

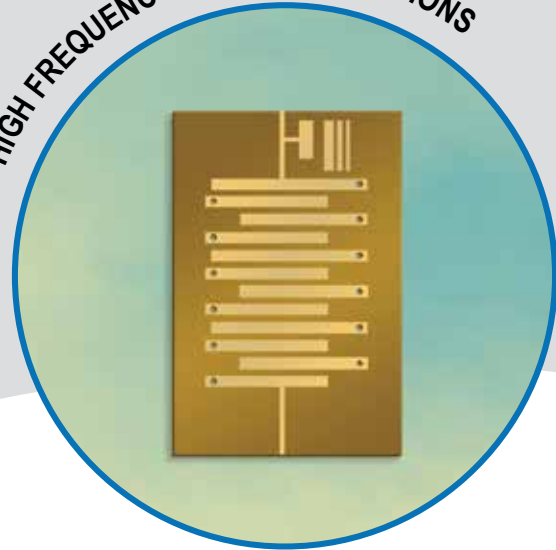


Substrates - Thin Film Patterned

Key Features:

- Quick turn prototype to high volume production.
- Advanced thin film manufacturing capabilities / features.
- Wide array of ceramic substrate materials / metal systems.
- Unique customer solutions.
- The ability to reduce circuit size and discrete components.

HIGH FREQUENCY CERAMIC SOLUTIONS



Substrate Selection

Choosing the correct substrate influences the mechanical and electrical function of a design. Johanson offers a wide range of dielectrics for use in application specific environments. These materials are available in lapped, polished, and “as fired” conditions. These substrates can be metallized or nonmetallized. Metallized substrates may be patterned to customer specifications by chemical etching, abrasive etching, and patterned plating.

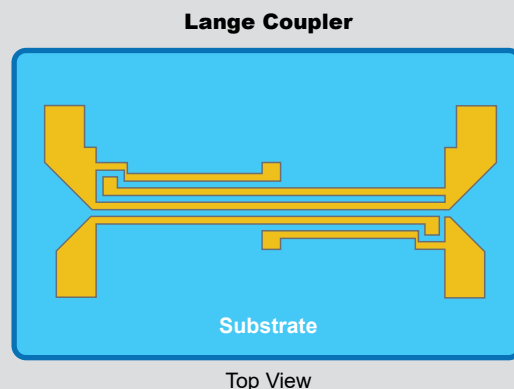
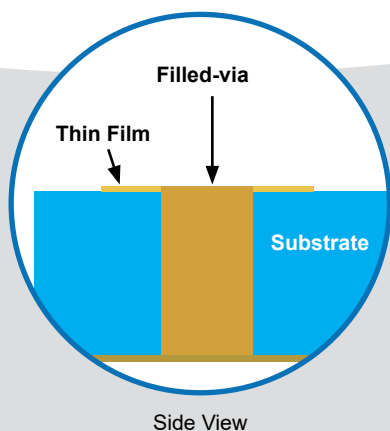
Coefficient of thermal expansion (CTE) and thermal conductivity are important parameters for circuits involved with high power. Care should be used when choosing a substrate because differences in CTE values of close metals, like housings or heat-sinks, will cause mismatch stresses in an assembly during temperature changes. Thermal conductivity defines the rate of heat transfer between hot and cold regions of your design. In applications where heat conduction is critical, designers must consider thermal conductivity of available substrates or use filled-vias as an alternative thermal path within a design.



