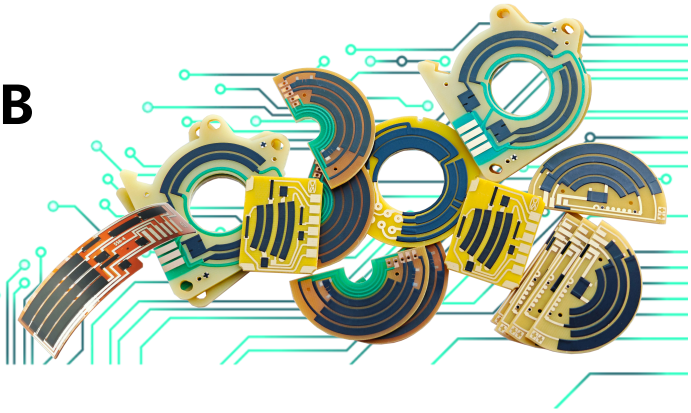
PANDA PCB

EXCELLENCE IN THICK FILM RESISTOR PCB

Thick Film Resistor PCB Product Introduction



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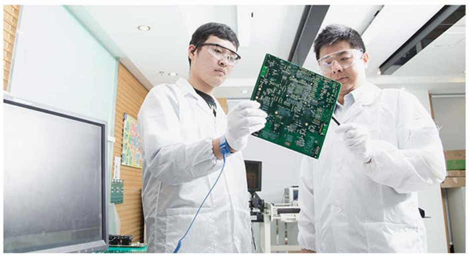
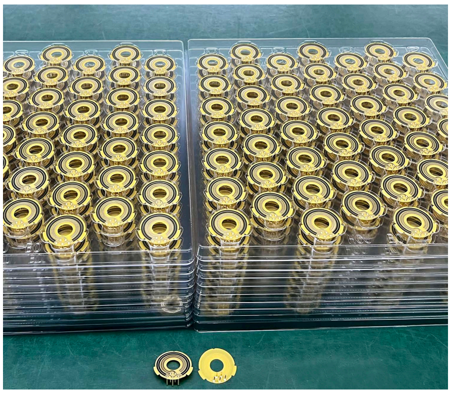


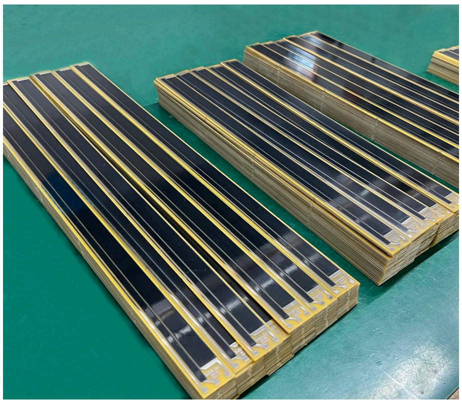
✿ Product Overview

What is Thick Film Resistor PCB ?



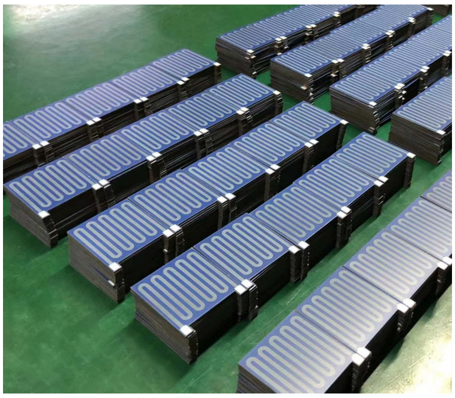
Thick Film Resistor PCB, also known as Thick Film PCB, is a compact, efficient, and unique type of printed circuit board that can highly integrate resistors, sensors, or heating elements into electronic circuits. It utilizes screen-printing techniques to deposit reliable resistive, conductive and insulating paste onto various substrates, then through manufacturing processes such as high-temperature curing, sintering, and laser trimming, which ultimately forming a thick film hybrid circuit onto the PCB.

Key Features :



- **Integration of Multiple Functions: Thick Film Resistor PCB can integrate resistors, sensors, and heating elements directly onto the PCB substrate, combining multiple electronic components into a single platform.**
- **Screen Printing Process: The resistive, conductive, and insulating pastes are deposited onto the PCB substrate using a screen-printing technique, enabling precise patterning and flexibility in design.**
- **Thick Film Hybrid Circuit: It utilizes high-temperature curing, sintering, and laser trimming processes to form a thick film hybrid circuit that includes both circuit traces and resistors.**
- **Specialized Electronic Substrate: This PCB integrates thick film resistors directly on the surface of the substrate, eliminating the need for separate resistor components.**
- **Resistor Pattern Creation: The resistive material is applied in specific areas to create the desired resistor patterns, offering customization and precision in resistance values.**

Key Advantages :



