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HS-500

Low Noise High Voltage Switch

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Data Sheet

Rev. 1.22

Features:

- **Fast low noise switches (SPDT)**
- **Up to 500V switching voltage**
- **TTL/CMOS level control**
- **Floating up to 500V vs. GND**

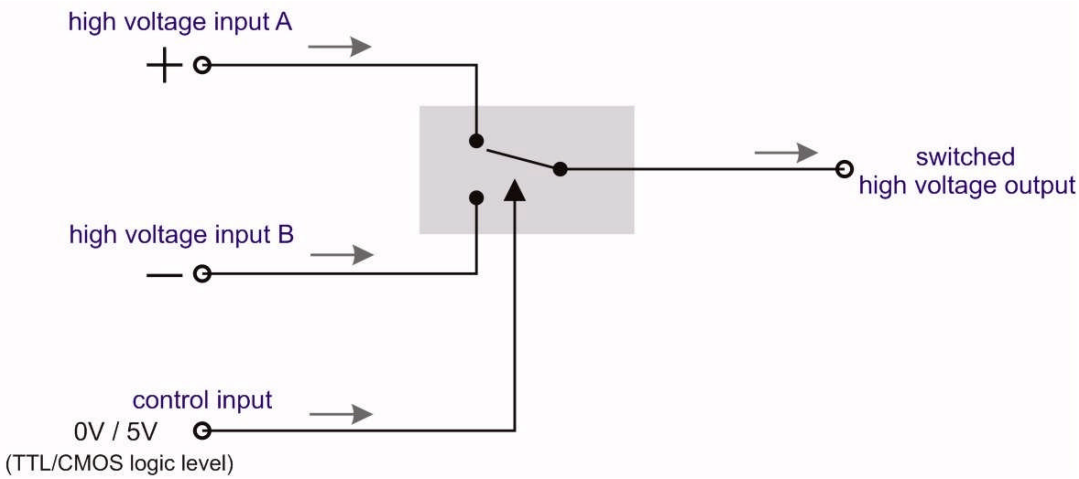
Typical Applications:

- **Ion Traps**
- **Beam Lines**
- **Fast Steerers**
- **Piezos**

Purpose and Characteristics of the Device

Purpose of the HS series devices is the fast switching of electrodes, electrostatic lenses, beam deflectors or ion traps. Unlike DC *power* switches, the outputs expect capacitive loads. The outputs are optimized for high stability and very low noise. The HS series switches are housed in standard 19-inch rack-mount cases. They are available in single-channel or dual-channels versions. In the dual channel version two completely identical switches are housed inside the same case. These two switches are completely independent.

The following scheme displays a block diagram of the internal structure. The control input (BNC) defines the position of the internal high voltage switch, which connects either input A or input B to the output. A digital signal (TTL/CMOS level 0V/5V) may be applied to this control input at a rate between 0Hz (static operation) to 1.5 kHz. A three-position manual switch on the front side allows to override the digital control signal. The high voltage switching elements inside the device are implemented as MOSFET-transistors, allowing fast switching transitions in the order of 100ns and less. The non-selected input is isolated from the output by a high isolation resistance. Nominal loads from 0pF to 300pF may be connected.

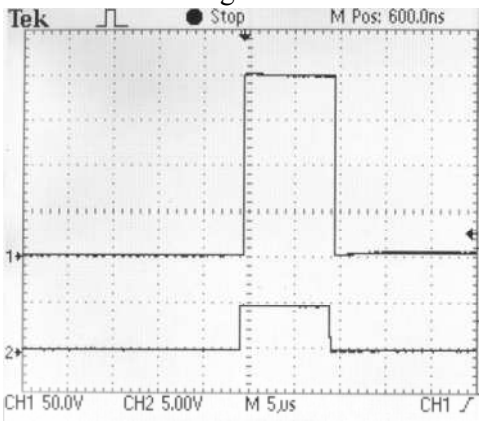


The applied supply voltages at inputs A and B obey a certain order: voltage at input A always needs to be more positive than voltage at input B. In general both input voltages may float up to +/-500V versus the case ground. However, for normal operation the voltage *difference* (A-B) should not exceed the rated voltage (500 Volts for HS-500).

Application example:
Generation of 10µs-duration positive 200Volt-pulse

The subsequent oscilloscope screen shot shows a typical application example. A control pulse of logic levels (high = 5V, low = 0V) is applied to the control input. High voltage inputs A and B were provided with an external voltage of 200V and 0V respectively. At the edges of the control signal the