Substrates - Thin Film Patterned

Table 1: Material Electrical and Mechanical Properties

Substrate Material (Code)	Temperature Coefficient (-55 to +125°C)	Dielectric Constant	Tan θ 1KHz/ 1MHz*/ 10 GHz**	Dielectric Strength (V/mil)	Coefficient of Thermal Expansion (ppm/°K)	Thermal Conductivity (W/m°-K) @ 25°C/100°C*
Diamond (D)	----- Consult with Factory -----					
Quartz (Q)		4.5	0.0001**	>635	0.55	5/2
AlN (F)	170 W/m °K	8.8	0.0005*/0.002**	355	4.6	190min/160, 170min/130
Alumina (G)	P120 +/- 30ppm	9.9	0.0001*	450	7	26.6
Titanate (C)	0 $\pm$ 30ppm/°C	23	$\leq$ 0.0015*	205	~ 9	1.55
Titanate (K)	0 $\pm$ 30 ppm/°C	39	$\leq$ 0.0015*	205	~ 9	1.55
Titanate (N)	0 $\pm$ 30 ppm/°C	76	$\leq$ 0.0015*	210	~ 9	1.55
Titanate (V)	-1500 + 500/-944 ppm/°C	160	$\leq$ 0.0025*	220	~ 10	1.55
Titanate (R)	-2200 $\pm$ 500ppm/°C	440	$\leq$ 0.0025*	150	N/A	N/A
Titanate (D)	$\pm$ 10 %	725	$\leq$ 0.025	175	N/A	N/A
Titanate (B)	$\pm$ 10 %	1410	$\leq$ 0.025	190	N/A	N/A
Titanate (W)	$\pm$ 10%	2300	$\leq$ 0.025	190	N/A	N/A
Titanate (X)	$\pm$ 15%	3150	$\leq$ 0.025	190	N/A	N/A
Titanate (T)	$\pm$ 15%	4100	$\leq$ 0.025	250	N/A	N/A



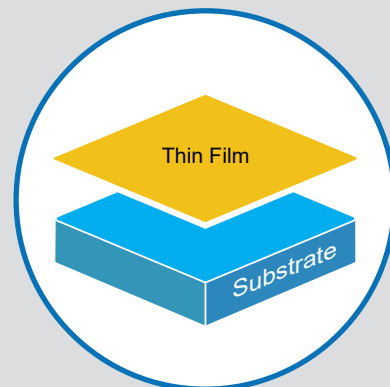


Substrates - Thin Film Patterned

Table 2: Standard Materials, Surface Finish, and Sizes

Substrate (Code)	Surface Finish (u-in)			Max L x W (in)	Standard Thickness (mils)
	As Fired	Lapped	Polished		
Diamond (D)	----- Consult with Factory -----				
Quartz (Q)					10 to 40
AlN (F)	20	20	3		5 to 40
Alumina (G)	20	20	3	4.8 x 4.8	5 to 60
Titanate (C)	30	10	3	1.5 x 1.5	5 to 15
Titanate (K)	30	10	3	1.5 x 1.5	5 to 15
Titanate (N)	30	10	3	1.5 x 1.5	5 to 15
Titanate (V)	30	10	3	1.5 x 1.5	5 to 15
Titanate (R)	30	10	3	1.5 x 1.5	5 to 15
Titanate (D)	50	10	3	1.5 x 1.5	5 to 15
Titanate (B)	50	10	3	1.5 x 1.5	5 to 15
Titanate (W)	50	10	3	1.5 x 1.5	5 to 15
Titanate (X)	50	10	3	1.5 x 1.5	5 to 15
Titanate (T)	50	10	3	1.5 x 1.5	5 to 15

- Standard substrate sizes range from .050" x .050" to 1.50" x 1.50"
- Larger sizes available for special requests.
- Typical operating temperatures for all available substrates is -55 to +125°C.




Substrates

Thin Film Patterned - Metals Selection

Johanson Technology offers several different metal schemes to meet customer needs. We offer single-sided or double-sided metallization. Each side can have unique design requirements and metallization. Each metal layer typically has a specific use, whether that be adhesion, barrier or conductor layers. Selection of a metal should be based on electrical functioning demands and/or requirements.

Some designs require pads suitable for solder attachment while others require metals that could readily be wire bonded. Solder-able metallization schemes are available by adding Ni or Cu barrier for thin film designs. For optimal wire bond integrity, Johanson recommends a minimum of 100μ" thickness on thin film designs, although good performance can be achieved with as low as 80μ".

Careful selection of particular metallizations are dependent on requirements for solder-ability, temperature resistance, wire bonding, and electrical performance. Note: Johanson has capability to sputter and plate other metals not listed in Table 3. We will review special requests for metallizations not listed here.

