

GENERAL DESCRIPTION

RMI's RMSWXXX™ RF-MEMS switches are electrostatically actuated cantilever beams connected in a three terminal configuration. Functionality is analogous to a field effect transistor (FET), the terminals being labeled Source, Gate, and Drain (Figure 1). Operation of the device can be understood referring to Figure 2.

When a DC actuation voltage is applied between the Gate and Source, the resulting electrostatic force pulls the free end of the beam into contact with the Drain. When the voltage is removed, the beam acts as a spring, generating sufficient restoring force to open the connection between source and drain, thus breaking the circuit. In multi-throw switches, each throw is an independently actuated cantilever beam.

SWITCH ACTUATION

The gate to source actuation voltage is insensitive to polarity, i.e. the gate may be driven either positive or negative with respect to the source. The recommended actuation voltage is +/-100 V.

Since these are three terminal devices, note that the bias applied to the gate, V_{GS} , to actuate the switch must be made relative to the source. In the event that voltage of the signal being switched (i.e., conducted between the source and the drain) is not small compared with V_{GS} , (i.e., if V_S exceeds 5V) the gate voltage V_G will have to be varied to keep V_{GS} constant.

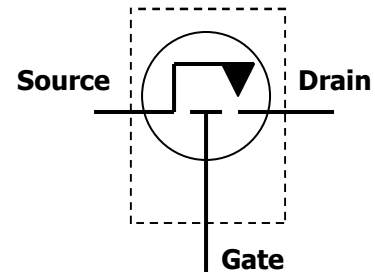


Figure 1 – Functional block diagram of SPST switch

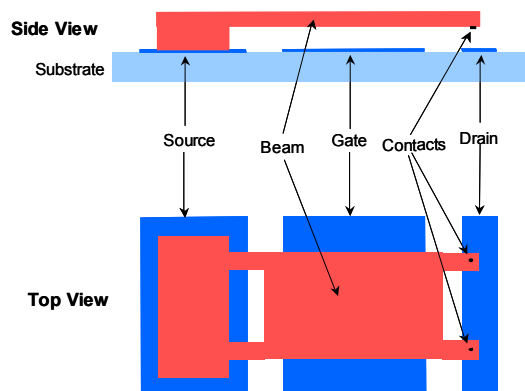


Figure 2 – Simplified representation of a switch

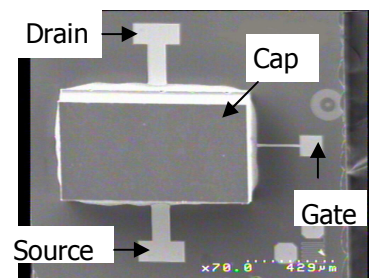
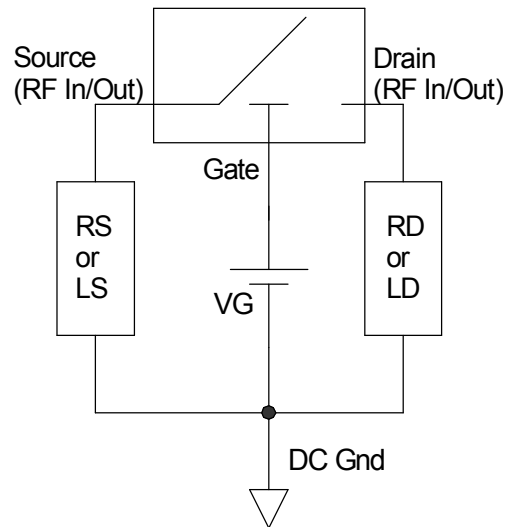


Figure 3 – SEM image of a RMSW100™ SPST Switch

RECOMMENDED APPLICATION

Parasitic capacitances in the test system will cause capacitive coupling of the actuation signal to the drain and source terminals. In order to minimize hot-switching caused by the coupled signals, a resistor RS (40 KΩ-100 KΩ) or inductor LS should be used to provide a path to DC Ground from the Source (each Source of a multi-throw switch). Similarly, a resistor RD (40 KΩ-100 KΩ) or inductor LD should be used to provide a path to DC Ground from the Drain (common Drain of a multi-throw switch).



DIE ASSEMBLY

The gold backside-metallization on the die is designed to be mounted with electrically conductive silver epoxy. Ball-bonds should be utilized to attach 1 mil wires (as many as three 1 mil wires may be used side by side) to the bond pads. Die should be handled with vacuum pickups, or alternatively with plastic tweezers.

