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 upto 24 kA/µs. The safe and synchronous control of all SCR's is performed by a special driver circuit which also provides the high galvanic isolation necessary for high-side circuits and safety-relevant applications (e.g. medical equipment).

In contrast to conventional high voltage switches like spark gaps, electron tubes, gas discharge tubes and mechanical switches, thyristor switches of series SCR and SCR/DT show very 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 3-10 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). he turn-off process requires insofar a current commutation, a current limitation or a current bypass.

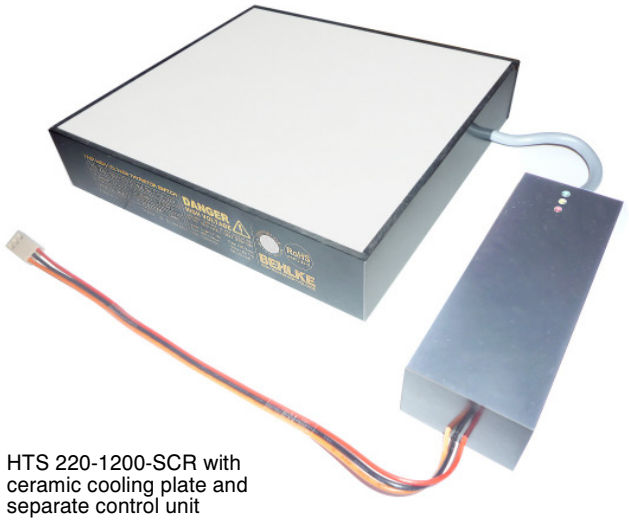
Capacitor discharge applications with charging currents less than the holding current do not require special turn-off measures. In all other cases, the switches can be anyway. turned off by a slight current reversal, which is nevertheless given in most pulsed power applications.

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 loads, there are additional cooling options such as ceramic cooling surface, non-isolated cooling fins, grounded cooling flange or direct liquid cooling, either for conductive and non-conductive liquids. With these options the Max. Continuous Power Dissipation Pd(max) can be increased from 50 to 30.000 Watts.

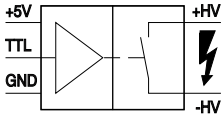
For further design recommendations please refer to the general instructions.

HTS 220-1200-SCR 22kV/12kA



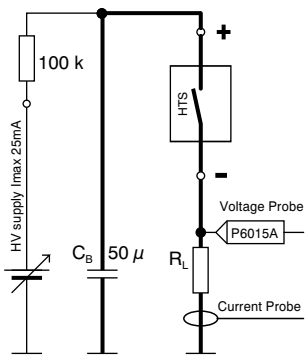
HTS 220-1200-SCR with ceramic cooling plate and separate control unit

SCR TECHNOLOGY



Compact Design
Extremely High di/dt
High Surge Current Capability

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

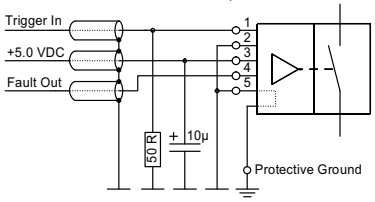


Notes:

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 inductance mass resistors, CESIWID series 900, washer style, 3 inch disc diameter, E_{max}=27600 J /disc.
4. Voltage probe: Tektronix P6015A
   Current probe: Pearson 4997
   Oscilloscope: Tektronix TDS684C

Control Connection

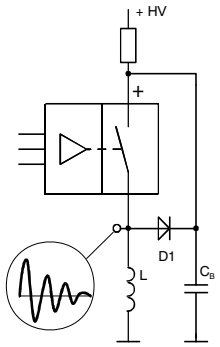
- Use shielded cables or apply optical decoupling at trigger input
- Input should be terminated properly if connected via coaxial line
- Never mix control wiring and load circuit wiring. Heavy magnetic fields of the load circuit can cause dangerous overvoltage spikes on the input wiring. Malefunction or even irrepairable damage of the control circuit could be the consequence.



