SKYWORKS

DATA SHEET

AA110-85, AA110-85LF: GaAs IC 5-Bit Digital Attenuator with Driver 1 dB LSB Positive Control DC–2 GHz

Features

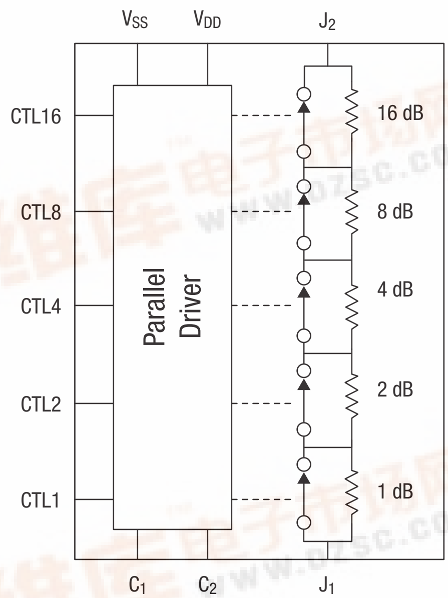
- Attenuation 1 dB steps to 31 dB with high accuracy
- Single positive control (3 V or 5 V) for each bit
- Low DC power consumption
- CMOS integrated silicon driver
- Designed for use at IF frequencies at input power levels > -10 dBm
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AA110-85 is a 5-bit, single positive control GaAs IC FET digital attenuator with driver. It is particularly suited at IF frequencies where high attenuation accuracy, low insertion loss and low intermodulation products are required. Typical applications include base station, wireless data, broadband and wireless local loop gain control circuits. For low-power applications (< -10 dBm) see part number AA117-85.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram

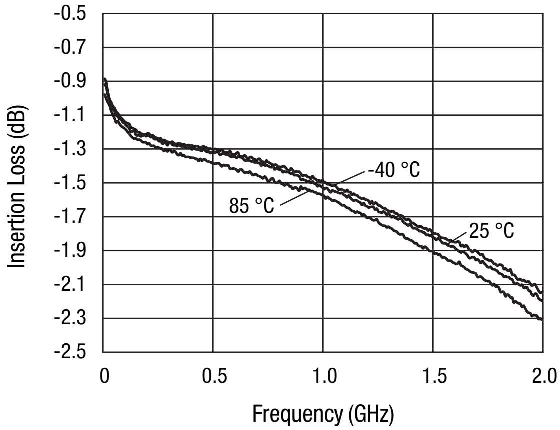


Electrical Specifications at -40 °C to +85 °C (V_{CC} = 5 V)

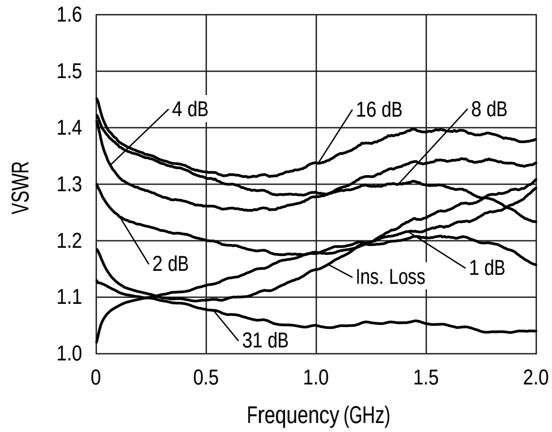
Parameter[1]	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]		DC–0.5 GHz DC–1.0 GHz DC–2.0 GHz		1.4 1.7 2.2	1.7 2.1 2.6	dB dB dB
Attenuation range				31		dB
Attenuation accuracy[3]		DC–0.5 GHz DC–1.0 GHz DC–2.0 GHz	± (0.2 + 2% of Attenuation Setting in dB) ± (0.25 + 3% of Attenuation Setting in dB) ± (0.4 + 6% of Attenuation Setting in dB)			dB dB dB
VSWR (I/O)[4]		DC–2.0 GHz		1.5:1	1.8:1	
Switching characteristics Rise, fall On, off Video feedthru	 10/90% or 90/10% RF) 50% CTL to 90/10% RF) T_{RISE} = 1 ns, BW = 500 MHz			 15 50 50		 ns ns mV
Input power for 1 dB compression	V_{CC} = 5 V	0.5–2.0 GHz 0.05 GHz	22 16	27 20		dBm dBm
Intermodulation intercept point (IP3)	For two-tone input power 5 dBm V_{CC} = 5 V	0.5–2.0 GHz 0.05 GHz	40 28	46 34		dBm dBm
Thermal resistance				85		°C/W
Supply voltage	V_{CC} = 5 V @ 750 μA typ., 1 μA max.					
Control voltages	CTL1, CTL2, CTL4, CTL8, CTL16, low = 0 to 0.8 V @ 20 μA typ. CTL1, CTL2, CTL4, CTL8, CTL16, high = 3 to 5 V @ 20 μA typ.					

