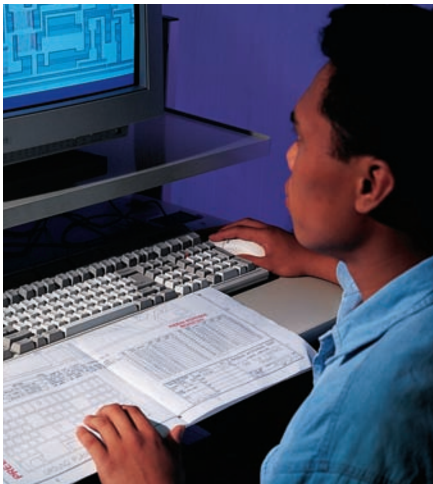
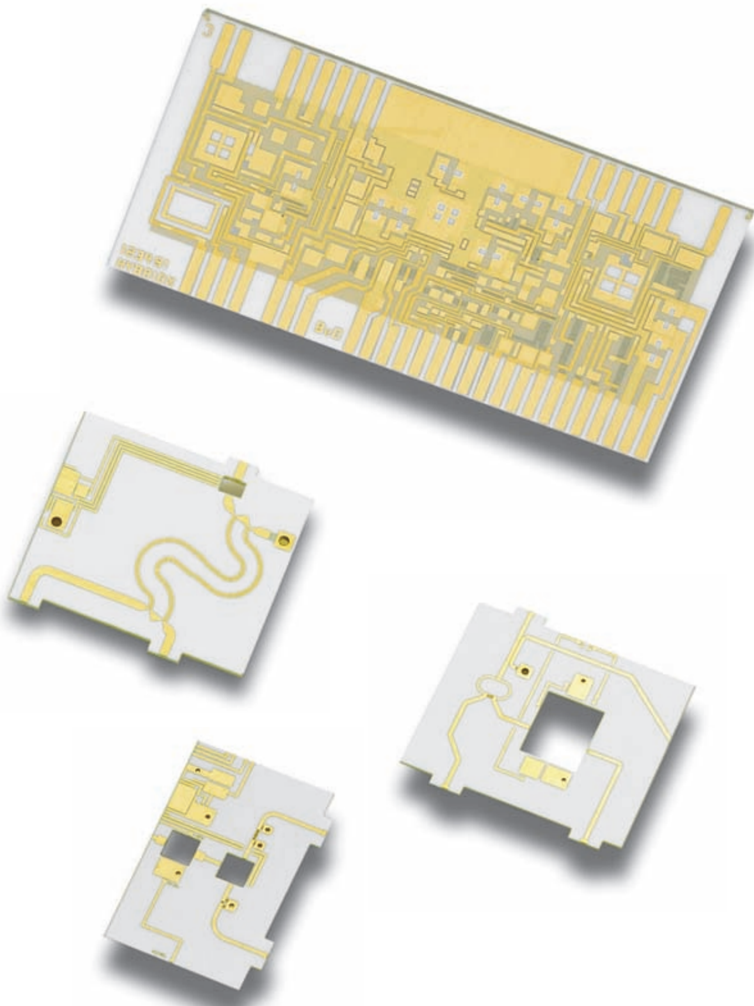
ATC Custom Thin Film Products





ISO 9001
REGISTERED
COMPANY

American Technical Ceramics

ATC Advanced Technology Center - Jacksonville, Florida

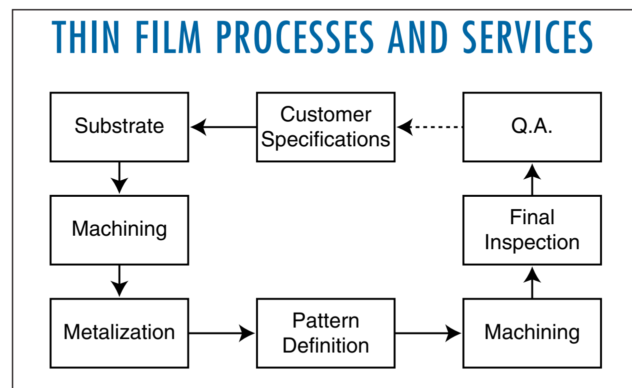
ABOUT ATC CUSTOM THIN FILM PRODUCTS

ATC brings a new standard of responsiveness and quality to thin film technology products and services. Custom metalization and patterned substrates are offered to address a broad spectrum of deposition and hybrid circuit fabrication requirements.

