BDA4700

7-bit Digital Step Attenuator

1MHz – 9000MHz

Device Features

- 7-bit Serial & Parallel Interface
- 31.75 dB Control Range 0.25 dB step
- Glitch-safe attenuation state transitions
- 2.7 V to 5.5 V supply
- 1.17 V to 3.6 V control logic
- Excellent Attenuation Accuracy
  ±(0.15 + 1.5% of attenuation state) @ 1.9GHz
  ±(0.25 + 3.5% of attenuation state) @ 3.5GHz
  ±(0.25 + 7.0% of attenuation state) @ 7.2GHz
- Low Insertion Loss
  0.9dB @ 1.9GHz
  1.2 dB @ 3.5GHz
  2.3 dB @ 7.2GHz
- Ultra linearity IIP3 > +65 dBm @ 3.5GHz, ATT=0dB
- Input 0.1dB Compression (P0.1dB) 32dBm @ 3.5GHz, ATT=0dB
- Programming modes
  Direct parallel
  Latched parallel
  Serial
- Stable Integral Non-Linearity over temperature
- Low Current Consumption 200 µA typical
- -40 °C to +105 °C operating temperature
- ESD rating : Class1C (1kV HBM)
- Lead-free/RoHS2-compliant 24-lead 4mm x 4mm x 0.9mm QFN SMT package

24-lead 4mm x 4 mm x 0.9mm QFN

Figure 1. Package Type

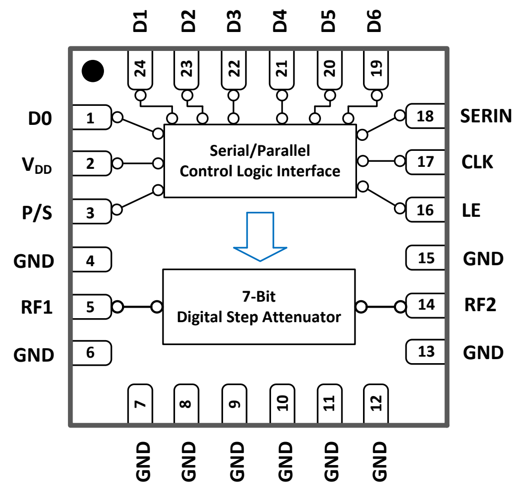


Figure 2. Functional Block Diagram

Product Description

The BDA4700 is a broadband, Highly accurate 50Ω digital step attenuator model which provides adjustable attenuation from 0 to 31.75 dB in 0.25 dB steps. The control is a 7-bit serial interface and latched parallel interface.

BDA4700 supports a broad operating frequency range from 1MHz to 9.0 GHz. BDA4700 is offering the High linearity, low power consumption, high attenuation accuracy and low insertion loss, typically less than 3.1dB up to 8.5GHz.

The device features a safe state transitions with no negative/positive Glitch technology optimized for excellent step accuracy.

Basically the RF input and output are internally matched to 50 Ω and do not require any external matching components. In some cases to optimize Return loss for above 4 - 8.5GHz, Shunt capacitor can be added near RF1 and RF2 respectively. The design is bi-directional; Therefore, the RF input and output are interchangeable.

The BDA4700 does not require blocking capacitors. If DC is presented at the RF port, add a blocking capacitor. This is packaged in a RoHS2-compliant with QFN surface mount package.

Application

- 6G/5G/4G/3G Cellular Base station/Repeater Infrastructure
- Digital Pre-Distortion
- Distributed Antenna Systems, DAS
- Remote Radio Heads
- NFC Infrastructure
- Test Equipment and sensors
- Military Wireless system
- Cable Infrastructure
- General purpose Wireless

Table 1. Electrical Specifications

Specifications are performance on the BeRex EVKit at VDD=3.3V, 25°C, 50Ω system. Performance were measured based on Typical application circuits Table 12. (See the Page 9)

Parameter		Condition	Frequency	Min	Typ	Max	Unit
Frequency Range				1		8000	MHz
Attenuation range		0.25dB step			0 - 31.75		dB
Insertion Loss[1]		ATT = 0dB	1MHz - 1GHz		0.6	0.7	dB
			1 - 2GHz		0.9	1.0	dB
			2 - 4GHz		1.2	1.4	dB
			4 - 6GHz		1.9	2.5	dB
			6 - 8GHz		2.5	2.6	dB
Attenuation Error		0.25dB Step					
		0-31.75dB	1MHz - 2GHz			±(0.15 + 1.5% of attenuation state)	dB
			2 - 3GHz			±(0.15 + 2.5% of attenuation state)	
			3 - 5GHz			±(0.25 + 3.5% of attenuation state)	
			5 - 6GHz			±(0.25 + 5.0% of attenuation state)	
		1dB Step					
		0-31.0dB	1MHz - 2GHz			±(0.15 + 1.5% of attenuation state)	dB
			2 - 3GHz			±(0.15 + 2.5% of attenuation state)	
			3 - 5GHz			±(0.25 + 3.5% of attenuation state)	
			5 - 6GHz			±(0.25 + 5.0% of attenuation state)	
			6 - 8GHz			±(0.25 + 7.0% of attenuation state)	
Input Return Loss		ATT = 0dB	1 - 4GHz		18		dB
			4 - 8GHz		10		
Output Return Loss		ATT = 0dB	1 - 4GHz		19		
			4 - 8GHz		11		
Relative Phase Error		All States	1GHz		7		degree
			2GHz		14		
			3GHz		21		
			4GHz		29		
			5GHz		38		
			6GHz		46		
Input Linearity	Input 0.1dB Compression point	ATT = 0dB	3.5GHz		32		dBm
	Input IP3	Pin = +18dBm/tone, △f = 20MHz ATT = 0.0dB RF Input = RF1 Port	2.5GHz		69		dBm
			3.5GHz		65		
			4.5GHz		66		
			7.25GHz		51		
		Pin = +18dBm/tone, △f = 20MHz ATT = 31.75dB RF Input = RF1 Port	2.5GHz		57		
			3.5GHz		58		
			4.5GHz		55		
			7.25GHz		50		
		Pin = +18dBm/tone, △f = 20MHz ATT = 0.0dB RF Input = RF2 Port	2.5GHz		64		
			3.5GHz		60		
			4.5GHz		57		
			7.25GHz		53		
		Pin = +18dBm/tone, △f = 20MHz ATT = 31.75dB RF Input = RF2 Port	2.5GHz		56		
			3.5GHz		58		
			4.5GHz		57		
			7.25GHz		56		

Table 1. Electrical Specifications (Cont.)

Parameter	Condition	Frequency	Min	Typ	Max	Unit
RF Rising / Falling Time	10%/90% RF	2GHz		121		ns
Switching time	50% CTRL to 90% or 10% RF	2GHz		224		ns
Settling time	50% CTRL to Max or Min Attenuation to settle within 0.05 dB of final value	2GHz		500		ns
Attenuation Transient (envelope)[2]	Positive glitch, Any ATT step	3.5GHz		0.3		dB
Maximum Spurious level	Measured at RF1 and RF2 port	1 - 5MHz		-117		dBm/10Hz
		>5MHz[3]		< -145		

1. The Evaluation board Kit insertion loss (PCB & RF Connector) is de-embedded.
2. Attenuation Transient is glitch level due to attenuation transitions
3. No spurious signals were detected above 5MHz.

Table 2. Electrical Specifications[1] (Optimized Return Loss Application)

Specifications are performance on the BeRex EVKit at VDD=3.3V, 25°C, 50 Ω system. Performance were measured based on Optimized Return Loss Application Circuits Table 13. (See the Page 16)

Parameter	Condition	Frequency	Min	Typ	Max	Unit
Frequency Range			1		9000	MHz
Attenuation range	0.25dB step			0 - 31.75		dB
Insertion Loss[2]	ATT = 0dB	1MHz - 1GHz		0.7		dB
		1 - 2GHz		1.0		dB
		2 - 3GHz		1.1		dB
		3 - 4GHz		1.2		dB
		4 - 6GHz		1.7		dB
		6 - 8GHz		2.4		dB
		8 - 9GHz		4.0		dB
Attenuation Error	0-31.75dB / 0.25dB Step	1MHz - 2GHz			±(0.15 + 1.5% of attenuation state)	dB
		2 - 3GHz			±(0.15 + 2.5% of attenuation state)	dB
		3 - 4GHz			±(0.25 +3.5% of attenuation state)	dB
		4 - 6GHz			±(0.25 +5.0% of attenuation state)	dB
		6 - 9GHz			±(0.35 +7.0% of attenuation state)	dB
Input Return Loss	ATT = 0dB	1 - 4GHz		18		dB
		4 - 6GHz		15		
		6 - 9GHz		18		
Output Return Loss	ATT = 0dB	1 - 4GHz		19		dB
		4 - 6GHz		16		
		6 - 9GHz		19		
Relative Phase Error	All states	1GHz		7		degree
		2GHz		13		
		3GHz		20		
		4GHz		30		
		5GHz		38		
		6GHz		48		
		7GHz		59		
		8GHz		73		
		9GHz		86		

1. In order to improve Return loss above 4GHz, shunt capacitor 0.1pF was added to each RF1 & RF2. (See Optimized Return loss application circuits Table 13 on page 16)
2. The Evaluation board Kit insertion loss (PCB & RF Connector) is de-embedded.

Table 3. Recommended Operating Condition

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Supply Voltages		V_{DD}		2.7		5.5	V
Supply Current		I_{DD}			200	350	µA
Digital Control Input	**High**	V_{CTLH}	V_{DD}=3.3V or 5V	1.17		3.6	V
	Low	V_{CTLL}	V_{DD}=3.3V or 5V	-0.3		0.6	V
Operating Temperature Range		T_{case}	Exposed Paddle	-40		105	°C
RF Max Input Power		P_{IN_CW}	RF1 or RF2, CW (> 50MHz)			24	dBm
Impedance		Z_{Load}	Single ended		50		Ω

Specifications are not guaranteed over all recommended operating conditions.

Table 4. Absolute Maximum Ratings

Parameter		Symbol	Min	Typ	Max	Unit
Supply Voltage		V_{DD}	-0.3		5.5	V
Digital Input Voltage		V_{CTL}	-0.3		3.6	V
Maximum Input Power		P_{IN_CWMAX}			31	dBm
Temperature	**Storage**	T_{ST}	-65		150	℃
	Reflow	T_R			260	℃
ESD Sensitivity	**HBM**[1]	ESD_{HBM}			±1000 (Class 1C)	V
	CDM[2]	ESD_{CDM}			±1000 (Class C3)	V

Operation of this device above any of these parameters may result in permanent damage.
1. HBM : Human Body Model (JEDEC **Standard JS-001-2017**)
2. CDM : Charged Device Model (JEDEC **Standard JS-002-2018**)

Table 5. Package Thermal Characteristics

Parameter	Symbol	Value	Unit
Junction to Ambient Thermal Resistance	θ_{JA}	37.5	°C/W

Figure 3. Pin Configuration (Top View)

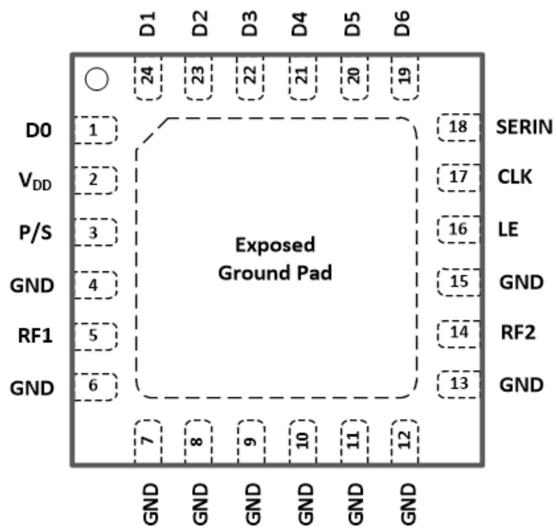


Table 6. Pin Descriptions

Pin	Pin name	Description
1	D0[2]	Parallel Control Voltage Inputs, Attenuation control bit 0.25dB
2	VDD	Power Supply (nominal 3.3V)
3	P/S	Parallel/Serial Mode Select. For parallel mode operation, set this pin to low. For serial mode operation, set this pin to HIGH.
4, 6-13, 15	GND	Ground, These pins must be connected to ground
5	RF1[1]	RF1 port (Attenuator RF Input) This pin can also be used as an output because the design is bidirectional. RF1 is dc-coupled and matched to 50 Ω
14	RF2[1]	RF2 port (Attenuator RF Output.) This pin can also be used as an input because the design is bidirectional. RF2 is dc-coupled and matched to 50 Ω.
16	LE	Latch Enable input
17	CLK	Serial interface clock input
18	SERIN	Serial interface data input
19	D6[2]	Parallel Control Voltage Inputs, Attenuation control bit 16dB
20	D5[2]	Parallel Control Voltage Inputs, Attenuation control bit 8dB
21	D4[2]	Parallel Control Voltage Inputs, Attenuation control bit 4dB
22	D3[2]	Parallel Control Voltage Inputs, Attenuation control bit 2dB
23	D2[2]	Parallel Control Voltage Inputs, Attenuation control bit 1dB
24	D1[2]	Parallel Control Voltage Inputs, Attenuation control bit 0.5dB
Pad	GND	Exposed pad: The exposed pad must be connected to ground for proper operation

1. RF pins 5 and 14 must be at 0V DC. The RF pins do not require DC blocking capacitors for proper Operation if the 0V DC requirement is met
2. It is recommended to ground the D0 ~ D6 in serial mode.

