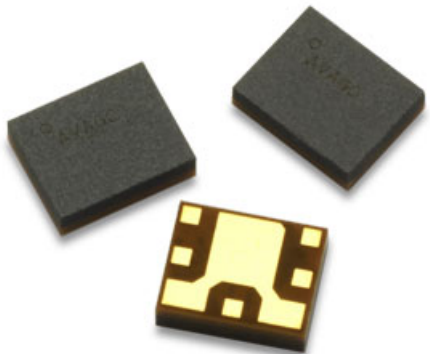
BROADCOM®

Data Sheet

ACFM-7045

Band 25 / Band 66 Quadplexer



Description

The Broadcom® ACFM-7045 is a quadplexer that combines Band 25 and Band 66 duplexers into a single, miniature package.

The ACFM-7045 features a single antenna connection, eliminating the need for antenna switching. High Isolation between bands enables the use of carrier aggregation.

The ACFM-7045 is designed with Broadcom's Film Bulk Acoustic Resonator (FBAR) technology. The ACFM-7045 also uses Broadcom's innovative Microcap bonded-wafer, chip scale packaging technology. This unique process results in an assembled in a module with a footprint of only 2 mm × 2.5 mm with a maximum height of 0.80 mm.

Low Tx Insertion Loss of the ACFM-7045 reduces power amplifier current, extending battery life. The ACFM-7045 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 Broadcom's FBAR bulk-mode resonators supports the high power levels used in mobile communications devices while adding virtually no distortion.

Features

- Single antenna
- High cross band isolation
  - Enables carrier aggregation
- High power rating
  - +31 dBm absolute maximum Tx power
- Miniature size
  - 2.0 mm × 2.5 mm size
  - 0.80 mm maximum height
- Environmental
  - RoHS compliant
  - Halogen and TBBPA free

Specifications

Performance guaranteed –20° to +85°C

- Band 25 duplexer Rx
  - Insertion loss: 3.8 dB maximum
  - Noise blocking: 55 dB minimum
- Band 25 Duplexer Tx
  - Insertion loss: 3.8 dB maximum
  - Interferer blocking: 55 dB minimum
- Band 66 duplexer Rx
  - Insertion Loss: 3.1 dB maximum
  - Noise blocking: 55 dB minimum
- Band 66 duplexer Tx
  - Insertion loss: 4.0 dB maximum
  - Interferer blocking: 55 dB minimum

Applications

Smartphones, tablets, and mobile/portable communications devices operating in Band 25 and Band 66

Functional Block Diagram

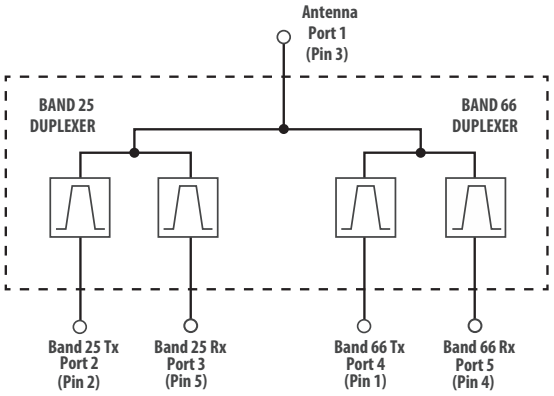


Table 1: ACFM-7045 Electrical Specifications[a], Z_0=50Ω, T_C as indicated[b]. Specifications include matching shown in Figure 1.

Symbol	Parameter	Units	–20°C		+25°C			+85°C	
			Min.	Max.	Min.	Typ.[c]	Max.	Min.	Max.
Band 25 Duplexer									
Antenna Port to Rx Port									
S31	Insertion Loss in Rx Band, 1930.25–1994.75 MHz	dB	—	3.8		2.0	3.5	—	3.5
S31	Attenuation in Band 25 Tx, 1850.25–1914.75 MHz	dB	50	—	50	67.8	—	50	—
S31	Attenuation in Band 66 Tx, 1710–1780 MHz	dB	50	—	50	62.8	—	50	—
S31	Attenuation in Band 30 Tx, 2305–2315 MHz	dB	45	—	45	64.2	—	45	—
S31	Attenuation in ISM/Bluetooth Bands, 2400–2500 MHz	dB	40	—	40	70.8	—	40	—
S31	Attenuation in Band 25 Rx 2H, 3860.5–3989.5 MHz	dB	40	—	40	49.6	—	40	—
S31	Attenuation in ISM 5G Bands, 4900–5950 MHz	dB	35	—	35	68.0	—	35	—
S33	Return Loss (SWR) of Rx Port, 1930.25–1994.75 MHz	dB	8	(2.3)	8	16.3	(2.3)	8	(2.3)
S11	Return Loss (SWR) of Ant Port, 1930.25–1994.75 MHz	dB	8	(2.3)	8	18.3	(2.3)	8	(2.3)
Transmit Port to Antenna Port									
S12	Insertion Loss in Tx Band, 1850.2–1914.75 MHz	dB	—	3.0	—	1.5	3.0	—	3.8
S12	Attenuation in Rx Band, 1930.25–1994.75 MHz	dB	50	—	50	58.9	—	50	—
S12	Attenuation in GNSS Bands, 1559–1608 MHz	dB	40	—	40	53.0	—	40	—
S12	Attenuation in Band 66 Rx, 2110 –2200 MHz	dB	50	—	50	58.0	—	50	—
S12	Attenuation in Band 30 Rx, 2350–2360 MHz	dB	40	—	40	53.1	—	40	—
S12	Attenuation in ISM/Bluetooth Bands, 2400–2485 MHz	dB	40	—	40	50.8	—	40	—
S12	Attenuation in Tx 2nd Harmonic Band, 3700.5–3829.5 MHz	dB	40	—	40	46.3	—	40	—
S12	Attenuation in ISM 5G Bands, 4900–5950 MHz	dB	20	—	20	41.4	—	20	—
S12	Attenuation in Tx 3rd Harmonic Band, 5550.75–5744.25 MHz	dB	20	—	20	42.4	—	20	—
S22	Return Loss (SWR) of Tx Port, 1850.25–1914.75 MHz	dB	9.5	(2.0)	9.5	24.2	(2.0)	9.5	(2.0)
S11	Return Loss (SWR) of Ant Port, 1850.25–1914.75 MHz	dB	9.5	(2.0)	9.5	21.3	(2.0)	9.5	(2.0)

Table 1: ACFM-7045 Electrical Specifications[a], Z_0=50Ω, T_C as indicated[b]. Specifications include matching shown in Figure 1.

Symbol	Parameter	Units	–20°C		+25°C			+85°C	
			Min.	Max.	Min.	Typ.[c]	Max.	Min.	Max.
Isolation, Transmit Port to Receive Port									
S32	Isolation in Receive Band, 1930.25–1933.25 MHz[d]	dB	55	—	55	65.6	—	55	—
S32	Isolation in Receive Band, 1933.25–1994.75 MHz	dB	55	—	55	61.7	—	55	—
S32	Isolation in Transmit Band, 1850.25–1911.75 MHz	dB	55	—	55	66.8	—	55	—
S32	Isolation in Transmit Band, 1911.75–1914.75 MHz[d]	dB	55	—	55	66.7	—	55	—
Band 66 Duplexer									
Antenna Port to Rx Port									
S51	Insertion Loss in Rx Band, 2110–2200 MHz	dB	—	3.0	—	1.7	2.8	—	3.1
S51	Attenuation in Tx Band, 1710–1780 MHz	dB	50	—	50	66.6	—	50	—
S51	Attenuation in Band 25 Tx, 1850–1915 MHz	dB	50	—	50	70.4	—	50	—
S51	Attenuation in Band 30 Tx, 2305–2315 MHz	dB	40	—	40	52.7	—	40	—
S51	Attenuation in ISM/Bluetooth Bands, 2400–2500 MHz	dB	40	—	40	53.2	—	40	—
S51	Attenuation in Band 66 Rx 2H, 4220–4400 MHz	dB	23	—	23	34.8	—	23	—
S51	Attenuation in ISM 5G Bands, 4900–5950 MHz	dB	25	—	25	45.5	—	25	—
S55	Return Loss (SWR) of Rx Port, 2110–2200 MHz	dB	8	(2.3)	8	17.9	(2.3)	8	(2.3)
S11	Return Loss (SWR) of Ant Port, 2110–2200 MHz	dB	8	(2.3)	8	16.7	(2.3)	8	(2.3)
Transmit Port to Antenna Port									
S14	Insertion Loss in Tx Band, 1710–1775 MHz	dB	—	2.8	—	1.8	2.5	—	2.5
S14	Insertion Loss in Tx Band, 1775–1780 MHz	dB	—	3.5	—	1.9	3.5	—	4
S14	Attenuation in Rx Band, 2110–2200 MHz	dB	50	—	50	68.6	—	50	—
S14	Attenuation in GNSS Bands, 1559–1608 MHz	dB	40	—	40	57.3	—	40	—
S14	Attenuation in Band 25 Rx, 1930–1995 MHz	dB	50	—	50	66.3	—	50	—
S14	Attenuation in Band 30 Rx, 2350–2360 MHz	dB	45	—	45	64.5	—	45	—
S14	Attenuation in ISM/Bluetooth Bands, 2400–2485 MHz	dB	40	—	40	65.4	—	40	—
S14	Attenuation in Tx 2nd Harmonic Band, 3420–3560 MHz	dB	40	—	40	55.8	—	40	—
S14	Attenuation in ISM 5G Bands, 4900–5950 MHz	dB	23	—	23	43.8	—	23	—
S14	Attenuation in Tx 3rd Harmonic Band, 5130–5340 MHz	dB	23	—	23	48.4	—	23	—
S44	Return Loss (SWR) of Tx Port in Tx Band, 1710–1780 MHz	dB	9.5	(2.0)	9.5	21.1	(2.0)	9.5	(2.0)
S11	Return Loss (SWR) of Ant Port in Tx Band, 1710–1780 MHz	dB	9.5	(2.0)	9.5	20.0	(2.0)	9.5	(2.0)
Isolation, Transmit Port to Receive Port									
S54	Isolation in Rx Band, 2110–2200 MHz	dB	55	—	55	63.5	—	55	—
S54	Isolation in Tx Band, 1710–1780 MHz	dB	55	—	55	63.5	—	55	—
Cross Band Isolation, Band 25 Tx to Band 66 Rx									
S52	Isolation in Band 66 Rx, 2110–2200 MHz	dB	55	—	55	68.0		55	
S52	Isolation in Band 25 Tx, 1850.25–1914.75 MHz	dB	55	—	55	61.8		55	

