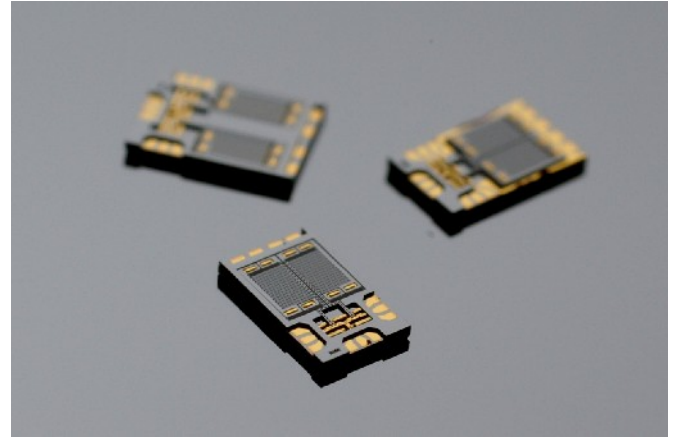


# Micromechanical RF Switches

## General Description

MEMS RF switches are miniaturized mechanical devices for switching high frequency electromagnetic signals. The advantages of MEMS RF switches compared to PIN diodes and field-effect transistors are minimum insertion loss, maximum isolation, a superior signal linearity, and a very low power consumption.

Protron's RF switches have metallic ohmic contacts which are actuated by silicon electrostatic comb drives. The switch concept can be adapted to frequencies from DC to ca. 26GHz. Hermetic zero-level packaging avoids contamination of the contact area. The switch is designed as a discrete chip suitable for flip-chip or wire bonding.



SPDT switches

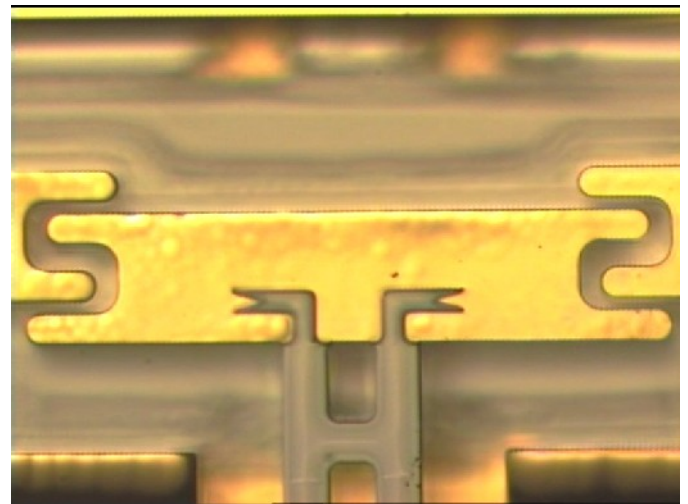
## Details

### Actuator

The electrostatic comb drive is made by deep reactive ion etching in single crystal silicon. The high aspect ratio and the high number of parallel plates result in a high contact force. Furthermore a pull out mechanism avoids the contact sticking and guaranties a good reliability.

### Waveguide, Contact

The coplanar waveguides of the switch and the ohmic contact structure are made of electroplated gold alloy. The massive structure enables the switching of signal powers up to several watts and possesses a small electrical resistance. Furthermore, the robust metallic contact guaranties a high durability.



Metal contact

## Main Features

- frequency range: DC to 26 GHz
- electrostatic silicon actuator
- low power consumption
- actuation voltage: 24V – 28V
- electroplated CPW lines
- electroplated ohmic contact
- superior insertion loss, isolation and linearity
- switching speed: approx. 0,2ms

## Design Variations

- SPST, SPDT
- impedance: 50 Ohm
- chip size: 1.6 x 2.8mm<sup>2</sup> to 3.0 x 2.8mm<sup>2</sup>
- flip-chip or wire bond connection
- custom specific designs on demand

### Preliminary Reliability Tests

- 36dBm hot switched: > 10<sup>5</sup> cycles
- 36dBm cold switched: > 10<sup>7</sup> cycles

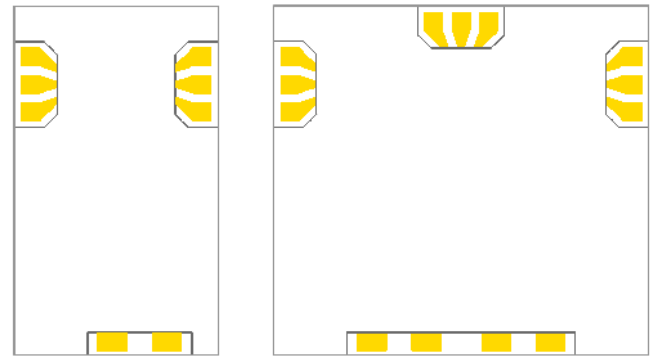
tests stopped without system failure

### Dimensions / Connection

SPST switch: 2.8 x 1.6mm<sup>2</sup>  
 SPDT switch: 2.8 x 3.0mm<sup>2</sup> (2.8 x 1.6mm<sup>2</sup> in development)  
 substrate height (pad layer): 200µm  
 cap height: 380µm  
 totally height: 580µm

coplanar waveguide pads: 150 x 150µm<sup>2</sup>, 70µm gap  
 actuator pads: 150 x 240µm<sup>2</sup>  
 electrical connection by wire bonding, flip chip design is in development

actuator connection: 24 - 28V for closing contacts  
 DC voltage is isolated from RF lines



SPST switch

SPDT switch

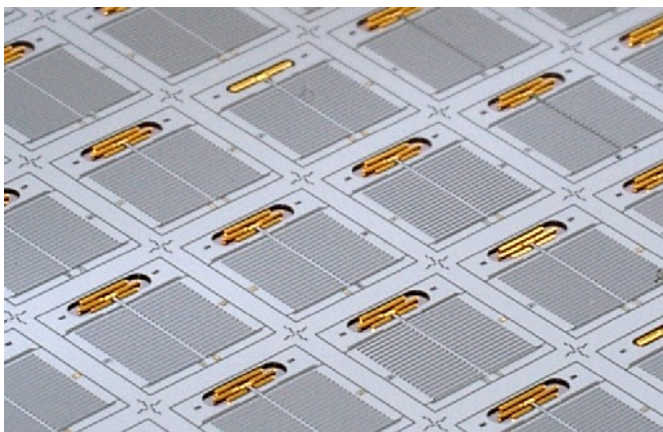
Coplanar waveguides on top, DC connection on bottom

### RF Performance (SPST switch)

- @ 5 GHz
- insertion loss: approx. 0,2dB
  - isolation: approx. 35dB
- @ 10 GHz
- insertion loss: approx. 0,3dB
  - isolation: approx. 30dB
- @ 20 GHz
- insertion loss: approx. 0,4dB
  - isolation: approx. 25dB

### RF Performance (SPDT switch)

- @ 2 GHz
- insertion loss: approx. 0,2dB
  - isolation: approx. 40dB
- @ 6 GHz
- insertion loss: approx. 0,3dB
  - isolation: approx. 25dB
- @ 12 GHz
- insertion loss: approx. 0,4dB
  - isolation: approx. 23dB



RF switches on wafer-level

### Contact

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