Honeywell manufactures a line of digitally controlled RF Attenuators and Switches using Silicon On Insulator (SOI) CMOS technology. This application note defines the correct methods for AC coupling RF signals when using the RF Attenuators and Switches.

Refer to the full data sheet for the Attenuator and Switch performance specifications. The data sheet can be downloaded at www.honeywell.com/microwave.

RF SIGNAL PATH COUPLING

The attenuators and switches are designed for DC coupling of the RF signal with a ground reference. This is to support a wide operating frequency range and specifically low frequency operation. There are no internal DC blocking capacitors which limit the lower frequency. However, many applications require isolation of voltage levels between circuits. This application note will describe the alternative methods for correctly implementing AC coupling when it is required.

ATTENUATORS

Internal DC Ground Reference Operation

When the attenuator is programmed to attenuate the RF signal, a DC reference to ground is provided through a resistive network. This impedance will vary depending on the amount of attenuation.

When the attenuator is programmed to zero attenuation state (all control signals at logic 0), the DC ground reference is removed because the resistive attenuation networks are removed. Therefore, the RF signal path is “high impedance” relative to ground when in the zero attenuation state. External circuit elements must provide a DC ground reference in this state.

If the device is AC coupled on both sides and DC ground reference is not provided, the RF signal line is essentially “electrically floating” in this state. This may cause the attenuator to exhibit symptoms of unusually high or varying impedance at the “zero attenuation” state. All other attenuation states provide an internal DC ground reference through the attenuation elements.

Recommended AC Coupling

When the circuit application requires AC coupling to DC isolate adjacent circuits, AC coupling is allowed but a DC reference to ground must be provided. The introduction of AC coupling will also determine the low frequency cutoff.

AC Coupling – One side of device (Recommended)

It is recommended that AC coupling only be implemented on one side of the attenuator. See Figure 1. The input side is recommended to minimize any impact on frequency response of circuit. The external Circuit 2 will provide the DC reference.

AC Coupling – Both sides of device

If AC coupling on both sides of the attenuator is required, a DC ground reference must be provided. The absence of a ground reference can cause the internal circuits to “electrically float” and may exhibit unexpected performance. The configuration in Figure 2 must be avoided because it does not provide a DC ground reference.

A simple method to provide a DC ground reference is to add a resistor or inductor from the RF input to Ground. See Figure 3. This may be placed on either the input or the output of the attenuator. The resistor value range of 1k ohms to 200k ohms will work in a 50 ohm system. The performance is dependent on the user’s application circuit. The user should test several values to ensure overall system performance is maintained.

The addition of the resistor or inductor should be implemented with good RF design practices. The resistor placement should provide a high RF impedance at the system operating frequencies.
RF SWITCHES

The RF Switches are also DC coupled devices to maximize operating frequency range. If it required to AC couple the signals, a ground reference is required on the RF path. The I/O signals that are in the “OFF” state have 50 ohm terminations. Due to these 50 ohm terminations, the DC voltage on the OFF state pins should be at zero volts to eliminate DC current draw.

If switches are connected in series to provide higher switch fanout, only one ground reference is required for the RF signal path. See Figure 4.

Figure 2 - Incorrect AC Coupling (no ground ref.)

Figure 3 – DC Ground Reference provided if AC Coupled on both sides of device

Figure 4 – Ground Reference for cascade of RF switches

For further questions, please call for applications support at 800-323-8295 (USA toll free) or 763-954-2474 or visit our website at www.honeywell.com/microwave.

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