Ridgetop Group, Inc.

Ridgetop Group Facilities in Tucson, AZ

- Arizona-based firm, founded in 2000, with focus on electronics for critical applications
- Two divisions: Semiconductor & Precision Instruments (SPI) and Advanced Diagnostics & Prognostics (ADP)
- Technology leader in precision test structures for QA and prognostic applications
- Wide range of commercial and government customers

- Worldwide nanotechnology R&D partners in industry and academia
- Foundation and focus in physics-of-failure for electronic systems

Ridgetop Europe Facilities in Brugge, Belgium

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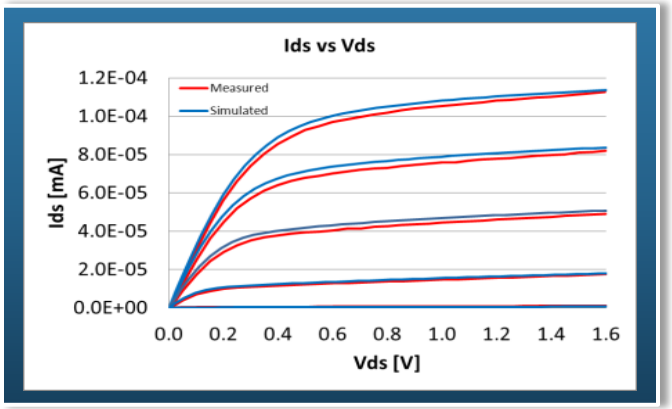
ProChek™

Semiconductor Process Qualification & Reliability Characterization System

Foundry PDK May Not Be Sufficient

Reliability Concerns	Foundry PDK	ProChek
Variations Across Wafers & Lots		■
Application-specific effects (e.g., temperatures, radiation, biasing, specific geometries)		■
Physical fabrication effects (e.g., directional, wafer angle)		■
Random parameter fluctuation simulation data		■

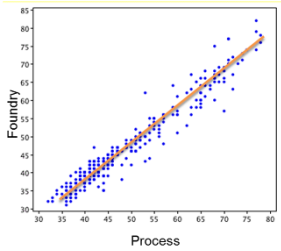


Characterization Systems Should…

Deliver lots of data

- Quickly
- Accurately & repeatably
- For different devices
- For different operating conditions

Be inexpensive to own and operate



Allow for direct correlation across foundries and processes

Be easy to use

What is ProChek?

An innovative low-cost technique to rapidly

characterize intrinsic process reliability and monitor process quality

ProChek…

- Is a flexible & dedicated semiconductor qualification and reliability characterization system.
- Is based on a cost-effective bench-top instrument.
- Uses a specially designed test chip integrated with the bench-top instrument.
- Accelerates testing of semiconductor devices in volume.
- Puts key instrumentation on silicon to reduce cost, increase flexibility, improve capability, shrink the footprint.

ProChek reduces data collection from months to days

ProChek Characteristics

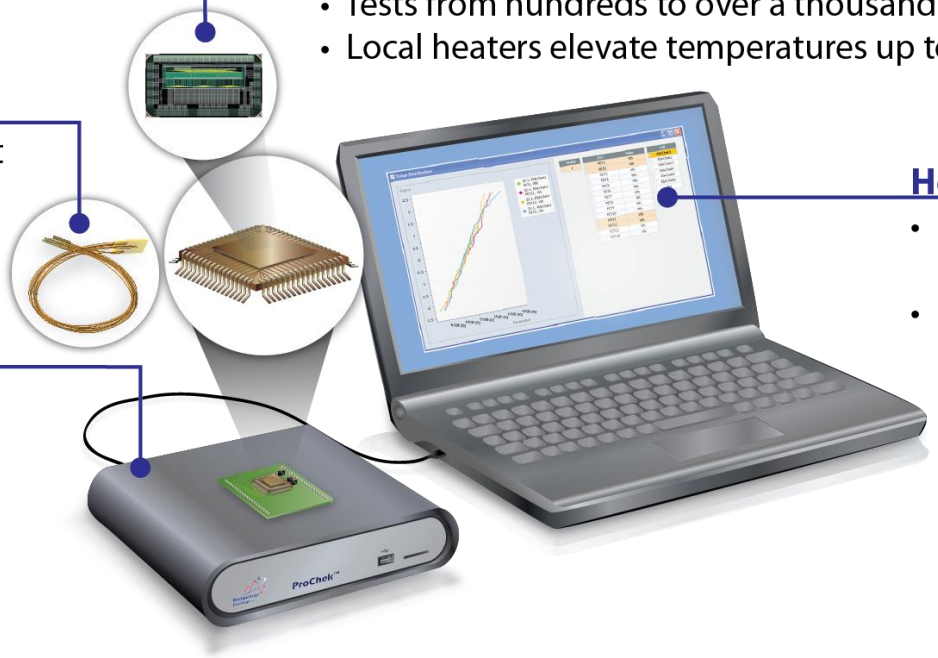
Characterizes deep submicron (DSM) processes (bulk CMOS, SiGe, SOI) reliability and variability effects

