

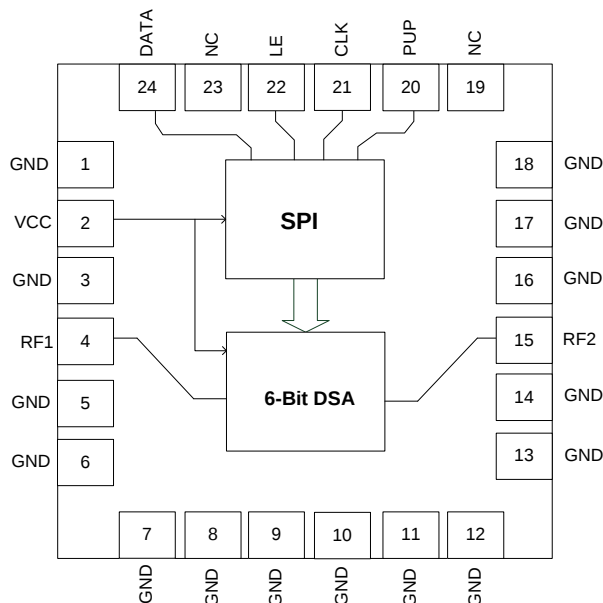


Features

- Frequency Range 5MHz to 2000MHz
- 6-Bits, 75Ω, 31.5dB Range, 0.5dB Step
- High Linearity, IIP3 >50dBm
- 3V and 5V Logic Compatible
- Serial-to-Parallel Controller
- Serial Programming Interface
- Power-up Programming Modes
- On-chip ESD Protection Class 1C HBM
- Single Supply, 5V Operation
- Footprint Compatible with Most 24-Pin, 4mm x 4mm, QFNs

Applications

- CATV/Satellite Set Top Boxes
- Cable Modems
- CATV Infrastructure
- Data Network Equipment



Functional Block Diagram

Product Description

RFMD's RFSA2654 is a 6-bit, 75Ω digital step attenuator (DSA) that features high linearity over the entire 31.5dB gain control range with excellent step accuracy in 0.5dB steps. The RFSA2654 is programmed via a serial mode control interface that is both 3V and 5V compatible. The RFSA2654 also offers a rugged Class 1C HBM ESD rating via on-chip ESD circuitry. The MCM package is footprint compatible with most 24-pin 4mm x 4mm QFN packages.

Ordering Information

RFSA2654SQ	Sample bag with 25 pieces
RFSA2654SR	7" Sample reel with 100 pieces
RFSA2654TR13	13" Reel with 2500 pieces
RFSA2654PCK-410	5MHz to 2000MHz PCBA with 5-piece sample bag

Optimum Technology Matching® Applied

- | | | | |
|--------------------------------------|--------------------------------------|--|------------------------------------|
| ☐ GaAs HBT | ☐ SiGe BiCMOS | ☒ GaAs pHEMT | ☐ GaN HEMT |
| ☐ GaAs MESFET | ☐ Si BiCMOS | ☒ Si CMOS | ☐ BiFET HBT |
| ☐ InGaP HBT | ☐ SiGe HBT | ☐ Si BJT | |

Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	+5.5	V
DC Supply Current	15	mA
Power Dissipation	83	mW
Max RF Input Power	28.3	dBm
Operating Temperature (T _{CASE})	-40 to +85	°C
Storage Temperature	-40 to +150	°C
Junction Temperature	150	°C
ESD Rating (HBM)	Class 1C	
Moisture Sensitivity Level	MSL3	



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.

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RFMD Green: RoHS compliant per EU Directive 2002/95/EC, 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.

