ProChek™

Wafer Level Reliability Test Application

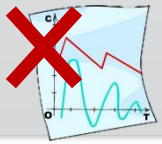
Agenda

- Introduction
- ProChek & Test Structures
- ProChek WLR Application
- ProChek Test Considerations & Test Results
- ProChek Plus
- Summary
- Q&A.

Why ProChek

Obtaining Data

- End-User Perspective
  - Incomplete data for reliability analysis
  - May not provide detailed data
  - Does not provide radiation data
- Fab Perspective
  - Expensive and lengthy process to obtain test result data
  - Data Management
    - Several types of data need to be collected accurately
    - Several devices under test (DUTs) are tested at the time



Long & Resource Intensive

- Defining and characterizing semiconductor reliability attributes takes a lot of time and resources.

Expensive Equipment

- Modern test equipment requires a large capital investment, is complicated to use, and may be focused on a single purpose.

Comparative Data

- Selecting the foundry that provides the best performance devices for your products.
- Tracking long term performance and product quality.

What is ProChek ?

An innovative low-cost concept serving to rapidly

characterize intrinsic process reliability and monitor process quality

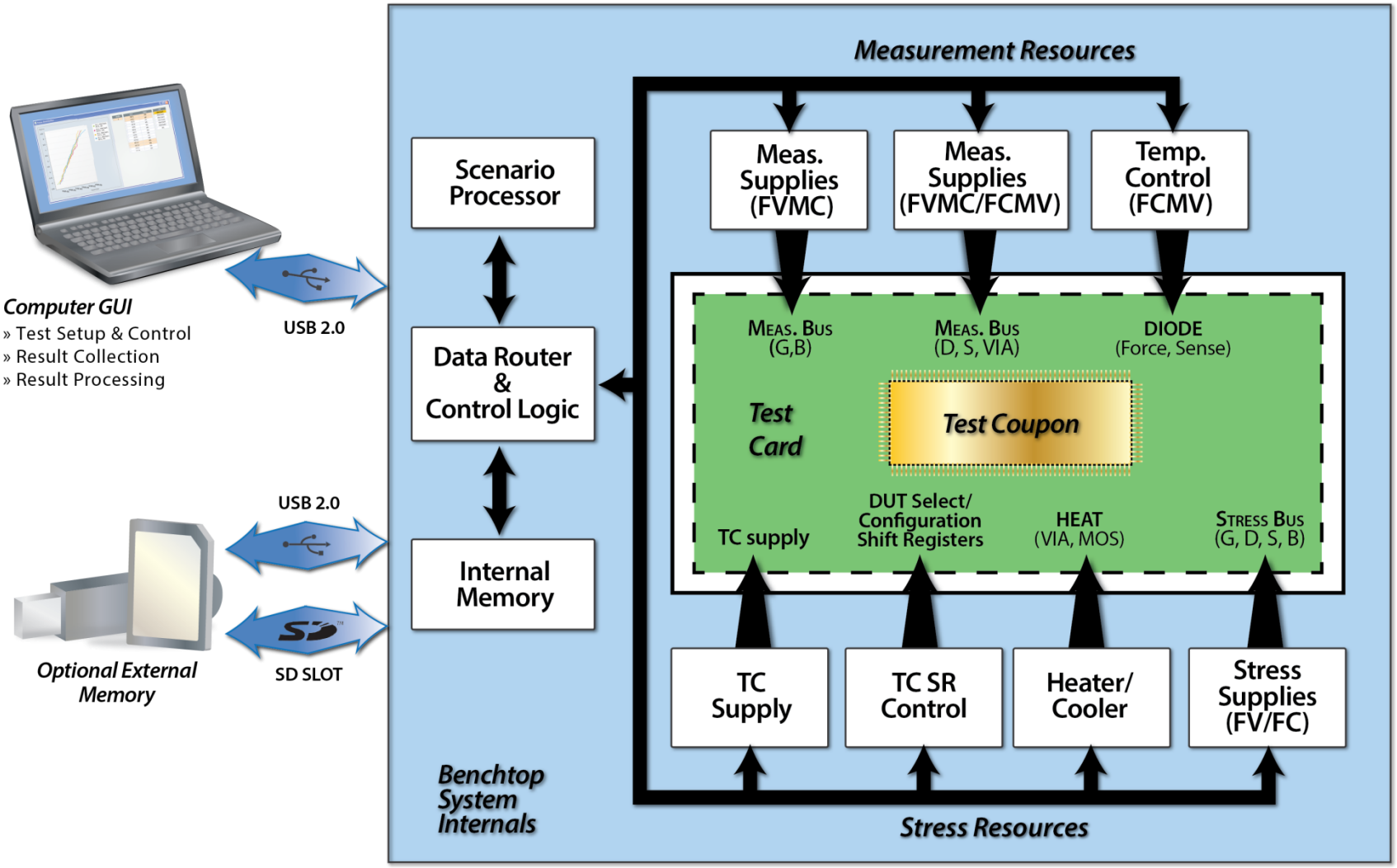
ProChek…

- Is a flexible & dedicated semiconductor qualification and reliability characterization system.
- Is based on a cost-effective bench-top instrument.
- Interfaces to a variety of test structures
  - Single devices
  - Wafer level test structures
  - Dedicated test chips.
- Accelerates testing of semiconductor devices in volume.

ProChek Applications

- ProChek serves to
  - Characterize/quantify existing and new processes from a quality/performance perspective
    - → gather device data (I/V curves, point measurement data)
  - Characterize/quantify existing and new processes from a reliability perspective
    - → evaluate performance degradation over time in function of operation and stress conditions

ProChek Architecture



ProChek Resource Overview

- ProChek offers full 4-terminal (gate, drain, source, body) control
  - Resources:
    - → 4 Stress resources, serving to apply electrical stress
      - can operate in Force Voltage (FV) or Force Current (FI) mode
    - → 4 SMUs, serving to collect data
      - can operate in Force Voltage Measure Current (FVMI) or in Force Current (FI) mode,
      - 10µs sampling, 4K data buffer per instrument, 24bit data
    - → Voltmeter
      - Can operate in absolute or differential mode
      - Can operate as “slow” (10µs sampling) or as “fast” (500ns sampling) meter
    - → Utilities
      - Utility Voltage source
