## Product Features

Operating Frequency: 10MHz ~ 4GHz

Attenuation Range: 0.5dB LSB Steps to 31.5dB

Parallel Control Interface

TTL/CMOS-Compatible Control

Maximum Attenuation Error:

± (0.4+2%* attenuation amount) dB

+5V/+3.3V Power Supply

Package: QFN24

## Application

4G Infrastructure and Hotspot Devices

Microcellular /3G/4G and UWB

WiMAX, WiBN & Fixed Wireless

Test Equipment and Sensors

Short-wave and Ultra-short-wave Wireless

Communication Equipment

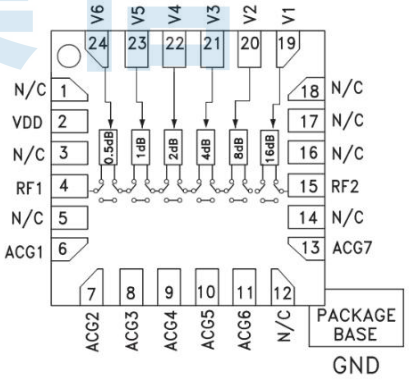
## Ordering Information

| Part Number | Package | Description |
|---|---|---|
| BR9155FP | QFN24 | 10MHz ~ 4GHz 6-bit Parallel Digital Attenuator |

## General Description

The BR9155FP is a wideband 6-bit digital attenuator in a low-cost leadless surface-mount QFN24 package. This single positive control line per bit digital attenuator incorporates off chip AC ground capacitors for near DC operation, making it suitable for a wide variety of RF and IF applications. Covering a frequency band of 10MHz to 4GHz, the BR9155FP typically offers insertion loss of less than 3dB, and can be programmed to provide an attenuation range of 31.75dB in 0.25dB steps with maximum attenuation error of ±(0.8+2%)dB. 6-bit TTL/CMOS control inputs are used to select each attenuation state. A single Vdd bias of +5V/+3.3V is required.

## Functional Block Diagram



## Electrical Specifications

| Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Insertion Loss | 0.01GHz to 1.0GHz | -1.0 | -1.3 | -1.7 | dB |
| | 1.0GHz to 4.0GHz | -1.7 | -2.5 | -3.1 | |
| Attenuation Range | 0.01GHz to 4.0GHz | 0.5 | - | 31.5 | dB |
| Input Return Loss | 0.01GHz to 4.0GHz | - | -15 | - | dB |
| Output Return Loss | 0.01GHz to 4.0GHz | - | -15 | - | dB |
| Attenuation Accuracy: (reference insertion loss)<br>0.5dB ~ 16dB attenuation state<br>16.5dB ~ 31.5dB attenuation state | 0.01GHz to 4.0GHz | ± (0.2+2%* attenuation amount)<br>± (0.4+2%* attenuation amount) | | | dB |
| Input Power for 1dB Compression | 0.6GHz to 2.5GHz | 32 | 33 | 34 | dBm |
| Input-Third-Order Interception | 0.05GHz ~ 4GHz | 38 | - | - | dBm |
| Switching Characteristics<br>Trise (50% CTL-90% RF)<br>Tfall (50% CTL-10% RF) | 200MHz at 16dB attenuation state | -<br>- | 70<br>70 | -<br>- | ns<br>ns |
| Test Conditions: VDD=+5V, I=3mA, Input IP3 spacing=1MHz, Pin=0dBm/tone, Temp.=+25℃ | | | | | |

## Absolute Maximum Ratings

Maximum Operating Voltage: +5.5V;

Maximum RF Input Power:

27dBm (All Attenuated states);

Control Voltage Range: 0V ~ VDD;

Note: Operation of the device outside the parameter ranges given absolute-maximum-ratings conditions may cause permanent damage, and exposure to absolute-maximum-ratings conditions for extended periods will affect the reliability.