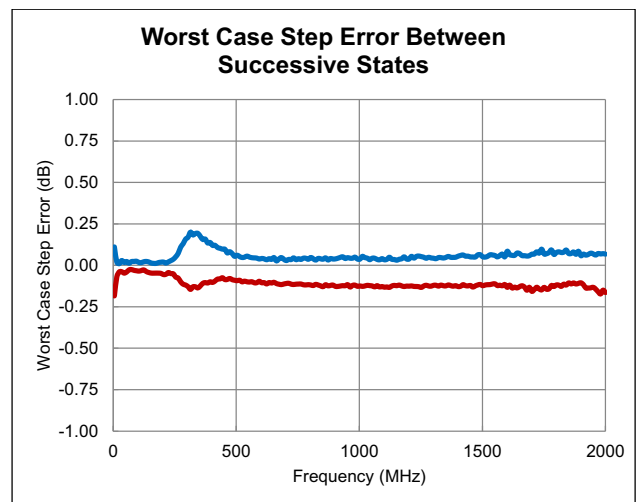
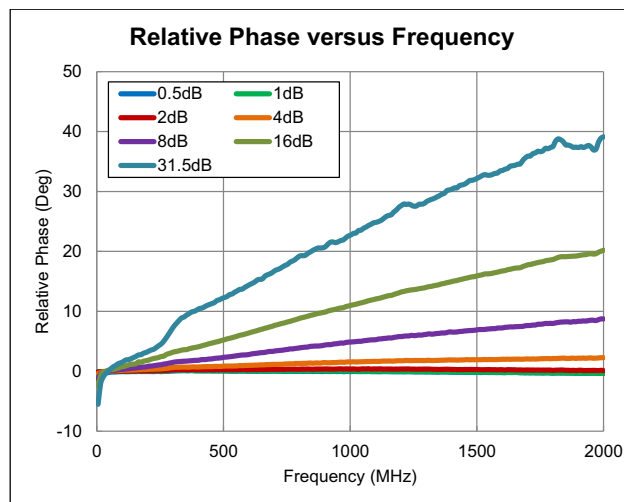
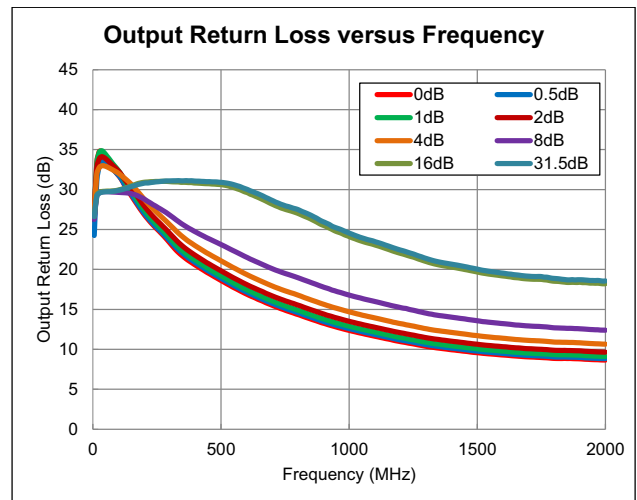
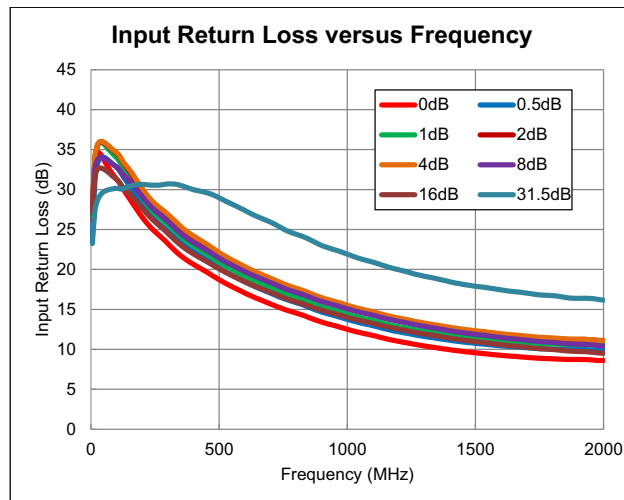
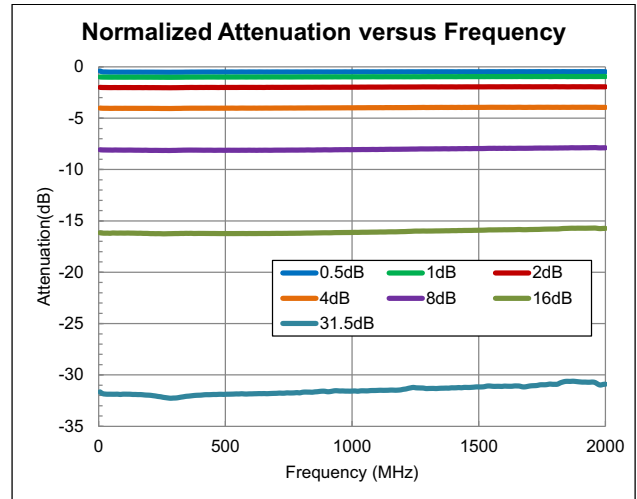
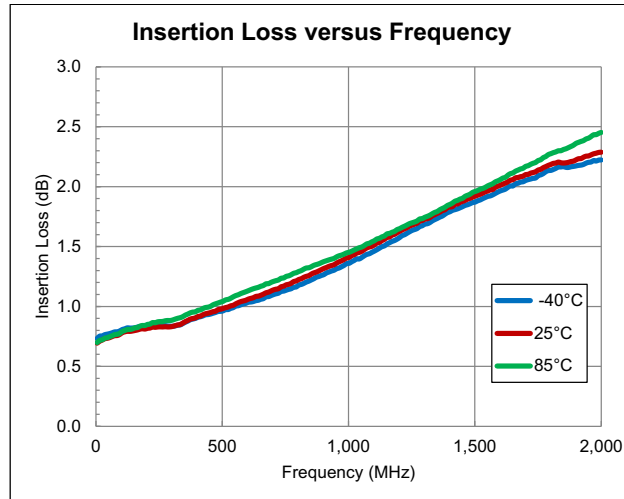
Nominal Operating Parameters

