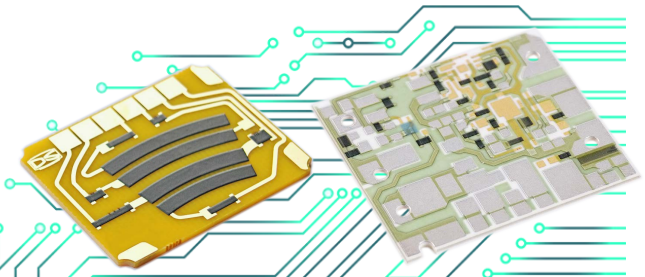
PANDA PCB

# EXCELLENCE IN THICK FILM TECHNOLOGY

## Thick Film Technology Product Introduction



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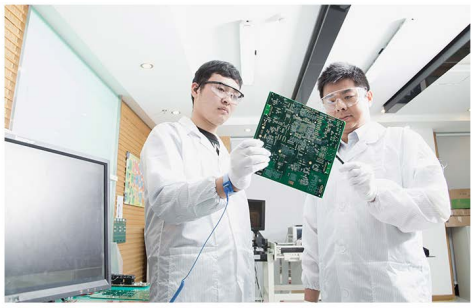
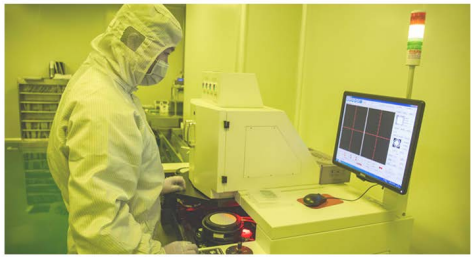
- ✿ Product Applications
- ✿ Design Guidelines



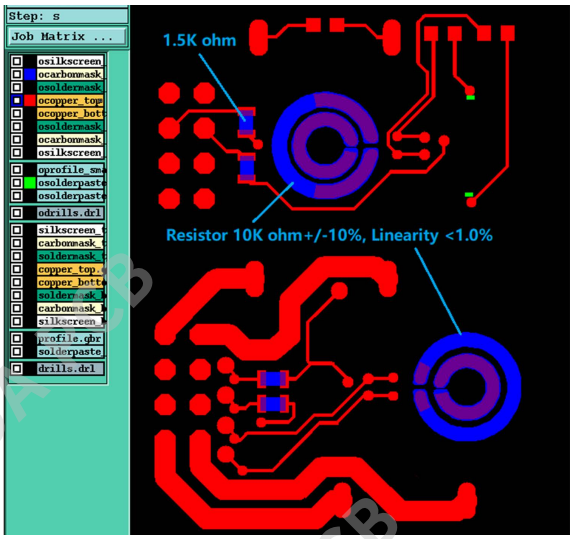


# ✿ Design Guidelines

## Design Guidelines :

Design guidelines for thick film technology focus on several key factors to ensure the reliability and performance of the circuits. First, the Engineering Specification provides the foundation for the entire design, ensuring the product's adaptability and functionality under specific application conditions. The Metallization Process is a crucial step in the manufacturing process, determining the quality and stability of the conductive layers, typically involving processes such as metal screen printing and sintering. The choice of substrate is critical, with flexible PI, FR4, ceramic or metal substrates commonly used.

Common paste used in thick film technology include conductive pastes, resistive pastes, dielectric pastes, and insulating pastes. Each paste formulation and its performance need to be carefully designed according to the circuit's functional requirements to ensure electrical performance, thermal stability, and long-term reliability. Overall, the design must consider thermal expansion matching, material compatibility, and manufacturing feasibility to ensure the performance, stability, and production efficiency of thick film circuits.




