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/µs. 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 1µs 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.

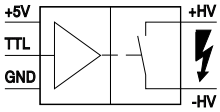
An interference-proof control circuit provides signal conditioning, auxiliary voltage monitoring, frequency limitation and temperature protection. In case of false operating conditions the switches are immediately inhibited and a fault signal is generated. Three LED's indicate the operating state. The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

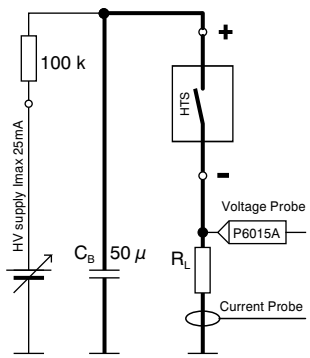
HTS 220-1000-SCR with ceramic cooling surface (Opt. CCS)

Patented



Extremely High di/dt
High Surge Current Capability

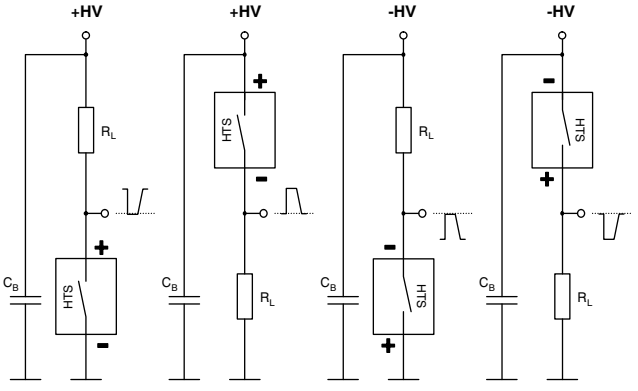
Test Circuit for $t_{r(on)}$



Notes:

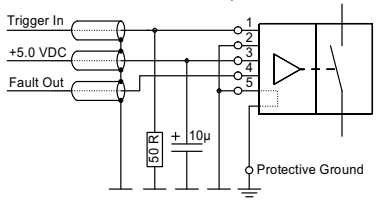
1. Total wiring inductance < 50 nH
2. C_B is a MAXWELL low inductance energy storage capacitor (<10 nH)
3. R_L depends on voltage and peak current test conditions. Low inductance mass resistors, CESIWID series 900, washer style, 3 inch disc diameter, E_{max}=27600 J /disc.
4. Voltage probe: Tektronix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

Basic Circuits



Control Connection

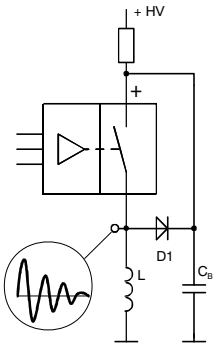
- Use shielded cables or apply optical decoupling at trigger input
- Input should be terminated properly if connected via coaxial line
- Never mix control wiring and load circuit wiring. Heavy magnetic fields of the load circuit can cause dangerous overvoltage spikes on the input wiring. Malefunction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

Specification	Symb.	Condition / Comment			220-1000-SCR/DT 240-1000-SCR/DT	Unit
Maximum Operating Voltage	$V_{O(max)}$	I_{off} < 300 µADC, T_{case} = 70°C			22000 24000	VDC
Minimum Operating Voltage	$V_{O(min)}$				0	VDC
Typical Breakdown Voltage	V_{br}	I_{off} > 3 mADC, T_{case} = 70°C			24200 26400	VDC
Maximum Off-State Current	I_{off}	0.8 x V_O, T_{case} = 25°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°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%		10000 5000 3400 2000	ADC
Max. Non-repetitive Peak Current	$I_{P(nr)}$	T_{case} / T_{fin} = 25°C	Half sine single pulse, tp<200µs Half sine single pulse, tp< 20µs		20000 40000	ADC
Max. Continuous Load Current	I_L	T_{case} / T_{fin} = 25°C	Standard plastic case With option CCS (air >4m/s)		0.74 2.22	ADC
Typical Holding Current			T_{case} / T_{fin}= 25°C T_{case} / T_{fin}= 70°C		50 35	mADC
Typical On-State Voltage	V_{sat}	T_{case} / T_{fin} = 25°C t_p< 10µs, duty cycle <1%	0.01 x $I_{P(max)}$ 0.1 x $I_{P(max)}$ 1.0 x $I_{P(max)}$		27 45 120	VDC
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 $I_{P(max)}$ 0.8 x $V_{O(max)}$, 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 x $V_{O(max)}$		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 x $V_{O(max)}$		Standard „DT“ Option DT-10	1.3 10.3	µs
Typical Turn-Off Time	t_{off}, t_q	T_{case} / T_{fin} = 25°C, inductive load		0.1 x $I_{P(max)}$ 1.0 x $I_{P(max)}$	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°C	Standard plastic case With option CCS (air stream >4m/s)		20 60	Watts
Linear Derating		Above 25°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	°C
Coupling Capacitance	C_C	HV side against control side			270	pF
Auxiliary Supply Voltage	V_{aux}	Stabilized to ± 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)	**Option UL94-V0**	Flame retardant casting resin UL 94-V0
HTS 240-1000-SCR/DT	Thyristor switch, 24 kVDC, 10 kA (pk)	**Option DT-10**	Delayed Trigger, 10 µs Delay Time
Option CCS	Ceramic Cooling Surface	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.