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Overall					5V, 25 °C, 75Ω, typical condition unless otherwise stated.
Frequency Range	5		2000	MHz	
Insertion Loss		0.69		dB	5MHz, 0dB attenuation
		1.3		dB	880MHz, 0dB attenuation
		1.92		dB	1200MHz, 0dB attenuation
		2.21		dB	1880MHz, 0dB attenuation
		2.29		dB	2000MHz, 0dB attenuation
Gain Control Range		31.5		dB	0.5dB step size
Step Accuracy	±(0.1 + 5.0% attenuation setting)			dB	
Input IP3	46	52		dBm	30MHz to 2000MHz, all states, tested into 50Ω, minimum at 31.5dbm attenuation
Input P0.5dB		25		dBm	100MHz, all states, tested into 50Ω
	27	30		dBm	200MHz to 2000MHz, 27dBm for 8, 16-bit Steps, tested into 50Ω
Input Return Loss	11	17.5		dB	5MHz to 1200MHz, all states
Output Return Loss	11	17.5		dB	5MHz to 1200MHz, all states
Control Interface		6-bit, Serial		bit	Serial interface
Settling Time		200		ns	t _{RISE} , t _{FALL} (10%/90% RF)
Switching Speed		200		ns	t _{ON} , t _{OFF} (50% CTL to 10%/90% RF)
Supply Voltage (V _{DD})	4.75	5.0	5.25	V	Typical performance based on 5V operation.
Supply Current		5.7		mA	
Control Voltage (V _{CTL})	Low, V _{CTL} = 0V to 0.8V			V	
	High, V _{CTL} = 2.0V to V _{DD}			V	

