

TECH SPECS

Advanced Technology Today

**Thick and Thin Film
Lasered Substrates**
10,22-4-0201

COORSTEK
Amazing Solutions.

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I. Scope and Intent

This technical specification is designed to provide engineers with design guidelines, inspection methods and quality standards for laser machining/profiling, drilling and scribing of CoorsTek thick and thin film alumina substrates. These guidelines will aid in optimizing lasered substrate design in order to meet your technical requirements cost-effectively.

If a lasered substrate design does not comply with these guidelines, we may still be able to offer options to your specific design requirements. CoorsTek will indicate exceptions to customer prints and specifications should they differ from these guidelines, for the purpose of offering alternatives and possible cost reduction. Please contact your CoorsTek sales representative for more information.

II. Design Guidelines

The following design standards represent factors that should be considered to ensure optimal substrate design and material selection.

A. Definition of Terms

1. Annealing: Heat treatment of thick and thin film ceramic substrates to thermally modify the heat-affected zone (HAZ) allowing for improved via metal adhesion or, in some cases, to relieve residual stresses.
2. As-Fired Edge: The edge of a substrate produced by mechanical punching of unfired (green) ceramic tape.
3. Buffed Edge: The edge of a substrate produced by a mechanical abrasion process on a laser scribed or as-fired edge.
4. Chamfered Corner: A unique reference used to locate the datum point and/or the working surface ("A" side) for thin film substrates (reference Figure 1).
5. Coating: Used to protect substrate surface during laser processing.
6. Cut Slot: Laser machined feature through thickness of substrate with length greater than width (reference Figure 1).
7. Datum: Reference point (0,0) from which all other ceramic substrate features are measured.
8. Drilling: Laser machining of round holes through the substrate thickness.
9. Fiducial: A marking used as a standard reference for substrate orientation and alignment (reference Figure 1).
10. HAZ: Acronym for **H**eat **A**ffected **Z**one. Region of material adjacent to the laser scribe or cut.
11. Hole Roll-Off: In a cross-sectional view of a laser drilled hole, the radius at the intersection of the hole wall (tangent point) and the face of the substrate, on the beam entry side only (reference Figure 3b).
12. Hooking: A small protrusion left along the edge after breaking. Hooks are considered acceptable if within overall specification limits.
13. LASER: Acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.
14. Laser Tick: An identifying reference mark typically found on the "B" face (non-working surface) of a thin film substrate, and "A" face of thick film substrates.
15. Locating Hole: Customer-specified optical and/or mechanical feature (reference Figure 1).

16. Machining/Profiling: Cutting through a ceramic substrate with a laser beam to produce a desired shape.
17. Multi-Up Design: A single substrate containing multiple laser scribed parts to allow for batch processing in the customer's process (reference Figure 1).
18. Pin Flat: Machined indentation, located on substrate edges, used for precise mechanical alignment of the substrate in the customer's process (reference Figure 1).
19. Pulse Depth: Average penetration distance of a laser pulse measured from the entrance side of the substrate (reference Figure 2b).
20. Pulse Spacing: Separation distance between two adjacent laser pulses measured from centerline to centerline (reference Figure 2).
21. Scribing: To laser machine a line by perforating the material's surface. Separation of the material may then be done along the perforated line, thus achieving the desired part dimensions (reference Figure 2).
22. Singulation: Act of separating segments of the scribed substrate into the final part dimensions.
23. Slag: Resolidified ceramic material on the substrate's surface resulting from laser processing.
24. Tab: Ceramic material left inside a laser cut feature as the result of the start/stop point of the laser beam. Alternatives are available should this cause a problem to the function of the part.
25. Taper: Slope of the wall resulting from laser drilling and machining through the substrate thickness (reference Figure 3b).
26. Web: Distance separating a hole from another substrate feature. This distance is measured from the hole entrance side (reference Figure 3a).

