Programmable Direct-Reading Attenuators for Test & Measurement Applications

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For decades, direct-reading waveguide attenuators have provided users with the ability to easily adjust microwave signal levels over wide ranges with accuracy as good as 0.1 dB. Based on rotary vane designs that were first developed in the 1950s, direct-reading waveguide attenuators have endured as standard microwave lab equipment due to their accuracy, durability and flat frequency responses. More recently, direct-reading attenuator designs have advanced to subterahertz frequencies. Many now include stepper motors and internal electronics that enable remote control in automated test systems. Eravant's newly upgraded family of direct-reading and programmable attenuators provide the accuracy and "ease of use" expected in traditional attenuator designs, in addition to the remote control capability needed for automated test and measurement applications. An example of this family is shown in ***Figure 1***. The attenuators cover full waveguide bands ranging from 18 to 330 GHz as seen in ***Table 1***.

Fig. 1 **Direct-reading and programmable attenuators.**

A rotary vane attenuator has a circular waveguide section containing a thin, lossy

TABLE 1
ERAVANT DIRECT-READING AND PROGRAMMABLE ATTENUATOR FAMILY

Model	Waveguide Size	Frequency (GHz)	Attenuation Range (dB)
STA-40-03-S1	WR-03	220 to 330	40
STA-40-05-S1	WR-05	140 to 220	40
STA-60-06-S1	WR-06	110 to 170	60
STA-60-08-S1	WR-08	90 to 140	60
STA-60-10-S1	WR-10	75 to 110	60
STA-60-12-S1	WR-12	60 to 90	60
STA-60-15-S1	WR-15	50 to 75	60
STA-60-19-S1	WR-19	40 to 60	60
STA-60-22-S1	WR-22	33 to 50	60
STA-60-28-S1	WR-28	26.5 to 40	60
STA-60-34-S1	WR-34	22 to 33	60
STA-60-42-S1	WR-42	18 to 26.5	60

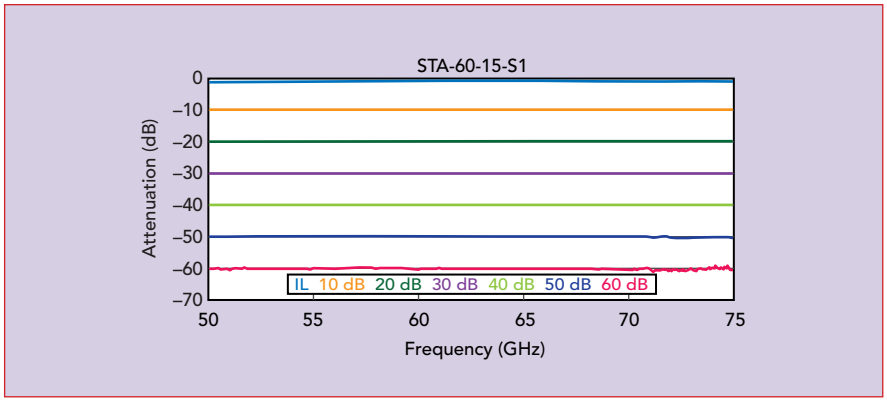

Fig. 2 **Frequency response of STA-60-15-S1.**

plate that functions as an attenuating vane. The vane absorbs a portion of the incident waveform with the amount of absorption depending on the orientation of the vane. The electric field component parallel to the vane is highly attenuated while the perpendicular field component is unaffected. Total attenuation follows a precise trigonometric function of the vane's angular position relative to the polarization of the incident waveform.

Manually operated rotary vane attenuators traditionally included a numerical scale and a mechanical indicator that provided a direct-reading of attenuation. The scale indicator and the circular waveguide containing the absorbing vane were mechanically linked to a rotary dial. A variety of motor-driven rotary vane attenuators were developed for automated test and measurement systems and other applications, but most could not be operated without a computer interface.

Eravant's direct-reading and programmable attenuators are hybrid instruments, capable of either manual or programmed operation. During manual operation, the user adjusts the attenuation by rotating a large dial. The attenuation value appears on an LCD screen powered by an internal rechargeable battery. With the attenuators in programmed mode, control is fully automated via a USB connection to a host computer. The USB connection emulates a serial port providing a reliable interface to automated test and measurement programs such as LabVIEW or VEE. The attenuator's command set allows setting the attenuation to a specified level, resetting the attenuation to the maximum level, or reading the current attenuation level. Setting up the controlling software entails selecting and configuring the communication port connected to the attenuator.

