

# CSR-101 Calibration Substrate

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Accurate probe tip measurements on wafers and planar circuits require accurate system calibration to the probe tip end. Calibration eliminates systematic measurement errors caused by the imperfection of the measurement instrument and system accessories (cables, connectors, probe tips, etc.). The quality of calibration significantly depends on the accuracy of calibration standards. Calibration substrates contain precise standards providing an exact system calibration over a wide frequency range.

The |Z| Probe and the CSR family of calibration substrates are developed jointly with Rosenberger Hochfrequenztechnik ([www.rosenberger.de](http://www.rosenberger.de)), a worldwide leading manufacturer of high-frequency coaxial connectors and accessories with over 30 years of experience in the RF and microwave industry.

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## Benefits

- Laser trimmed LOAD resistor, unique accuracy
  - Supports SOLT, SOLR, TRM methods
  - Special alignment elements for all standards
  - Four non-dispersive standard types: LOAD, OPEN, SHORT, THRU/LINE
  - Suitable for 100 to 300  $\mu\text{m}$  pitches
  - GSG and GS/SG footprints
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## Characteristics

|                        |   |
|------------------------|---|
| Material               | Alumina   |
| Size                   | 18 x 22 mm  |
| Thickness              | 635 $\mu\text{m}$   |
| Dielectric Constant    | $\epsilon = 10.2$   |
| Effective Permittivity | 5.73  |
| Effective Velocity     | 0.43  |
| Phase Velocity         | 7.36 ps/m   |
| THRU Impedance         | nominally 50 $\Omega$   |
| DC accuracy (LOAD)     | 50 $\Omega$ +/- 0.15 Ohm (< 0.3 %)                                |
| Temperature drift      | < 0.3 % between $-263^{\circ}\text{C}$ ... $+150^{\circ}\text{C}$ |
| Maximum Power          | 0.3 W   |

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## Substrate Elements

### Standard Name

Each standard on the substrate has a unique name that is used to address it on the substrate standards map. The standards on the substrate are identified by numbers. Each standard has an index number indicating the row and the column of the standard's location.

### Standard Type

Standards on a substrate are divided into two groups: transmission and reflection elements.

The reflection elements include OPEN, SHORT and LOAD standards. When calibrating a system, these elements are used to provide different reflection factors: fully matched (for Load) or highly reflective (for Open and Short)

Transmission elements are the THRU and LINE standards. They are used for measurements of transmission parameters, providing a physical connection between at least two ports of the system. The electrical length of a transmission element is defined in pico-seconds. THRU standards are the shortest lines on the substrate. The length of the THRU standard is equal to the spacing of all reflective standards. LINE standards are the longer transmission elements and used as LINE for TRL calibration or verification purposes.

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## Standard Ports

A standard on the calibration substrate consists of two elements that form a pair. This layout is determined to reduce the calibration time and movement on the substrate with high accuracy measurement. This pair contains two elements formed from the same type. CSR-101 is designed for two-port calibration by using up to four GSG or SG/GS probes. The design is made for right angle configuration between the probes. This design allows simultaneous calibration for up to four probes coming from all four directions.

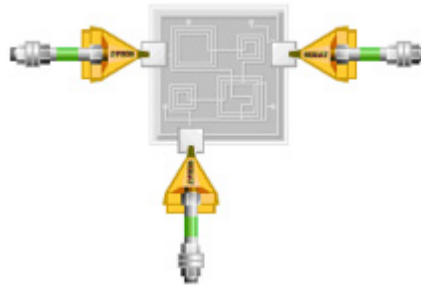


Figure 1. Sample Three-Port configuration

## Location

A map of the standards' locations is defined to enable automated positioning of the probes on the substrate via calibration software. These locations are defined in (X, Y) coordinates in microns according to a specific reference element which has the reference position (0,0). CSR-101 has one reference element for OPEN, SHORT, LOAD, THRU (0,0) to align the probe distance without touching the standards.



Figure 2. Reference alignment standard 07 at position 0,0

# CSR-101 Calibration Substrate

## Probe Spacing and Length of Standards

The distance between probe tips in contact position with the substrate defines the probe spacing in Figure 3.

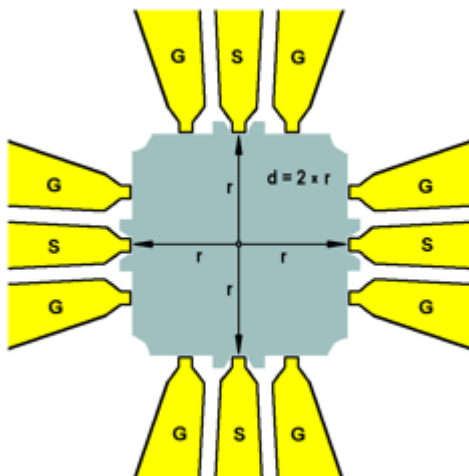


Figure 3. Probe spacing

The electrical length of a LINE standard is defined by the propagation delay time in (ps), which describes the propagation delay for the transmission between two probe tips. This value is calculated from the probe spacing for the transmission elements and the effective velocity of light.

