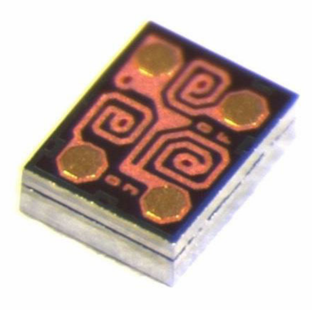
ACPF-7A24

2.4 GHz Wi-Fi Bandpass Filter for Coexistence with LTE Bands 7, 38, 40A, and 41B



Description

The Broadcom® ACPF-7A24 is a chip scale bandpass filter designed for use in mobile Wi-Fi/Bluetooth applications (2401 MHz to 2481.5 MHz), which require high attenuation of adjacent spectrum (for example, LTE Bands 7, 38, 40A, and 41B) to meet coexistence requirements.

The ACPF-7A24 is designed with Broadcom's innovative Film Bulk Acoustic Resonator (FBAR) technology, which makes possible ultra-small, high-Q filters at a fraction of their usual size.

The ACPF-7A24 also uses Broadcom's advanced Microcap bonded-wafer technology. This chip scale miniaturization process results in a package size of only 0.585 mm x 0.721 mm and maximum height of 0.244 mm, making the ACPF-7A24 smaller than a 0402 size SMT component.

The ACPF-7A24 is compatible with high volume, lead-free SMT soldering processes and can be direct-surface mounted to a PCB or a transfer molded module.

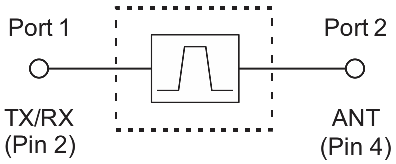
Specifications

- Performance guaranteed –30°C to +85°C
- Wi-Fi Band Insertion Loss (Absolute): 1.2 dB Typ, +25°C
  Wi-Fi Band Insertion Loss (Ch Avg): 0.9 dB Typ, +25°C

Features

- 50Ω input/output
- No external matching required
- Low insertion loss
- High rejection
  - Enables concurrent operation with other 2.5-GHz bands
- Subminiature size
  - 0.585 mm × 0.721 mm footprint
  - 0.244 mm maximum height
- High power rating
  - +27 dBm maximum power rating (LTE modulation, average)
- Environmental
  - RoHS 6 compliant
  - Halogen free
  - TBBPA Free

Functional Block Diagram



Applications

Wi-Fi/Bluetooth-enabled mobile communications devices operating concurrently with other wireless standards

Table 1: ACPF-7A24 Electrical Specifications[a], Z_0=50Ω, T_C[b] as indicated. Specifications are defined using "Ground Layer 2" as shown in the following PCB Design Guideline.

Symbol	Parameter	Frequency (MHz)	Temp, T_C (°C)	Units	Min.	Typ.[c]	Max.
S21	Attenuation	2401 to 2480	–30 to +85	dB	—	1.2	2.9
S21	Insertion Loss Channel Average[d]	2402.5 to 2421.5 (Wi-Fi Ch 1)	–30 to +85	dB	—	1.1	1.5
		2407.5 to 2426.5 (Wi-Fi Ch 2)	–30 to +85	dB	—	1.0	1.3
		2412.5 to 2471.5 (Wi-Fi Ch 3 to 11)	–30 to +85	dB	—	0.8	1.2
		2457.5 to 2476.5 (Wi-Fi Ch 12)	–30 to +85	dB	—	0.9	1.3
		2462.5 to 2481.5 (Wi-Fi Ch 13)	–30 to +85	dB	—	1.0	1.8
∆S21	Amplitude Ripple (p-p over any 19 MHz Wi-Fi channel)	2402.5 to 2421.5 (Wi-Fi Ch 1)	+25	dB	—	0.9	1.3
		2407.5 to 2426.5 (Wi-Fi Ch 2)	+25	dB	—	0.7	1.1
		2412.5 to 2471.5 (Wi-Fi Ch 3 to 11)	+25	dB	—	0.5	0.9
		2457.5 to 2476.5 (Wi-Fi Ch 12)	+25	dB	—	0.6	1.0
		2462.5 to 2481.5 (Wi-Fi Ch 13)	+25	dB	—	0.7	1.1
S21	Attenuation	800 to 2300	–30 to +85	dB	30	35	—
S21	Attenuation, LTE Band 40 (Channel Average[e])	2300 to 2370	–30 to +85	dB	35	40	—
		2370 to 2380		dB	—	25	—
S21	Attenuation in LTE Band 7 (Channel Average[e])	2500 to 2505	–30 to 0	dB	20	30	—
			0 to +25	dB	30	35	—
			+25 to +85	dB	35	40	—
		2505 to 2690	–30 to +85	dB	33	40	—
S21	Attenuation, LTE Band 38 (Channel Average[e])	2570 to 2620	–30 to +85	dB	35	40	—
S21	Attenuation	2690 to 2690	–30 to +85	dB	33	40	—
S21	Attenuation	2690 to 4000	–30 to +85	dB	33	40	—
S21	Attenuation	4000 to 6800	–30 to +85	dB	25	30	—
2H	2nd Harmonic, +22.5 dBm CW	2422	+25	dBc	—	–75	—
3H	3rd Harmonic, +22.5 dBm CW	2422	+25	dBc	—	–125	—
S11, S22	Return Loss, Input/Output	2402.5 to 2481.5	–30 to +85	dB	9.5	17	—

a. Min./Max. specifications are guaranteed at the specified temperature.

b. T_C is the case temperature and is defined as the temperature of the underside of the device where it contacts the circuit board.

c. Unless otherwise noted, Typical data is the average value (arithmetic mean) of the parameter over the indicated band at 25°C.

d. Channel average Insertion Loss is obtained by averaging |S21| over the center 19 MHz of channels and converting to dB value.

e. Channel average attenuation is obtained by averaging |S21| over 5 MHz channels and converting to dB value.