Custom metalization consists of sputtered and electroplated coatings made to specifications. Products may include via holes and odd shaped substrates in a wide choice of ceramics and dielectric materials. Three-target, batch sputtering systems with load-locks are utilized for producing the most consistent film quality.

Etched or pattern-plated substrates are made to specifications. Designs may include metalized, via holes, crossovers and air bridges.

ATC's experienced engineering staff is available to provide assistance in choosing the proper substrates and metalization systems at the inception of a project. They will also assist in troubleshooting a customer's process if difficulties are encountered.



The traditional ATC Quality Assurance Program is now certified to ISO 9001 and will meet most existing military and aerospace requirements. MIL-STD-883 is used as a guide for 100% visual inspection in our in-process procedures. MIL-STD-105D Level II sampling is used for final QA Inspection.

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SPUTTERED AND ELECTROPLATED COATINGS

MATERIALS COATED
Alumina
Beryllia
Dielectrics
Ferrites
Quartz
Sapphire
Other

BARRIER LAYERS
Titanium/Tungsten (TiW)
Nickel (Ni)

ADHESION LAYERS
Chromium (Cr)
Titanium (Ti)
Titanium/Tungsten (TiW)
Nickel/Chromium (NiCr)

CONDUCTIVE LAYERS
Copper (Cu)
Gold (Au)

RESISTIVE LAYERS
Tantalum Nitride (TaN)
Nickel/Chromium (NiCr)

PATTERNED SUBSTRATES
Pattern Plating
Wet Chemical Etch-Back

SUBSTRATE MACHINING
Laser
Precision Diamond Saw
Ultrasonic

TYPICAL HYBRID CIRCUIT FEATURES

Conductors: Lines and spaces width ≥ .0005 inches
Resistors: Tolerances ≥ 0.1%
Via Holes: Conventional or Enhanced Vias
Air Bridges: Over Lange Coupler - To eliminate need for wire bonding
Crossovers: With Polyimide over conductor lines
Wraparounds: Edge patterning
Solder Dam: Polyimide and others

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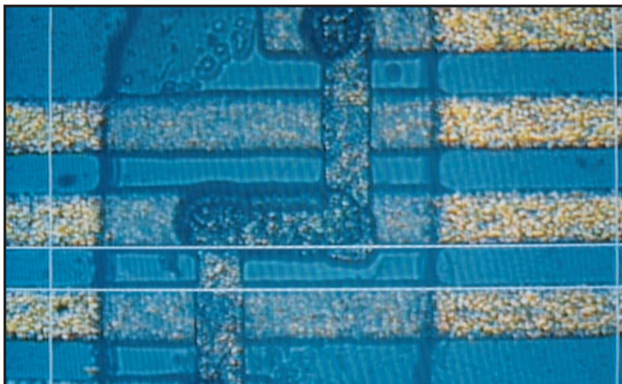
TYPICAL HYBRID CIRCUIT APPLICATIONS

CIRCUIT TYPE	APPLICATION	SUBSTRATE
Conductor	High Density Interconnection Laser Diode Mount Power Supply	Alumina Beryllia
Resistor	D/A-A/D Converter Power Supply Resistor Network	Alumina Beryllia
Microwave	Attenuator Filter Amplifier Power Divider Capacitor Antenna	Alumina Beryllia Ferrite Quartz Other Dielectrics

GLOSSARY OF COMMONLY USED TERMS

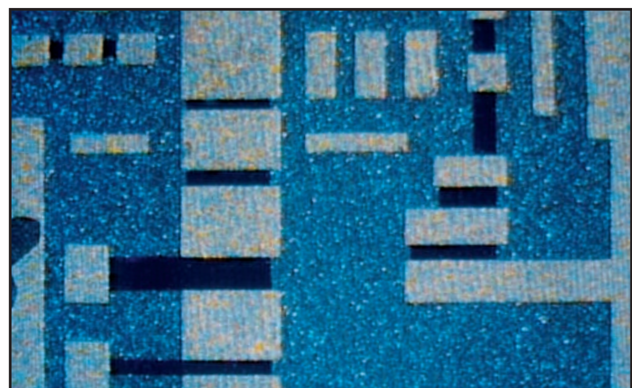
ACTIVE CIRCUIT AREA
Functioning circuit area, including conductors, resistors and other metalized elements.