## Recommended Probes and Standard Models

Calibration Substrate CSR-101 can be used with RF probes with pitches from 100 to 300  $\mu\text{m}$  and a GSG footprint. The IZI Probes are recommended to achieve the best measurement accuracy.

Measured values from the calibration substrate include parasitic effects associated with the standards. In order to make the calibration independent of these effects, a simulation of the electric field patterns of the probe touching the standard is done. The results are called correction values. By using these correction values delivered with each IZI Probe, it is possible to set the calibration plane accurately at the end of the tips. The calibration coefficients delivered with the probes are parallel capacitance for the OPEN, series inductance for SHORT and series inductance for LOAD. These values must be entered into the VNA before manual calibration. Using calibration software, these values are adjusted automatically.

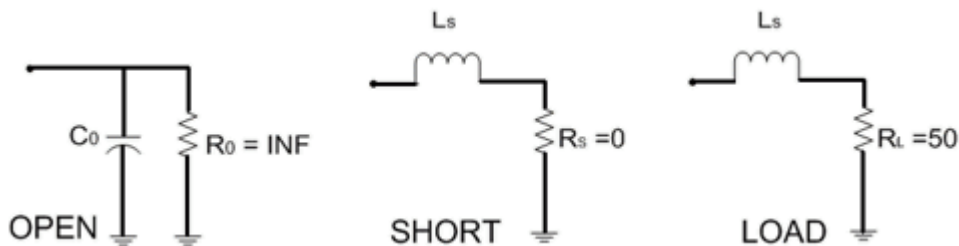
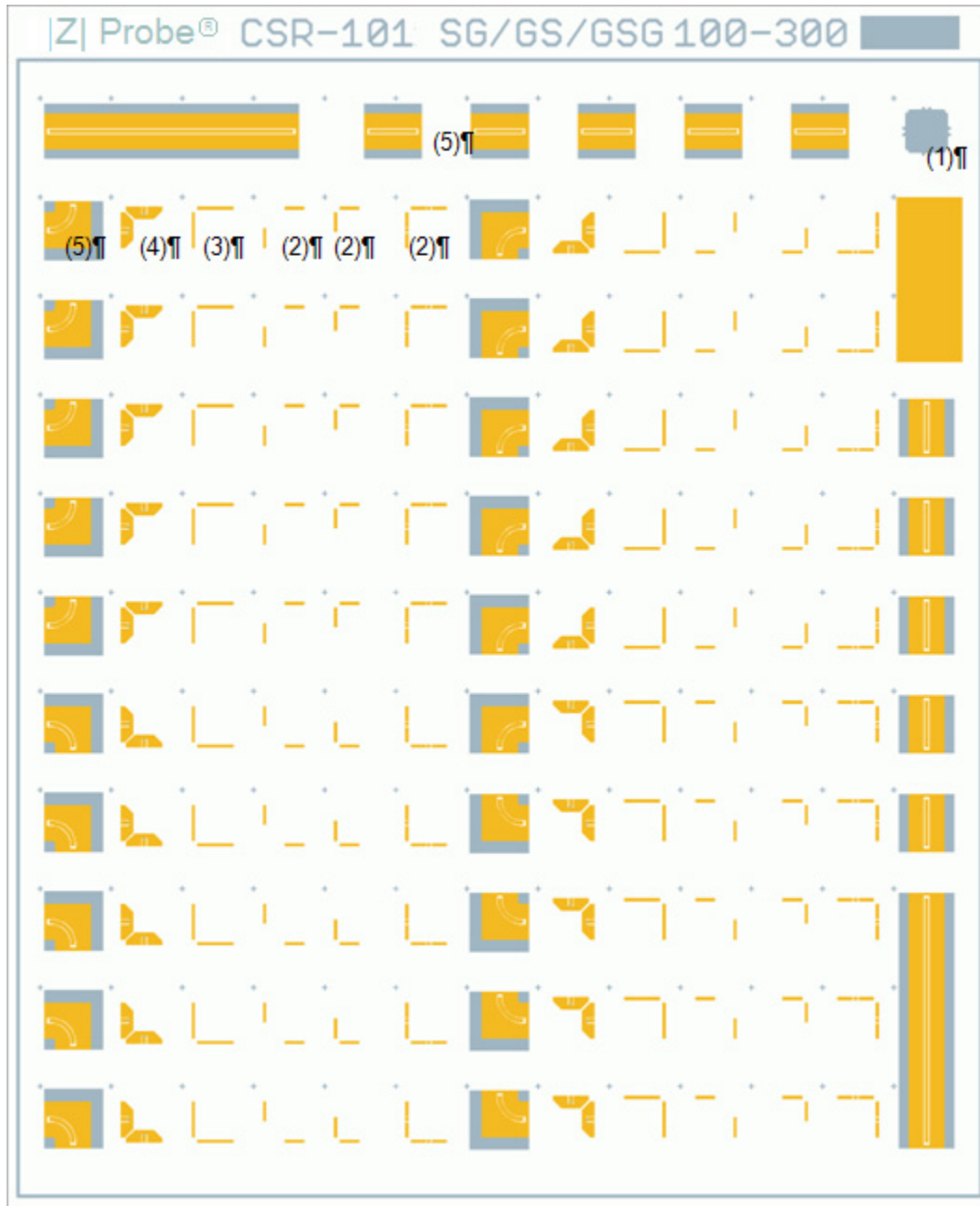