Test Coupon

- Low cost
- Easily ported
- Small as 1 mm x 1 mm area
- Easily controlled: Fully programmable test conditions cover DC and AC stress cases
- Highest throughput: Test time reduced from months to hours
  - Tests from hundreds to over a thousand devices
  - Local heaters elevate temperatures up to over 300 °C

ECTC

- Environmental chamber test cable for placing test card in environmental chamber (optional)



Host Controller

- Easy-to-use software interface
- Local data processing

Benchtop Tester

- Universal: Supports all test coupons
- Low cost: No "big iron" ATE or oven required
- Contains/controls all stress and measurement instruments

Key ProChek Benefits: Accurate, Comprehensive, Fast, Affordable

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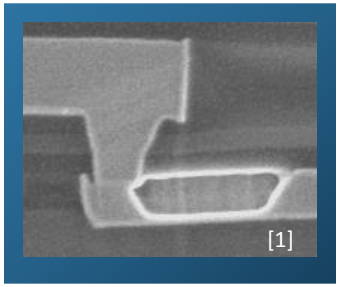
ProChek Data Collection

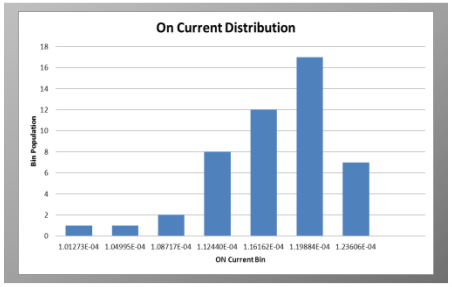
Major degradation effects and accelerated stress

- Negative Bias Temperature Instability (NBTI / Fast-NBTI)
- Positive Bias Temperature Instability (PBTI / Fast-PBTI)
- Time-Dependent Dielectric Breakdown (TDDB)
- Hot Carrier (HC) Damage
- Electromigration (EM)
- Stress Migration (SM)



Accelerated data collection

- Collection of data from multiple DUTs simultaneously
- DUT degradation is accelerated with electrical and thermal overstress
- Statistical analysis of collected data/results