Table 3: Available Plated Metals

Plated Metals	Metal Thickness (min/max)	Metal Thickness Tolerance	Typical Uses
Copper (Cu)	50-200μ" (1.27μm - 5.08μm)	± 50μ" (1.27μm)	Wire bond/Conductor
Gold (Au)	50-200μ" (1.27μm - 5.08μm)	± 50μ" (1.27μm)	Wire bond/Conductor
Nickel (Ni)	50-100μ" (1.27μm - 2.54μm)	± 25μ" (.635μm)	Barrier/solder attach

Table 4: Available Sputtered Metals

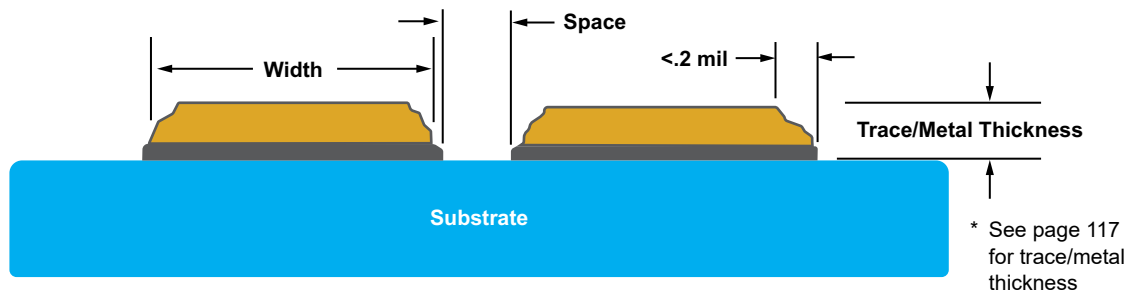
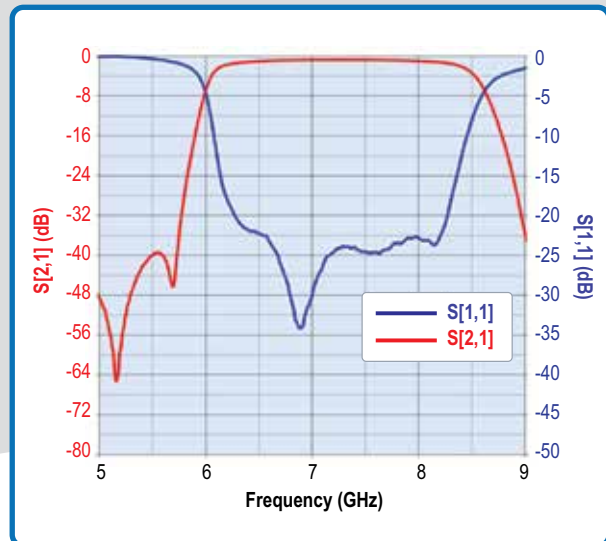
Sputtered Metals	Metal Thickness (min/max)	Metal Thickness Tolerance	Typical Uses
TiW (TiW)	200-500 Å	± 100Å	Barrier, adhesion
Nickel (Ni)	500-1,000 Å	± 250Å	Barrier, solder
Gold (Au)	1,000-2,000 Å	± 250Å	Wire bond/conductor
Platinum (Pt)	Å	± 100Å	Barrier, adhesion
Chromium (Cr)	250-750 Å	± 100Å	Barrier, adhesion
Silver (Ag)	500-1,000 Å	± 100Å	Conductor
Palladium (Pd)	750-2,000 Å	± 250Å	Barrier
Copper (Cu)	1,000-2,000 Å	± 250Å	Conductor



Substrates

Thin Film Patterned - Conductor Traces

Precise management of critical geometric features lead to excellent and dependable performances in RF, microwave, and millimeter wave designs. With accurate conductor line widths and spacing, designers can control the characteristic impedance of transmission lines, coupling between RF traces, and even manage thermal loads within RF circuits. Using high quality conductor traces with little variation allows designers to have consistent performance in RF components such as filters and couplers.



Conductor Trace Diagram

Johanson Technology's standard offering is the gold conductor trace. Other materials, like copper can be used in some instances.

Table 5: Standard Line Traces and Tolerances

Sputtered / Plated Metals			
Standard line width/space	.0010" (25.40µm)	Standard line width/space	.0010" (25.40µm)
Standard line width/space tolerance	.0002" (5.08µm)	Line width/space tolerance	.0002" (5.08µm)
Min. line width/space	.0005" (12.70µm)		
Min. line width/space tolerance	.0001" (2.54µm)		



Substrates

Thin Film Patterned - Designing With Vias

Johanson has advanced experience incorporating vias into substrate designs with demanding requirements. Vias can be offered as either filled, through-hole or plated-through. Engineers must review the existing electrical and thermal properties of their design before deciding between filled or plated-through vias. The overall process is completed by lasering through a substrate from the top to bottom layer and then sputtering or plating over the substrate via opening. Both via options are effective in routing electrical signals from one side to another.