Programming Options

BDA4700 can be programmed using either the parallel or serial interface, which is selectable via P/S pin(Pin3).
Serial mode is selected by pulling it to a voltage logic HIGH and parallel mode is selected by setting P/S to logic LOW

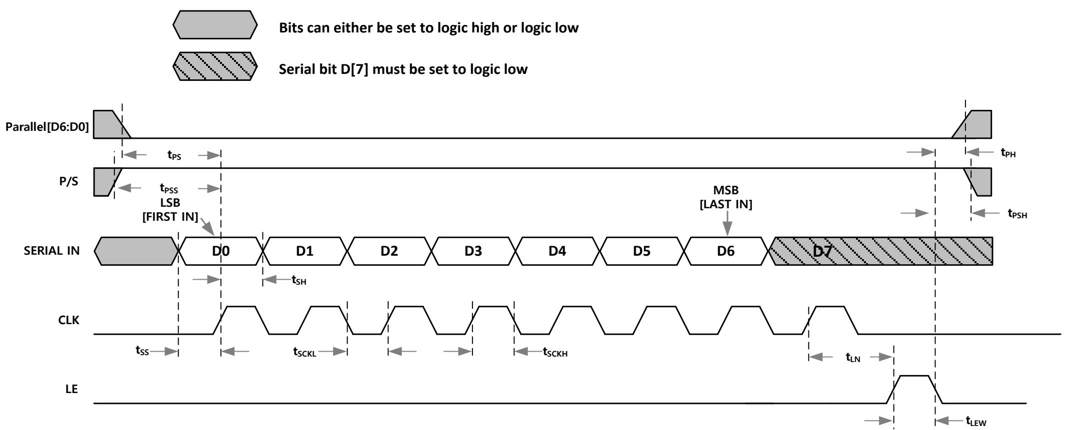
Serial Control Mode

The serial interface is a 8-bit shift register to shift in the data LSB (D0) first. When serial programming is used, It is recommended all the parallel control input pins (D0-D6) are grounded.
It is controlled by three CMOS-compatible signals: SERIN, Clock, and Latch Enable (LE).

Table 7. Truth Table for Serial Control Word

Digital Control Input								Attenuation state (dB)
D7 (MSB)	D6	D5	D4	D3	D2	D1	D0 (LSB)	
LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW	0 (RL)
LOW	LOW	LOW	LOW	LOW	LOW	LOW	**HIGH**	0.25
LOW	LOW	LOW	LOW	LOW	LOW	**HIGH**	LOW	0.5
LOW	LOW	LOW	LOW	LOW	**HIGH**	LOW	LOW	1.0
LOW	LOW	LOW	LOW	**HIGH**	LOW	LOW	LOW	2.0
LOW	LOW	LOW	**HIGH**	LOW	LOW	LOW	LOW	4.0
LOW	LOW	**HIGH**	LOW	LOW	LOW	LOW	LOW	8.0
LOW	**HIGH**	LOW	LOW	LOW	LOW	LOW	LOW	16.0
LOW	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	31.75

Figure 4. Serial Mode Timing Diagram



The BDA4700 has a 3-wire serial peripheral interface (SPI): serial data input (SERIN), clock (CLK), and latch enable (LE). The serial control interface is activated when P/S is set to HIGH.

In serial mode, the 7-bit SERIN data is clocked LSB first on the rising CLK edges into the shift register and then LE must be toggled HIGH to latch the new attenuation state into the device. LE must be set to LOW to clock new 7-bit data into the shift register because CLK is masked to prevent the attenuator value from changing if LE is kept HIGH (see Figure 4 and Table 7).

In serial mode operation, both the serial control inputs (LE,CLK,SERIN) and the parallel control inputs (D0 to D6)must always be kept at a valid logic level (V_{CTLH} or V_{CTLL}) and must not be left floating. It is recommended to connect the parallel control inputs to ground and to use pull-down resistors on all serial control input lines if the device driving these input lines goes high impedance during hibernation.

Table 8. Serial Interface Timing Specifications

Symbol	Parameter	Min	Typ	Max	Unit
f_{CLK}	Serial data clock frequency			10	MHz
t_{PS}	Parallel data setup time	100			ns
t_{PH}	Parallel data hold time	100			ns
t_{PSS}	Parallel/Serial setup time	100			ns
t_{PSH}	Parallel/Serial hold time	100			ns
t_{SS}	Serial Data setup time	10			ns
t_{SH}	Serial Data hold time	10			ns
t_{SCKH}	Serial clock high time	30			ns
t_{SCKL}	Serial clock low time	30			ns
t_{LN}	LE setup time	10			ns
t_{LEW}	Minimum LE pulse width	30			ns

Table 9. Mode Selection

P/S	Control Mode
LOW	Parallel
HIGH	Serial

Serial Register Map

The BDA4700 can be programmed via the serial control on the rising edge of Latch Enable (LE) which loads the last 8-bits data word in the SHIFT Register. Serial Data is clocked in LSB(D0) first.

Figure 5. Serial Register Map

MSB [LAST IN] → Q7 ... LSB [FIRST IN] → Q0

Q7	Q6	Q5	Q4	Q3	Q2	Q1	Q0
D7	D6	D5	D4	D3	D2	D1	D0

8- Bit Atteunuation Word

Bits must be to logic low (shaded: D7)

The attenuation word is derived directly from the value of the attenuation state. To find the attenuation word, multiply the value of the state by four, then convert to binary.

For example, to program the 15.75dB state :

4 x 15.75 = 63
63 -> 00111111

Serial Input : 00111111

0	0	1	1	1	1	1	1
D7	D6	D5	D4	D3	D2	D1	D0

Power-UP states Settings

The BDA4700 will always initialize to the maximum attenuation setting (31.75 dB) on power-up for both the Serial and Latched Parallel modes of operation and will remain in this setting until the user latches in the next programming word.
In Direct Parallel mode, the DSA can be preset to any state within the 31.75 dB range by pre-setting the Parallel control pins prior to power-up.
In this mode, there is a 400 µs delay between the time the DSA is powered-up to the time the desired state is set.

Figure 6. Default Register Settings

0	1	1	1	1	1	1	1
D7	D6	D5	D4	D3	D2	D1	D0

8- Bit Atteunuation Word

Programming Options

Parallel Control Mode

The parallel control interface has seven digital control input lines (D6 to D0) to set the attenuation value. D6 is the most significant bit (MSB) that selects the 16 dB attenuator stage, and D0 is the least significant bit (LSB) that selects the 0.25 dB attenuator stage (see Figure 7).

Direct Parallel Mode

For direct parallel mode, The LE pin must be kept HIGH. The attenuation state is changed by the control voltage inputs (D0 to D6) directly. This mode is ideal for manual control of the attenuator. In this mode the device will immediately react to any voltage changes to the parallel control pins [pins 1, 19, 20, 21,22, 23, 24]. Use direct parallel mode for the fastest settling time.

Latched Parallel Mode

The LE pin must be kept LOW when changing the control voltage inputs (D0 to D6) to set the attenuation state. When the desired state is set, LE must be toggled HIGH to transfer the 7-bit data to the bypass switches of the attenuator array, and then toggled LOW to latch the change into the device until the next desired attenuation change (see Figure 7 and Table 10).

- Set P/S is logic LOW.
- Set LE to logic LOW.
- Adjust pins [1, 19, 20, 21,22, 23, 24] to the desired attenuation setting. (Note the device will not react to these pins while LE is a logic LOW).
- Pull LE to a logic HIGH. The device will then transition to the attenuation settings reflected by pins D6 - D0.
- If LE is pulled to a logic LOW then the attenuator will not change state.

Latched Parallel Mode implies a default state for when the device is first powered up with P/S pin set for logic LOW and LE logic LOW. In this case the default setting is **Maximum attenuation** .

Table 10. Truth Table for the Parallel Control Word

D6	D5	D4	D3	D2	D1	D0	P/S	LE	Attenuation State(dB)
LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW	**HIGH**	0 (RL)
LOW	LOW	LOW	LOW	LOW	LOW	**HIGH**	LOW	**HIGH**	0.25
LOW	LOW	LOW	LOW	LOW	**HIGH**	LOW	LOW	**HIGH**	0.5
LOW	LOW	LOW	LOW	**HIGH**	LOW	LOW	LOW	**HIGH**	1.0
LOW	LOW	LOW	**HIGH**	LOW	LOW	LOW	LOW	**HIGH**	2.0
LOW	LOW	**HIGH**	LOW	LOW	LOW	LOW	LOW	**HIGH**	4.0
LOW	**HIGH**	LOW	LOW	LOW	LOW	LOW	LOW	**HIGH**	8.0
HIGH	LOW	LOW	LOW	LOW	LOW	LOW	LOW	**HIGH**	16.0
HIGH	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	LOW	**HIGH**	31.75

Figure 7. Latched Parallel Mode Timing Diagram

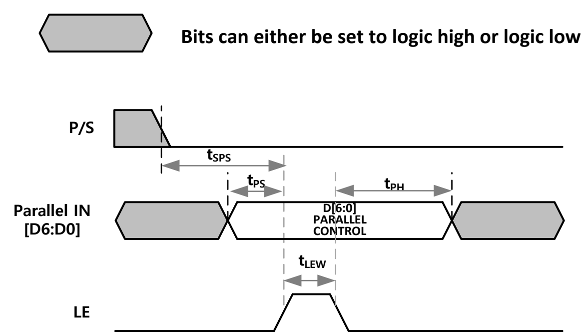


Table 11. Parallel Interface Timing Specifications

Symbol	Parameter	Min	Typ	Max	Unit
t_{SPS}	Serial to Parallel Mode Setup Time	100			ns
t_{LEW}	Minimum LE pulse width	10			ns
t_{PH}	Data hold time from LE	10			ns
t_{PS}	Data setup time to LE	10			ns