Table 2: Absolute Maximum Ratings[a]

Parameter	Units	Value
Storage temperature	°C	–40 to +125
Maximum RF Input Power to Port 1 (Tx/Rx, Pin 2)[b]	dBm	+27
Maximum DC Voltage, Pins 2 and 4 to GND[c]	VDC	+5

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

[b] Maximum power ratings are for average LTE OFDM modulated signal.

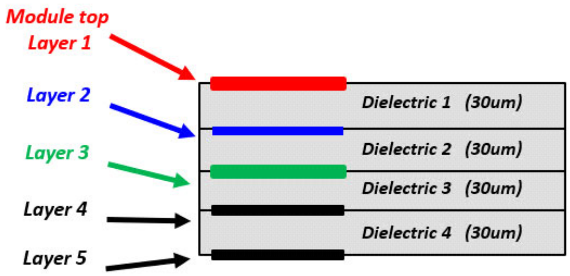
NOTE: The ACPF-7A24 is not symmetrical. he higher system power (Tx) should be connected to the Input side of the filter, Port 1 (Pin 2).

[c] The DC resistance from Pins 2 and 4 to ground of this device is typically hundreds of kΩ to MΩ.

PCB Design Guideline

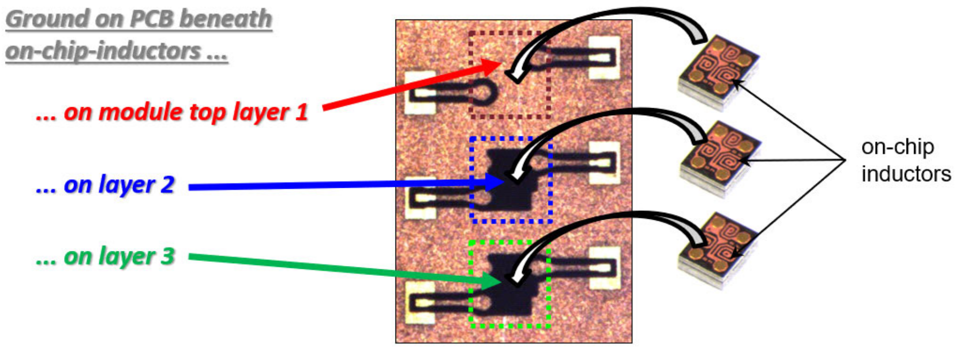
Attenuation characteristics depend on ground design at the module level. ACPF-7A24 Electrical Specifications refer to grounding on "Ground Layer 2".

Figure 1: Ground Layers in Typical PCB Stack



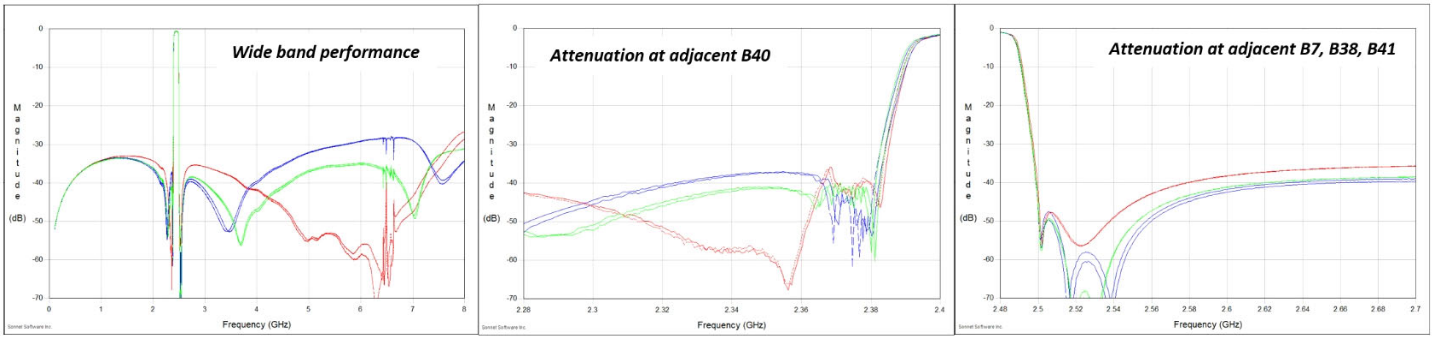
Three options are shown for choosing the ground layer beneath the ACPF-7A24 in the following figure.

Figure 2: Ground Layer Options



Out-of-band performance depends on choice of ground layer under the ACPF-7A24. Spacing between ground and die-inductors has a significant influence of out-of-band performance. The same is true if there is only partial grounding beneath the on-chip-inductor. Note, there is no influence regarding in-band insertion loss or return loss performance (only out-of-band shown in the following figure).

Figure 3: Example of Out-of-Band Performance vs. Ground Layer



NOTE: In the preceding figure, **Red = Ground Layer 1**, **Blue = Ground Layer 2**, **Green = Ground Layer 3**.

