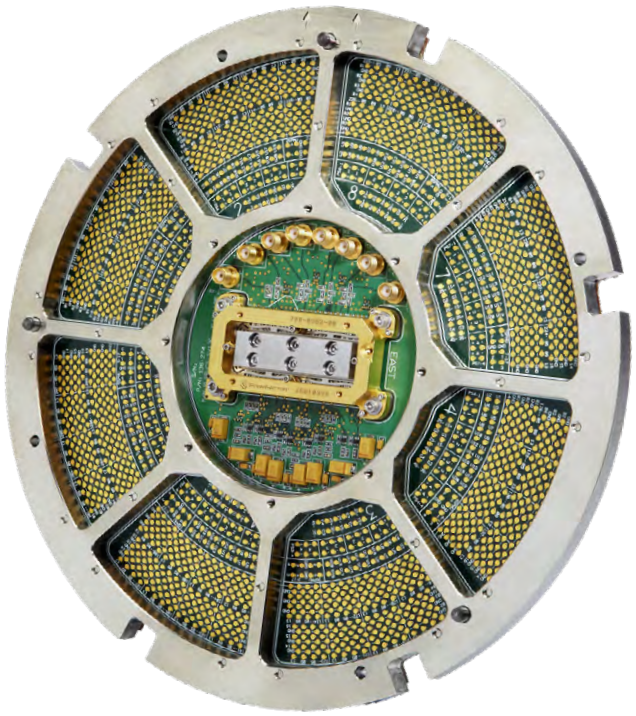
# RF Series

## High-performance RF Pyramid Probe® Card

## Overview

FormFactor's high-performance RF Pyramid Probe cards provide state-of-the-art signal integrity for wireless RF and microwave production test. Microstrip transmission lines maintain impedance control all the way to the bond pad. Patented ground and power planes with bypass capacitors provide resonance-free power supplies directly to the IC. In addition, the RF Pyramid Probe card delivers minimal pad damage and extremely long life, dramatically reducing the cost of ownership versus other RF production probe card offerings. Form Factor's innovative Pyramid Plus™ manufacturing process ensures a substantially lower cost of ownership, while delivering superior RF signal integrity in a single solution.



## Features / Benefits

| | |
|---|---|
| **Superior signal performance** | • High-bandwidth RF transmission lines and guarded DC traces to probe tips guarantee performance and ensure low signal loss<br>• Patented ground and power planes, with bypass capacitors, provide resonance-free stable power supplies directly to the DUTs<br>• Consistent low contact resistance and low-inductance probe tips ensure accurate and repeatable high-speed digital and analog measurements |
| **Mechanical robustness** | • MicroScrub® technology provides consistent low contact resistance and inductance on a variety of pad materials and flip-chip bumps<br>• High-density photolithographically-placed contact probe tips are stable over lifetime of product.<br>• Low maintenance and permanent probe tip placement improve test cell uptime, reducing the cost of ownership compared to other probing technologies |
| **Versatile and cost-effective** | • Lower maintenance overhead with less cleaning and no need for probe tip alignment |
| **Advanced membrane technology** | • FormFactor's industry-leading Pyramid Plus manufacturing process delivers higher performance, plus unique features that lower your cost of test |

## Mechanical Specifications

| | P100-P800 | P800-S |
|---|---|---|
| Minimum pitch, peripheral | 50 µm | 67 µm |
| Staggered pitch, peripheral | 36 µm/72 µm | 44 µm / 88 µm |
| Minimum pitch, array | 180 µm (dependent on maximum array size) | 180 µm (dependent on maximum array size) |
| Dimensional stability for lifetime | 10 µm for single temperature | 10 µm for single temperature |
| Probe tip size Al, Cu (nominal) | 12 µm | N/A |
| Probe tip size Low K/PoAA (nominal) | 18 µm | N/A |
| Probe tip size Au, solder balls (nominal) | 25 µm | 25 µm |
| Probe tip material | Non-oxidizing nickel alloy | Non-oxidizing nickel alloy |
| Temperature range | -50°C to 125°C | -50°C to 125°C |
| Pad and bump materials | Al, Cu, Au, all types of solder balls | All types of solder balls |
| Spring rate | 1.67 g/mil | 3.33 g/mil |
| Edge sense | Optional | Not available |