Switching Feature Description

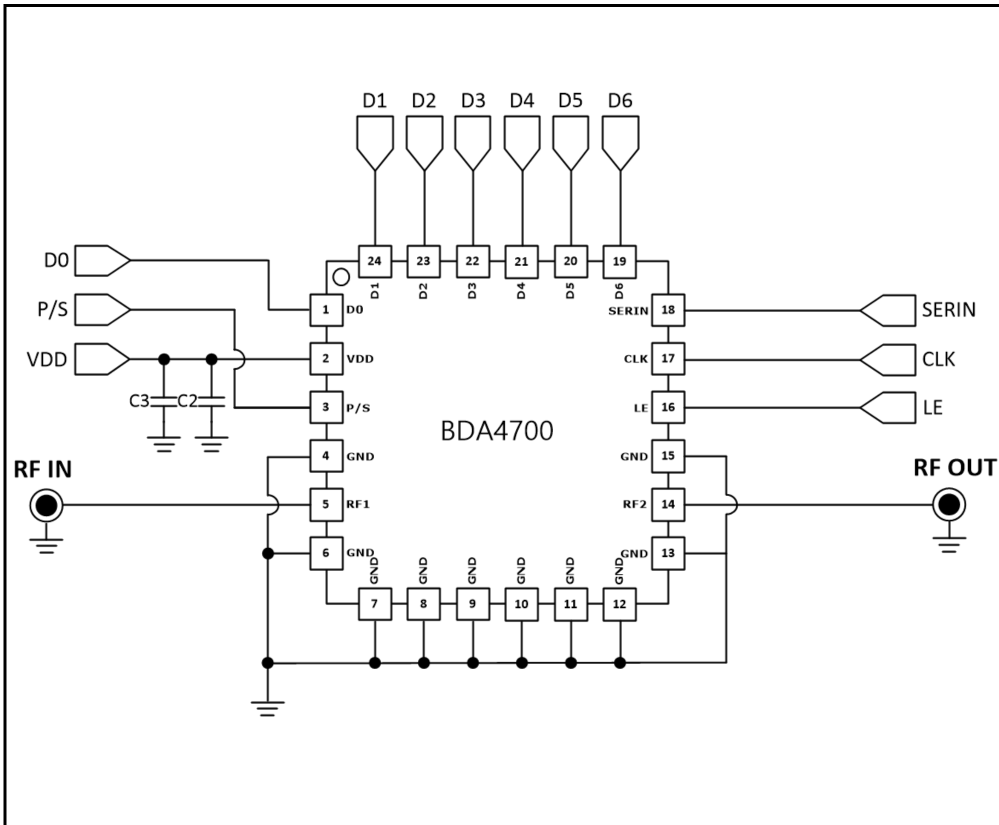
Glitch-Safe Attenuation State Transient

The BDA4700 is the latest product applied *Glitch-Safe* technology with less than 1dB ringing (pos/neg) across the attenuation range when changing attenuation states. This technology protects Amplifiers or ADC during transitions between attenuation states.
(see Figure 40,41).

Typical RF Performance Plot - BDA4700 EVK - PCB (Typical Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Table 12. Typical Application Circuits



BOM	
C2	100pF
C3	100nF

1. See the page 21 the Evaluation Board Circuits for the detailed application circuit information.

Figure 8. Insertion Loss vs Temp.

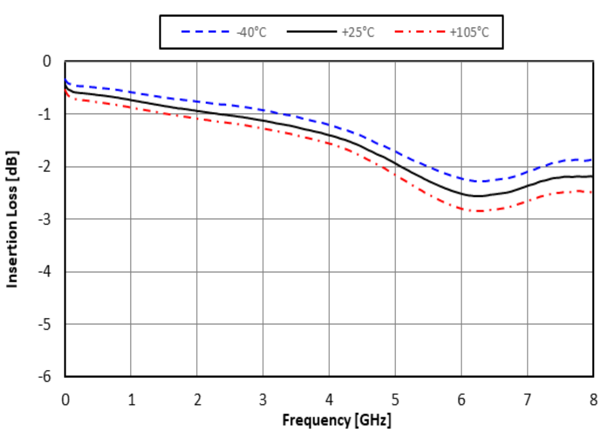
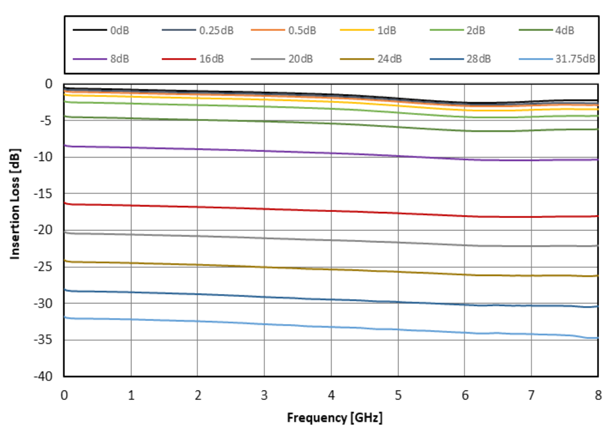


Figure 9. Insertion Loss vs ATT Setting



Typical RF Performance Plot - BDA4700 EVK - PCB (Typical Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 10. Input Return Loss vs ATT Setting

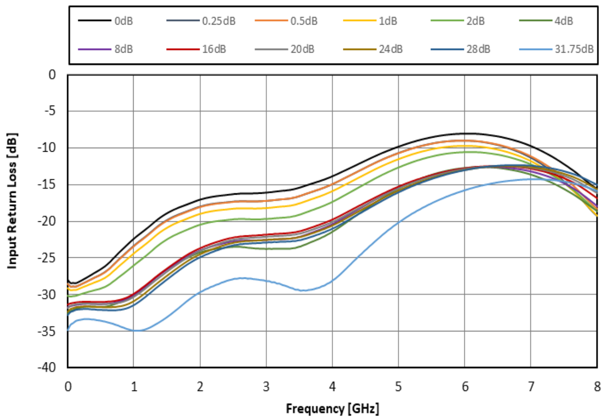


Figure 11. Output Return Loss vs ATT Setting

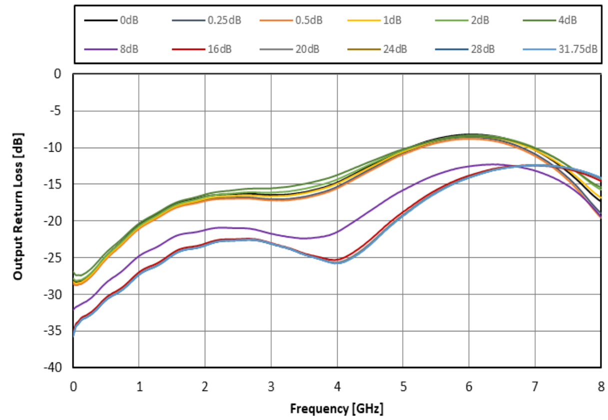


Figure 12. Input Return Loss vs Temp. @ ATT = 16dB

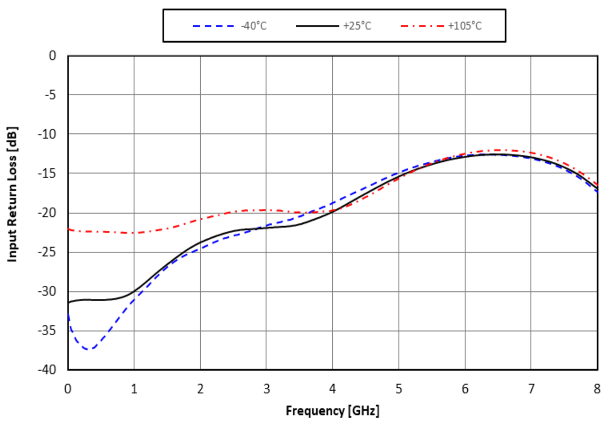


Figure 13. Output Return Loss vs Temp. @ ATT = 16dB

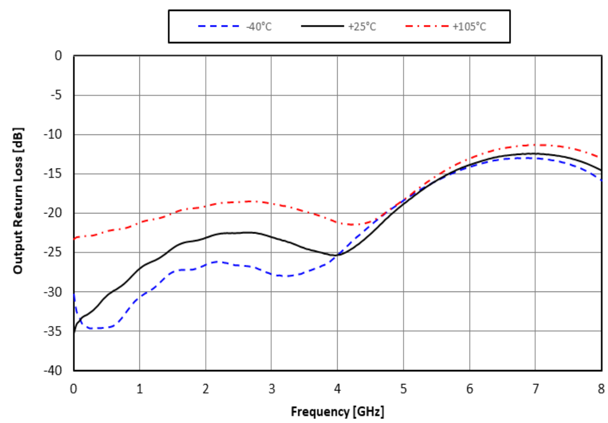


Figure 14. Relative Phase Error vs ATT Setting

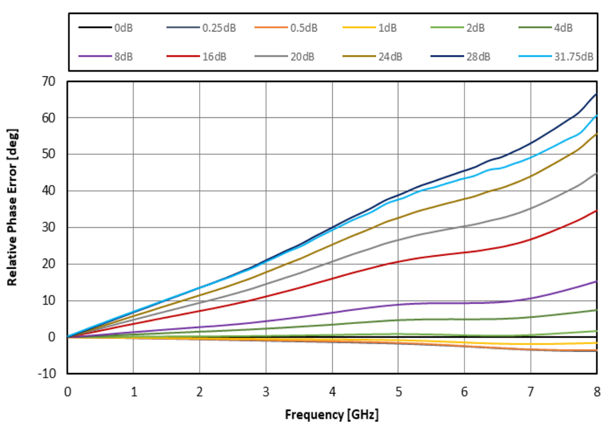
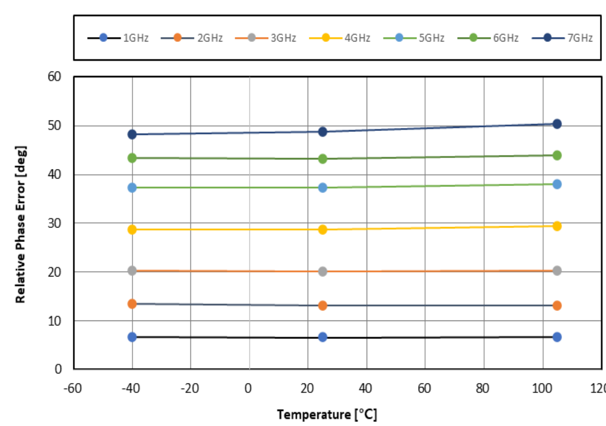


Figure 15. Relative Phase Error vs Frequency @ ATT = 31.5dB



Typical RF Performance Plot - BDA4700 EVK - PCB (Typical Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 16. ATT Error vs Temp. @ 900MHz

