

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 16 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.

The switching modules described here are specially designed for civilian purposes and do not fall under 3A228c of the BIS Commerce Control List (Germany: 3A228c of BAFA Ausfuhrliste). Please note in this connection: SCR products marked with "SCR/DT" or option "DT-.." show turn-on delay times of at least 1 μ s and have a significant time jitter. Synchronization I/O's are not available for those products.

In contrast to conventional high voltage switches like spark gaps, electron tubes, gas discharge tubes and mechanical switches, thyristor switches of the 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). 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 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 loads there are additional cooling options such as ceramic cooling surface, non-isolated cooling fins, grounded cooling flange or direct liquid cooling. With these options the Maximum Continuous Power Dissipation $P_{d(max)}$ can be increased from 50 to 30.000 Watts. For further design recommendations please refer to the general instructions.

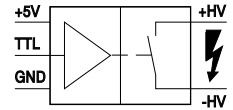
HTS 240-1000-SCR/DT 24 kV / 10 kA
HTS 220-1000-SCR/DT 22 kV / 10 kA

HTS 220-1000-SCR
 with ceramic
 cooling surface
 (Opt. CCS)

SCR
 TECHNOLOGY

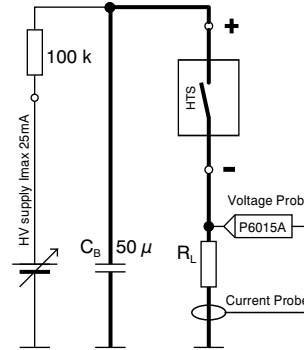


Patented



Extremely High di/dt
High Surge Current Capability

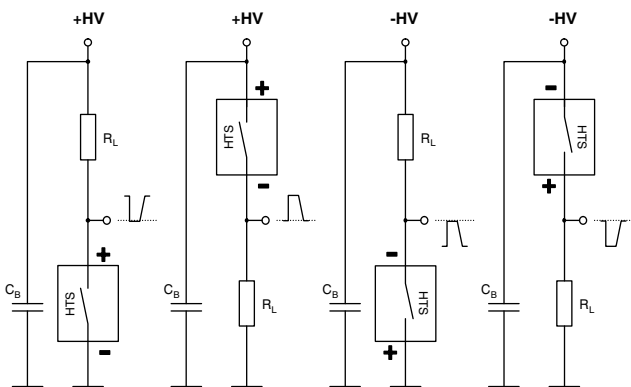
Test Circuit for $t_{r(on)}$



Notes:

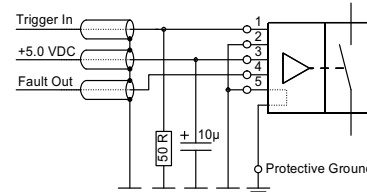
- Total wiring inductance < 50 nH
- C_b is a MAXWELL low inductance energy storage capacitor (<10 nH)
- R_L depends on voltage and peak current test conditions. Low inductance mass resistors, CESIWID series 900, washer style, 3 inch disc diameter, $E_{max}=27600$ J/disc.
- Voltage probe: Tektronix P6015A
 Current probe: Pearson 4997
 Oscilloscope: Tektronix TDS684C

Basic Circuits



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. Malfunction or even irreparable damage of the control circuit could be the consequence.



