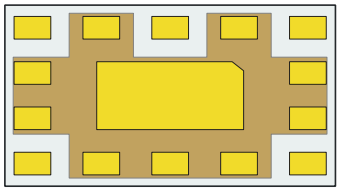
ACFM-7024

Band 2 / Band 4 Quadplexer

Data Sheet

Lead (Pb) Free
RoHS 6 fully
compliant



Description

The Avago Technologies' ACFM-7024 is a quadplexer that combines LTE Band 2 and Band 4 duplexers into a single, miniature package.

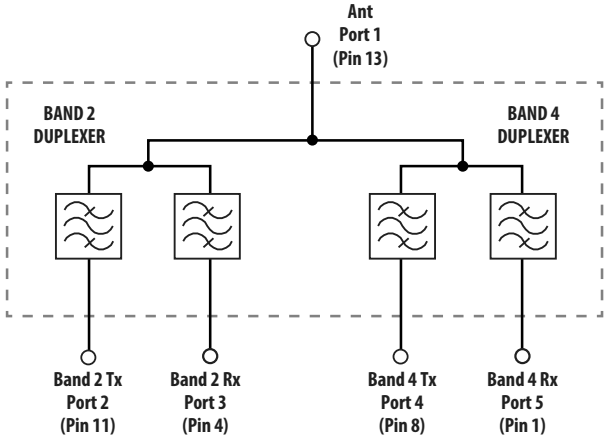
The ACFM-7024 features a single antenna connection, eliminating the need for antenna switching. All ports are matched to 50 ohms.

The ACFM-7024 is designed with Avago Technologies' Film Bulk Acoustic Resonator (FBAR) technology. The ACFM-7024 also utilizes Avago Technologies' innovative Microcap bonded-wafer, chip scale packaging technology. This process allows the filters to be assembled in a module with a footprint of only 3.6 x 2 mm with a maximum height of 0.80 mm.

Low Tx Insertion Loss of the ACFM-7024 reduces power amplifier current, extending battery life. The ACFM-7024 enhances receiver sensitivity and dynamic range with low Rx Insertion Loss and high rejection of Tx signals at the Rx ports.

The excellent power handling capability of Avago Technologies' FBAR bulk-mode resonators supports the high Tx output power levels needed mobile communications devices while adding virtually no distortion.

Functional Block Diagram



Features

- Single Antenna
- B2+B4 carrier aggregation
- Miniature size
  - 3.6 x 2 mm Footprint
  - 0.80 mm Max height
- High Power Rating
  - +31 dBm Max Tx Power
- Environmental
  - RoHS 6 Compliant
  - Halogen Free
  - TBBPA Free

Specifications

- Performance guaranteed –20° to +85°C
- Band 2 Duplexer Rx (1930 – 1990 MHz)
  - Insertion Loss: 4.2 dB Max
  - Noise Blocking: 52 dB Min
- Band 2 Duplexer Tx (1850 – 1910 MHz)
  - Insertion Loss: 3.5 dB Max
  - Interferer Blocking: 55 dB Min
- Band 4 Duplexer Rx (2110 – 2155 MHz)
  - Insertion Loss: 2.5 dB Max
  - Noise Blocking: 55 dB Min
- Band 4 Duplexer Tx (1710 – 1755 MHz)
  - Insertion Loss: 2.3 dB Max
  - Interferer Blocking: 55 dB Min

Applications

- Smartphones, tablets, and mobile/portable communications devices operating in Bands 2 and 4

ACFM-7024 Electrical Specifications, Z_0=50 Ω, T_C [1, 2] as indicated. Specifications include matching shown in Figure 1.

Band 2 Duplexer Performance

			–20°C		+25°C			+85°C	
Symbol	**Parameter**	**Units**	**Min**	**Max**	**Min**	**Typ [3]**	**Max**	**Min**	**Max**
	Antenna Port to Band 2 Rx Port								
S31	Insertion Loss in Rx Band	dB							
	1930 – 1933 MHz			4.2		2.6	3.5		3.5
	1933 – 1990 MHz			3.5		1.6	3.5		3.5
S31	Attenuation in Tx Band, 1850 – 1910 MHz	dB	48		48	61		48	
S31	Attenuation, 10 – 1835MHz	dB	25		25	51		25	
S31	Attenuation in Band 4 Tx, 1710 – 1755 MHz	dB	45		45	63		45	
S31	Attenuation in Bluetooth Bands 2400 – 2483 MHz	dB	30		30	48		30	
S31	Attenuation, 3780 – 3900 MHz	dB	25		25	56		25	
S31	Attenuation, 5630 – 5810 MHz	dB	25		25	79		25	
S33	Return Loss (SWR) of Rx Port in Rx Band 1930 – 1990 MHz	dB	8	(2.3)	8	16	(2.3)	8	(2.3)
S11	Return Loss (SWR) of Ant Port in Rx Band	dB							
	1930 – 1933 MHz		6	(3.0)	8	13	(2.3)	8	(2.3)
	1933 – 1990 MHz		8	(2.3)	8	16	(2.3)	8	(2.3)
	Band 2 Tx Port to Antenna Port								
S12	Insertion Loss in Tx Band	dB							
	1850 – 1905 MHz			3.0		1.3	3.0		3.0
	1905 – 1910 MHz			3.0		1.8	3.0		3.5
S12	Attenuation in Rx Band, 1930 – 1990 MHz	dB	45		45	60		45	
S12	Attenuation, 10 – 1565 MHz	dB	30		30	41		30	
S12	Attenuation in Band 5 Rx, 869 – 894 MHz	dB	40		40	52		40	
S12	Attenuation in GPS Band, 1565 – 1606 MHz	dB	40		40	47		40	
S12	Attenuation in AWS Rx Band, 2110 – 2155 MHz	dB	45		45	59		45	
S12	Attenuation in Bluetooth Bands 2400 – 2483 MHz	dB	35		35	55		35	
S12	Attenuation in Tx 2nd Harmonic Band 3700 – 3820 MHz	dB	28		28	34		28	
S12	Attenuation in Tx 3rd Harmonic Band 5550 – 5730 MHz	dB	10		10	36		10	
S22	Return Loss (SWR) of Tx Port in Tx Band 1850 – 1910 MHz	dB	9	(2.1)	9	17	(2.1)	9	(2.1)
S11	Return Loss (SWR) of Ant Port in Tx Band 1850 – 1910 MHz	dB	9	(2.1)	9	19	(2.1)	9	(2.1)
	Isolation, Band 2 Tx Port to Rx Port								
S32	Isolation, Tx to Rx port in Rx Band [4]	dB							
	1930 – 1933 MHz		52		55	66		55	
	1933 – 1990 MHz		55		55	72		55	
S32	Isolation, Tx to Rx port in Tx Band 1850 – 1910 MHz	dB	55		55	62		55	

Notes:

1. T_C (Case Temperature) is defined as the temperature of the bottom mounting surface of the quadplexer where it makes contact with the circuit board.
2. Min/Max specifications are guaranteed at the indicated temperature with the input power to the Tx ports equal to or less than +27 dBm over all Tx frequencies unless otherwise noted.
3. Typical data is the arithmetic mean value of the parameter over its indicated frequency range at 25°C. Typical values may vary over time.
4. Integrated channel average Isolation, obtained by averaging Sij over the center 2.7 MHz of LTE 3 MHz (15 RB) channels.

ACFM-7024 Electrical Specifications, Z0=50 Ω, TC [1, 2] as indicated. Specifications include matching shown in Figure 1.

Band 4 Duplexer Performance

			–20°C		+25°C			+85°C	
Symbol	**Parameter**	**Units**	**Min**	**Max**	**Min**	**Typ [3]**	**Max**	**Min**	**Max**
	Antenna Port to Band 4 Rx Port								
S51	Insertion Loss in Rx Band, 2110 – 2155 MHz	dB		2.5		1.6	2.5		2.5
S51	Attenuation in Tx Band, 1710 – 1755 MHz	dB	48		48	59		48	
S51	Attenuation, 10 – 1605 MHz	dB	30		30	51		30	
S51	Attenuation in Band 2 Tx, 1850 – 1910 MHz	dB	45		45	60		45	
S51	Attenuation, 1910 – 1955 MHz	dB	25		25	59		25	
S51	Attenuation in Wi-Fi, Bluetooth Bands 2400 – 2483 MHz	dB	30		30	52		30	
S51	Attenuation, 3820 – 3910 MHz	dB	24		24	38		24	
S51	Attenuation, 5530 – 5665 MHz	dB	25		25	37		25	
S55	Return Loss (SWR) of Rx Port in Rx Band 2110 – 2155 MHz	dB	9	(2.1)	9	16	(2.1)	9	(2.1)
S11	Return Loss (SWR) of Ant Port in Rx Band 2110 – 2155 MHz	dB	9	(2.1)	9	18	(2.1)	9	(2.1)
	Band 4 Tx Port to Antenna Port								
S14	Insertion Loss in Tx Band, 1710 – 1755 MHz	dB		2.3		1.6	2.3		2.3
S14	Attenuation in Rx Band, 2110 – 2155 MHz	dB	45		45	63		45	
S14	Attenuation, 10 – 1565 MHz	dB	30		30	54		30	
S14	Attenuation in Band 5 Rx, 869 – 894 MHz	dB	35		35	51		35	
S14	Attenuation in GPS Band, 1565 – 1606 MHz	dB	40		40	53		40	
S14	Attenuation Band 2 Rx, 1930 – 1990 MHz	dB	45		45	62		45	
S14	Attenuation in , Bluetooth Bands 2400 – 2483 MHz	dB	30		30	37		30	
S14	Attenuation in Tx 2nd Harmonic Band 3410 – 3520 MHz	dB	35		35	39		35	
S14	Attenuation in Tx 3rd Harmonic Band 5120 – 5350 MHz	dB	10		10	26		10	
S44	Return Loss (SWR) of Tx Port in Tx Band 1710 – 1755 MHz	dB	10	(1.9)	10	19	(1.9)	10	(1.9)
S11	Return Loss (SWR) of Ant Port in Tx Band 1710 – 1755 MHz	dB	10	(1.9)	10	23	(1.9)	10	(1.9)
	Isolation, Band 4 Tx Port to Rx Port								
S54	Isolation, Tx to Rx port in Rx Band [4] 2110–2155 MHz	dB	55		55	65		55	
S54	Isolation, Tx to Rx port in Tx Band 1710 – 1755 MHz	dB	55		55	60		55	
	Cross-Band Isolation								
S34	Isolation, Band 4 Tx to Band 2 Rx in Band 4 Tx 1710 – 1755 MHz	dB	55		55	67		55	
S34	Isolation, Band 4 Tx to Band 2 Rx in Band 2 Rx [4] 1930 –1990 MHz	dB	55		55	61		55	
S52	Isolation, Band 2 Tx to Band 4 Rx in Band 2 Tx 1850 –1910 MHz	dB	55		55	62		55	
S52	Isolation, Band 2 Tx to Band 4 Rx in Band 4 Rx [4] 2110 – 2155 MHz	dB	55		55	73		55	