AIR BRIDGE
Conductor path suspended in air over other conductor paths.



Air Bridge

BLOCK RESISTOR
A solid rectangular Thin Film resistor. Can be oversized to permit trimming to value.



Block Resistor

BRIDGING
Inadvertent connection between designed metalization paths.

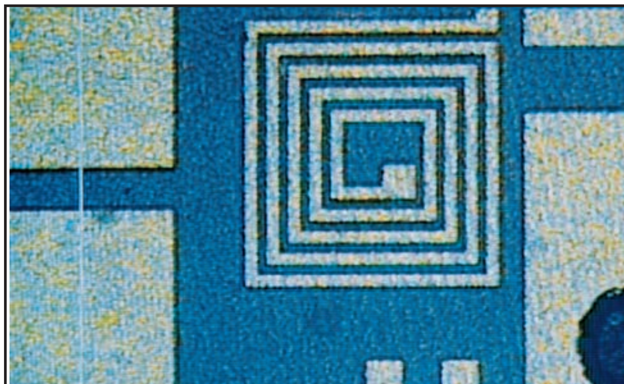
CORROSION
Chemical reduction of metal.

CROSSOVER
Insulated metalization path crossing over other metalized surfaces.

FOREIGN MATTER
Displaced or unintended attached material.

KERF
Open area produced by laser trimming or dicing.

METALIZATION SCHEME
Metalization layers used for producing desired circuit performance.



Inductor

PASSIVE ELEMENTS
Stripline conductors, capacitors, inductors and resistors.

PROTRUSION
Elevated defect.

SELF PASSIVATING RESISTOR
Resistor with thermally grown passivation layer.

SCRATCH
Surface tear of resistor or conductor metalization layer without exposing underlying material.

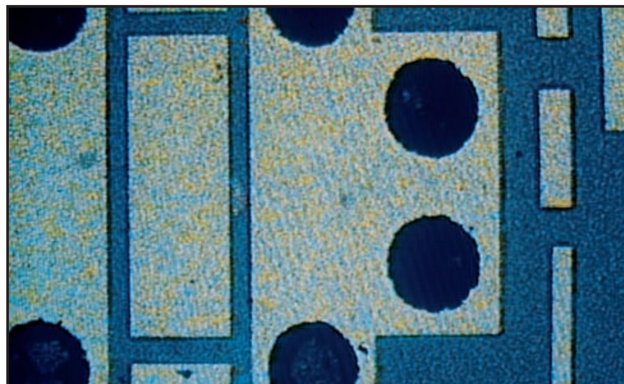
SUBSTRATES
Functional and/or structural base for metalized circuit.

TERMINAL
Metalized area provided for connection to circuit elements.

THICK FILM
Conductive, resistive or dielectric material, screen printed and fused by firing onto the substrate.

THIN FILM
Conductive, resistive or dielectric material, deposited by sputtering or vacuum evaporation.

VIA
A hole in the substrate that facilitates a vertical connection between top and bottom surfaces.



Via

VOID
Openings in metalization or resistive layer exposing the base substrate surface.

WRAPAROUND
Conductor path that extends around the edge of the substrate.

DESIGN CONSIDERATIONS

The engineer must consider attachment methods plus conductor, resistor, dielectric and dimensional requirements when designing a film system.

ATC FACTORY ENGINEERING SUPPORT

Direct consultation from experienced thin film technology experts is available as required. This is the same high level of support that ATC customers traditionally receive.

