

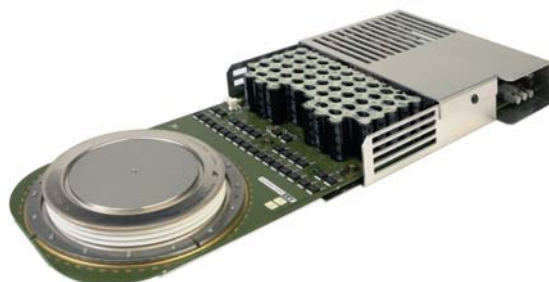
V_{DRM}	=	4500 V
I_{TGQM}	=	3600 A
I_{TSM}	=	28×10^3 A
$V_{(\text{T0})}$	=	1.7 V
r_{T}	=	0.454 mΩ
V_{DC}	=	2800 V

Asymmetric Integrated Gate-Commutated Thyristor

5SHY 40L4511

Doc. No. 5SYA1252-00 March 11

- High snubberless turn-off rating
- Optimized for medium 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

Mechanical data (see Fig. 11, 12)

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Mounting force	F_{m}		36	40	44	kN

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Pole-piece diameter	D_{p}	± 0.1 mm		85		mm
Housing thickness	H		25.3		25.8	mm
Weight	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	l	± 1.0 mm		439		mm
Height	h	± 1.0 mm		41		mm
Width IGCT	w	± 1.0 mm		173		mm

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

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



GCT Data

On-state (see Fig. 3, 4, 5, 6, 14, 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			1430	A
Max. RMS on-state current	$I_{T(RMS)}$				2240	A
Max. peak non-repetitive surge on-state current	I_{TSM}	$t_p = 3\text{ ms}$, $T_j = 125\text{ °C}$, sine wave after surge: $V_D = V_R = 0\text{ V}$			39×10^3	A
Limiting load integral	$I^2 t$				2.4×10^6	A ² s
Max. peak non-repetitive surge on-state current	I_{TSM}	$t_p = 10\text{ ms}$, $T_j = 125\text{ °C}$, sine wave after surge: $V_D = V_R = 0\text{ V}$			28×10^3	A
Limiting load integral	$I^2 t$				3.92×10^6	A ² s
Max. peak non-repetitive surge on-state current	I_{TSM}	$t_p = 30\text{ ms}$, $T_j = 125\text{ °C}$, sine wave after surge: $V_D = V_R = 0\text{ V}$			21×10^3	A
Limiting load integral	$I^2 t$				5.6×10^6	A ² s
Stray inductance between GCT and antiparallel diode	L_D	Only relevant for applications with antiparallel diode to the IGCT			300	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 puls is required.			200	A/μs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
On-state voltage	V_T	$I_T = 3300\text{ A}$, $T_j = 125\text{ °C}$		2.95	3.2	V
Threshold voltage	$V_{(T0)}$	$T_j = 125\text{ °C}$ $I_T = 2000 \dots 3600\text{ A}$			1.7	V
Slope resistance	r_T				0.454	mΩ

Turn-on switching (see Fig. 14, 15)*Maximum rated values* ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Critical rate of rise of on-state current	$di_T/dt_{(cr)}$	$f = 0..500 \text{ Hz}$, $T_j = 0...125 \text{ °C}$, $I_T = 3300 \text{ A}$ $V_D = 2800 \text{ V}$, $I_{TM} \leq 3960 \text{ A}$			1000	A/ μs

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Turn-on delay time	$t_{d(on)}$	$V_D = 2800 \text{ V}$, $T_j = 0...125 \text{ °C}$ $I_T = 3300 \text{ A}$, $di/dt = V_D / L_i$ $L_i = 5 \mu\text{H}$			3.5	μs
Turn-on delay time status feedback	$t_{d(on) \text{ SF}}$	$C_{CL} = 10 \mu\text{F}$, $L_{CL} = 0.3 \mu\text{H}$ $D_{FWD} = D_{CL} = 5\text{SDF } 10\text{H}4503$			7	μs
Rise time	t_r				1	μs
Turn-on energy per pulse	E_{on}				1.5	J