ACPF-7A24 Typical Performance at T_C = 25°C

Figure 4: Insertion Loss, 2400 to 2482 MHz

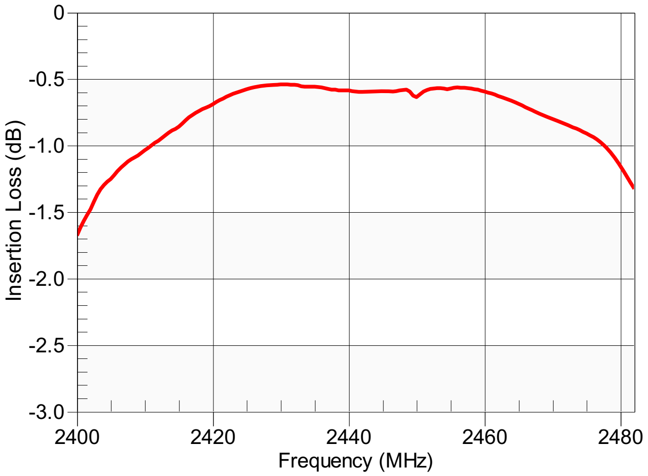


Figure 5: Wideband Attenuation, 100 to 8000 MHz

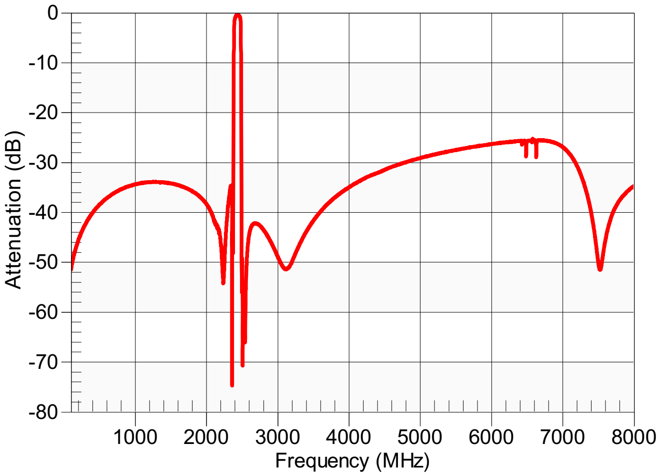


Figure 6: Attenuation, 800 to 2300 MHz

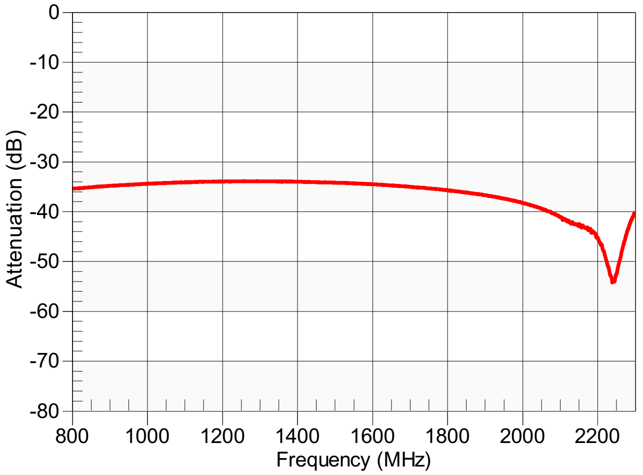
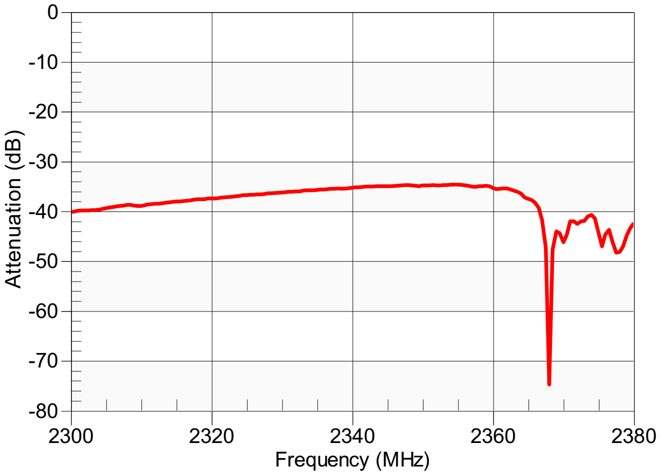


Figure 7: Rejection in LTE Band 40 (2300 to 2380 MHz)



ACPF-7A24 Typical Performance at T_C = 25°C (Continued)

Figure 8: Rejection in LTE Band 7 (2500 to 2690 MHz)

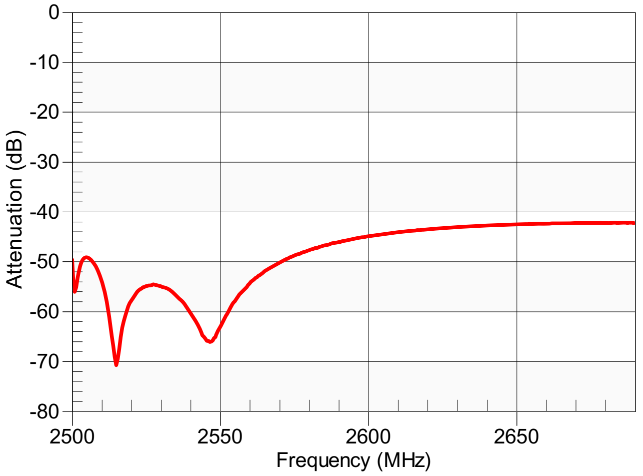


Figure 9: Rejection in LTE Band 38 (2570 to 2620 MHz)