## 1, Engineering Specification

| Items: | Typical Values | Advanced Capabilities |
|---|---|---|
| 1, Substrates : | FR4, Ceramic ( Al203, ALN, BeO, ZrO2), Polyimide (Flexible PI), Stainless Steel (SUS304), Mica | FR4, Ceramic ( Al203, ALN, BeO, ZrO2), Polyimide (Flexible PI), Stainless Steel (SUS304), Mica |
| 2, Conductor (Paste) Materials : | Copper, Silver , Gold , Silver-Palladium, Palladium-Gold, Platinum-Silver, Platinum-Gold | Copper, Silver , Gold , Silver-Palladium, Palladium-Gold, Platinum-Silver, Platinum-Gold |
| 3, Thick Film Carbon Thickness : | 15um +/-5 um | 30um +/-5 um |
| 4, Conductors Thickness : | 12um+/-5um | 20um+/-5um |
| 5, Min Width of Thick Film Line : | 0.30 mm +/-0.05 mm | 0.20 mm +/-0.05 mm |
| 6, Min Space of Thick Film Line : | 0.30mm +/-0.05 mm | 0.20 mm +/-0.05 mm |
| 7, Min Overlap (Carbon to Conductor) : | No less than 0.25mm | 0.20mm (Minimum) |
| 8, Sheet Resistivity (ohms/square): | Printed resistors in milli ohm to mega ohm range (Customizable) with tolerances of 1-10% are fabricated and protected with overglaze materials. | Printed resistors in milli ohm to mega ohm range (Customizable) with tolerances of 0.5-10% are fabricated and protected with overglaze materials. |
| 9, Resistor Value Tolerance (ohms) : | +/-10.0% (Standard) (Customizable) | +/-0.5% (Laser trimming) |
| 10, Linearity : | +/-1.0% (Standard) (Customizable) | +/-0.2 ~ +/-0.5% (Laser trimming) |
| 11, Synchronism of Double Channels : | +/-2.0% (Standard) (Customizable) | +/-1.0% (Laser trimming) |
| 12, Durability of Carbon Ink (Life time) : | 0.5 Million (Min), 2.0 Million (Standard) | 5.0-10.0 Million (Max) with Surface Polishing |
| 13, Working Temperature : | - 40°C / + 150°C | - 40°C / + 180°C |

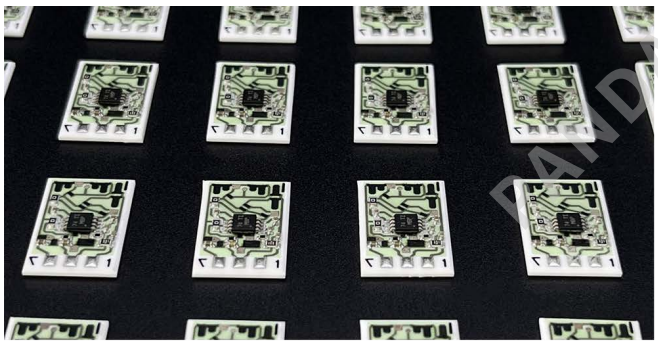
# 2, Optional Metallization Processes

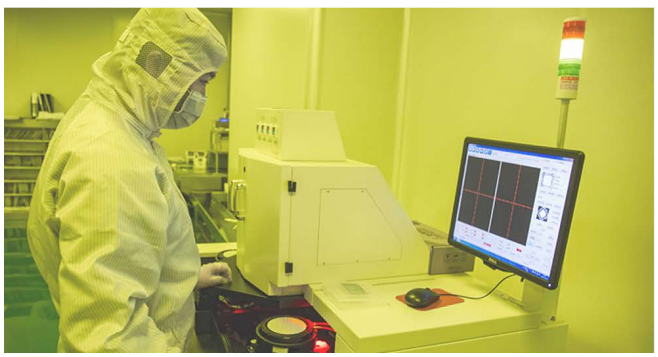
| Metalization Types : | Thick Film Substrates (Screen-Printed) | | Thin Film Substrates (Photo-Imaged) | | |
|---|---|---|---|---|---|
| Process Types : | TFM Capabilities | HTCC / LTCC Capabilities | DBC Capabilities | DPC Capabilities | AMB Capabilities |
| Layer Counts : | 1, 2, 3, 4 Layers | 1, 2 Layers | 1, 2 Layers | 1, 2 Layers | 1, 2 Layers |
| Max Board Dimension : | 200*230mm | 200*200mm | 138*178mm | 138*190mm | 114*114mm |
| Min Board Thickness : | 0.25mm | 0.25mm | 0.30mm~0.40mm | 0.25mm | 0.25mm |
| Max Board Thickness : | 2.2mm | 2.0mm | 2.0mm | 2.0mm | 1.8mm |
| Conductor Thickness : | 10um - 20um | 5um - 1500um | 1oz - 9oz | 1um - 1000um | 1oz- 22oz |
| Min Line Width/Space : | 8/8mil (0.20/0.20mm) | 6/6mil (0.15/0.15mm) | 10/10mil (0.25/0.25mm) | 6/6mil (0.15/0.15mm) | 12/12mil (0.30/0.30mm) |
| Substrates Types : | Al203, ALN, BeO, ZrO2 | Al203, ALN, BeO, ZrO2 | Al2O3, AlN, ZrO2, PbO, SiO2, ZTA, Si3N4, SiC, Sapphire, Polycrystalline Silicon, Piezoelectric | Al2O3, AlN, ZrO2, PbO, SiO2, ZTA, Si3N4, SiC, Sapphire, Polycrystalline Silicon, Piezoelectric | Al203, ALN, BeO, ZrO2, Si3N4 |
| Min Hole Diameter : | 4mil (0.15mm) | 4mil (0.15mm) | 4mil (0.1mm) | 4mil (0.1mm) | 4mil (0.1mm) |
| Outline Tolerance : | Laser: +/-0.05mm | Laser: +/-0.05mm | Laser: +/-0.05mm | Laser: +/-0.05mm | Laser: +/-0.05mm |
| | Die Punch: +/-0.10mm | Die Punch: +/-0.10mm | Die Punch: +/-0.10mm | Die Punch: +/-0.10mm | Die Punch: +/-0.10mm |
| Substrate Thickness : | 0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable | 0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable | 0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable | 0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable | 0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable |
| Thickness Tolerance : | 0.25-0.38: +/-0.03mm | 0.25-0.38: +/-0.03mm | 0.25-0.38: +/-0.03mm | 0.25-0.38: +/-0.03mm | 0.25-0.38: +/-0.03mm |
| | 0.50-2.00: +/-0.05mm | 0.50-2.00: +/-0.05mm | 0.50-2.00: +/-0.05mm | 0.50-2.00: +/-0.05mm | 0.50-2.00: +/-0.05mm |
| Surface Treatment : | Ag, Au, AgPd, AuPd | Ag, Au, AgPd, AuPd | OSP/Ni Plating, ENIG | OSP/ENIG/ENEPIG | OSP/ENIG/ENEPIG |
| Min Solder PAD Dia : | 10mil (0.25mm) | 10mil (0.25mm) | 8mil (0.20mm) | 6mil (0.15mm) | 8mil (0.20mm) |


