FAST HIGH VOLTAGE TRANSISTOR SWITCHES

These MOSFET switching modules have been designed for general high voltage switching applications such as industrial power electronics, HV test instruments, pulse generators, deflection- and accleration grid drivers. The switching modules described here are distinguished above all by their very short transition time, high switching frequency and extraordinary high dv/dt immunity against HV transients. The switches can therefore be used in all hard switching applications without limitations.

The switching modules incorporate all features of the well known HTS switch family: Easy handling, high reliability, low jitter and reproducible switching behaviour.

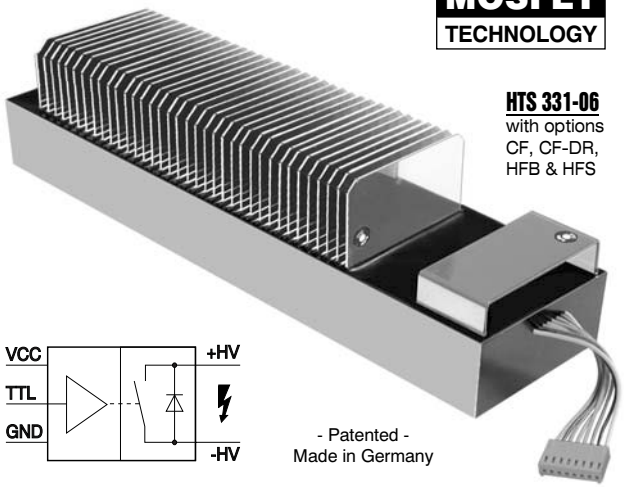
The switch is turned on by a positive going signal of 3 to 6 volts amplitude, provided the auxiliary power supply is permanently connected to the +5.00 VDC input. The on-time may simply be varied between 150 ns and infinity by the input control pulse width. An interference-proof driver circuit provides signal conditioning, auxiliary voltage monitoring, frequency limitation and temperature protection. In case of any false operating condition the switches turn off immediately and a fault signal is generated (TTL level). The high frequency burst operation (>10 pulses/100μs) requires the option HFB (connection of external buffer capacitors at the driver). For operation at higher frequencies than specified under $f_{(max)}$ the option HFS must be used. In that case an internal DC/DC converter must be supported by an external supply of +250 VDC (± 5%, approx. 2-10 Watts depending on switching frequency).

Due to the high galvanic isolation the switches may simply be operated also in floating set-up's or in high-side circuits. Several housing options are available to meet individual constructional and power requirements. The standard plastic housing is used in low frequency applications with low average power dissipation. The plastic modules can additionally be fitted with non-isolated cooling fins (available as options CF, CF-X2 and CF-X3), which improves the max. Continuous Power Dissipation $P_{d(max)}$ by approx. factor 10 with forced air (>4m/s) or by factor 50, if the switching modules are immersed in isolating cooling liquids (e.g. GALDEN HT200, flow rate >0.1m/s, standard cooling fins). Another cooling method is given by the use of the grounded cooling flange (option GCF and GCF-X2). In conjunction with an optional water cooling plate or any other high performance heatsink, maximum power dissipations in the range of 1 to 4 kW are possible, with customized cooling flanges even up to 10 kW.

The modules can be installed on a printed circuit board, but if operated under air conditions, the use of option PT-HV (pigtails for HV connection) is recommended, in order to ensure a sufficient creepage distance according to industrial standards. For detailed design recommendations please refer to the general instructions for use.