Standard Plug
1 - Trigger Input (3-10 V)
2 - GND (Logic Ground)
3 - +5.00 VDC (600 mADC)
4 - Fault Signal Output (TTL)
5 - GND (Logic Ground)

Option SPT-C (Lemo Plug)
1 - Trigger Input (3-10 V)
2 - GND (Logic Ground)
3 - +5.00 VDC (600 mADC)
4 - Fault Signal Output (TTL)
Shielding - GND

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
HIGH-TECH IN HIGH VOLTAGE

Technical data for HTS 220-1200-SCR, with modification F-0-237

	Specification	Symbol	Condition / Comment		HTS 220-1200-SCR / F-0-237	Unit
ABSOLUTE MAXIMUM RATINGS	Maximum Operating Voltage	$V_{O(max)}$	I_{off} < 300 µADC, T_{case} = 70°C		22000	VDC
	Maximum Isolation Voltage	V_I	Galvanic isolation between HV switch and control input / GND		50000	VDC
	Maximum Housing Insulation Voltage	V_{INS}	Insulation between internal switch and housing surface, 3 minutes		25000	VDC
	Maximum Turn-On Peak Current	$I_{P(max)}$	T_{case} = 25°C, half sine. Please consult factory for further data.	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%	12000 6000 4080 2400	ADC
	Max. Non-Repetitive Peak Current	$I_{P(nr)}$	T_{case} = 25°C, switch only	Half sine single pulse, tp<200µs Half sine single pulse, tp< 20µs	24000 48000	ADC
	Maximum Continuous Load Current	I_L	T_{case} = 25°C		3.26	ADC
	Max. Rate-of-Rise of Off-State Voltage	dv/dt	@ $V_{O(max)}$, exponential waveform		150	kV/µs
	Max. Continuous Power Dissipation	$P_{d(max)}$	Air cooling, 25°C ambient temperature, air stream > 4 m / s		75	Watts
	Linear Derating		Above 25°C ambient temperature		1.5	W/K
	Operating Temperature Range	T_O			-40...75	°C
	Storage Temperature Range	T_S			-40...100	°C
	Maximum Auxiliary Supply Voltage	$V_{aux(max)}$			5.25	VDC
ELECTRICAL CHARACTERISTICS	Permissible Operating Voltage Range	V_O			0 - 22000	VDC
	Typical Breakdown Voltage	V_{br}	**CAUTION:** V_{br} is a test parameter for quality control purposes and not applicable in normal operation. Breakdown tests require special		>26000	VDC
	Typical Off-State Current	I_{off}	0.8 x V_O, T_{case} = 25°C		< 400	µADC
	Typical On-State Voltage	V_{sat}	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 $I_{P(max)}$	23 27 43 115	VDC
	Typical Holding Current			T_{case} = 70°C	35	mADC
	Typical Turn-On Delay Time	$t_{d(on)}$	0.1 $I_{P(max)}$, 0.8 x $V_{O(max)}$, resistive load, 50-50%	Standard	0.4	µs
	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 $V_{O(max)}$, 1.0 x $I_{P(max)}$	550 170 500	ns
	Typical Turn-Off Time	t_{off}, t_q	T_{case} = 25°C, With internal free- wheeling diode and 5 µH inductive load	0.01x $I_{P(max)}$ 0.1 x $I_{P(max)}$ 1.0 x $I_{P(max)}$	10 35 90	µs
	Maximum On-Time	$t_{on(max)}$	Depends on holding current only. See product description		unlimited	
	Internal Driver Recovery Time	t_{rc}			1000	µs
	Typical Turn-On Jitter	$t_{j(on)}$	V_{aux} / V_{tr} = 5.00 VDC	Standard	1	ns
	Max. Continuous Switching Frequency	$f_{(max)}$	Please note $P_{d(max)}$ limitations, increased $f_{(max)}$ on request		400	Hz
	Maximum Burst Frequency	$f_{b(max)}$	With option HFB, $I_{P(max)}$ < 16 kA, please consult factory With option HFB, $I_{P(max)}$ < 3 kA, please consult factory		1 10	kHz
	Coupling Capacitance	C_C	HV side against control side		320	pF
	Auxiliary Supply Voltage Range	V_{aux}	5.00 VDC ± 2% recommended, safety turn-off below 4.70 VDC		4.75 - 5.25 VDC	VDC
	Auxiliary Supply Current	aux	T_{case} = 25°C	@ < 10 Hz trigger frequ. @ $f_{(max)}$	350 600	mADC
	Trigger Voltage Range	V_{tr}	Switching behaviour is not influenced by trigger quality		3-10	VDC
GENERAL	HV Switch Dimensions				160 x 150 x 32	mm^3
	Control Unit Dimensions				102 x 36 x 26	mm^3
	Total Weight		Including control unit		1600	g
	LED Operating Mode Indication	Green LED: Power good, switch ready for operation Yellow LED: Switch successful triggered / thyristors successful fired Red LED: Fault: Switch temperature over 75°C / trigger frequency over limit / V_{aux} below 4.70 VDC				
	High Voltage Connection	Low inductance terminals for printed circuit boards				
	Control Connection	Pigtail with 5 pole MOLEX plug				
	Cooling	Natural or forced air convection.				

All data and specifications subject to change without notice.