Notes:
1. T_C (Case Temperature) is defined as the temperature of the bottom mounting surface of the quadplexer where it makes contact with the circuit board.
2. Min/Max specifications are guaranteed at the indicated temperature with the input power to the Tx ports equal to or less than +27 dBm over all Tx frequencies unless otherwise noted.
3. Typical data is the arithmetic mean value of the parameter over its indicated frequency range at 25°C. Typical values may vary over time.
4. Integrated channel average Isolation, obtained by averaging Sij over the center 2.7 MHz of LTE 3 MHz (15 RB) channels.

Absolute Maximum Ratings [1]

Parameter	Unit	Value
Storage temperature	°C	–65 to +125
Maximum RF Input Power to Tx Ports	dBm	+31

Maximum Recommended Operating Conditions [2]

Parameter	Unit	Value
Operating temperature, Tc [3] , Tx Power ≤ 29 dBm	°C	–40 to +100
Operating temperature, Tc [3] , Tx Power ≤ 30 dBm	°C	–40 to +85

Notes:
1. Operation in excess of any one of these conditions may result in permanent damage to the device.
2. The device will function over the recommended range without degradation in reliability or permanent change in performance, but is not guaranteed to meet electrical specifications.
3. T_C (Case Temperature) is defined as the temperature of the bottom mounting surface of the quadplexer where it makes contact with the circuit board.

Applications Information

The Antenna and Band 2 Rx terminals of the ACFM-7024 quadplexer are internally matched to 50-ohms.

For purposes of electrical specification, and to illustrate optimum performance, the matching components shown in Figure 1 are used to match the Band 4 Rx and Tx terminals to 50-ohms.

For most applications, these matching components will be absorbed into the interstage match between the quadplexer and power amplifiers.

For best performance, matching components should be placed immediately adjacent to the quadplexer.

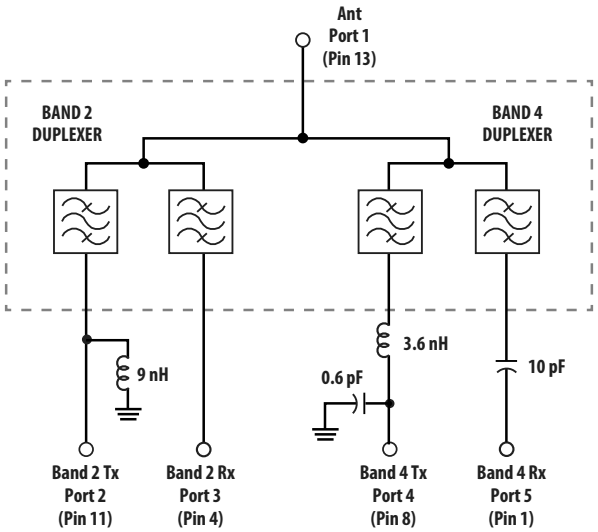


Figure 1. Typical Application.

ACFM-7024 Typical Performance at Tc = 25°C, include matching shown in Figure 1.

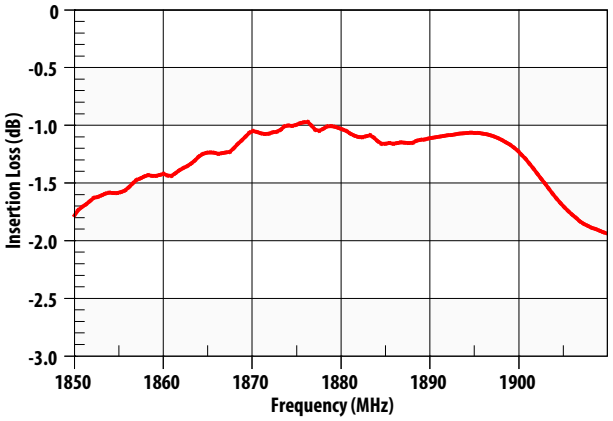


Figure 2. Band 2 Tx-Ant Insertion Loss.

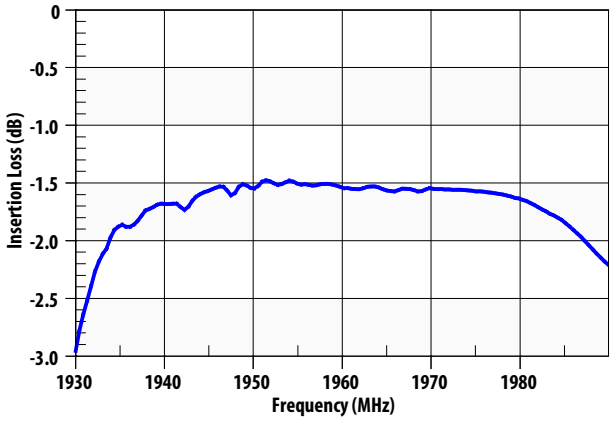


Figure 3. Band 2 Ant-Rx Insertion Loss.

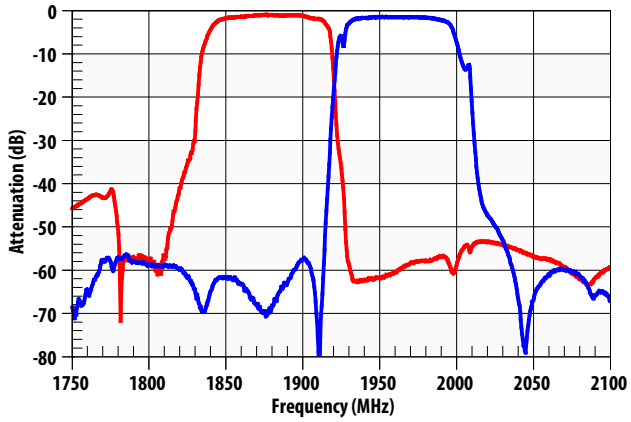


Figure 4. Band 2 Tx Rejection in Rx Band and Rx Rejection in Tx Band.

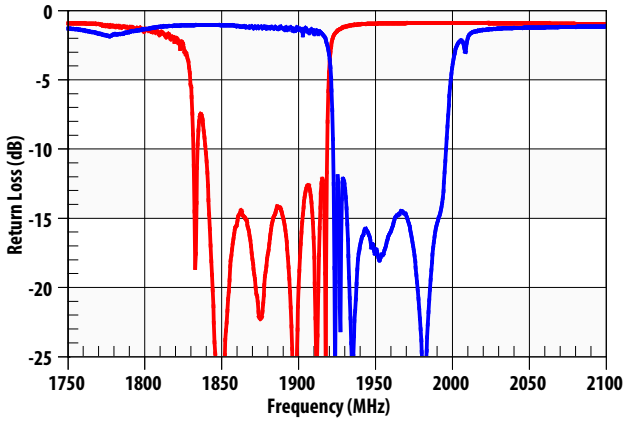


Figure 5. Band 2 Tx and Rx Port Return Loss.

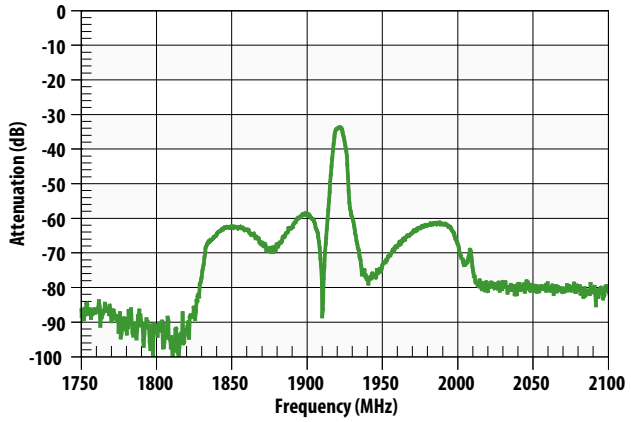


Figure 6. Band 2 Tx-Rx Isolation.

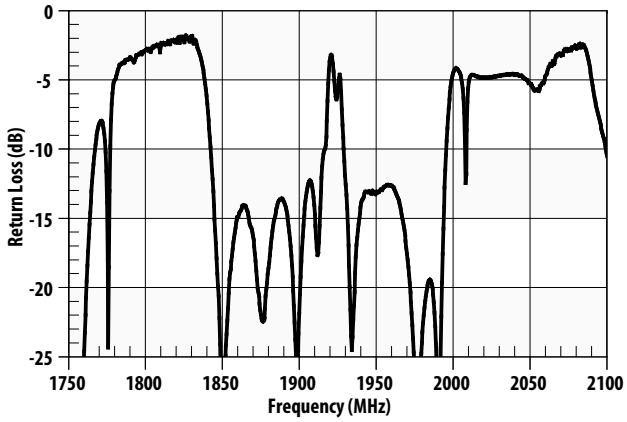


Figure 7. Band 2 Antenna Port Return Loss.