Table 1: ACFM-7045 Electrical Specifications[a], Z_0=50Ω, T_C as indicated[b]. Specifications include matching shown in Figure 1.

Symbol	Parameter	Units	–20°C		+25°C			+85°C	
			Min.	Max.	Min.	Typ.[c]	Max.	Min.	Max.
Cross Band Isolation, Band 66 Tx to Band 25 Rx									
S34	Isolation in Band 25 Rx, 1930.25–1991.75 MHz	dB	55	—	55	63.5	—	55	—
S34	Isolation in Band 25 Rx, 1991.75–1994.75 MHz[d]	dB	55	—	55	59.5	—	55	—
S34	Isolation in Band 66 Tx, 1710–1780 MHz	dB	55	—	55	64.7	—	55	—

a. 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.

b. T_C is the case temperature and is defined as the temperature of the underside of the Duplexer where it makes contact with the circuit board.

c. Typical data is the average value of the parameter over the indicated band at the specified temperature. Typical values may vary over time.

d. Integrated channel average Isolation, obtained by averaging Sij over the center 2.7 MHz of LTE 3 MHz (15 RB) channels.

Table 2: Absolute Maximum Ratings[a]

Parameter	Unit	Value
Storage temperature	°C	–65 to +125
Maximum RF Input Power to Tx Ports	dBm	+31
Maximum DC Voltage, Pin 1 (Ant) to GND[b]	VDC	0
Maximum DC Voltage, Pins 2, 3, 4, 5 to GND[c]	VDC	+5

a. Operation in excess of any one of these conditions may result in permanent damage to the device.

b. Internal DC resistance of Pin 1 (Ant) to ground is approximately a short circuit.

c. The DC resistance from Pins 2, 3, 4, 5 to ground of this device is typically hundreds of kilohms to megohms.

Table 3: Maximum Recommended Operating Conditions[a]

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

a. 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.

b. T_C is defined as case temperature, the temperature of the underside of the duplexer where it makes contact with the circuit board.

Applications Information

The ACFM-7045 Antenna and Rx impedances are internally matched to 50 Ω. The impedances looking into the Tx ports are Z1 (Band 25) = 30 – j21 and Z2 (Band 66) = 23 – j18 Ω.

For purposes of electrical specification and to show optimum performance, the four labeled matching components shown in Figure 1 are used to externally match the Tx ports to 50Ω.

Component values:

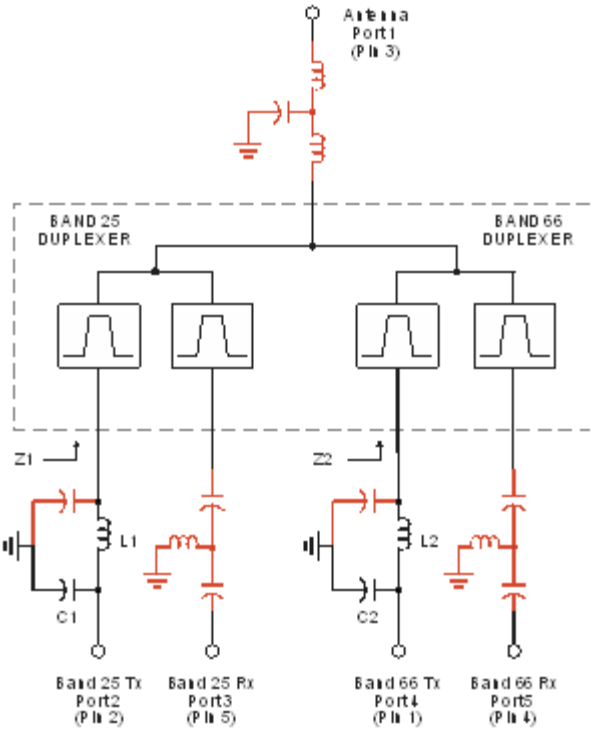
L1 = 4.1 nH L2 = 4.0 nH
C1 = 1.5 pF C2 = 2.0 pF

The optional components shown in red are suggested for use in complete phone board designs. These 3-element matching circuits provide the flexibility desirable for optimizing interfaces with adjacent circuit blocks (PA, LNA/ Baseband, Ant/switches, and so on). These particular topologies (low pass, high pass, DC blocking) were selected to simultaneously match the quadplexer and optimize phone performance.

For most applications, these additional matching components will be absorbed into the interstage match between the quadplexer and adjacent stages.

For best performance, the electrical distance between the ACFM-7045, the matching components, and adjacent stages should be minimized.

Figure 1: Typical Application



ACFM-7045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 2: Band 25 Tx-Ant Insertion Loss