HTS 161-06 16 kV / 60 A
HTS 221-06 22 kV / 60 A
HTS 331-06 33 kV / 60 A

MOSFET TECHNOLOGY

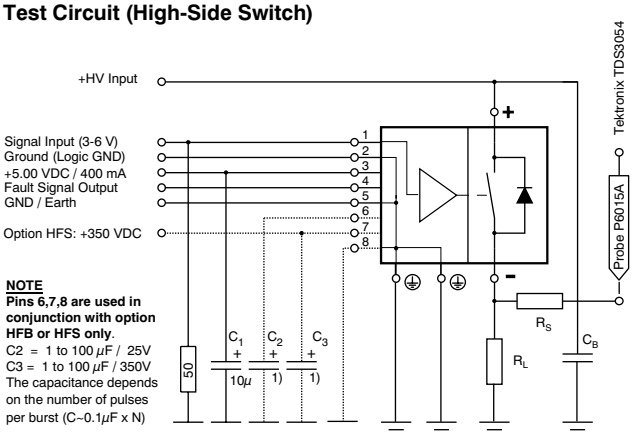


HTS 331-06
with options
CF, CF-DR,
HFB & HFS

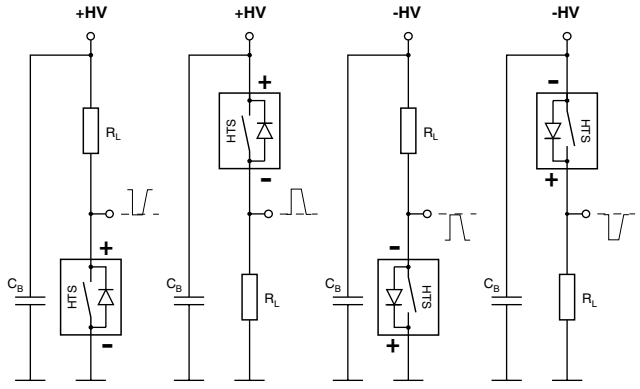
- Patented -
Made in Germany

Variable On-Time
High Switching Frequency

Test Circuit (High-Side Switch)

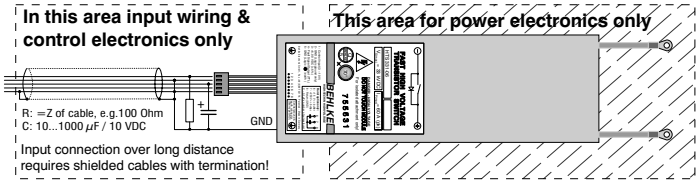


Basic Circuits



Important EMC Design Hints

- Keep the wiring as short as possible and avoid large induction loop areas of the peak current carrying lines; the forward and return lines should be installed as closely as possible together. Control and power circuit must not be mixed. Always keep the transformer principle in mind!
- Use shielded leads at the control side to minimize noise induction. Low impedance drivers with 5 Volt output swing (into 50 Ohm) are required for driving long pulse transmission lines. Signal transmission lines must be terminated properly (e.g. by 50 Ohm). The auxiliary power supply must be well decoupled by a sufficient buffer capacitor.
- This high speed switching module can generate extreme di/dt's and dv/dt's. Therfore it is not useful to operate the switch and its peripheric components without a shielded housing. Other electronics including power supplies (!) may be disturbed. Please note your local EMC / EMI regulations. Please also see our option offers for possible EMC / EMI relevant modifications.



Behlke Electronic GmbH, 61476 Kronberg, Germany, **Tel.** +49 (0) 6173 9290 -20, **Fax** -30, **email** info@behlke.de

