FAST HIGH VOLTAGE THYRISTOR SWITCHES

These solid-state switches are designed for high voltage high peak current switching applications such as shock wave generators, flash lamp drivers, crow bar circuits and surge generators. The switching modules contain a large number of reverse blocking thyristors (SCR) connected in series and in parallel. Each single thyristor is controlled by its own low-impedance gate drive, which allows an extremely large di/dt without reduction of reliability and life expectancy.

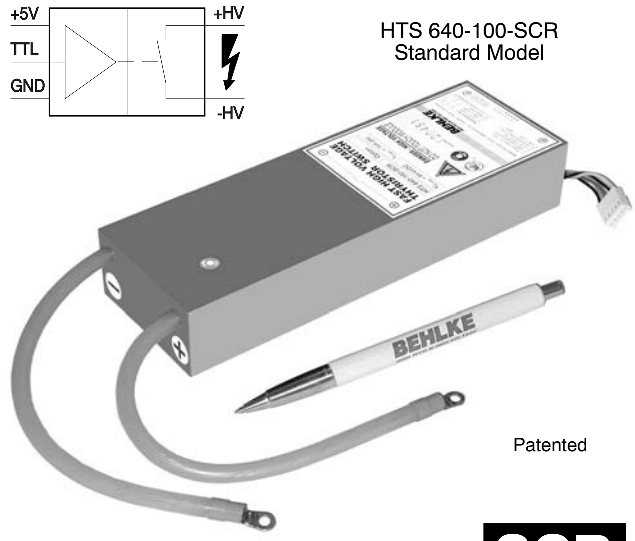
The safe and synchronous control of all SCR's is performed by a patented driver which also provides the high galvanic isolation necessary for high-side circuits and safety-relevant applications.

In contrast to conventional high voltage switches like spark gaps, electron tubes, gas discharge tubes and mechanical switches, thyristor switches of the HTS-SCR series show very low jitter and stable switching characteristics independent of temperature and age. The mean time between failures (MTBF) is by several orders of magnitude higher than that of the classical HV switches.

An interference-proof control circuit provides signal conditioning, auxiliary voltage monitoring, frequency limitation and temperature protection. In case of false operating conditions the switches are immediately inhibited and a fault signal is generated. Three LED's indicate the operating state.

The switches are triggered by a positive going pulse of 3-6 Volts. The switching behaviour will not be influenced by the trigger rise time or the trigger amplitude. After being triggered the switches remain in on-state until the load current drops below the holding current (typical thyristor behaviour). Therefore the turn-off process requires a current commutation, a current limitation or a current bypass. Capacitor discharge applications with charging currents less than the holding current do not require special turn-off measures. In all other cases the switches can be turned off by a slight current reversal, which is given in most pulsed power applications anyway. If the current reversal is higher than 10% and if the periodic duration of the current is shorter than 1 ms, a free-wheeling diode (e.g. Behlke FDA) must be used to avoid hard turn-off, which can damage the switching module under certain circumstances. Please also compare the application note below. For further design recommen-dations please refer to the general instructions for use.

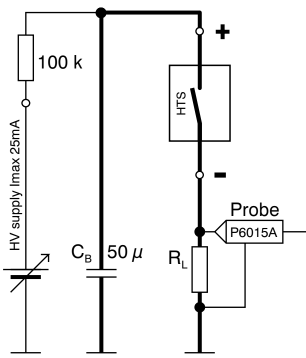
HTS 640-100-SCR 64 kVDC / 1kA pk.
HTS 800-100-SCR 80 kVDC / 1kA pk.