## Recommended Operating Conditions

Supply Voltage: 5V/3.3V;

Control Voltage Threshold:

0V ~ 0.8V (low level);

2.7V ~ VDD (high level);

Storage Temperature: -65℃ ~ +150℃;

Operating Temperature: -55℃ ~ +125℃;

Supply Current: 3mA;

Note: when VDD=5V, Vctl=0V/3.3V can also work normally; But when VDD=3.3V, Vctl=0V/5V will not work properly.

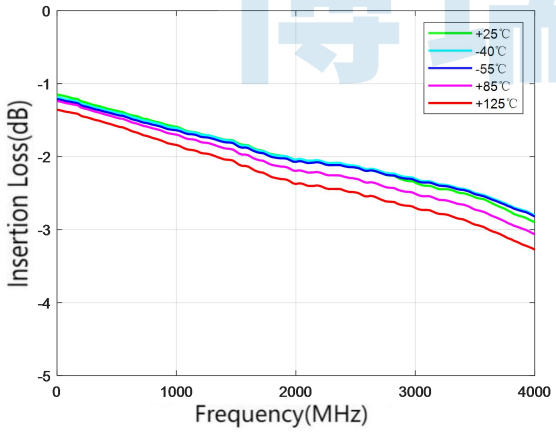
## ESD WARNING

**ELECTROSTATIC SENSITIVE DEVICE**

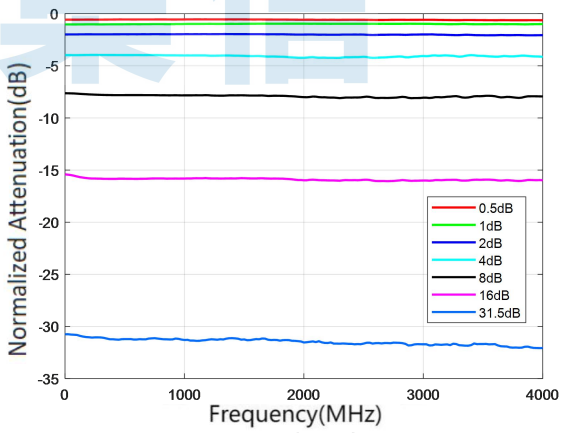
**OBSERVE HANDLING PRECAUTIONS**

## Typical Performance (EVB test results)

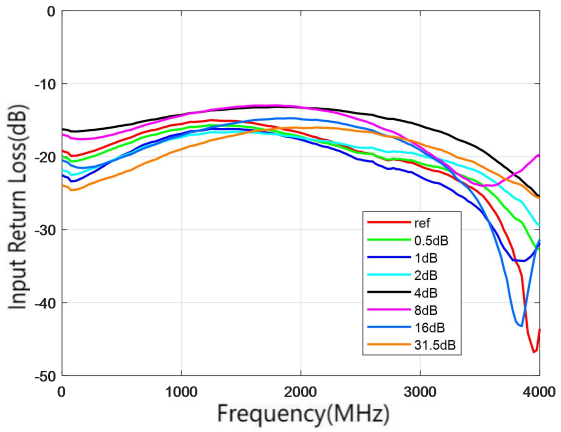
| Parameter | Typ. | | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| Frequency | 10 | 100 | 600 | 1000 | 2000 | 3000 | 4000 | MHz |
| Reference State Insertion loss | -1 | -1.2 | -1.4 | -1.6 | -2 | -2.3 | -2.9 | dB |
| Attenuation Accuracy (0.5dB) | -0.11 | -0.07 | -0.01 | -0.03 | -0.07 | -0.08 | -0.12 | dB |
| Attenuation Accuracy (1 dB) | -0.03 | -0.03 | 0.03 | 0.02 | 0.06 | 0.02 | 0.01 | dB |
| Attenuation Accuracy (2 dB) | -0.04 | -0.02 | 0.05 | 0.03 | -0.01 | -0.03 | -0.09 | dB |
| Attenuation Accuracy (4 dB) | 0.01 | -0.01 | 0.01 | -0.04 | -0.25 | -0.20 | -0.16 | dB |
| Attenuation Accuracy (8 dB) | 0.26 | 0.27 | 0.12 | 0.05 | -0.23 | -0.13 | 0.17 | dB |
| Attenuation Accuracy (16 dB) | 0.48 | 0.27 | 0.07 | 0.05 | -0.25 | -0.16 | -0.02 | dB |
| Attenuation Accuracy (31.5dB) | 0.67 | 0.47 | -0.08 | 0.31 | -0.37 | -0.41 | -0.76 | dB |
| Input Return Loss | -18.66 | -20.1 | -17.26 | -15.77 | -16.98 | -20.1 | -42 | dB |
| Output Return Loss | -19.43 | -20.1 | -17.26 | -15.77 | -18.96 | -24.8 | -30.76 | dB |
| Input Power for 1dB Compression | 13.6 | 22.5 | 30.6 | 31.7 | 33 | - | - | dBm |
| Switching Time | 66.7ns rise switch | | | | 66.7ns down switch | | | ns |
| Test Conditions: VDD=+5V, I=3mA, Temp. =+25℃ | | | | | | | | |