- **Compact and Efficient Design: By integrating resistors, sensors, and heating elements directly into the PCB, this technology helps reduce the overall size of the electronic system, making it more compact and efficient.**
- **Cost-Effective: Since resistors are integrated directly into the PCB, the need for additional resistor components is eliminated, reducing both manufacturing costs and assembly complexity.**
- **Customization: The screen printing and laser trimming processes allow for high precision in creating customized resistor values and patterns, making it adaptable for various applications.**
- **Reliability: The thick film hybrid circuit formed through high-temperature processes ensures durability and reliability, even under harsh operating conditions.**
- **Wide Application Range: This technology is widely used in automotive electronics, industrial control, medical devices, and household appliances, offering versatility in various industries.**
- **Improved Heat Dissipation: Thick film resistors can also serve as heating elements, benefiting applications requiring heat generation or management, such as in automotive and industrial settings.**

✿ Product Solutions

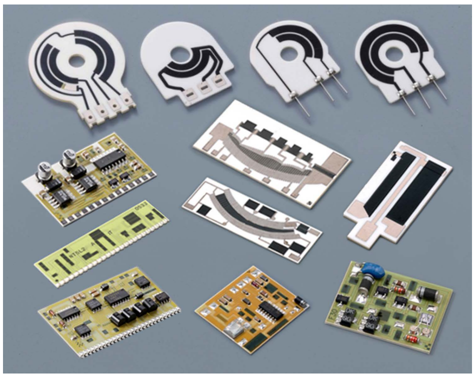
High-Performance Solutions :

Thick Film Resistor PCBs offer versatile and cost-effective solutions for various electronic applications, from precision circuits to harsh environmental systems, enabling compact, high-performance, and durable designs, Below are some of the key product solutions:

- **Flexible Thick Film PCB :** Flexible thick film PCBs use polyimide (PI) as the substrate material, making them suitable for electronic devices that need to be bent or folded, such as wearable devices and portable electronics. These PCBs can withstand high temperatures and mechanical stress, offering high reliability and flexibility.

- **Thick Film Sensors :** Thick Film Sensors are a type of sensor designed to measure a range of physical parameters, including temperature, pressure, humidity, and gas concentration, These sensors are fabricated using thick film technology, a process that entails depositing conductive, resistive, and insulating materials onto a substrate in the form of inks or pastes..

- **Thick Film Ceramic PCB :** Thick film ceramic PCBs are used in sensor applications, with ceramic substrates offering outstanding thermal conductivity and high-temperature resistance. These are commonly used in automotive, aerospace, and medical industries that require high precision and stability for sensor products.

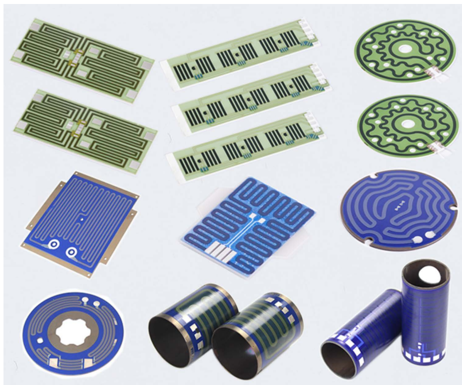


- **Thick Film Potentiometer PCB :** Thick film potentiometer PCBs use thick film materials to create potentiometers, which are used to adjust voltage or current. These potentiometers are widely used in audio devices, testing instruments, and industrial control systems, offering high-temperature resistance and long lifespan.

- **Thick Film Ceramic Resistors :** Thick film ceramic resistors use ceramic materials as substrates, with thick film technology applied to form high-precision resistors. These are used in power systems, communication equipment, automotive electronics, and other fields, providing excellent stability and anti-interference capabilities.

- **Thick Film Circuits :** Thick film circuits combine both thin-film and thick-film technologies, integrating multiple electronic components into a single package to provide higher functional density. These hybrid circuits are used in high-frequency, power-dense applications, such as aerospace electronics, medical devices, and military technology.

- **Thick Film Heaters :** Thick film heaters are manufactured using thick film technology to create heating components that provide uniform heat distribution in small volumes. These are widely used in heaters, electric warmers, and vehicle heating systems, offering long service life and stable heating performance.



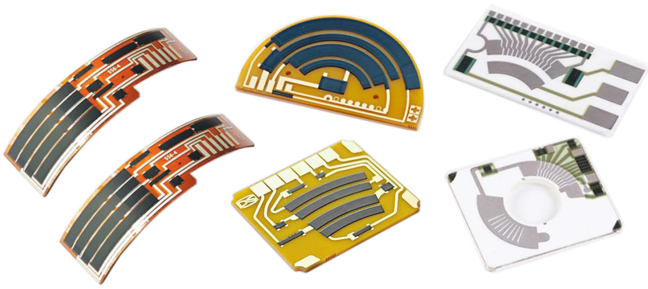
- **Thick Film Substrates :** Thick film substrates form the base for fabricating electronic components, typically made of ceramic or metal materials. Thick film technology is used to print various conductive, insulating, and resistive materials on the surface of these substrates. These are widely used in high-frequency, high-power electronic components.