ACFM-7024 Typical Performance at Tc = 25°C, include matching shown in Figure 1.

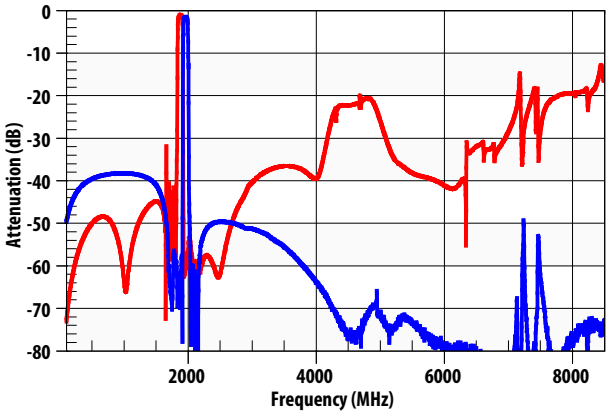


Figure 8. Band 2 Tx-Ant and Ant-Rx Wideband Insertion Loss.

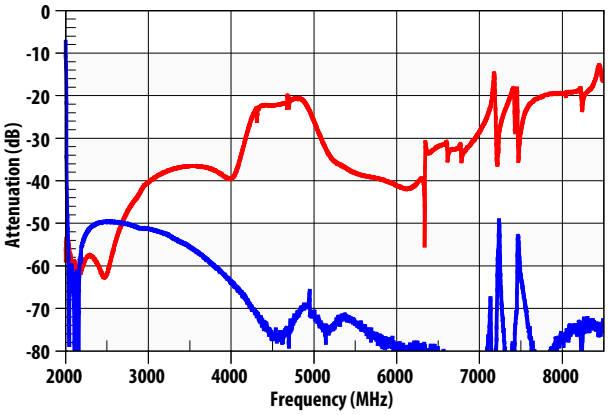


Figure 9. Band 2 Tx-Ant and Ant-Rx High Frequency Attenuation.

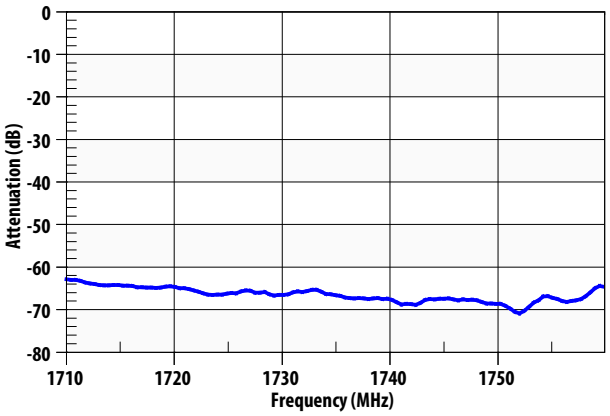


Figure 10. Band 2 Ant-Rx Attenuation in Band 4 Tx, 1710 - 1755 MHz.

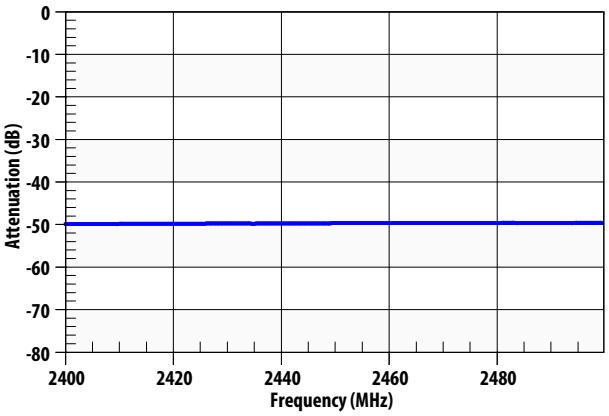


Figure 11. Band 2 Ant-Rx Attenuation in Bluetooth/ISM Bands.

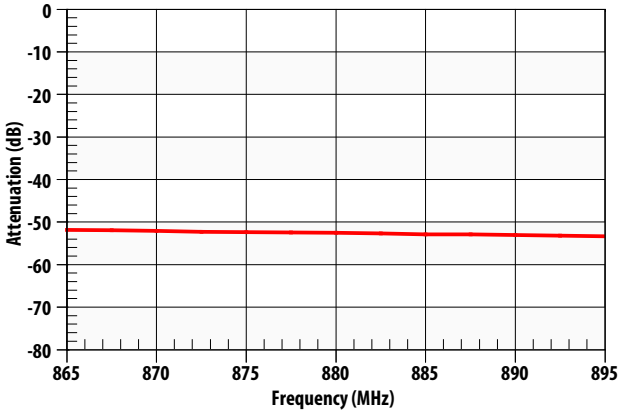


Figure 12. Band 2 Tx-Ant Attenuation in Band 5 Rx, 869 - 894 MHz.

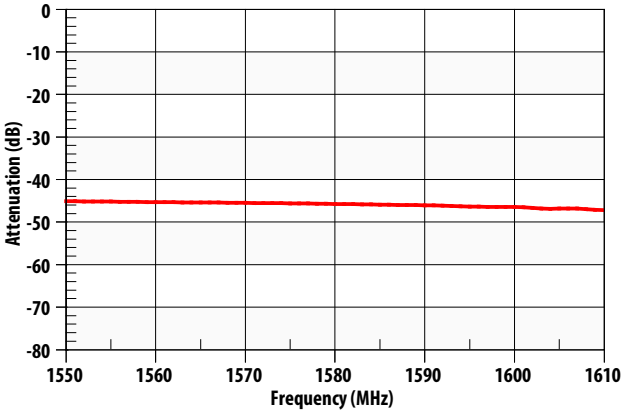


Figure 13. Band 2 Tx-Ant Attenuation in GNSS Bands.

ACFM-7024 Typical Performance at Tc = 25°C, include matching shown in Figure 1.

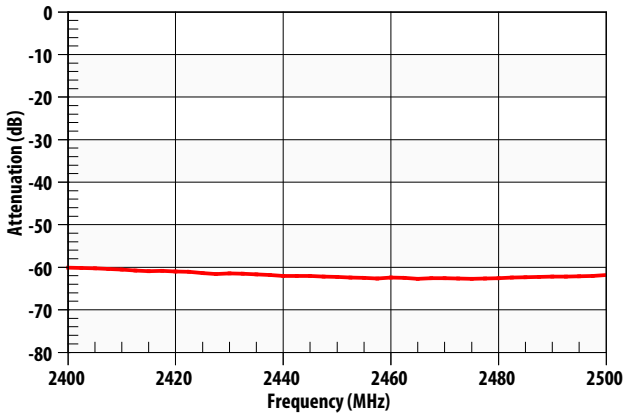


Figure 14. Band 2 Tx-Ant Attenuation in Bluetooth/ISM Bands.

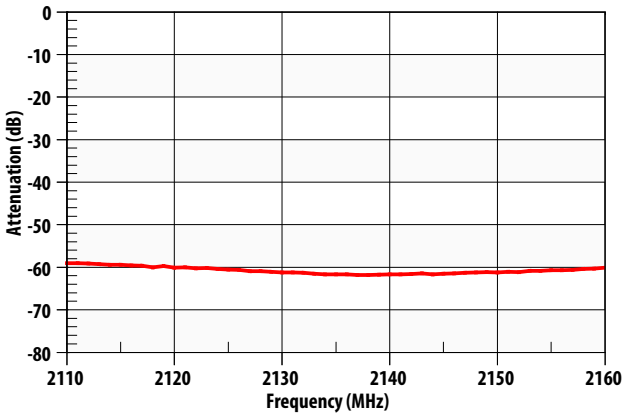


Figure 15. Band 2 Tx-Ant Attenuation in AWS Rx Band, 2110 - 2155 MHz.

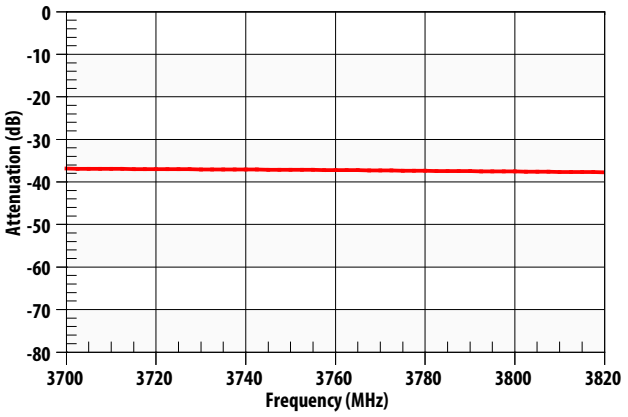


Figure 16. Band 2 Tx-Ant Attenuation at Tx Second Harmonic.

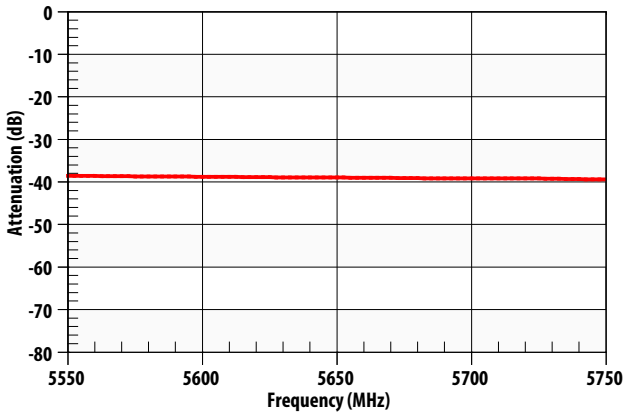


Figure 17. Band 2 Tx-Ant Attenuation at Tx Third Harmonic.