Turn-off switching (see Fig. 2, 7, 8, 10, 14, 15)*Maximum rated values* ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Max. controllable turn-off current	I_{TGQM1}	$V_{DM} \leq V_{DRM}$, $T_j = 0...125 \text{ °C}$, $V_D = 2800 \text{ V}$ $t_{on} > 100 \mu\text{s}$			3600	A
Max. controllable turn-off current	I_{TGQM2}	$R_S = 0.625 \Omega$, $V_D = 2800 \text{ V}$ $C_{CL} = 10 \mu\text{F}$, $40 \mu\text{s} < t_{on} < 100 \mu\text{s}$ $L_{CL} \leq 0.3 \mu\text{H}$, $f = 0..500 \text{ Hz}$ ²⁾ $D_{FWD} = D_{CL} = 5\text{SDF } 10\text{H}4503$			3600	A

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Turn-off delay time	$t_{d(off)}$	$V_D = 2800 \text{ V}$, $T_j = 125 \text{ °C}$			7	μs
Turn-off delay time status feedback	$t_{d(off) \text{ SF}}$	$V_{DM} \leq V_{DRM}$, $R_S = 0.625 \Omega$ $I_{TGQ} = 3300 \text{ A}$, $L_i = 5 \mu\text{H}$ $C_{CL} = 10 \mu\text{F}$, $L_{CL} = 0.3 \mu\text{H}$ $D_{FWD} = D_{CL} = 5\text{SDF } 10\text{H}4503$			7	μs
Turn-off energy per pulse	E_{off}			12	14	J

2) Higher frequency is applicable with reduced max. turn-off conditions (contact factory).

Gate Unit Data

Power supply (see Fig. 2, 9, 10, 12, 13)

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Gate Unit voltage (Connector X1)	$V_{\text{Gin RMS}}$	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	$I_{\text{Gin Min}}$	Rectified average current see application note 5SYA 2031	2			A
Gate Unit power consumption	$P_{\text{Gin Max}}$				130	W

Characteristic values

Parameter	Symbol	Conditions	min	typ	max	Unit
Internal current limitation	$I_{\text{Gin Max}}$	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	$P_{\text{on CS}}$	CS: Command signal SF: Status feedback Valid for 1mm plastic optical fiber (POF)	-15		-1	dBm
Optical noise power	$P_{\text{off CS}}$				-45	dBm
Optical output power	$P_{\text{on SF}}$		-19		-1	dBm
Optical noise power	$P_{\text{off SF}}$				-50	dBm
Pulse width threshold	t_{GLITCH}	Max. pulse width without response			400	ns
External retrigger pulse width	t_{retrig}		700		1100	ns

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

Connectors ²⁾ (see Fig. 11, 12, 13)

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⁾

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

3) AMP, www.amp.com

4) Avago Technologies, www.avagotech.com

Visual feedback (see Fig. 13)

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)

Thermal

Maximum rated values ¹⁾

Parameter	Symbol	Conditions	min	typ	max	Unit
Junction operating temperature	T_{vj}		0		125	°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			8.5	K/kW
Thermal resistance case-to-heatsink of GCT	$R_{th(c-h)}$	Double side cooled			3	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
$R_i(K/kW)$	5.562	1.527	0.868	0.545
$\tau_i(s)$	0.5119	0.0896	0.0091	0.0024

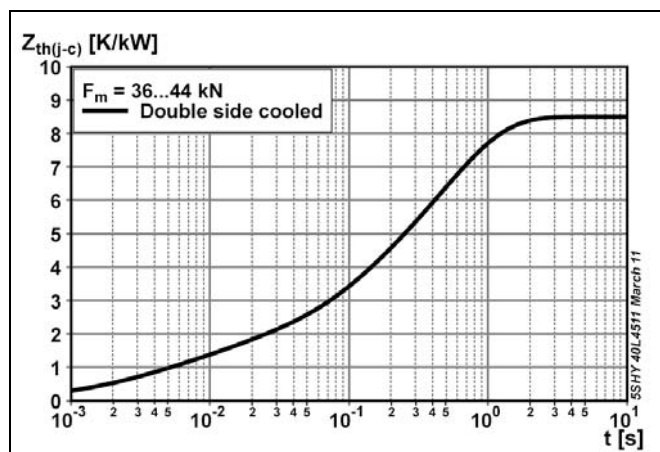


Fig. 1 Transient thermal impedance (junction-to-case) vs. time (max. values)