# 3, Ceramic Substrates

| Substrates : | Alumina (Al2O3) | Aluminum Nitride (AlN) | Beryllium Oxide (BeO) | Zirconium Dioxide (ZrO2) |
|---|---|---|---|---|
| Max Application Temperature : | 662 - 1832 | 1832 | 2300 | 2432 |
| Max Power Density (W/in²): | 75 | 1010 | 250 | 300 |
| Max Ramp Up Speed (°F/sec): | 122 | 572 | 400 | 350 |
| Thermal Conductivity (W/mK): | 20-35 | 180-220 | 200-300 | 2.0-5.0 |
| Density (g/cm³): | 3.75 | 3.26 | 2.8 | 5.9 |
| Dielectric Loss: | 0.0001 - 0.001 | 0.0001 - 0.0005 | 0.0001 - 0.0002 | 0.0005 - 0.001 |
| Dielectric Constant: | 9.4 - 10.2 | 8.5 - 9.0 | 6.0 - 7.0 | 25 - 30 |
| CTE, ppm/°C: | 6.0 - 8.0 | 4.0 - 5.0 | 7.0 - 9.0 | 10.0 - 11.0 |
| Substrate Thickness (mm): | 0.25 - 2.0 | 0.25 - 2.0 | 0.25 - 2.0 | 0.25 - 2.0 |
| Typical Max. Dimension (inch): | 6 x 12 | 5 x 11 | 6 x 6 | 4 x 4 |
| Theoretical Total Wattage (W): | 5400 | 55000 | 15000 | 20000 |