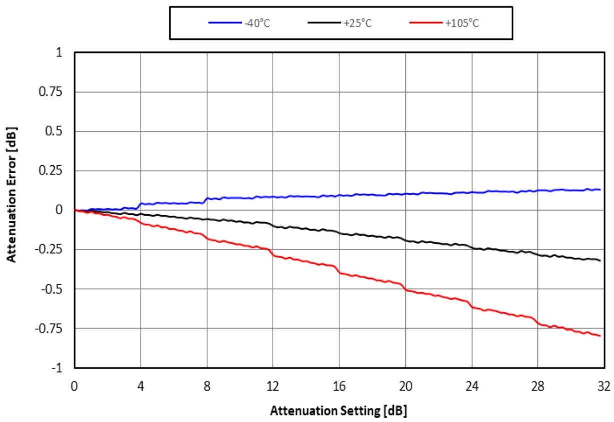


Figure 17. ATT Error vs Temp. @ 1800MHz

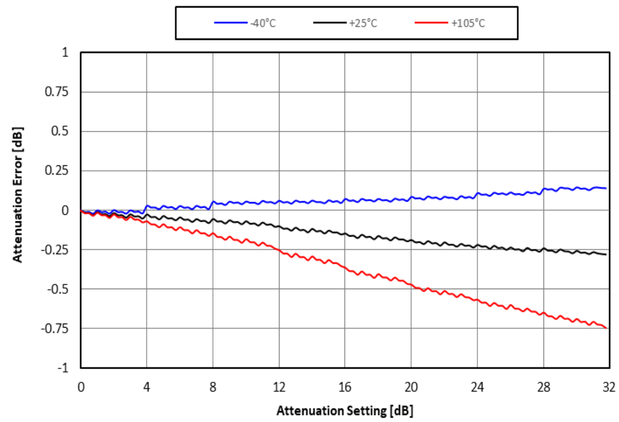


Figure 18. ATT Error vs Temp. @ 2200MHz

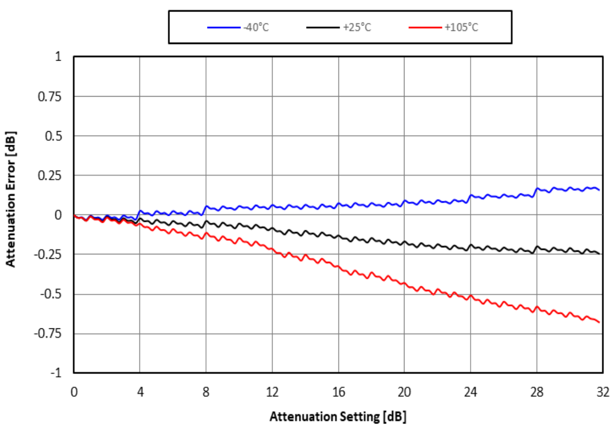


Figure 19. ATT Error vs Temp. @ 3500MHz

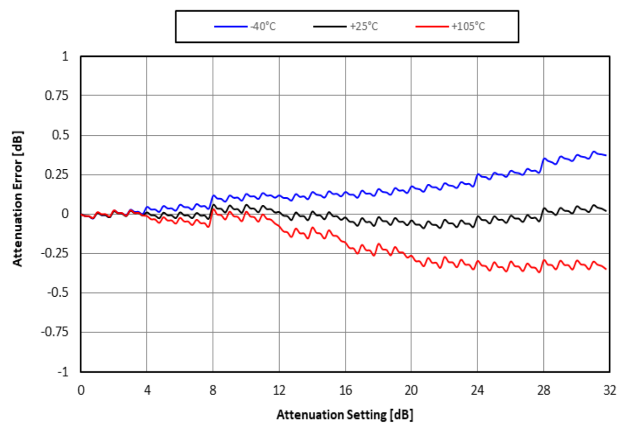


Figure 20. ATT Error vs Temp. @ 4600MHz

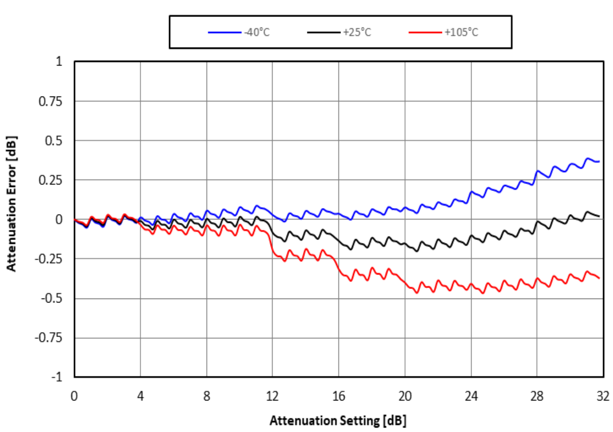
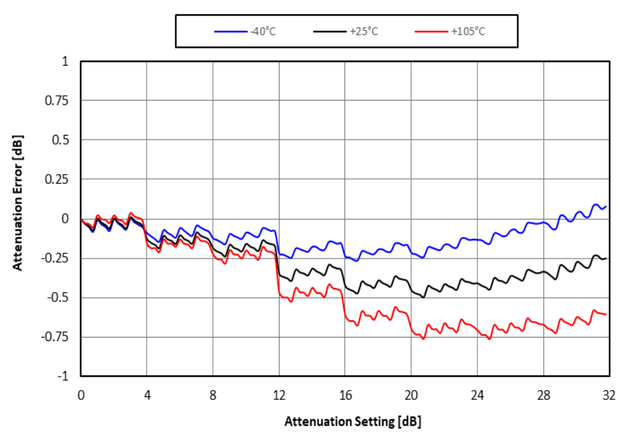


Figure 21. ATT Error vs Temp. @ 5800MHz



Typical RF Performance Plot - BDA4700 EVK - PCB (Typical Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 22. IIP3 vs Temp. @ 2500MHz

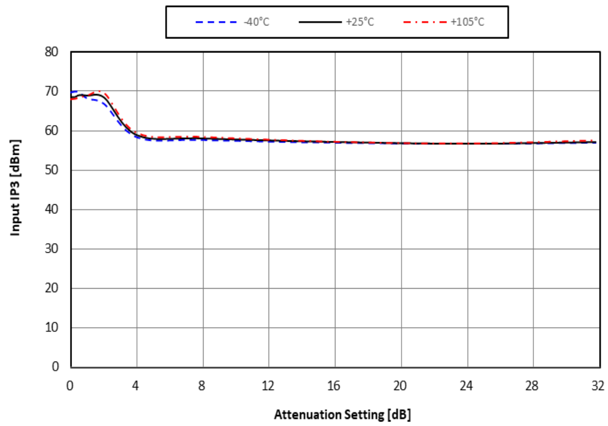


Figure 23. IIP3 vs Temp. @ 3500MHz

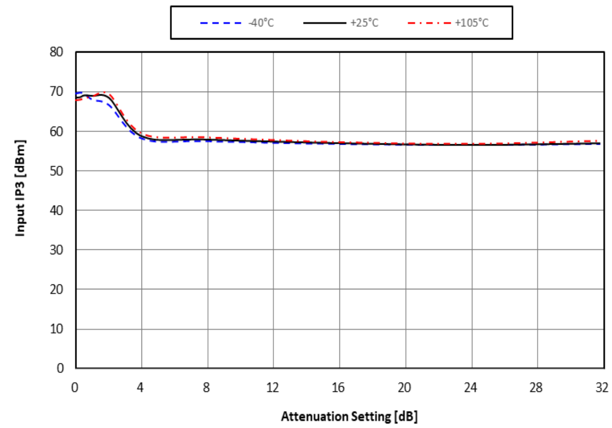


Figure 24. IIP3 vs Temp. @ 4500MHz

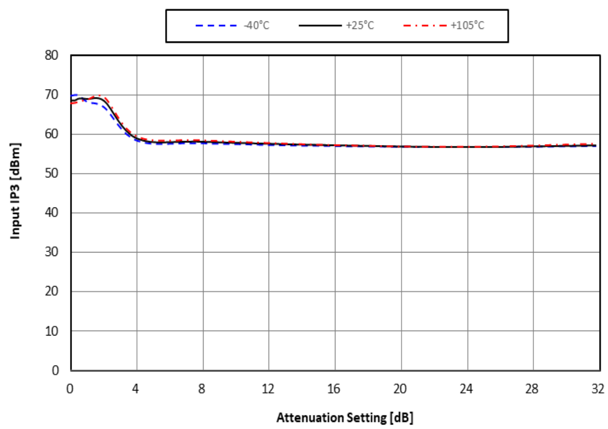


Figure 25. IIP3 vs Temp. @ 6400MHz

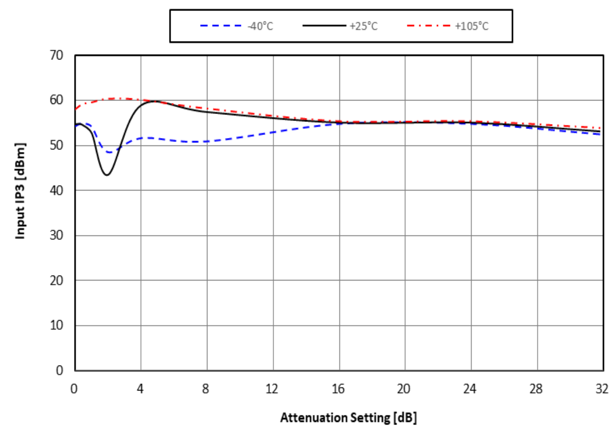


Figure 26. IIP3 vs Temp. @ 7250MHz

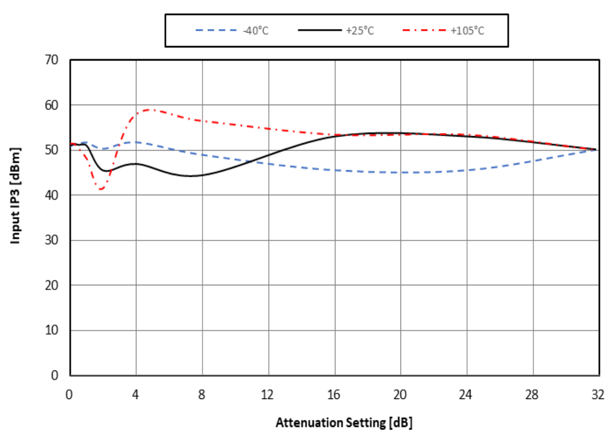
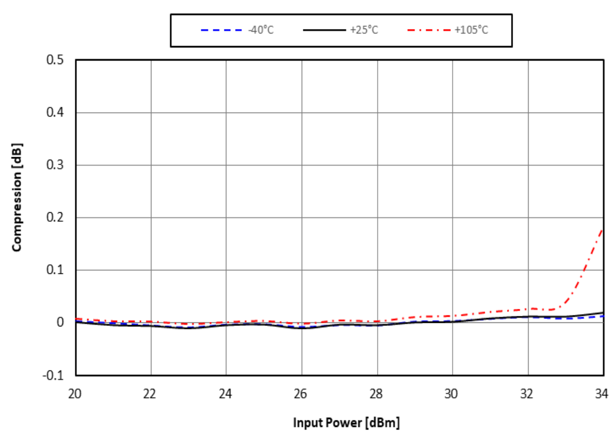


Figure 27. Input 0.1dB Compression vs Temp. @ 2500MHz



Typical RF Performance Plot - BDA4700 EVK - PCB (Typical Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 28. Input 0.1dB Compression vs Temp. @ 3500MHz

