Product Features

Operating Frequency: DC~8GHz

Attenuation Range: 0.5dB LSB Steps to 31.5dB

Parallel Control Interface

TTL/CMOS-Compatible Control

Supply Voltage: +5V

Package: QFN24 (4mm×4mm)

Application

Communication Base Station

Test Equipment

Point-to-Point Communication

VHF/UHF Radio Station

Microcellular /3G/4G and UWB

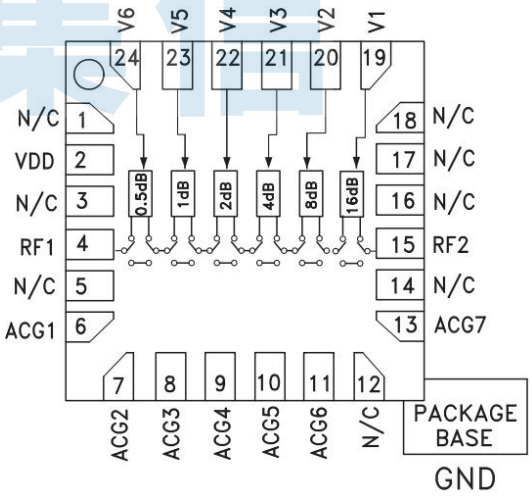
General Description

BR91531FPJ is a broadband 6-bit digital attenuator in a low-cost leadless surface-mount 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 DC to 8GHz, the digital attenuator typically offers insertion loss of less than 2.0dB, attenuator bit value of 0.5dB (LSB), 1dB, 2dB, 4dB, 8dB, and 16dB for a total attenuation of 31.5dB. 6-bit TTL/CMOS control inputs are used to select each attenuation state. A single Vdd bias of +5V/+3.3V is required.

Ordering Information

Part Number	Package	Description
BR91531FPJ	QFN24	DC~8GHz 6-Bit Parallel Digital Attenuator

Functional Block Diagram



Electrical Specifications

Parameter	Test Conditions	Min.	Typ.	Max.	Units
Insertion Loss	0.001GHz to 3.0GHz	0.9	1.3	1.6	dB
	3.0GHz to 8.0GHz	1.4	2.0	2.3	
Attenuation Range	0.001GHz to 8.0GHz	0.5	-	31.5	dB
Input Return Loss	0.001GHz to 8.0GHz	-	-17.9	-	dB
Output Return Loss	0.001GHz to 8.0GHz	-	-17.9	-	dB
Attenuation Accuracy: (Referenced to Insertion Loss) 0.5dB~4dB states 8dB to 31.5dB states	0.001GHz to 8.0GHz	±0.1 ±0.7			dB
Input Power for 1dB Compression	0.01GHz to 6GHz	20.6	36.4	37.4	dBm
Input Third-Order Interception	1GHz to 5GHz	42.7	48.0	-	dBm
Switching Characteristics Trise (50% CTL-90% RF) Tfall (50% CTL-10% RF)	200MHz at 16dB attenuation state	- -	65.0 42.6	- -	ns ns
Test Conditions: Vdd=+5V, I=3mA, IIP3 spacing=1MHz, Pout=10dBm/tone, Temp=+25℃					

Absolute Maximum Ratings

Maximum Supply Voltage (VDD): +7V

Maximum RF input Power: +28dBm (reference state)

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

Supply Current: 3mA

Control Voltage: 0V~1.1V (low)

1.6V~VDD (high)

Storage Temperature: -65℃ ~ +150℃

Operating Temperature: -55℃ ~ +125℃

Note: When VDD=5V, Vctrl=0V/3.3V, the attenuator can work normally; But when VDD=3.3V, Vctrl=0V/5V, the attenuator can not work normally.

