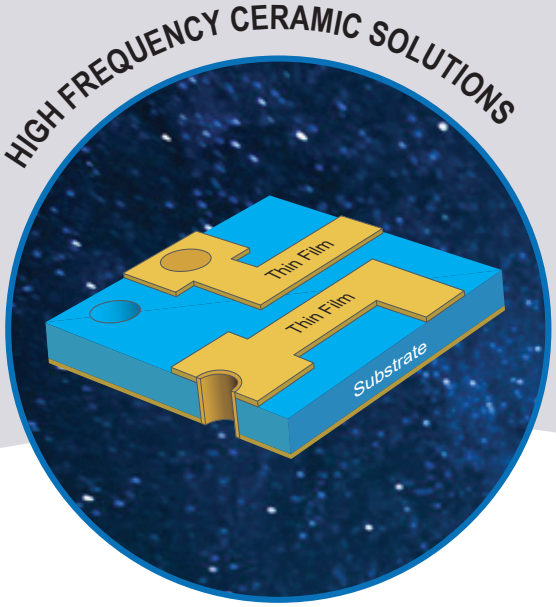
# Substrates - Thin Film Patterned

**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.




## 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.

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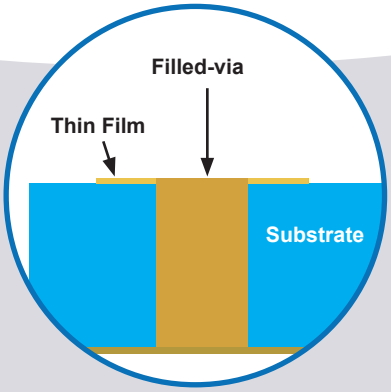
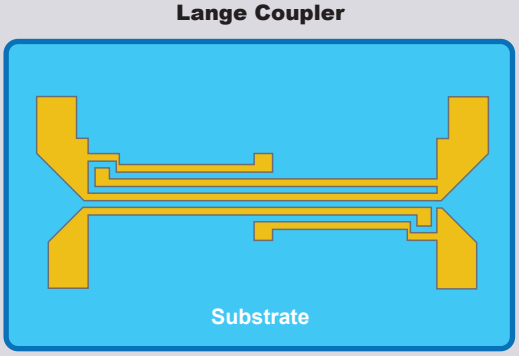
# Material Properties

## Table 1: Material Electrical and Mechanical Properties

| Substrate Material (Code) | Temperature Coefficient (-55 to +125°C) | Dielectric Constant | Tanθ 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 |
| **AIN (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 ± 30ppm/°C | 23 | ≤0.0015* | 205 | ~ 9 | 1.55 |
| **Titanate (K)** | 0 ± 30 ppm/°C | 39 | ≤0.0015* | 205 | ~ 9 | 1.55 |
| **Titanate (N)** | 0 ± 30 ppm/°C | 76 | ≤0.0015* | 210 | ~ 9 | 1.55 |
| **Titanate (V)** | -1500 + 500/-944 ppm/°C | 160 | ≤0.0025* | 220 | ~ 10 | 1.55 |
| **Titanate (R)** | -2200 ± 500ppm/°C | 440 | ≤0.0025* | 150 | N/A | N/A |
| **Titanate (D)** | ± 10 % | 725 | ≤0.025 | 175 | N/A | N/A |
| **Titanate (B)** | ± 10 % | 1410 | ≤0.025 | 190 | N/A | N/A |
| **Titanate (W)** | ± 10% | 2300 | ≤0.025 | 190 | N/A | N/A |
| **Titanate (W)** | ± 15% | 3150 | ≤0.025 | 190 | N/A | N/A |
| **Titanate (T)** | ± 15% | 4100 | ≤0.025 | 250 | N/A | N/A |




Side View



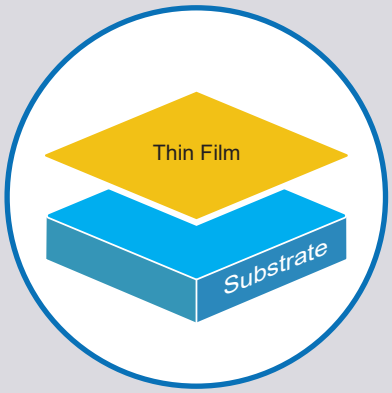

Top View

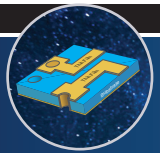
# Material Properties - continued

## 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 |
| AIN (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.





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# 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 |