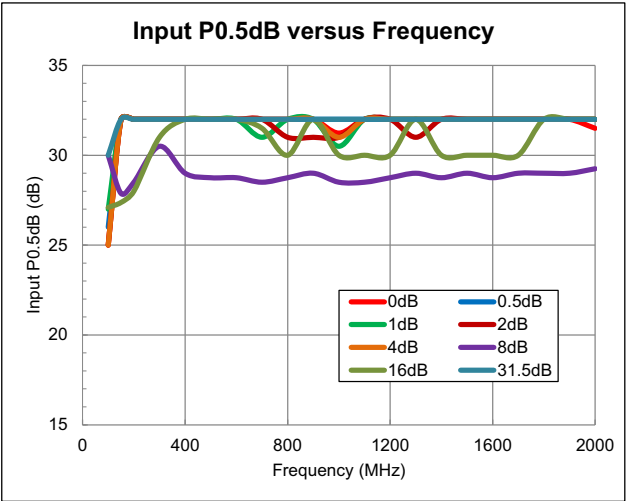
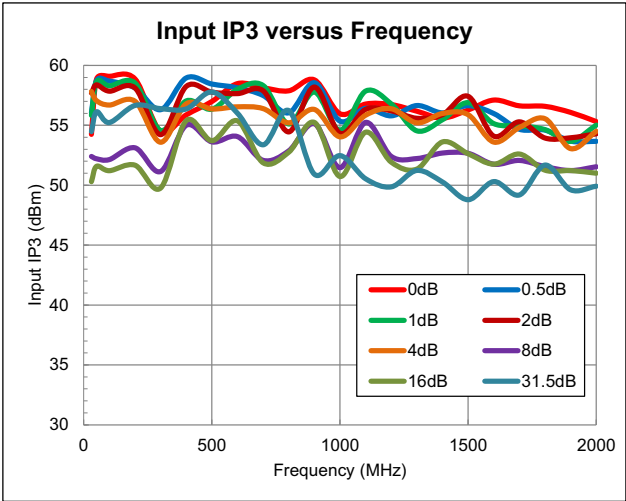
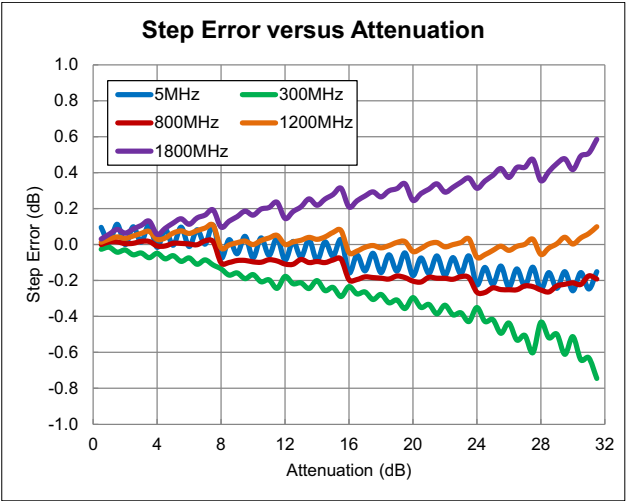
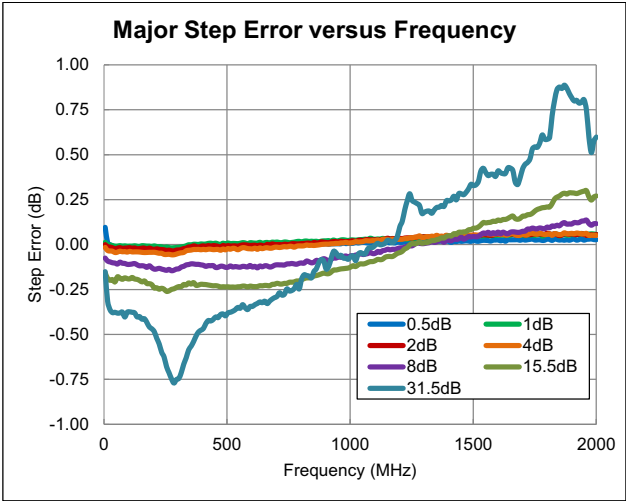
Notes:

- V_{DD} = 5V, V_{CTL} = 5V, T = 25 °C
- IIP3 measured with P_{IN} = +12dBm/tone, 1MHz spacing