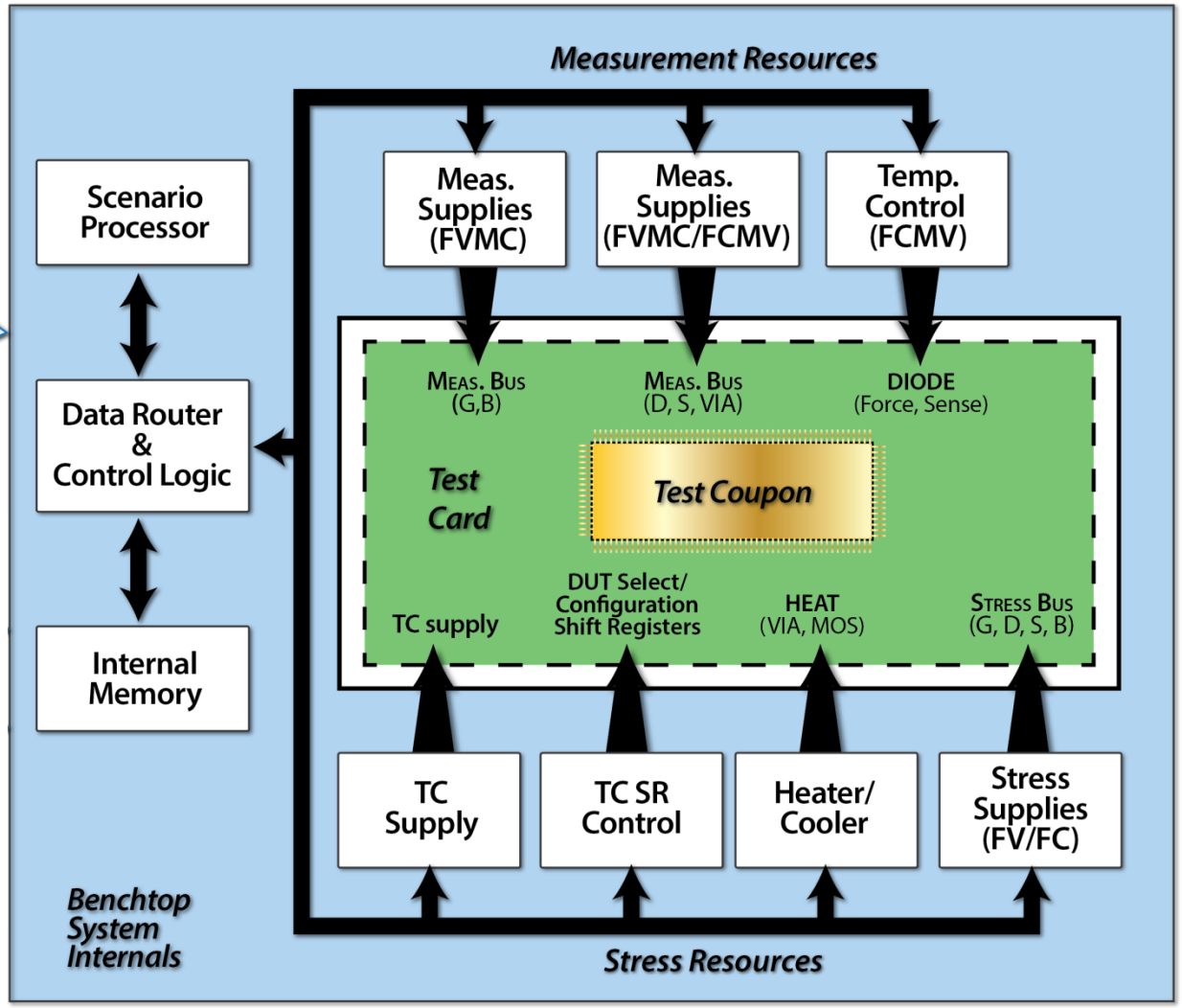


[1] Ki-Don Lee, et al., "VIA PROCESSING EFFECTS ON ELECTROMIGRATION IN 65 NM TECHNOLOGY", 44th Annual International Reliability Physics Symposium, San Jose, 2006

ProChek Benchtop Tester Architecture

Computer GUI
» Test Setup & Control
» Result Collection
» Result Processing

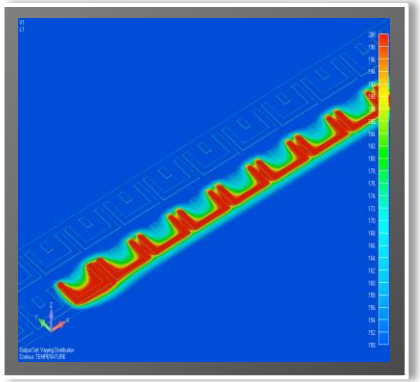
USB 2.0



Accelerated Testing

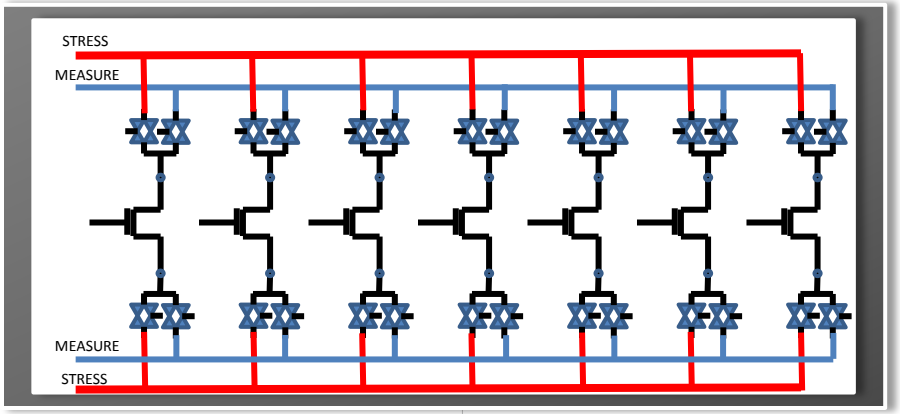
Combining Thermal and Electrical Overstress