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

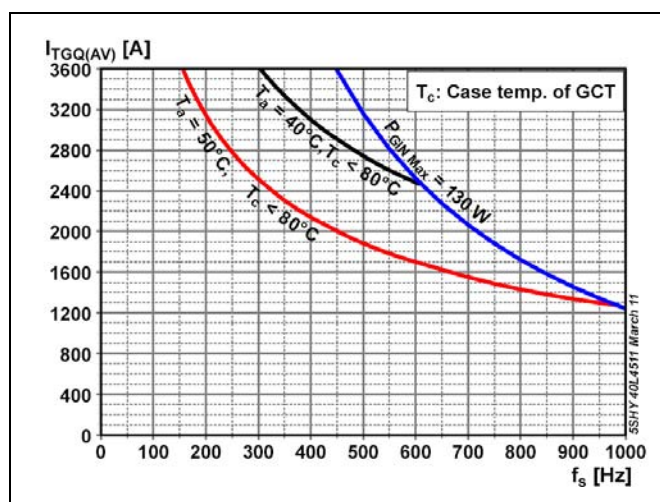


Fig. 2 Max. turn-off current vs. frequency for lifetime operation

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 $I_T = 500 - 20000$ A

A ₂₅	B ₂₅	C ₂₅	D ₂₅

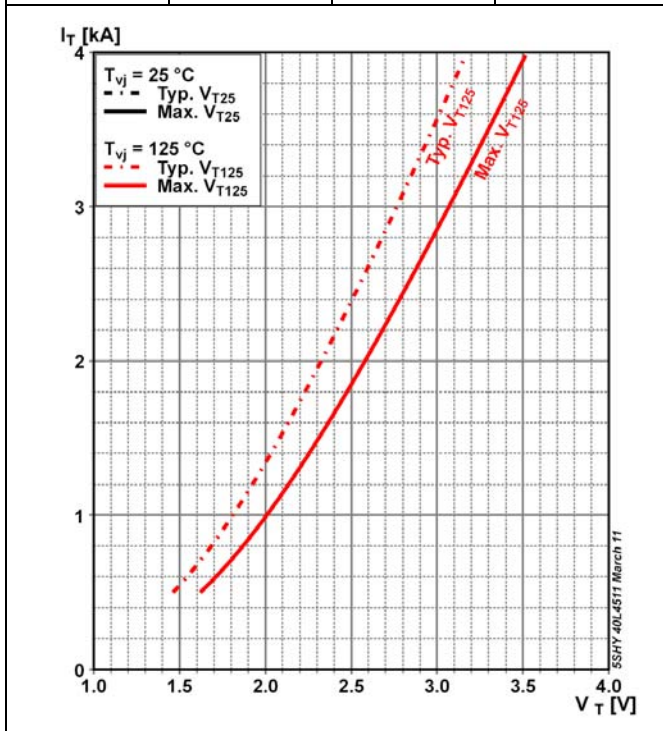


Fig. 3 GCT on-state voltage characteristics

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 $I_T = 500 - 20000$ A