## Electrical

| | |
|---|---|
| Leakage | 1.4 nA/V |
| Contact resistance | 0.1 to 0.2 Ω (Al pads), 0.005 to 0.010 Ω (Au pads), 0.3 to 0.5 Ω (solder balls) |
| Maximum current / tip | 1 A (Au pads), 200 mA (Al pads, Cu pads and solder balls) |
| Maximum power 50 Ω microstrip | +33 dBm CW, +36 dBm pulsed |
| Max. power 50 Ω Co-Planar Waveguide (CPW) | +33 dBm CW, +39 dBm pulsed |

## Power Supply Performance

| | |
|---|---|
| Power trace impedance | 10 Ω |
| Power supply non-resonant | up to 10 GHz |
| Inductance to first capacitor | 0.2 nH |
| Maximum current standard power trace | 1 A |
| Maximum current per power supply | 10 A |

## Signal Trace Performance

| **Standard** | |
|---|---|
| Signal line impedance | 50 Ω nominal |
| Ground inductance (typical) | 0.04 nH |
| Return loss (S11) to coax | >10 dB @ specified bandwidth |
| Input reflection | ±80 mrho @ 50 Ω |

| **Optional** | |
|---|---|
| Range of trace impedances | 2 Ω to 120 Ω ±20% |
| Differential impedance | 50 Ω, 100 Ω and 200 Ω |

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## Signal Trace Length Matching

| | |
|---|---|
| Typical signal | No match |
| Optimized signal (custom layout) | ±1.5 ps (3 ps window) |

## Series Path Resistance (Typical)

| | P100 | P300 | P400 | P500 | P800/P800-S |
|---|---|---|---|---|---|
| DC resistance | 1 Ω | 1 Ω | 1.6 Ω | 2.5 Ω | 2.5 Ω |
| Microstrip | 1.2 Ω | 1.2 Ω | 2 Ω | 3 Ω | 3 Ω |
| CPW | 0.8 Ω | 0.8 Ω | 1 Ω | 1.2 Ω | 1.2 Ω |

## Typical Isolation Measurements

| | | |
|---|---|---|
| Filter and switch | 2 GHz | 50 dB to 70 dB |
| High pin count | 10 GHz | 50 dB |
| Telecom | 20 GHz | 45 dB |

## Matching Network Examples

| | Output Impedance | Components | Correlation to Package |
|---|---|---|---|
| Power amplifiers | 2 Ω to 8 Ω | 125 ps from DUT | ±0.5 dB |
| Wireless RF | 100 Ω to 120 Ω differential | Balun on PCB | ±1 dB |

## Component on Membrane

| | |
|---|---|
| Package type | SMT |
| Sizes | 01005, 0201, 0402, 0603, 0805 |

## Components Defined Within Membrane

| | |
|---|---|
| Inductors | 0.3 nH to1 nH (±0.3 nH) |
| Inductors | 1 nH to 10 nH (±30 %) |
| Trimmed inductors | 0.3 nH to 10 nH (±0.1 nH) |
| Capacitors | 20 fF to 2 pF (±20 %) |

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## Pyrimid Core Options and Name Correlation

| Frame Core | | P100 | P300 | P400 | P500 | P800 | P800-S |
|---|---|---|---|---|---|---|---|
| Previous frame core | | RFC | SRF | MSI | LSI | VLSR | P800-S |
| I/O capacity | | 108 | 264 | 408 | 520 | 804 | 804 |
| XY area (mm) | | 4.1 x 4.1 | 4.1 x 4.1 | 9.6 x 9.6 | 24 x 24 | 38 x 11 | 38.4 x 12.5 |
| Components on core | | 32 | 32 | 40 | 100 | 120 | 120 |
| Depth* from tester side, mm (in.) | Shallow | | | 6.096 (0.240) | 6.096 (0.240) | 6.096 (0.240) | |
| | Standard | 4.521 (0.178) | 4.521 (0.178) | 6.985 (0.275) | 8.712 (0.280) | 8.712 (0.280) | 8.712 (0.280) |
| | Extra | 5.334 (0.210) | 5.334 (0.210) | 8.712 (0.343) | 8.712 (0.343) | 8.712 (0.343) | 8.712 (0.343) |
| | Deep | 6.223 (0.245) | 6.223 (0.245) | 10.287 (0.405) | 10.287 (0.405) | 10.287 (0.405) | 10.287 (0.405) |
| | 440 | | | 11.176 (0.440) | | 11.176 (0.440) | 11.176 (0.440) |