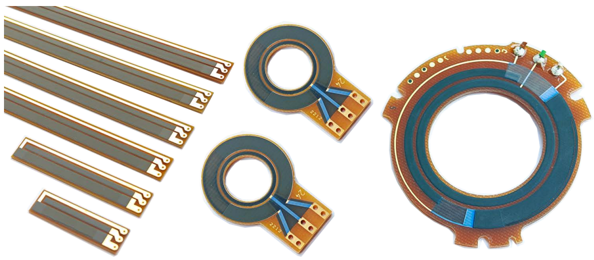
- **Hybrid Integrated Circuits:** Hybrid integrated circuits combine different materials and processes, using thick film technology to integrate multiple components into a single package, offering high performance and multi-functionality. These are commonly applied in communications, consumer electronics, and medical devices.

✿ Product Applications

Automotive Industry :

- Fuel Level Sensor PCB (Fuel Level Sender PCB)
- Tank Fuel Level Sensor PCB
- Liquid Level Sensor PCB
- LP Gas Liquid Level Gauges
- Oil Level Sensor PCB
- Motorcycle Fuel Level Sender PCB
- Throttle Position Sensor PCB
- Pedal Position Sensor PCB
- Engine Oil Pressure Sensor PCB



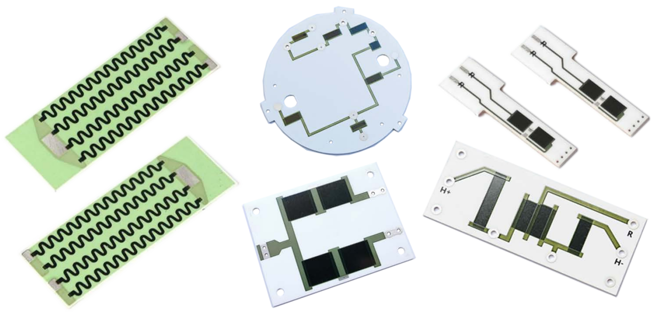


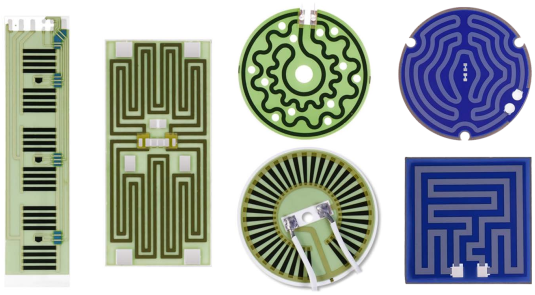
Industrial Control Systems :

- Potentiometer PCB
- Flexible Potentiometer PCB
- Linear Potentiometer PCB
- Rotary Potentiometer PCB
- Position Sensor PCB
- Flexible Position Sensor PCB
- Linear Position Sensor PCB
- Rotary Position Sensor PCB

Ceramic Resistors :

- High Voltage Ceramic Resistors
- High Value Ceramic Resistors
- Ceramic Humidity Sensitive Resistors
- Non-Inductive Thick Film Resistors
- Radio Frequency Power Resistors
- High Energy Thick Film Resistors
- High Power Thick Film Resistors
- Thick Film Resistor Networks
- Tubular Thick Film Resistors
- Ceramic Variable Resistors



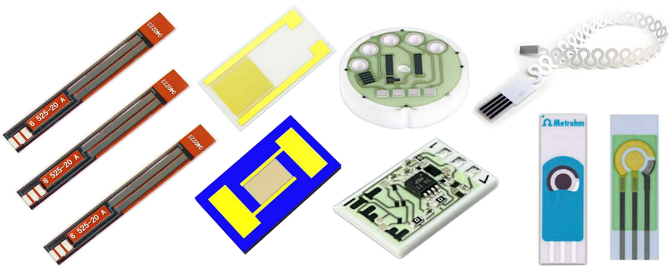


Heating Elements :

- Ceramic Thick Film Heaters
- Stainless Steel-Thick Film Heaters
- Flexible Heaters
- PI Heaters
- PET Heaters
- Mica Heaters
- Vacuum Packer- Thick Film Heaters
- E-Cigarettes Heaters
- Laser Printer-Thick Film Heaters

Electronic Sensors :

- Interdigital Electrodes
- Printed Flexible Electronic PCB
- Flexible Sensor PCB
- Ceramic Pressure Sensors
- Piezoelectric Ceramic Pressure Sensors
- Screen Printed Electrodes (Electrochemical Sensors)