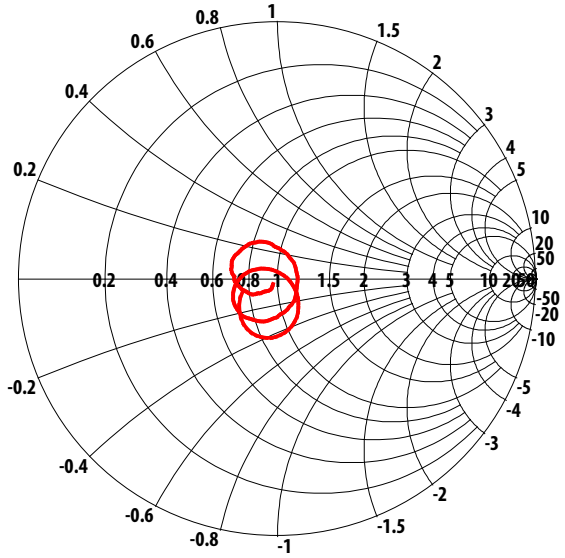


Figure 18. Band 2 Tx Port Impedance in Tx Band.

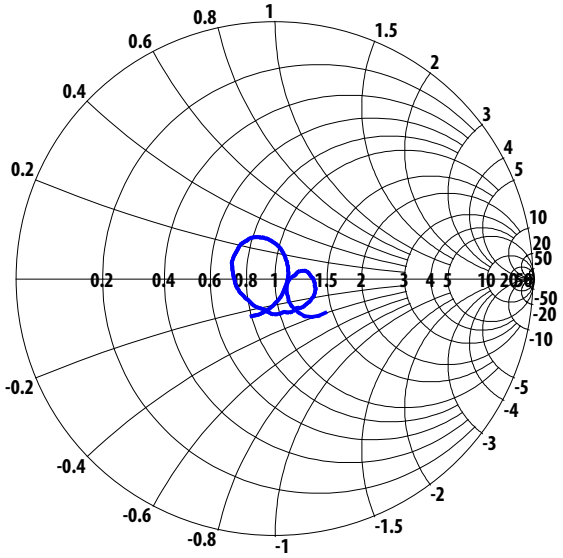


Figure 19. Band 2 Rx Port Impedance in Rx Band.

ACFM-7024 Typical Performance at Tc = 25°C, include matching shown in Figure 1.

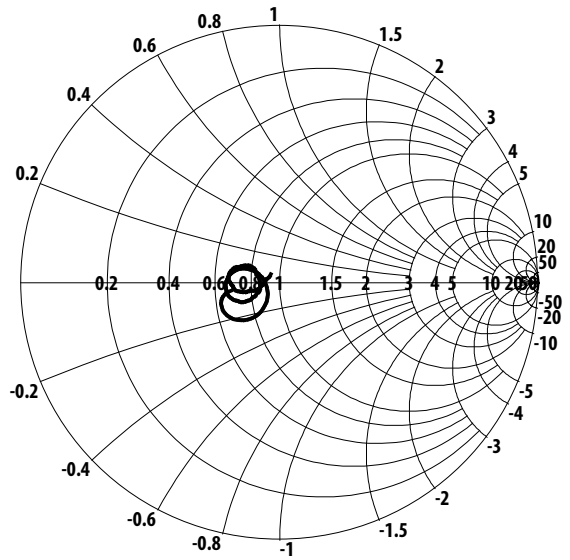


Figure 20. Band 2 Ant Port Impedance in Tx Band.

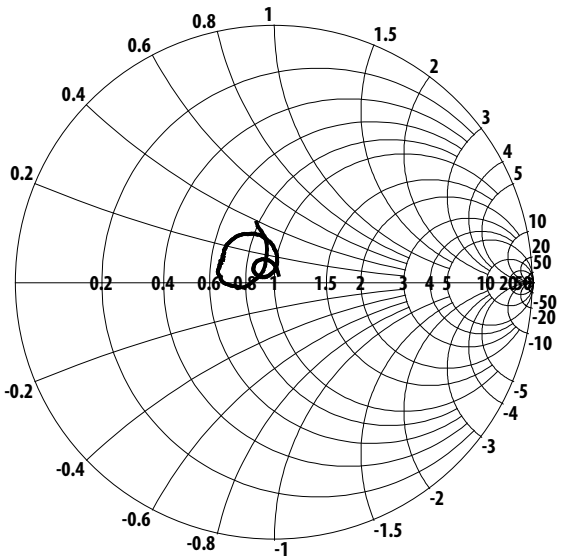


Figure 21. Band 2 Ant Port Impedance in Rx Band.

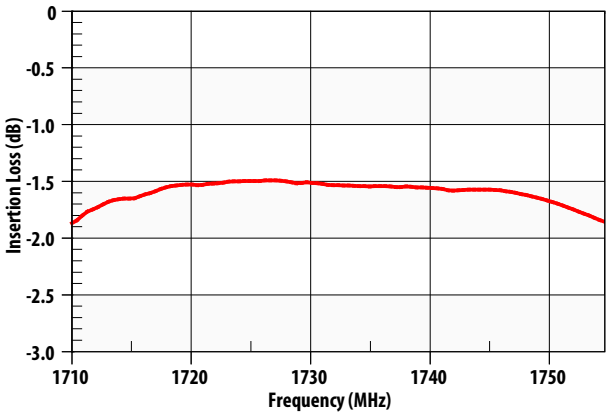


Figure 22. Band 4 Tx-Ant Insertion Loss.

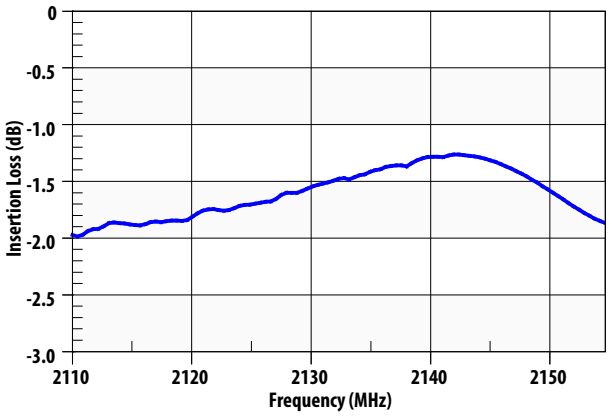


Figure 23. Band 4 Ant-Rx Insertion Loss

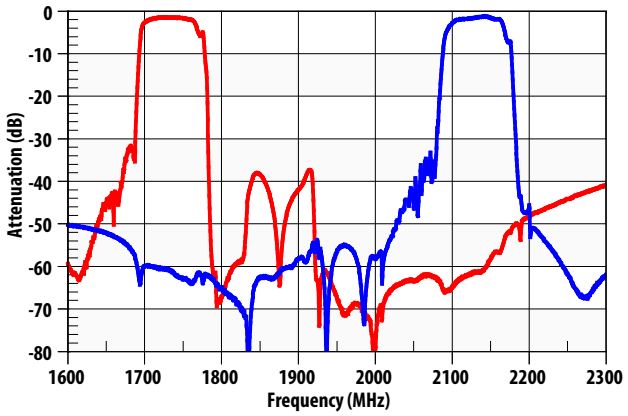


Figure 24. Band 4 Tx Rejection in Rx Band and Rx Rejection in Tx Band.

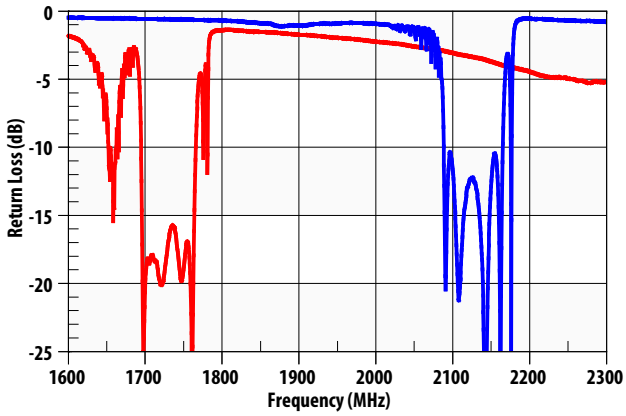


Figure 25. Band 4 Tx and Rx Port Return Loss.

ACFM-7024 Typical Performance at Tc = 25°C, include matching shown in Figure 1.

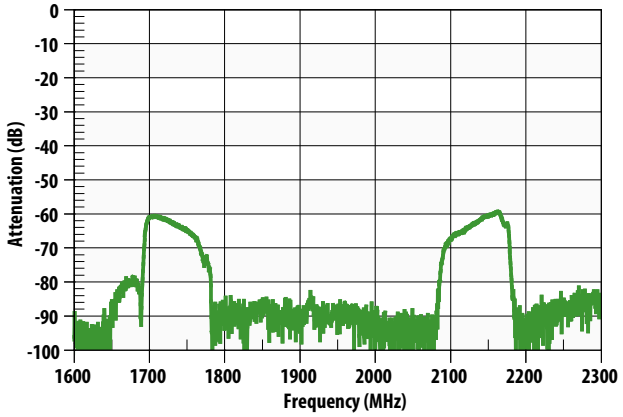


Figure 26. Band 4 Tx-Rx Isolation.

