28 GHz Bidirectional 0 to 62 dB Voltage Controlled Variable Digital Attenuator for 5G Application

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***Abstract*—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. This paper shows the implementation, features, operation, and 5 G application of Bidirectional voltage variable digital attenuator with 0-62 dB attenuation range and how it is used to test 28 GHz 5 G signal.**

I. Introduction

The attenuator is one of the key components of modern communications. Therefore, the design of attenuator with high resolution, large attenuation, low insertion loss and low phase variation has great value, and very broad application prospects. 28 GHz Bidirectional 0-60 dB Voltage Controlled Digital Attenuator is a digital attenuator with attenuation range of 0-60 dB. The attenuation level is controlled by TTL signal. It comes in very small size and works in both directions. The RF signal can be transmitted and received simultaneously. The attenuation is varied between 0 to 62 dB range in 1 dB steps.

II. FEATURES

A. Bidirectional

The attenuator is bidirectional, and signal can be transmitted in any directional simultaneously. This feature is useful when the signal has to be transmitted and received simultaneously during 5G radio filed testing.

B. Digital Attenuator

The attenuator is 6 bit digital attenuator with 1dB LSB steps.

C. Small Size

The size is very small compared to programmable rotary vane attenuators and best for applications where the space is limited.

D. Excellent Attenuation Accuracy

The attenuator has excellent accuracy with +/-1 dB typical bit error.

E. Switching Characteristics

The proposed attenuator is much faster than programmable rotary vane attenuators. Rise and Fall time is 70 nano Seconds.

F. Wide Attenuation Range

The attenuator provides 0 to 62 dB attenuation range.

G. Insertion Loss

This attenuator provides 0 dB insertion Loss.

III. Specifications

A. Electrical Specifications

Frequency	**27.5 to 28.5 GHz**
Reference Insertion Loss	0 dB typical over band
Attenuation	1 dB LSB steps to 62 dB
Rise Time/Fall Time	Less than 70 nano Seconds
DC Bias	+8V@0.293A, +12 Volts maximum
TTL Control	+5V Maximum for TTL High
Input 1 dB Compression Point	20 dBm
Maximum RF Input Power (C.W.)	25 dBm maximum
Attenuation Accuracy	1 dB typ. Bit Error

B. Operating Precautions

a) Case Temperature of the digital Attenuator should never exceed above +60 degree Celcius.

b) Reverse Biasing will destroy the digital attenuator.

c) Power on Sequence: Apply +8 Volts and then TTL signals per attenuation.

d) Power off Sequence: Always turn off TTL signals before +8 V supply.

C. Physical Dimensions

Input Port	WR-28 Waveguide with UG-599/U
Output Port	WR-28 Waveguide with UG-599/U
TTL Port	Feed Thru Pins
DC Bias Pin	Feed Thru Pins

Material	Aluminum
Finish	Gold Plated
Size	1.5”X1.5”X1.5”
Weight	2 Ounces

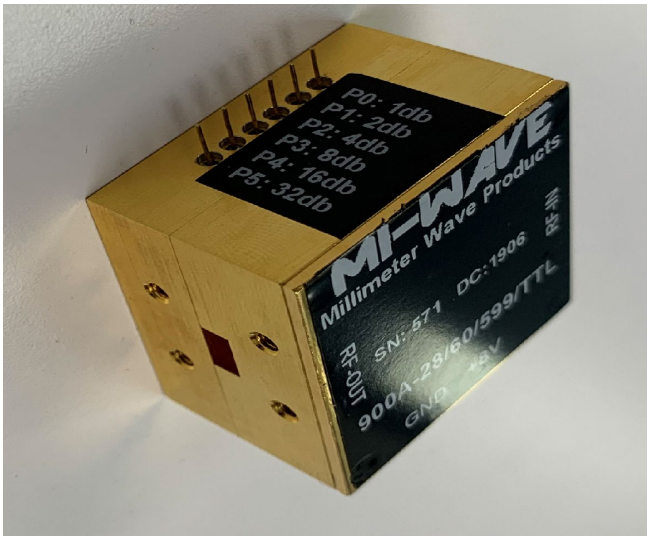
D. Truth Table

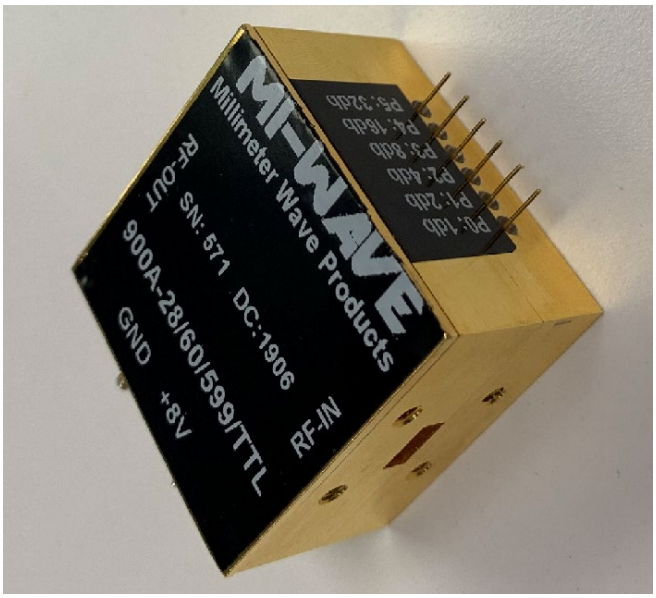
P5 32 dB	P4 16 dB	P3 8 dB	P2 4 dB	P1 2 dB	P0 1 dB	Attenuation State
High	High	High	High	High	High	Reference Insertion Loss
High	High	High	High	High	Low	1 dB
High	High	High	High	Low	High	2 dB
High	High	High	Low	High	High	4 dB
High	High	Low	High	High	High	8 dB
High	Low	High	High	High	High	16 dB
High	Low	Low	Low	Low	Low	31 dB
Low	Low	Low	Low	Low	Low	62 dB

- Any combination of the above states will provide an attenuation approximately equal to the sum of the bits selected.

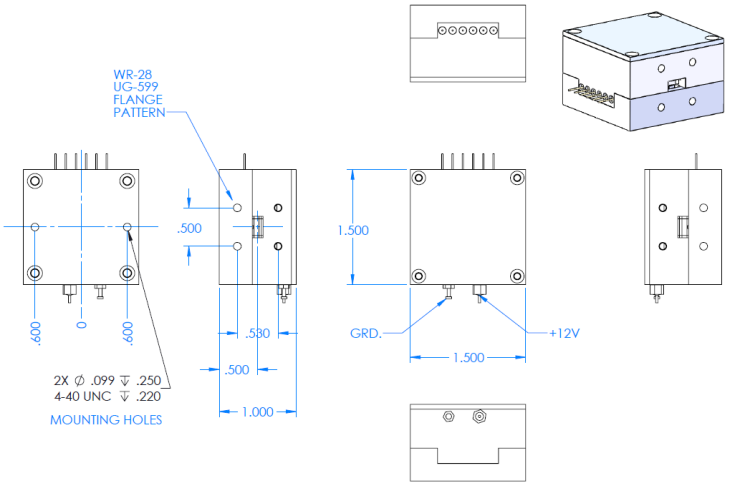
III. IMPLEMENTATION

Picture





Outline



IV. APPLICATION

- Fiber Optics & Broadband Telecom
- Microwave Radio & VSAT
- Military Radios, Radar & ECM
- Space Applications
- Sensors
- Test & Measurement Equipment
- 5G Radio Field Test