# FAST HIGH VOLTAGE TRANSISTOR SWITCHES

## DESCRIPTION

The ultra fast transistor switches of the UF series are distinguished above all by an extremely short rise time which remains constant over a wide range of operating voltage and load. BEHLKE solid-state switches are actively controlled devices (no avalanche technique) and have a highly reliable and reproducible switching behaviour regardless to temperature and load conditions. Compared to conventional high voltage switching elements, such as gas discharge tubes and spark gaps, BEHLKE switches do not show aging effects and achieve life times by several orders of magnitude higher than any other classical high voltage switch.

The switches are very easy to handle and only require a well stabilized +5.00 VDC auxiliary supply and a TTL-compatible trigger signal at the control side. The trigger can be any positive going pulse of at least 50 ns width and 3 to 10 volts amplitude. Due to the schmitt-trigger input characteristics and the very high signal amplification neither the switching behaviour nor the turn-on rise time will be influenced by the waveshape of the trigger pulse. After being triggered the switch turns on for about 100 nanoseconds. Shorter on-times respectively pulses of a few nanoseconds duration may simply be generated by means of the on-time options OT-5ns, OT-10ns and OT-20ns. Any other customized on-time above 20 ns is possible if the turn-off rise time is of secondary interest. Above 30 ns the on-time can also be adjusted by means of option OT-P (Programmable On-Time) within certain limits. The recovery time after a switching cycle is less than 1$\mu$s, making burst frequencies of up to 1MHz possible. Burst frequencies of up to 10 MHz can be realized on a custom design base.

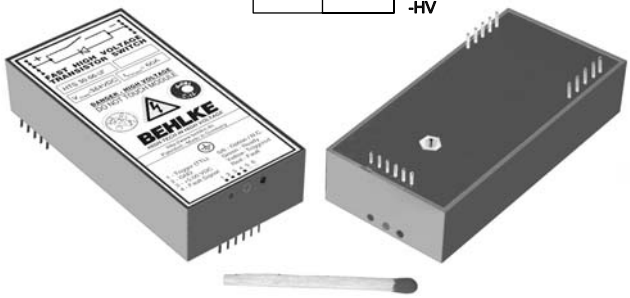
The internal driving circuit provides signal conditioning, auxiliary voltage monitoring, frequency limitation and temperature protection. The operating conditions are indicated by three built-in LEDs. In case of a fault (auxiliary voltage <4.75 VDC, frequency >f(max) and case temperature >75°C) the red LED will indicate the error and the switch is inhibited for at least 1 sec respectively for the duration of the fault condition. At the same time a TTL compatible fault signal is generated (Low=Fault). The reset time in case of over temperature can last some minutes depending on the ambient conditions. A green LED indicates "Ready for Operation" and a yellow one flashes if the switch has been triggered succesfully.

The standard plastic housing is the cost efficient solution in low power / low frequency applications with up to 5 watts power dissipation. Above that the cooling option CF (non-isolated cooling fins) should be applied. Another cooling method is given by the grounded cooling flange, available as option GCF. The advantages are simplified heat removal by grounded heat sinks and less installation space, but the option GCF also implicates an increased coupling capacitance and consequently also slower rise times. Depending on circuitry, $t_r$ may increase by approximately 10 to 50% when option GCF is used.

## CIRCUIT DESIGN RECOMMENDATIONS

In order to achieve the maximum turn-on rise time and the best HV pulse shape, all leads and circuit paths should be of lowest possible inductance. This can be achieved by means of very wide and short circuit tracks on the printed circuit board, if necessary in several layers (multi layer PCB). Part components such as $R_S$, $C_{BP}$ and $C_B$ must be "inductance-free" and should only be connected with shortest possible wires / circuit tracks. Ground conducting tracks including the logic ground must be connected to a common ground point (star-type ground). Induction loop areas of dynamically current-carrying circuit paths should always be as small as possible. HV wiring and control circuitry should always be kept on distance. For further design recommendations please refer to the general instructions.

