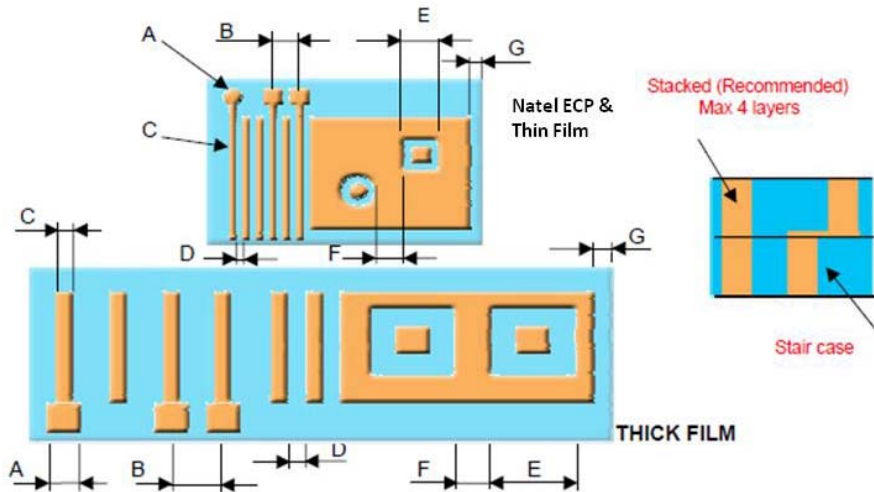


NATEL Thick Film Design Guidelines



High Frequency applications through 100 GHz

- T/R Modules
- Power Amplifiers/Drivers
- Switches
- Couplers
- Wave Guides

Etched conductors (0.001", 0.0254mm) lines and spaces

Specialty Materials / Processing

- DuPont Photo-imageable dielectrics
- Diffusion patterning

Precision layer to layer alignment (+/-12.5 micron)

High Interconnect Density

Microwave Transitions (low insertion loss)

High Power Dissipation (18-285 W/mK ceramics)

Item	Designation & Measurements	Thick Film Inches (mm)	ECP * Inches (mm)	Thin Film Inches (mm)
A	Via	0.010 (ø 0.254)	0.003 (ø 0.078)	0.003 (ø 0.078)
B	Via Pitch	0.015 (0.381)	0.006 (0.152)	0.006 (0.152)
C	Line Width	0.005 (0.127)	0.001 (0.025)	0.001 (0.025)
D	Line Clearance	0.005 (0.127)	0.001 (0.025)	0.001 (0.025)
E	Clearance Diameter	0.020 (0.508)	0.005 (0.127)	0.005 (0.127)
F	Clearance Space	0.005 (0.127)	0.001 (0.025)	0.001 (0.025)
G	Edge Clearance	0.005 (0.127)	0.001 (0.025)	0.001 (0.025)
Layer to Layer Alignment		0.003 (0.078)	0.0002 (0.005)	0.0002 (0.005)

* ECP (Etch Conductor Photolithography) is NATEL's proprietary Thick Film Etch process



Detailed Thick Film Design Rules are available to help you design amazing products. Contact us at www.NatelEMS.com

Thick Film Systems: Microwave Circuitry and Packaging

NATEL offers standard Thick Film Substrates used in most signal, high speed and power applications. We work with a variety of substrates including BeO, AlN and Alumina(Al_2O_3).

- DuPont, Ferro, ESL, and Heraeus Gold, Silver, Platinum, Palladium, and Copper Conductors
- Substrate sizes up to 5"x5"
- Solid through hole filling for front to back Interconnect
- Complex Multilayer Stack up
- Flying Probe Testers for 100% Electrical Testing
- Dicing
- CO2 laser machining of Ceramics / Laser Trim of resistors and Capacitors
- Solder and Brazing Pins, leads, and Seal Rings (Sn solders and Au/Sn brazing)

Microcircuit Technologies

Technology Comparison

Parameter	Thick-film	Thin-film	Monolithic
Performance	High	High	Limited
Design Flex, Digital	Medium	Medium	High
Design Flex, Analog	High	High	Low
Parasitic	Low	Low	High
Ω Max. Sheet	High	Low	High
Ω TCR	Low	Lowest	High
Ω Tolerance	Low	Lowest	High
Power Dissipation	High	High	Low
Frequency Limit	Medium	High	Medium
Voltage Swing	High	High	Low
Size	Small	Small	Smallest
Package Density	Medium	Medium	High
Reliability	High	High	Highest
Development Time	2 months	2 months	4 months
Turn Time Design Change	2 weeks	1 month	2 months
Cost Development	Low	Medium	High
Production Setup & Tooling Cost	Low	Medium	High

Thick Film / Thin Film Comparison

Parameter	Thick-film	Thin-film
Conductor Spacing	0.005"	0.0001"
Conductor Line Width	0.005"	0.0001"
Solder Pad Spacing	0.005"	0.020"
Resistor Tolerance	$\pm 1\%$	$\pm 0.1\%$
Resistor TCR	± 100 ppm/ $^{\circ}C$	± 50 ppm/ $^{\circ}C$
Resistor Tracking	25 ppm/ $^{\circ}C$	1 ppm/ $^{\circ}C$
Resistor Ratio Match	0.5%	0.01%
Resistor Length	0.005"	N/A
Resistor Width	0.005"	0.0025"
Via Hole Size	0.006"	0.0001"
Ω/Sq Resistivity Range	1-100M	5-500
Ω Thermal Stability (150 $^{\circ}C$ /1000hrs)	$< \pm 0.5$	$< \pm 0.2$
Voltage Coefficient of Resistance PPM/V	0.5-5	1
Conductors Compatible with Resistors	Au,Ag,Cu PdAg,PtAg	Au,Cu,Al

Thin Film resistors based on tantalum nitride.

Capital Outlay: NONE when you partner with NATEL.