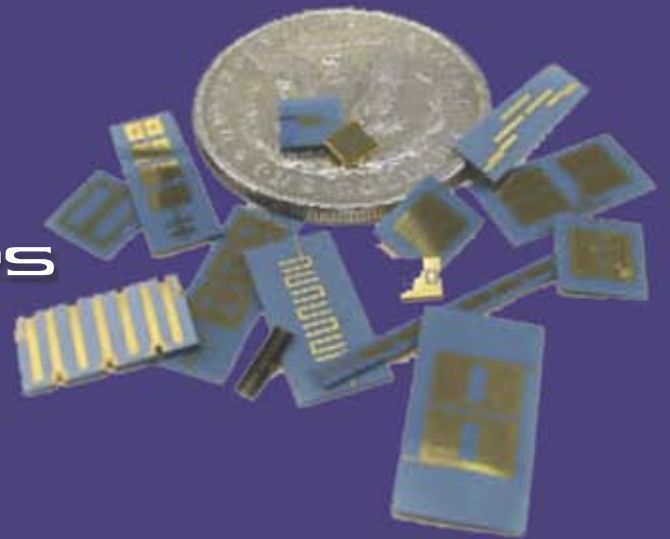


Build-to-Print Design Guide

Thin Film Technologies



DLI - the Global Leader for High Frequency Solutions



Company Overview

Dielectric Laboratories, Inc. (DLI) is your global partner for application specific microwave and millimeter wave components serving customers in fiber optic, wireless, medical, transportation, semiconductor, space, avionics and military markets. With over 35 years of experience, you can turn to DLI with confidence for your high frequency Single-Layer Capacitors, Multi-Layer Capacitors that are difficult to build and tight tolerance, Heat Sinks, Resonators, Filters, and Build-To-Print or Custom Thin Film Components.

DLI offers a broad range of Multi-Layer Capacitor products which are summarized in this catalog. Our products include C04, C06, C07, C08, C11, C17, C18, C22 and C40 High-Q Multi-Layer Capacitors. DLI has the world's most comprehensive array of Broadband Blocking Capacitors. We have the expertise in customizing, tight tolerances and meeting specific design targets. DLI continues to introduce exciting new innovations in custom ceramic resonator and filter technologies. These patent-protected products leverage decades of ceramic and Thin Film experience, creative and clever design expertise, and advanced prototyping and testing capabilities. Please discuss your needs with our Sales and Applications Engineering Team.

We are committed to serving you and thank you for your business.

RoHS Compliance Statement

DLI is a leading supplier to the electronic components market and is fully committed to offering products supporting Restriction of Hazardous Substances (RoHS) directive 2002/95/E. All of our Dielectric formulations are RoHS compliant and we offer a broad range of capacitors with RoHS compliant terminations. DLI complies with the requirements of the individual customer and will maintain product offerings that meet the demands of our industry.



Quality and Environmental Policy

DLI's reputation for quality and environmental responsibility is based on a commitment not only to meet our customers' requirements, but to exceed their expectations. The entire organization, beginning with top management, strives to achieve excellence in designing, manufacturing and delivering high Q capacitors and proprietary thin film components for niche high frequency applications, while maintaining safe and healthy working conditions. Furthermore, DLI commits to achieve these goals in an environmentally responsible manner through our commitment to comply with environmental regulations and implement pollution prevention initiatives. DLI strives to continually improve the effectiveness of our Quality and Environmental Management System through the establishment and monitoring of objectives and targets

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Introduction

What Makes DLI Unique?

DLI has built its global reputation as a manufacturer of high frequency, high Q capacitors. In recent years, DLI has emerged as a comprehensive manufacturer of specialty ceramic components for high frequency applications. With over three decades of material science formulation and development, more than one hundred proprietary and/or patented ceramic formulations, and multiple recent patent filings, DLI is the pre-eminent ceramic component manufacturer in the industry. The marriage of ceramic

expertise, manufacturing know-how, product quality, customer service, product customization, and clever microwave and RF design engineering sets us apart from all others in the industry.

DLI invented the DiCap® in 1974 and it has become the world standard for reliable high performance ceramic Single-Layer Capacitors. DLI literally defined the industry and currently serves the overwhelming majority of the world markets as the leader of high Q, high frequency Single Layer Capacitors.