- Peltier device and embedded polysilicon heaters elevate/reduce DUT thermal stress from -30 ˚C to over 300 ˚C
- 4 terminals available to apply electrical stress to each DUT



Multiple Measurements In Parallel

- High throughput
- Parallel test of 32 – 1024 devices
- Test time reduced from months to hours

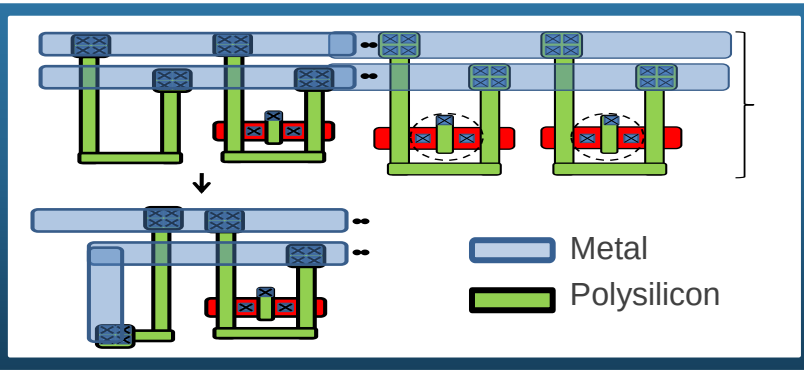


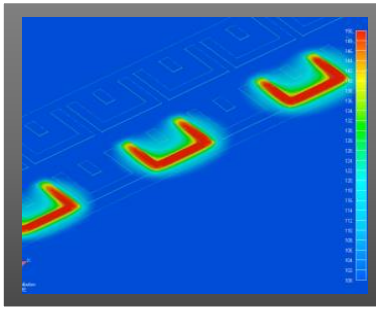
Parallel Test Systems

- Up to 8 benchtop instruments may be controlled from a single PC

Local Heating Structures

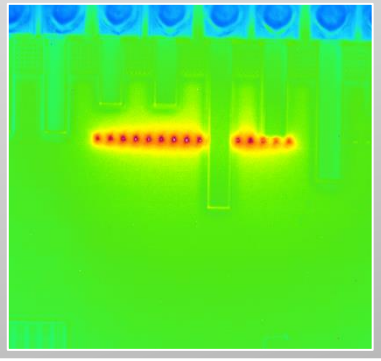
- Polysilicon tracks are used to create a border around each DUT.





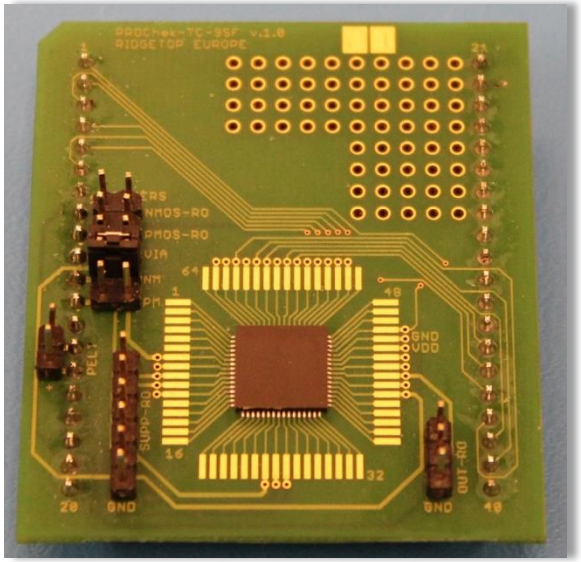
- Localized DUT heaters reach maximum temperature in milliseconds. Non-stressed structures do not undergo any damage.
- Current is forced through these resistive elements to heat the area around the DUTs to over 300 ºC.

- Infrared camera data from embedded heating test from IBM 8HP test coupon
- Increasing temperatures will reduce EM, SM and BTI test time and cost

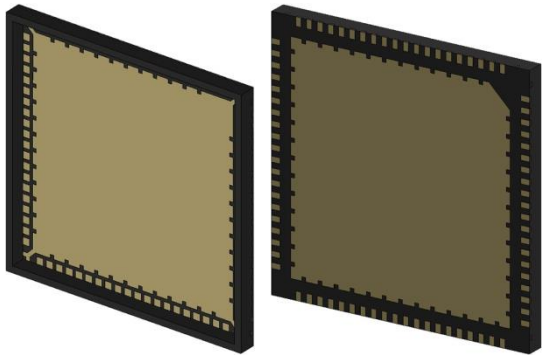


ProChek Test Coupon

- The Test Coupon contains the DUTs, heaters, temperature sensors, switches and control structures (the on-chip switching matrix) necessary for performing reliability test with the ProChek Benchtop Tester.
- Coupons are packaged in open cavity Plastic or Ceramic packages.
- Packages must have an exposed thermally conductive bulk (usually copper) to ensure good heat conduction.