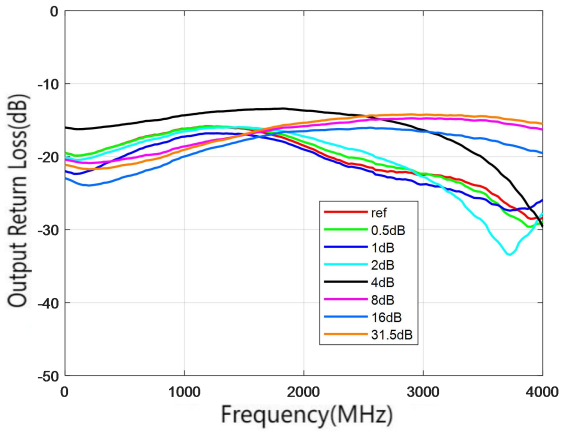

Insertion Loss



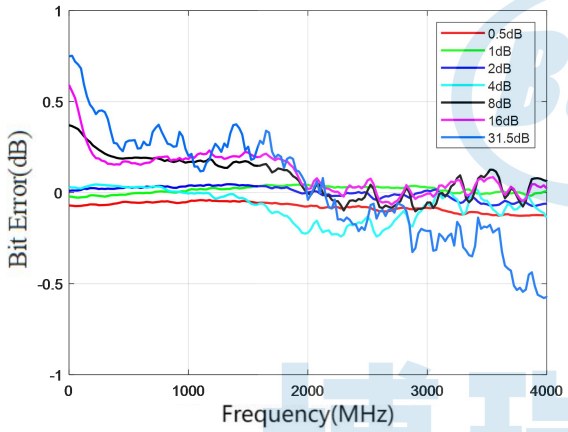

Normalized Attenuation



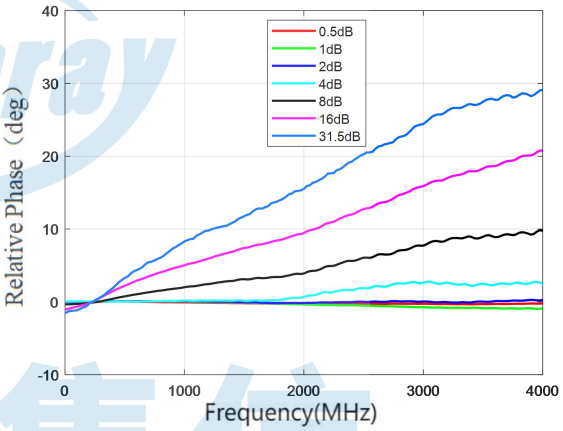

**Input Return Loss**



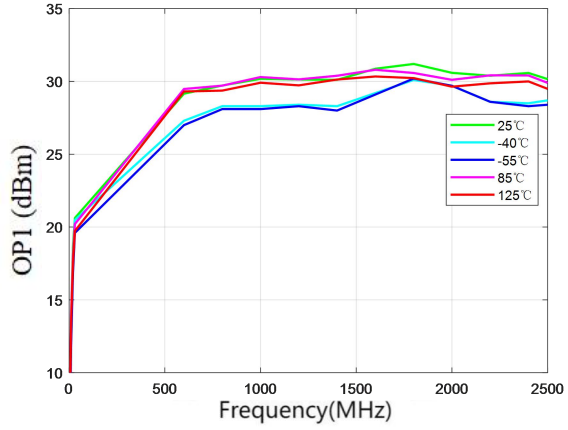

**Output Return Loss**




**Bit Error**

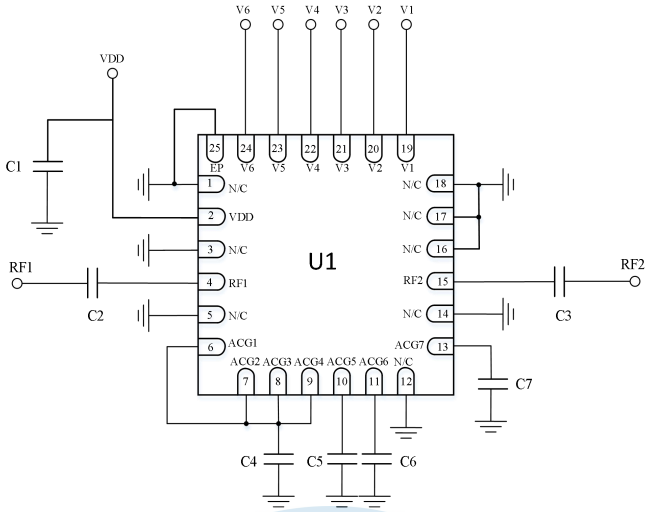