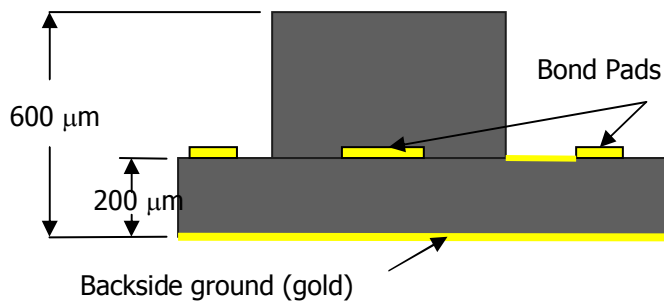


Figure 4 — Timing recommendations to assure cold switching

ESD AND TEST PRECAUTIONS

RMI's RF-MEMS switches have been fabricated without any ESD protection. Because of the extremely small size, low on-resistance, and minimal parasitic capacitance, the devices have a ESD (Human Body Model) sensitivity of 100 V. Stored charge inadvertently conducted through the switches can result in immediate permanent damage to the devices.

All handling precautions applicable to ESD-sensitive devices should be observed, including working only on static dissipative surfaces, wearing wrist-straps or other ESD control devices, storing unused devices in conductive foam, etc.

Care should also be taken connecting signals to these units under test:

- a. Avoid connecting "live" signal sources. Assure that outputs are switched off (preferably grounded) before connecting to devices under test. Assure that all instrumentation shares a common chassis ground.
- b. Avoid running measurement instruments (e.g. DMM's, etc.) in auto range modes. Some instruments can generate large transient compliance voltages when switching ranges.
- c. Use the highest practical range (i.e. lowest resolution) setting for resistance measurements. This will minimize compliance voltages.
- d. Where practical, avoid using coaxial cable for DC connections. Energy stored in the cable capacitance can be inadvertently discharged through a device under test.

COLD SWITCHING

The longest lifetime of the switches and best contact resistance stability will be achieved when they are cold-switched, that is, there is no difference between the drain and source potentials when the switch opens or closes. This assures that no additional energy is dissipated at the contacts during switching events. Here, a few measures are strongly recommended to assure cold-switching.

Parasitic capacitances in the test system will cause capacitive coupling of transitions in the gate bias signal to the drain and source terminals. In order to minimize hot-switching caused by the coupled signals:

- **the test system must provide a path (resistance 100 KΩ or less) from the drain and source terminals to ground;**
- **the bias applied to turn the switch on should have a minimum rise time (from 0 to the final value, V_{GS}) of 10 μs.**

Contact bounce will occur immediately after the switch closes (the duration of the bounce depends on the rise time of the gate bias signal). In order to avoid hot switching during contact bounce, **the switch signal (voltage between drain and source) should be applied a minimum of 5 μs after the final bias voltage, V_{GS} , is reached.**

Finally, the switch signal should be removed a minimum of 1 μs before the gate bias signal is removed.

The above timing recommendations are summarized in Figure 4.

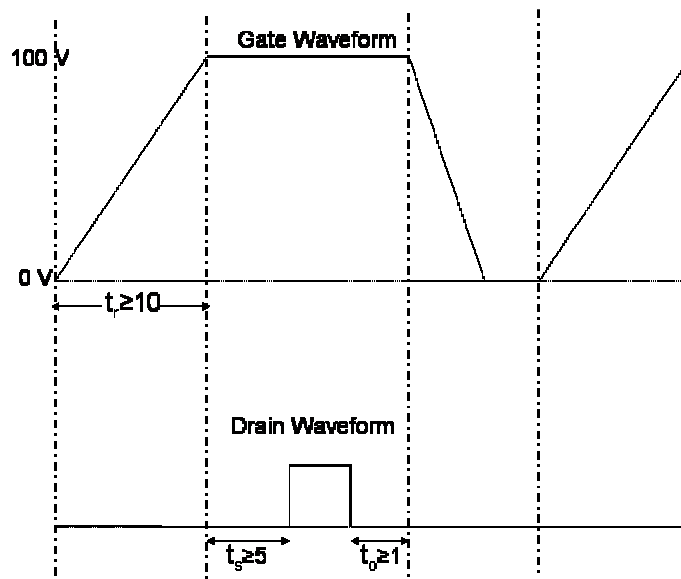


Figure 4 — Timing recommendations to assure cold switching