Packaged ProChek Test Coupon assembled on ProChek Test Card



Top and bottom view of package

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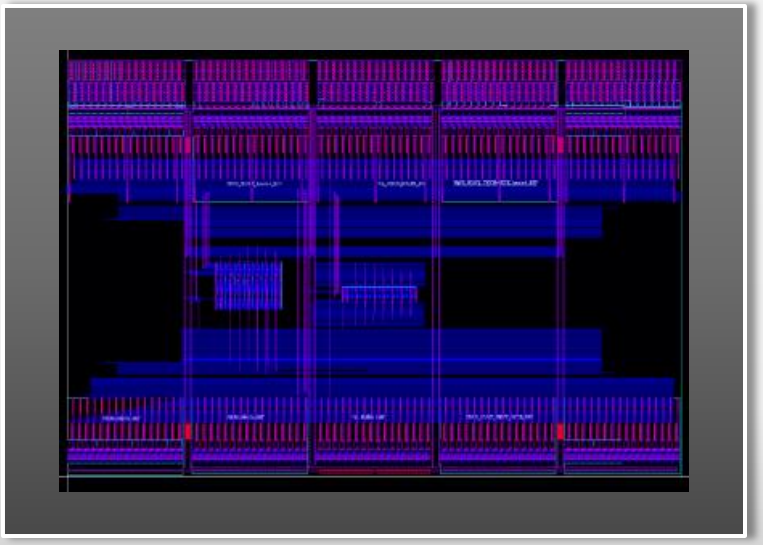
Types of ProChek Test Coupons

Integrated Test Coupon

- DUT test structures, control, selection logic, switches, and heaters on a single die.
- Requires both:
  - “Mature”, well defined process, for which there is a stable and well-qualified PDK
  - Process featuring more robust transistors than the DUT test structures



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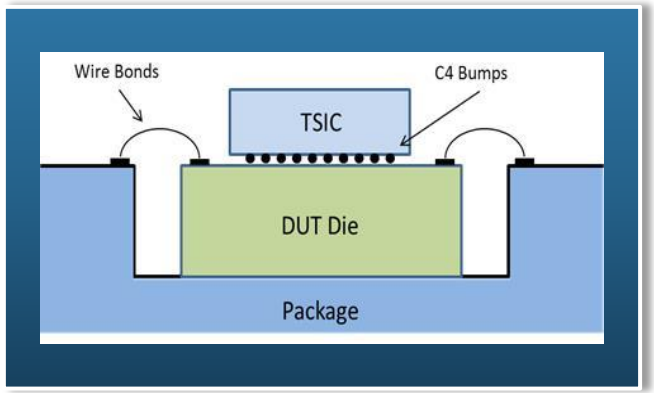
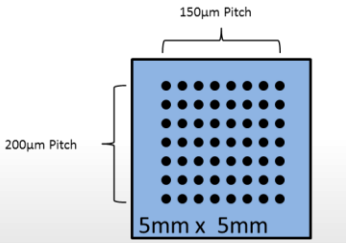
Types of ProChek Test Coupons

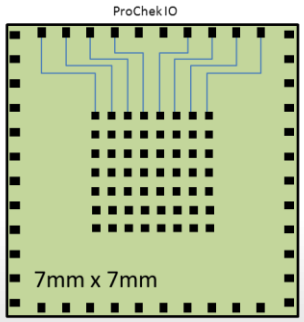
Test Supervisor IC + DUT IC

- A combined Test Coupon solution consists of a Test Supervisor IC (TSIC) and one or more DUT ICs.
- TSIC:
  - Contains Control and Switching matrix
  - separate die in a mature, higher voltage process.
- DUT IC:
  - DUT structures and heaters
  - separate die using the process of interest.
- The two dies are combined in a single package.