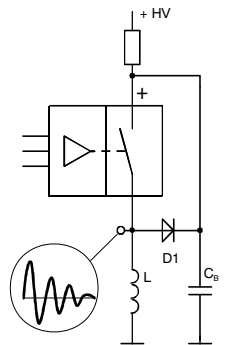
Standard Plug

- 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

Specification	Symb.	Condition / Comment	220-1000-SCR/DT	240-1000-SCR/DT	Unit
Maximum Operating Voltage	$V_{O(max)}$	$I_{off} < 300 \mu ADC$, $T_{case} = 70^\circ C$	22000	24000	VDC
Minimum Operating Voltage	$V_{O(min)}$			0	VDC
Typical Breakdown Voltage	V_{br}	$I_{off} > 3 mADC$, $T_{case} = 70^\circ C$	24200	26400	VDC
Maximum Off-State Current	I_{off}	$0.8 \times V_O$, $T_{case} = 25^\circ C$		300	μADC
Galvanic Isolation	V_I	HV side against control side, continuously		40000	VDC
Maximum Turn-On Peak Current	$I_{P(max)}$	$T_{case} / T_{fin} = 25^\circ C$, half sine. Please consult factory for further data.	$t_p < 100 \mu s$, duty cycle <1% $t_p < 500 \mu s$, duty cycle <1% $t_p < 1 ms$, duty cycle <1% $t_p < 10 ms$, duty cycle <1%	10000 5000 3400 2000	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, $t_p < 20 \mu s$	20000 40000	ADC
Max. Continuous Load Current	I_L	$T_{case} / T_{fin} = 25^\circ C$	Standard plastic case With option CCS (air >4m/s)	0.74 2.22	ADC
Typical Holding Current			$T_{case} / T_{fin} = 25^\circ C$ $T_{case} / T_{fin} = 70^\circ C$	50 35	mADC
Typical On-State Voltage	V_{sat}	$T_{case} / T_{fin} = 25^\circ C$ $t_p < 10 \mu s$, duty cycle <1%	$0.01 \times I_{P(max)}$ $0.1 \times I_{P(max)}$ $1.0 \times I_{P(max)}$	27 45 120	VDC
Typical Turn-On Rise Time	$t_{r(on)}$	Resistive load, 10-80 %	$0.1 \times V_{O(max)}$, $0.1 \times I_{P(max)}$ $0.8 \times V_{O(max)}$, $0.1 \times I_{P(max)}$ $0.8 \times V_{O(max)}$, $1.0 \times I_{P(max)}$ $0.8 \times V_{O(max)}$, $I_P = 500 A$	500 170 440 300	ns
Typical Turn-On Delay Time	$t_{d(on)}$	Resistive load, 50-50% $I_P = 500 A$, $0.8 \times V_{O(max)}$	Standard „DT“ Option DT-10	1 10	μs
Total Turn-On Time	$t_{t(on)}$	$t_{d(on)} + t_{r(on)}$, resistive load, 50-50% $I_P = 500 A$, $0.8 \times V_{O(max)}$	Standard „DT“ Option DT-10	1.3 10.3	μs
Typical Turn-Off Time	t_{off} , t_q	$T_{case} / T_{fin} = 25^\circ C$, inductive load	$0.1 \times I_{P(max)}$ $1.0 \times I_{P(max)}$	35 90	μs
Critical Rate-of-Rise of Off-State Voltage	dv/dt	@ $V_{O(max)}$, exponential waveform		150	kV/ μs
Maximum On-Time	$t_{on(max)}$	Depends on holding current only.		unlimited	
Internal Driver Recovery Time	t_{rc}	Standard devices With option HFB		1000 100	μs
Typical Turn-On Jitter	$t_{j(on)}$		Standard „DT“ Option DT-10	50 500	ns
Max. Cont. Switching Frequency	$f_{(max)}$	Please note $P_{d(max)}$ limitations		400	Hz
Maximum Burst Frequency (Triggered)	$f_{b(max)}$	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
Maximum Continuous Power Dissipation	$P_{d(max)}$	$T_{case} = 25^\circ C$	Standard plastic case With option CCS (air stream >4m/s)	20 60	Watts
Linear Derating		Above $25^\circ C$ T_{case}	Standard plastic case With option CCS (air stream >4m/s)	0.44 1.33	W/K
Temperature Range	T_O			-40...85	$^\circ C$
Coupling Capacitance	C_C	HV side against control side		270	pF
Auxiliary Supply Voltage	V_{aux}	Stabilized to $\pm 5\%$ (4.75...5.25 VDC)		5.00	VDC
Auxiliary Supply Current	I_{aux}	@ $f_{(max)}$		600	mADC
Trigger Voltage Range	V_{tr}	Switching behaviour is not influenced by trigger quality		3-10	VDC
Fault Signal Output		Short circuit proof, source/sink current max. 10mADC (TTL compatible)	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=Fault		-	-
High Voltage Connection		Low inductance terminals for printed circuit boards		-	-
Dimensions		Standard plastic case With option CCS		252 x 150 x 40 160 x 150 x 30	mm ³
Weight		Standard plastic case With option CCS		1900 1500	g

ORDERING INFORMATION

HTS 220-1000-SCR/DT Thyristor switch, 22 kVDC, 10 kA (pk)

HTS 240-1000-SCR/DT Thyristor switch, 24 kVDC, 10 kA (pk)

Option CCS Ceramic Cooling Surface

Option UL94-V0 Flame retardant casting resin UL 94-V0

Option DT-10 Delayed Trigger, 10 μs Delay Time

For further options please refer to the product catalog, page A1.

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

240-1000-SCR-07.03