

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) with a special chip architecture for high surge conditions. Several hundred of these SCR's, each with its own low-impedance gate drive, are connected in series and in parallel to ensure the extreme di/dt of up to 32 kA/ μ s. The safe and synchronous control of all SCR's is performed by a patented driver which provides also 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 series HTS-SCR 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.

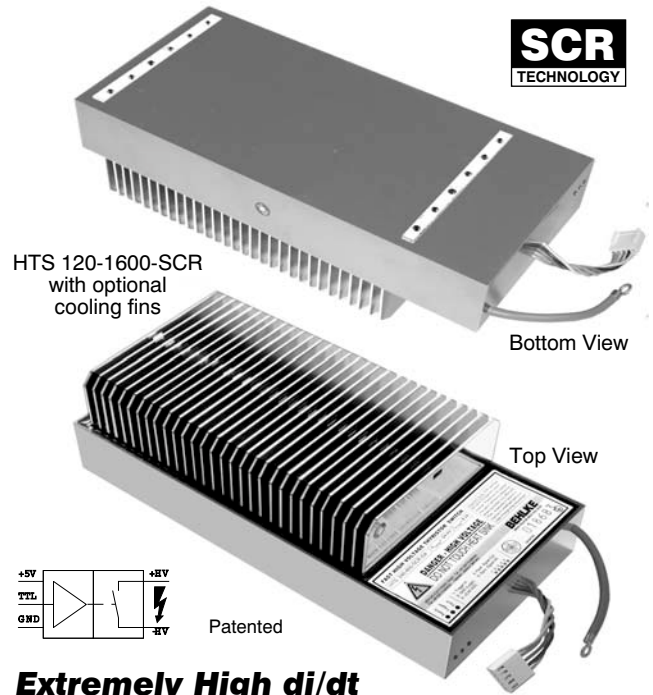
An interference-proof control circuit provides signal conditioning, auxiliary voltage monitoring, frequency limitation and temperature protection. In case of false operating conditions the switches are immediately inhibited and a fault signal is generated. Three LED's indicate the operating state. A special synchronization input/output (Sync.) allows a simple parallel connection of up to 50 switching modules to multiply the turn-on peak current capability.

The switches are triggered by a positive going pulse of 3-10 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). The turn-off process requires insofar 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 the 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 compare also the application note below.

The plastic case is the cost-effective standard package in low frequency applications with low average power. For higher load the Maximum Continuous Power Dissipation $P_{d(max)}$ can be increased by optional cooling fins which are available in different sizes for a $P_{d(max)}$ of up to 1.5 kW in air (forced convection >4m/s) and approximately up to 15 kW in liquids. For further design recommendations please refer to the general instructions.

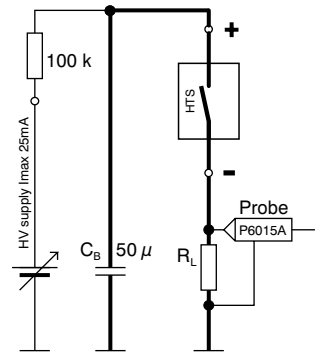
HTS 120-1600-SCR 12000 V / 16000 A
HTS 160-1600-SCR 16000 V / 16000 A

SCR
TECHNOLOGY



Extremely High di/dt
High Surge Current Capability

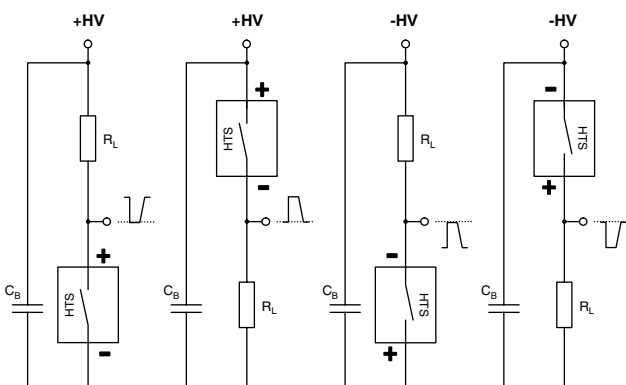
Test Circuit for $t_{tr(on)}$



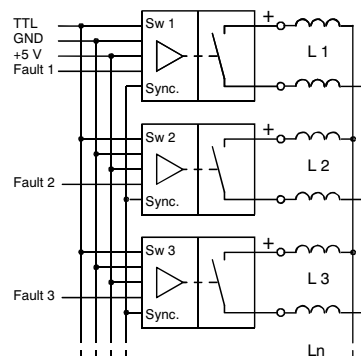
Notes:

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 inductance 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

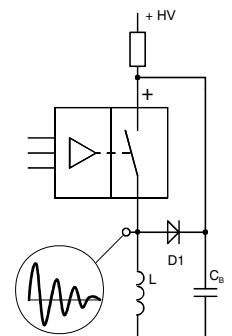


Parallel Connection



Note: Symmetrical layout is recommended for good dynamic current sharing (Wiring inductance L_1 to L_n should be equal).

Inductive Load



Note: D1 is a fast recovery diode with Kiloamps peak current capability (E.g. Behlke Series FDA)

HVP

High Voltage Products. High Voltage Experts.