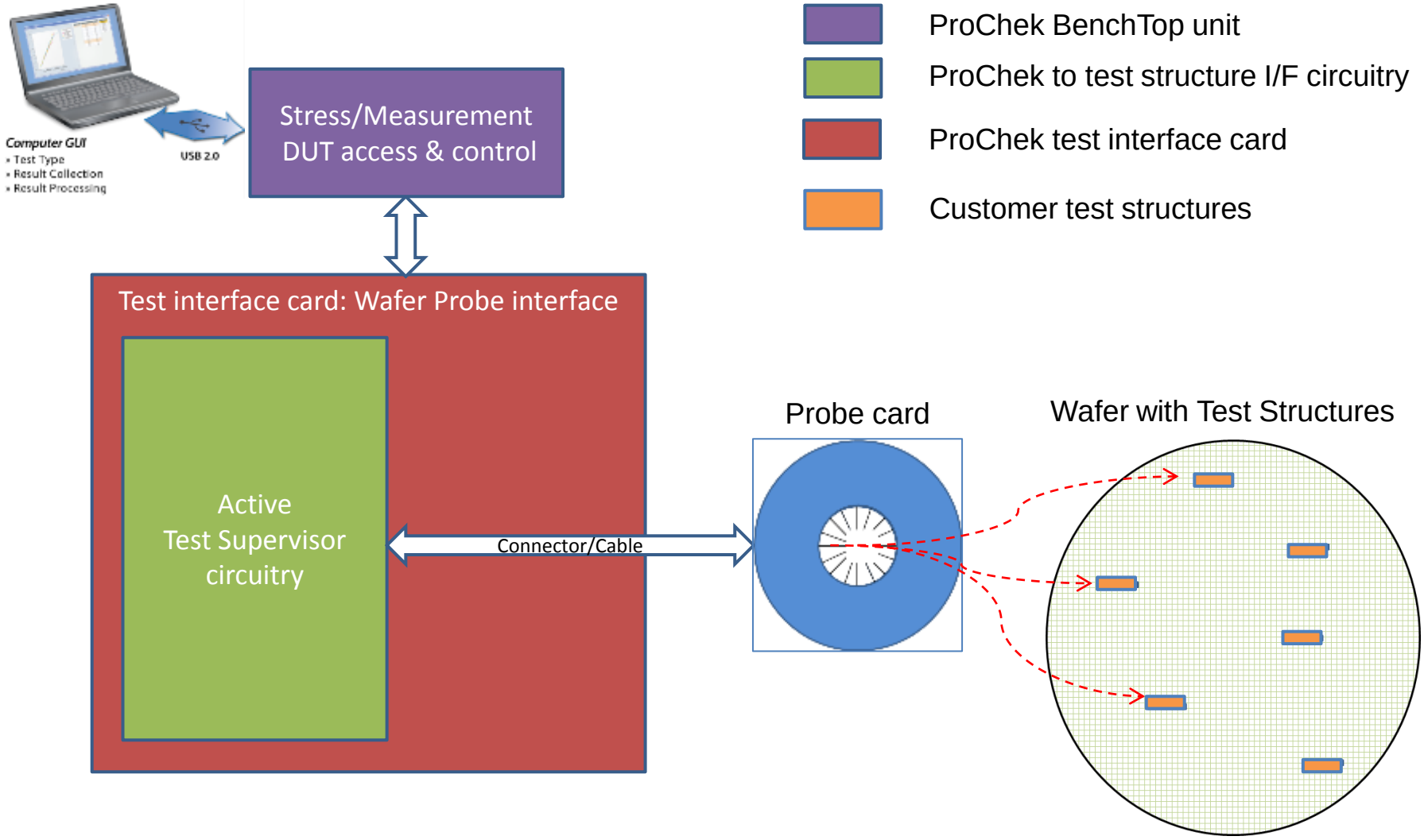


TSIC- High Voltage CMOS

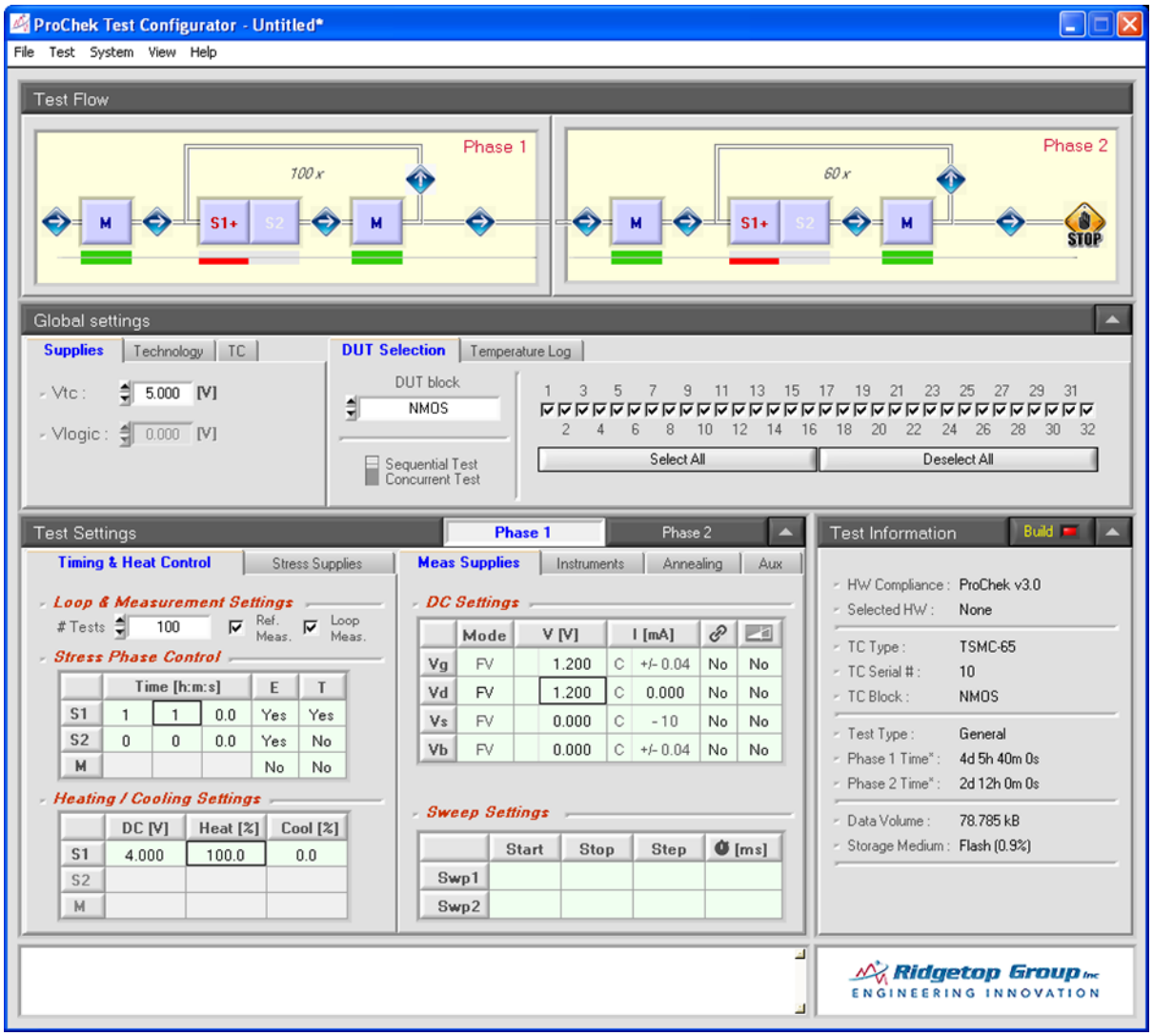


DUT IC – Process of Interest

Customized Wafer Probe Interface

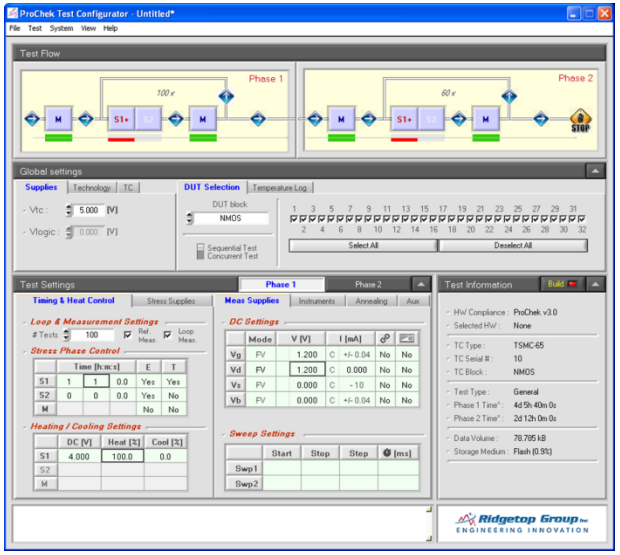


ProChek Software Interface



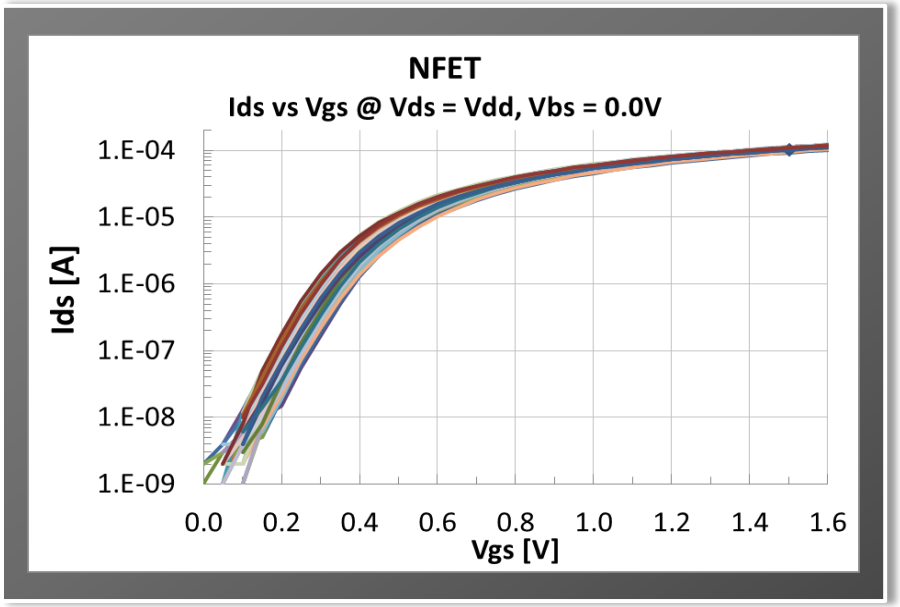
ProChek Benefits

- Accelerated characterization of new and existing processes
- Ample and accurate process quality information