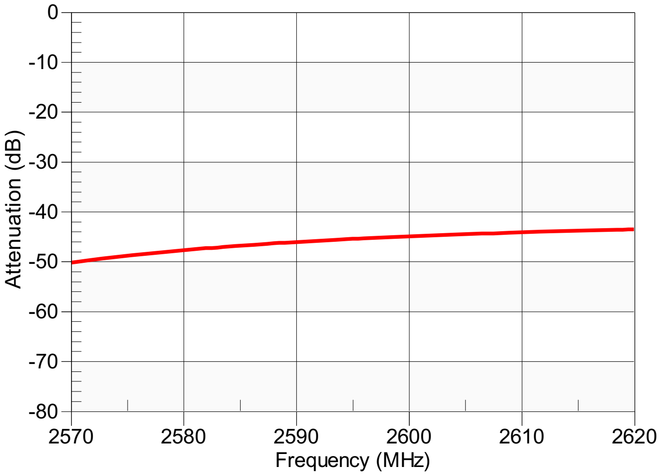


Figure 10: Attenuation, 2690 to 6800 MHz

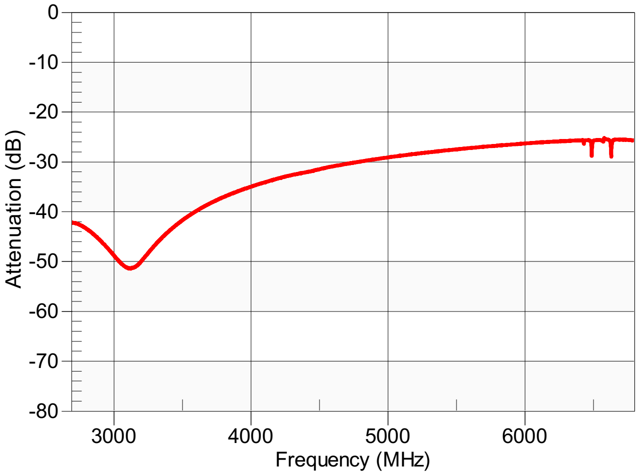
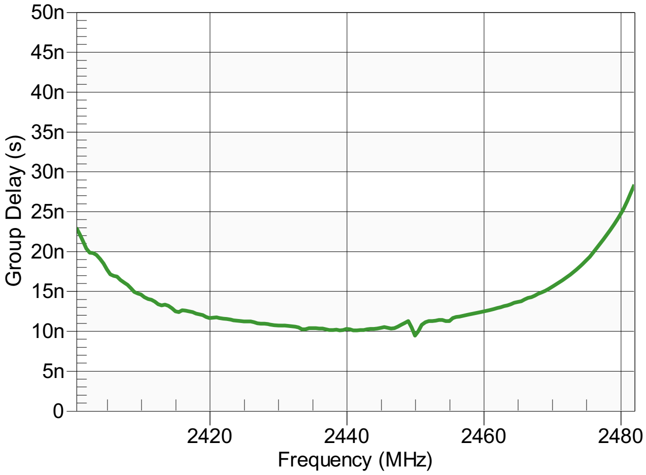


Figure 11: Group Delay (ns), 2400 to 2482 MHz



ACPF-7A24 Typical Performance at T_C = 25°C (Continued)