A ₁₂₅	B ₁₂₅	C ₁₂₅	D ₁₂₅
-374.0×10^{-3}	371.0×10^{-6}	291.0×10^{-3}	0.0

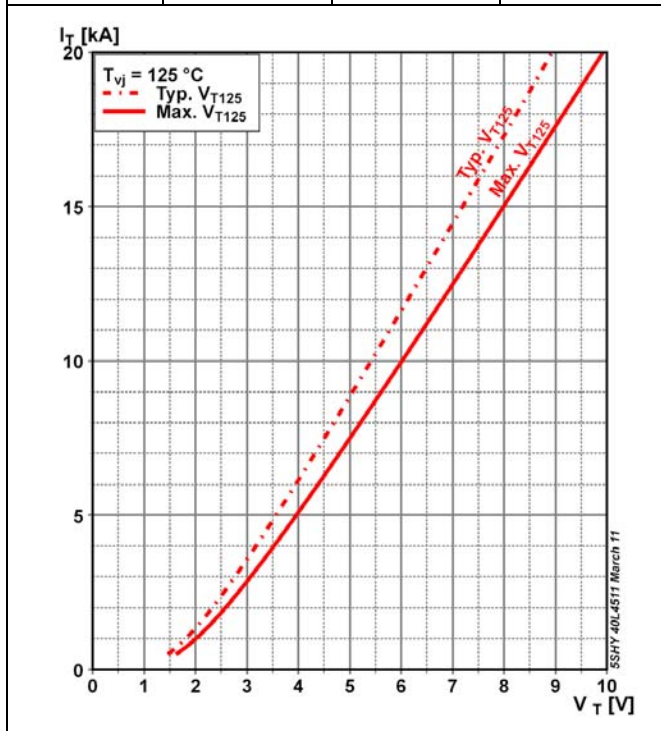


Fig. 4 GCT on-state voltage characteristics

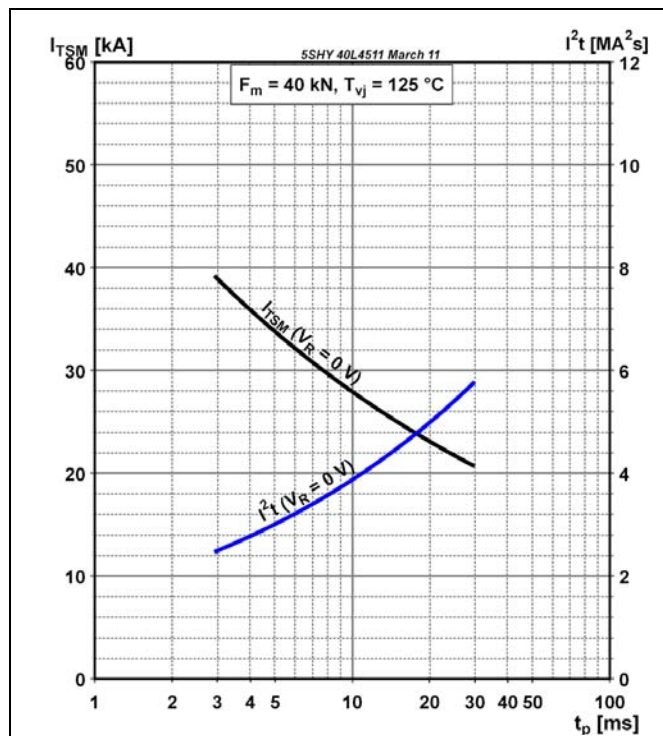


Fig. 5 Surge on-state current vs. pulse length, half-sine wave, no reappplied voltage

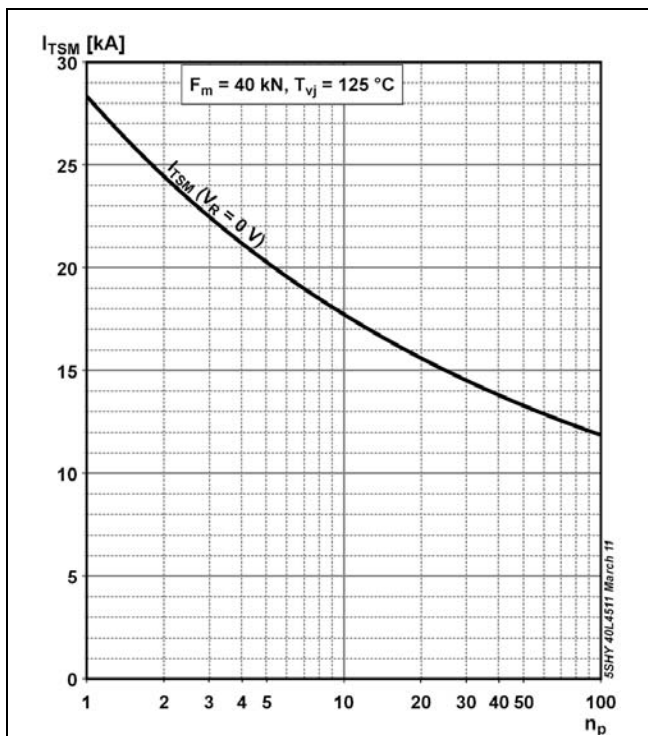


Fig. 6 Surge on-state current vs. number of pulses, half-sine wave, 10 ms, 50Hz, no reappplied voltage