ESD Warnings

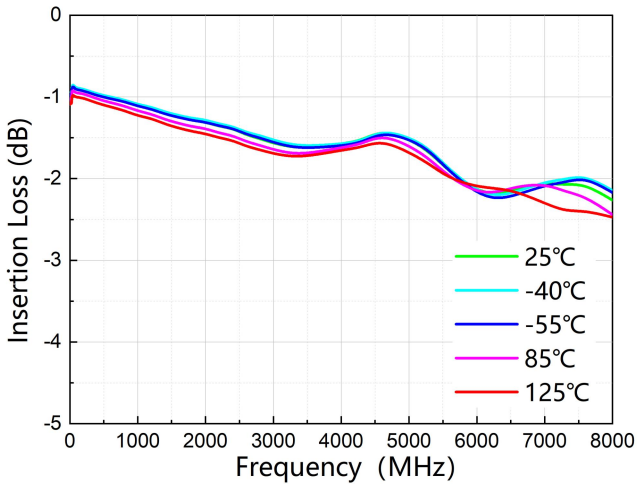
ELECTROSTATIC SENSITIVE DEVICE

OBSERVE HANDLING PRECAUTIONS

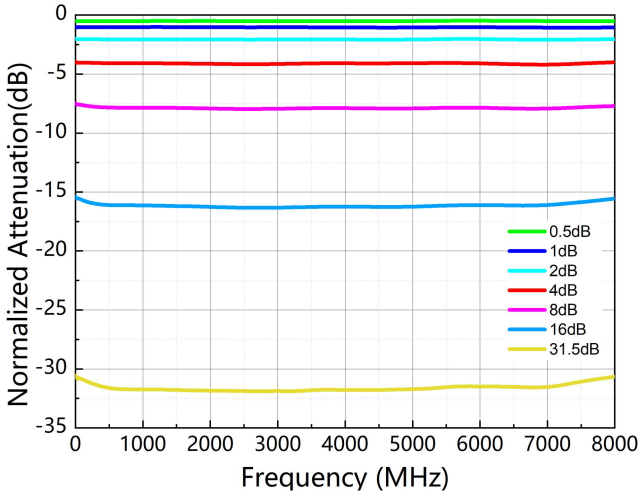
ESD Rating: Class 1C

Typical Performance (EVB test results)

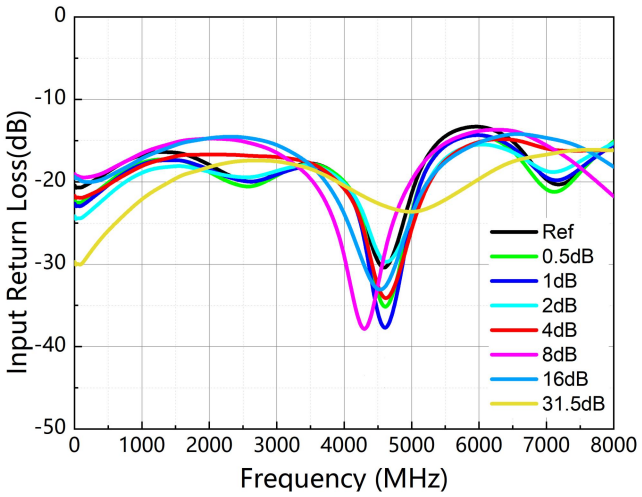
Parameter	Typ.							Units
Frequency	10	100	1000	2000	4000	6000	8000	MHz
Insertion Loss	-0.98	-0.90	-1.11	-1.31	-1.57	-2.15	-2.27	dB
Attenuation Accuracy (0.5dB)	-0.01	-0.02	-0.01	0.00	-0.02	0.03	-0.02	dB
Attenuation Accuracy (1dB)	-0.02	-0.03	-0.02	-0.02	-0.04	-0.02	-0.05	dB
Attenuation Accuracy (2dB)	-0.04	-0.04	-0.05	-0.06	-0.07	-0.03	-0.04	dB
Attenuation Accuracy (4dB)	-0.02	-0.03	-0.09	-0.13	-0.08	-0.08	0.01	dB
Attenuation Accuracy (8dB)	0.43	0.37	0.15	0.08	0.12	0.15	0.30	dB
Attenuation Accuracy (16dB)	0.49	0.32	-0.13	-0.26	-0.24	-0.11	0.45	dB
Attenuation accuracy (31.5dB)	0.84	0.63	-0.25	-0.33	-0.29	0.03	0.84	dB
Input Return Loss	-20.7	-20.7	-16.7	-17.9	-19.5	-13.1	-15.1	dB
Output Return Loss	-20.6	-20.5	-16.7	-17.9	-20.1	-12.6	-14.1	dB
Input Power for 1dB Compression	20.6	26.2	36.1	36.4	36.2	36.4	-	dBm
Switching Characteristics (16dB attenuation state)	65.0 T_{rise} (50% CTL-90% RF)				42.6 T_{fall} (50% CTL-10% RF)			ns
Test Conditions: Vdd=+5V, I=3mA, Temp=+25℃								



