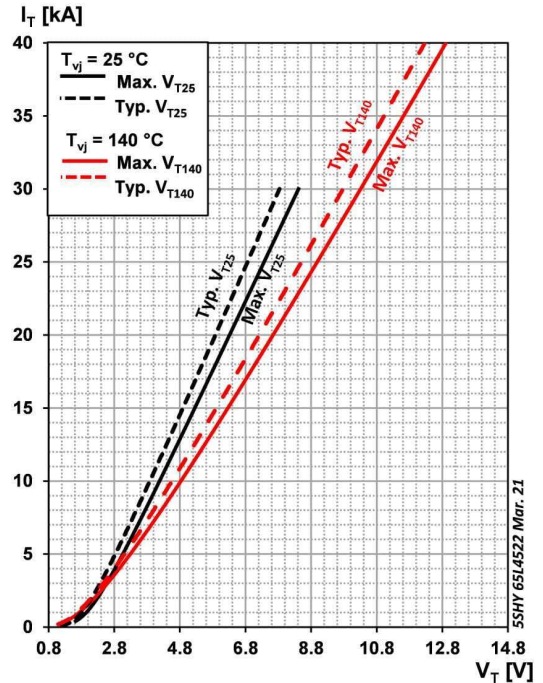


Fig. 4 GCT on-state voltage characteristics

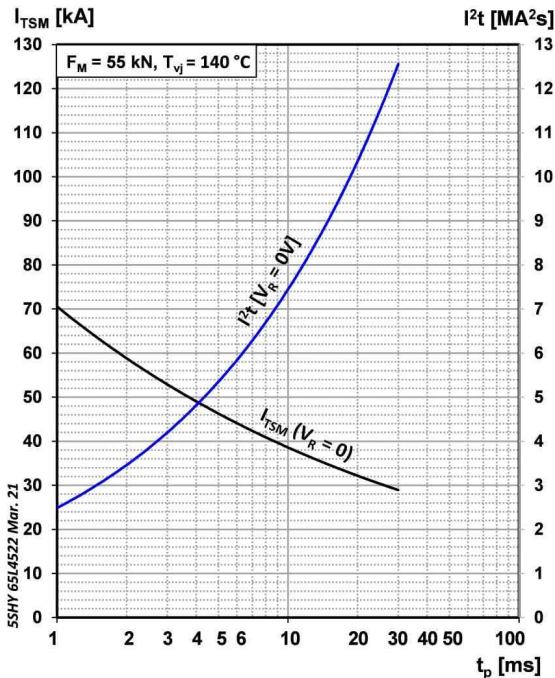


Fig. 5 Surge on-state current vs. pulse length, half-sine wave, no reapplied voltage

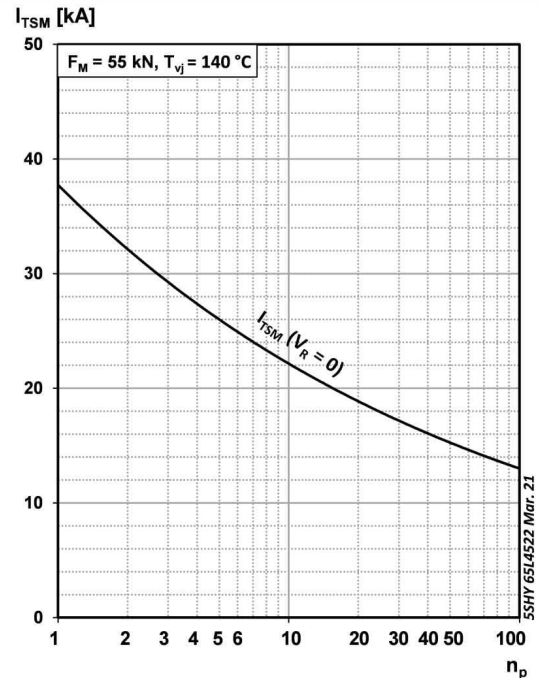


Fig. 6 Surge on-state current vs. number of pulses, half-sine wave, 10 ms, 50Hz, no reapplied voltage