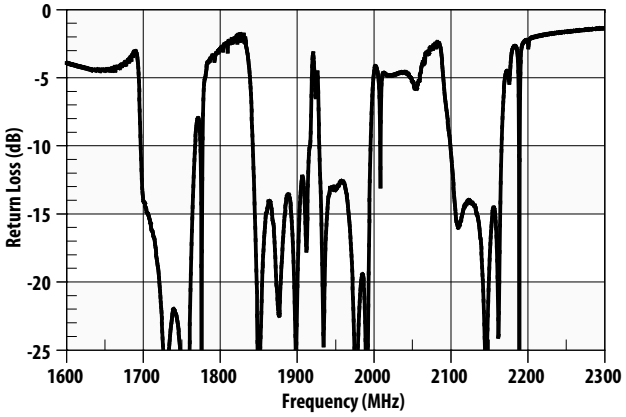


Figure 27. Band 4 Antenna Port Return Loss.

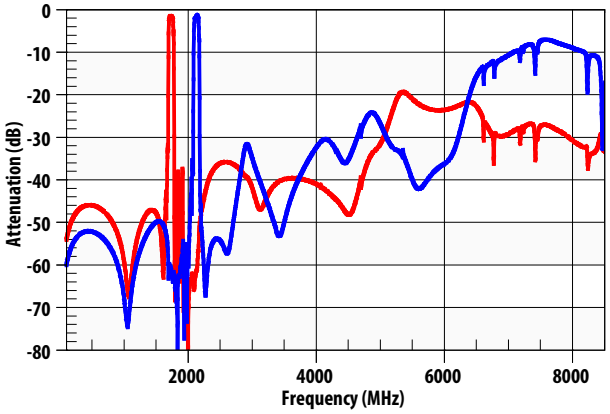


Figure 28. Band 4 Tx-Ant and Ant-Rx Wideband Insertion Loss.

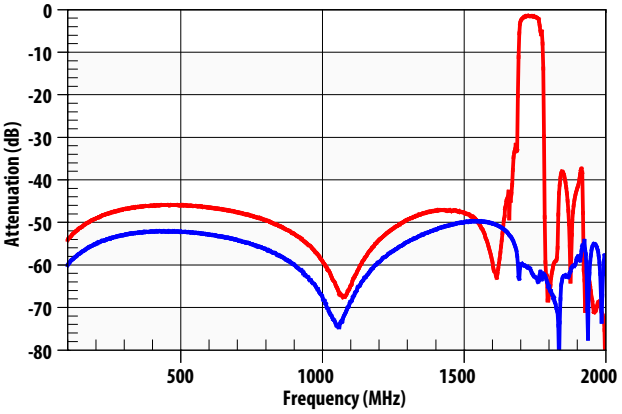


Figure 29. Band 4 Tx-Ant and Ant-Rx Low Frequency Attenuation.

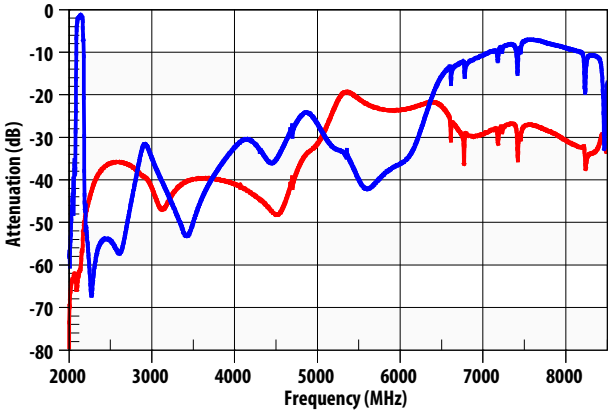


Figure 30. Band 4 Tx-Ant and Ant-Rx High Frequency Attenuation.

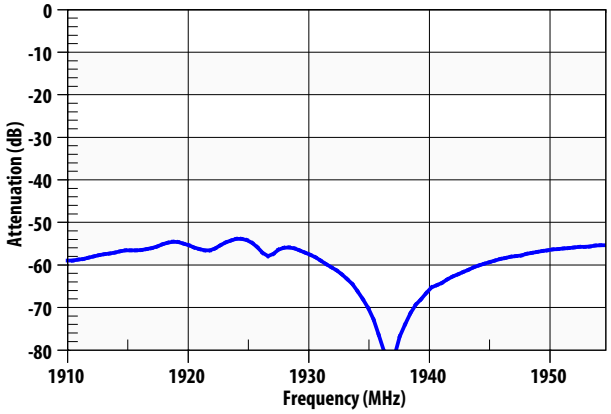


Figure 31. Band 4 Ant-Rx Attenuation, 1910 - 1955 MHz.

ACFM-7024 Typical Performance at Tc = 25°C, include matching shown in Figure 1.

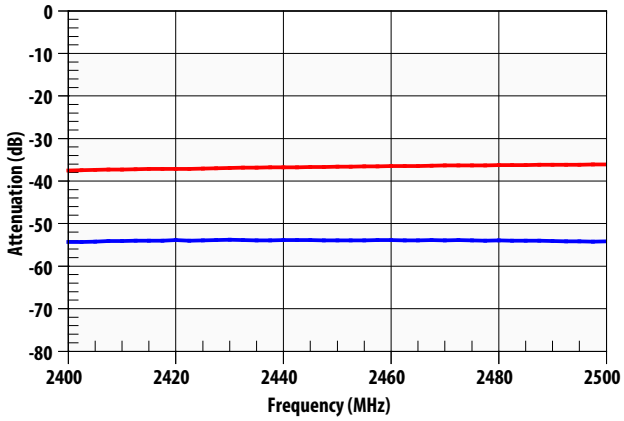


Figure 32. Band 4 Tx-Ant and Ant-Rx Attenuation in Bluetooth Band.

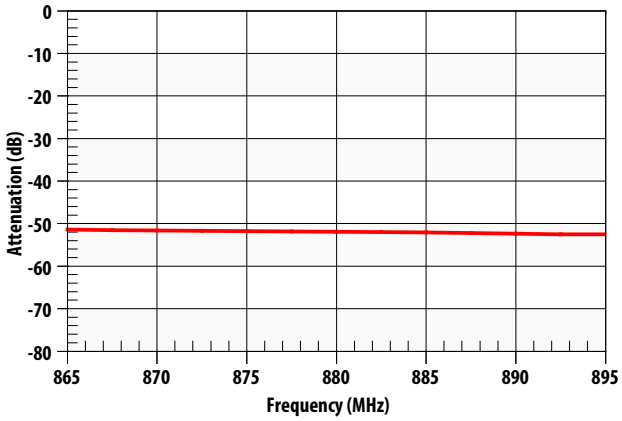


Figure 33. Band 4 Tx-Ant Attenuation in Band 5 Rx, 869 - 894 MHz

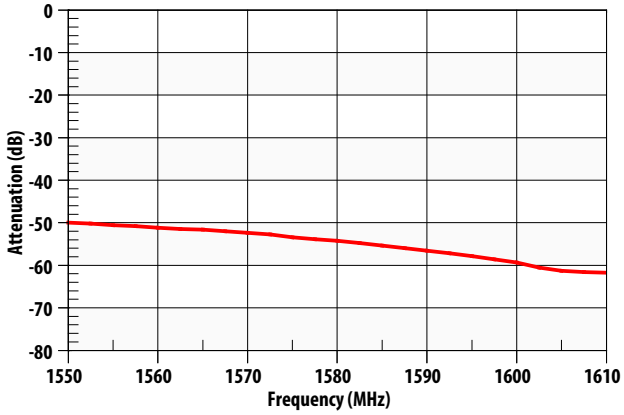


Figure 34. Band 4 Tx-Ant Attenuation in GNSS Bands.

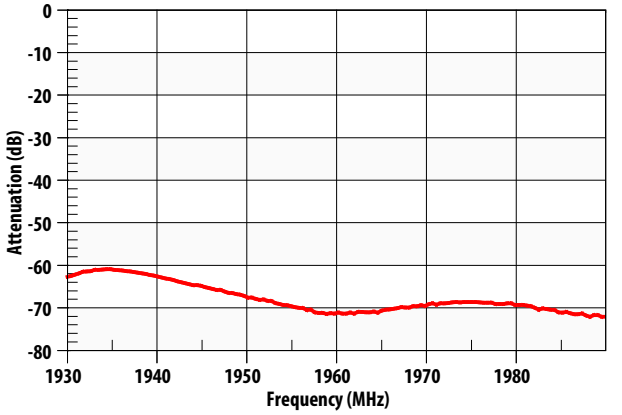


Figure 35. Band 4 Tx-Ant Attenuation Band 2 Rx, 1930 - 1990 MHz.

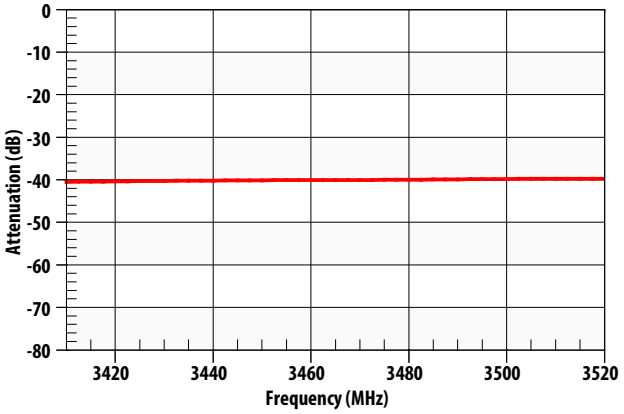


Figure 36. Band 4 Tx-Ant Attenuation at Tx Second Harmonic.

