Analog Devices Welcomes Hittite Microwave Corporation

NO CONTENT ON THE ATTACHED DOCUMENT HAS CHANGED
Positive Voltage Control of MMIC
Multi-Throw Switches with Floating Ground Technique

Hittite Microwave Corporation developed multi-throw switches with onboard-decoders in the mid-1990’s. The Hittite Microwave SPNT switch product line includes non-reflective and reflective switches in standard configurations of HMC165S14 SP4T, HMC182S14 SP4T, HMC172QS24 SP6T, and HMC183QS24 SP8T. All are plastic encapsulated devices in industry standard SOIC and QSOP packages, readily used in automated assembly environments.

The decoder-on-board technology developed by Hittite Microwave provides the user with the advantage of a simplified control interface. Decoder topologies for each switch style are as follows: 2:4 decoder for the SP4T, 3:6 decoder for the SP6T, and 3:8 decoder for the SP8T switch. This directly simplifies board layout by reducing the number of driver lines required to control the switch. The reduction of control lines on the PCB serves directly to reduce pathways for RF crosstalk on the bias & control lines and ingress of signal from one channel to another thus enhancing isolation performance of the multi-throw switch. There is a −Vee bias requirement (-5.0 to -6.5 Vdc +/-10%) for each SPNT switch and the control lines accept negative logic voltages of; Low = 0.0 to -1.0 Vdc & High = Vee +/-0.25 Vdc.

The RF performance using Hittite Microwave proprietary driver & RF circuitry has inherently low loss & linear performance. The active elements of the circuit are depletion mode MESFET’s (Metal Semiconductor Field Effect Transistor) or “FETs”, a voltage controlled device. In standard operation, the drain & source of each FET is held at DC ground with the potential at the gate of the FET held at 0 volts placing the FET in the low loss or “on” state, and the potential of the gate held at -5 volts for the high impedance or “off” state.

The system designer may not have negative voltage bias & control signals readily available. The floating ground switch driver method described below can be used to enable positive bias & control operation of the GaAs multi-throw switch. By the use of blocking capacitors, pull-up resistors, and careful attention to layout details of the PCB, the floating ground switch driver approach can be used with good results and a minimum of additional circuitry.

Because the FET is a voltage controlled device there must be a potential difference of >-3.5 Vdc to <- 7 Vdc between the gate and drain-source channel to establish the certain pinch-off of the channel, therefore achieving the high loss or “off” state in the FET. This can be accomplished by holding the source and drain at +5 Vdc +/-10% and toggling the gate between 0 and +5 Vdc +/- 10% to change the state of the FET. All DC bias points and control signals are therefore raised +5Vdc from their normal potentials.

An example of this floating ground technique using microstrip transmission lines is shown in Figure 1 for the HMC182S14 SP4T non-ref-
FLOATING GROUND SPNT
MMIC SWITCH DRIVER TECHNIQUES

The bias pin, Vee, of the HMC182S14 must now be held to Vdc (DC ground) versus its normal non-floating bias of -5 to -6.5 Vdc. Direct connection to the HMC182S14 switch A & B control lines by the +5 Vdc biased 74HCT04 hex inverter (or any positive logic HCT TTL logic driver device) is now possible.

Table I shows the truth table of the HMC182S14 in positive bias operation for the floating ground circuit topology of Figure 1.

<table>
<thead>
<tr>
<th>TTL A Control Input</th>
<th>TTL B Control Input</th>
<th>RF Path “ON” State</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI</td>
<td>HI</td>
<td>RF to RF1</td>
</tr>
<tr>
<td>HI</td>
<td>LO</td>
<td>RF to RF2</td>
</tr>
<tr>
<td>LO</td>
<td>HI</td>
<td>RF to RF3</td>
</tr>
<tr>
<td>LO</td>
<td>LO</td>
<td>RF to RF4</td>
</tr>
</tbody>
</table>

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