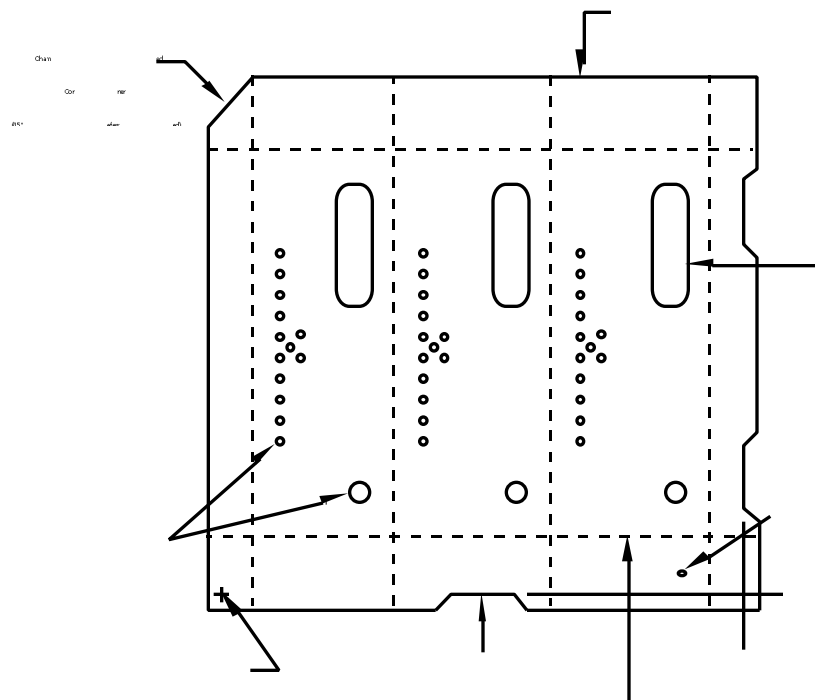


Fig. 1. Typical Lasered Ceramic Substrate

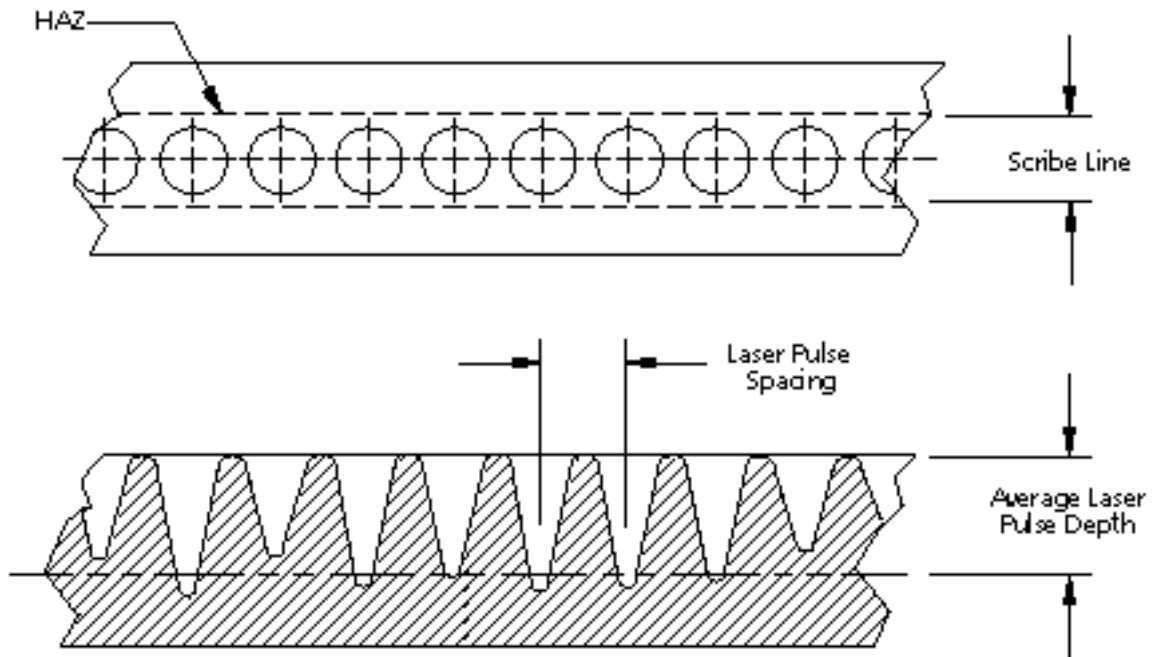


Fig. 2. Typical Laser Scribed Line: (a) Top View of Laser Scribed Line; (b) Cross Section of Laser Scribed Line