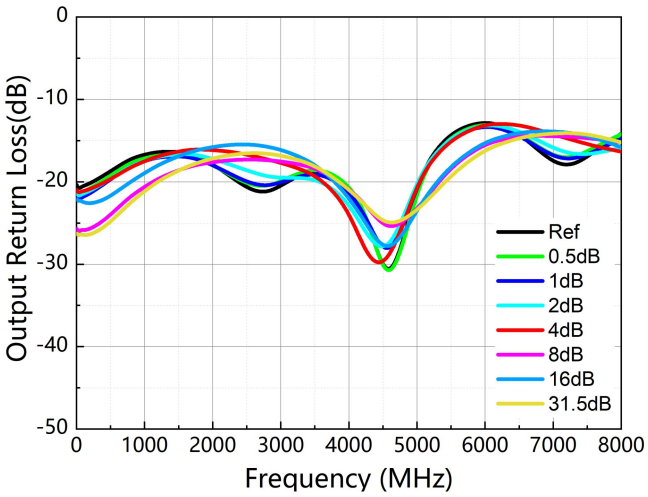
Insertion Loss vs. Freq



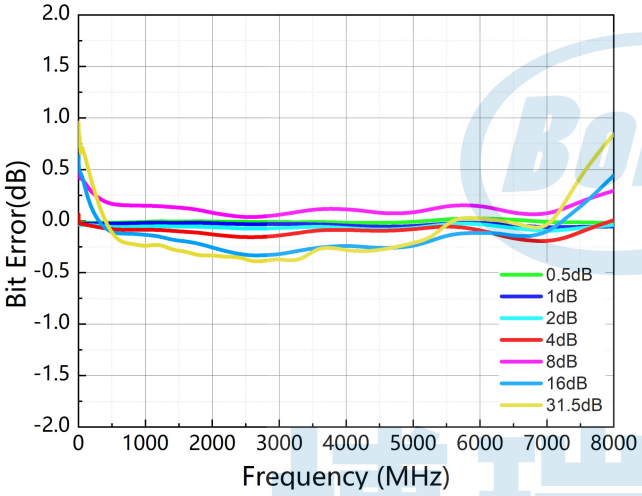
Normalized Attenuation vs. Freq



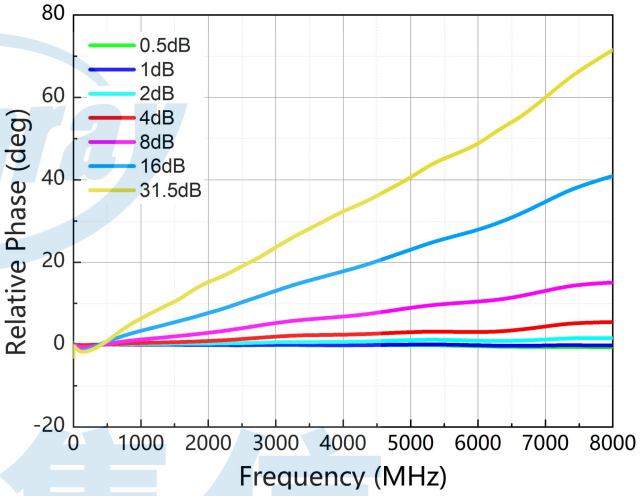
Input Return Loss vs. Freq



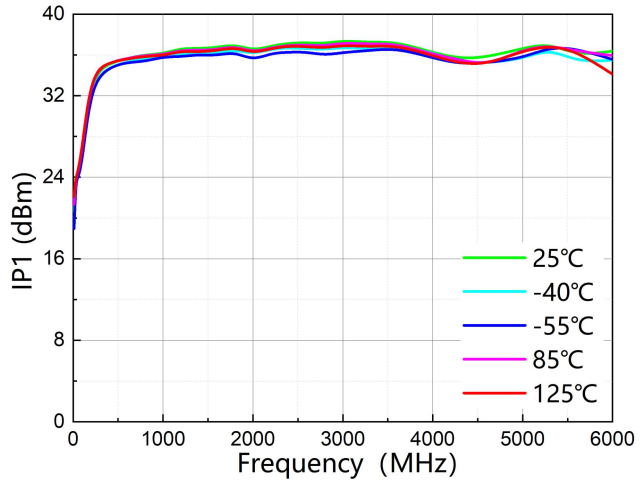
Output Return Loss vs. Freq



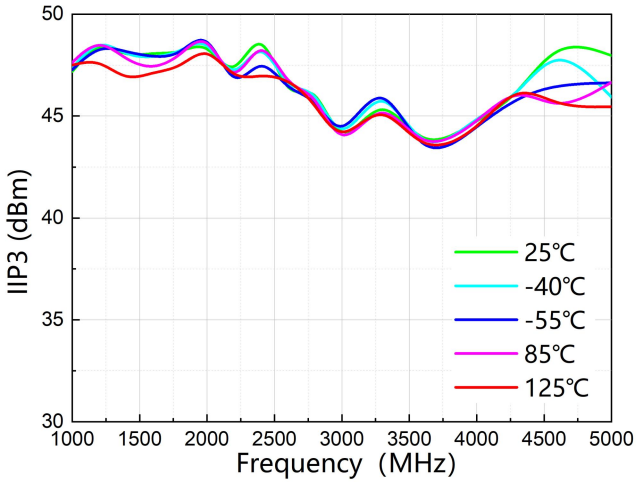
Bit Error vs. Freq



Relative Phase vs. Freq

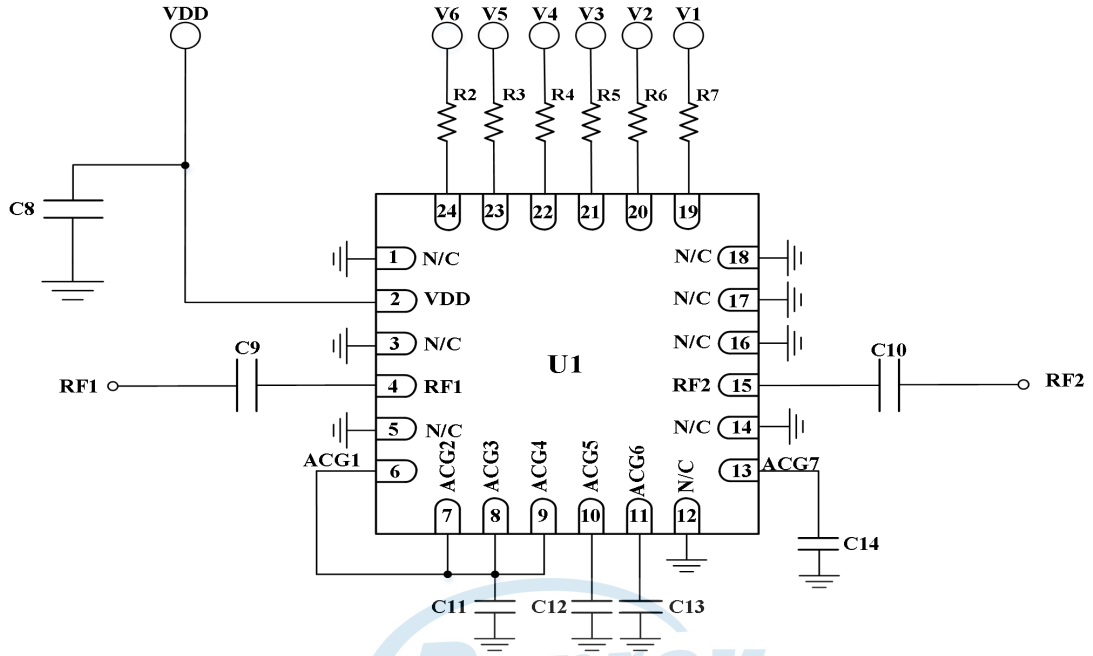


Input Power for 1dB Compression vs. Freq



Input Third-Order Interception vs. Freq