# HTS 30-08-UF 3000 V / 80 A
# HTS 30-06-UF 3600 V / 60 A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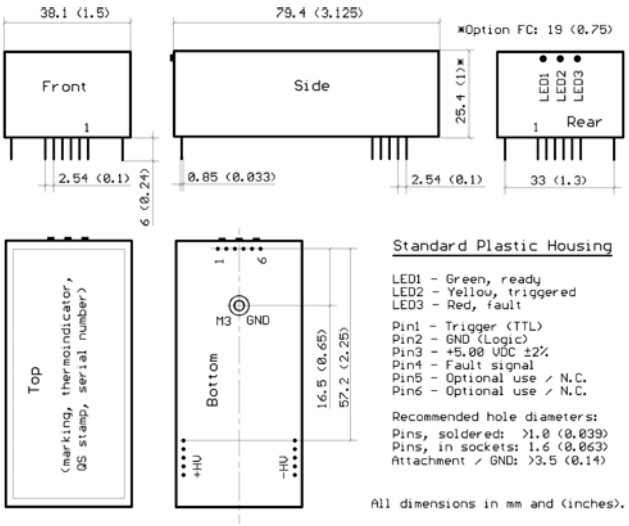
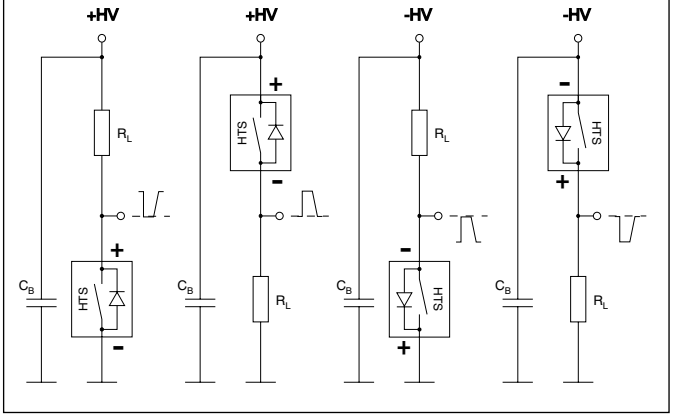
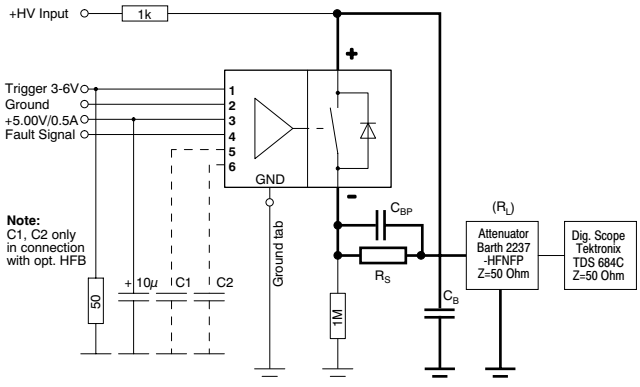
## *ULTRA FAST ULTRA COMPACT*