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Attenuation referenced to insertion loss.
4. Input/output.

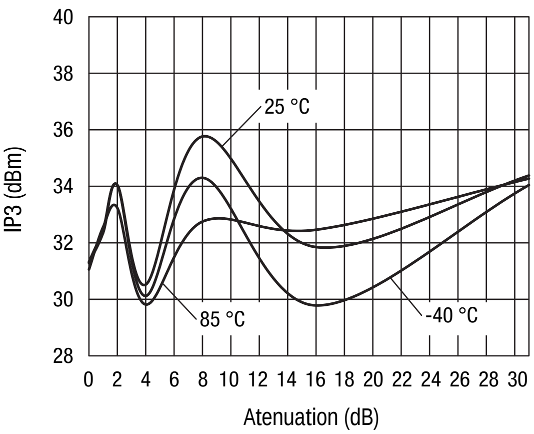
Typical Performance Data (V_{CC} = 5 V, Z_0 = 50 Ω)



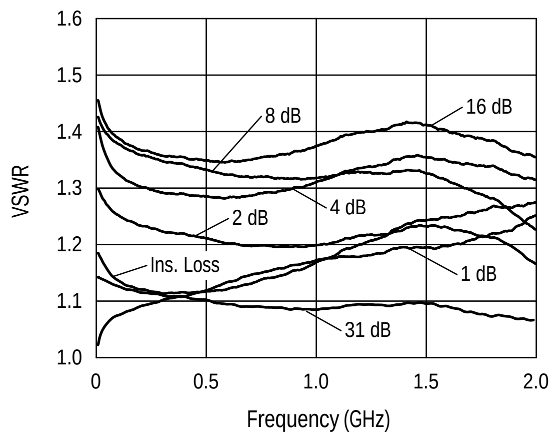
Insertion Loss vs. Frequency



VSWR vs. Frequency (25 °C)



IP3 vs. Attenuation and Temperature, Main Bits (50 MHz) V_{SS} = 5 V

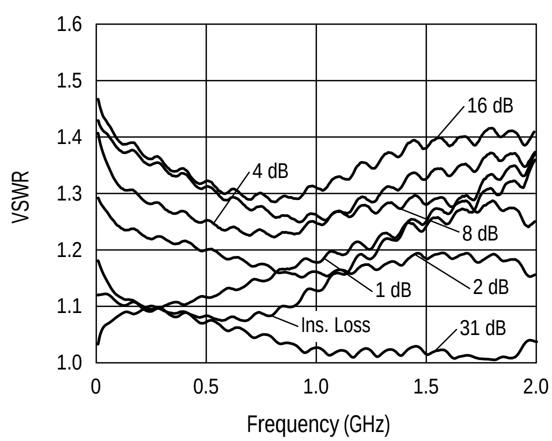


VSWR vs. Frequency (85 °C)

