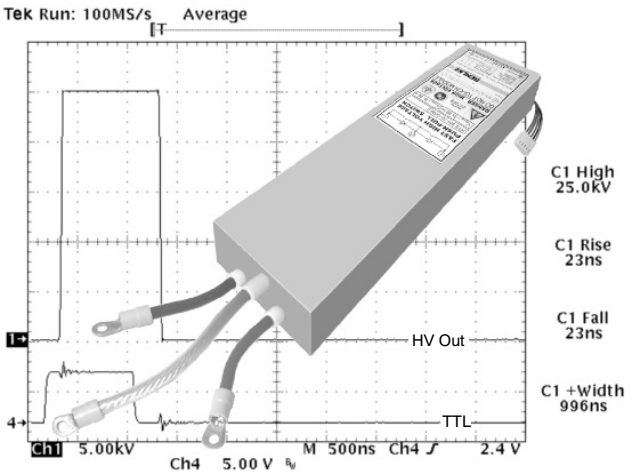
FAST HIGH VOLTAGE TRANSISTOR SWITCHES

The switching modules of the series HTS-GSM consist of two identical MOSFET switching paths that form a so-called half bridge circuit respectively push-pull circuit. Both switching paths are controlled by a common driver, which also provides a logic signal negation for one of the switches. The switches are mutually passively locked, so that a short in the bridge is excluded under all circumstances, including if the control input is disturbed by electromagnetic interferences (due to bad EMC design, for example). Especially in pulse generator applications with capacitive load, the push-pull principle has considerable advantages in comparision with the conventional circuitry using a single-switch with a working resistor. Push-pull circuits do not require large energy storage capacitors for a low pulse drop and, because there are no working resistor power losses, the efficiency of a push-pull pulser is excellent regardless of pulse width, frequency and duty cycle. The pulsers draw only currents for charging the connected load capacitance. Thanks to an extremely precise timing of the switches, there are also almost no cross currents in the bridge, except peak charging currents of the switch natural capacitances.

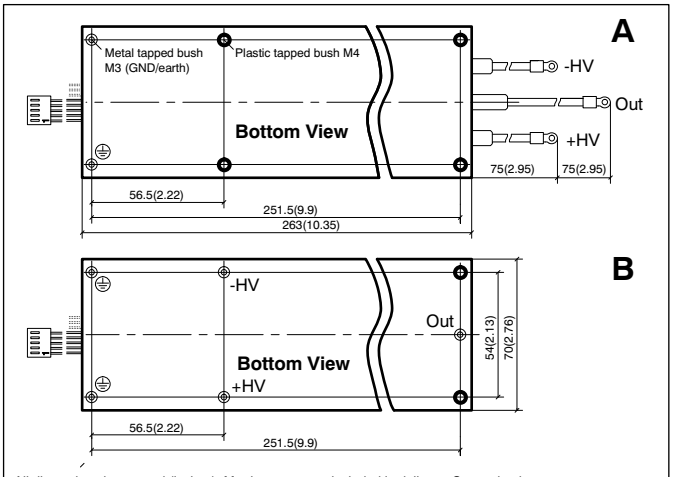
The switches are controlled by positive going signals of 3 to 10 Volts amplitude. Fault conditions as overfrequency, thermal overload (long-term overload) and incorrect auxilliary supply set the switching path A in off-state and the switching path B in on-state. Faults are indicated as an "L" signal at the fault signal output. Without 5VDC supply, both switching paths (A and B) are in off-state. That implies, without 5VDC the output potential could be undefined if the HV is still applied. To ensure a defined high voltage output potential in such cases, pull-up or pull-down resistors must be connected to the output. For further design recommendations, please refer to the general instructions.

HTS 161-06-GSM 2x16kV / 60A
HTS 301-03-GSM 2x30kV / 30A

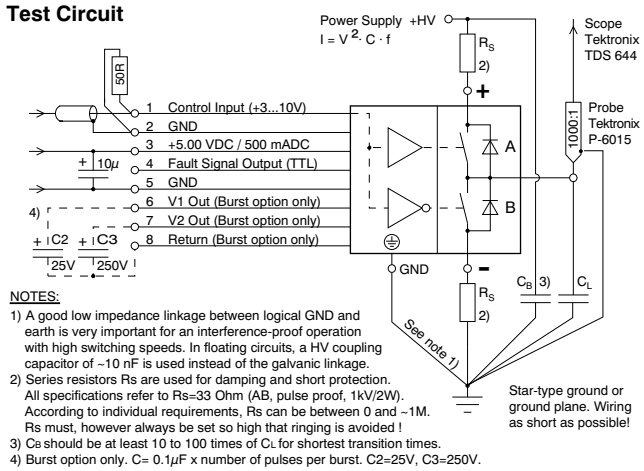


- Fast transition times, rise time and fall time ~20 ns
- Variable pulse width from 200 ns to infinity
- No pulse droop and very low ripple on the pulse top
- No working resistor power, small buffer capacitors