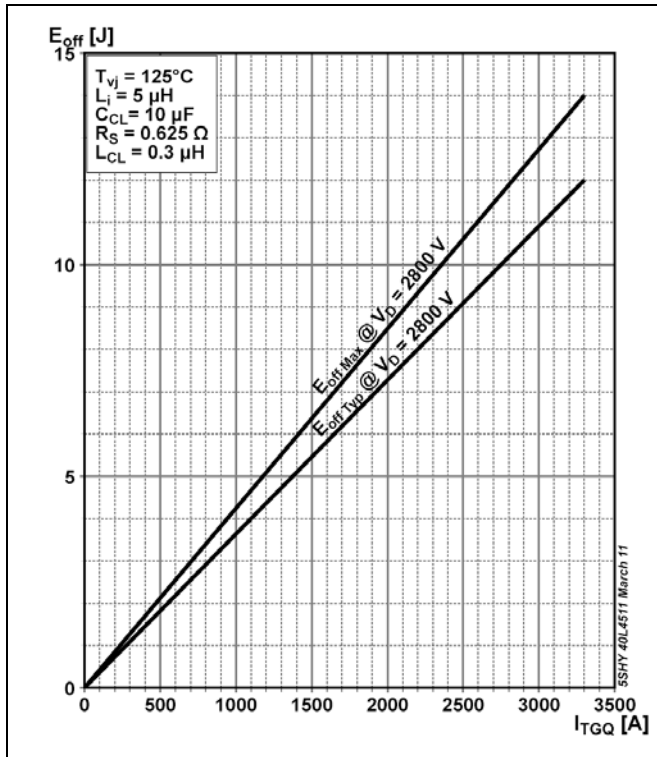


Fig. 7 GCT turn-off energy per pulse vs. turn-off current

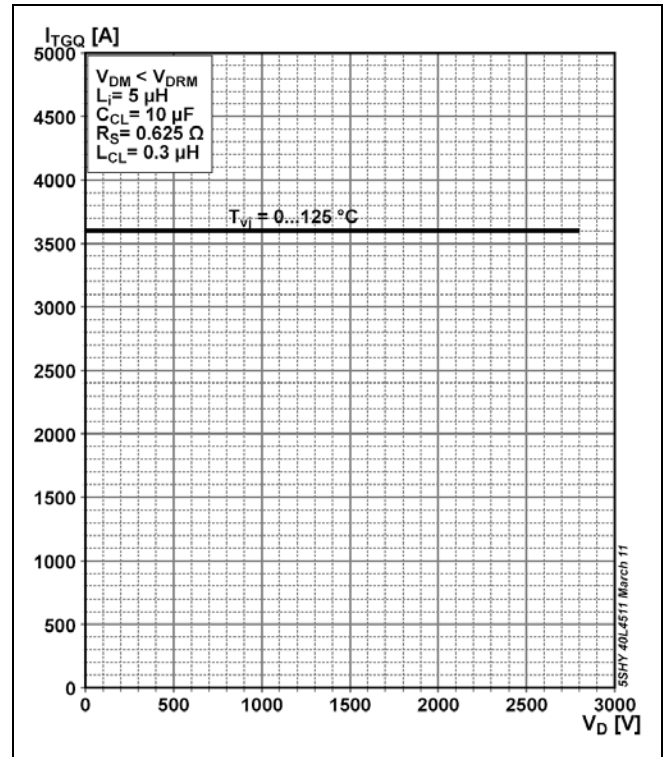


Fig. 8 Safe Operating Area

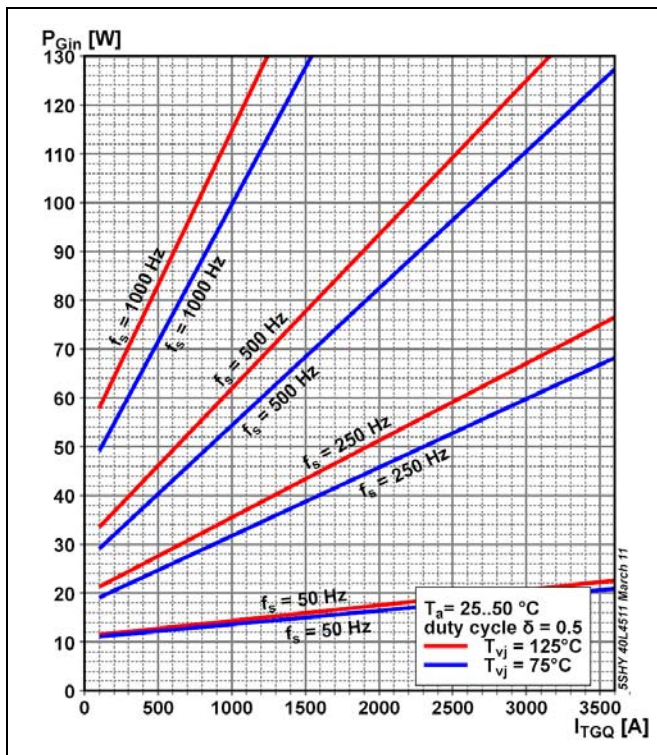


Fig. 9 Max. Gate Unit input power in chopper mode

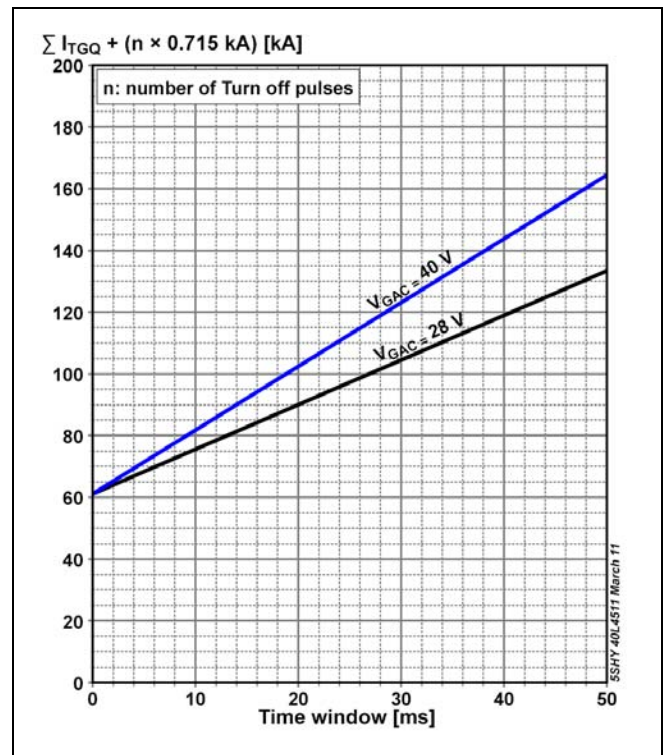


Fig. 10 Burst capability of Gate Unit



- 1) V_{Gin} (AC or DC+)
- 2) V_{Gin} (AC or DC+)
- 3) Cathode
- 4) V_{Gin} (AC or DC-)
- 5) V_{Gin} (AC or DC-)

The diagram illustrates the AS-IGCT system architecture, which is divided into two main functional blocks: the **Gate Unit** and the **AS-GCT**.

Gate Unit:

- Supply (V_{GIN}):** Provides the main power source to the internal supply.
- Internal Supply (No galvanic isolation to power circuit):** A central power distribution block that receives input from the V_{GIN} supply and provides power to various components within the Gate Unit and the AS-GCT.
- Logic Monitoring:** Receives a **Command Signal (Light)** (CS) and provides a **Status Feedback (Light)** (SF) output. It also interfaces with the Turn-On and Turn-Off circuits.
- Turn-On Circuit:** Controls the switching of the AS-GCT.
- Turn-Off Circuit:** Controls the switching of the AS-GCT.
- LEDs (LED1, LED2, LED3, LED4):** A set of light-emitting diodes that provide visual feedback or status indication.
- Tx (Transmitter) and Rx (Receiver):** Communication components for the Command Signal and Status Feedback.

AS-GCT:

- Anode:** The positive terminal of the AS-GCT.
- Gate:** The control terminal of the AS-GCT.
- Cathode:** The negative terminal of the AS-GCT.

The internal supply is connected to the Anode, Gate, and Cathode of the AS-GCT. The Logic Monitoring block is connected to the Gate and Cathode. The Turn-On and Turn-Off circuits are connected to the Gate and Cathode. The internal supply is also connected to the LEDs and the Tx/Rx blocks.

