

# **RFDA4005**

6-Bit, Digital Controlled Variable Gain Amplifier 50MHz to 4000MHz

RFMD's RFDA4005 is a digitally controlled variable gain amplifier featuring high linearity over the entire gain control range with noise figure less than 6dB in its maximum gain state. The gain of the 6-bit digital step attenuator is programmed with a serial mode control interface. The RFDA4005 is packaged in a small 5.2mm x 5.2mm leadless laminate MCM which contains plated through thermal vias for ultra-low thermal resistance. The footprint for this module is directly compatible with a 5mm x 5mm QFN. This module is easy to use with no external matching components required.



Functional Block Diagram

#### **Ordering Information**

RFDA4005SQ	Sample bag with 25 pieces
RFDA4005SR	7" Reel with 100 pieces
RFDA4005TR13	13" Reel with 2500 pieces
RFDA4005PCK-410	50MHz to 4000MHz PCBA with 5-piece sample bag

RF Micro Devices Inc. 7628 Thorndike Road, Greensboro, NC 27409-9421

For sales or technical support, contact RFMD at +1.336.678.5570 or customerservice@rfmd.com.

DS140902

rfmd⋙ RFDA4005

# Package: MCM, 32-pin, 5.2mm x 5.2mm

#### **Features**

- Broadband 50MHz to 4000MHz
  Operation
- 6-Bit Digital Step Attenuator
- Serial Mode Programming
- Gain = -13.5dB to +18dB (0.5dB Step Size)
- High Output IP3/P1dB = +36dB/ 20dBm
- Single +5V Supply
- Small 32-Pin, 5.2mm x 5.2mm, MCM (Footprint Compatible with 5mm x 5mm, 32-Pin QFN)

#### **Applications**

- Cellular, 3G Infrastructure
- WiBro, WiMax, LTE
- Microwave Radio
- High Linear Power Control

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#### **Absolute Maximum Ratings**

Parameter	Rating	Unit
Supply Voltage	5.5	V
DC Supply Current	110	mA
Power Dissipation	605	mW
Maximum RF Input Power	20	dBm
Storage Temperature Range	-40 to +150	°C
ESD Rating – HBM	1000 (Class 1C)	V
ESD Rating – CDM	1000 (Class 3C)	V
Moisture Sensitivity Level	MSL3	



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RFMD Green: RoHS status based on EU Directive 2011/65/EU (at time of this document revision), halogen free per IEC 61249-2-21, < 1000ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

Caution! ESD sensitive device.

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

### **Recommended Operating Condition**

Parameter	S	Unit			
	Min	Тур	Max	Onit	
Operating Temperature Range	-40		+85	°C	
Operating Junction Temperature <sup>1</sup>			165	°C	
Supply Voltage	4.75	5	5.25	V	

Note 1: MTTF = 1.0E6 hours at 165°C junction temperature

#### **Nominal Operating Parameters**

Parameter	Specification		Unit	Condition	
Falalletei	Min	Тур	Мах	Onit	Condition
General Performance					Temp = 25°C, V <sub>DD</sub> = 5V
Frequency Range	50		4000	MHz	
Coin Max	17.5	19	20.5	dB	500MHz, 0dB attenuation
Gairi Max	15.5	17.5	18.5	dB	2700MHz
Step Accuracy	<del>ا</del> Atten	- (0.1+5 uation S	% Setting)	dB	
		20		dBm	1900MHz
		19		dBm	2700MHz
		36		dBm	1900MHz
Ouputirs		33		dBm	2700MHz
Control Interface		6		Bit	Serial mode
Settling Time		250		nsec	T <sub>ON</sub> , T <sub>OFF</sub> (10 / 90% RF)
Noise Figure		6.3		dB	1900MHz
Impedance		50		Ω	
Input Return Loss		-15		dB	

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Parameter	Specification			Unit	Condition
ralametei	Min Typ Max Condition		Condition		
General Performance					Temp = 25°C, V <sub>DD</sub> = 5V
Output Return Loss		-15		dB	
Supply Current		82		mA	
Thermal Resistance		80.7		°C/W	Junction to backside of device

#### **Typical RF Performance at Key Operating Frequencies**

Parameter	Unit	500MHz	850MHz	1.95GHz	2.4GHz	3.5GHz	4GHz
Maximum Small Signal Gain	dB	18.9	18.7	17.6	17.2	15.7	13.7
Output P1dB	dBm	20.5	20.4	20.4	19.4	16.9	14.7
Output IP3	dBm	39	40	36	34.8	28.5	27.1
Input Return Loss	dB	-36	-24	-16	-15	-14	-10
Output Return Loss	dB	-18	-22	-15	-11	-16	-27
Noise Figure	dB	5.5	5.5	5.9	6.2	8.3	10



#### Typical Application Schematic 50MHz to 4000MHz Application Circuit



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#### Typical Performance: $T = 25^{\circ}C$ , $V_{DD} = 5V$ unless otherwise noted













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#### Typical Performance: T = 25°C, V<sub>DD</sub> = 5V unless otherwise noted











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Step Accuracy versus Frequency,

Temp = -40°C, Major Bits

1dB

-8dB

0.5dB

31.5dB

4dB

2.0

1.5

1.0

0.5

-1.0

-1.5

-2.0

0

500

1000

1500

2000

Frequency (MHz)