Typical Application Schematic



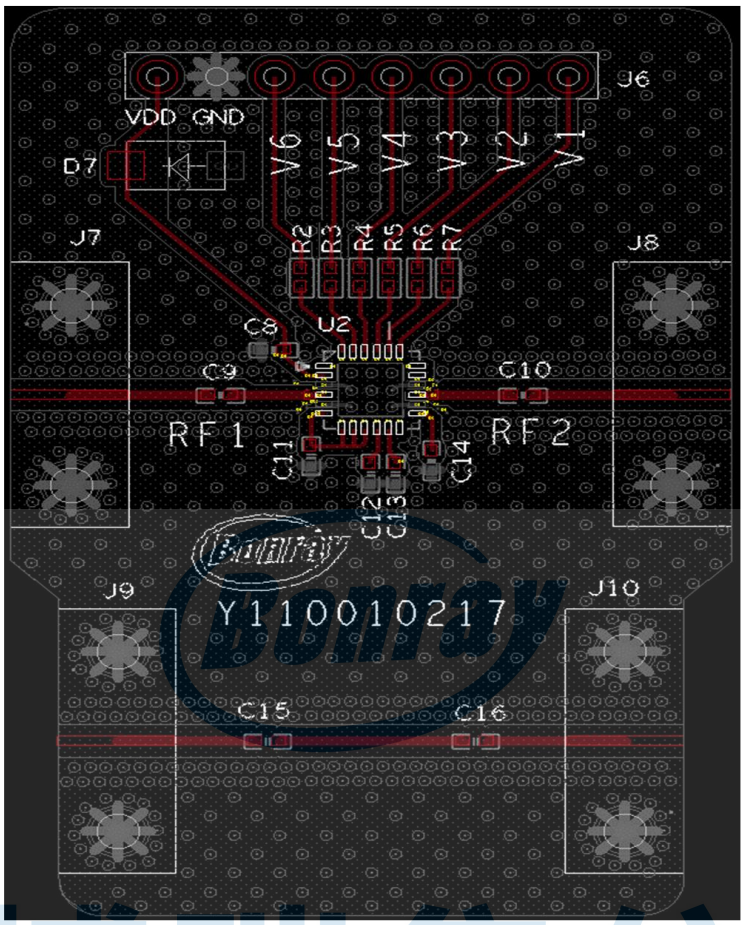
Bill of Material

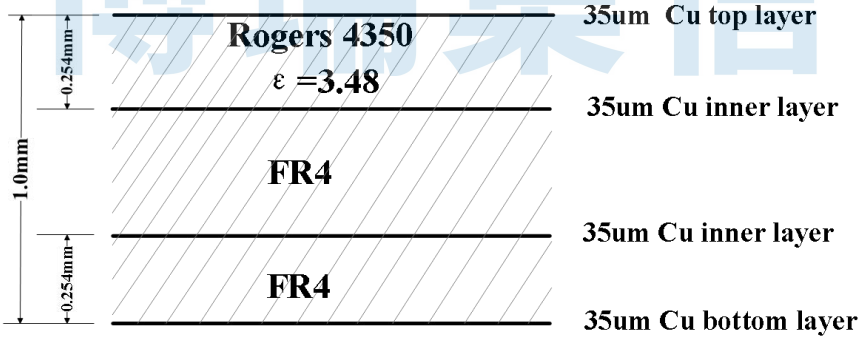
Reference Designator	Package	Value	P/N
C8	0402	1nF	GRM155R71H102KA37D
C9, C10	0402	100nF	GRM155R71H104KE14D
C11, C12, C13, C14	0402	1uF	GCM155C71A105KE38D
R2, R3, R4, R5, R6, R7	0402	100Ω	RC0402JR-07100RL

Truth Table

Control Voltage Input						Attenuation State RF1/RF2
V1 16dB	V2 8dB	V3 4dB	V4 2dB	V5 1dB	V6 0.5dB	
1	1	1	1	1	1	Insertion loss in reference state
1	1	1	1	1	0	0.5dB