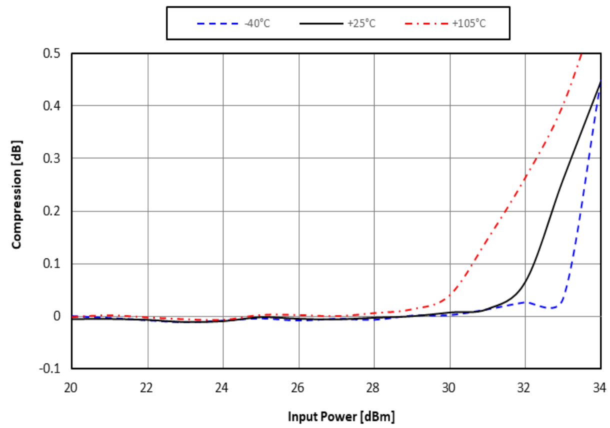


Figure 29. Input 0.1dB Compression vs Temp. @ 4500MHz

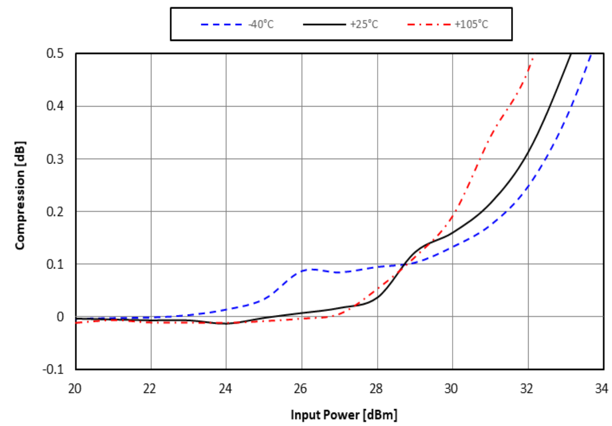


Figure 30. Input 0.1dB Compression vs Temp. @ 5500MHz

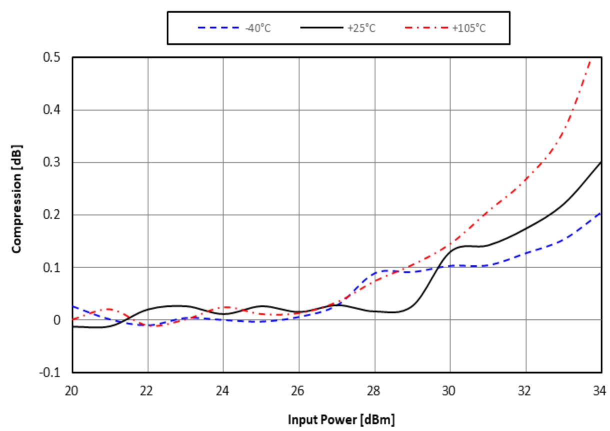


Figure 31. Input 0.1dB Compression vs Temp. @ 7250MHz

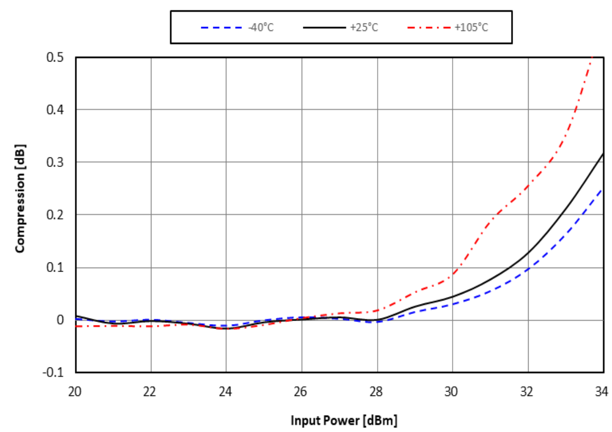


Figure 32. 0.25dB Step ATT vs Frequency

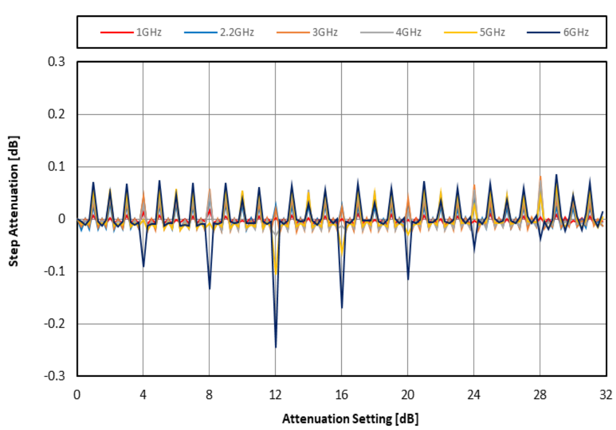
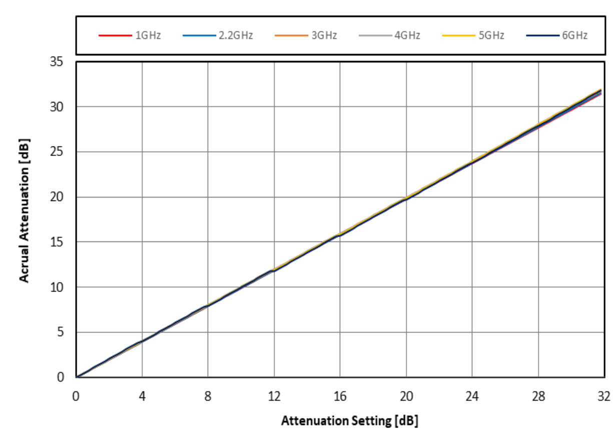


Figure 33. 0.25dB Step Actual ATT vs Frequency



Typical RF Performance Plot - BDA4700 EVK - PCB (Typical Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 34. 0.25dB Major State Bit Error vs ATT Setting

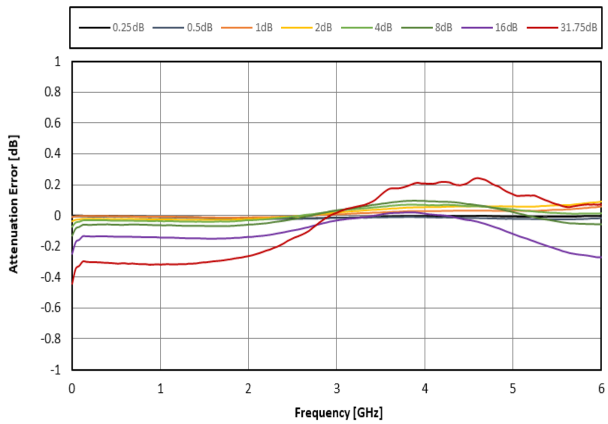


Figure 35. 0.25dB Step ATT Error vs Frequency

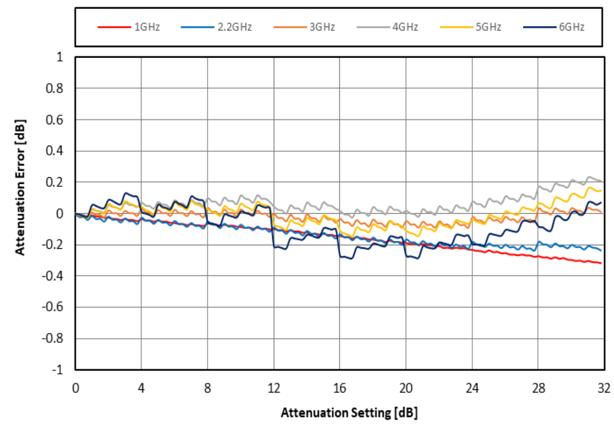


Figure 36. 1dB Step ATT vs Frequency

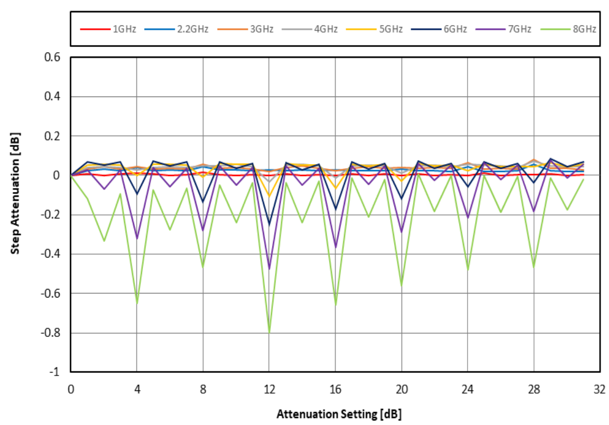


Figure 37. 1dB Step Actual ATT vs Frequency

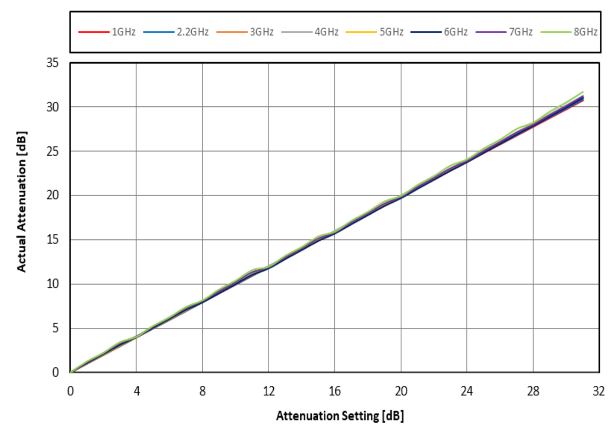


Figure 38. 1dB Major State Bit Error vs ATT Setting

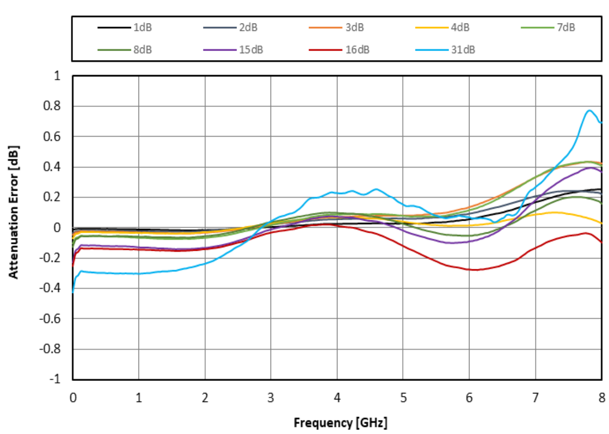
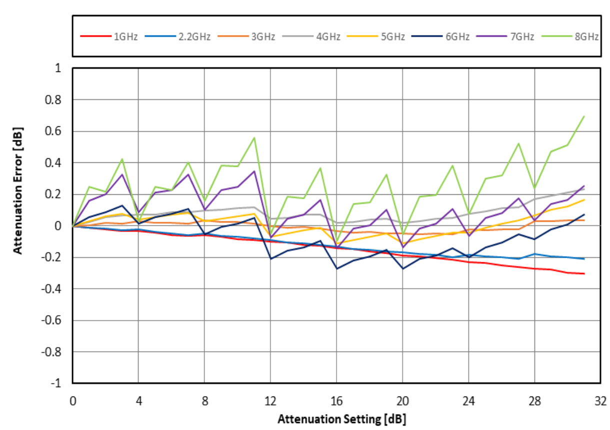


Figure 39. 1dB Step ATT Error vs Frequency



Typical RF Performance Plot - BDA4700 EVK - PCB (Typical Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 40. ATT Transient (15.75 to 16dB, Pin=18dBm)

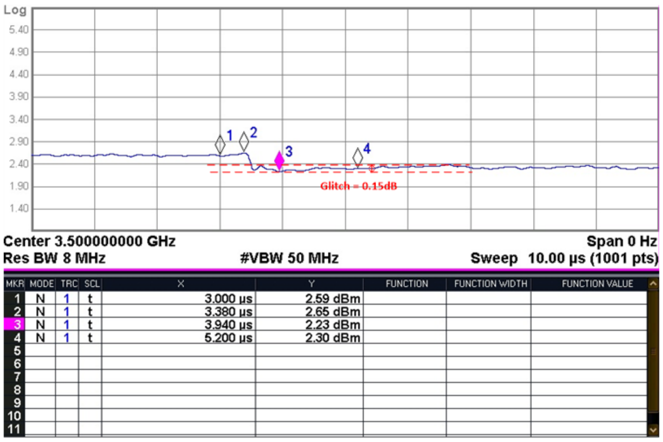
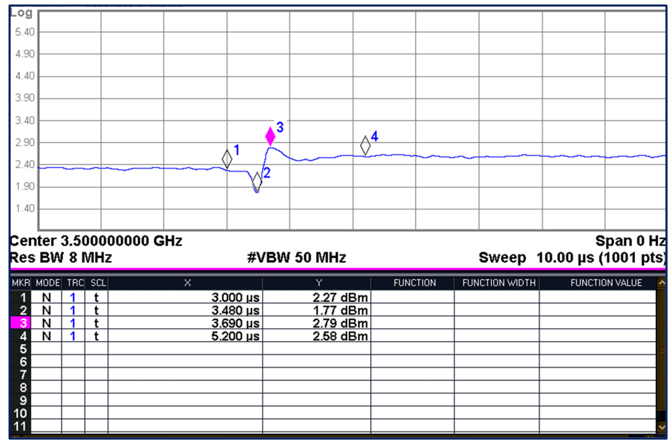


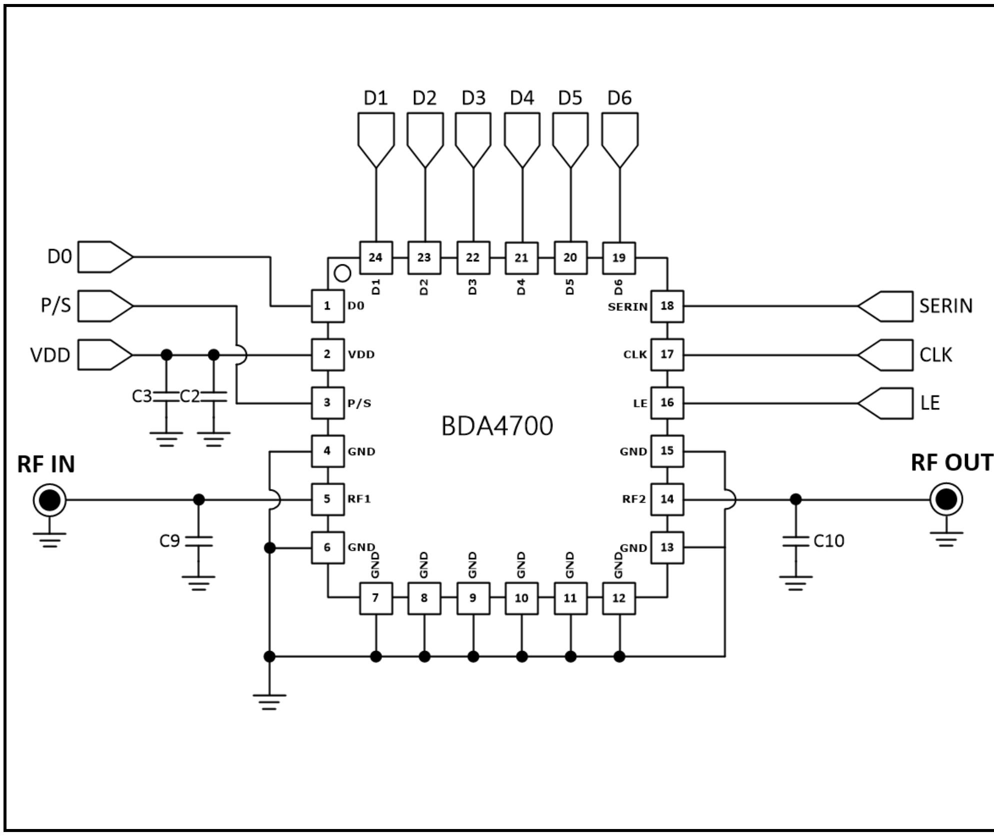
Figure 41. ATT Transient (16 to 15.75dB, Pin=18dBm)



Typical RF Performance Plot - BDA4700 EVK - PCB (Optimized Return Loss Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Table 13. Optimized Return Loss Application Circuits for 4GHz - 8.5GHz



BOM	
C2	100pF
C3	100nF
C9,C10	0.1pF

1. See the page 21 the Evaluation Board Circuits for the detailed application circuit information.
2. In order to optimized Return loss for above 4GHz, shunt capacitor 0.1pF was added near RF1 & RF2, respectively.