PUSH-PULL - Patented - Made in Germany **MOSFET TECHNOLOGY**



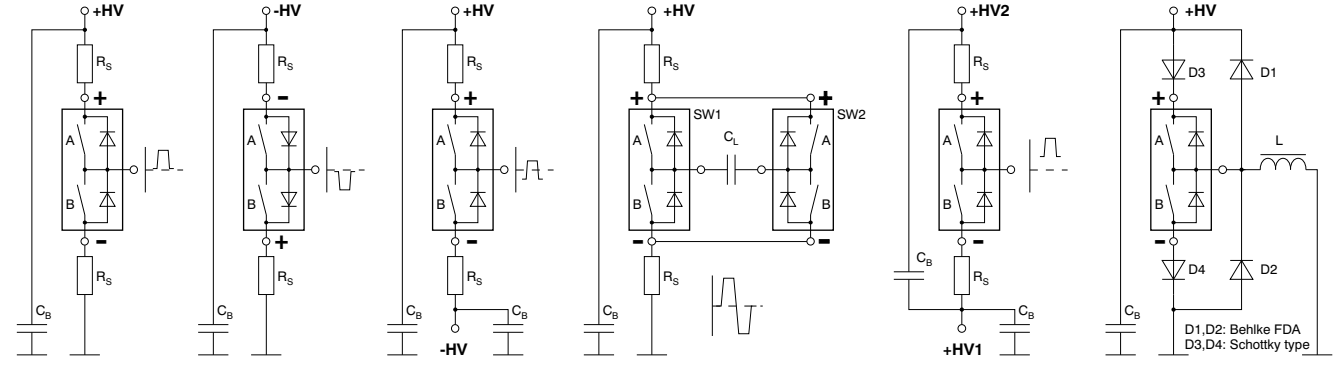
All dimensions in mm and (inches). Metric screws are included in delivery. Customized cases on request.



NOTES:

1) A good low impedance linkage between logical GND and earth is very important for an interference-proof operation with high switching speeds. In floating circuits, a HV coupling capacitor of ~10 nF is used instead of the galvanic linkage.
2) Series resistors Rs are used for damping and short protection. All specifications refer to Rs=33 Ohm (AB, pulse proof, 1kV/2W). According to individual requirements, Rs can be between 0 and ~1M. Rs must, however always be set so high that ringing is avoided !
3) C_B should be at least 10 to 100 times of C_L for shortest transition times.
4) Burst option only. C= 0.1µF x number of pulses per burst. C2=25V, C3=250V.

Basic Circuits



Positive Pulses

Negative Pulses

Pos./Neg. Pulses
The sum of I+HVI and I-HVI must not exceed Vo(max).

Full Bridge Circuit
Control signal for SW2 is negated.

Floating Pulser (Pos.)
HV1 + HV2 must not exceed the Max. Isolation Voltage!

Inductive Load
External diodes must be used to avoid reverse currents through internal diodes!

D1,D2: Behlke FDA
D3,D4: Schottky type

Behlke Power Electronics GmbH, Phone +49 (0)6173-9290-20, Fax -30, www.behlke.com