Figure 12: Input Return Loss (S11), 2400 to 2482 MHz

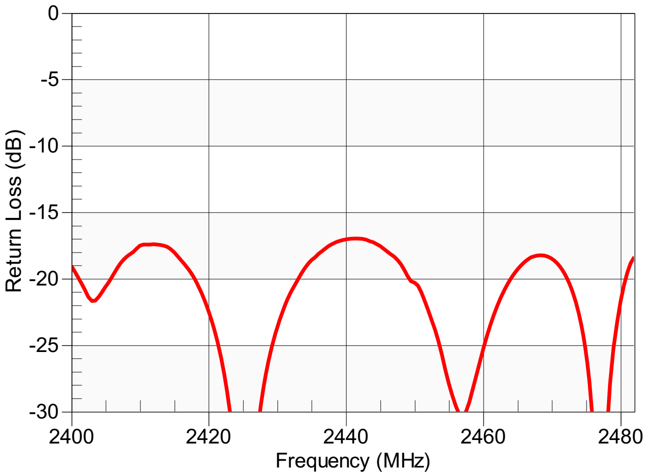


Figure 13: Input Port Impedance (S11), 2400 to 2482 MHz

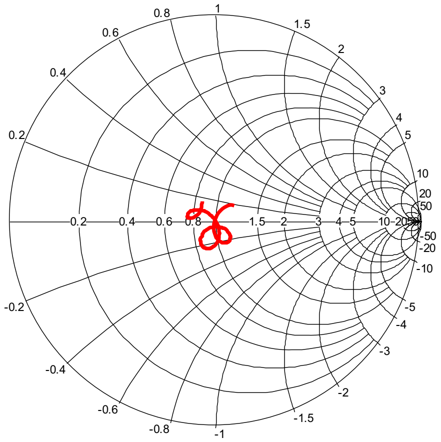


Figure 14: Output Return Loss (S22), 2400 to 2482 MHz

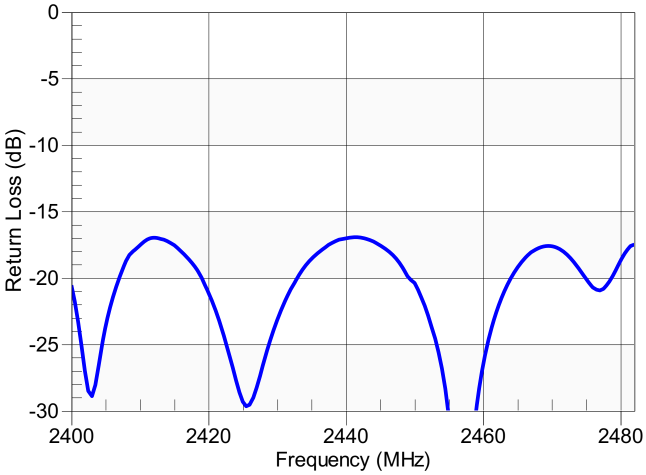


Figure 15: Output Port Impedance (S22), 2400 to 2482 MHz

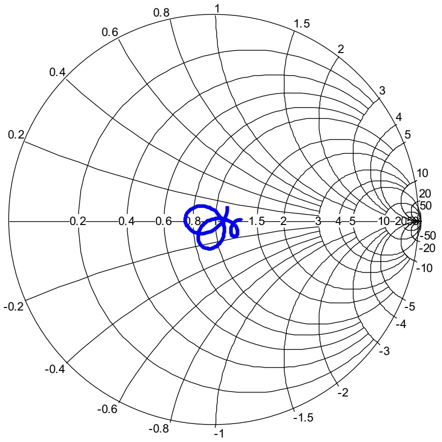
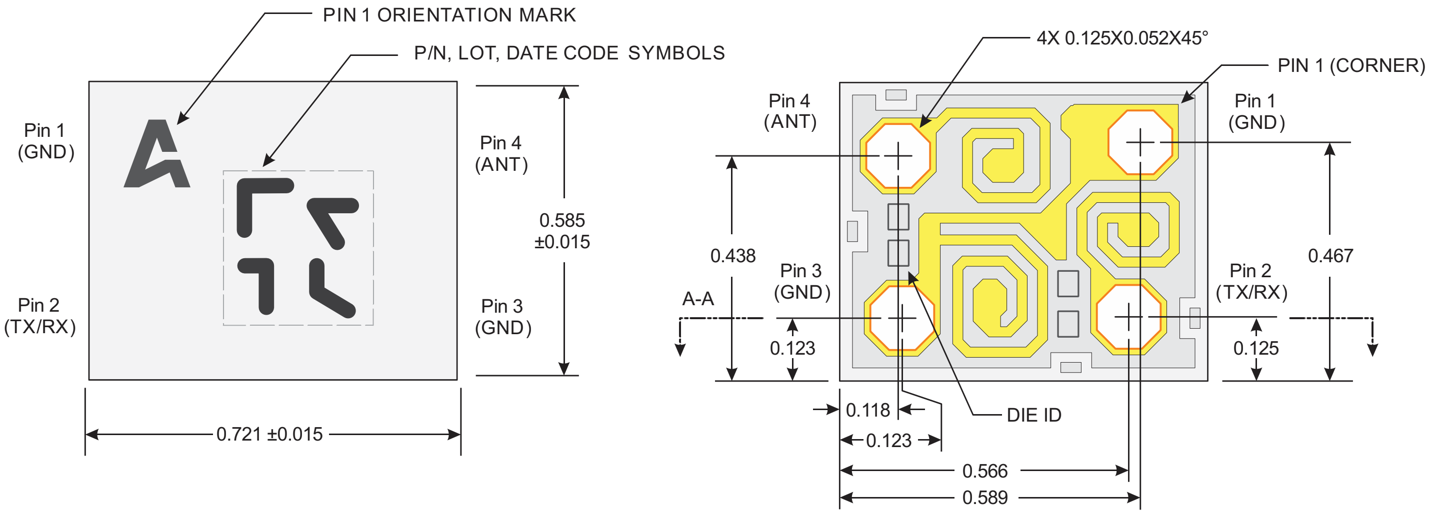


Figure 16: Package Outline Drawing and Marking

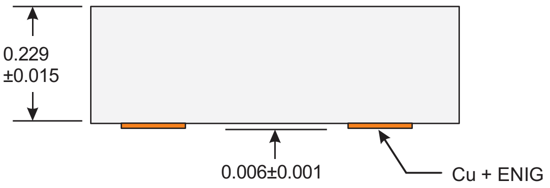


TOP VIEW

BOTTOM VIEW

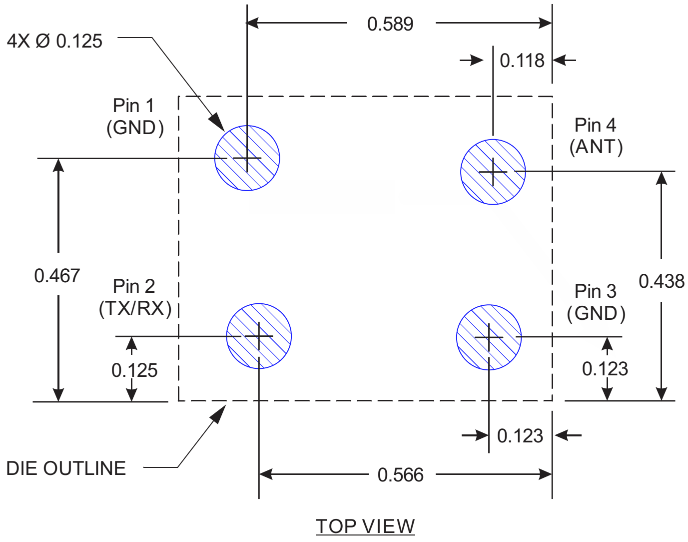
Notes:

1. Dimensions in millimeters



A-A CROSS SECTION

Figure 17: Recommended Land Pattern



NOTE:

1. Dimensions in mm.
2. Pad size is Ø 0.125 mm, minimum.
3. Pad dimple, 0.005 mm, maximum.
4. Pad surface finish, OSP only.
5. Fan out, both via in pads and via off pad allowed.