### Basic Circuits




### Test Circuit (High-Side Switch)

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# TECHNICAL DATA

| Specification | Symbol | Condition / Comment | | 30-06-UF | 30-08-UF | Unit |
|---|---|---|---|---|---|---|
| Max. Operating Voltage | $V_{O(max)}$ | $I_{off}$ < 100 µADC | | 3600 | 3000 | VDC |
| Lowest Useful Operating Voltage | $V_{O(min)}$ | Use option 05 for lower voltages | Standard devices | 100 | | |
| | | | With OT Options | 750 | | VDC |
| Typical Breakdown Voltage | $V_{Br}$ | $I_{off}$ > 1mADC, $T_{case}$ = 70 °C | | 3960 | 3300 | VDC |
| Galvanic Isolation | $V_I$ | HV side against control side | | 10000 | | VDC |
| Max. Peak Current | $I_{P(max)}$ | $t_p$ < 50ns | | 60 | 80 | ADC |
| Static On-Resistance | $R_{stat}$ | Current-dependent | 0.1 x $I_{P(max)}$ | 3.6 | 2.5 | |
| | | | @ $I_{P(max)}$ | 9.4 | 6.2 | Ω |
| Max. Off-State Current | $I_{off}$ | 0.8 x $V_O$ | | 50 | | µADC |
| Turn-On Delay Time | $t_{d(on)}$ | @ $I_{P(max)}$ | | 45 | | ns |
| Typical Turn-On Rise Time | $t_{r(on)}$ | 0.8x$V_O$, $R_L$=50, $R_S$=33, 50Ω BARTH attenuator | | 1.9 | 1.6 | |
| | | 0.8x$V_O$, $R_L$=1k, $C_L$=7.5pF, HV probe PM 9100 | | 0.7 | 0.6 | ns |
| On-Time (Standard) | $t_{on}$ | Voltage-dependent | @ $V_{O(max)}$ | 100 | | |
| | | | @ $V_{O(min)}$ | 120 | | ns |
| Min. Optional On-Time | $t_{on(min)}$ | ±20% tolerance over the full voltage range | | 5 | | ns |
| Max. Optional On-Time | $t_{on(max)}$ | Voltage-depending | | 1 | | µs |
| Switch Recovery Time | $t_{rc}$ | (Minimum pulse spacing) | | 1 | | µs |
| Typical Turn-On Jitter | $t_{j(on)}$ | $V_{aux}$ / $V_{tr}$ = 5.00 VDC | | 100 | | ps |
| Max. Switching Frequency | $f_{(max)}$ | Continuously, @$V_{O(max)}$, plastic case | | 5 | | kHz |
| Max. Burst Frequency | $f_{b(max)}$ | Use „Burst Option“ for >10 pulses | | 1 | | MHz |
| Max. Power Dissipation | $P_{d(max)}$ | Standard plastic case | | 5 | | |
| | | Option CF, cooling fins in air >4m/s | | 60 | | |
| | | With option GCF, grounded cooling flange | | 300 | | Watts |
| Linear Derating | | Above 25°C | Standard plastic case | 0.1 | | |
| | | | Option CF, cooling fins in air >4m/s | 1.2 | | |
| | | | With option GCF, grounded cooling flange | 6 | | W/K |
| Temperature Range | $T_O$ | Extended range on request | | -40...75 | | °C |
| Natural Capacitance | $C_N$ | @ $V_{O(max)}$ | Standard devices | 150 | | |
| | | | With OT options | 50 | | pF |
| Coupling Capacitance | $C_C$ | HV side against control side / GND | Standard device | 7 | | |
| | | | Option GCF | 31 | | pF |
| Diode Reverse Recovery | $t_{rrc}$ | 0.2 x $I_{P(max)}$ | | 1 | | µs |
| Auxiliary Supply Voltage | $V_{aux}$ | Stabilized to ± 5% | | 5.0 | | VDC |
| Auxiliary Supply Current | $I_{aux}$ | @ $f_{max}$ | | 400 | | mADC |
| Trigger Signal | $V_{tr}$ | > 3VDC recommended | | 2-10 | | VDC |
| Fault Signal Output | | Short circuit proof, source/sink current max.10mADC. See product description. | Ready = High | >4.0 | | |
| | | | Fault = Low | <0.8 | | VDC |
| Fault Detection | | By internal protection circuits. In case of fault the switch will be inhibited for approx. 1 sec respectively for the duration of fault. Reset time for thermal overload is ~5min | | - Over temperature<br>- Bad auxiliary voltage (<4.75 V)<br>- Too high switching frequencies | | |
| Operating Mode Indication | | Built-in LEDs. | | Green: Ready for trigger<br>Yellow: Transistors triggered<br>Red: Fault, switch is inhibited | | |
| High Voltage Connection | | Standard plastic case<br>With option GCF, grounded cooling flange | | Threated tabs at bottom for PCBs<br>Threated tabs (metric M3) on top | | |
| Control Connection | | Standard plastic case<br>With option GCF, grounded cooling flange | | 6 gold plated pins at bottom<br>Pigtail with 5-pole miniature plug | | |
| Dimensions | | Standard plastic case | | 79 x 38 x 25 | | |
| | | Option FC, flat case | | 79 x 38 x 19 | | |
| | | Option CF, non-isolated cooling fins | | 79 x 38 x 60 | | |
| | | Opt. GCF, grounded cooling flange (overall dimension) | | 99 x 58 x 33 | | $mm^3$ |
| Weight | | Standard plastic case | | 137 | | |
| | | Option FC, flat case | | 116 | | |
| | | Option CF, non-isolated cooling fins | | 185 | | |
| | | Option GCF, grounded cooling flange | | 420 | | g |

## Ordering Informations

| | |
|---|---|
| **HTS 30-06-UF** | Transistor switch, 3600 VDC, 60 Amps. |
| **HTS 30-08-UF** | Transistor switch, 3000 VDC, 80 Amps. |
| **Option OT-5ns** | On-time 5 ns |
| **Option OT-10ns** | On-time 10ns |
| **Option OT-20ns** | On-time 20ns |
| **Option OT-C** | Customized on-time, pls. indicate on-time |
| **Option OT-P** | Programmable on-time (only for tp >30 ns) |
| **Option ST** | Stage tapping, pls. indicate tapping position |
| **Option UL** | Flame retardend casting resin according to UL94-VO |
| **Option CF** | Non-isolated cooling fins, d=0.5 mm, height 35 mm |
| **Option GCF** | Grounded cooling flange |
| **Option GCF-W** | Water cooler plate for the above cooling flange |
| **Option FC** | Flat case, 19 mm height |
| **Option HFB** | High frequency burst, for >10 pulses within <100 µs |
| **Option IPC** | Integrated part components (e.g. serial resistor or buffer capacitor) according to customers specification |





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