Choosing a Substrate/Material

Substrate Materials and Properties

Substrate Material	Dielectric Constant (Tolerance)	Typical Loss Tangent	Coefficient of Thermal Expansion (ppm/°K)	Temperature Coefficient of Capacitance (ppm/°C)	Surface Finish (m-inch)	Application
Fused Quartz (SiO ₂) QZ	3.82 @ 1MHz	0.000015 @ 1 MHz 0.00033 @ 24 GHz	0.55	—	<0.1	Suitable for microwave and millimeter wave frequency applications. Low loss. Thermal Conductivity: 1.38 W/m-°K.
Aluminum Nitride (AlN) AG	8.6 (± 0.35) @ 1MHz	0.001	4.6	—	As Fired <20 Polished <2	Suitable for circuits requiring high power dissipation. RF and microwave circuit applications. Thermal Conductivity: 170 W/m-°K or 200W/ m-°K.
96% Alumina (Al ₂ O ₃) PJ	9.5 (± 1) @1 MHz	0.0004	6.4 - 8.2	—	As Fired <4 Polished <1	General circuit applications. Compatible with Si and GaAs chip technology. Thermal Conductivity: 26 W/m-°K.
99.6% Alumina (Al ₂ O ₃) PI	9.9 (± 0.15) @1MHz	0.0001	6.5 - 7.5	P120 ± 30	Polished <5	General circuit applications. Compatible with Si and GaAs chip technology. Thermal Conductivity: 27 W/m-°K.
PG	12.5 (± 0.5)	0.0002	7.6	P22 ± 30	Polished <5	Replacement for Alumina - improved temperature stability.
AH	20 (± 0.5)	0.0002	9.6	P90 ± 20	Polished <5	Suitable for circuit miniaturization. RF and microwave circuit applications.
NA	23 (± 1)	0.0003	10.1	0 ± 15	Polished <5	Suitable for circuit miniaturization. RF and microwave circuit applications.
CF	25 (± 2)	0.0003	9.0	0 ± 15	Polished <5	Excellent temperature stability. Suitable for circuit miniaturization. RF and microwave circuit applications.
CD	38 (± 1)	0.0004	5.8	N20 ± 1	Polished <5	Suitable for circuit miniaturization. RF and microwave circuit applications.
CG	67 (± 3)	0.0008	9.0	0 ± 30	Polished <5 Lapped <20	Excellent temperature stability. Suitable for circuit miniaturization. RF and microwave circuit applications.
NP	85 (± 10%)	0.0008	—	N750 ± 200	Polished <5	Suitable for circuit miniaturization. RF and microwave circuit applications. Microwave power transistor matching; eg. GaN, SiC
NR	152 (± 5%)	0.0006	10.0	N1500 ± 500	Polished <5	
NS	300 (± 10%)	0.005	—	N2400 ± 500	Polished <5	
NU	600 (± 10%)	0.015	—	N3700 ± 1000	Polished <5	



Standard substrate thicknesses are in 5 and 10 mil thick increments but can be custom to 0.1 mil. Polished and lapped surfaces are available to ±0.0005" tolerance where As-Fired materials are accurate to ±0.001". Alternative surface finish may also be available, please consult the factory for more options.



Choosing a Metal System

The metal system utilized is typically chosen based on the the following requirements: current carrying requirement, chip and component mounting strategies, line width and spacing requirements and if utilizing an integrated resistor. Higher current requirements can employ thicker gold or copper metal but then limit the ability for fine line geometries. Wire

bonding to the surface of a circuit generally requires 100 μ " of gold. When tin/lead soldering is required, gold thickness is decreased to reduce embrittlement and a nickel/platinum barrier layer is utilized. DLI also has the capability to selectively apply gold/tin solder for attachment of discrete die.