SCR TECHNOLOGY

Compact Design
Extremely High di/dt
High Surge Current Capability

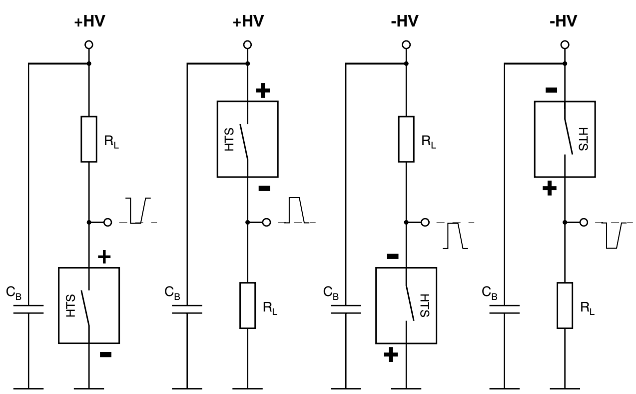
Test Circuit for $t_{r(on)}$



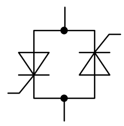
Notes:

1. Total wiring inductance < 50 nH
2. C_B is a MAXWELL low inductance energy storage capacitor (<10 nH)
3. R_L depends on voltage and peak current test conditions. Low induc-tance mass resistors, CESIWID series 900, washer style, 3 inch disc diameter, E_{max}=27600 J /disc.
4. High-voltage probe TEKTRONIX P 6015 A must be connected by the Kelvin method to exclude measurement errors.

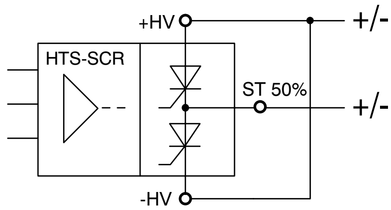
Basic Circuits



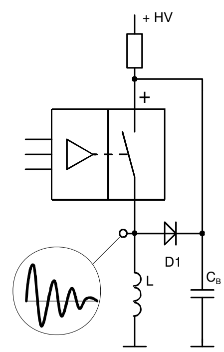
Antiparallel Circuit using Option ST



An antiparallel circuit can simply be realized by use of the stage tapping option ST (50%). The thyristor stack will be electrically divided into two identical switching paths and connected as shown below. The Max. Operating Voltage will consequently be reduced to half the value.



Inductive Load



Note: D1 is a fast recovery diode with kiloamps peak current capability, e.g. Behlke FDA 640-xxx or FDA 800-xxx

