



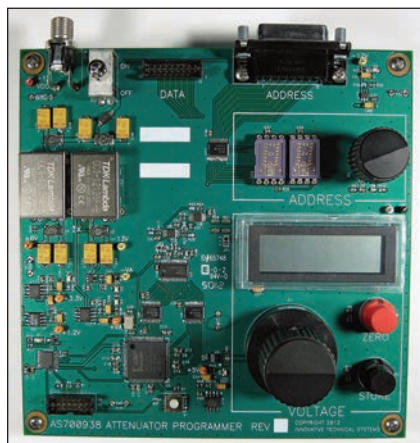
Ka-Band Digital Attenuator

Digitally controlled attenuators are the key components in communication, radar, instrumentation and automatic test systems. Broad bandwidth, high dynamic attenuation range, low insertion loss, high control resolution and fast control speed are key considerations in nearly all applications. Sage Millimeter has introduced a new line of digitally controlled attenuators offering the best of these parameters in Ka- through W-Band waveguide bands. These attenuators are configured with an analog PIN diode attenuator and a programmable digital driver that provide up to 8 bits of input control.

Over the entire Ka-Band frequency range from 26.5 to 40 GHz, the Sage Millimeter model SKA-2734033040-2828-D1 digitally controlled attenuator offers 3.0 dB insertion loss and 40 dB dynamic range. The attenuation flatness is ± 2.0 dB across the band with a CW power handling capability of +23 dBm. The attenuation level is controlled by a digitizing driver which features TTL control with up to 8 bits of resolution. The bias voltage required is ± 10 VDC/90 mA. The RF interfaces of the attenuator are with standard WR-28 waveguide with UG599/U flanges.

Without the digital driver, the attenuator can be used as an analog attenuator with control voltage from 0 to 5 V DC and current up to 25 mA.

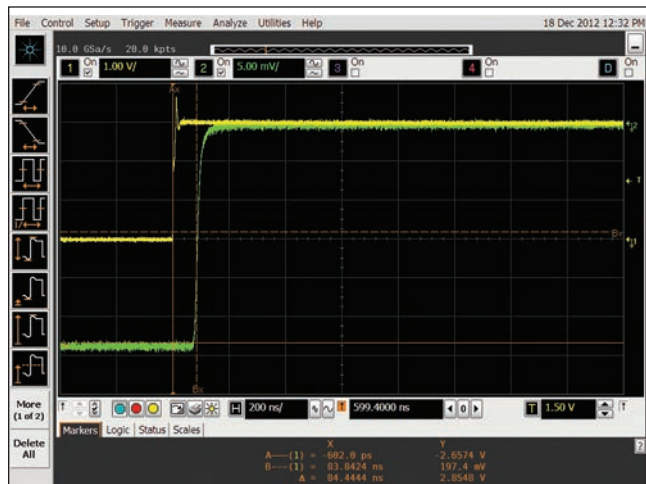
The digital attenuator driver is fully programmable and can be configured to operate with 1 to 8 bits of digital input data for the standard version, and up to 12 bits for custom versions. This allows the driver to be easily configured for different attenuation ranges and resolutions. Switching speed for the driver is under 80 nsec from the digital input to the analog voltage output from the driver. Overall digital-to-RF switching time is dependent upon the specific bias circuit design within the attenuator, but overall switching times under 100 nsec are achievable. The programmable digital driver consists of a digital input buffer that drives a static, non-volatile memory with 12 bit output that drives a high-speed DAC. Internally, the digital input word is sampled every 10 nsec to provide very fast update rates for the driver. A differential current-to-voltage converter transforms the DAC output and provides a single-ended drive to the PIN attenuator. A current-limiting resistor within the



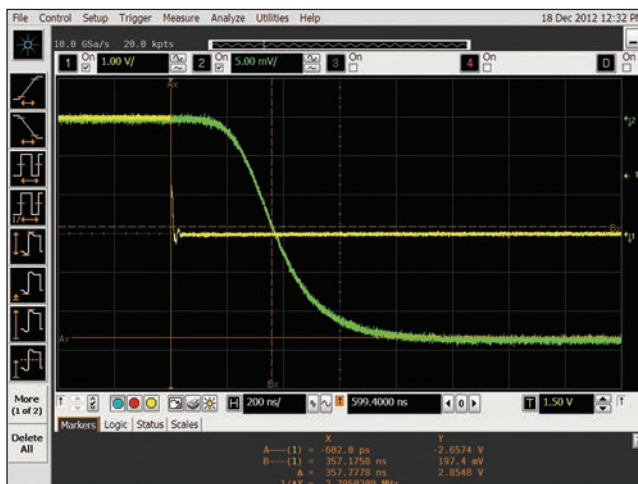
▲ Fig. 1 Programming board for programming attenuator driver.

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▲ Fig. 2 Attenuator switching time to 30 dB attenuation.



▲ Fig. 3 Attenuator switching time to low insertion loss state.

attenuator limits the overall current to the PIN diodes, but the 80 mA output capability of the driver will easily handle wide dynamic range attenuator designs with multiple PIN diodes.

Figure 1 shows the custom developed model SKA-WC-E01-P programming board for programming the attenuator driver. The program-

ming board is a standalone product designed for connecting directly to a programming header inside the driver enclosure, along with a ribbon cable to the driver sub-D connector. Programming the attenuator is a simple procedure that involves measuring the insertion loss of the attenuator on a network analyzer or power meter while dialing the setting knobs for a

specific data address and output voltage. The programmer can set the 8 bit digital input word to the driver and then allow the attenuator drive voltage to be set to any desired value with 12 bit resolution. Values are saved in the non-volatile driver memory by simply pressing a STORE button on the programmer. Once the programming is completed, the programmer is removed and the attenuator is ready for remote control or system use.

The featured digitally controlled attenuator was designed to provide over 40 dB of dynamic range with 1 dB attenuation resolution. Only a 6 bit digital input word was required for this resolution; however, due to the 12 bit DAC resolution within the driver, the accuracy of the attenuation could be set to within 0.25 dB of any desired attenuation value. The attenuator exhibits ± 0.25 dB attenuation accuracy and a switching time from the low insertion loss state to 30 dB attenuation in 84 nsec, as shown in **Figure 2**. Conversely, the switching time from 30 dB attenuation to the low insertion loss state was 357 nsec, as shown in **Figure 3**.

While the featured Ka-Band digitally controlled attenuator is packaged with a separate driver enclosure, an integrated version is available as a custom design. The attenuators are available in frequency bands from Ka- to W-Band under various model numbers.

VENDORVIEW

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