**Relative Phase**




**Input Power for 1dB Compression**

## Typical Application Schematic



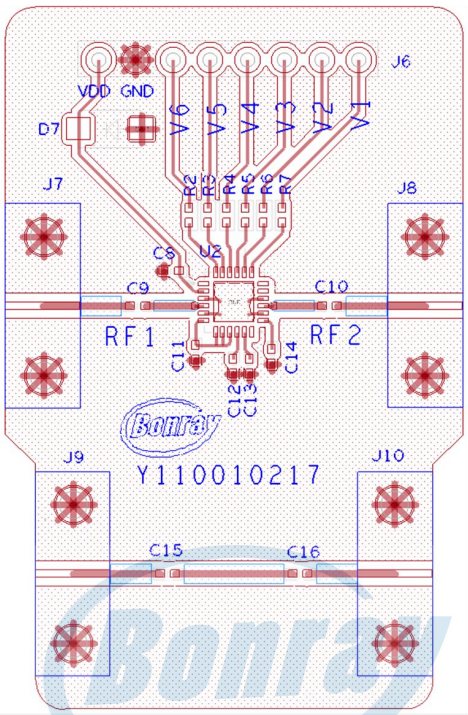

### Bill of Material

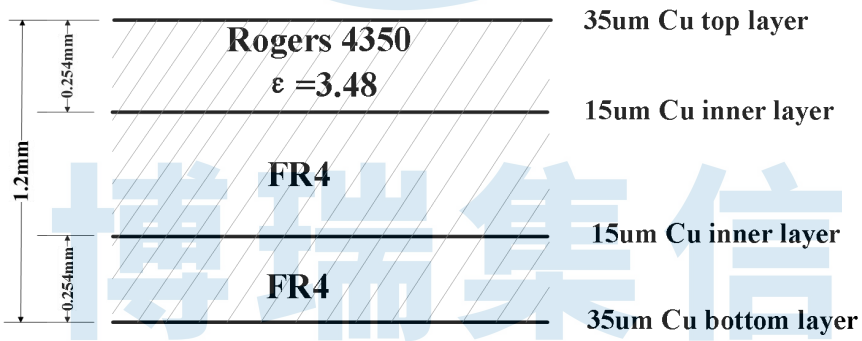
| Reference Designator | Package | Description | Part Number |
|---|---|---|---|
| C1 | 0402 | 1nF | GRM1555C1H102JA01D |
| C2~C7 | 0402 | 1uF | GRM1555C1H105JA01 |