TYPICAL METALIZATIONS

TYPICAL METALIZATIONS	APPLICATION	ATTACHMENT METHOD	METALIZATION/ RESISTOR LAYERS	TYPICAL VALUE
1. TaN –TiW – Au	RF/Microwave circuits: attenuators, loads and DC biasing networks. Hybrids with resistors and spiral inductors. End products: Power supplies, couplers, splitters, filters, amplifiers, SAW devices, laser diode mounts and others.	Pb/In, Au/Si, Au/Ge – Eutectic Epoxy Wire Bonding	TaN 25 to 100 ohms/sq. TiW 300 to 500 Å Au 20 to 300 µ"	50 300 150
2. TiW – Au	Same as 1. – without resistors		TiW 300 to 500 Å Au 20 to 300 µ"	300 150
3. TaN –TiW – Au – Ni – Au	Same as 1. – When repeated soldering is required for repairs	Pb/Sn, Au/Sn soldering Pb/Sn Eutectic Epoxy Wire Bonding	TaN 25 to 100 ohms/sq. TiW 300 to 500 Å Au 20 to 300 µ" Ni 35 to 75 µ" Au 20 to 100 µ"	50 300 20 min. 35 min. 150
4. TiW – Cu – Ni* – Au	High Power/Low Loss RF and Power Supply	Pb/Sn, Au/Sn soldering Epoxy Wire Bonding	TiW 300 to 500 Å Cu 50 to 2000 µ" Ni 35 to 75 µ" Au 20 to 100 µ"	300 500 35 min. 40 min.
5. TiW – Au – Cu – Ni* – Au	High Power/Low Loss RF and Power Supply	Pb/Sn, Au/Sn soldering Epoxy Wire Bonding	TiW 300 to 500 Å Au 3000 to 5000 Å Cu 50 to 2000 µ" Ni 35 to 75 µ" Au 20 to 100 µ"	300 3000 min. 500 35 min. 40 min.
6. TaN – TiW – Au Cu – Ni* – Au	High Power/Low Loss RF and Power Supply with Resistors	Pb/Sn soldering Epoxy Wire Bonding	TaN 25 to 100 ohms/sq. TiW 300 to 500 Å Au 3000 to 5000 Å Cu 50 to 2000 µ" Ni 35 to 75 µ" Au 20 to 100 µ"	50 300 3000 min. 500 35 min. 40 min.

* Optional

Other metalizations available upon request.

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TYPICAL SUBSTRATE PROPERTIES

TYPICAL SUBSTRATE PROPERTIES	ALUMINA 99.5%	FUSED QUARTZ	BERYLLIA 99.5%	ALUMINUM NITRIDE
Dielectric Constant – ε_r @ 10 GHz	9.8	3.78	6.6	8.7
Loss Tangent @ 10 GHz	0.0002	0.0001	0.0003	0.001
Coefficient of Thermal Expansion (PPM/°C)	6.7	0.5	7.5	4.5
Thermal Conductivity (Cal/Cm – Sec – °C)	0.088	0.0033	0.6	0.4
Volume Resistivity (ohm – cm)	10^{14}	10^{14}	10^{14}	10^{13}
Dielectric Strength (KV/MM)	7.9	100	14	>10

NiCr vs. TaN THIN FILM RESISTORS

THIN FILM RESISTORS	TaN	NiCr
Process	High process temperature (no diffusion) Resistance to harsh environment	Low TCR
Typical Sheet Resistance (ohms/sq.)	25 – 100	25 to 200
TCR (ppm/°C -25 to 125°C)	-50 to -100	0 to 50
Stability (Change after 1000 hours @ 125°C)	0.02%	0.02%
Recommended Stabilization Treatment	1/2 hr. @ 400°C	1 hr. @ 325°C
Recommended Device Environment	Air or Inert (Ar)	Inert (Ar) or with Passivation Layer
Max. Device Processing Temperature	Up to 1/2 hr. @ 350°C	Up to 1/2 hr. @ 250°C

COMMON ETCHANTS

LAYERS	CHEMICAL ETCHANTS	TEMP.
Au	4g – Potassium Iodide + 1g – Iodine + 14ml – DI Water	50 ±5°C
Cr	5g – Ceric Ammonium Nitrate + 4ml – Nitric Acid (70%) + 50ml – DI Water	25 ±5°C
Cu	5ml – Nitric Acid (70%) + 5ml – DI Water	25 ±3°C
Ni	25ml – Nitric Acid (70%) + 15g – Ammonium Persulfate + 100ml – DI Water	25 ±3°C
NiCr	10g – Ceric Ammonium Nitrate + 10ml – Nitric Acid (70%) + 100ml DI Water	25 ±3°C
Pd	3g – Potassium Dichromate + 260ml – Phosphoric Acid (85%) + 20ml Hydro-chloric Acid (37%) + 120ml – DI Water	25 ±3°C
TaN	50ml – Nitric Acid (70%) + 100ml – Hydrofluoric Acid (49%) + 50ml DI Water	25 ±3°C
TiW	Hydrogen Peroxide (30%)	40 ±5°C

Caution: Chemicals should only be handled by trained personnel. Wear hand and eye protection in a properly ventilated area. Consult the factory for detailed mixing and etching procedures.