Plated-through vias are often recommended for low-power applications or in designs that require an opening to be maintained. In contrast, filled-vias are best used in high power applications or to enhance thermal properties of the hybrid design. Filled-vias are useful in keeping heat away from the substrate, which in turn helps to prevent defects or circuit failures. Filled-vias offer the lowest RF inductance and thermal resistance. Laser machined vias have a taper equal to approximately 10% of the material thickness.

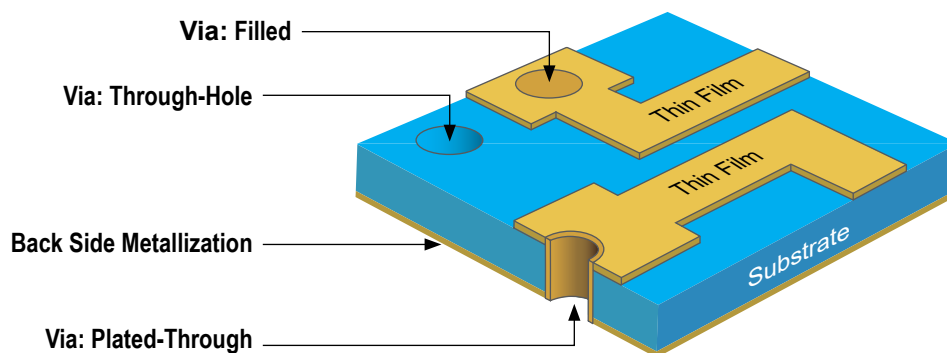


Table 6: Via Features

Dimension	Plated	Filled	Through Hole
Substrate Thickness	0.005"-0.035" (0.127-0.889mm)	0.005"-0.035" (0.127-0.889mm)	0.005"-0.035" (0.127-0.889mm)
Min. Via Diameter	60% of Substrate Thickness	60% of Substrate Thickness	60% of Substrate Thickness
Via Positional Tolerance	±0.002" (0.051mm)	±0.002" (0.051mm)	±0.002" (0.051mm)
Via Diameter Tolerance	±0.002" (0.051mm)	±0.002" (0.051mm)	±0.002" (0.051mm)
Min. Via Center to Center	1x Diameter	1x Diameter	1x Diameter
Min. Via Spacing Center to Edge	1x Diameter	1x Diameter	1x Diameter
Via Taper	10% of Substrate Thickness	10% of Substrate Thickness	10% of Substrate Thickness