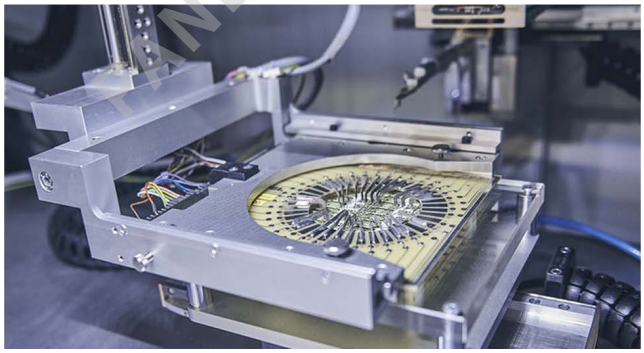






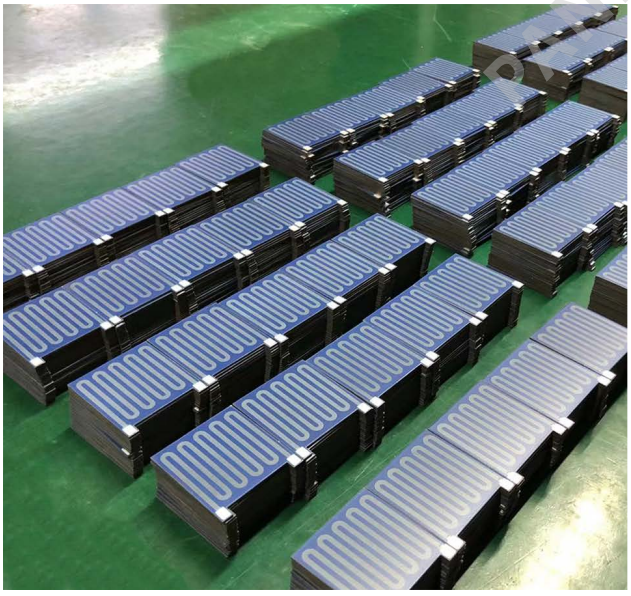
# 4, Conductive Paste

| Paste ( Materials) : | Conductor Width/Space | Soldering / Bonding |
|---|---|---|
| Gold : | 8/8mil (0.20/0.20mm) | Gold is a good conductor material and allows thermo-compression gold wire bonding and eutectic die attachment. It is, of course, costly and has poor solderability. |
| Silver : | 8/8mil (0.20/0.20mm) | Soldering & Silver is lower in cost, and solderable, but is not leach-resistant with tin/lead solders.More seriously, silver atoms migrate under the influence of DC electric fields, both causing short-circuits and reacting with many of the resistor paste formulations. |
| Platinum-Silver : | 6/6mil (0.15/0.15mm) | Soldering & Surface Mount, Palladium and platinum alloyed to the gold and silver produce good conductor pastes,with good adhesion to the substrate, good solderability, and moderately good wire bonding characteristics.. Copper and nickel are examples of materials that have been proposed for paste systems as substitutes for noble metals. |
| Palladium-Silver : | 8/8mil (0.20/0.20mm) | Soldering & Surface Mount ,Solderable, Wire bondable, (good aged adhesion general purpose), Silver-palladium conductor inks are the most commonly used materials, with both price and performance (primarily resistance to solder) increasing with palladium content. |
| Platinum-Gold : | 6/6mil (0.15/0.15mm) | Soldering & Au or Al Wire Bonding, Solderable (excellent aged adhesion with no migration). |
| Palladium-Gold : | 8/8mil (0.20/0.20mm) | Soldering & Au or Al Wire Bonding, Wire bondable. |



# 5, Resistive Paste

| Performances : | Common Values/Range | Description |
|---|---|---|
| Resistance Value : | 1Ω to several MΩ | The resistance value depends on the type and ratio of carbon black, typically ranging from 1Ω to Mega ohm. |
| Resistance Tolerance : | ±1% to ±10% | High-precision resistors can achieve ±0.1% tolerance used laser trimming process. |
| Temperature Coefficient (TCR) : | ±50ppm/°C to ±200ppm/°C | High-quality resistive paste should have a low TCR, preferably below ± 100ppm/°C. |
| Stability : | ≤1% | Resistors must undergo high-temperature aging and humidity tests to ensure stability. |
| Sintering Temperature : | 850°C to 950°C | The sintering temperature for carbon paste depends on material properties, typically in this range. |
| Conductivity : | $10^{4}$ S/m to $10^{8}$ S/m | Conductivity depends on the type and ratio of carbon black, affecting resistance precision and stability. |
| Surface Smoothness : | Ra≤ 1 μm | The surface must be free of cracks, bubbles, and non-uniform layers to ensure good mechanical and electrical properties. |
| Insulation Resistance : | ≥$10^{4}$ Ω | Carbon paste should have good insulation properties to avoid leakage or short circuits. |
| Mechanical Strength : | ≥100 MPa | The resistive layer must have good compressive and bending strength to ensure the reliability of the resistor. |
| Volatility : | Solvent residue ≤ 1% | High volatility solvents help with even coating and drying, but excessive volatility may affect electrical performance. |
| Oxidation Resistance : | >1000 hours | High-quality carbon paste should have strong oxidation resistance to extend the service life. |
| Humidity Resistance : | ≥1000 hours | Resistors should be able to withstand high-humidity conditions to ensure long-term stable performance, no significant changes. |