TECHNICAL DATA

Specification	Symb.	Condition / Comment		HTS:	161-06	221-06	331-06	Unit
Maximum Operating Voltage	$V_{O(max)}$	I_{off} < 60 σADC			16	22	33	kVDC
Minimum Operating Voltage	$V_{O(min)}$	Increased $t_{r(on)}$ and $t_{r(off)}$ below 0.1x $V_{O(max)}$				0		kVDC
Typical Breakdown Voltage	V_{br}	I_{off} > 1mADC, T_{case} = 75 °C			18	24	36	kVDC
Galvanic Isolation	V_I	Continuously	Standard housing / PCB attachment		25	25	40	
			Option PT-HV, pigtails for HV		40	40	40	
			Option PT-HV + Option ISO-80 **1)**		80	80	80	kVDC
Maximum Peak Current	$I_{P(max)}$	T_{case} = 25°C	t_p < 100 µs, duty cycle <1%			60		
		T_{fin} = 75°C*	t_p < 1 ms, duty cycle <10%			49		
		*measured at base	t_p < 10 ms, duty cycle <10%			36		ADC
Maximum Continuous Load Current	I_L	T_{case} = 25°C	Standard plastic case		0.81	0.77	0.69	
		T_{flange} =25°C	Option CF, fins in air >4m/s		2.5	2.5	2.5	
		T_{fin} = 75°C*	Option CF, in Galden⊇ >0.1m/s		5.2	5.2	5.2	
		*measured at base	Opt. GCF, grounded cooling flange		6.6	6.6	6.6	ADC
Static On-Resistance	R_{stat}	T_{case} = 25°C	0.1 x $I_{P(max)}$		17	22	33	
			1.0 x $I_{P(max)}$		42	55	83	T
Maximum Off-State Current	I_{off}	0.8xV_O, T_{case}=75°C, <5σA leakage optionally available				50		σADC
Turn-On Delay Time	$t_{d(on)}$	@ $I_{P(max)}$			170	180	200	ns
Typical Turn-On Rise Time	$t_{r(on)}$	0.1 x V_O, 0.1 x $I_{P(max)}$			9	9	10	
		0.5 x V_O, 0.1 x $I_{P(max)}$			12	12	13	
		0.8 x V_O, 0.1 x $I_{P(max)}$			13	15	16	
		0.8 x V_O, 1.0 x $I_{P(max)}$			18	24	28	ns
Typical Turn-Off Rise Time	$t_{r(off)}$	0.8 x V_O, 0.1x $I_{P(max)}$, resistive load, 10-90%				25		ns
Minimum On-Time	$t_{on(min)}$	Lower $t_{on(min)}$ on request				200		ns
Maximum On-Time	$t_{on(max)}$	Please note possible $P_{d(max)}$ limitations				∞		
Switch Recovery Time	t_{rc}	t_{rc} = minimum pulse spacing				500		ns
Typical Turn-On Jitter	$t_{j(on)}$	V_{aux} / V_{tr} = 5.0 VDC, fixed switching frequency				1		ns
Max. Switching Frequency	$f_{(max)}$	T_{case} = 25°C	Standard, safety turn-off @1.5x $f_{(max)}$		6	5	4	
			Option HFS, please consult factory		max. 50	max. 50	max. 50	kHz
Maximum Burst Frequency	$f_{b(max)}$	Use option HFB for >5 pulses within100 µs				2		MHz
Maximum Continuous Power Dissipation	$P_{d(max)}$	T_{case} = 25°C	Standard plastic case incl. option		28	33	40	
		T_{flange} =25°C	FC Option CF, fins in air >4m/s		270	360	540	
		T_{fin} = 75°C*	Option CF, in Galden⊇ >0.1m/s		1120	1500	2250	
		*measured at base	Opt. GCF, grounded cooling flange		1800	2400	3600	Watts
Linear Derating		T_{case} = 25°C	Standard plastic case incl. option		0.56	0.66	0.8	
		T_{flange} =25°C	FC Option CF, fins in air >4m/s		6	7.2	8.64	
		T_{fin} = 75°C*	Option CF, in Galden⊇ >0.1m/s		25	30	36	
		*measured at base	Opt. GCF, grounded cooling flange		50	60	72	W/K
Operating Temperature Range	T_O	Extended range on request, safety turn-off @ 77°C				-40...75		°C
Storage Temperature Range	T_{ST}					-50...90		°C
Natural Capacitance	C_N	Capacitance between switch poles at $V_{O(max)}$			66	50	33	pF
Coupling Capacitance	C_C	HV side to	Standard devices		21	30	48	
		control / GND	Opt. GCF, grounded cooling flange		165	222	336	pF
Diode Reverse Recovery Time	t_{rrc}	I_F= 10 A, T_{case} = 25°C	MOSFET parasitic diode			500		ns
Diode Forward Voltage Drop	V_F	I_F= 10 A, T_{case} = 25°C	MOSFET parasitic diode		28	37	56	VDC
Auxiliary Supply Voltage	V_{aux}	Stabilized to ∂ 2%, safety turn-off below 4.75 VDC				5.0		VDC
Auxiliary Supply Current	I_{aux}	@ f_{max}				600		mADC
Control Signal Voltage	V_{tr}	> 3VDC recommended				2-6		VDC
Fault Signal Output		TTL, short circuit proof, L=Fault (=safety turn-off)				H= 4 V, L= 0.5 V		VDC
Dimensions	LxWxH	Standard plastic case			171x70x28	200x70x35	263x70x35	
		Option FC, flat case			171x70x19	200x70x19	263x70x19	
		Option CF, non-isolated cooling fins, standard size			171x70x70	200x70x70	263x70x70	
		Option GCF, grounded cooling flange **2)**			252x120x45	252x120x45	312x120x45	mm^3
Weight		Standard plastic case			750	1020	1050	
		Option FC, flat case			440	590	610	
		Option CF, non-isolated cooling fins, standard size			1125	1560	1590	
		Option GCF, grounded cooling flange **2)**			2700	3420	3450	g

Notes: 1) Not available in connection with Option GCF. **2)** Also available in other sizes for higher or lower $P_{d(max)}$. Please consult factory.

Ordering Information

HTS 161-06	Transistor switch, 16 kVDC, 60 Amps.	**Option ISO-80**	Increased isolation voltage, 80 kVDC isolation
HTS 221-06	Transistor switch, 22 kVDC, 60 Amps.	**Option SPT-C**	Shielded pigtail for control connection (LEMO miniature plug)
HTS 331-06	Transistor switch, 33 kVDC, 60 Amps.	**Option PT-HV**	Pigtails for HV connection (instead of bottom screw terminals)
Option HFB	High frequency burst	**Option UL-94**	Flame-retardant casting resin according to UL94-V0
Option HSF	High switching frequency (pls. consult factory)	**Option FC**	Flat plastic case, module height reduced to 19 mm
Option LP	Low pass filter at control input	**Option CF**	Non-isolated cooling fins, standard size, 35 mm height
Option S-TT	Soft transition time for simplified EMC design	**Option GCF**	Grounded cooling flange, direct attachment to heat sink

Further data and mechanical drawings are available on request. All data and specifications subject to change without notice.