BEHLKE HIGH-TECH IN HIGH VOLTAGE

TECHNICAL DATA

Specification	Symbol	Condition / Comment		161-06-GSM	301-03-GSM	Unit
Maximum Operating Voltage	$V_{O(max)}$	I_{off} < 10 µADC		2 x 16	2 x 30	kVDC
Minimum Operating Voltage	$V_{O(min)}$	Increased transition times below 0.1 x $V_{O(max)}$		0		kVDC
Typical Breakdown Voltage	V_{br}	Static voltage, I_{off} > 1 mADC, , T_{case} = 70 °C		2 x 18	2 x 36	kVDC
Galvanic Isolation Voltage	V_I	Standard plastic case (see note 1)		25	40	
		Option 08A (Pigtail version only, see drawing A)		40	-	
		Option 08B (Pigtail version only, see drawing A)		80	80	kVDC
Maximum Peak Current	$I_{P(max)}$	T_{case} = 25°C	t_p<10 μs, duty cycle <1%	2 x 60	2 x 30	ADC
Max. Continuous Load Current	I_L	T_{case} = 25°C	Standard plastic case (see note 1)	2 x 0.7	2 x 0.33	
		T_{fin} = 25°C	Opt.03, increased thermal conductivity	2 x 0.86	2 x 0.41	
			Opt. 04, cooling fins (air >4m/s)	2 x 2.2	2 x 1.05	ADC
Static On-Resistance	R_{stat}	T_{case} = 25°C	0.1 x $I_{P(max)}$	2 x 18	2 x 72	
			1.0 x $I_{P(max)}$	2 x 40	2 x 180	Ω
Maximum Off-State Current	I_{off}	0.8xV_O, T_{case}= 25...70°C, reduced I_{off} on request		10		µADC
Propagation Delay Time	t_d	Resistive Load		190		ns
Typical Output Transition Time (Rise Time & Fall Time)	t_r, t_f	0.8 x V_O 10-90%	R_S = 33 Ω, C_L = 10pF	10	20	
			R_S = 33 Ω, C_L = 50pF	15	35	
			R_S = 33 Ω, C_L = 100pF	17	50	
			R_S = 33 Ω, C_L = 200pF	25	90	
			R_S = 22 Ω, C_L = 1000pF	60	230	ns
Minimum Output Pulse Width	$t_{p(min)}$	Reduced output pulse width on request.		200		ns
Maximum Output Pulse Width	$t_{p(max)}$			No limitation, up to ∞		
Minimum Pulse Spacing	$t_{ps(min)}$	(Switch recovery time)		400		ns
Typical Output Pulse Jitter	t_j	V_{aux}=5.0 VDC	Fixed switching frequency, >2kHz	0.1		
		V_{tr} =5.0 VDC	Sweeped frequency, <2kHz	5		ns
Max. Continuous Switching Frequency	$f_{(max)}$	Please note possible $P_{d(max)}$ limitations. Increased switching frequency on request.		2		kHz
Maximum Burst Frequency	$f_{b(max)}$	Use option 01 for >10 pulses per 200μs burst		2.5		MHz
Maximum Continuous Power Dissipation	$P_{d(max)}$	T_{case} = 25°C	Standard plastic case (see note 1)	2 x 20		
		T_{fin} = 25°C	Opt. 03, incr. thermal conductivity	2 x 30		
			Opt. 04, air speed >4m/s (s. note 2)	2 x 200		Watts
Linear Derating		Above 25 °C	Standard plastic case	2 x 0.44		
			Opt.03, incr. thermal conductivity	2 x 0.66		
			Opt. 04, air speed >4m/s	2 x 4.44		W/K
Operating Temperature Range	T_O			-40...70		°C
Typical Natural Capacitance	C_N	Capacitance between the	0.1 x $V_{O(max)}$	< 90		
		terminals of <u>one</u> switch path	0.8 x $V_{O(max)}$	< 30		pF
Typical Coupling Capacitance	C_C	Both switches against ground respectively control		< 30		pF
Reverse Recovery Time of the intrinsic diodes (parasitic MOSFET diodes)	t_{rrc}	**<u>Important Note:</u>** Due to the high t_{rrc} of the parasitic diodes any current reversal must be avoided! Unclamped inductive load or high stray inductance of wiring may cause a short circuit in the bridge. Danger of irreparable damage! Use serial resistors, snubbers or fast free-wheeling diode networks to avoid any current reversal.		500...1000		ns
Auxiliary Supply Voltage	V_{aux}	Stabilized to ± 5%		5.00		VDC
Auxiliary Supply Current	I_{aux}	@f_{max}, (Limitation of approx. 1 A recommended)		600		mADC
Control Signal	V_{tr}	>3VDC recommended for low jitter		3...10		VDC
Fault Signal Output		Short circuit proof, source/sink	Ready = High	≥4.0		
		current max. 10 mA	Fault = Low	≤0.8		VDC
Dimensions	LxWxH	Standard case (Without pigtails & opt. cooling fins)		263x70x35		mm^3
Weight		Standard plastic case		800		
		With option 04 (cooling fins in standard size)		1450		g

<u>Notes:</u>

1) The standard case is „A“ for the HTS 301-03-GSM and „B“ for the HTS 161-06-GSM. Please refer to the drawing overleaf. Version „B“ is optionally also available for the HTS 301-03-GSM (option 06) but only in connection with additional isolation measures (e.g. oil immersion) or in case of operating voltages less than 20 kVDC. The version “B” for attachment on printed circuit boards is preferred in high speed circuits with transition times in the order of 10 to 20 ns or in case of critical EMC aspects.
2) Cooling fins are not recommended if the HTS 301-03-GSM shall be operated in air above 20 kVDC. No limitations if operated in oil. Please consult factory for further oil cooling information.

<u>Ordering Information</u>

HTS 161-06-GSM	Push-pull transistor switch	**Option 05**	High power metal case (on request)
HTS 301-03-GSM	Push-pull transistor switch	**Option 06**	Printed circuit board version of HTS 301-03-GSM.
Option 01	High frequency burst	**Option 08A**	40kV isolation for HTS 161-06-GSM (pigtail version „A“ only)
Option 03	Increased thermal conductivity	**Option 08B**	80kV isolation (pigtail version „A“ only)
Option 04	Non-isolated cooling fins (oil immersion for Vo >20 kV)		

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