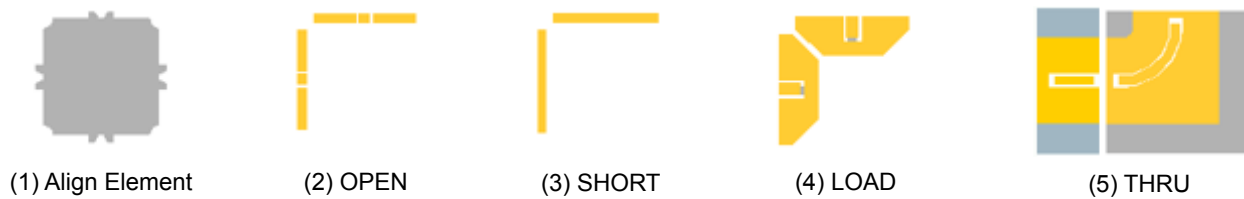
Figure 4. Parasitic elements

# CSR-101 Calibration Substrate

## Substrate Layout



18 x 22 mm



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## Loads Specification

The LOAD standards are laser trimmed thin-film resistors, specified at  $50\Omega$  with certain accuracy. The LOAD standard consists of a pair of resistances, where each is an equivalent resistance of two parallel resistances. The standard and its electrical model is found below, where Table 1 includes the values of the resistances and their tolerances. Due to fabrication, one of the LOAD standards may not be present on the substrate.

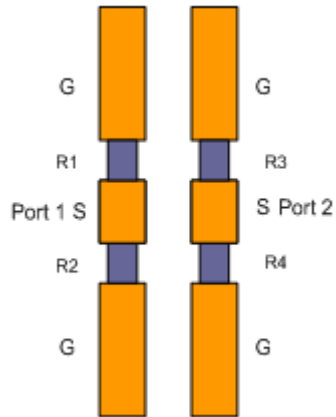


Figure 5. Standard model

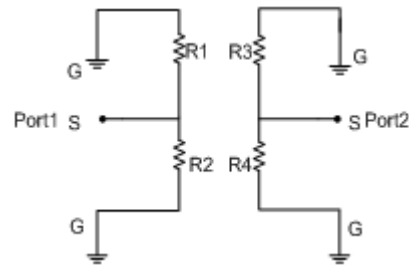


Figure 6. Electrical model

# CSR-101 Calibration Substrate

Table 1. Load resistances and Tolerances

| Substrate ID: |        |    |           |        |    |           |
|---------------|--------|----|-----------|--------|----|-----------|
| Number        | Port 1 |    | Deviation | Port 1 |    | Deviation |
|               | R1     | R2 |           | R3     | R4 |           |
| 9             |        |    |           |        |    |           |
| 400           |        |    |           |        |    |           |
| 401           |        |    |           |        |    |           |
| 402           |        |    |           |        |    |           |
| 403           |        |    |           |        |    |           |
| 404           |        |    |           |        |    |           |
| 405           |        |    |           |        |    |           |
| 406           |        |    |           |        |    |           |
| 407           |        |    |           |        |    |           |
| 408           |        |    |           |        |    |           |
| 409           |        |    |           |        |    |           |
| 410           |        |    |           |        |    |           |
| 800           |        |    |           |        |    |           |
| 801           |        |    |           |        |    |           |
| 802           |        |    |           |        |    |           |
| 803           |        |    |           |        |    |           |
| 804           |        |    |           |        |    |           |
| 805           |        |    |           |        |    |           |
| 806           |        |    |           |        |    |           |
| 807           |        |    |           |        |    |           |
| 808           |        |    |           |        |    |           |
| 809           |        |    |           |        |    |           |
| 810           |        |    |           |        |    |           |

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