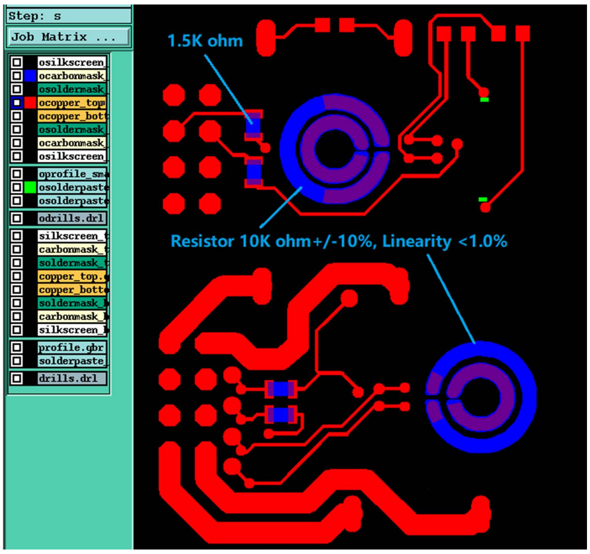


✿ Design Guidelines

Design Guidelines :

Thick Film Resistor PCB design involves various aspects, from electrical performance to manufacturing details that require careful planning. First, engineering design specifications are crucial for the stability and reliability of the circuit. During the design process, factors such as minimum trace width, spacing, the minimum footprint of the carbon film resistor, sheet resistivity, and resistor value tolerance must be considered.

Material selection plays a decisive role in the manufacturing and performance of thick film resistors. Common substrates include PI (polyimide), ceramics (e.g., Al2O3), and FR4, with ceramics being widely used due to their excellent thermal management and electrical isolation properties. The choice of conductive paste, resistor paste, dielectric paste, and insulating paste directly impacts the temperature stability, long-term drift characteristics, and mechanical stress resistance of the resistor. The design must not only consider the electrical and thermal properties of the materials but also assess their compatibility and the manufacturability of the process to ensure the production of high-quality thick film resistors with long-term stability and efficiency.



1, Engineering Specification

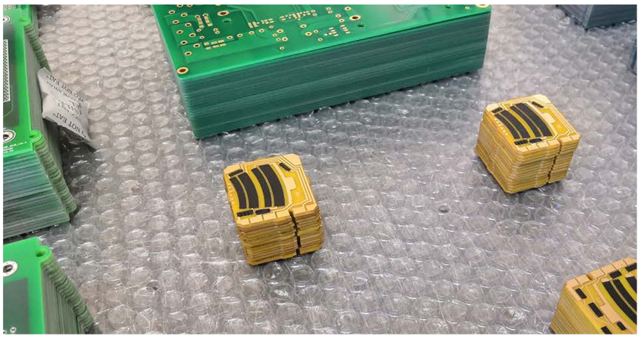
Items:	Typical Values	Advanced Capabilities
1, Substrates :	FR4, Ceramic (Al203, ALN, BeO, ZrO2), Polyimide (Flexible PI), Stainless Steel (SUS304), Mica	FR4, Ceramic (Al203, ALN, BeO, ZrO2), Polyimide (Flexible PI), Stainless Steel (SUS304), Mica
2, Conductor (Paste) Materials :	Copper, Silver , Gold , 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

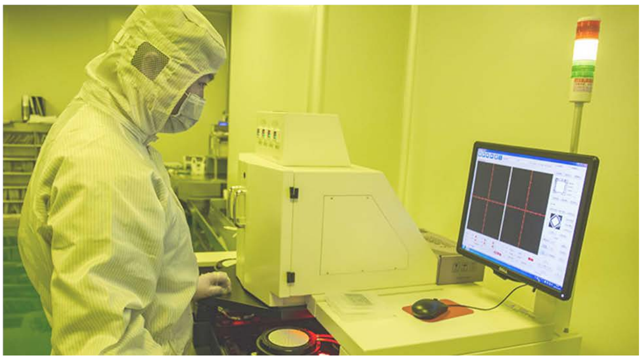
2, Optional Metallization Processes

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 (Al_2O_3)	Aluminum Nitride (AlN)	Beryllium Oxide (BeO)	Zirconium Dioxide (ZrO_2)
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 :	10^6 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 :	≥10^9 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), 3.0 ~ 3.5 (PI), 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), ≤ 0.005 (PI), ≤ 0.0002 (PTFE)	Polyimide and PTFE have lower dielectric loss, making them ideal for high-frequency applications.
Operating Temperature :	-55 ~ +180°C (Epoxy), -50 ~ +250°C (PI), -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), 10 ~ 40 × 10^{-6} (PI), 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), 0.2 ~ 0.3W/m•K (PI), 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/cm³	1.1 ~ 1.4 g/cm³	1.1 ~ 1.4 g/cm³
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