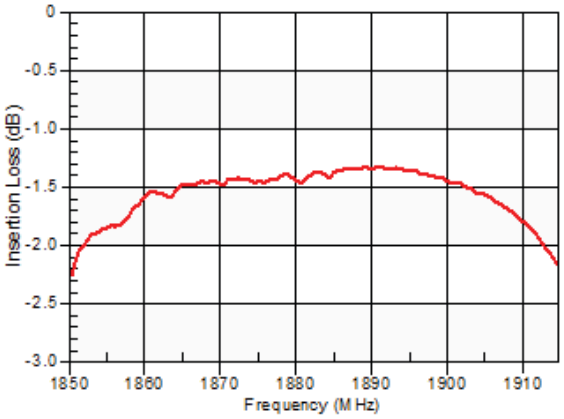


Figure 3: Band 25 Rx-Ant Insertion Loss

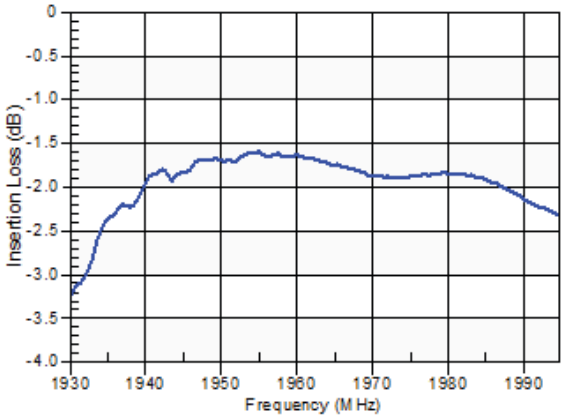


Figure 4: Band 25 Tx Rejection in Rx Band and Rx Rejection in Tx Band

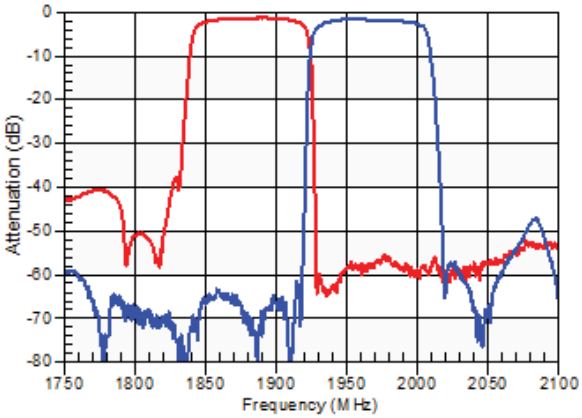


Figure 5: Band 25 Tx and Rx Port Return Loss

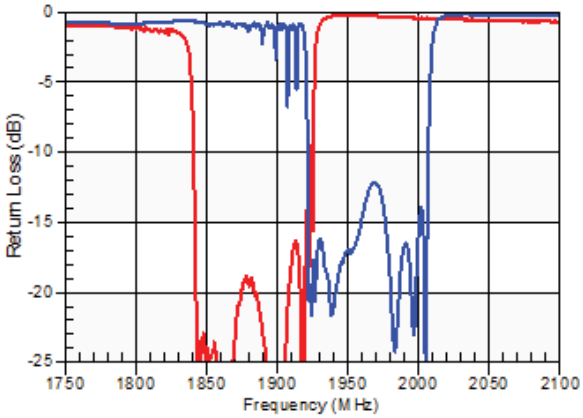


Figure 6: Band 25 Tx-Rx Isolation

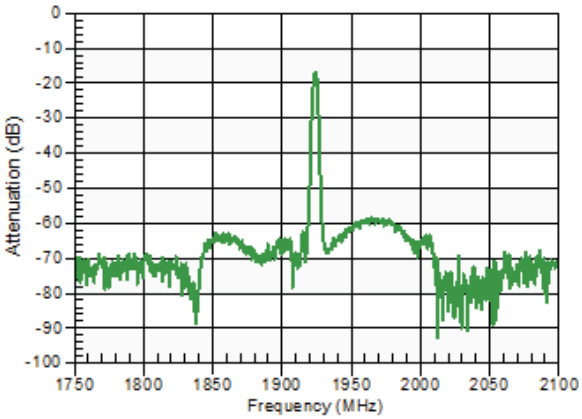
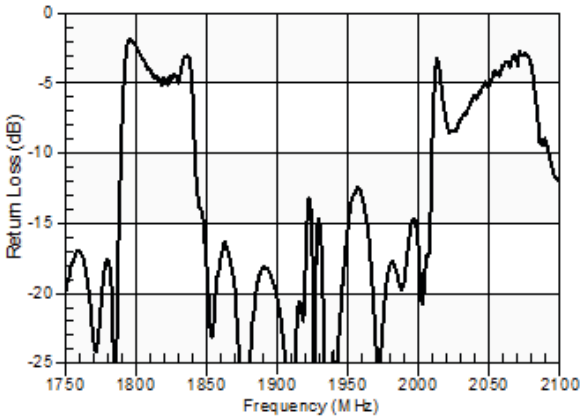


Figure 7: Band 25 Antenna Port Return Loss



ACFM-70457045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 8: Band 25 Tx-Ant and Ant-Rx Wideband Insertion Loss

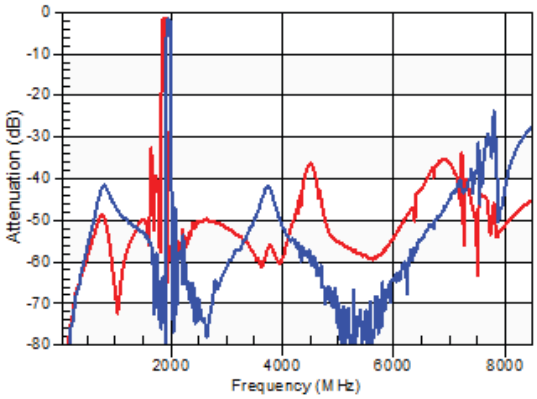


Figure 9: Band 25 Tx-Ant and Ant-Rx Low Frequency Insertion Loss

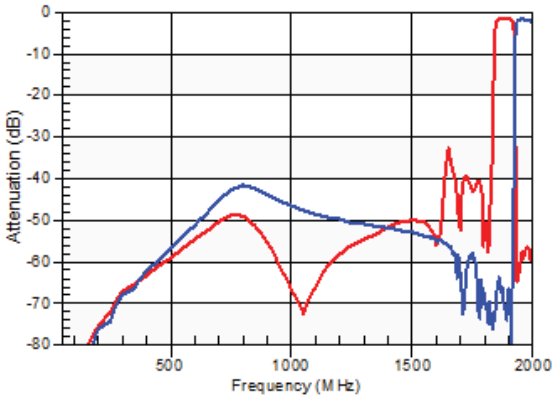


Figure 10: Band 25 Tx-Ant Attenuation in GNSS Bands

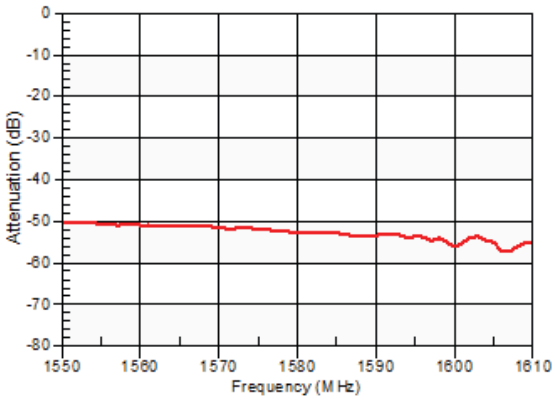


Figure 11: Band 25 Tx-Ant Attenuation in Band 66 Rx, 2110–2200 MHz

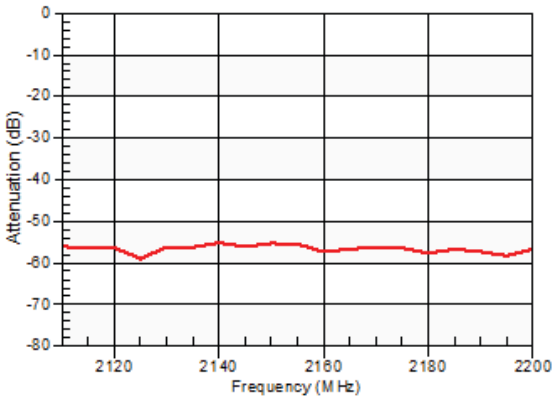


Figure 12: Band 25 Tx-Ant Attenuation in Band 30 Rx, 2350–2360 MHz

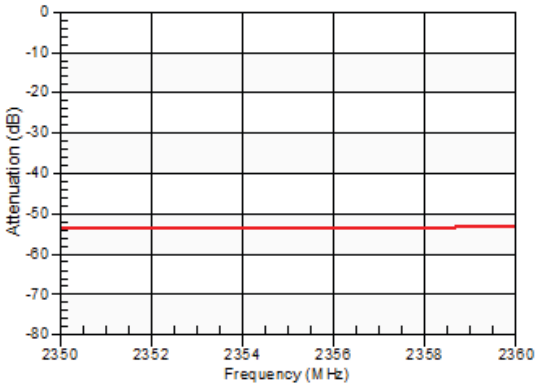
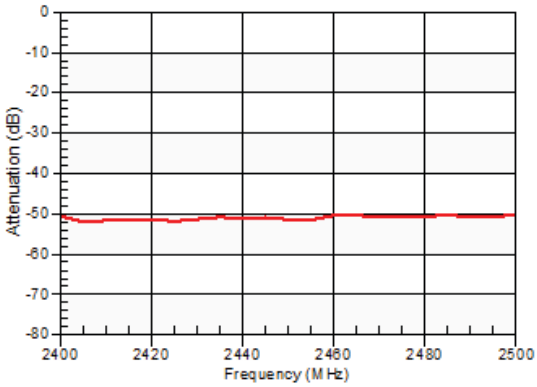


Figure 13: Band 25 Tx-Ant Attenuation in Bluetooth/ISM Bands



ACFM-70457045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 14: Band 25 Tx-Ant Attenuation at Tx Second Harmonic