- Low cost of ownership
- Small, portable, and easy to use

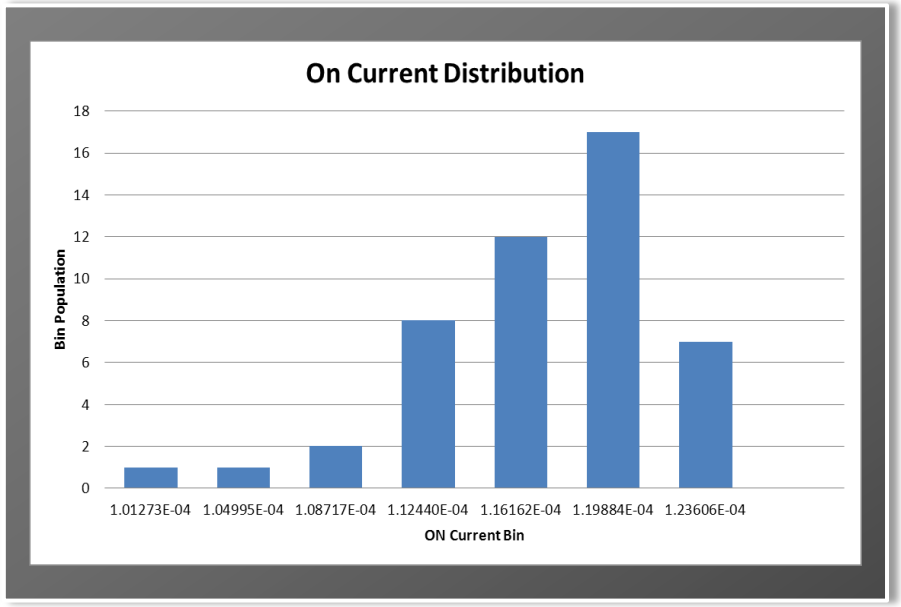


Bottom Line: ProChek Value

- The ProChek approach allows for a statistical analysis of data relevant to quality monitoring. By increasing the volume of data recorded, a robust analysis can be performed.



Ids Vds curves for 48 NFET DUTs



Distribution of On Current in 48 NFET DUTs

- Slides and recording of the webinar will be available shortly via an e-mail from Ridgetop

- E-mail follow-up questions & comments to:
  - Dr. Jim Lloyd: jrlloyd@vinfiz.net
  - Andrew Levy: andrew.levy@ridgetopgroup.com

- Please fill out our brief feedback survey at https://www.surveymonkey.com/s/FHM62W9

Thanks for your time and interest!

Thank you!

Ridgetop Group, Inc.

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