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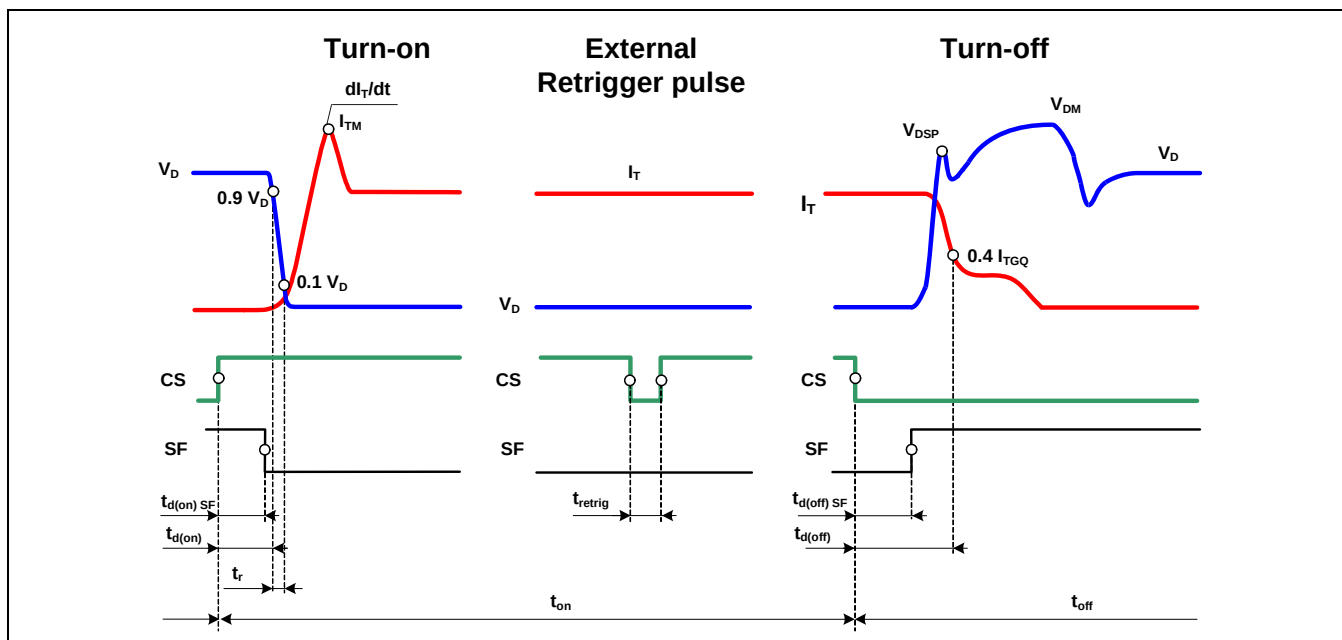


Fig. 14 General current and voltage waveforms with IGCT - specific symbols

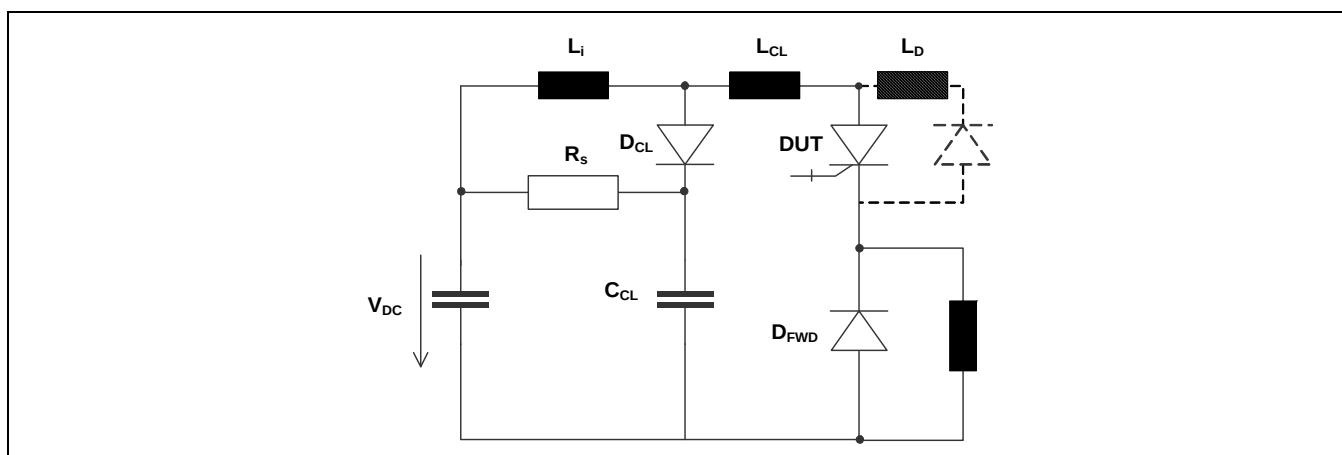


Fig. 15 Test circuit

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 9107	Specification of environmental class for pressure contact IGCTs, OPERATION available on request, please contact factory

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

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