Attenuation flatness and accuracy have always been hallmarks of rotary vane attenuators. Eravant's direct-reading and programmable attenuators are no exception. Model STA-60-15-S1 operates from 50 to 75 GHz, providing accuracy of +/- 0.1 dB or 3 percent of the reading, whichever is larger, up to 40 dB, as seen in ***Figure 2***. Resolution is 0.1 dB for attenuation up to 10 dB, 0.2 dB for attenuation between 10 and 30 dB and 0.5 dB for attenuation between 30 and 40 dB. The typical return loss is 20 dB.

Automated measurement of amplifier responses using different levels of input power is a common application for programmable attenuators. A representative test setup to measure 1 dB compression is shown in ***Figure 3***. When such measurements are performed in a coaxial test environment using a typical network analyzer, the source power can be adjusted over a wide range using a variable attenuator internal to the instrument. When waveguide frequency extenders are involved, however, the test signal power cannot be controlled accurately by the network analyzer. By adding a waveguide attenuator to the test signal path, the signal power applied to the amplifier input can be controlled accurately.

A common amplifier test is to measure gain (S21) at various input power levels to determine

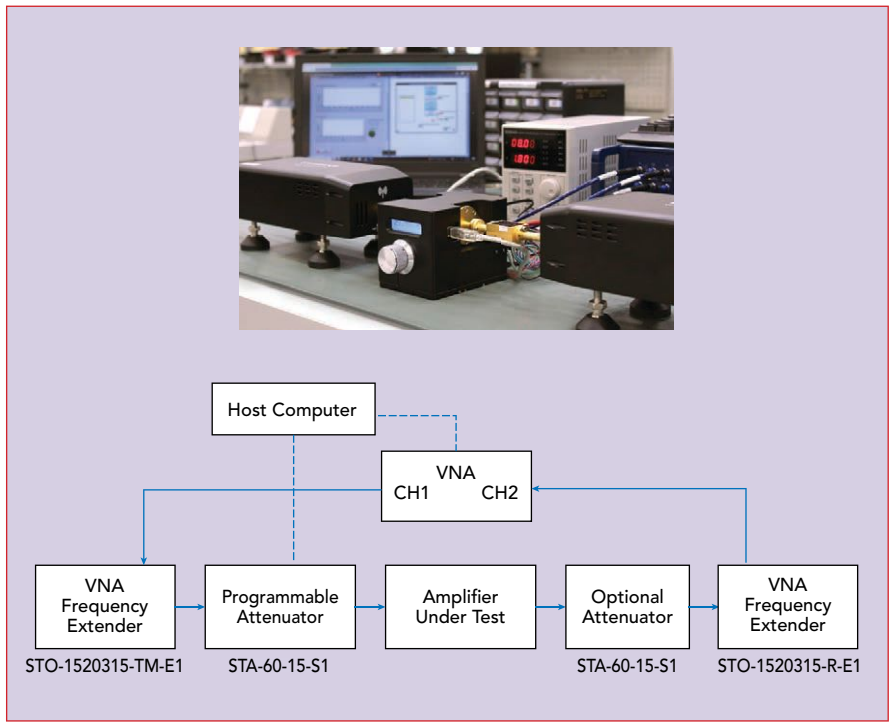

Fig. 3 **Measuring amplifier 1 dB gain-compression point with a 50 to 75 GHz test system.**

the 1 dB gain-compression point. In a coaxial test environment, this test is easily performed manually using an automatic network analyzer that allows the operator to vary the test signal amplitude. The measured amplifier response for a small input signal is saved and subsequently compared to new gain measurements taken at increasing power levels. When the gain trace decreases by 1 dB, the desired 1 dB compression point is reached and the test is concluded.

When using an external attenuator in the signal path between a pair of waveguide frequency extenders, the combined response of the attenuator and the DUT is measured for different levels of attenuation. As a result, manually finding the 1 dB compression point is more tedious. If only one variable attenuator is used, the test system operator must repeatedly vary the attenuation between a fixed high level and a variable low level, each time comparing the change in S21 to the change in the attenuator setting. If two variable attenuators are used at the input and output ports of the amplifier, both attenuators can be adjusted by equal amounts in opposite directions between gain measurements, thus simplifying the measurement task somewhat. With either approach the procedure is time-consuming and prone to operator errors, making it an excellent candidate for automated testing.

A wide range of other components can be measured or calibrated automatically using a programmable attenuator, including signal detectors, mixers, modulators and receivers. By allowing manual operation as well as automatic control, Eravant's direct-reading and programmable attenuators support the manual adjustments that are often required during calibration or verification procedures. Switching between manual and automated modes of operation is a fast and fail-safe task, providing maximum flexibility for various test system needs. In many new or upgraded test facilities, dual-use attenuators are economical and practical alternatives to separate sets of direct-reading attenuators and programmable attenuators.

VENDORVIEW

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