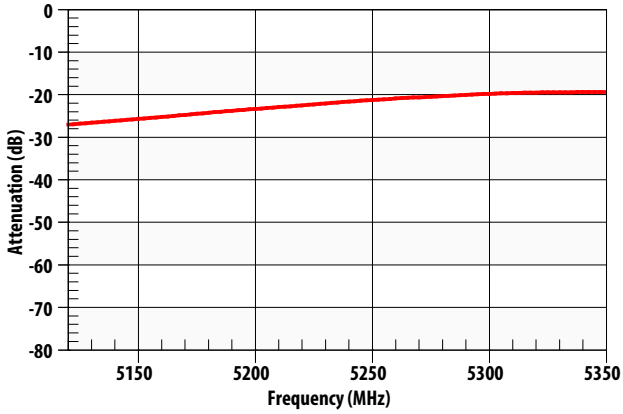


Figure 37. Band 4 Tx-Ant Attenuation at Tx Third Harmonic.

ACFM-7024 Typical Performance at Tc = 25°C, include matching shown in Figure 1.

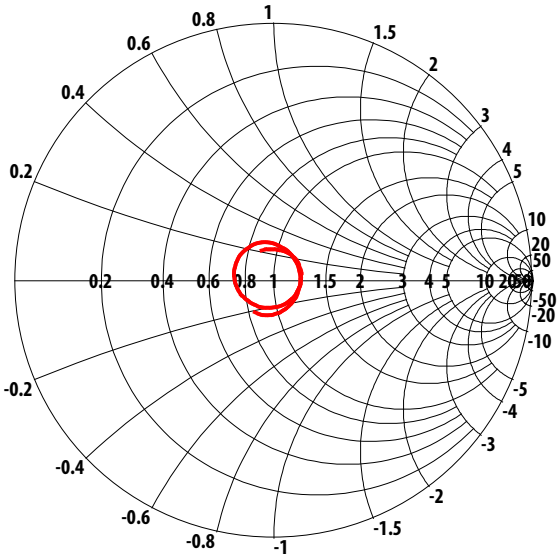


Figure 38. Band 4 Tx Port Impedance in Tx Band.

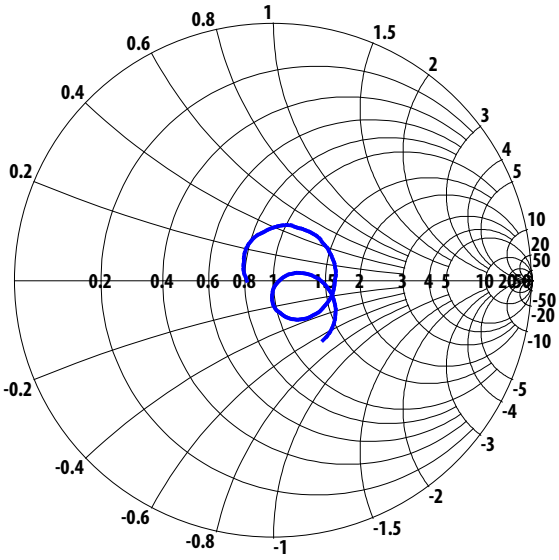


Figure 39. Band 4 Rx Port Impedance in Rx Band.

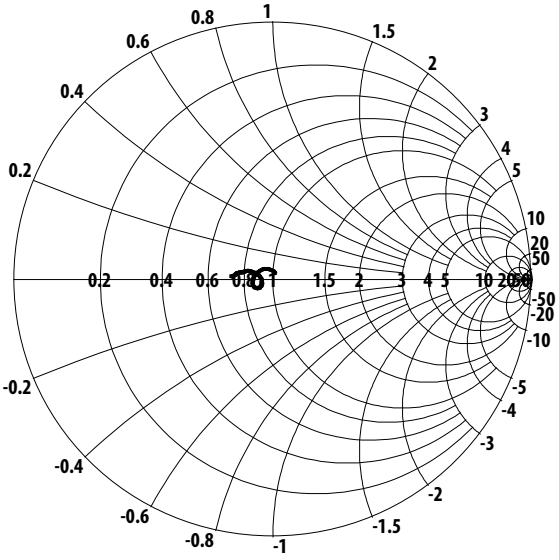


Figure 40. Band 4 Ant Port Impedance in Tx Band.

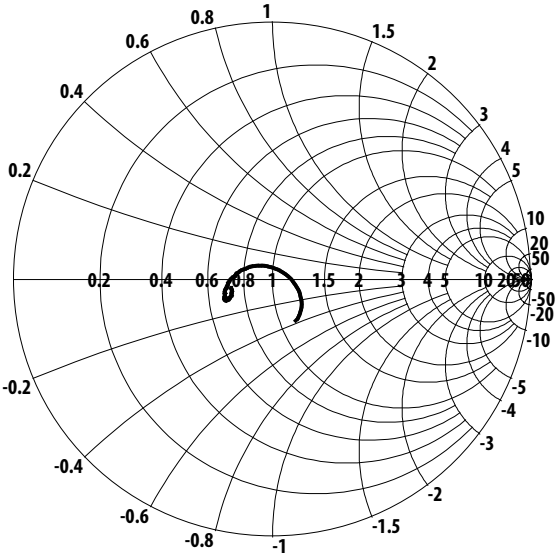


Figure 41. Band 4 Ant Port Impedance in Rx Band.

ACFM-7024 Typical Performance at Tc = 25°C, include matching shown in Figure 1.

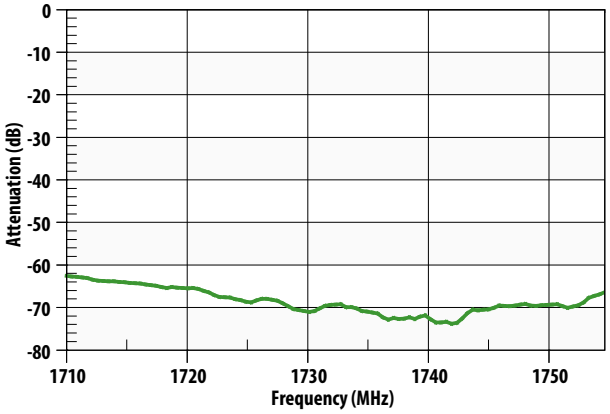


Figure 42. Cross-Band Isolation, Band 4 Tx to Band 2 Rx in Band 4 Tx, 1710 - 1755 MHz.

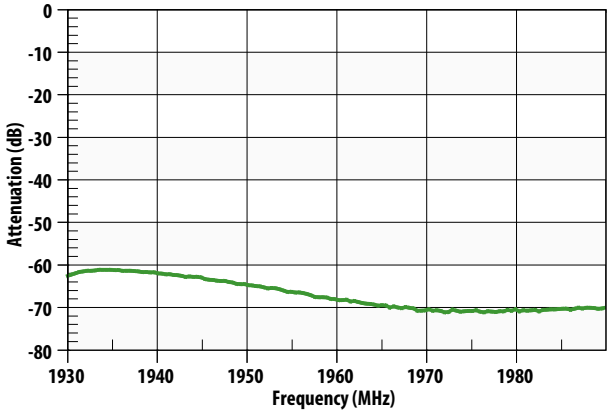


Figure 43. Cross-Band Isolation, Band 4 Tx to Band 2 Rx in Band 2 Rx, 1930 - 1990 MHz.

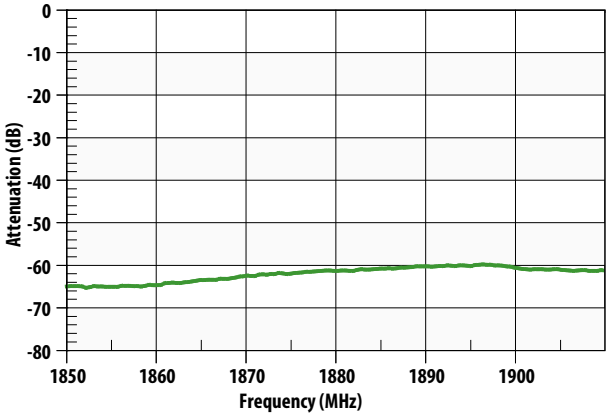


Figure 44. Cross-Band Isolation, Band 2 Tx to Band 4 Rx in Band 2 Tx, 1850 - 1910 MHz.

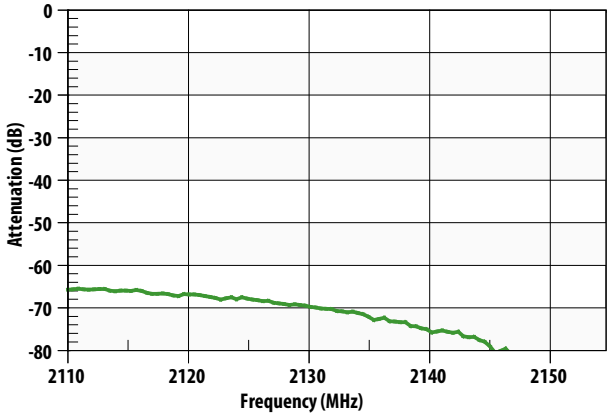
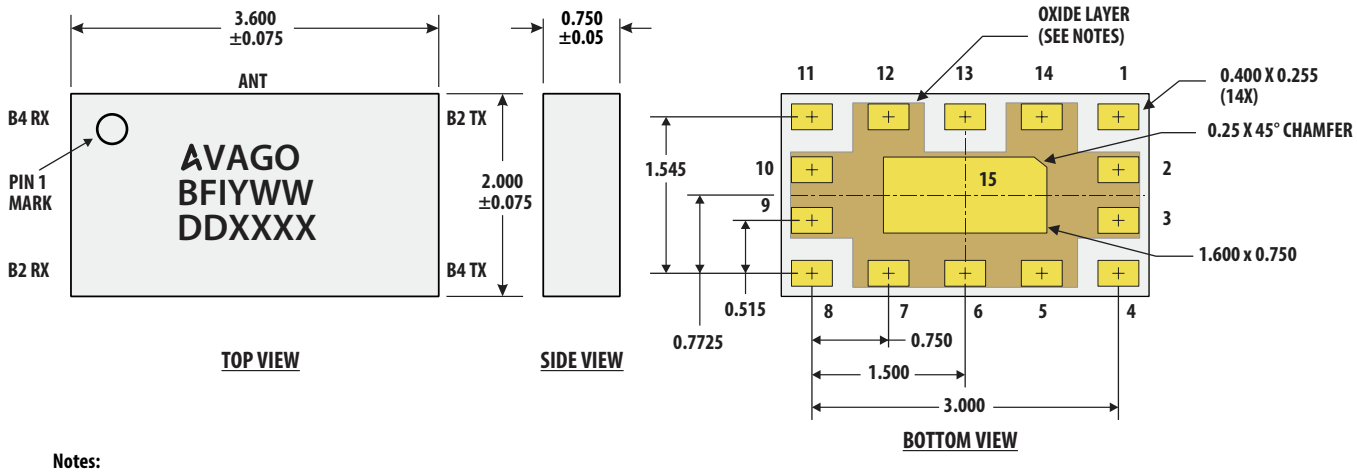