2500

3000

3500

4000

(dB)

Accuracy 0.0

Step -0.5 0dB

2dB

16dB

#### Typical Performance: T = 25°C, V<sub>DD</sub> = 5V unless otherwise noted







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### Evaluation Board Schematic 50MHz to 4000MHz Application Circuit



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#### Evaluation Board Bill of Materials (BOM) 50MHz to 4000MHz Application Circuit

Description	Reference Designator	Manufacturer	Manufacturer's P/N
RDA1005L with USB Evaluation Board	valuation Board PCB Itself Dynamic Details (DDI) Toronto		RDA1005L410(C)
50MHz to 4000MHz, G=18dB, P1=19dBm, 6-BIT, DVGA	U1	RFMD	RFDA4005SB
CAP, 1000pF, 10%, 50V, X7R, 0402	C2, C9-C10	Murata Electronics	GRM155R71H102KA01E
CAP, 1µF, 10%, 16V, X7R, 0805	C4, C14	Murata Electronics	GRM21BR71C104KA01K
CAP, 1000pF, 10%, 50V, X7R, 0603	C5, C13	Murata Electronics	GRM188R71H102KA01D
CAP, 100pF, 5%, 50V, C0G, 0402	C1, C3, C6-C8, C12	Murata Electronics	GRM1555C1H101JD01D
IND, 68nH, 5%, W/W, 1008	L1	Coilcraft	1008CS-680XJLC
RES, 1K, 1%, 1/16W, 0402	R1	Panasonic Industrial	ERJ-2RKF1001
RES ARRAY, 4-ELEM, 1K, 5%, SMD 4 x 0402	RP2	KOA	CN1E4KTTD102J
CONN, SMA, END LNCH, FLT, 0.062"	J1-J4	Emerson Network Power	142-0701-821
CONN, HDR, ST, PLRZD, 14-PIN, 0.100"	P1	ITW Pancon	MPSS100-14-C
CONN, HDR, ST, PLRZD, 2-PIN, 0.100"	P2	ITW Pancon	MPSS100-2-C
CONN, SKT, 24-PIN DIP, 0.600", T/H	P3	Aries Electronics Inc.	24-6518-10
MOD, USB TO SERIAL UART, SSOP-28	M1	Future Technology Devices Int'l	UM232R



#### **Evaluation Board Assembly Drawing**



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#### **Serial Attenuation Word Truth Table**

		Gain Relative to				
D5	D4	D3	D2	D1	D0	Max Gain
1	1	1	1	1	1	0dB / Reference Insertion Loss
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 Max Attenuation

#### **Timing Diagrams**







#### **Timing Specifications**

Parameter	Limit	Unit	Comments
t1	25	MHz, max	CLK Frequency
t2	20	ns min	CLK High
t3	20	ns min	CLK Low
t4	5	ns min	DATA to CLK Setup Time
t5	5	ns min	DATA to CLK Hold Time
t6	30	ns min	DATA Valid
t7	5	ns min	LE to CLK Setup Time
t8	5	ns min	CLK to LE Setup Time
t9	10	ns min	LE Pulse Width
t10	20	ns max	Output Set

#### **Control Voltage**

State	Low	High
$V_{DD} = 3V$	0V to 0.8V	2V to V <sub>DD</sub>
$V_{DD} = 5V$	0V to 0.8V	2V to V <sub>DD</sub>

## **Power-up Programming Truth Table**

PUP	Attenuator Setting
Low	Attenuator at Max, 31.5dB
High	Attenuator at Min, 0dB

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#### **Pin Names and Descriptions**

Pin	Name	Description				
1	AMPIN	RF Amplifier Input				
2	GND	RF/DC Ground Connection				
3	GND	RF/DC Ground Connection				
4	ATTOUT	Digital Attenuator Output				
5	NC	NC Connection; leave open or ground				
6	NC	NC Connection; leave open or ground				
7	NC	NC Connection; leave open or ground				
8	NC	NC Connection; leave open or ground				
9	NC	NC Connection; leave open or ground				
10	NC	NC Connection; leave open or ground				
11	GND	RF/DC Ground Connection				
12	ATTIN	Digital Attenuation Input				
13	GND	RF/DC Ground Connection				
14	NC	NC Connection; leave open or ground				
15	PUP	Power-up Programming Pin Low = Max attenuation setting at power up, -31.5dB High = Min attenuation setting at power up, 0dB				
16	NC	NC Connection; leave open or ground				
17	VDD	Supply Voltage				
18	NC	NC Connection; leave open or ground				
19	NC	NC Connection; leave open or ground				
20	NC	NC Connection; leave open or ground				
21	NC	NC Connection; leave open or ground				
22	NC	NC Connection; leave open or ground				
23	NC	NC Connection; leave open or ground				
24	NC	NC Connection; leave open or ground				
25	CLK	Serial Clock				
26	DATA	Serial Data				
27	LE	Latch Enable				
28	GND	RF/DC Ground Connection				
29	AMPOUT	RF Amplifier Output				
30	GND	RF/DC Ground Connection				
31	GND	RF/DC Ground Connection				
32	GND	RF/DC Ground Connection				

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#### Package Outline (Dimensions in millimeters)





#### Stencil Drawing (Dimensions in millimeters)



#### **Branding Diagram**





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