

## Design Rules

### Plated Copper on Thick Film Technology

These general parameters and specifications are intended to help manufacturing engineers and designers to create a circuit layout by utilizing the most effective metalization solutions while designing products with REMTEC's PCTF<sup>®</sup> technology in mind.

PCTF<sup>®</sup> Technology is based on plating copper on Thick Films on a ceramic substrate, in single or multiple up image arrays. Copper is plated to the required thickness and configuration. Basic rules developed for design and manufacturing with air fireable thick film hybrids are applicable with some additions and modifications as described in REMTEC's Design Guidelines.

### *Design Specifications Outline*

<b>Base Material</b>	<b>Alumina, Beryllia or Aluminum Nitride</b>
<b>Line Resolution (Signal)</b>	<b>0.004" / 0,1mm Lines and Spaces*</b>
<b>Line Resolution (Power)</b>	<b>0.008" / 0,2 mm Lines and Spaces*</b>
<b>Conductor Thickness</b>	<b>Available from 0.001"- 0.010" 0,0254 – 0,254 mm</b>
<b>Conductor Resistance</b>	<b>From 0.6 to 0.07 milliohms/square</b>
<b>Temperature Range</b>	<b>- 55°C to +200°C</b>
<b>Solderability</b>	<b>Complete wetting with Sn62 @ 230°C</b>
<b>Leach Resistance</b>	<b>No solder leaching or line reduction after 10, ten second dips in Sn62 @ 230°C</b>
<b>Moisture Resistance</b>	<b>No failures after 1,000 hours @ 85°C, 85% RH and 50 VDC</b>
<b>Wire Bondability</b>	<b>Excellent for Au and Al</b>

\* Note: For better line/spacing resolution, please contact the factory.

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**Designing with PCTF: Application Notes**

**Plated Copper Line Resistance**

Line Thickness	Resistivity
.001" / 0,0254 mm	0.65 mohms/sq
.002" / 0,0508 mm	0.35 mohms/sq
.003" / 0,0762 mm	0.26 mohms/sq
.005" / 0,1270 mm	0.14 mohms/sq
.007" / 0,1778 mm	0.10 mohms/sq
.010" / 0,2540 mm	0.06 mohms/sq

**Printed Thru Hole (PTH) & Copper Plated Thru Hole (CPTH) Resistance**

Ceramic thickness	Through Hole Diameter	PTH Resistance mohms	CPTH Resistance mohms
0.015" 0,381 mm	.008" 0,2 mm	2.5	0.40
.0.025" 0,635 mm	.010" 0,254 mm	4.0	0.52
0.040" 1,016 mm	0.012" 0,304 mm	8.0	0.70

**PowerPlugs: Copper Plated Plugged Via holes in Ceramic**

**Resistance**

Ceramic thickness	Plugged Via Size	Resistance-mohms (PCTF)	Resistance (mohms) Au
0.010" 0,254 mm	.005" 0,127 mm	0.5	1.5
0.015" 0,381 mm	.008" 0,2 mm	0.42	1.3
.0.020" 0,508 mm	.010" 0,254 mm	0.38	1.14
0.025" 0,635 mm	.010" 0,254 mm	0.47	1.4

### Thermal Conductivity

Via Plug Material	Thermal Conductivity, W/°CxM
PCTF	200
Au	65

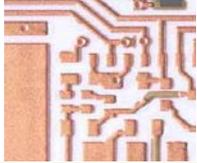
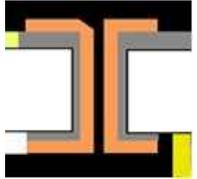
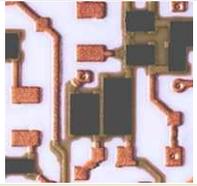
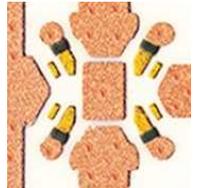
### Printed Resistors

Plated Cu and Printed Resistors: Wide range 50 mohms to 10 Mohms, ratio matched, power = 100 W, small geometry (.010" x .010").

- Standard air fireable thick film resistors, from 50 mohms up to 1 Mohms per square.
- Minimum resistor size .010"x .010" with .003" minimum overlap.
- Power rating: consult factory for rating and required geometry.
- Tolerances: +/- 1% typical.
- Matching: +/- 0.5% typical.
- TCR: 50- 200 ppm/°C typical.