Figure 45. Cross-Band Isolation, Band 2 Tx to Band 4 Rx in Band 4 Rx, 2110 - 2155 MHz.



Notes:

1. **Dimensions in millimeters**
2. **Tolerance, unless otherwise noted:**
   - **X.XX ± 0.05 mm**
   - **X.XXX ± 0.025 mm**
3. **Dimensions nominal unless otherwise noted**
4. **Angles 45° nominal**
5. **Contact areas are gold plated**
6. **Metal Gnd and I/O pads are solder mask defined by means of a thin (< 1µm) oxide layer**

Pin Connections:

1 = Band 4 Rx
4 = Band 2 Rx
8 = Band 4 Tx
11 = Band 2 Tx
13 = Ant
2, 3, 5-7, 9, 10, 12, 14, 15 = GND

Figure 46. Package Outline Drawing.

Notes:
1. Top View
2. Dimensions in mm

Package Marking Code:

AVAGO = Avago Technologies, Inc.
B = ACFM-7024
F = FBAR Technology
I = Assembly ID
Y = Year (last digit)
WW = Work Week
DD = Date Code
XXXX = Production Lot

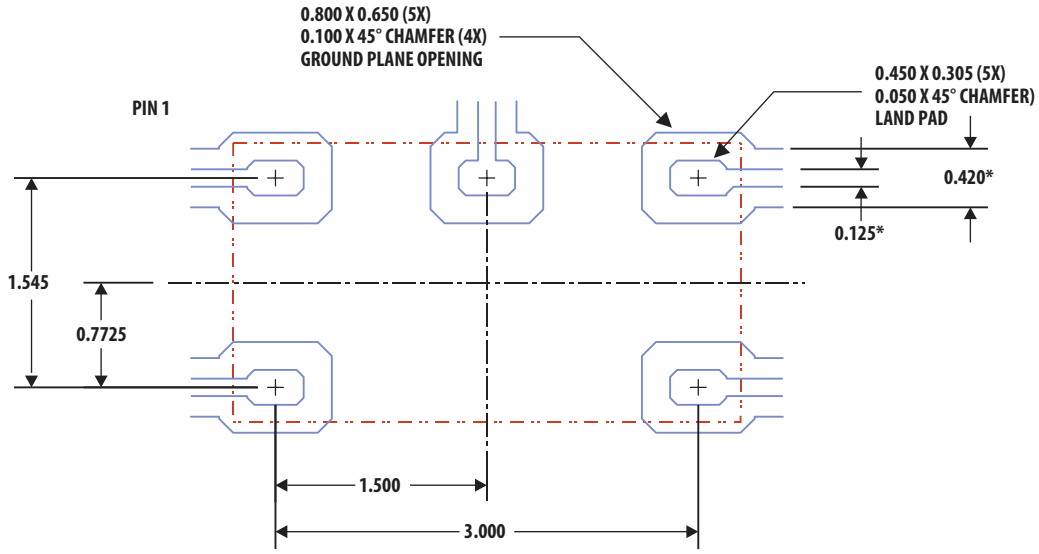


Figure 47. Recommended PCB RF Layout.

The transmission line dimensions shown are designed to achieve an impedance of 50 ohms for a 75µm thick PCB layer with a dielectric constant of 3.4. If other PCB materials or thicknesses are used, the two dimensions indicated with an "*" (line width and spacing) can be adjusted to maintain a Zo of 50 ohms.

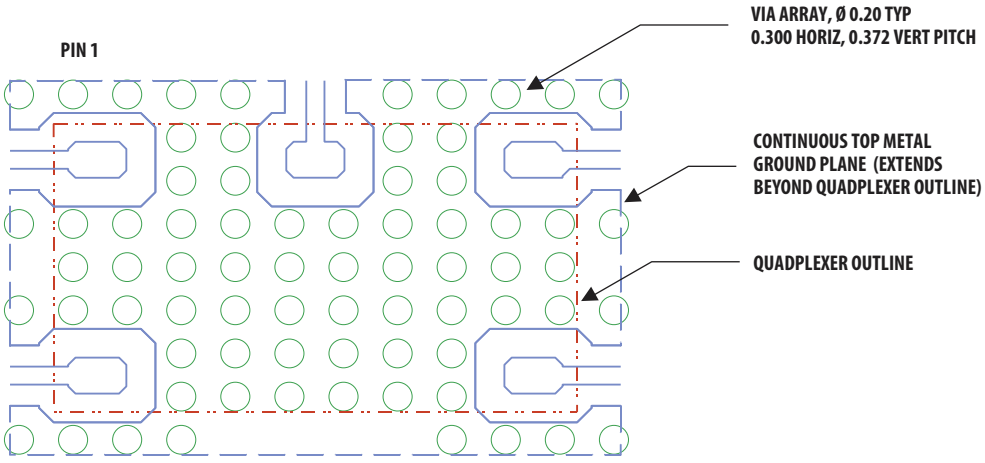


Figure 48. Recommended PCB Ground Vias (top view).

A circuit board layout using the principles illustrated in the figure above is recommended to optimize performance of the ACFM-7024.

It is important to maximize isolation between I/O ports. High isolation is achieved by: (1) maintaining a continuous ground plane around the I/O connections and quadplexer mounting area, (2) surrounding the I/O ports with sufficient ground vias to enclose the connections in a "Faraday cage," (3) making the I/O transmission lines as orthogonal to one another as reasonable, (4) preventing parallel runs of sensitive lines, and (5) if necessary, due to location and/or orientation of interconnecting components, route I/O lines that may potential couple on the third metal layer.

In addition to RF grounding, the vias under the ACFM-7024 mounting area are also used to provide adequate heat sinking for the device.

The second metal layer is a continuous ground plane.

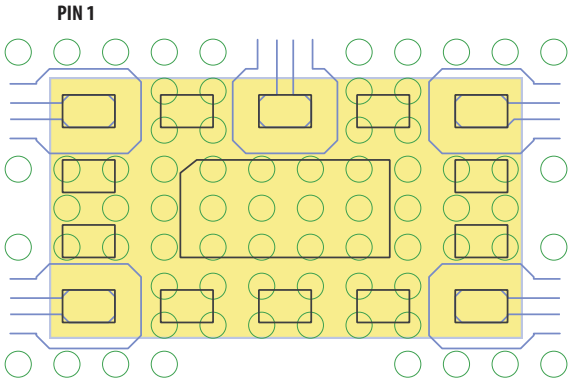


Figure 49. ACFM-7024 Superposed on PCB Pattern (top view)