# 6, Dielectric Paste

| Performances : | Typical Value | Explanation |
|---|---|---|
| Material Types : | Epoxy Resin, Polyimide, Polyurethane, Polytetrafluoroethylene | These resin types are commonly used to manufacture dielectric materials, providing good electrical insulation, thermal stability, and mechanical strength. |
| Dielectric Constant (εr) : | 3 ~ 4.5 (Epoxy),<br>3.0 ~ 3.5 (PI),<br>2.1 ~ 2.5 (PTFE) | Epoxy and polyimide are typically used in low-to-medium frequency circuits, while PTFE is preferred for high-frequency applications due to its lower dielectric constant. |
| Insulation Resistance : | ≥ $10^{12}$ Ω•cm | Resin-based materials usually exhibit extremely high insulation resistance, effectively isolating electrical currents and preventing leakage. |
| Dielectric Loss : | ≤ 0.01 (Epoxy),<br>≤ 0.005 (PI),<br>≤ 0.0002 (PTFE) | Polyimide and PTFE have lower dielectric loss, making them ideal for high-frequency applications. |
| Operating Temperature : | -55 ~ +180°C (Epoxy),<br>-50 ~ +250°C (PI),<br>-200 ~ +260°C (PTFE) | The sintering temperature for carbon paste depends on material properties, typically in this range. |
| Sintering Temperature : | 150 ~ 200°C | Resin-based dielectric materials require lower sintering temperatures, making them more energy-efficient compared to ceramic materials. |
| CTE, ppm/°C : | 20 ~ 60 × $10^{-6}$ (Epoxy),<br>10 ~ 40 × $10^{-6}$ (PI),<br>100 ~ 200 × $10^{-6}$ (PTFE) | PTFE has a higher thermal expansion coefficient but offers excellent chemical stability and corrosion resistance. Epoxy and polyimide have lower coefficients, making them more thermally stable. |
| Volume Resistivity : | ≥ $10^{13}$ Ω•cm | Resin materials typically have very high volume resistivity, making them ideal for electrical isolation applications. |
| Surface Resistivity : | ≥ $10^{9}$ Ω•cm | Resin materials exhibit high surface resistivity, ensuring that surface leakage currents are minimized. |
| Thermal Conductivity : | 0.2 ~ 0.3W/m•K (Epoxy),<br>0.2 ~ 0.3W/m•K (PI),<br>0.1 ~ 0.3W/m•K (PTFE) | Resin materials have low thermal conductivity, requiring additional heat dissipation designs to ensure thermal stability. |
| Adhesion Strength : | ≥ 20 N/cm² | Epoxy resin has good adhesion strength, making it suitable for various substrates, such as metal and ceramics. |

## 7, Insulating Paste

| Material Types : | Glass Enamel (Overglaze) | Epoxy Resin | Organic Polymers (Polyurethane, Polystyrene) |
|---|---|---|---|
| Insulation Resistance : | ≥ $10^{12}$ Ω•cm | ≥ $10^{12}$ Ω•cm | ≥ $10^{12}$ Ω•cm |
| Dielectric Constant (εr) : | 5 ~ 7 | 3 ~ 4.5 | 2 ~ 3.5 |
| Dielectric Loss : | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Operating Temperature : | -40 ~ +450 °C | -55 ~ +180 °C | -40 ~ +150 °C |
| Sintering Temperature : | 600 ~ 800 °C | 150 ~ 200 °C | 120 ~ 180 °C |
| Thermal Conductivity : | 1.0 ~ 1.5 W/m•K | 0.2 ~ 0.3 W/m•K | 0.1 ~ 0.3 W/m•K |
| CTE, ppm/°C : | 30 ~ 50 × $10^{-6}$ /°C | 30 ~ 60 × $10^{-6}$ /°C | 50 ~ 150 × $10^{-6}$ /°C |
| Density : | 2.5 ~ 3.0 g/$cm^3$ | 1.1 ~ 1.4 g/$cm^3$ | 1.1 ~ 1.4 g/$cm^3$ |
| Adhesion Strength : | High (suitable for metal substrates) | High, good adhesion properties | Medium (depends on polymer type) |
| Chemical Stability : | Excellent, resistant to acids, alkalis, and solvents | Good, resistant to most chemicals, but sensitive to some solvents | Moderate, some polymers like PVC have strong chemical resistance |
| Arc Resistance : | Excellent | Good | Moderate |
| Mechanical Strength : | High (hard and brittle) | Medium, good flexibility | Low, but good flexibility |
| Characteristics : | High-temperature sintering, excellent electrical insulation, good thermal and chemical stability | Low-temperature sintering, good adhesion and flexibility, good chemical resistance | Good flexibility, suitable for flexible circuits, but poor high-temperature performance |