Land Print Design

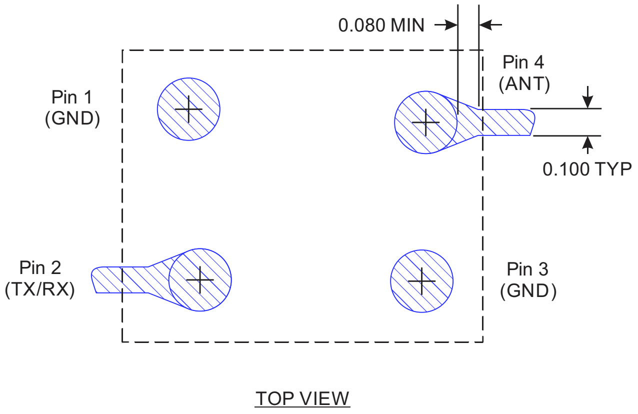
The PCB land print pattern shown in Figure 17 is recommended for the ACPF-7A24. The land print is non-solder mask defined (NSMD) pattern with a minimum metal pad size of 1:1 with the CuSMT pads on the bottom of the ACPF-7A24 die.

To maintain isolation, the second metal layer under the filter and Input/Output connection area is a continuous ground plane.

PCB Layout and Land Pad Considerations

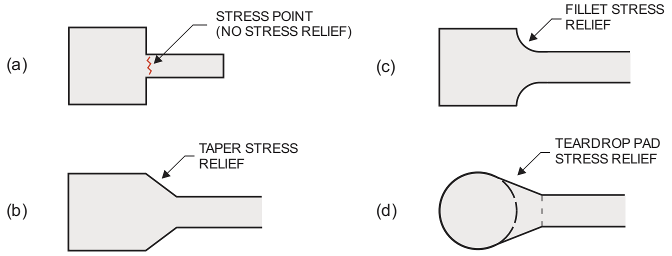
The design of the transition from land pads in Figure 17 to PCB signal traces is important to ensure reliability during assembly.

Figure 18: Recommended PCB Layout



NOTE: Dimensions in mm.

Figure 19: Land Pad-Trace Junction Options



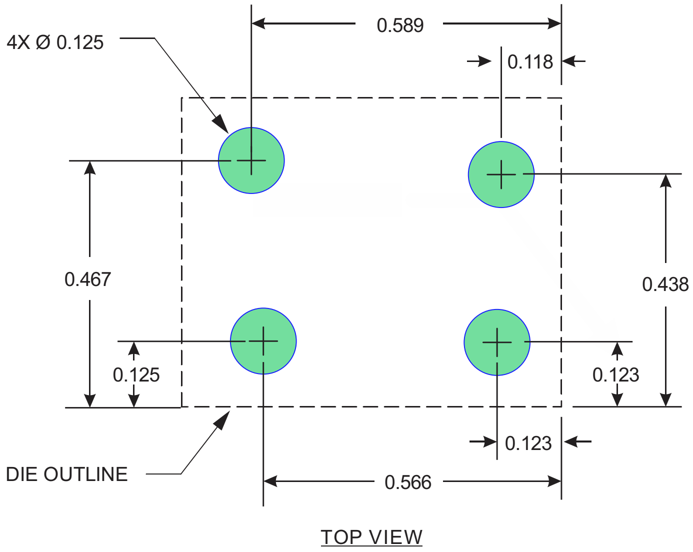
A significant mismatch in Coefficient of Thermal Expansion (CTE) exists between chip scale devices, like the ACPF-7A24, and common PCB materials. Unless precautions are taken, the difference in CTE can cause sufficient stress to break signal traces during the assembly process.

For example, Figure 19 (a) illustrates an abrupt transition between a square (or round) pad and a transmission line. This method does not provide stress relief and results in a weak point.

Figure 19 (b), (c), and (d) show methods of increasing the metal area in the critical junction between the land pad and signal trace. The purpose of the enlarged metal junction is to distribute stress during solder assembly, reducing risk of trace cracking.

For the ACPF-7A24, either the "teardrop" pad design of Figure 19 (d), as shown in Figure 18, or the tapered transition of Figure 19 (b) is recommended. The signal traces should be a minimum of 0.080 mm wide and the tapered stress relief section should extend a minimum distance of 0.080 mm from the pad. Beyond 0.080 mm from the land pad, the width of the signal traces is arbitrary and will be determined by RF design.