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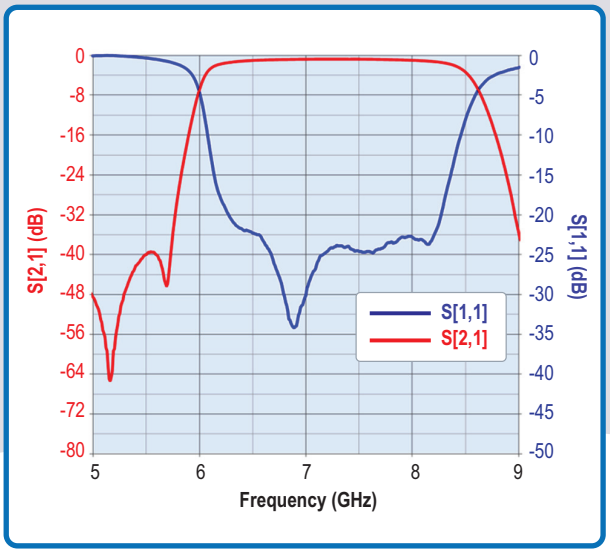
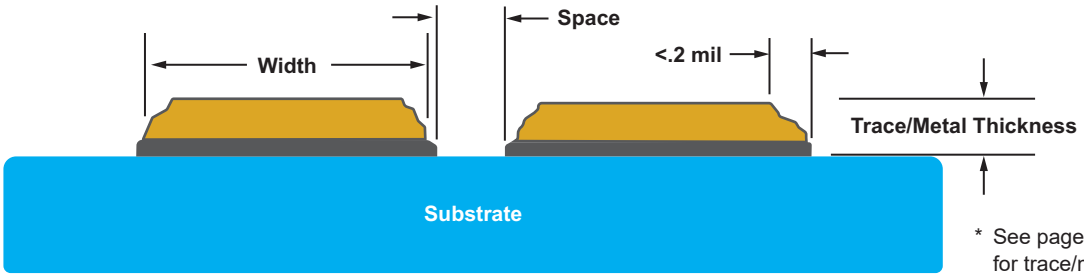
# Conductor Traces

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.




* See page 98 for trace/metal thickness

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

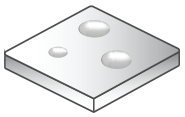
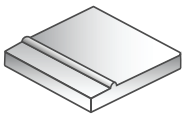
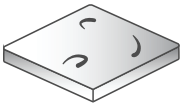
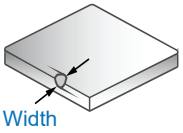
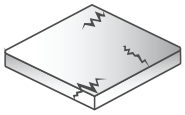
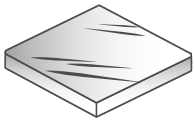
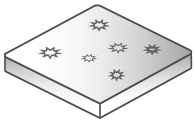
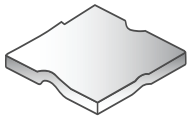
## Table 5: Standard Line Traces and Tolerances

| 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) | | |



# Inspection Methods & Our Quality Commitments

## Table 6: 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

JOHANSON TECHNOLOGY

www.johansontechnology.com

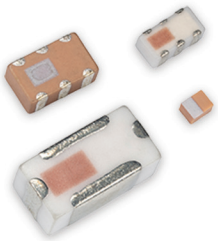
JOHANSON DIELECTRICS

www.johansondielectrics.com

# HIGH FREQUENCY

## CERAMIC SOLUTIONS

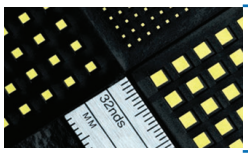
**Antennas**



**Integrated Passive Components:**

- Filters: Band Pass, Low Pass, & High Pass
- Baluns
- Couplers
- Power Couplers
- Diplexers & Triplexers
- Power Dividers

**High-Q Capacitors**

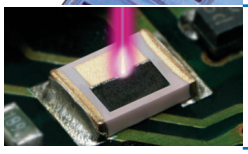


**Single Layer Capacitors**

**RF Assembles**

**Thin Film Substrates**

**RF Inductors: Ceramic and Wirewound**



**LaserTrim® Tuning Capacitors**

# POWER

## ELECTRONIC SOLUTIONS

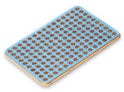
**High Voltage**

**EMI Filters**


**AC Safety**

**Swith Mode Capacitor**

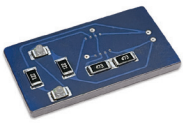
**Radial Leaded**



**Planar Arrays**

**Discoidals**

**AC Power**



**CapStrate® Capacitor Substrates**

**Variable Pitch Capacitors**

**High Temperature**

**High Capacitance**