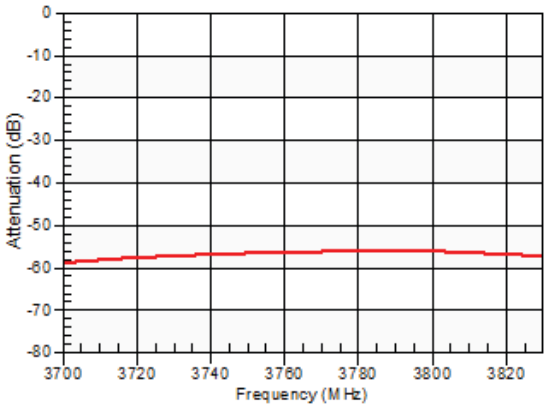


Figure 15: Band 25 Tx-Ant Attenuation in ISM 5G Bands, 4900–5950 MHz

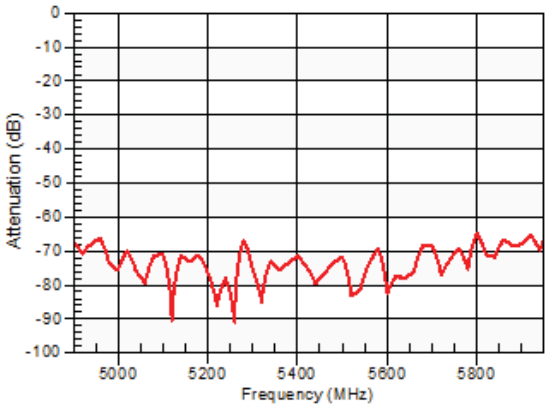


Figure 16: Band 25 Tx-Ant Attenuation at Tx Third Harmonic

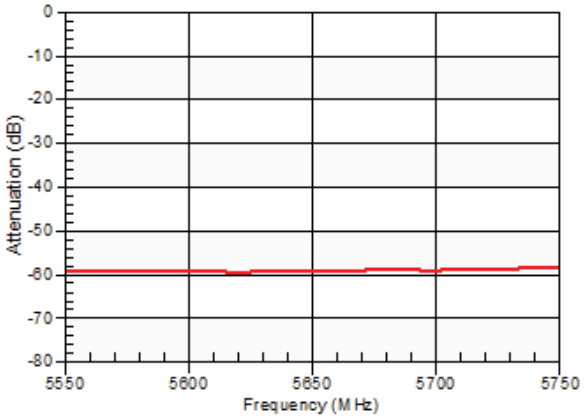


Figure 17: Band 25 Ant-Rx Attenuation in Band 66 Tx, 1710–1780 MHz

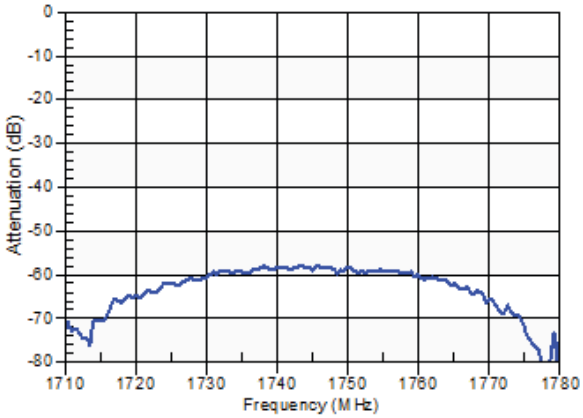


Figure 18: Band 25 Ant-Rx Attenuation in Band 30 Tx, 2305–2315 MHz

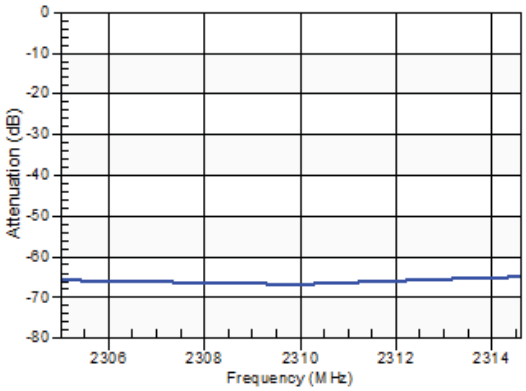
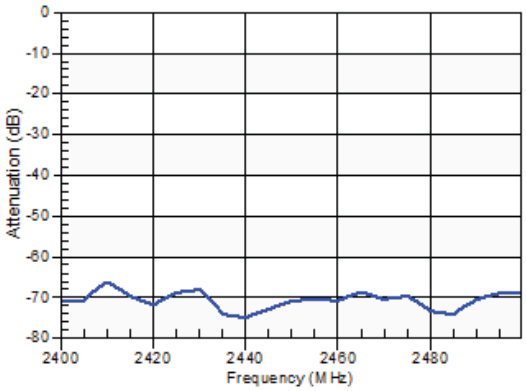


Figure 19: Band 25 Ant-Rx Attenuation in Bluetooth/ISM Bands



ACFM-70457045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 20: Band 25 Ant-Rx Attenuation in Band 25 Rx 2H, 3860–3990 MHz

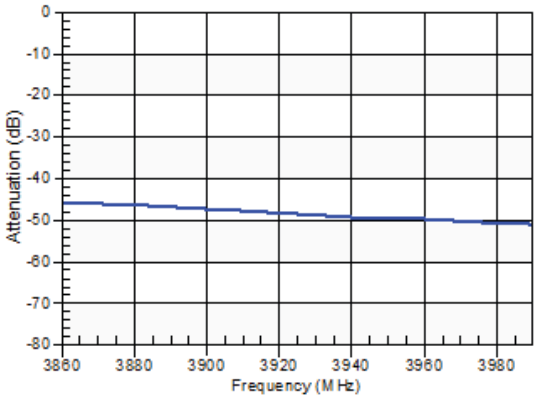


Figure 21: Band 25 Ant-Rx Attenuation in ISM 5G Bands, 4900–5950 MHz

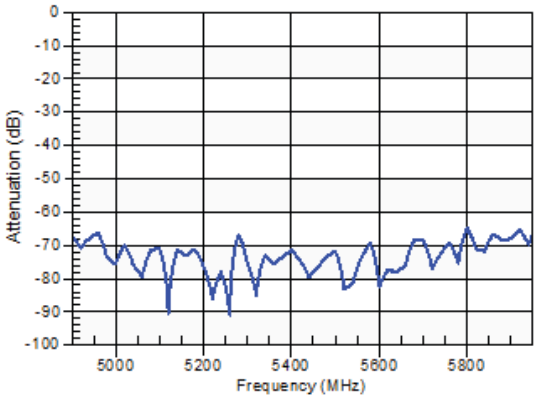


Figure 22: Band 25 Return Loss, Ant (black) and Tx (red) Ports, 1850–1915 MHz

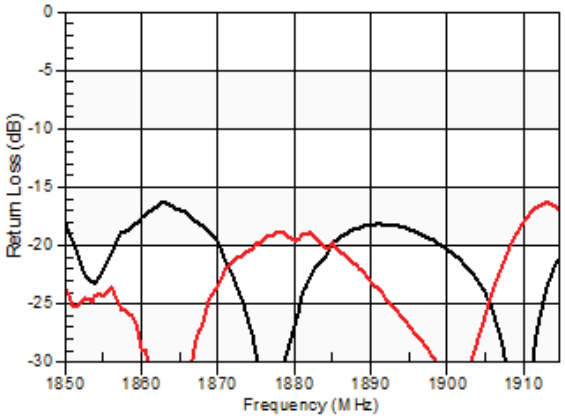


Figure 23: Band 25 Impedance, Ant (black) and Tx (red) Ports, 1850–1915 MHz

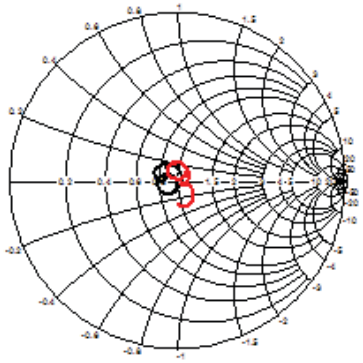


Figure 24: . Band 25 Return Loss, Ant (black) and Rx (blue) Ports, 1930–1995 MHz

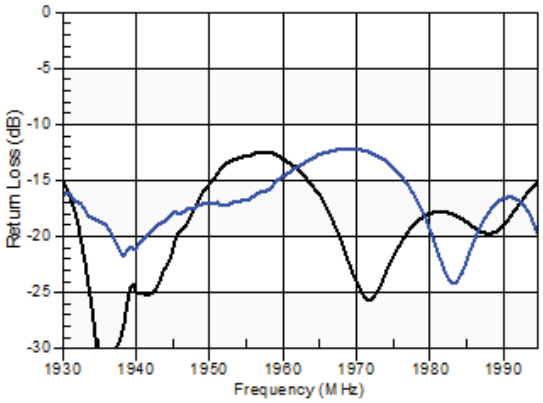
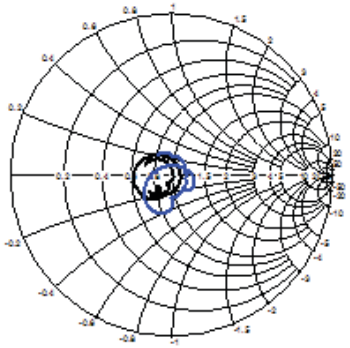


Figure 25: Band 25 Impedance, Ant (black) and Rx (blue) Ports, 1930–1995 MHz



ACFM-70457045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 26: Band 66 Tx-Ant Insertion Loss