1	1	1	1	0	1	1dB
1	1	1	0	1	1	2dB
1	1	0	1	1	1	4dB
1	0	1	1	1	1	8dB
0	1	1	1	1	1	16dB
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.						

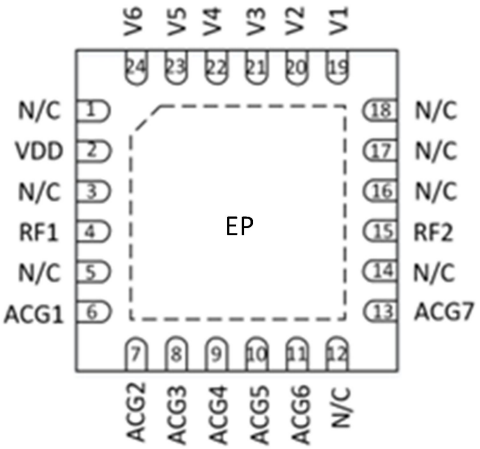
PCB Evaluation Board





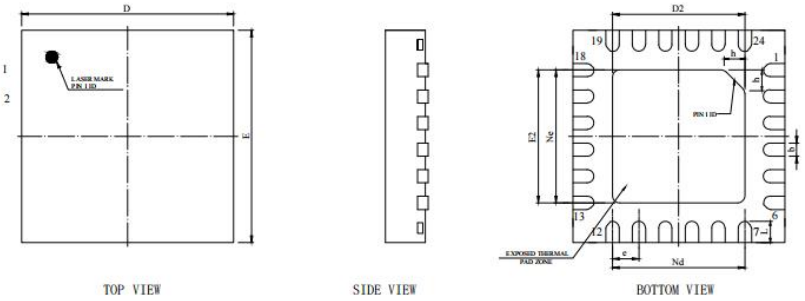
50ohm transmission line:
width=0.53mm,spacing=0.53mm

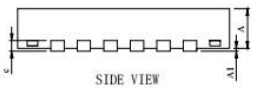
Pin Configuration and Description



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.
6~11,13	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