Figure 42. Insertion Loss vs Temp.

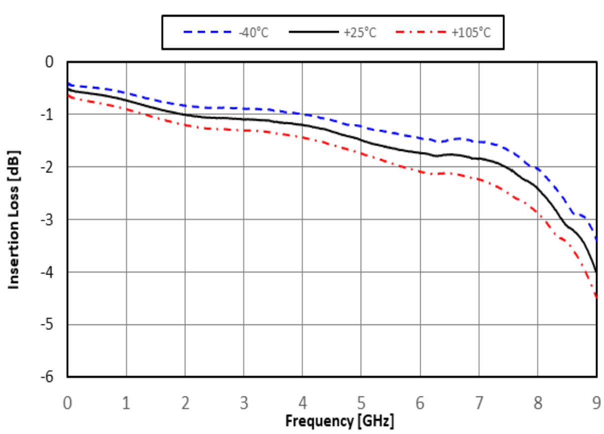
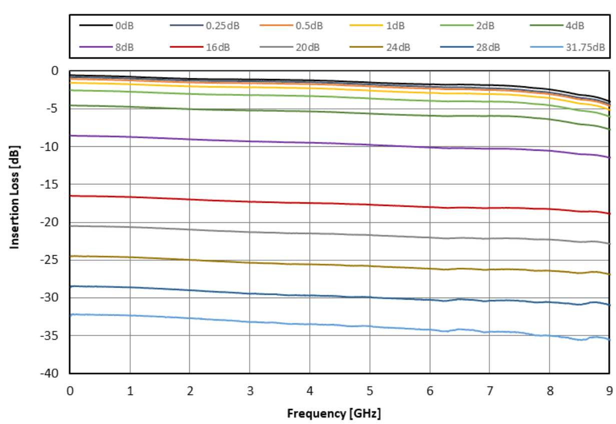


Figure 43. Insertion Loss vs ATT Setting



Typical RF Performance Plot - BDA4700 EVK - PCB (Optimized Return Loss Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 44. Input Return Loss vs ATT Setting

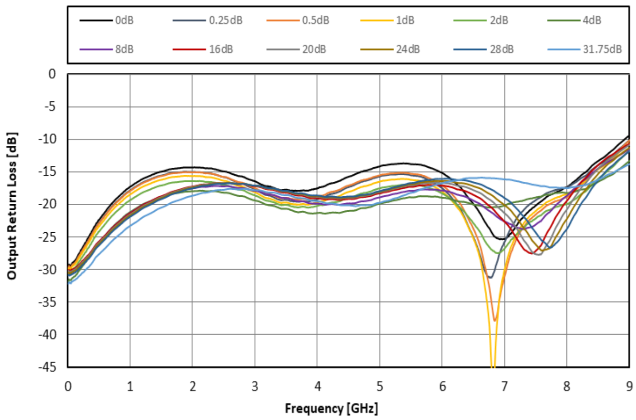


Figure 45. Output Return Loss vs ATT Setting

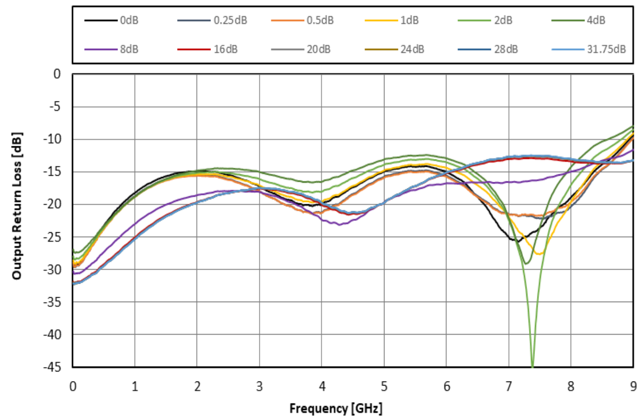


Figure 46. Input Return Loss vs Temp. @ ATT = 0dB

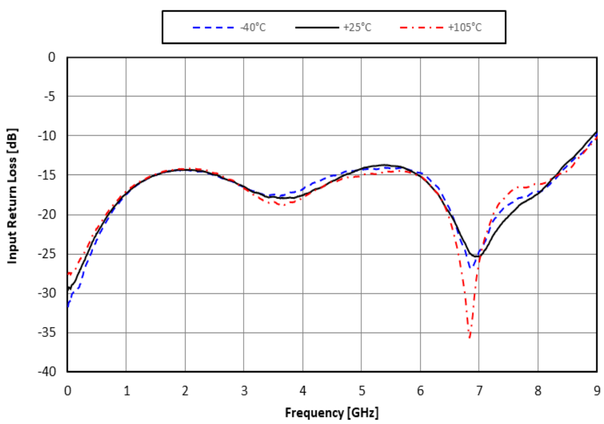


Figure 47. Output Return Loss vs Temp. @ ATT = 0dB

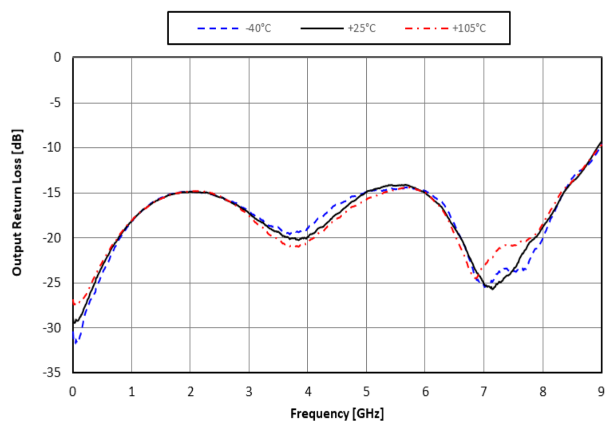


Figure 48. Relative Phase Error vs ATT Setting

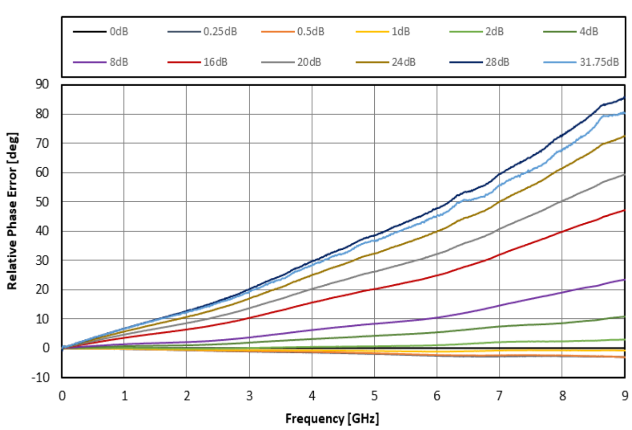
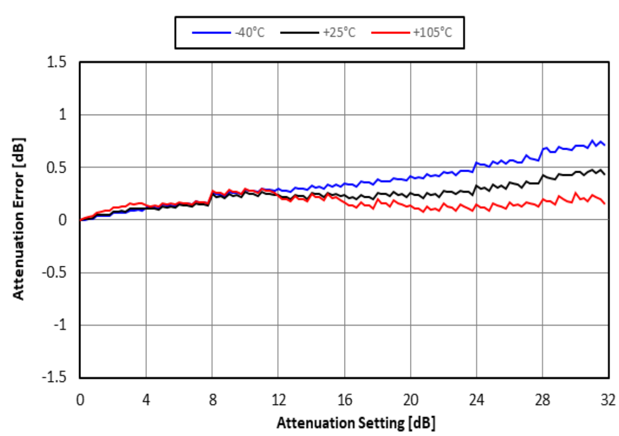


Figure 49. ATT Error vs Temp. @ 3500MHz



Typical RF Performance Plot - BDA4700 EVK - PCB (Optimized Return Loss Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 50. ATT Error vs Temp. @ 4600MHz