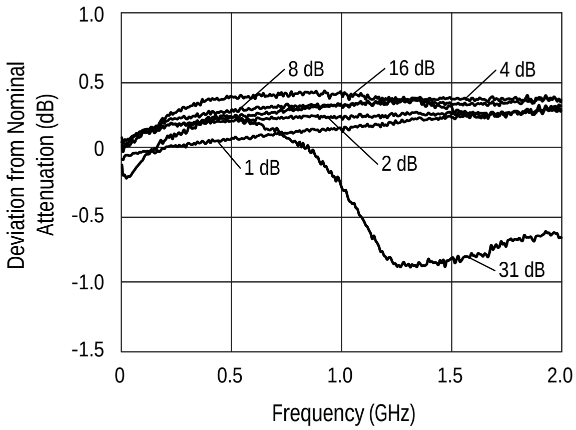
Compression Point vs. Attenuation, Voltage, and Temperature

Attenuation State	Control Voltage (V)	Input Power @ 1 dB Compression		
		25 °C (dBm)	85 °C (dBm)	-40 °C (dBm)
Ins. loss	5	17.2	17.3	19.9
1 dB	5	18.1	18.2	17.8
2 dB	5	19.3	19.5	19.2
4 dB	5	16.9	16.9	16.8
8 dB	5	21.3	21.6	22.4
16 dB	5	18.6	17.8	18.5
31 dB	5	21.4	21.1	21.3

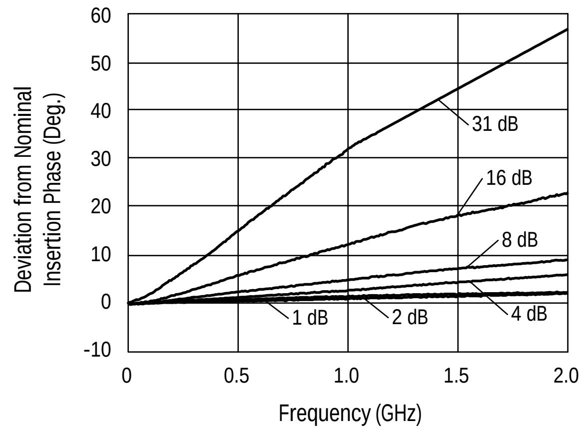
Frequency = 50 MHz.



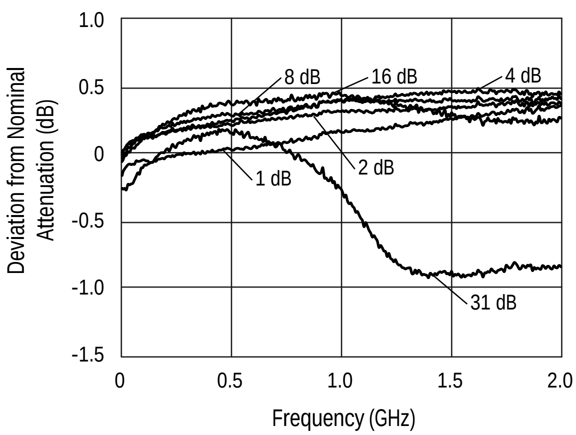
VSWR vs. Frequency (-40 °C)



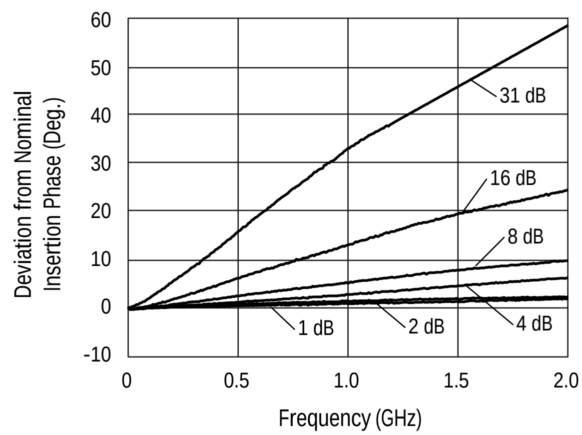
Attenuation Accuracy vs. Frequency (25 °C)