Notes:
1. Top View
2. Dimensions in mm

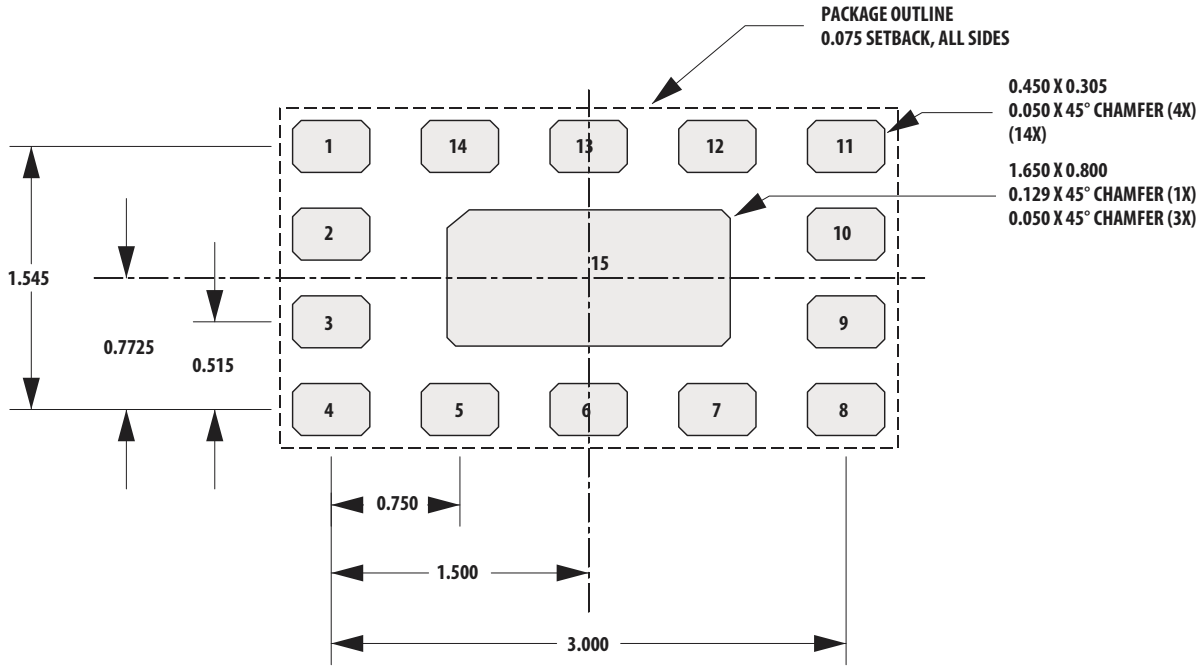


Figure 50. Recommended Landing Pad

Notes:
1. Top View
2. Dimensions in mm
3. Pad is solder mask defined

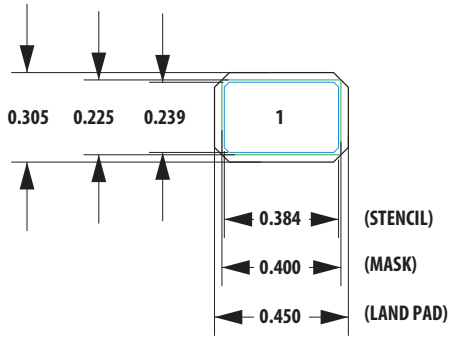


Figure 51. Typical Pad Construction

Notes:
1. Top View
2. Dimensions in mm

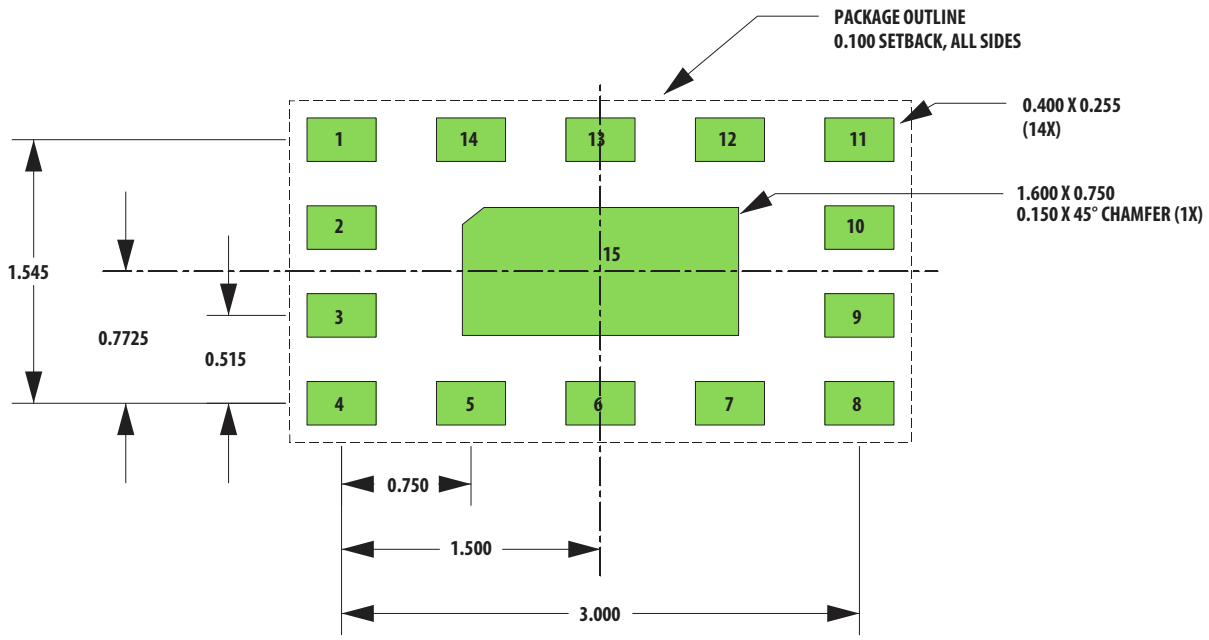


Figure 52. Recommended Solder Mask.

Notes:
1. Top View
2. Dimensions in mm
3. Typical stencil thickness = 75 µm

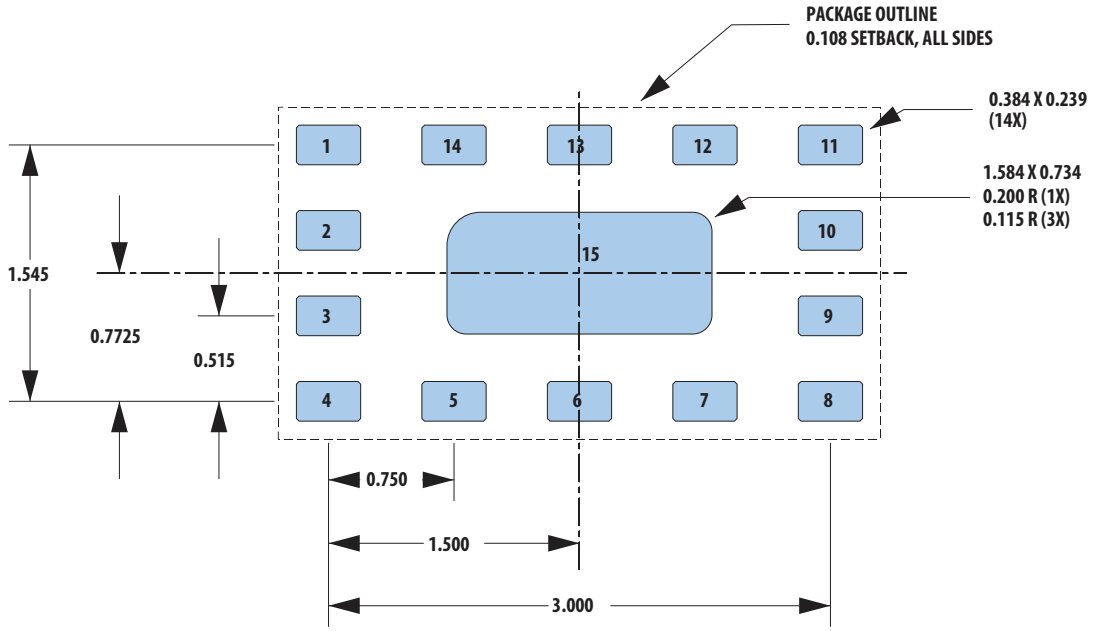


Figure 53. Recommended Solder Stencil.

Package Moisture Sensitivity

Feature	Test Method	Performance
Moisture Sensitivity Level (MSL) at 260°C	JESD22-A113D	Level 3

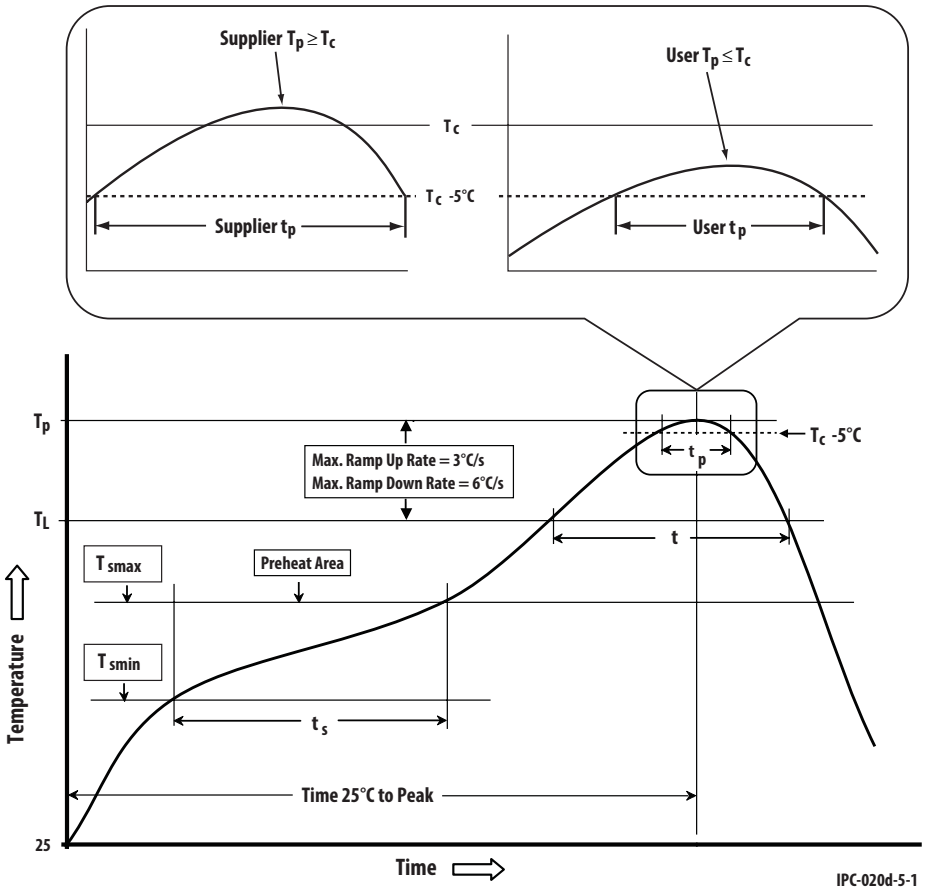


Figure 54. Compatible Lead-Free SMT Reflow Profile (JEDEC/IPC J-STD-020 D.1)

Ordering Information

Part Number	No. of Devices	Container
ACFM-7024-BLK	100	Tape strip or Gel-Pack
ACFM-7024-TR1	3000	7-inch (178 mm) Reel

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

AV02-4598EN - May 12, 2015