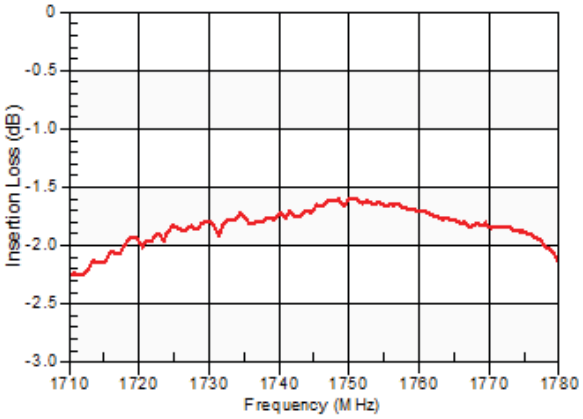


Figure 27: Band 66 Ant-Rx Insertion Loss

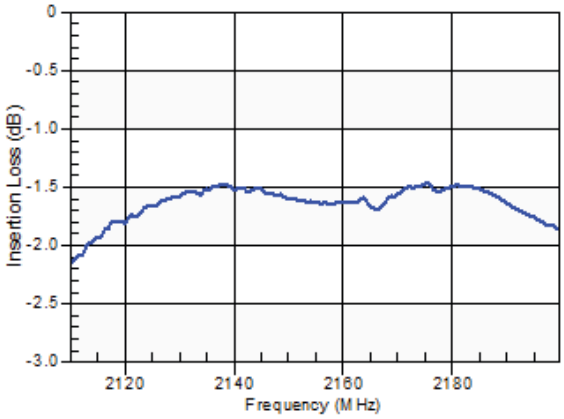


Figure 28: Band 66 Tx Rejection in Rx Band and Rx Rejection in Tx Band

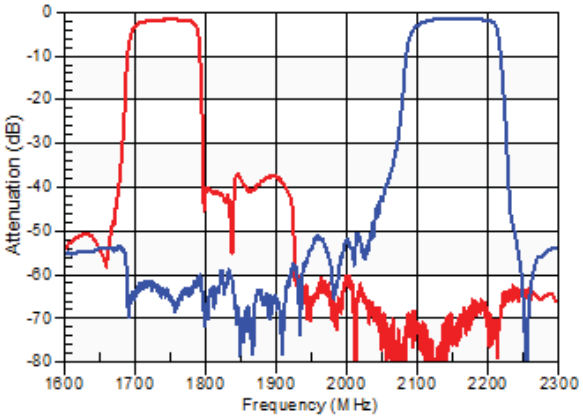


Figure 29: Band 66 Tx and Rx Port Return Loss

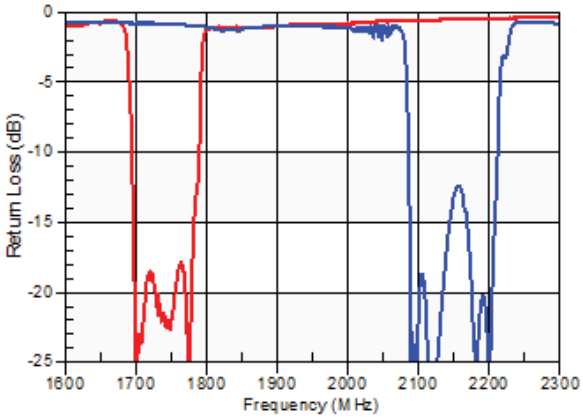


Figure 30: Band 66 Tx-Rx Isolation

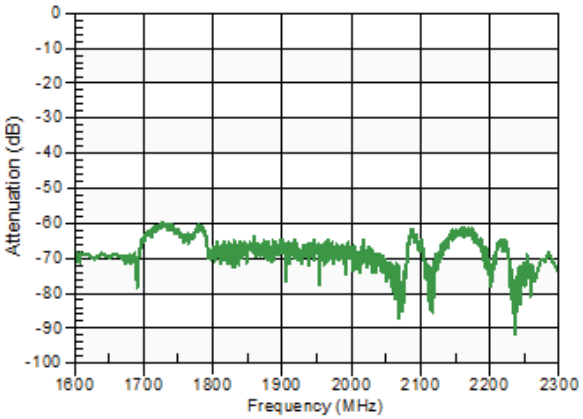
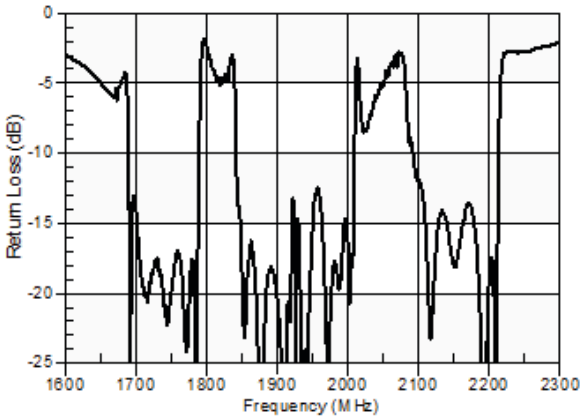


Figure 31: Band 66 Antenna Port Return Loss



ACFM-70457045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 32: Band 66 Tx-Ant and Ant-Rx Wideband Insertion Loss

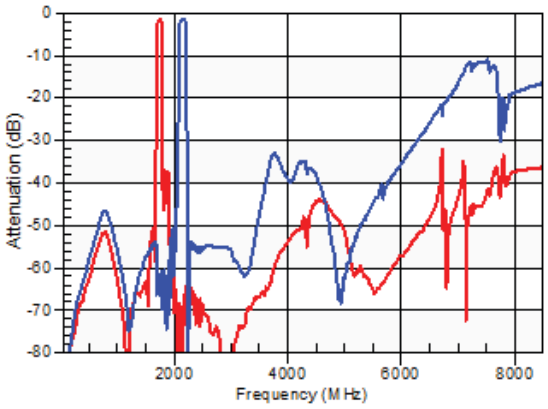


Figure 33: Band 66 Tx-Ant Attenuation in Band 5 Rx, 869–894 MHz

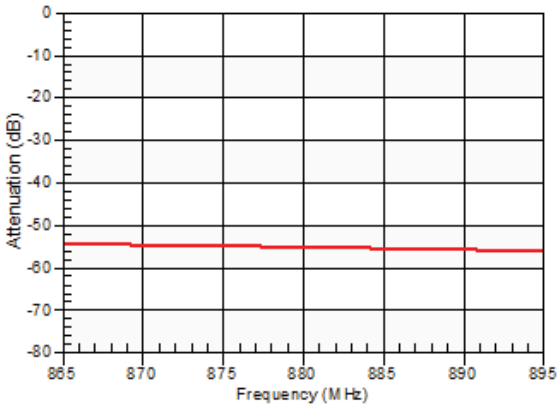


Figure 34: Band 66 Tx-Ant Attenuation in GNSS Bands

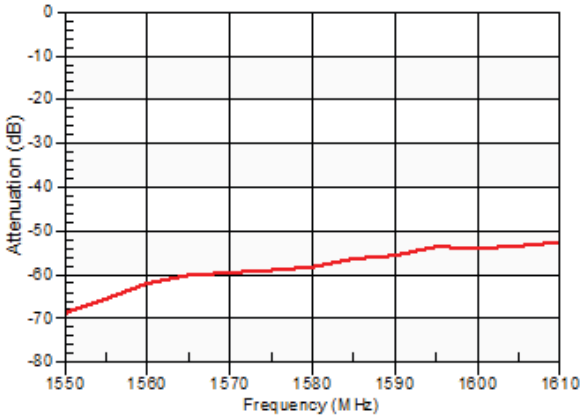


Figure 35: Band 66 Tx-Ant Attenuation Band 25 Rx, 1930–1995 MHz

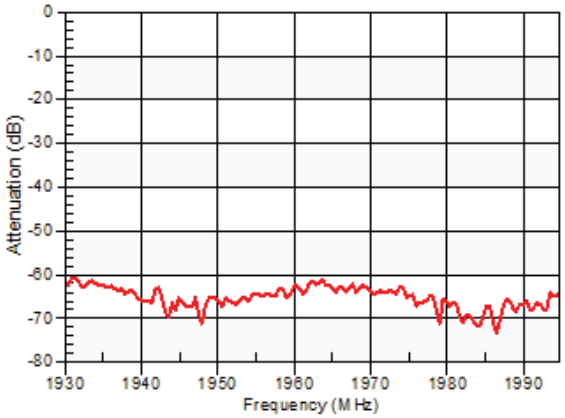


Figure 36: Band 66 Tx-Ant and Ant-Rx Attenuation in Bluetooth Band

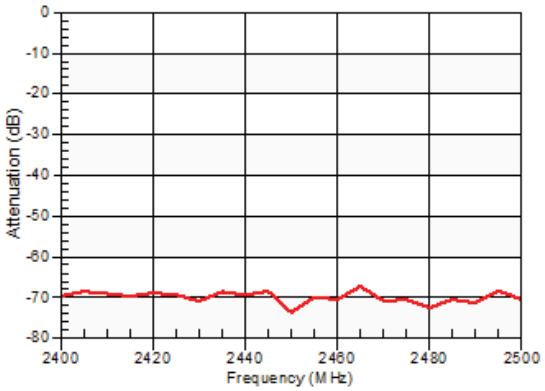
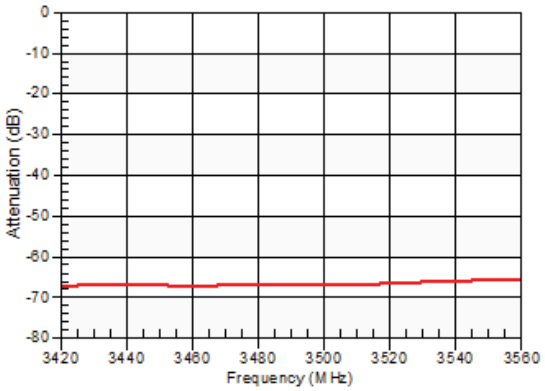