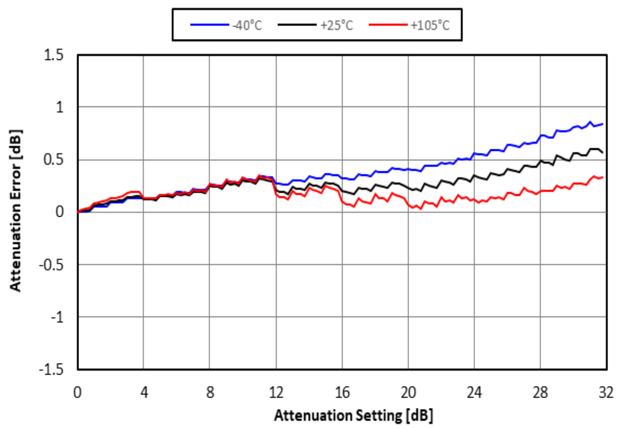


Figure 51. ATT Error vs Temp. @ 5800MHz

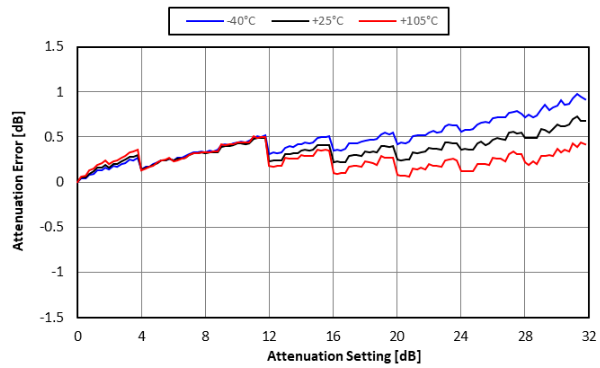


Figure 52. ATT Error vs Temp. @ 7200MHz

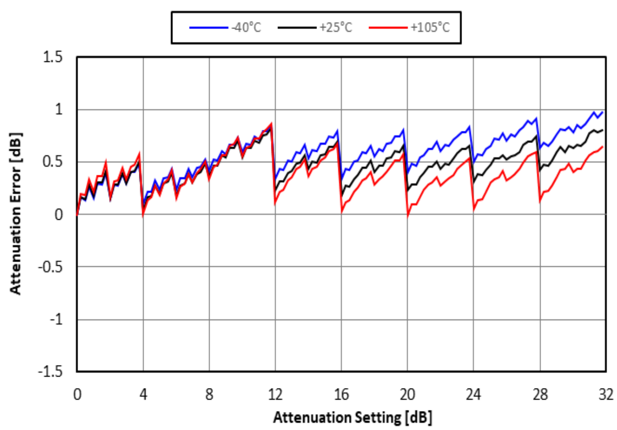


Figure 53. ATT Error vs Temp. @ 8500MHz

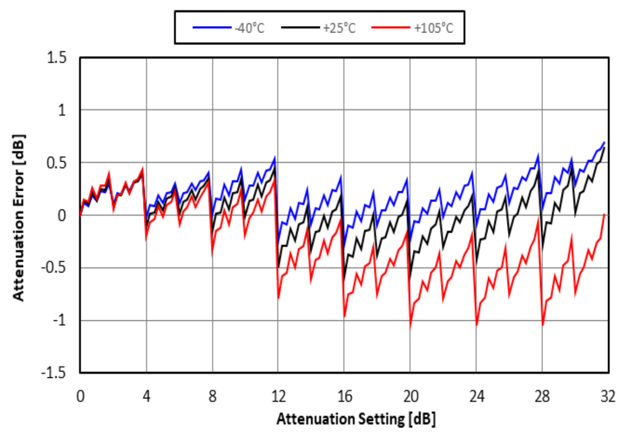


Figure 54. 0.25dB Step Actual ATT vs Frequency

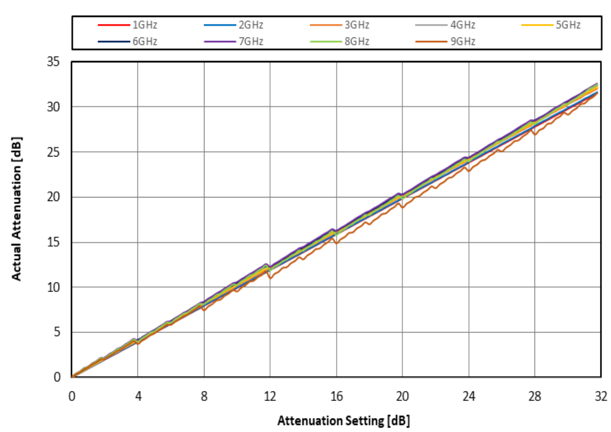
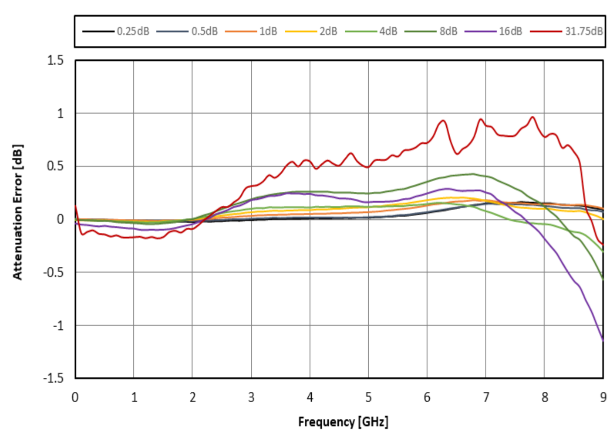


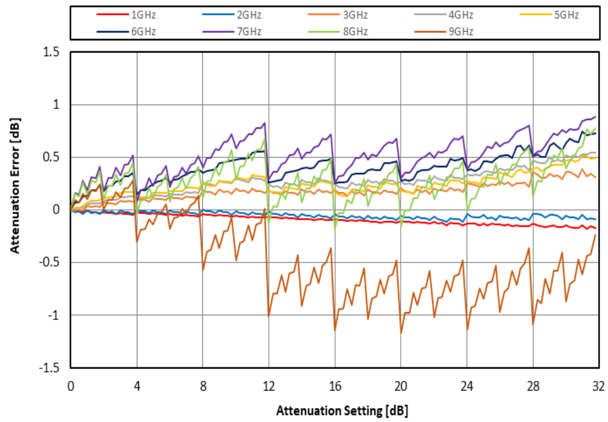
Figure 55. 0.25dB Major State Bit Error vs ATT Setting



Typical RF Performance Plot - BDA4700 EVK - PCB (Optimized Return Loss Application Circuits)

Typical Performance Data @ 25°C and V_{DD} = 3.3V, EVKit RF connector and board losses are de-embedded, unless otherwise noted

Figure 56. 0.25dB Step ATT Error vs Frequency



BDA4700 Evaluation board Kit Description

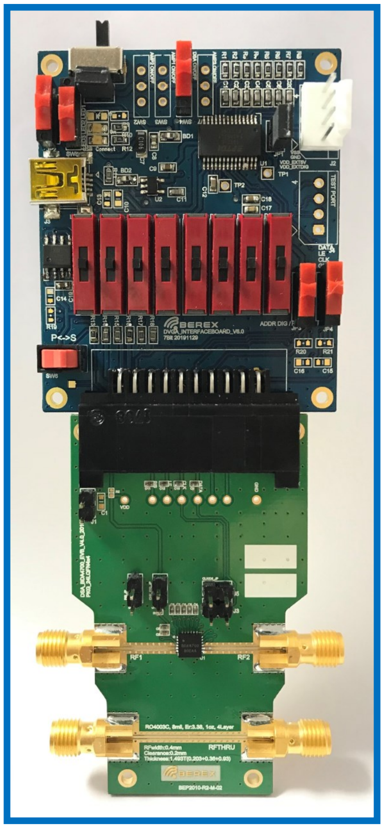


Figure 57. BDA4700 EVK

Evaluation board Kit Introduction

BDA4700 Evaluation Kit is made up of a combination of an RF board and an interface board

The schematic of the BDA4700 evaluation RF board is shown in Figure 57. The BDA4700 evaluation RF board is constructed of a 4-layer material with a copper thickness of 1oz(0.035mm) on each layer. Every copper layer is separated with a dielectric material. The top dielectric material is 8 mils RO4003. The middle and bottom dielectric materials are FR-4, used for mechanical strength and overall board thickness of approximately 1.63mm.
BDA4700 Evaluation INTERFACE board is assembled with a SP3T switches(D0~D6,LE), SP2T mechanical switch (P/S), and several header & switch.

Evaluation Board Programming Using USB Interface

In order to evaluate the BDA4700 performance, the Application Software has to be installed on your computer. And The DSA application software GUI supports Latched Parallel and Serial modes. software can be downloaded from BeRex's website

Serial Control Mode

- Connect directly the Evaluation INTEFRACE board USB port(J3) to PC
- Set the direction of P<->S Switch to S direction (P/S Logic HIGH)
- Set the D0~D6, LE switch to the middle position.
- Operate the 0~31.75dB attenuation state in GUI and then control the DSA

Latched Parallel Control Mode

- Connect directly the Evaluation INTEFRACE board USB port(J3) to PC
- Set the direction of P<->S Switch to P direction (P/S Logic LOW)
- Set the D0~D6, LE switch to the middle position.
- Operate the 0~31.75dB attenuation state in GUI and then control the DSA

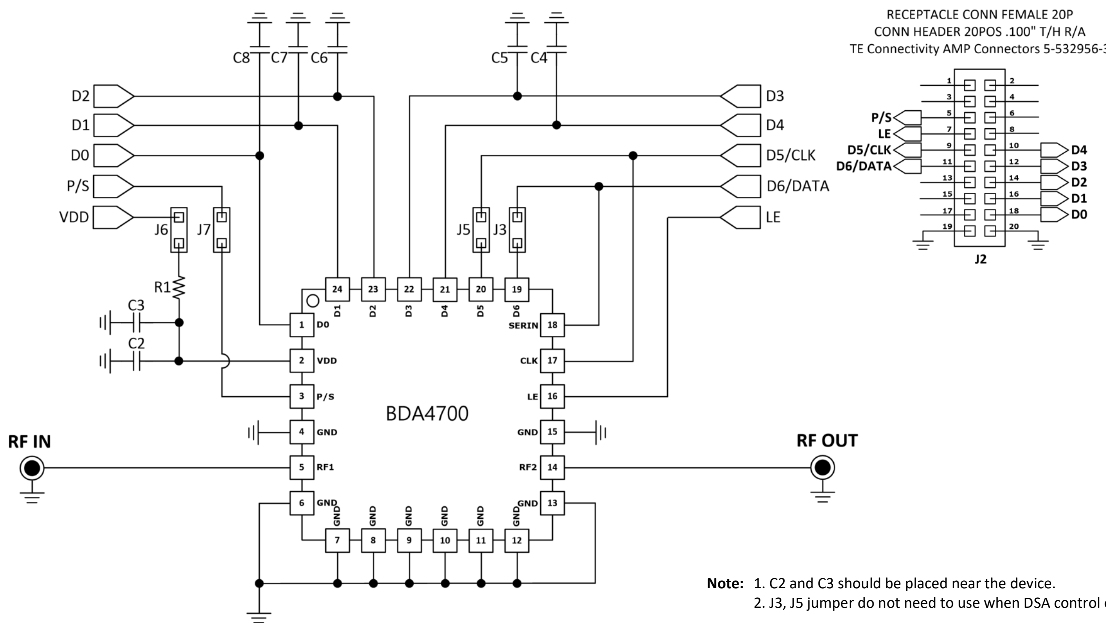
Direct Parallel Control Mode

- Set the direction of P<->S Switch to P direction (P/S Logic LOW)
- Set LE switch to the LOW Position
- For the setting to attenuation state, D0~D6 switches can be combined in manually program, refer to Table 10.

Please refer to user manual for more detailed operation method of BDA4700 EVK.

BDA4700 Evaluation board Kit Description

Figure 58. Evaluation Board Kit Schematic Diagram



Note: 1. C2 and C3 should be placed near the device.
2. J3, J5 jumper do not need to use when DSA control only serial.

Figure 59. Evaluation Board PCB Layout Information

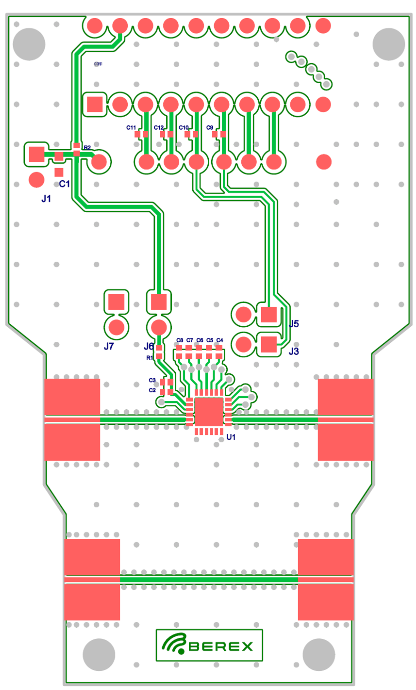


Table 14. Bill of Material - Evaluation Board

No.	Ref Des	Part Qty	Value	Description	Remark
1	C2,C4-C8	6	100pF	CAP, 0402, CHIP Ceramic, ±0.25%	
2	C3	1	100nF	CAP, 0402, CHIP Ceramic, ±0.25%	
3	R1	1	0 ohm	RES, 0402, CHIP, ±5%	
4	U1	1	Chip	DSA, BDA4700 QFN4x4 24L	
5	SMA1,SMA2	2	CON	SMA END LAUNCH	
6	J2	1	CON	Receptacle connector 20pin	
7	J1,J3,J5-J7	5	CON	Header 2.54mm 2pin	
8	C1,R2	2	NC	Not Connected	