Typical Performance - Broadband Application Circuit

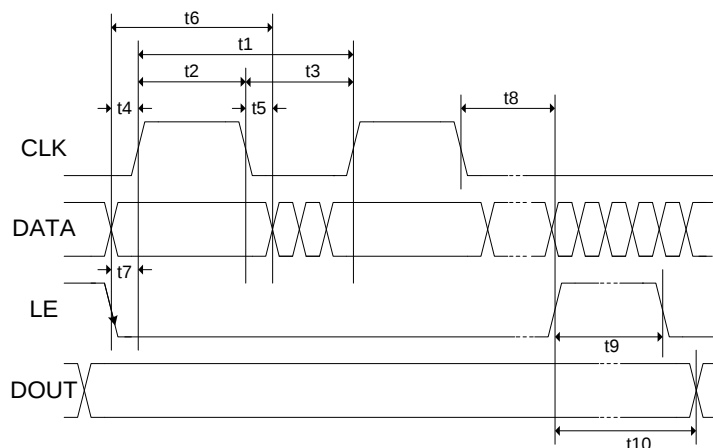


Typical Performance - Broadband Application Circuit

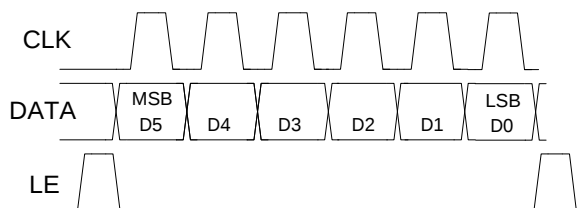


Serial Port Interface

SPI Timing Diagram



Programming Example - 6-Bit



Truth Table

Control Bits						Relative Gain Setting
C16	C8	C4	C2	C1	C0.5	
1	1	1	1	1	1	Max gain
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