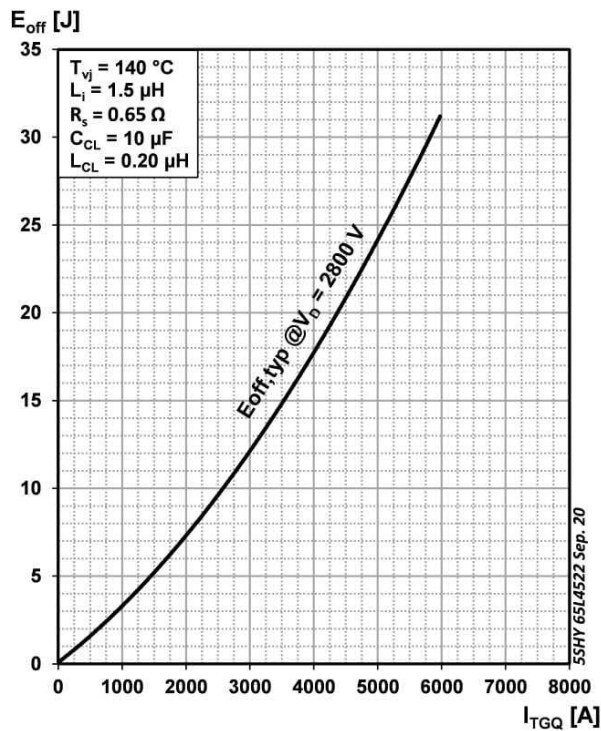


Fig. 7 GCT turn-off energy per pulse vs. turn-off current

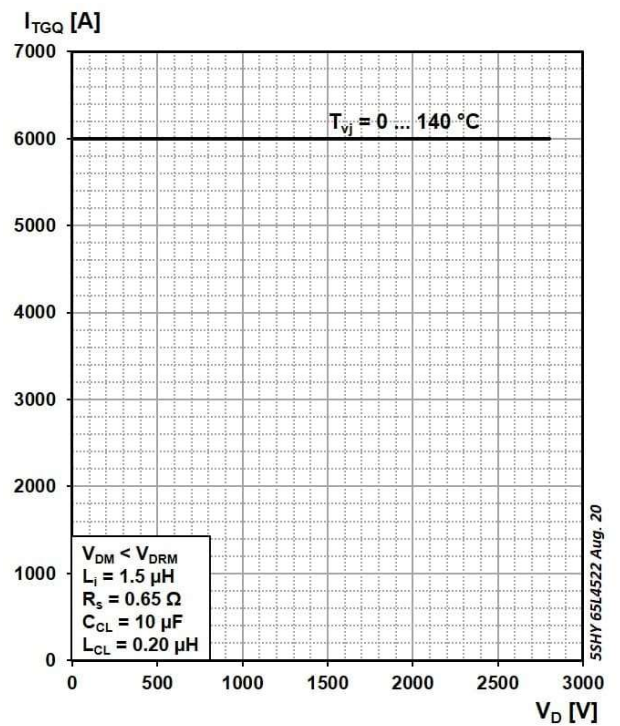


Fig. 8 Safe Operating Area, single pulse

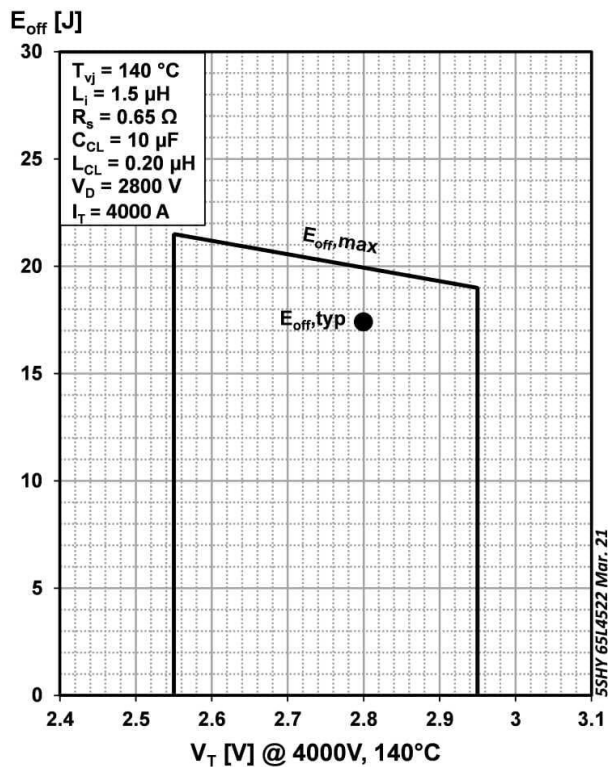


Fig. 9 GCT turn-off energy per pulse vs. on-state voltage

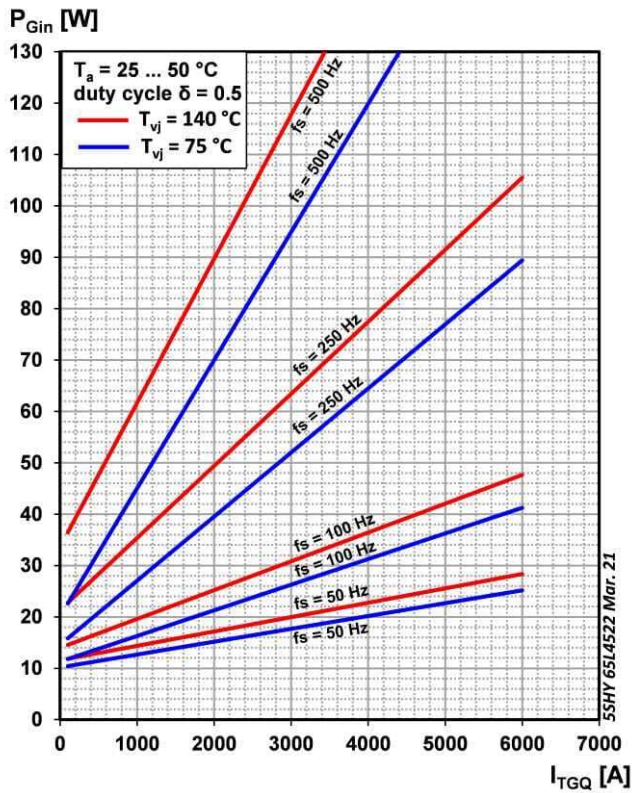