Figure 37: Band 66 Tx-Ant Attenuation at Tx Second Harmonic



ACFM-70457045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 38: Band 66 Tx-Ant Attenuation at Tx Third Harmonic

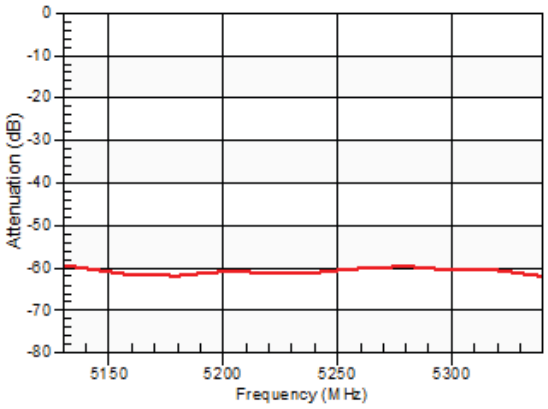


Figure 39: Band 66 Ant-Rx Attenuation in Band 25 Tx, 1850–1915 MHz

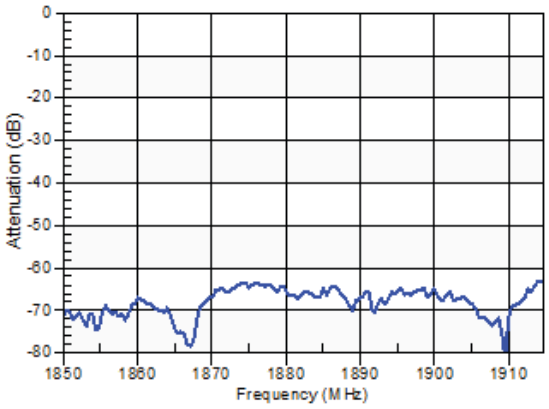


Figure 40: Band 66 Ant-Rx Attenuation in Band 30 Tx, 2305–2315 MHz

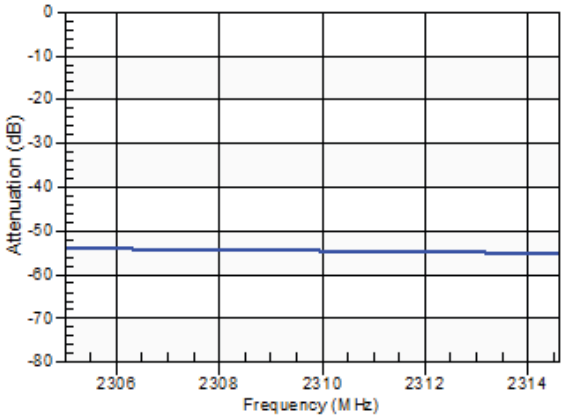


Figure 41: Band 66 Ant-Rx Attenuation in ISM/Bluetooth Bands, 2400–2500 MHz

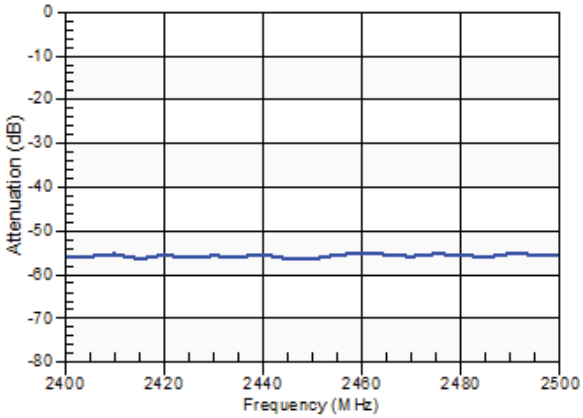


Figure 42: Band 66 Ant-Rx Attenuation in Band 66 Rx 2H, 4220–4400 MHz

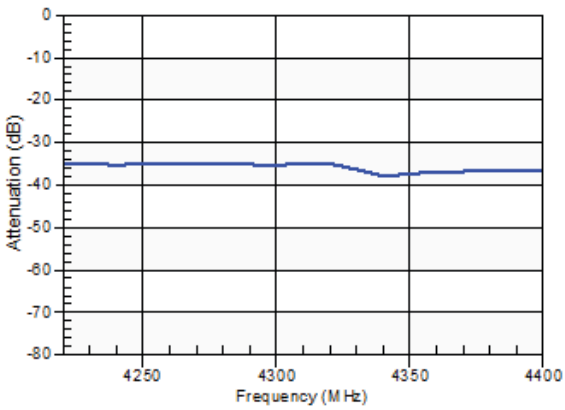
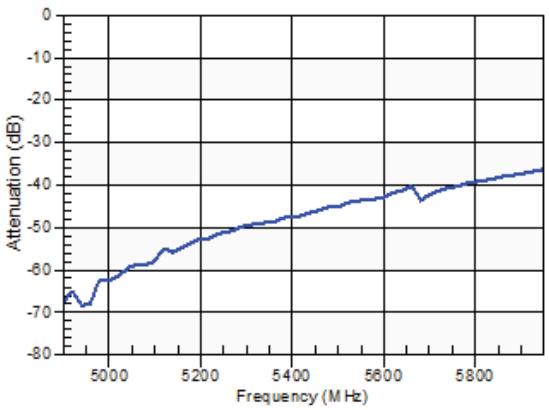


Figure 43: Band 66 Ant-Rx Attenuation in ISM 5G Bands, 4900–5950 MHz



ACFM-70457045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 44: Band 66 Return Loss, Ant (black) and Tx (red) Ports, 1710–1780 MHz

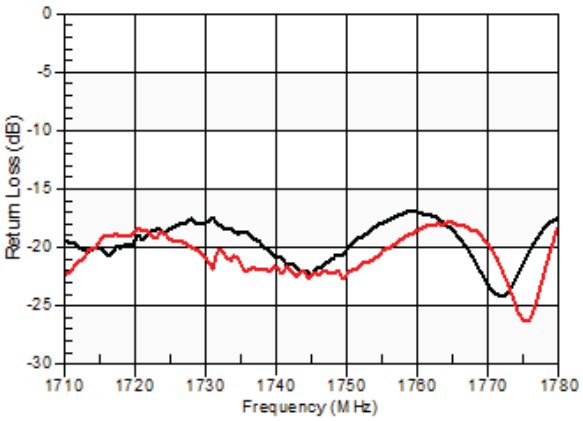


Figure 45: Band 66 Impedance, Ant (black) and Tx (red) Ports, 1710–1780 MHz

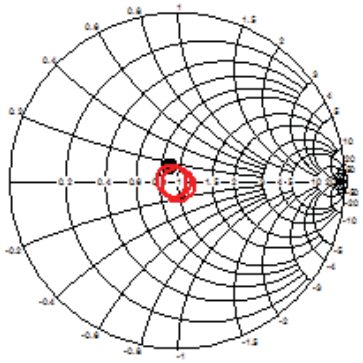


Figure 46: Band 66 Return Loss, Ant (black) and Rx (blue) Ports, 2110–2200 MHz

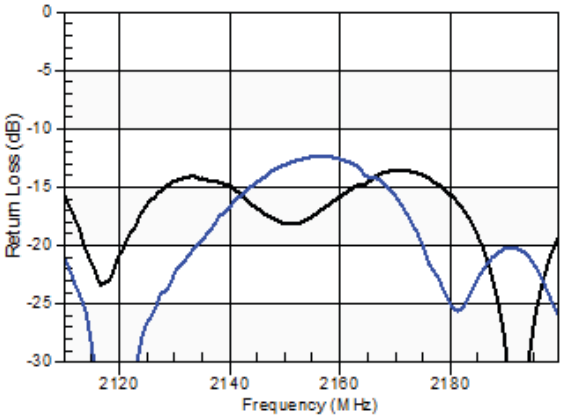


Figure 47: Band 66 Impedance, Ant (black) and Rx (blue) Ports, 2110–2200 MHz

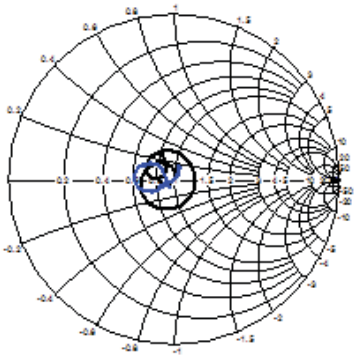


Figure 48: Cross-Band Isolation, Band 25 Tx to Band 66 Rx in Band 66 Rx, 2110–2155 MHz