BEHLKE

TECHNICAL DATA

Specification	Symb.	Condition / Comment	120-1600-SCR	160-1600-SCR	Unit
Maximum Operating Voltage	$V_{O(max)}$	$I_{off} < 600 \sigma ADC$, $T_{case} = 70^\circ C$	12000	16000	VDC
Minimum Operating Voltage	$V_{O(min)}$		0		VDC
Typical Breakdown Voltage	V_{br}	$I_{off} > 3 \text{ mADC}$, $T_{case} = 70^\circ C$	13200	17600	VDC
Maximum Off-State Current	I_{off}	$0.8 \times V_O$, $T_{case} = 25^\circ C$	100		μADC
Galvanic Isolation	V_I	HV side against control side, continuously	40000	40000	VDC
Maximum Turn-On Peak Current	$I_{P(max)}$	$T_{case} / T_{fin} = 25^\circ C$, half sine. Pls.consult factory for higher temperatures and other waveshapes.	$t_p < 100 \mu s$, duty cycle <1% $t_p < 500 \mu s$, duty cycle <1% $t_p < 1 \text{ ms}$, duty cycle <1% $t_p < 10 \text{ ms}$, duty cycle <1%	16000 8000 5440 3200	ADC
Max. Non-repetitive Peak Current	$I_{P(nr)}$	$T_{case} / T_{fin} = 25^\circ C$	Half sine single pulse, $t_p < 200 \mu s$ Half sine single pulse, $t_p < 20 \mu s$	32000 64000	ADC
Max. Continuous Load Current	I_L	$T_{case} / T_{fin} = 25^\circ C$	Standard plastic case Opt. 04, cooling fins (air >4m/s)	5.76 56	ADC
Typical Holding Current			$T_{case} / T_{fin} = 25^\circ C$ $T_{case} / T_{fin} = 70^\circ C$	100 70	mADC
Typical On-State Voltage	V_{sat}	$T_{case} / T_{fin} = 25^\circ C$ $t_p < 10 \mu s$, duty cycle <1%	$0.001 \times I_{P(max)}$ $0.01 \times I_{P(max)}$ $0.1 \times I_{P(max)}$ $1.0 \times I_{P(max)}$	13 14 23 60	17 19 30 80 VDC
Typical Turn-On Delay Time	$t_{d(on)}$	$0.1 I_{P(max)}$, $0.8 \times V_{O(max)}$ resistive load, 50-50%	450	470	ns
Typical Turn-On Rise Time	$t_{r(on)}$	Resistive load, 10-80 %	$0.1 \times V_{O(max)}$, $0.1 \times I_{P(max)}$ $0.8 \times V_{O(max)}$, $0.1 \times I_{P(max)}$ $0.8 \times V_{O(max)}$, $1.0 \times I_{P(max)}$	550 170 450	550 170 490 ns
Typical Turn-Off Time	t_{off} , t_q	$T_{case} / T_{fin} = 25^\circ C$, inductive load / free wheeling diode	$0.01 \times I_{P(max)}$ $0.1 \times I_{P(max)}$ $1.0 \times I_{P(max)}$	10 35 90	μs
Critical Rate-of-Rise of Off-State Voltage	dv/dt	@ $V_{O(max)}$, exponential waveform	75	100	kV/ μs
Maximum On-Time	$t_{on(max)}$	Depends on holding current only. See product description.	unlimited		
Internal Driver Recovery Time	t_{rc}	Standard devices With option 01	1000 100		μs
Typical Turn-On Jitter	$t_{j(on)}$	$V_{aux} / V_{tr} = 5.0 \text{ VDC}$	1		ns
Max. Cont. Switching Frequency	$f_{(max)}$	Please note $P_{d(max)}$ limitations, increased $f_{(max)}$ on request	500	350	Hz
Maximum Burst Frequency (Triggered)	$f_{b(max)}$	With option 01, $I_{P(max)} < 16 \text{ kA}$, please consult factory With option 01, $I_{P(max)} < 1 \text{ kA}$, please consult factory)		1 10	kHz
Maximum Continuous Power Dissipation	$P_{d(max)}$	$T_{case} = 25^\circ C$ $T_{fin} = 25^\circ C$	Standard plastic case Option 04, cooling fins (air stream >4m/s)	52 450	65 600 Watts
Linear Derating		Above $25^\circ C$ T_{case} / T_{fin}	Standard plastic case Option 04, cooling fins (air stream > 4m/s)	0.866 10	1.083 13.33 W/K
Temperature Range	T_O	Standard plastic case		-40...85	$^\circ C$
Coupling Capacitance	C_C	HV side against control side	210	290	pF
Auxiliary Supply Voltage	V_{aux}	Stabilized to $\pm 5\%$	5.0 ($\pm 5\%$)		VDC
Auxiliary Supply Current	I_{aux}	@ $f_{(max)}$	600		mADC
Trigger Voltage Range	V_{tr}	Switching behaviour cannot be influenced by trigger quality	3-10		VDC
Fault Signal Output		Short circuit proof, source/sink current max.10mADC. See product description.	Ready = High Fault = Low	>4.0 <0.8	VDC
Synchronization Input/Output		Short circuit proof, output pulse 4 VDC / 1ms	-		-
Operating Mode Indication		By LED's: Green=Ready, Yellow=Trigger, Red=Failure	-		-
High Voltage Connection		Low inductance screw terminals for printed circuit boards	-		-
Dimensions		Standard plastic case, reduced size on request. With option 04 (Please consult factory for detailed drawings)	204x103x31 204x103x66	253x103x31 253x103x66	mm ³
Weight		Standard plastic case, reduced weight on request. With option 04.	1950 2590	2400 3250	g

Ordering Informations

HTS 120-1600-SCR Thyristor switch, 12 kVDC, 16 kA(pk)

HTS 320-800-SCR Thyristor switch, 16 kVDC, 8 kA (pk)

Option 01 High frequency burst

Option 02 Flame retardend casting resin UL 94-V0

Option 03 Increased thermal conductivity (plastic case only)

Option 04 Cooling fins (Fins are on high voltage potential!)

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

160-1600-SCR-06.99