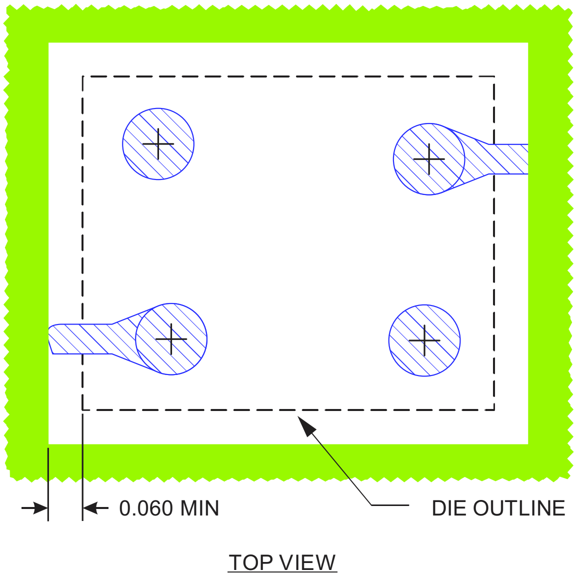
Figure 20: Recommended Solder Stencil



NOTE:

1. Dimensions in mm.
2. Stencil openings are 1:1 with the Cu Pillar size.

Figure 21: Recommended Solder Mask



NOTE:

1. Dimensions in mm.
2. Mask opening centered on landing pattern.
3. Setback from land pattern = 0.060 mm minimum.

Solder Stencil Design

The recommended solder stencil is shown in Figure 20. The stencil is electroformed with a typical thickness of 0.025 mm (1-mil).

Solder Mask

The recommended solder mask is shown in Figure 21. The solder mask is designed for a setback of 0.060 mm from the land pattern. The mask opening dimensions ensure the solderable area for all the land pattern pads are nearly identical.

Assembly Notes

1. Flux recommendations:
   a. Dipping: 0.025 mm to 0.050 mm (1 mill to 2 mil) typical flux film thickness.
   b. A water soluble flux is recommended (for example, Senju WF6317).
2. Surface mount assembly:
   a. PnP placement tolerance: ± 40 µm maximum.
   b. PnP placement force: 1.5 N typical, low force nozzle.
   c. Reflow: Standard JEDEC profile with 245°C typical peak temperature, N2 reflow.
   d. Clean: DI water or saponifier (for example, Kyzen) spray clean.
   e. **Do not use ultrasonic cleaning.**
   f. Shear strength: Minimum 3 kg/sq. mm × total pillar area.
   g. Solder void: Maximum 25% of solder joint area.
3. Underfill: Not tested with underfill, but CUF recommended for board level application.
4. MUF for package application:
   a. Mold compound: Maximum 32-µm filler size.
   b. Molding pressure: Maximum 1000 psi.
   c. Mold thickness: Maximum 600 µm.
   d. Mold/underfill voids: None under die.

Figure 22: SMT Tape Drawing

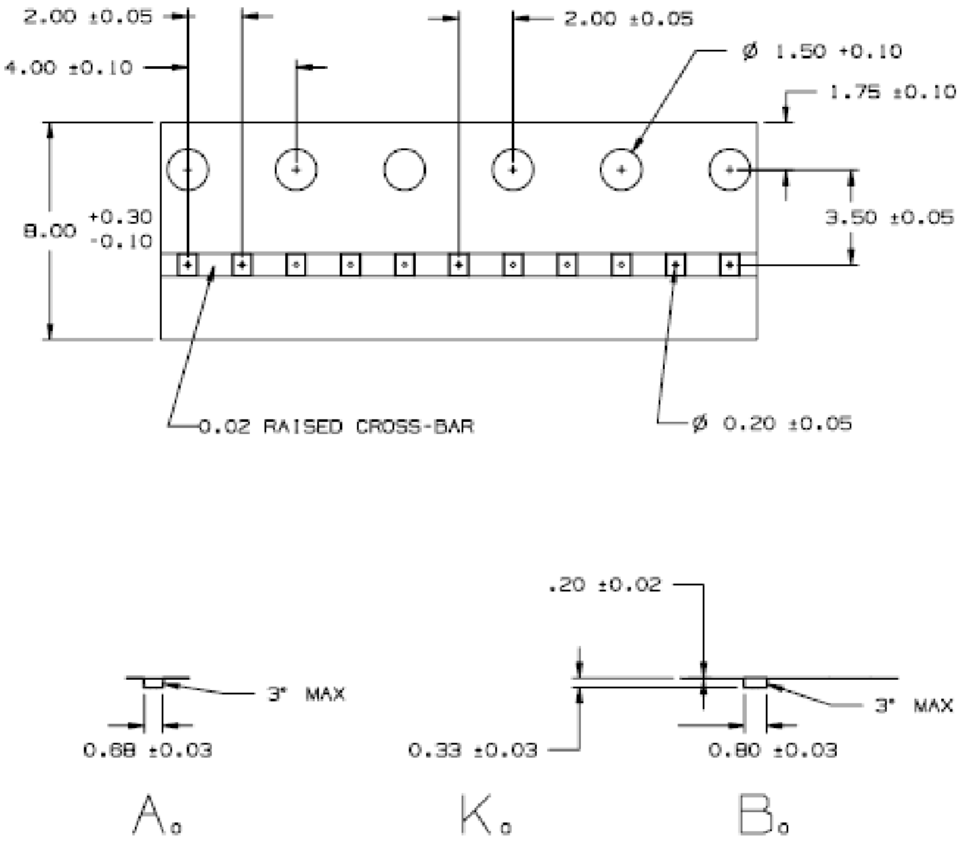
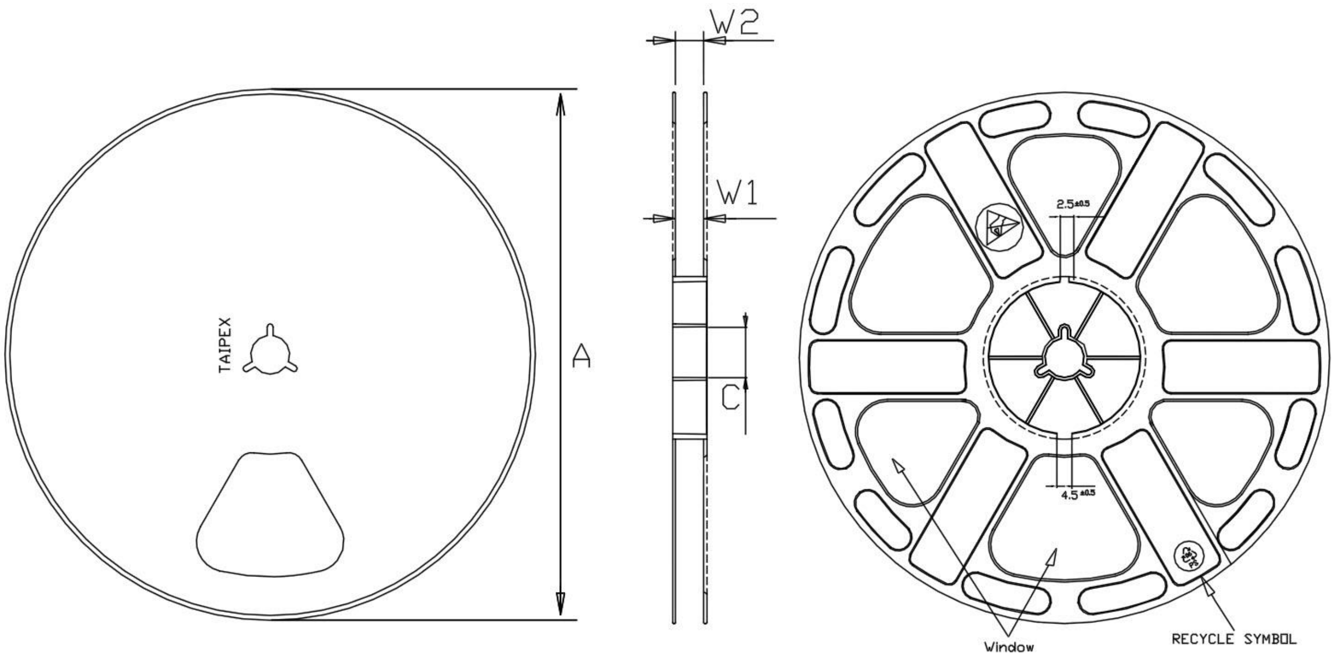