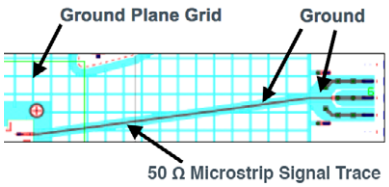
Depth variation is ± 0.30 mm (± 0.012”) from one design to another, and repeatable to ±0.10 mm (± 0.004”) within the same design.

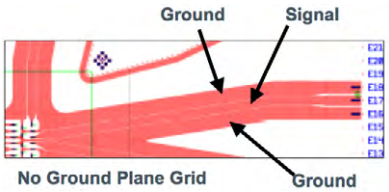
## RF-Class Bandwidth and Risetime Performance

| Transmission line | | | Frame Core Bandwidth and Rise Time | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Membrane** | **PCB** | **Connector** | **P100** | | **P300** | | **P400** | | **P500** | | **P800/P800-S** | |
| Microstrip | Microstrip | Pogo pad | 2 GHz | 200 ps | 2 GHz | 200 ps | 2 GHz | 200 ps | 2 GHz | 200 ps | 2 GHz | 200 ps |
| Microstrip | Microstrip | PCB coaxial | 7 GHz | 50 ps | 7 GHz | 50 ps | 7 GHz | 50 ps | 7 GHz | 50 ps | 7 GHz | 50 ps |
| Microstrip | Coax | K or V | 20 GHz | 22 ps | 20 GHz | 22 ps | 20 GHz | 22 ps | 15 GHz | 25 ps | 20 GHz | 22 ps |
| CPW | Coax | K or V | 20 GHz | 15 ps | 20 GHz | 15 ps | 20 GHz | 17 ps | 20 GHz | 22 ps | 20 GHz | 17 ps |

## 50Ω Signal Trace Options

| **Microstrip** | **Coplanar Waveguide (CPW)** |
|---|---|
| Standard option | Optional |
| Higher routing density/Smaller trace width | Lower routing density/Wider trace width (GSG) |
| Best choice for isolation | Higher power/Lower path resistance |

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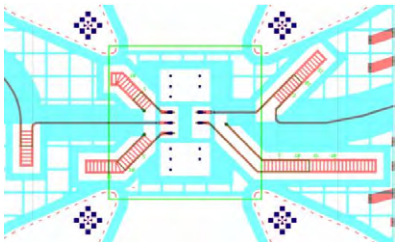
## Emulating Lead Inductance

Some circuits require proper inductive loading

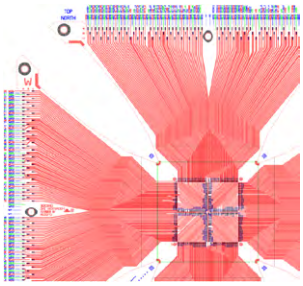
Effects cannot be calibrated out easily

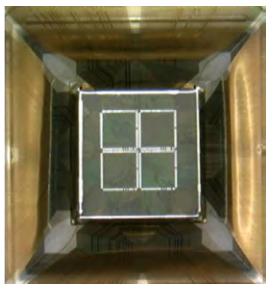
Embed inductance on all interface pins into probe card

Do not calibrate past lead inductance structures



## Multi-DUT Testing (Cell Phone Processor)





## Impedance Matching

Not all devices operate at 50 Ω

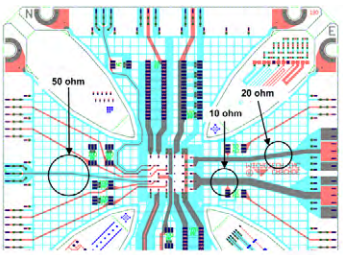
Matching to real impedance is needed for many tests

Incorporate into probe card

Many techniques: Lumped element

Quarter wave transmission line

Combination



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