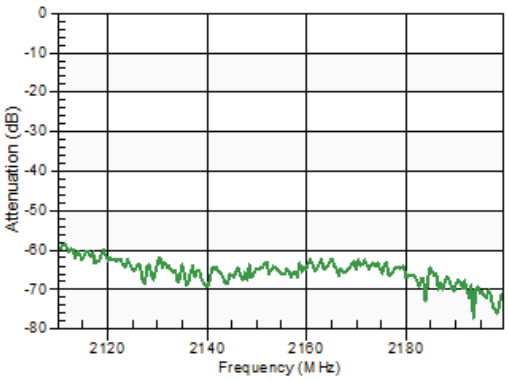
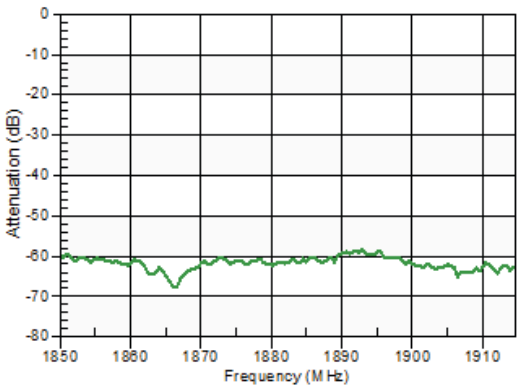


Figure 49: Cross-Band Isolation, Band 25 Tx to Band 66 Rx in Band 25 Tx, 1850–1915 MHz



ACFM-70457045 Typical Performance at Tc = 25°C, includes matching shown in Figure 1.

Figure 50: Cross-Band Isolation, Band 66 Tx to Band 25 Rx in Band 25 Rx, 1930–1995 MHz

Figure 51: Cross-Band Isolation, Band 66 Tx to Band 25 Rx in Band 66 Tx, 1710–1780 MHz

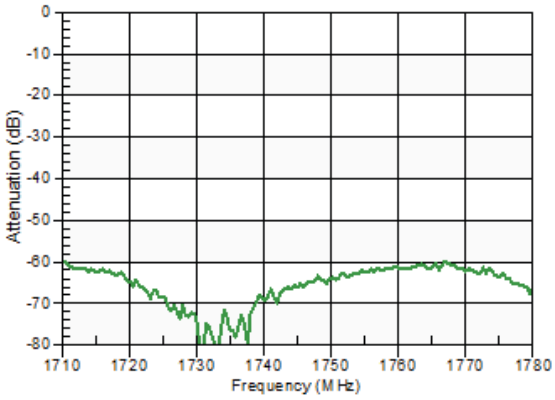
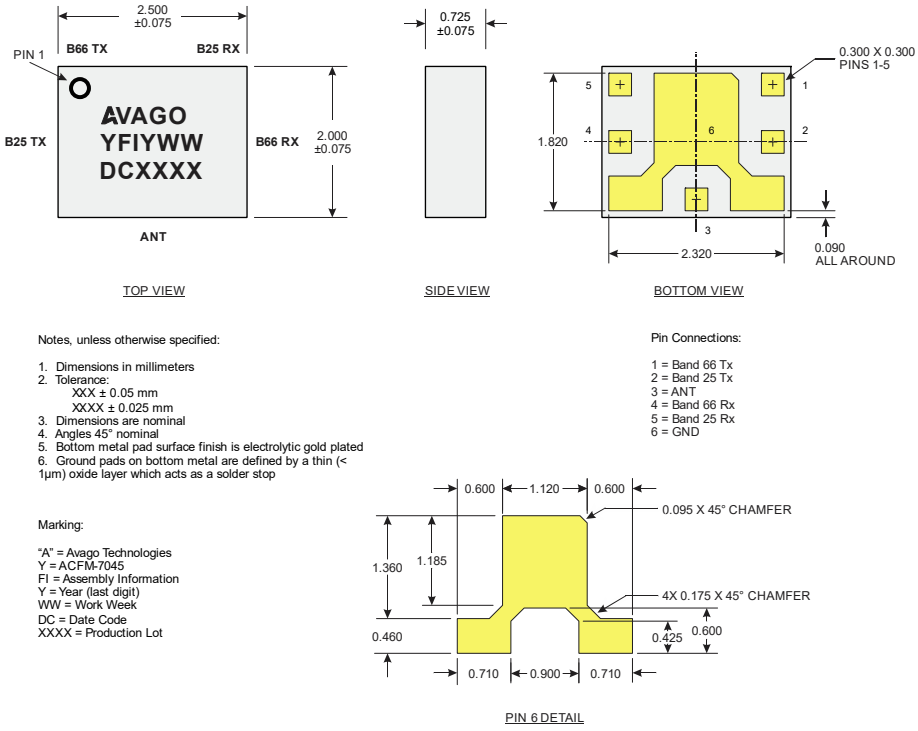


Figure 52: Package Outline Drawing and Marking



Notes, unless otherwise specified:

1. Dimensions in millimeters
2. Tolerance:
   XXX ± 0.05 mm
   XXXX ± 0.025 mm
3. Dimensions are nominal
4. Angles 45° nominal
5. Bottom metal pad surface finish is electrolytic gold plated
6. Ground pads on bottom metal are defined by a thin (< 1µm) oxide layer which acts as a solder stop

Marking:

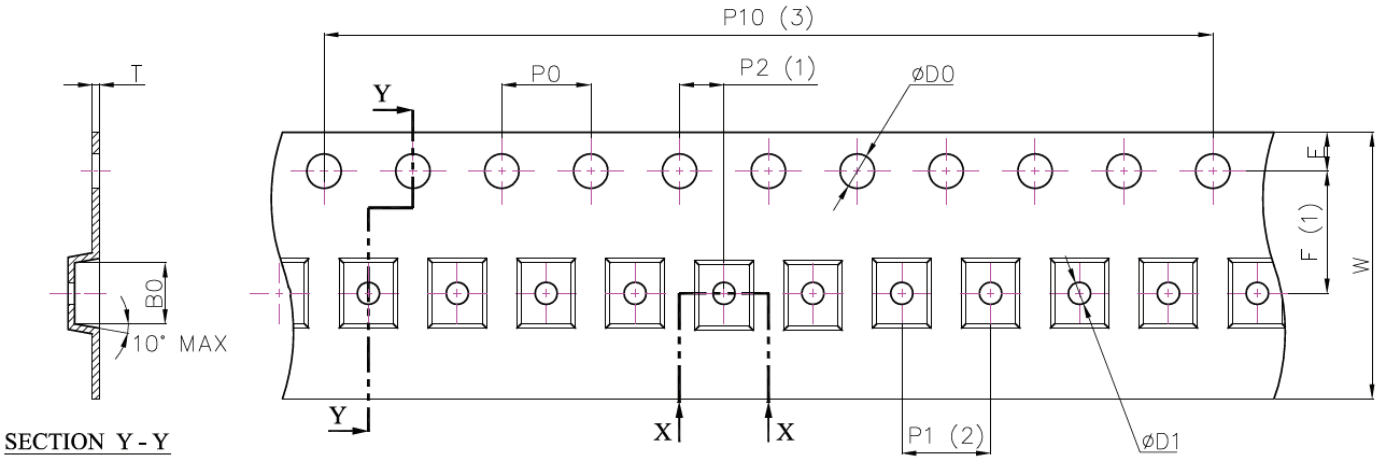
"A" = Avago Technologies
Y = ACFM-7045
FI = Assembly Information
Y = Year (last digit)
WW = Work Week
DC = Date Code
XXXX = Production Lot

Pin Connections:

1 = Band 66 Tx
2 = Band 25 Tx
3 = ANT
4 = Band 66 Rx
5 = Band 25 Rx
6 = GND

PIN 6 DETAIL

Figure 53: SMT Tape Drawing



NOTE(S):

1) MEASURE FROM CENTERLINE OF SPROCKET HOLE TO CENTERLINE OF POCKET.
2) MEASURE FROM CENTERLINE OF POCKET TO CENTERLINE OF POCKET.
3) PITCH TOLERANCE FOR SPROCKET HOLE, 10 PITCH CUMULATIVE TOLERANCE IS ±0.2mm.
4) ALLOWABLE CAMBER TO BE 1mm PER 250mm IN LENGTH.