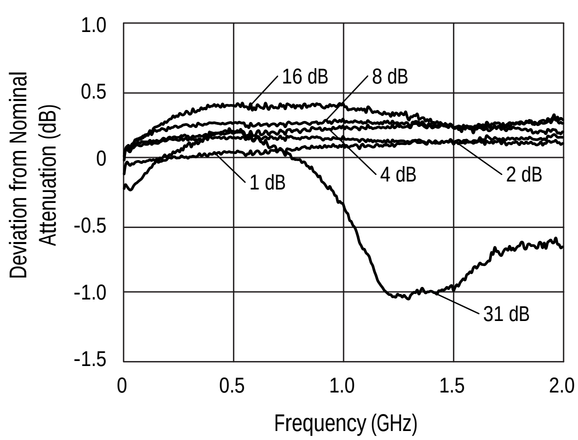
Attenuation Phase Accuracy vs. Frequency (25 °C)



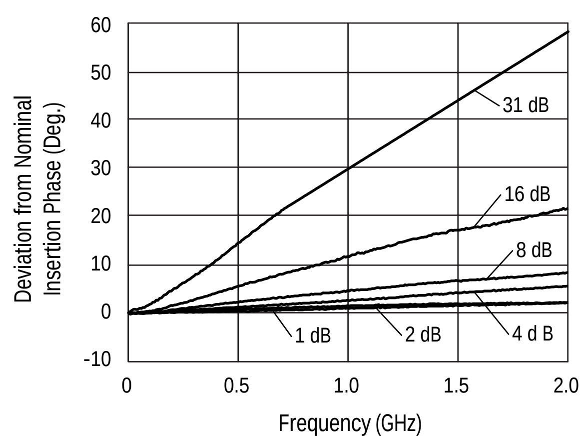
Attenuation Accuracy vs. Frequency (85 °C)



Attenuation Phase Accuracy vs. Frequency (85 °C)

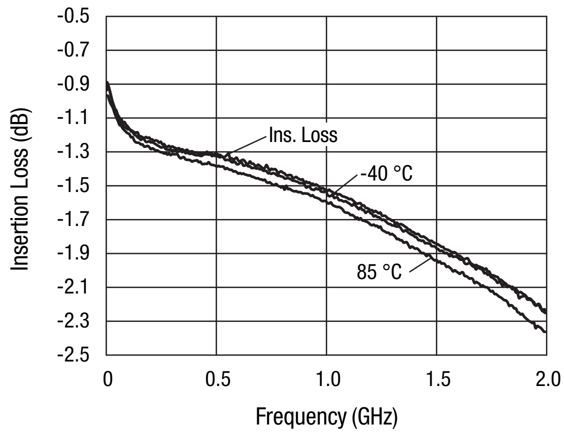


Attenuation Accuracy vs. Frequency (-40 °C)

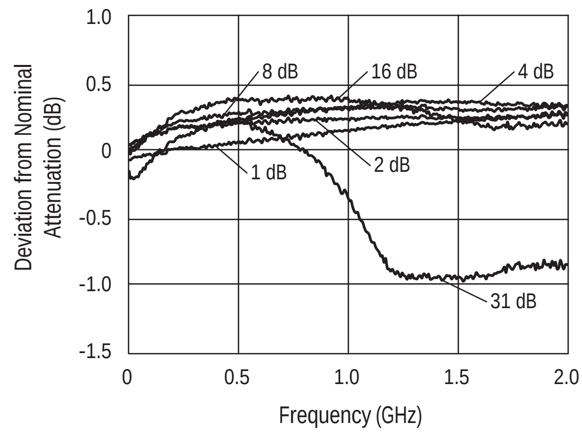


Attenuation Phase Accuracy vs. Frequency (-40 °C)

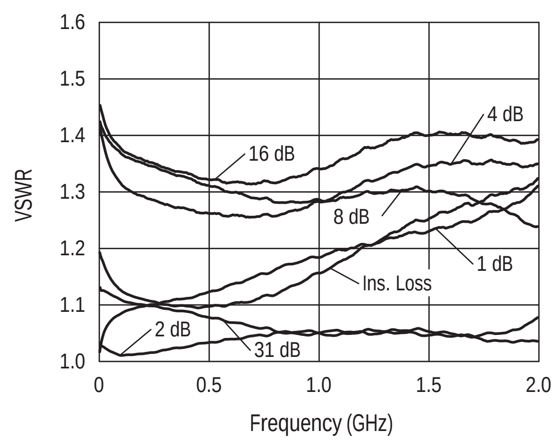
Typical Performance Data (V_{CC} = 3 V, Z_0 = 50 Ω)