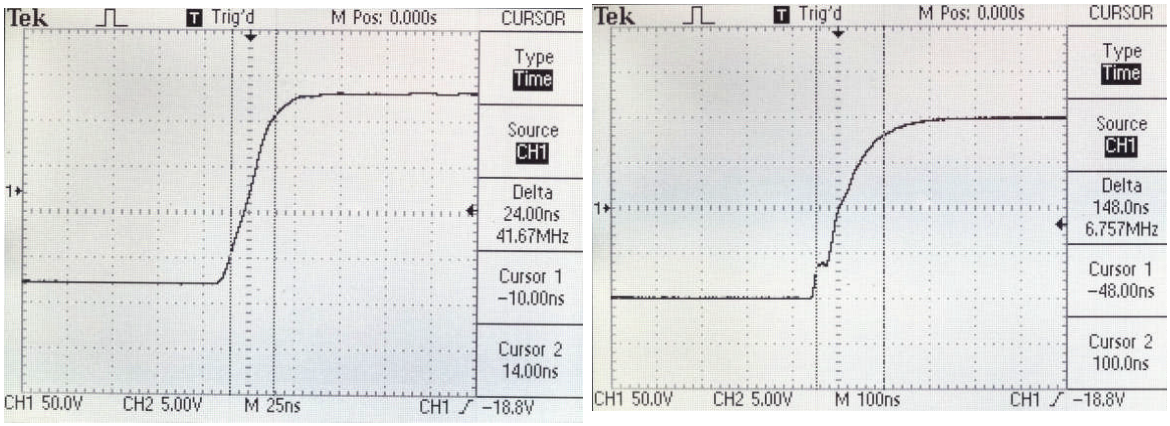
switch is triggered, and switches from 0V to 200V (trace 1: 50V/div.) and after 10µs back to 0 Volt. Trace 2 shows the control signal, being used to trigger the switch (trace 2: 5V/div.). A rectangular pulse results with steep slopes and constant-voltage static levels.



Oscilloscope screen shot of a positive 200V pulse, Δt = 10µs duration. The lower trace (trace 2) shows the digital control signal, trace 1 (upper trace) the output signal.

Dynamic Response

As soon as the internal switch connects either input A or B to the output, the latter assumes the voltage on the respective input. There is a time constant related to each voltage transition, essentially given by the internal switch resistance (approx. 140 Ω), the internal output current limit (approx. ±490mA) and the capacitive load on the output, including all cables to an experimental setup. The following oscilloscope screen shots show voltage step transitions observed at the output with small (17pF) and medium capacitive loads (300pF) for further illustration.



Left frame: voltage step of 200V with small capacitive load (C=17pF); transient rise time (10% to 90% of voltage step size) is in the order of 25ns. Right frame: positive voltage step of 200V with medium capacitive load of C = 300pF.

Noise and Ripple

In contrast to other devices, the HS series devices feature a very low noise level. This makes them specially suited for ion traps, ion sources and low energy beam line applications. Each output exhibits a very low broadband noise (DC to 20MHz) of smaller than 350µV_{rms} and a low ripple level (50Hz) smaller 50µV_{rms}. In general the outputs are completely free of parasitic switching spikes in the RF region.

Specifications

Control Input	typ.	max.	Conditions and remarks
required drive level	0V and 5V	-2V to +6V vs. GND	
threshold	2.4V		
input impedance	1kΩ // 6pF		
drive rate / switching rate		1.5kHz	
Output Switch, static			
static resistance from A or B to OUT "on"-state	140Ω	200Ω	$\lvert I_{OUT} \rvert < 200mA$
isolation resistance from A or B to OUT	>10MΩ		voltage differences from A or B to OUT smaller or equal 200V
leakage currents from A or B to OUT	40nA*	200nA*	voltage differences from A or B to OUT smaller or equal 200V
intrinsic switch capacitance on OUT terminal vs. GND	25pF to 35pF		
Noise		$350\mu V_{rms}$	
Transfer characteristics			
delay from control input change to output reaction	450ns		200V output step size (positive or negative going)
delay jitter	0.4ns rms		T = 25°C +/-1°C
max. pulse duration		infinite	
min. pulse duration	6.6µs		
Output rise or fall time, 10% to 90% step size	25ns		capacitive load of 17pF (probe head)
	145ns		capacitive load of 300pF
Input Voltage Rating			
Input A or B vs. GND		+/-500V	both polarities may be applied vs. GND
Voltage difference from A to B		+500V	input A always needs to be on more positive level with respect to B
Fuse rating	500mA fast		fuse replaceable on rear side
Environmental Conditions			
Magnetic Field		max. 5 mT	
Storage Temperature		-55 C° to +85 C°	
Operating Humidity & Temperature	noncondensing relative humidity up to 95% between temperatures of +10°C and +35°C.		
Power Supply	AC input voltage $230V_{AC}$ at 50Hz. Fuse: medium fast blow 1.0A; Power Consumption 3.9W typ.		
Case dimensions	19.00" wide x 10" deep x 44mm height. Front-panel rack mount holes		

Note *): Inputs A and B feature 200 MΩ resistors to ground for protection against charge up.
Currents through these protection resistors add to the numbers mentioned above.

Device Variety

HS-200	single or dual version	Output voltages of maximum 200V span[1)]
HS-500	single or dual version	Output voltages of maximum 500V span[1)]
HS-1000 (obsolete)	single or dual version	Output voltages of max. 1000V span[1)]

Note [1)]: span is the maximum voltage difference between positive and negative inputs A and B.

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