Fig. 10 Typ. Gate Unit input power in chopper mode

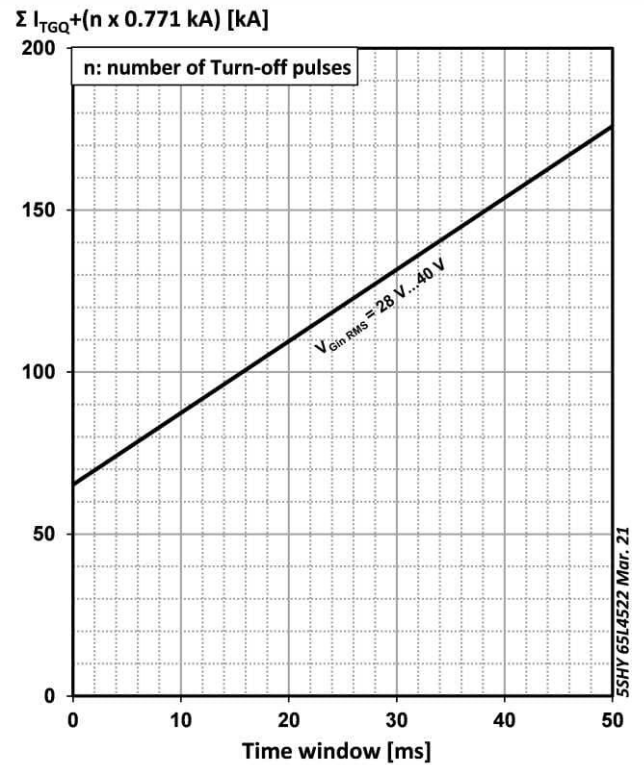


Fig. 11 Burst capability of Gate Unit

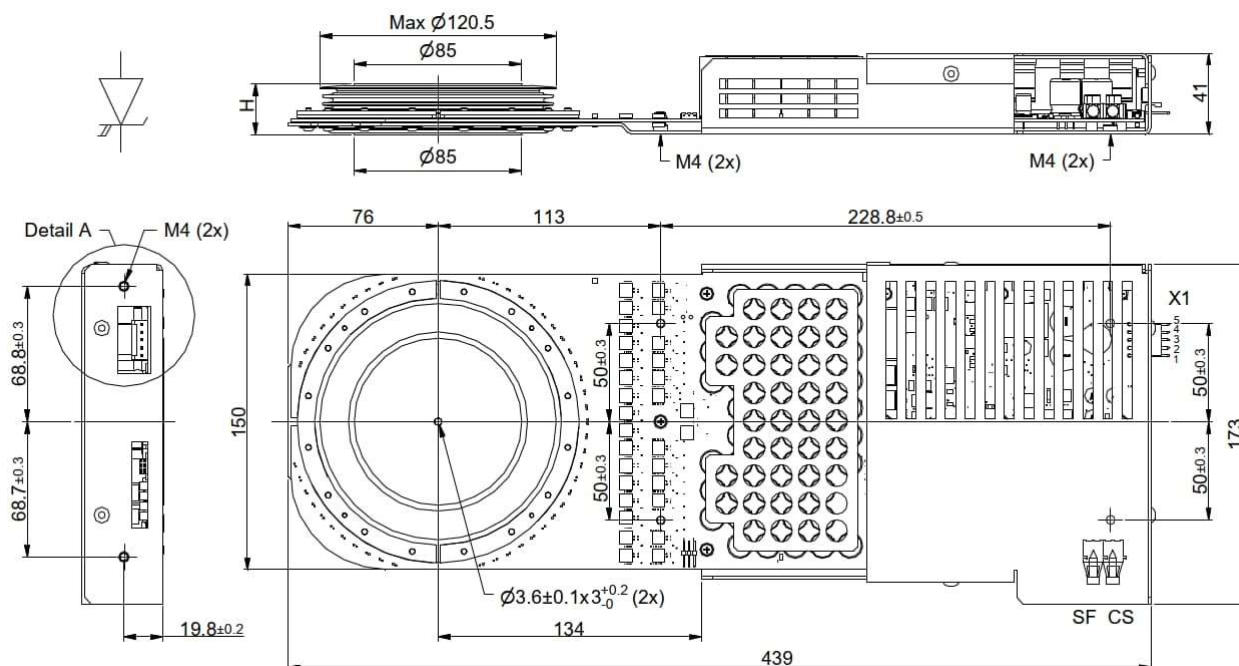


Fig. 12 Outline drawing; all dimensions are in millimeters and represent nominal values unless stated otherwise