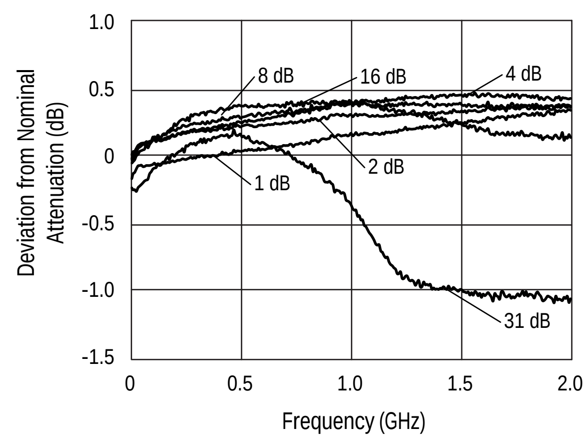
Insertion Loss vs. Frequency



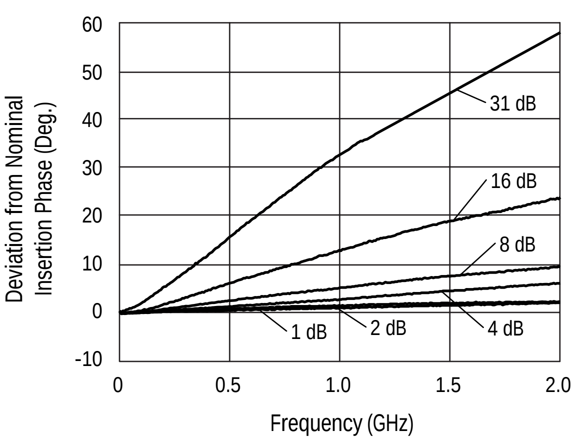
Attenuation Accuracy vs. Frequency (25 ˚C)



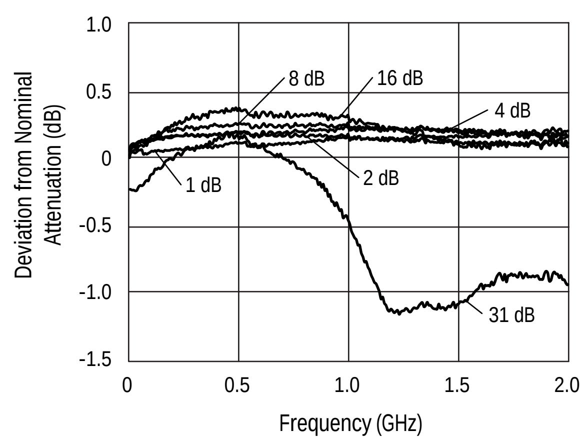
VSWR vs. Frequency (25 ˚C)



Attenuation Accuracy vs. Frequency (85 ˚C)



Attenuation Phase Accuracy vs. Frequency (25 ˚C)



Attenuation Accuracy vs. Frequency (-40 ˚C)

Compression Point vs. Attenuation, Voltage, and Temperature

Attenuation State	Control Voltage (V)	Input Power @ 1 dB Compression		
		25 °C (dBm)	85 °C (dBm)	-40 °C (dBm)
Ins. Loss	3	16.6	16.6	16.5
1 dB	3	17.5	17.5	17.5
2 dB	3	18.9	19	18.8
4 dB	3	16.3	16.6	16.3
8 dB	3	20.6	21.1	21.8
16 dB	3	15.5	15.1	16.2
31 dB	3	20.2	19.9	20.1

Frequency = 50 MHz.