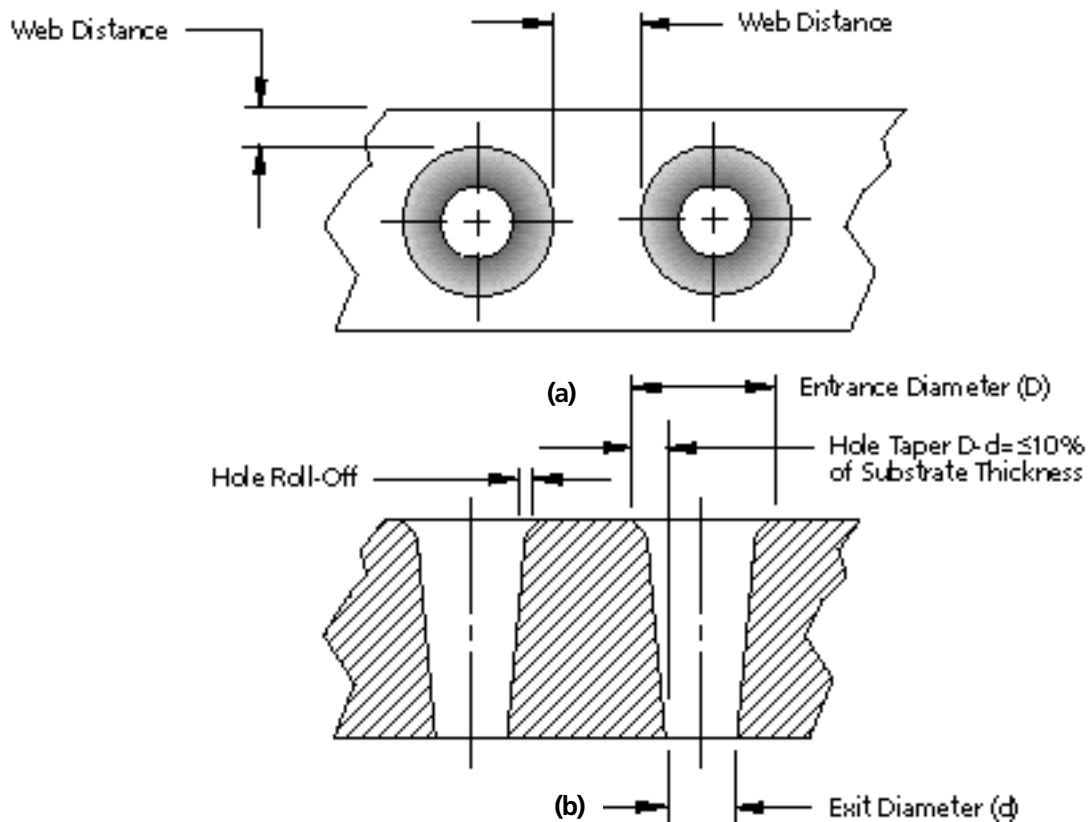


Fig. 3. Typical Laser Drilled Holes: (a) Top View of Laser Drilled Holes; (b) Cross Section of Laser Drilled Holes

B. Materials

Thick Film

- ADS-96R
- ADOS-90R (opaque)

Thin Film

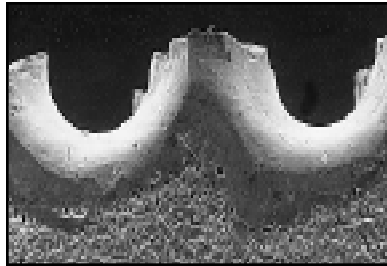
- Superstrate® 996
- ADS-996
- ADS-995

Note:

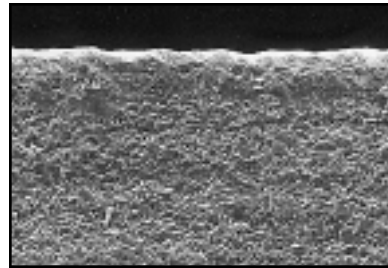
For material selection information concerning alumina substrates, consult CoorsTek [Thick Film Substrates Technical Specifications](#) and [Thin Film Substrates Technical Specifications](#).

C. Lasered Edge Treatments

To help minimize chipping, CoorsTek offers a variety of edge finishing treatments: laser scribed, laser scribed and buffed (not shown), and laser machined (reference Figure 4). Note: Laser scribed and buffed edge availability is geometry dependent.



Laser Scribed Edge



Laser Machined Edge

Fig. 4. Scanning Electron Photomicrographs of ADS-96R (175x)

D. Services

1. Design Consultation

We encourage the design and/or manufacturing engineer to work closely with Coorstek's lasering operations. This teamwork improves part design, part yields, efficiency and overall customer satisfaction.

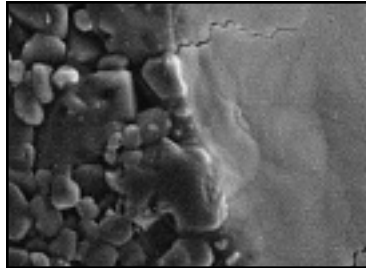
2. Enhanced Laser Scribing

CoorsTek offers special differential scribing to enhance preferential singulation. By varying the laser pulse spacing and depth in the (x) and (y) scribe directions, the sequence of singulation may be controlled precisely. Enhanced laser scribing helps to prevent hooking, chipping and premature breakage, which improves customer process yields.

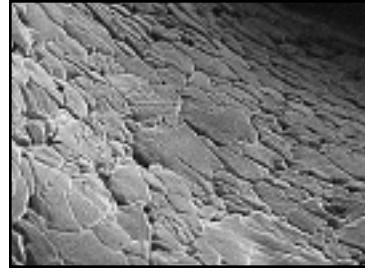
3. Annealing

CoorsTek offers an annealing treatment for ADS-96R to modify the microstructure of the heat affected zone (HAZ) in a laser drilled hole (reference Figure 5) and/or to relieve any residual substrate stresses. The annealed microstructure provides an enhanced surface for metallization, thus improving via metal adhesion. The annealing process also increases the breaking force required for singulation of laser scribed substrates.

Annealing treatments are also available for CoorsTek Superstrate® 996, ADS-996 and ADS-995 thin film substrates. For these materials, the customer defines the annealing parameters necessary to achieve specific circuit manufacturing requirements.



Unannealed Laser Pulse



Annealed Laser Pulse

Fig. 5. Scanning Electron Photomicrographs of ADS-96R (1,000x and 30° Tilt)

4. Laser Express

In order to meet your production needs, CoorsTek offers an expedited turnaround time on high-quality laser scribing, drilling and machining.

5. CAD-LINK

A modern service that allows for the simple and accurate transfer of computer aided design (CAD) data directly to CoorsTek's Cost and Product Engineering computer network. Contact your CoorsTek sales representative for details.

E. Tolerances

These specifications are based on the application of statistical process control methods to determine multibeam equipment capability to a $C_{pk} = 1.33$. Dimensional tolerances should be specified as close as necessary to facilitate customer process requirements and minimize cost.

Tighter tolerances are available upon request. For more information on tighter tolerances, please contact your CoorsTek sales representative.