## PCTF<sup>®</sup> Technology: Features and their Benefits

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<b>Features</b>	<b>Snap Shot</b>	<b>Benefits</b>
Thick Copper Tracks (.001" - .010")		<ul style="list-style-type: none"> <li>• Provide high current carrying capacity (to 50 Amps)</li> <li>• Low Conductor Resistance (0.6 to 0.07 mohm/square)</li> <li>• Heat Spreading Effect</li> </ul>
Plated Through Holes		<ul style="list-style-type: none"> <li>• Provide front-to-back high conductance connections</li> <li>• Low loss RF signal and ground interconnections</li> <li>• Minimize common to ground inductance</li> </ul>
Plugged Vias (PowerPlug)		<ul style="list-style-type: none"> <li>• PowerPlug vias are fully hermetic and withstand gross and fine leak test</li> <li>• Plugged via holes provide excellent electrical interconnections (signal and ground)</li> <li>• Combined with PCTF<sup>®</sup> serve as thermal heat pipes while ensuring low thermal resistance from top to bottom</li> </ul>
Printed Thick film Resistors		<ul style="list-style-type: none"> <li>• Ensure higher circuit density and higher resistor power rating</li> </ul>
Wraparound / Castellations for SMT Attach		<ul style="list-style-type: none"> <li>• Castellations enable large chip carrier (&gt;1x1cm) for direct PCB attachment, high conductance, low inductance, highly reliable connections</li> </ul>
Stand Off/Bump for SMT Attach		<ul style="list-style-type: none"> <li>• Solder bumps - SMT / Direct PCB attachment</li> </ul>
Thick film gold and plated copper pads with plugged vias		<ul style="list-style-type: none"> <li>• Allows a higher power and circuit density</li> <li>• Ensures capability for Au and Al wire bonding, brazing &amp; soldering</li> <li>• Excellent Solderability - Zero Solder Leaching and ability to withstand multiple soldering</li> <li>• Fine Line Resolution (0.004" Lines and Spacing)</li> </ul>

## Designing with PCTF<sup>®</sup> Technology

### Printed Resistors

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- Matching: +/- 0.5% typical.
- TCR: 50- 200 ppm/°C typical.

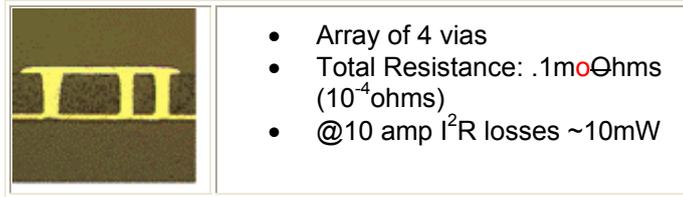
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### Cross-sectional View of Plugged Silver & Gold Vias



## POWERPLUGS: Copper Plated Plugged Via Holes in Ceramic

### High Electrical Conductance

Ceramic thickness	Plugged Via Size	Resistance-mohms (PCTF)	Resistance (mohms) gold filled
0.010" 0,254 mm	.005" 0,127 mm	0.50	1.5
0.015" 0,381 mm	.008" 0,2 mm	0.42	1.3
.0.020" 0,508 mm	.010" 0,254 mm	0.38	1.14
0.025" 0,635 mm	.010" 0,254 mm	0.47	1.4

### High Thermal Conductance

Via Plug Material	Thermal Conductivity <sub>T</sub>
Plated Copper (PCTF)	200 W/°C×M
Au	65 W/°C×M

PowerPlugs create an effective heat transfer path with a low thermal resistance

Example: A single die of 3mm x 3mm (.120"x.120") dissipating 5 W has 20 plugged vias underneath the chip.

Typical .008"-.012" plugged via in .015" - .020" thick alumina ceramic will create a thermal path with a thermal resistance of ~ 35-40°C/W per via.

An approximate thermal resistance will be about 2°C/W and the temperature rise should not exceed more than: ΔT=10°C max

### Via Hermeticity

Remtec's plugged via holes are normally used for input/output connections in metalized ceramic substrates, leadless chip carriers and hermetic packages without metal enclosure (Integral Substrate Package)

- Usually vias are hermetic and meet gross leak test requirements common for commercial and industrial applications.
- For more demanding applications, plugged via holes can be fabricated to meet full MIL STD hermeticity requirements for a fine leak test to 10<sup>-8</sup> std cc/sec.