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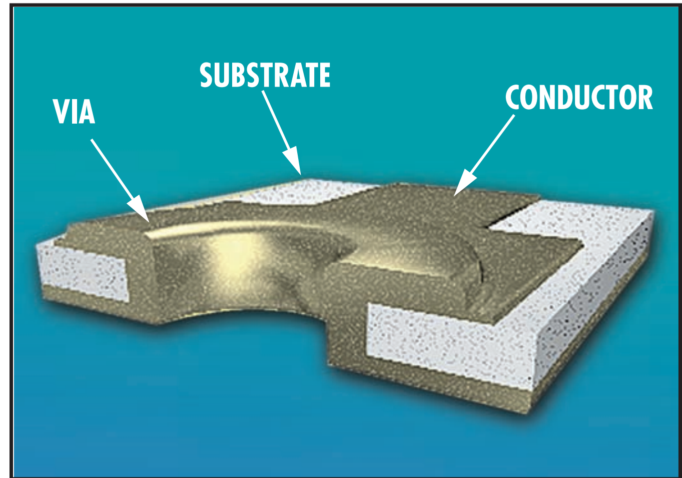
PROPERTIES OF ***ENHANCED VIAS***™

IMPROVED PERFORMANCE:
- Low resistance connection due to increased metalization thickness through via

IMPROVED RELIABILITY:
- Connection is independent of adhesion to via's walls and therefore blisters (up to 50% of via's circumference) are admissible without affecting performance / reliability
- Metal overlaps to top conductor pad
- Through hole can be inspected after mounting to carrier

LOW COST: ONLY 20% (AVERAGE) INCREASE TO STANDARD VIA COST

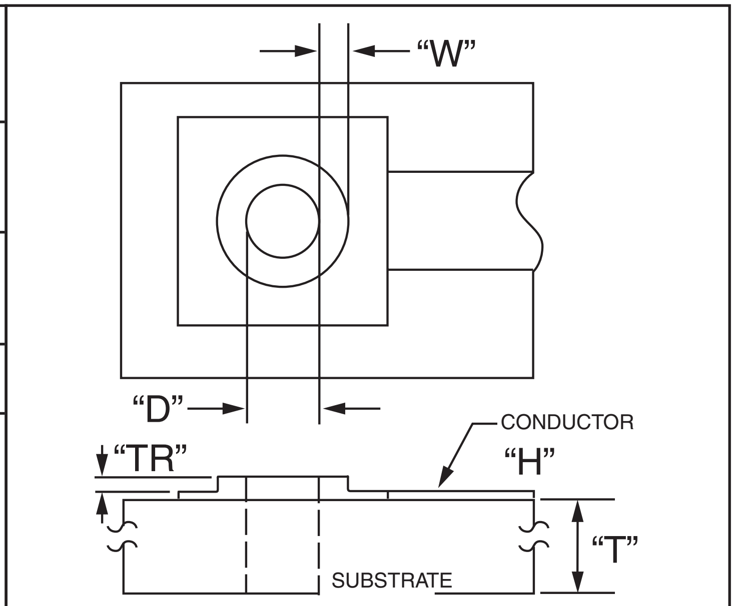
SHORT LEAD TIME: ADDS ONLY 1-2 DAYS TO STANDARD PROCESS



ENHANCED VIA™

DESIGN RULES AND SPECIFICATIONS FOR ***ENHANCED VIAS***™

PARAMETER	SYMBOL	LIMITS/ RECOMMENDATIONS
Hole diameter	D	Minimum: 0.6 X T Nominal: >=1 X T
Rim width	W	Minimum: 0.002" Nominal: 0.005"– 0.025"
Rim thickness	TR	400±200μ"
Nominal DC Resistivity (mΩ) (T&D in mils, TR&H in μ")		$\frac{318 \times T}{D \times (TR+H)}$