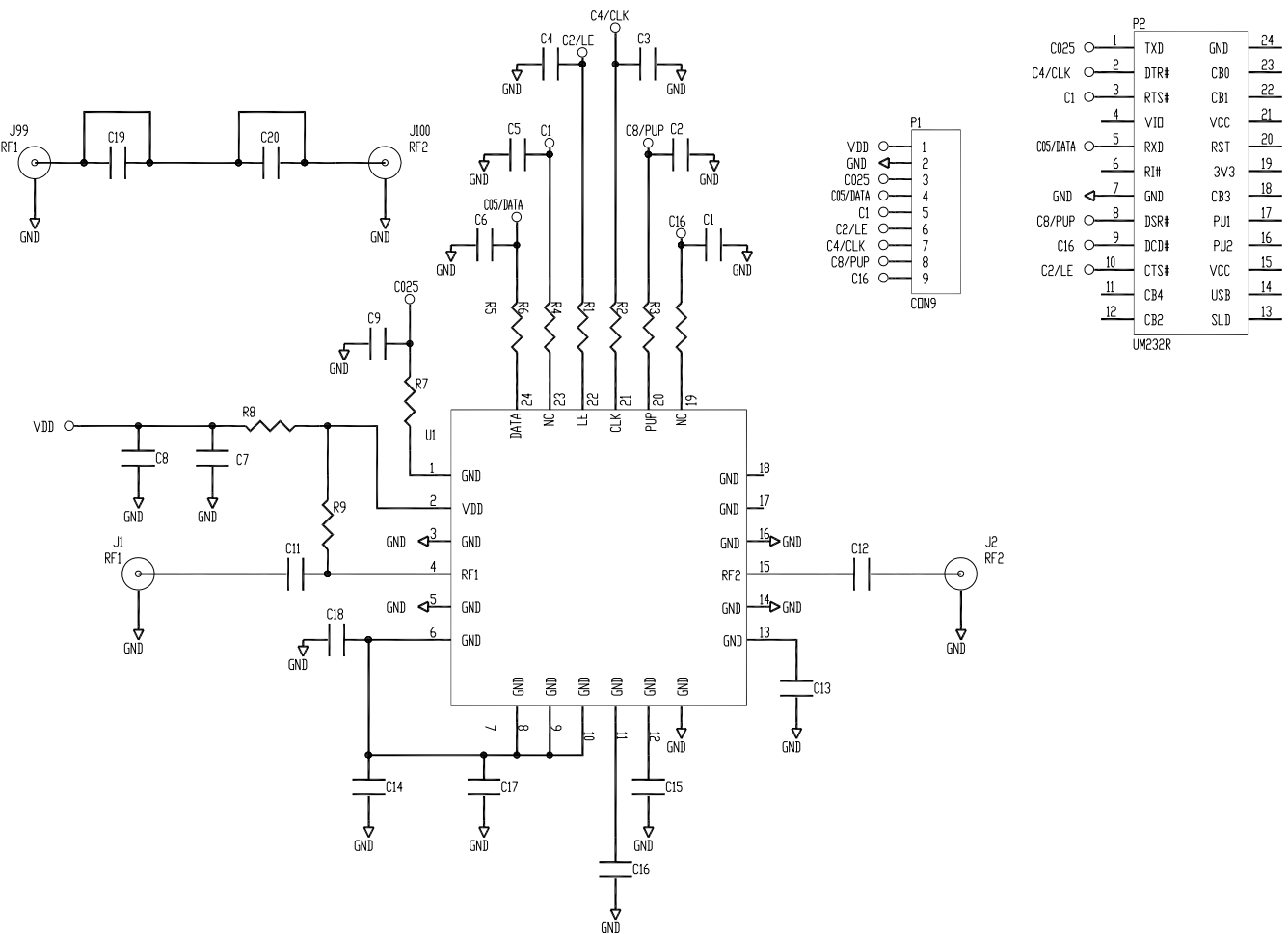
SPI Timing Diagram Specifications

Parameter	Limit	Unit	Comment
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 min	Output Set

Logic Voltage Levels	
State	Logic
Low	0V to 0.8V
High	2.0V to 5.0V

Power-up Programming Truth Table	
PUP	Attenuator Setting
Low	Attenuation at max, 31.5dB
High	Attenuation at min, 0dB