1. Laser Scribing

Table I. Laser Scribed Tolerances		
Nominal Substrate Thickness	Resultant Segment From Two Broken Edges	Laser Scribed Edge To First Scribe Line
.010" (0.254mm)	+ .006" (0.152mm) - .002" (0.051mm)	+ .004" (0.102mm) - .002" (0.051mm)
.015" (0.381mm)	+ .006" (0.152mm) - .002" (0.051mm)	+ .004" (0.102mm) - .002" (0.051mm)
.020" (0.508mm)	+ .006" (0.152mm) - .002" (0.051mm)	+ .005" (0.127mm) - .002" (0.051mm)
.025" (0.635mm)	+ .006" (0.152mm) - .002" (0.051mm)	+ .005" (0.127mm) - .002" (0.051mm)
.030" (0.762mm)	+ .008" (0.203mm) - .002" (0.051mm)	+ .006" (0.152mm) - .002" (0.051mm)
.035" (0.889mm)	+ .008" (0.203mm) - .002" (0.051mm)	+ .007" (0.178mm) - .002" (0.051mm)
.040" (1.016mm)	+ .008" (0.203mm) - .002" (0.051mm)	+ .007" (0.178mm) - .002" (0.051mm)
.050" (1.270mm)	+ .008" (0.203mm) - .002" (0.051mm)	+ .007" (0.178mm) - .002" (0.051mm)
.060" (1.524mm)	+ .014" (0.356mm) - .002" (0.051mm)	+ .010" (0.254mm) - .002" (0.051mm)

Notes:

1. Laser machined edges to first scribe line tolerance is $\pm .002"$ ($\pm 0.051\text{mm}$) for all substrate thicknesses.
2. Scribe line to scribe line tolerance prior to breaking is $\pm .002"$ ($\pm 0.051\text{mm}$).
3. Perpendicularity and parallelism of scribe lines and/or scribed and broken edges will not exceed $.0005"/"$ ($0.013\text{mm}/\text{mm}$) when measured at laser pulse centers.

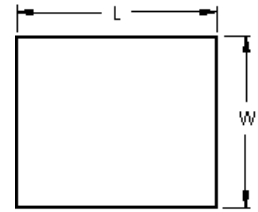
Table II. Recommended Laser Scribed Pulse Depth And Spacing		
Nominal Substrate Thickness	Laser Pulse Depth	Laser Pulse Spacing: Centerline To Centerline
.010" (0.254mm)	.004" (0.102mm)	.005" (0.127mm)
.015" (0.381mm)	.006" (0.152mm)	.006" (0.152mm)
.020" (0.508mm)	.008" (0.203mm)	.006" (0.152mm)
.025" (0.635mm)	.012" (0.305mm)	.006" (0.152mm)
.035" (0.889mm)	.015" (0.381mm)	.006" (0.152mm)
.040" (1.016mm)	.018" (0.457mm)	.006" (0.152mm)
.060" (1.524mm)	.029" (0.737mm)	.007" (0.178mm)

Notes:

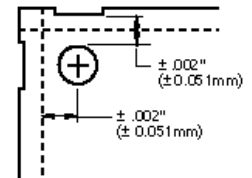
1. Laser pulse depth and laser pulse spacing are reference dimensions.
2. Laser pulse depth and laser pulse spacing can be adjusted to individual customer specifications.

2. Laser Drilling and Machining/Profiling

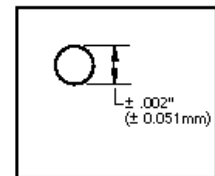
- a. Length and Width • $\pm .002$ " (± 0.051 mm)



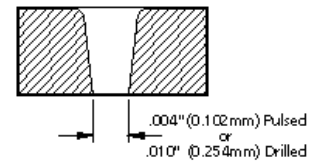
- b. Hole Location
- $\pm .002$ " (± 0.051 mm) from any machined area to hole centerline
 - $\pm .002$ " (± 0.051 mm) from center of scribe lines to hole centerline



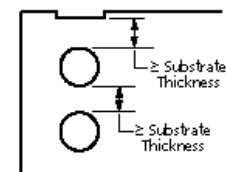
- c. Hole Diameter • $\pm .002$ " (± 0.051 mm)