Metal Systems

Metalization System	Application	Component Attachment Method	Typical Thickness Range	Comments	Max Temp. °C
S19 Tantalum Nitride (TaN) Titanium Tungsten (TiW) Gold (Au)	Standard Thin Film Metal System for Conductors with Resistor Layer	Au/Sn, Au/Si, Au/Ge - Eutectic Epoxy	TaN: 12 to 200 Ω/\square TiW: 300 to 500 Å Au: 5 to 300 μ "	Not recommended for Tin/Lead Solder Attach - Maintain Gold 5-20 μ " for Solder Attach. Compatible with Wire bonding - Maintain Gold \geq 100 μ " for Wire bonding.	380
S5 Titanium Tungsten (TiW) Gold (Au)	Standard Thin Film Metal System for Conductors	Au/Sn, Au/Si, Au/Ge - Eutectic Epoxy	TiW: 300 to 500 Å Au: 5 to 300 μ "	Compatible with Tin/Lead Solder Attach - Maintain Gold 5-20 μ " for Solder Attach. When repeated soldering is required for repairs. Compatible with Wire bonding - Maintain Gold \geq 100 μ " for Wire bonding.	425
Tantalum Nitride (TaN) Titanium Tungsten (TiW) Gold (Au) Copper (Cu) Nickel (Ni) Gold (Au)	High Current & Low Loss With or without TaN Resistor Layer	Au/Sn, Au/Si, Au/Ge - Eutectic Sn/Pb Epoxy	TaN: 12 to 200 Ω/\square TiW: 300 to 500 Å Au: 5 to 10 μ " Cu: 150 to 600 μ " Ni: 40 to 100 μ " Au: 5 to 300 μ "	Compatible with Tin/Lead Solder Attach - Maintain Gold 5-20 μ " for Solder Attach. When repeated soldering is required for repairs. Compatible with Wire bonding - Maintain Gold \geq 100 μ " for Wire bonding.	350
S10 Tantalum Nitride (TaN) Titanium Tungsten (TiW) Gold (Au) Nickel (Ni) Gold (Au)	High Current & Low Loss With or without TaN Resistor Layer	Au/Sn, Au/Si, Au/Ge - Eutectic Sn/Pb Epoxy	TaN: 12 to 200 Ω/\square TiW: 300 to 500 Å Au: 5 to 300 μ " NiV: 40 to 100 μ " Au: 5 to 70 μ "	Compatible with Tin/Lead Solder Attach - Maintain Gold 5-20 μ " for Solder Attach. When repeated soldering is required for repairs. Compatible with Wire bonding - Maintain Gold \geq 100 μ " for Wire bonding.	350
Tantalum Nitride (TaN) Titanium Tungsten (TiW) Gold (Au) Nickel (Ni) Gold Tin (AuSn)	With or without TaN Resistor Layer For selective Gold/Tin Attach and Wire bond locations	Au/Sn	TaN: 12 to 200 Ω/\square TiW: 300 to 500 Å Au: 5 to 100 μ " NiV: 40 to 100 μ " AuSn: 100 to 350 μ "	Eliminates solder preform. Direct die attach to pad. (Au/Sn)	280
S2 Titanium Tungsten (TiW) Nickel (Ni) Gold Tin (AuSn)	For Gold/Tin Solder Systems Without TaN Resistor Layer	Au/Sn	TiW: 300 to 500 Å NiV: 40 to 100 μ " AuSn: 100 to 350 μ "		280
S7 Titanium Tungsten (TiW) Platinum (Pt) Gold (Au)		Au/Sn, Au/Si, Au/Ge - Eutectic Sn/Pb Epoxy	TiW: 300 to 500 Å Pt: 6-10 μ " Au: 5 to 300 μ "	Compatible with Tin/Lead Solder Attach - Maintain Gold 5-20 μ " for Solder Attach. When repeated soldering is required for repairs. Compatible with Wire bonding - Maintain Gold \geq 100 μ " for Wire bonding.	>400
S1 Titanium Tungsten (TiW) Nickel (Ni) Gold (Au)		Sn/Pb Epoxy	TiW: 300 to 500 Å NiV: 40 to 100 μ " Au: 5 to 300 μ "	Compatible with Tin/Lead Solder Attach - Maintain Gold 5-20 μ " for Solder Attach. When repeated soldering is required for repairs. Compatible with Wire bonding - Maintain Gold \geq 100 μ " for Wire bonding.	350

Note: Titanium can be substituted depending on substrate composition. Custom Metalizations and thicknesses are available upon request. Nickel Vanadium may be substituted for Nickel in some applications; contact applications engineering for details.

Build-to-Print Reference Guide

Metal Coatings

- Gold (Au)
- Nickel (Ni)
- Titanium Tungsten (TiW)
- Platinum (Pt)
- Titanium (Ti)
- Copper (Cu)
- Nickel Vanadium (NiV)
- Gold Tin (AuSn)
- Tantalum Nitride (TaN)
(Resistive Layer)

Lithography

- | | | |
|----------|------------|----------------|
| ■ Gold | ≤150 μ" | ≤0.5 ± 0.1 mil |
| ■ Gold | 150-300 μ" | 1.0 ± 0.2 mil |
| ■ Copper | 50-600 μ" | 3.0 ± 0.4 mil |
| ■ Nickel | 50-125 μ" | 3.0 ± 0.4 mil |