Evaluation Board Schematic

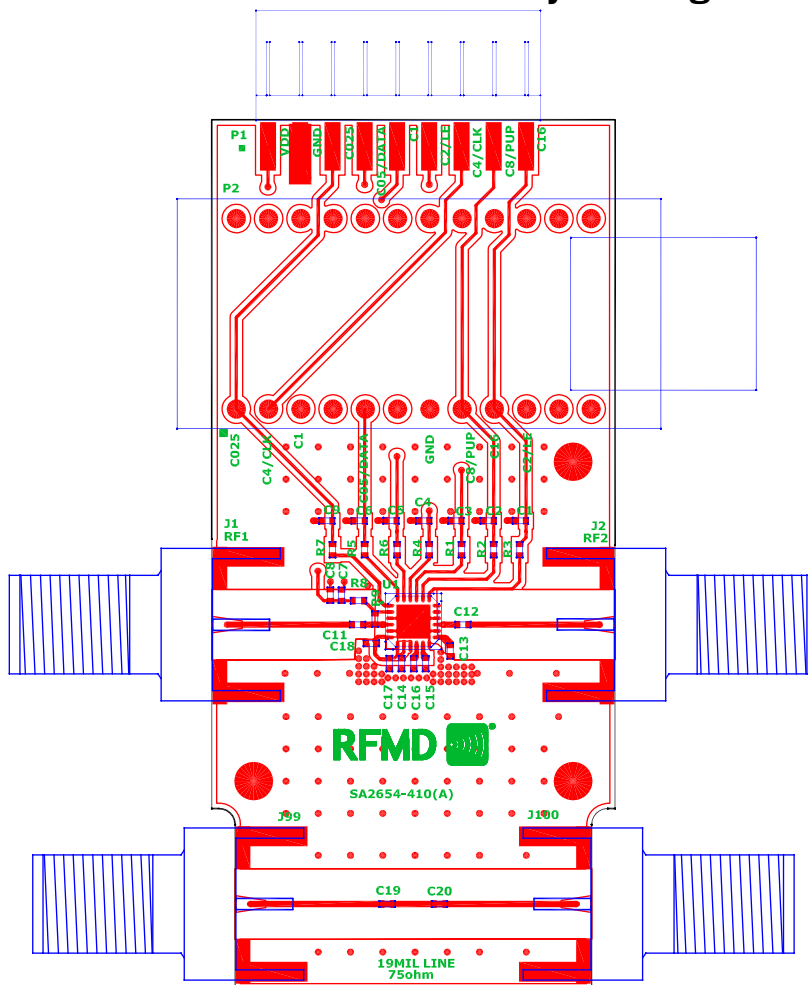


Evaluation Board Bill of Materials (BOM)

Description	Reference Designator	Manufacturer	Manufacturer's P/N
Evaluation Board			SA2654410(A)
RFSA2654	U1	RFMD	RFSA2654
CAP, 1nF, 10%, 10V, X5R, 0402	C7	Taiyo Yuden (USA), Inc.	RM UMK105BJ102KV-F
CAP, 10000pF, 10%, 25V, X7R, 0402	C11-C12*	Murata Electronics	GRM155R71E103KA01D
RES, 0Ω, 5%, 1/16W, 0402	R1-R2, R4-R5, R8	Kamaya, Inc	RMC1/16SJPTH
DNP	R3, R6-R7, R9		
DNP	C1-C6, C8-C9, C13-C20		
CONN, F FEM EDGE MOUNT, 75Ω, 0.035"	J1-J2	Millimeter Wave Technologies, LLC	MW-846-F-DD-75
DNP	J99-J100		
CONN, HDR, ST, PLRZD, 9-PIN	P1	ITW Pancon	MPSS100-9-C
CONN, SKT, 24-PIN DIP, .600", T/H	P2	Aries Electronics Inc.	24-6518-10

* Evaluation board shipped with 470pF C11-C12 to support 2GHz operation. 10,000pF required for 5MHz operation.

Evaluation Board Assembly Drawing



Pin Names and Descriptions

Pin	Name	Description
1	GND	Connect to Low Inductance Path to Ground.
2	VDD	Power Supply.
3	GND	Connect to Low Inductance Path to Ground.
4	RF1	RF port. External DC block required.
5	GND	Connect to Low Inductance Path to Ground.
6	GND	Connect to Low Inductance Path to Ground.
7	GND	Connect to Low Inductance Path to Ground.
8	GND	Connect to Low Inductance Path to Ground.
9	GND	Connect to Low Inductance Path to Ground.
10	GND	Connect to Low Inductance Path to Ground.
11	GND	Connect to Low Inductance Path to Ground.
12	GND	Connect to Low Inductance Path to Ground.
13	GND	Connect to Low Inductance Path to Ground.
14	GND	Connect to Low Inductance Path to Ground.
15	RF2	RF port. External DC block required.
16	GND	Connect to Low Inductance Path to Ground.
17	GND	Connect to Low Inductance Path to Ground.
18	GND	Connect to Low Inductance Path to Ground.
19	NC	No internal connection. EVB can be ground or no connect.
20	PUP	Power-up Programming pin. Low = max attenuation (31.5dB) at power-up. High = min attenuation (0dB) at power-up.
21	CLK	Serial Clock.
22	LE	Latch Enable.
23	NC	No internal connection; EVB can be ground or no connect.
24	DATA	Serial Data.
EPAD	GND	DC and RF Ground; Must be soldered to EVB ground plane over a bed of vias for thermal and RF performance.

1. Shaded area represents Pin 1 location.

A = 0.250 x 0.400 mm
B = 0.400 x 0.250 mm
C = 2.680 x 2.680 mm

SA2654
YYWW
Trace Code

4.200

4.200

YY = Year
WW = Week