Figure 23: SMT Reel Drawing; Tape Size for ACPF-7A24 is 8 mm



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

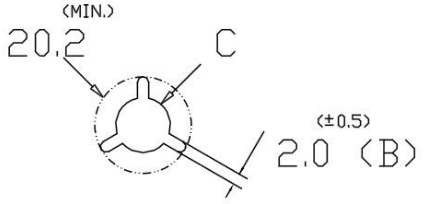
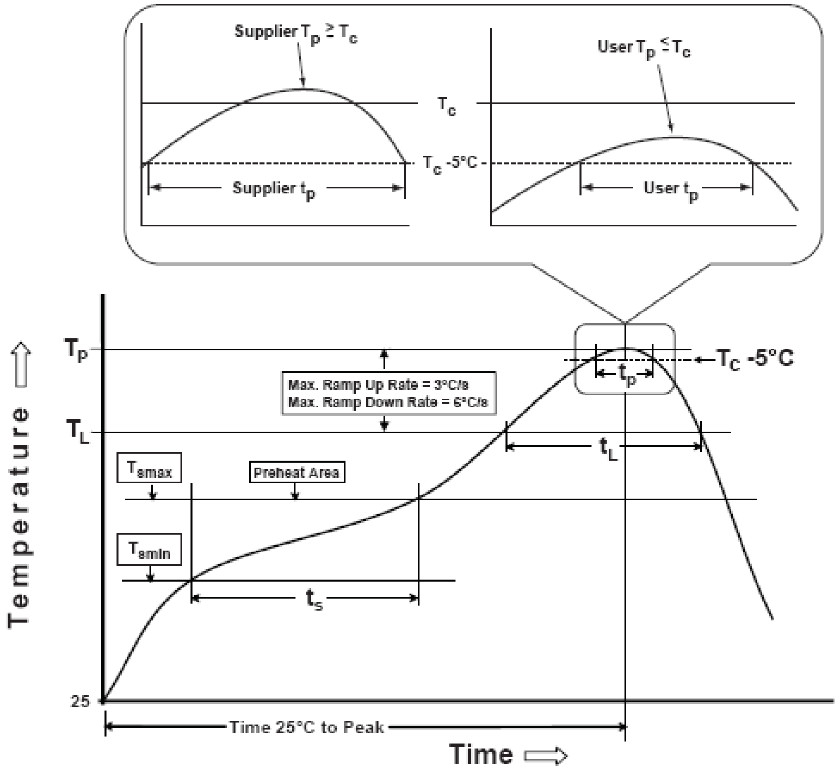


Table 3: Package Moisture Sensitivity

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

Figure 24: Verified SMT Solder Profile.



IPC-020d-5-1

Table 4: Ordering Information

Part Number	Number of Devices	Container
ACPF-7A24-BLK	100	Tape strip or Gel-Pack
ACPF-7A24-TR1	1000	178 mm (7-inch) reel
ACPF-7A24-TR2	5000	178 mm (7-inch) reel