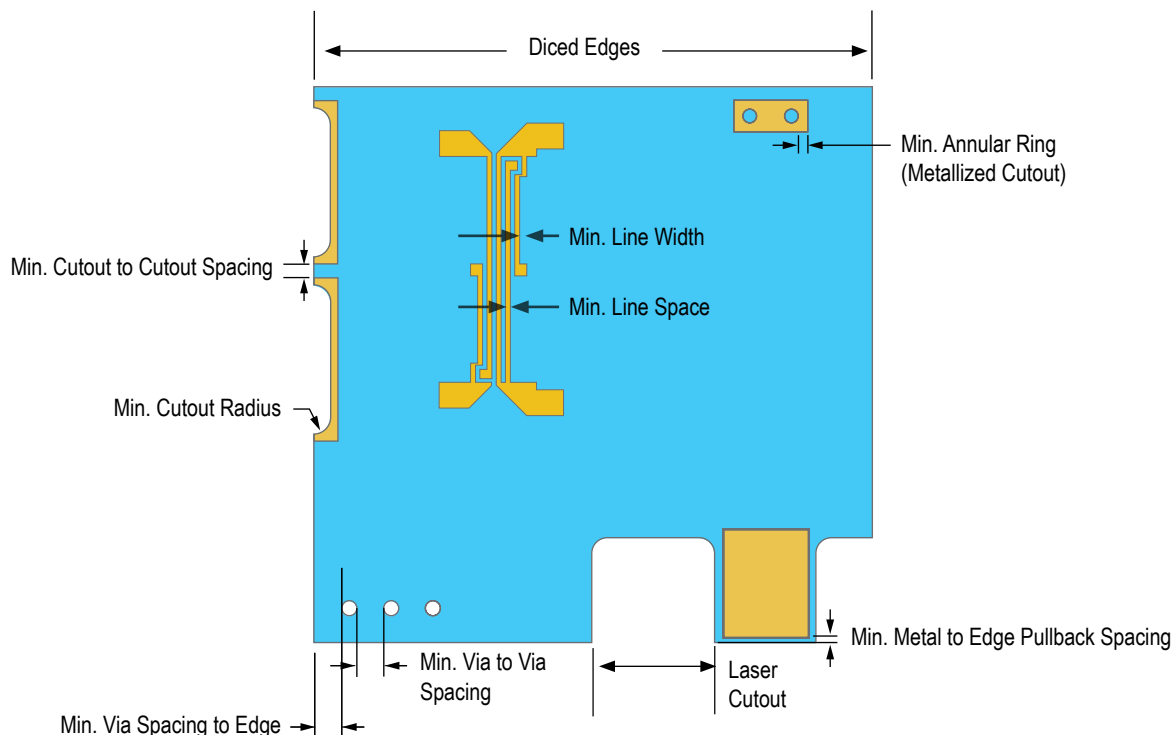
Substrates

Thin Film Patterned - Laser Machining

Laser machining is available to provide designers with controlled hole locations, custom shapes and sizes, and superb edge accuracy. Johanson's team allows engineers to realize flexible designs within the ceramic substrates. Johanson's standard laser features and tolerances can be visualized below.

Table 7: Laser Machining

Dimension	Lasered
Substrate Thickness	0.005"-0.035" (0.127-0.889mm)
Diced Edges Tolerance	±0.002" (0.051mm)
Min. Metal To Edge Pullback Spacing	0.002" (0.051mm)
Min. Cutout Radius	0.006" (0.152mm)
Laser Cutout Tolerance	±0.002" (0.051mm)
Laser Cutout Positional Tolerance	±0.002" (0.051mm)
Min. Cutout to Cutout Spacing	0.050" (1.27mm)
Min. Annular Ring (Metallized Cutout)	0.0025" (0.064mm)
Lasered Taper	10% of Substrate Thickness




Substrates
Thin Film Patterned - Inspection & Quality Commitments
Table 8: Visual Inspection Criteria for Unmetallized Substrates

Attribute	Definition of Visual Attribute	Diagram	Acceptable Conditions
Blister	Formation of small to large, broken, or unbroken bubbles.		Smooth no blisters.
Bumps, Fins, and Ridges	Streak of excess material.		Smooth no bumps, fins, or ridges.
Burrs	A raised edge or fragment of external material on the surface.		Height less than 1 millimeters and diameter less than 10 millimeters.
Chips	Visual evidence remaining on the substrate indicative of material loss from corners or edges due to mechanical damage, lack of material integrity, or both.		Less than 10 millimeters.
Cracks	Line on the surface which has split without breaking apart.		Solid no cracks.
Pits, Holes, and Pocks	A cavity or void.		Diameter less than 5 millimeters.
Scratches	A long, thin, or small gash/cut on the plane.		Less than 2 millimeters deep and less than 25 millimeters length.
Snowflakes	Microscopic metallic residue on X-dielectric surfaces.		Smooth no bumps, fins, or ridges.
Warpage	Substrate deformed or misshapen.		Height variation less than 10 millimeters per 100 millimeters in length.



Substrates

Thin Film Patterned - Design Submissions

"We encourage all designers to submit their drawings or ideas for quick and easy feedback."

How to Submit Custom Thin Film Designs. . .

Our outstanding, experienced technical team can provide feedback on reproducibility and help with custom layout design from concept stage to completion.

Before submitting your design, use the "preferred practices" checklist:

- Follow Johanson's design guidelines and standard specifications
- Provide CAD data in multiple layers
- Identify "A" side and "B" side for double-patterned circuits
- Provide tolerances and annotation
- DWG, DXF, Gerbers, and STEP files are preferred

Information needed:

- **Substrate:** Material, surface finish, thickness, and dimensions
- **Metallizations:** Thickness and tolerances
- **Conductor traces:** Type, spacing, and tolerances
- **Other:** Inspection or acceptance criteria

Resources:

Technical Questions

johansontechnology.com/ask-a-question

RoHS Compliance

johansontechnology.com/rohs-compliance

MSL Rating

johansontechnology.com/msl-rating