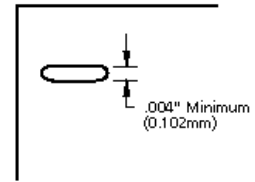
- d. Minimum Hole Diameter
- pulsing $.004$ " (0.102mm)
 - drilling $.010$ " (0.254mm)



- e. Minimum Web Thickness
- hole edge to another edge substrate thickness
 - between adjacent holes substrate thickness

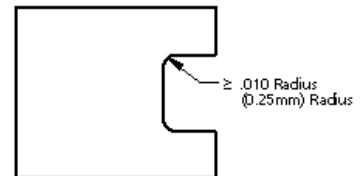


- f. Narrowest Cut Slot • .004" (0.102mm) minimum



- g. Corner Radius • .010" (0.254mm) Radius

Note: Specify internal corner radii rather than sharp corners (90°) to avoid microcracking and chipping.



III. Inspection Methods

The following list describes CoorsTek's standard inspection methods. If you prefer a different measuring technique, please specify it during quoting process.

A. Hole Sizes and Shapes

Hole diameters and shapes are verified using computer-enhanced optical measuring with top or back light equipment or pin gauges (CoorsTek's preferred method), depending on the customer's preference.

B. Hole Locations

Hole locations are inspected with computer-enhanced optical measuring equipment on the entry side (standard procedure) using top light.

C. Scribe Lines

1. Before Break: Scribe line locations are inspected using computer-enhanced optical measuring equipment.
2. After Break: The part segments are inspected with digital calipers.

D. Chips

Inspection for chips is done under a high-intensity, low-angle light using the unaided eye. If observed, verification of chip size is done with computer-enhanced optical measuring equipment at a magnification of 30x. Chips will not extend more than .030" (0.762mm) into print face.

E. Part Features

Location and size of part features are inspected with computer-enhanced optical measuring equipment.

F. Pulse Depth

Average laser pulse depth is inspected on a substrate cross section using enhanced optical methods at a magnification of 30x. The average is determined over a minimum of 20 adjacent pulses (reference Figure 2).

G. Pulse Spacing

Average laser pulse spacing is inspected using enhanced optical methods at a magnification of 30x. The average is determined over a minimum of 10 adjacent pulses.

H. Slag Height

Slag height is inspected with a micrometer and is not to exceed .001" (0.025mm) in height.

I. Cracks

Inspection for cracks is done using dye penetrant, or other appropriate techniques.

J. Camber

Camber is inspected using two parallel ground plates set to a customer-specified distance and a 45° angle. Consult CoorsTek [Thick Film Technical Specifications](#) and [Thin Film Technical Specifications](#) for details on the camber test method.

K. Surface Finish

Surface finish is inspected with a .0004" (0.010mm) radius stylus profilometer using a .030" (0.762mm) cutoff. The center line average is recorded in microinches.

L. Visual Inspection Method for Surface Imperfections

After lasering, the ceramic substrate is visually inspected for defects under a high-intensity, low-angle light using the unaided eye. Consult CoorsTek [Thick Film Technical Specifications](#) and [Thin Film Technical Specifications](#) for details on visual defect methods.

IV. Quality Assurance

A. Quality System

Our quality system is built around Total Quality Commitment. It is a philosophy that embraces continuous improvement. Quality is achieved by using our customer's expectations to select target values and minimize variation around those values. CoorsTek's quality system is certified to ISO-9000, which encompasses every aspect of design, manufacturing, process control and inspection processes.

B. Acceptable Quality Level (AQL) Requirements

CoorsTek applies the ANSI/ASQ Z1.4 Sampling by Attributes General Insp. Level II for visual and dimensional inspections. Alternate acceptance plans and criteria can be negotiated at the time of quotation.

If you have any questions, please call.



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Note: Information in this bulletin illustrates the general laser services of CoorsTek. Users are responsible for selection of laser services suitable for specific applications.