### Control Voltage Truth Table

| Control Voltage Inputs | | | | | | Attenuation State RF1/RF2 |
|---|---|---|---|---|---|---|
| V1 16dB | V2 8dB | V3 4dB | V4 2dB | V5 1dB | V6 0.5 dB | |
| 1 | 1 | 1 | 1 | 1 | 1 | Insertion loss in reference state |
| 1 | 1 | 1 | 1 | 1 | 0 | 0.5 dB |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 dB |
| 1 | 1 | 1 | 0 | 1 | 1 | 2 dB |
| 1 | 1 | 0 | 1 | 1 | 1 | 4 dB |
| 1 | 0 | 1 | 1 | 1 | 1 | 8 dB |
| 0 | 1 | 1 | 1 | 1 | 1 | 16 dB |
| 0 | 0 | 0 | 0 | 0 | 0 | 31.5dB |
| Note: Any combination of the above states will provide an attenuation approximately equal to the sum of the bits selected. | | | | | | |

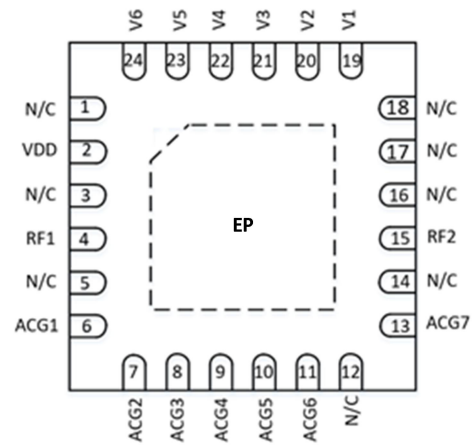
**PCB Evaluation Board**



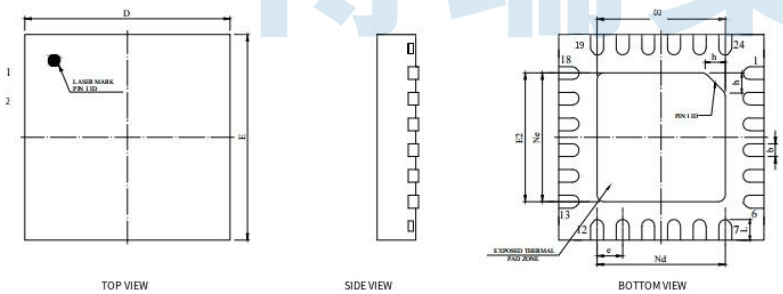

**50ohm transmission line:**
**width=0.53mm,spacing=0.53mm**

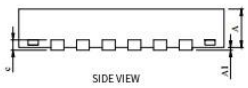
## Pin Configuration and Description




| Pin Number | Pin Name | Description |
|---|---|---|
| 1,3,5,12, 14,16,17,18 | N/C | No electrical connection. These pins should be connected to ground |
| 2 | VDD | Power supply pin. |
| 4, 15 | RF1, RF2 | Attenuator RF input/output pins. DC block is required. |
| 6 to 11,13 | ACG1 ~ ACG7 | External capacitors to ground are recommended for low and high frequency operation. Select value for lowest frequency of operation. Place capacitor as close to pins as possible. |
| 19～24 | V1-V6 | Parallel control voltage input pins. Select the required attenuation. See Truth Table. |
| - | EP | Exposed pin. The exposed pad must be connected to RF/DC ground. |

## Package Dimensions (mm)




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 0.75 | 0.80 | 0.85 |
| A1 | 0.01 | 0.02 | 0.05 |
| b | 0.20 | 0.25 | 0.30 |
| c | | 0.270REF | |
| D | 3.90 | 4.00 | 4.10 |
| D2 | 2.60 | 2.70 | 2.80 |
| e | | 0.50BSC | |
| Ne | | 2.50BSC | |
| Nd | | 2.50BSC | |
| E | 3.90 | 4.00 | 4.10 |
| E2 | 2.60 | 2.70 | 2.80 |
| L | 0.35 | 0.40 | 0.45 |
| h | 0.35 | 0.40 | 0.45 |