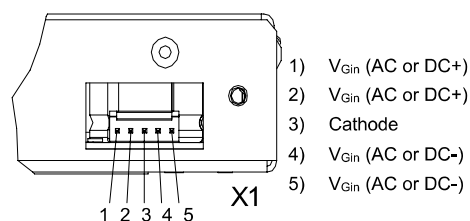


Fig. 13 Detail A: pin out of supply connector X1

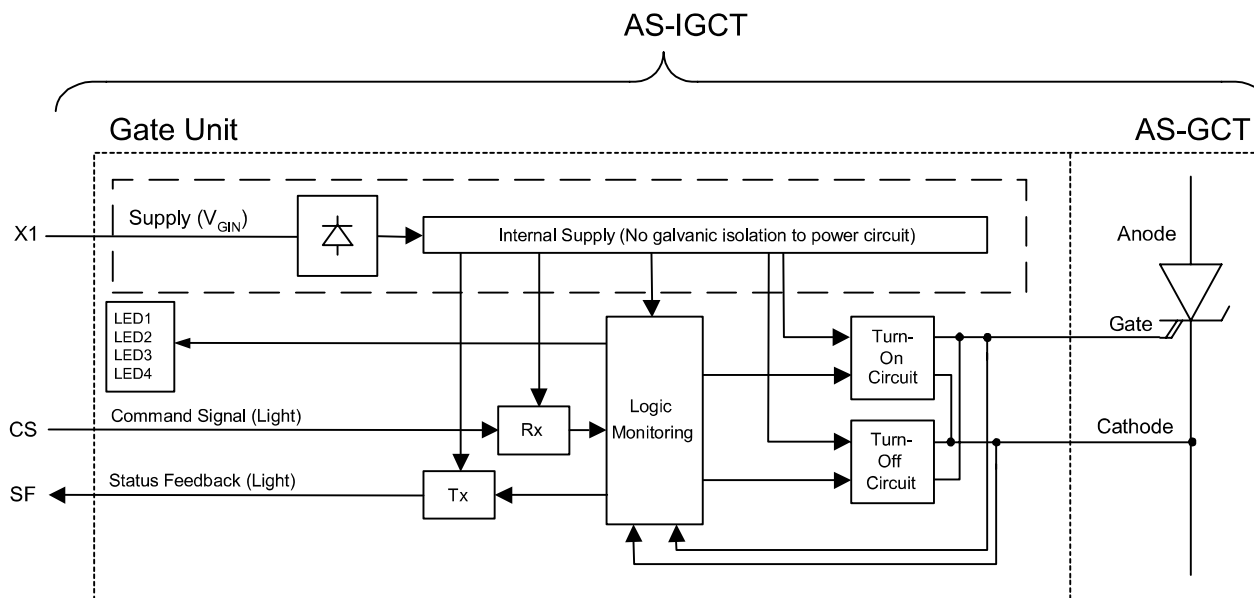


Fig. 14 Block diagram

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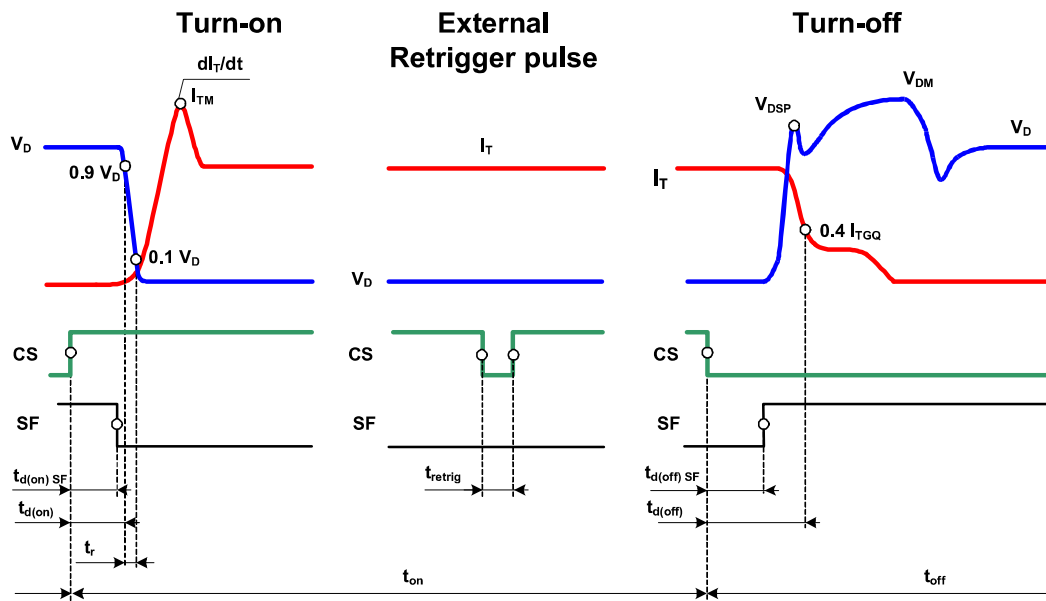


Fig. 15 General current and voltage waveforms with IGCT - specific symbols

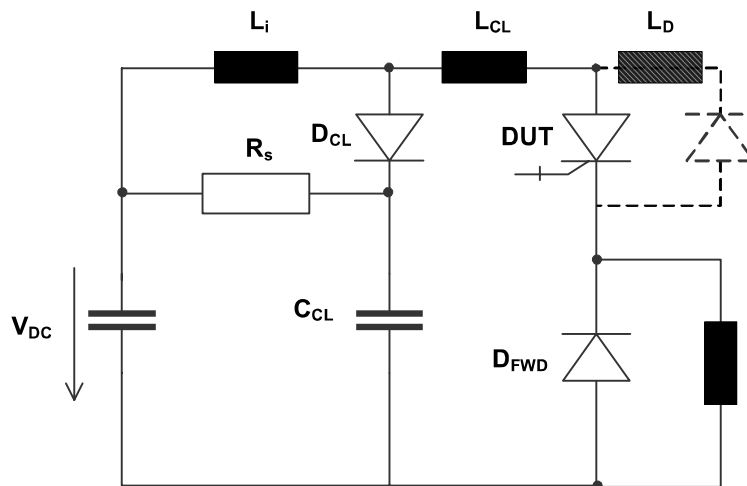


Fig. 16 Test circuit

Related documents:

5SYA 2031	Applying IGCT Gate Units
5SYA 2032	Applying IGCTs
5SYA 2036	Recommendations regarding mechanical clamping of Press Pack High Power Semiconductors
5SYA 2046	Failure rates of IGCTs due to cosmic rays
5SYA 2048	Field measurements on High Power Press Pack Semiconductors
5SYA 2051	Voltage ratings of high power semiconductors
5SZK 9118	General Environmental Conditions for High Power Semiconductors

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