Truth Table

CTL1	CTL2	CTL4	CTL8	CTL16	Attenuation $J_1–J_2$
0	0	0	0	0	Ins. loss
1	0	0	0	0	1 dB
0	1	0	0	0	2 dB
0	0	1	0	0	4 dB
0	0	0	1	0	8 dB
0	0	0	0	1	16 dB
1	1	1	1	1	31 dB

"0" = 0 to 0.8 V (V_{CC} = 5 V).
"1" = 3 to 5 V (V_{CC} = 5 V).

Application Information

The control FETs that switch fixed attenuator sections into or out of the main signal path in AA110-85 require negative source voltage (V_{CC}) for proper operation. The AA110-85 includes an internal negative voltage generator with a charge pump. The charge pump oscillator operates at approximately 600 kHz. This signal and its harmonics can couple into the RF signal path, which can degrade signal to noise ratio for frequencies less than approximately 200 MHz. The signal to noise ratio for operation at frequencies above approximately 200 MHz is not affected.

For applications where the input signal amplitude is less than -10 dBm and its frequency is less than approximately 200 MHz, the AA117-85 is recommended. This part is identical to AA110-85, but with the internal negative voltage generator circuit disabled. Consequently, an external negative voltage source is required for proper operation. Please refer to the data sheet for AA117-85, available at www.skyworksinc.com.

Absolute Maximum Ratings

Characteristic	Value
RF input power	2 W > 500 MHz, 0/6 V 0.5 W > 50 MHz, 0/6 V
Supply voltage	6 V
Control voltage[1]	-0.2 V, +6 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

1. Control voltage must not exceed supply voltage.
Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

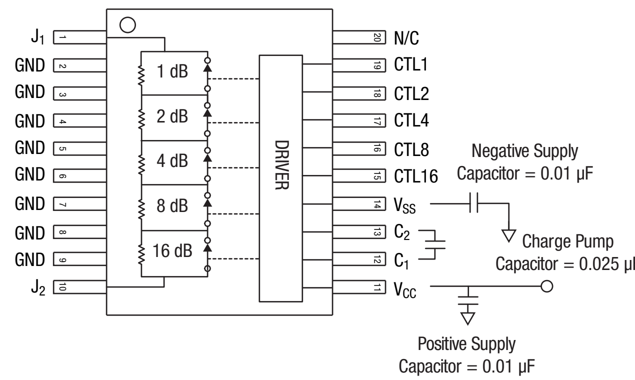
Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Pin Descriptions

Pin Number	Pin Name	Description
1, 10	J1, J2	RF Input/Output – RF input/output port.
2, 3, 4, 5, 6, 7, 8, 9	GND	Equipotential Point – Internal circuit common, which must be connected to the PCB ground or common via the lowest possible impedance.
11	V_{CC}	Positive supply voltage input – Must be bypassed to commmon via a 0.01 µF, or larger, capacitor.
12, 13	C1, C2	Charge Pump Capacitor – Capacitor that accumulates charge to produce negative voltage supply. This capacitor is 0.025 µF, nominal.
14	V_{CC}	Source Voltage Input – Filter terminal for negative supply voltage. Must be bypassed to commmon via a 0.01 µF, or larger, capacitor.
15	CTL16	Control Voltage 16 – High impedance control voltage input. The logic level voltage applied to this pin determines whether the 16 dB bit (MSB) is switched into the main signal path or is bypassed.
16	CTL8	Control Voltage 8 – High impedance control voltage input. The logic level voltage applied to this pin determines whether the 8 dB bit is switched into the main signal path or is bypassed.
17	CTL4	Control Voltage 4 – High impedance control voltage input. The logic level voltage applied to this pin determines whether the 4 dB bit is switched into the main signal path or is bypassed.
18	CTL2	Control Voltage 2 – High impedance control voltage input. The logic level voltage applied to this pin determines whether the 2 dB bit is switched into the main signal path or is bypassed.
19	CTL1	Control Voltage 1 – High impedance control voltage input. The logic level voltage applied to this pin determines whether the 1 dB bit (LSB) is switched into the main signal path or is bypassed.
20	N/C	No internal connection.

Pin Out



SSOP-20