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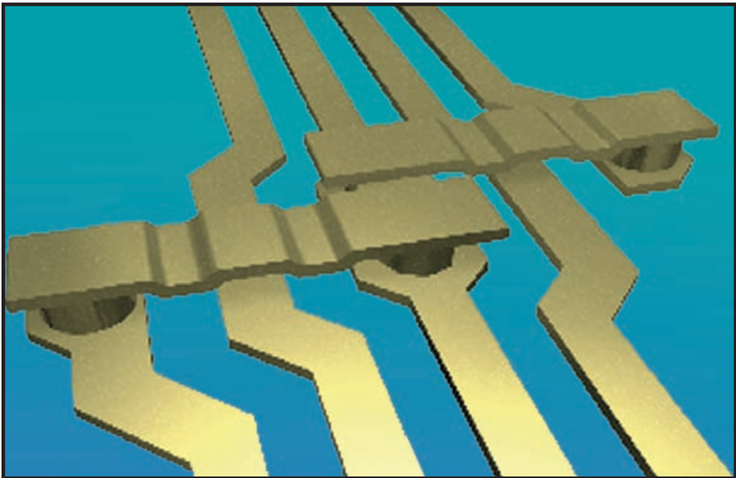
AIR BRIDGES



- Reliable bridging for ‘too-small-to-wire’ geometries
- Improved performance at high frequencies compared to wire-bonded bridges

DESIGN GUIDELINES FOR AIR BRIDGES

PARAMETER	LIMITS/ RECOMMENDATIONS
Minimum gap between lines	0.5 mil (0.0005")
Minimum line width	0.5 mil (0.0005")
Minimum pillar's base diameter	2.0 mil (0.002")
Minimum pillar diameter	1.3 mil (0.0013")
Bridge height	300-500µ"
Minimum bridge width	1.3 mil (0.0013")
Dielectric	Air (polyimide optional)

ATC Sample
Air Bridge Layout

0.002" (Min.)
(Typ.)

GENERAL DESIGN GUIDELINES

Category	Parameter	Value
CONDUCTORS	Minimum Line Width / Minimum Space Width	.0005″
	Line Width Tolerance	.0002" Standard .0001" Select
	Space Tolerance	.0002" Standard .0001" Select
	Minimum Pad Size Around VIA (D = hole diameter)	.010" + D
RESISTORS	Minimum Tolerance	.1%
	Minimum Spacing Between Resistors	.002"
	Minimum Length and / or Width	.002"
	Minimum Termination Size	.003" x .003"
	Pre Trim Designed Value	–20%
	Nominal Sheet Resistance (ohms /□) Preferred Sheet Resistance (ohms /□)	10 – 200 50 or 100
METALIZED HOLES (VIA'S)	Minimum Aspect Ratio (Hole diameter: Substrate thickness)	0.6:1
	Minimum Tolerance	.002"
	Minimum Distance from Hole Circumference To Edge (T = substrate thickness) or adjacent hole circumference	T
	Minimum True Center Tolerance	.001"
SUBSTRATES	Minimum Thickness Tolerance	.0001"
	Minimum Length / Width Tolerance	.001"
	Surface Finish (Microinch – CLA not available in all materials)	.2 – 10
	Minimum Camber (Polished only) Typical Camber – Polished Typical Camber – As Fired	.0002"/" .0005"/" .002"/"
DATA FORMAT	DXF, DWG, GDSII, Gerber (Consult Factory For Other Formats)	
	Traces: Closed Polylines (0 Width)	
	Minimum Resistor On Conductor Overlap	.002"

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INSPECTION METHODS

Visual:	100%	-Per MIL-STD-883C, method 2032 Class B (10X microscope min.)
Dimensional:	AQL	-Pattern features: Microscope Substrate: Micrometer and calipers
Resistors:	AQL	-2 Point Probe
Adhesion:	AQL	-Tape pull test with 3M #610 tape
Other:	Customer Specified	

ATC SALES RESPONSIVENESS

Typical quotes are usually provided by the factory within 24 hours.

For design/applications assistance:

call: (904) 726-3426

fax: (904) 725-2279

GENERAL ORDERING INFORMATION

Substrates:	Type, surface finish, dimensions and tolerances.
Resistive Films:	Type, nominal resistivity, tolerance after heat treatment. Heat treatment temperature and time.
Conductive Films:	Type, thickness and tolerance.
General:	Specifications and acceptance criteria.
Artwork:	Dimensioned Drawings, Ruby, Film, Master Mask, or Computer data file.
Processing:	Temperatures, bonding/soldering methods and environment.

Sales of ATC products are subject to the terms and conditions contained in American Technical Ceramics Corp. Terms and Conditions of Sale(ATC document #001-992 Rev. A 10/03). Copies of these terms and conditions will be provided upon request. They may also be viewed on ATC's website at www.atceramics.com/productfinder/default.asp. Click on the link for Terms and Conditions of Sale.

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