Laser Drilling

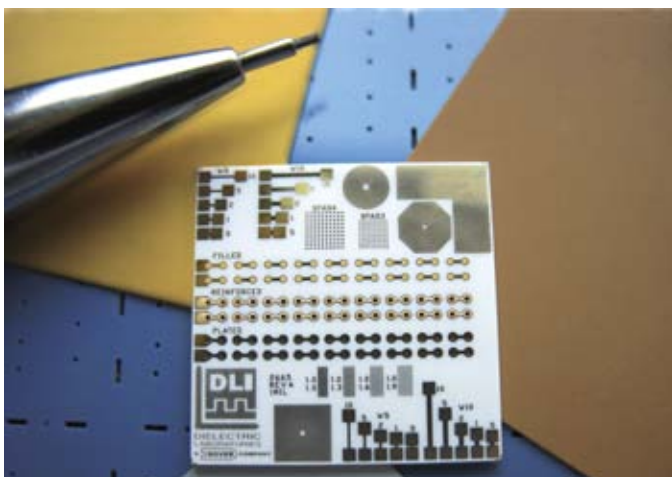
- Features as small as 0.003" dia.
- Drill features in high k dielectrics

Other Options

- Edge-wrap metallization
- Castelated Vias
- Gold Filled Vias
- Reinforced Vias
- Spiral Inductors
- Interdigitated Capacitors
- Lange Coupler
- Resistors
 - Notched
 - Flush
 - Top-Hat
- Polyimide

- Solder Dam
- Selective Metallization
 - different top and bottom substrate metal scheme
 - different metal schemes on the same side of substrate
- RF test capabilities up to 67 GHz
- Contoured Surfaces
- Packaging
 - Photon Ring Packaging repopulation
 - Tape and Reel
 - Anti-Static Waffle Packaging up to 4" square

TF Coupon



Resistors can be incorporated directly into the circuit design with the advantage of reducing assembly steps, improving thermal dissipation and improving reliability through the reduction of interconnections.

DLI's resistor technology utilizes TaN. This material has higher maximum exposure temperature and superior resistance to harsh environments (soldering and processing).

Under most circumstances DLI can tune a resistor in to tolerance of 10% without trimming. Although when tighter tolerance is required laser trimming is available.

DLI offers reinforced vias when higher current is required which gives better mechanical strength and lower resistance to the via hole.

Filled vias provide improved performance and reliability over plated vias but have a higher processing cost. Filled vias increase current carrying capacity and have higher thermal conductivity to the ground plane. When mounting active die, use of filled vias effectively conducts heat away from the die. DLI offers gold fill (copper or silver can diffuse into other layers of the metallization leading to reliability issues).

The precision of conductor line width and line spacing can be critical to achieving the performance required. Control of metal geometries is key to repeatable performance in microwave structures. Characteristic impedance of transmission lines is governed by line widths. DLI has extensive experience and can assist in tailoring ceramic/metallization systems to your design to achieve maximum performance. DLI is capable of meeting as small as 0.0005" line width and spacing with 0.0001" tolerance.

Build-to-Print Request for Quotation Design Sheet

Contact Information

Name: _____ Title: _____
 Company: _____
 Address: _____

 Country: _____
 Telephone & FAX: _____

Export Control

End User: _____ Application: _____

Design Considerations

Ceramic: Material Type: _____
 Surface Finish: Polished Lapped As-Fired
 Thickness: mm _____ or mil _____ Tolerance: ± 1 mil ± 0.5 mil

Part Size: Length: mm _____ or mil _____ Width: mm _____ or mil _____

Metal System: Conductor Metal Thickness: μ _____ or mil _____
Top Layer Std Metal System: _____
Bottom Layer Std Metal System: _____

Critical Pattern Features: Min. Line Width: Width: mm _____ or mil _____ Tolerance: _____ ± _____ %
 Min line Spacing: Width: mm _____ or mil _____ Tolerance: _____ ± _____ %

Mounting Requirements:
Resistors: Type: Notched Flush Top-Hat None Other _____
 Resistor Value: Tolerance: _____ ± _____ %
 No. resistors/part: _____

Vias: Type: Filled Reinforced None
 Min. Diameter: mm _____ or mil _____
 No. vias/part: _____

Testing Requirements RF Test Wire Bond Solderability
 Other: _____

Packaging Requirements: _____

Volume: Monthly: _____ Annually _____

Target Price: USD/Piece _____

NRE (Tooling if required): Add this charge as a *lump sum* to the quote price
OR
 Add this charge to the *unit price* of the individual piece

Please include/attach any drawings with this form (.dwg or .pdf file format preferred)
 To submit this form or to inquire for further information please email to sales@dilabs.com;
 fax to 315-655-0445 or complete our online form at <http://www.dliextra.net/filters/BTPform.htm>

Thank you!

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