TECHNICAL DATA

Specification	Symbol	Condition / Comment		640-100-SCR	800-100-SCR	Unit
Maximum Operating Voltage	$V_{O(max)}$	I_{off} < 250 σADC, T_{case} = 70°C		64	80	kVDC
Minimum Operating Voltage	$V_{O(min)}$	Increased turn-on rise time at low operating voltages		0		kVDC
Typical Breakdown Voltage	V_{br}	I_{off} > 3 mADC, T_{case} = 70 °C		72	88	kVDC
Maximum Off-State Current	I_{off}	0.8x$V_{O,}$ T_{case} =25°C, lower leakage current on request		150		µADC
Galvanic Isolation	V_I	HV side against control side, continuously		70	90	kVDC
Maximum Turn-On Peak Current	$I_{P(max)}$	T_{case}=25°C, half sine single pulse. Please note $P_{d(max)}$ limitations!	t_p <100 µs, duty cycle <1% t_p <500 µs, duty cycle <1% t_p <1 ms, duty cycle <1% t_p <10 ms, duty cycle <1% t_p <100ms, duty cycle <1%	1000 800 650 240 115		ADC
Max. Non-repetitive Peak Current	$I_{P(nr)}$	T_{case}=25°C		Please consult factory		ADC
Max. Continuous Load Current	I_L	T_{case}=25°C	Increased I_L on request	0.7		ADC
Typical Holding Current	I_H		T_{case} = 25°C T_{case} = 70°C	100 70		mADC
Typical On-State Voltage	V_{sat}	T_{case} = 25°C t_p< 10µs, duty cycle <1%	0.001 x $I_{P(max)}$ 0.01 x $I_{P(max)}$ 0.1 x $I_{P(max)}$ 1.0 x $I_{P(max)}$	29 34 86 480	36 42 108 600	VDC
Typical Turn-On Delay Time	$t_{d(on)}$	0.1 $I_{P(max)}$, 0.8 x $V_{O(max)}$ resistive load, 50-50%		200	210	ns
Typical Turn-On Rise Time	$t_{r(on)}$	Resistive load, 10-80 %	0.1 x $V_{O(max)}$, 0.1 x $I_{P(max)}$ 0.8 x $V_{O(max)}$, 0.1 x $I_{P(max)}$ 0.8 x $V_{O(max)}$, 0.5 x $I_{P(max)}$ 0.8 x $V_{O(max)}$, 1.0 x $I_{P(max)}$	880 130 220 270	900 150 240 310	ns
Typical Turn-Off Time	t_{off}, t_q	Inductive load with free-wheeling diode	0.1 x $I_{P(max)}$ 1.0 x $I_{P(max)}$	40 100		µs
Critical Rate-of-Rise of Off-State Voltage	dv/dt	@ $V_{O(max)}$, exponential waveform		96	120	kV/µs
Maximum On-Time	$t_{on(max)}$	Please note $P_{d(max)}$ limitations!		Infinitely if I_L > I_H		
Typical Turn-On Jitter	$t_{j(on)}$	V_{aux} / V_{tr} = 5.00 VDC		1		ns
Max. Switching Frequency	$f_{(max)}$	Please note $P_{d(max)}$ limitations!		6	5	kHz
Maximum Burst Frequency	$f_{b(max)}$	HFB option required, @ 0.1 x $I_{P(max)}$		20		kHz
Max. Continuous Power Dissipation	$P_{d(max)}$	T_{case} = 25°C, increased $P_{d(max)}$ on request. Power losses are determined by P_d ʒ V_{sat} x I_L x duty factor		20	24	Watts
Linear Derating		Above 25°C		0.444	0.533	W/K
Operating Temperature Range	T_O	Extended temperature range on request		-40...70		°C
Storage Temperature Range	T_S			-50...90		°C
Coupling Capacitance	C_C	HV side against control side		30	35	pF
Auxiliary Supply Voltage	V_{aux}	Stabilized to ∂ 5% (∂ 1% recommended for low jitter)		5.00 (∂ 5%)		VDC
Auxiliary Supply Current	I_{aux}	@ $f_{(max),}$ current limitation to < 1A is recommended		600		mADC
Trigger Pulse Voltage Range	V_{tr}	Trigger signals above 5 VDC are clamped internally		3-6		VDC
Minimum Trigger Pulse Width		Trigger pulse has no influence on switching behaviour		> 50		ns
Fault Signal Output Voltage		Output goes low if V_{aux} < 4.75 VDC, if T_O > 75°C or if $f_{(max)}$ or $f_{b(max)}$ is exceeded substiantally		Low: < 0.5 VDC High: > 4 VDC		
Fault Signal Output Load		Sink / source current. Output is short circuit proof.		10		mADC
LED Indicators		Green: Power / Ready Yellow: Flashes when triggered successfully Red: Indicates the above mentioned fault conditions				
Typ. Insulation Strength of Housing	V_{Ins}	**Caution:** Keep appropriate distance between module housing and all conductive elements of the set-up!		20		kVDC
Dimensions		Standard case, other housing dimensions on request		206x70x35	250x70x35	mm^3
Weight		Standard case, reduced weight on request		880	1020	g

Ordering Information

HTS 640-100-SCR	Thyristor switch, 64 kVDC, 1000 A (pk)	**Option LP**	Low pass at trigger input
HTS 800-100-SCR	Thyristor switch, 80 kVDC, 1000 A (pk)	**Option ST**	Stage tapping (pls. indicate the tapping position in %)
Option HFB	High frequency burst	**Option UL94-V0**	Flame retardend casting resin UL94-V0

All data and specifications subject to change without notice. Custom designed devices on request.