Figure 60. Evaluation Board PCB Layer Information

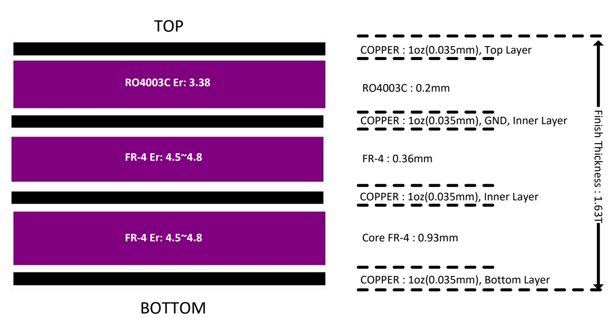
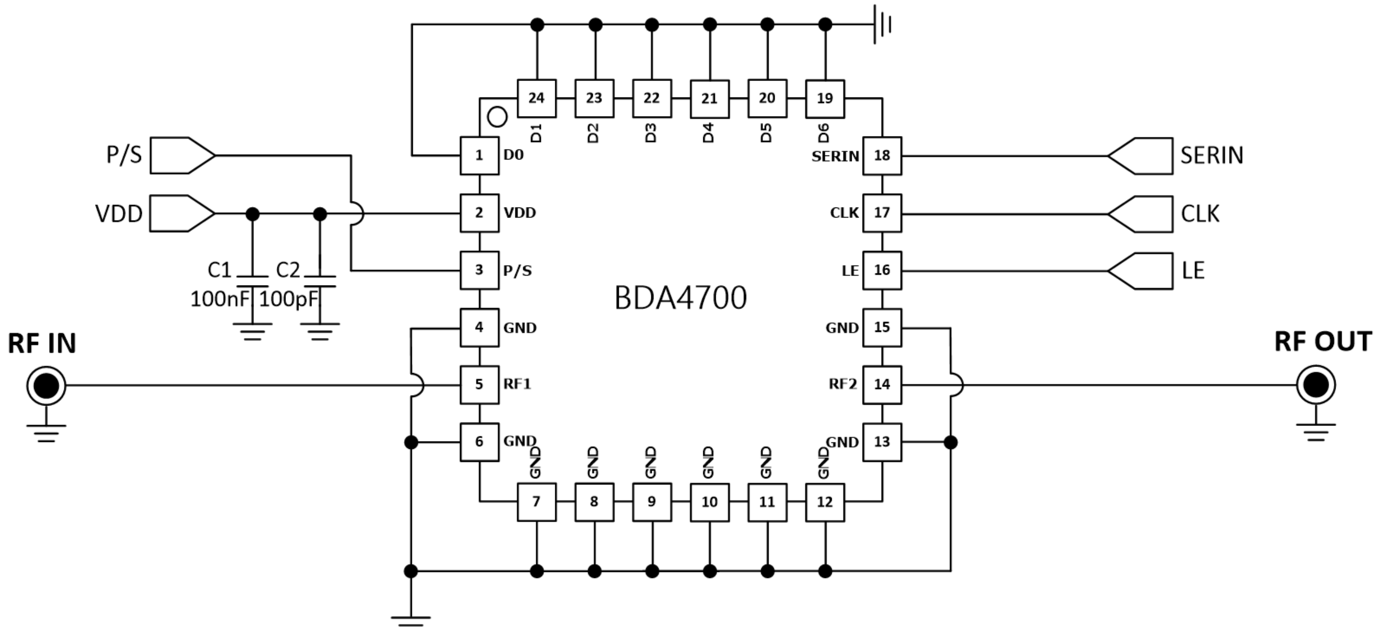
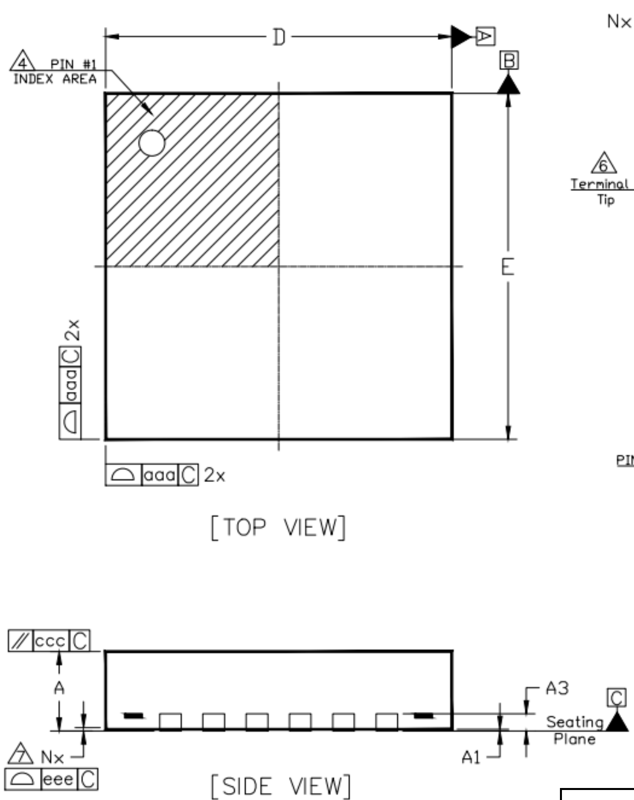


Figure 61. Recommended Serial mode Application Circuit Schematic



Note: 1. C1 and C2 should be placed near the device.

Figure 62. Packing Outline Dimension



NOTE :
1. Dimensioning and tolerancing conform to ASME Y14.5-2009.

2. All dimensions are in millimeters.

3. N is the total number of terminals.

4. The location of the marked terminal #1 identifier is within the hatched area.

5. ND and NE refer to the number of terminals on each D and E side respectively.

6. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip. If the terminal has a radius on the other end of it, dimension b should not be measured in that radius area.

7. Coplanarity applies to the terminals and all other bottom surface metallization

Dimension Table				
Symbol	Thickness			NOTE
	MINIMUM	NOMINAL	MAXIMUM	
A	0.80	0.90	1.00	
A1	0.00	0.02	0.05	
A3	---	0.203 Ref	---	
b	0.2	0.25	0.3	6
D		4.0 BSC		
E		4.0 BSC		
e		0.5 BSC		
D2	2.65	2.70	2.75	
E2	2.65	2.70	2.75	
K	0.2	---	---	
L	0.3	0.4	0.5	
aaa		0.05		
bbb		0.10		
ccc		0.10		
ddd		0.05		
eee		0.08		
N		24		3
NE		6		5

Figure 63. Recommend Land Pattern

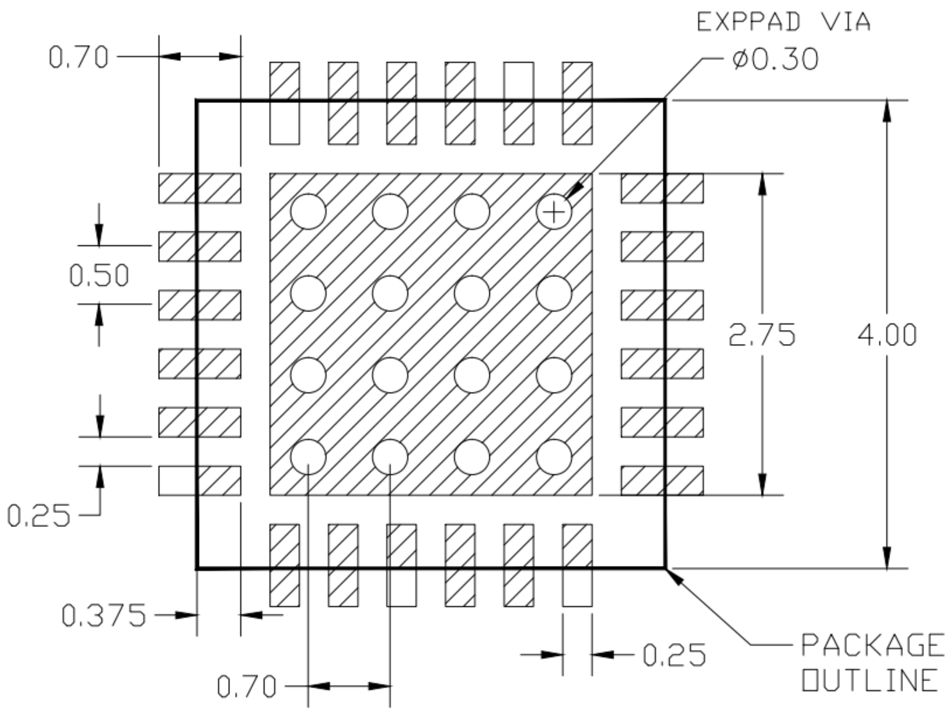
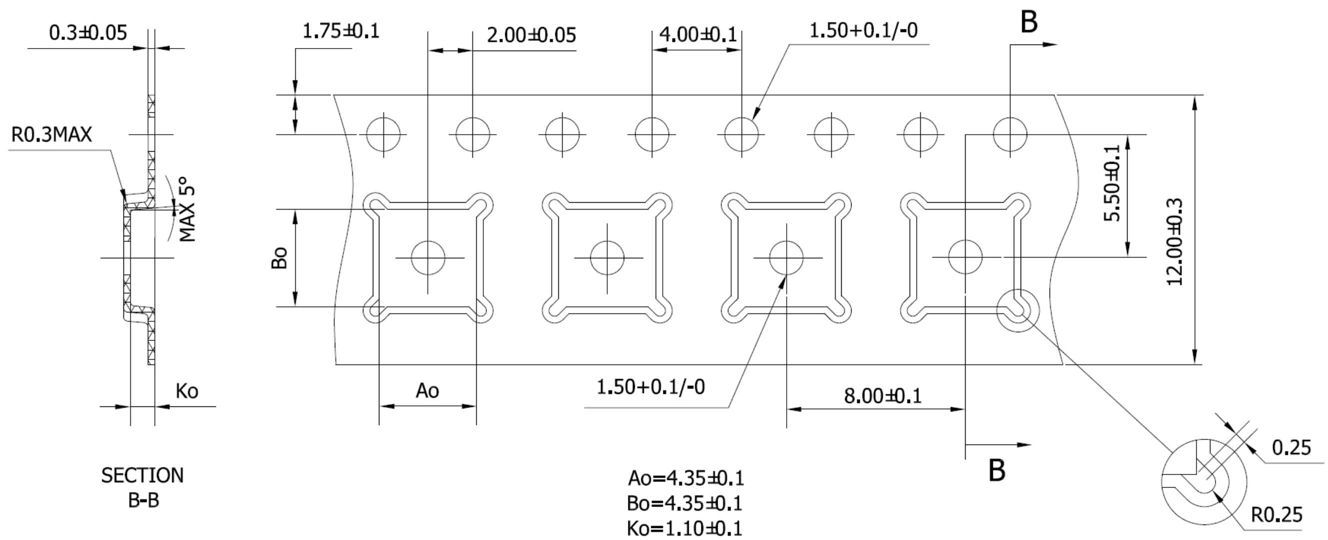


Figure 64. Package Marking

Marking information:	
BDA4700	Device Name
YY	Year
WW	Work Week
XX	LOT Number

Figure 65. Tape & Reel



[Unit: MM]

NOTES:
1 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2 CAMBER IN COMPLIANCE WITH EIA 481
3 POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET,NOT POCKET HOLE

Packaging information:	
Tape Width	12mm
Reel Size	7inch
Device Cavity Pitch	8mm
Devices Per Reel	1k

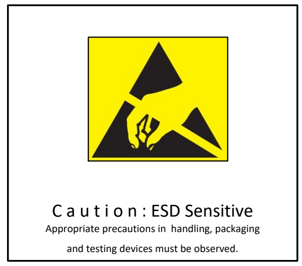
Lead plating finish

100% Tin Matte finish

(All BeRex products undergoes a 1 hour, 150 degree C, Anneal bake to eliminate thin whisker growth concerns.)

MSL / ESD Rating

ESD Rating:	Class 1C
Value:	±1000V
Test:	Human Body Model (HBM)
Standard:	JEDEC Standard JS-001-2017
ESD Rating:	Class C3
Value:	±1000V
Test:	Charged Device Model (CDM)
Standard:	JEDEC Standard JS-002-2018
MSL Rating:	**Level 1 at +260°C convection reflow**
Standard:	JEDEC Standard J-STD-020



Proper ESD procedures should be followed when handling this device.

RoHS Compliance

This part is compliant with Restrictions on the use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive 2011/65/EU as amended by Directive 2015/863/EU.

This product also is compliant with a concentration of the Substances of Very High Concern (SVHC) candidate list which are contained in a quantity of less than 0.1%(w/w) in each components of a product and/or its packaging placed on the European Community market by the BeRex and Suppliers.

NATO CAGE code:

2	**N**	**9**	**6**	**F**