Dimension List			
Annote	Milimeter	Annote	Milimeter
A0	2.25±0.10	P2	2.00±0.05
B0	2.75±0.10	P10	40.00±0.20
K0	1.10±0.10	E	1.75±0.10
D0	$1.50^{+0.10}_{-0}$	F	5.50±0.05
D1	1.00±0.05	W	$12.00^{+0.30}_{-0.10}$
P0	4.00±0.10	T	0.30±0.03
P1	4.00±0.10		

Figure 54: Orientation in Tape

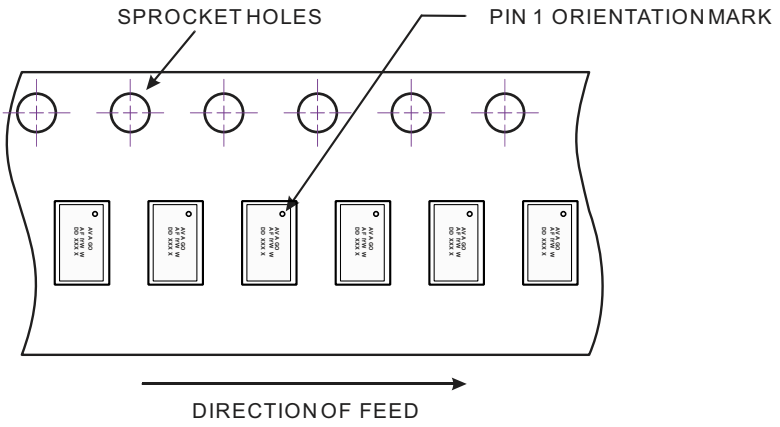
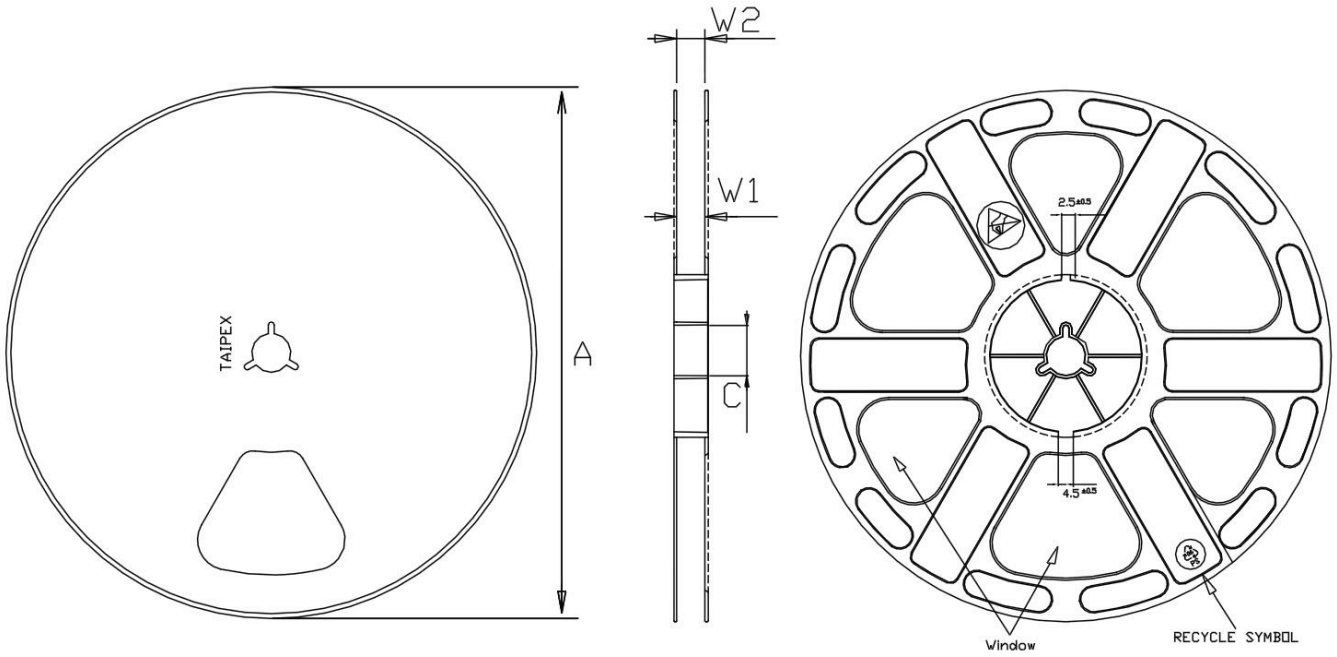


Figure 55: SMT Reel Drawing; Tape Size for ACFM-7045 is 12 mm



Tape Size (mm)	A	B	C	W1	W2	(CCC) Colour
8mm	178+0.5 −0.5	1.5 min 2.5 max	12.8 min 13.5 max	8.4min. 9.9max	10.9+0.0 −3.0	(DBL) Dark Blue
12mm	178+0.5 −0.5	1.5 min 2.5 max	12.8 min 13.5 max	12.4min 14.4max	15.4+0.0 −3.5	(LBL) Light Blue
16mm	178+0.5 −0.5	1.5 min 2.5 max	12.8 min 13.5 max	16.4min 18.4max	19.4+0.0 −3.5	(NAT) Natural White

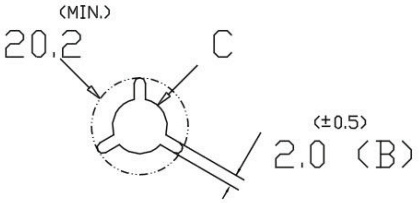


Table 4: Package Moisture Sensitivity

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

Figure 56: Verified SMT Solder Profile

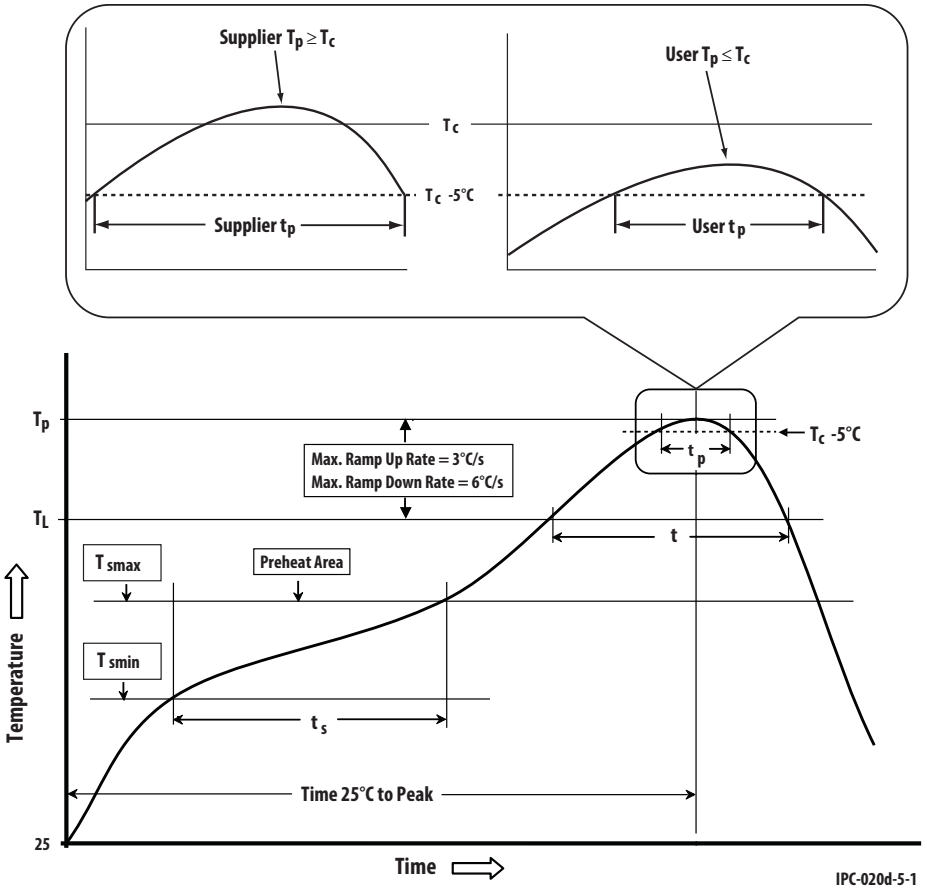


Table 5: Ordering Information

Part Number	Number of Devices	Container
ACFM-7045-BLK	100	Tape strip or gel-pack
ACFM-7045-TR1	3000	178 mm (7-inch) reel

BROADCOM®