      - Utility Current source
      - Utility Voltmeter
      - Heater/Cooler control

ProChek Extensions

- ProChek has provisions for expansion with additional (add-on) instruments.
  - New ProChek Plus platform supports up to 24 (48) instruments/SMUs
- User specific test structures can easily be converted to a native ProChek test structure by means of an active interface board.

ProChek Concept

- Analogy: Orchestra
  - ProChek resources == musical instruments
  - Scenario processor == Conductor
  - Test Strategy == Music piece
  - User == Composer
    - → Controls how the music is played (key, timbre, …)
    - → Can write his own partitions
      - Generic Test strategy support
    - → Can rely on predefined (but yet configurable) strategies (EM, SM, HCI, QBD, TDDB, xBTI, …)

ProChek Application

- ProChek System
- Device under Test (DUT) or a set of DUTs
- Interface to link DUT with ProChek system
  - Function of DUT nature (packaged, wafer structure, set of DUTs)
    - → Simple cable with appropriate connectors
    - → Passive Adapter/interface board with DUT socket
    - → Active interface board with DUT socket
    - → Probe card + link between probe card and ProChek system

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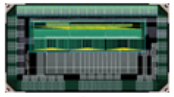
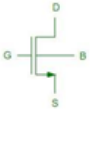
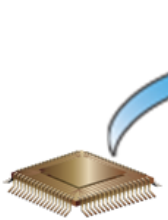
ProChek & Test Structures



High Throughput Test Coupon
- Multiple arrays of various types of test devices
- Embedded precision switching matrix
- Parallel stressing of multiple test devices
- Embedded heaters generate temperatures to 250 °C
- Easily ported across fabrication processes



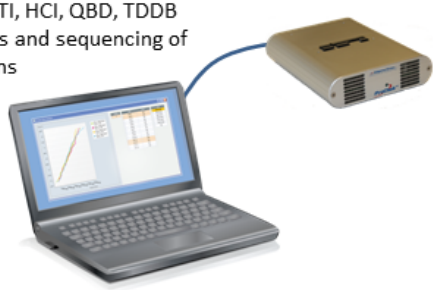
Wafer-level
- Existing test structures
- Direct dock or cable interface
- Connects to active interface board



Package-level
- Existing test structures
- Mounted on active interface board

Optional Extension Cable
- Connects to interface card or probe card
- Remote test structure control

Host Controller
- Easy-to-use software interface
- Test configuration, data extraction & conversion
- Test templates include EM/SM, xBTI, HCI, QBD, TDDB
- Fully programmable test conditions and sequencing of stress-and-measurement operations
- Local data processing
- Data visualization



ProChek Platform
- Benchtop or direct dock to probe card
- Contains/controls all stress/measurement units (SMUs)
- Fast (500 ns to 10 µs sampling) measurements
- Supports all test coupons and individual test structures
- Low-cost stand-alone unit replaces ATE or rack & stack equipment
- Built-in heating/cooling control

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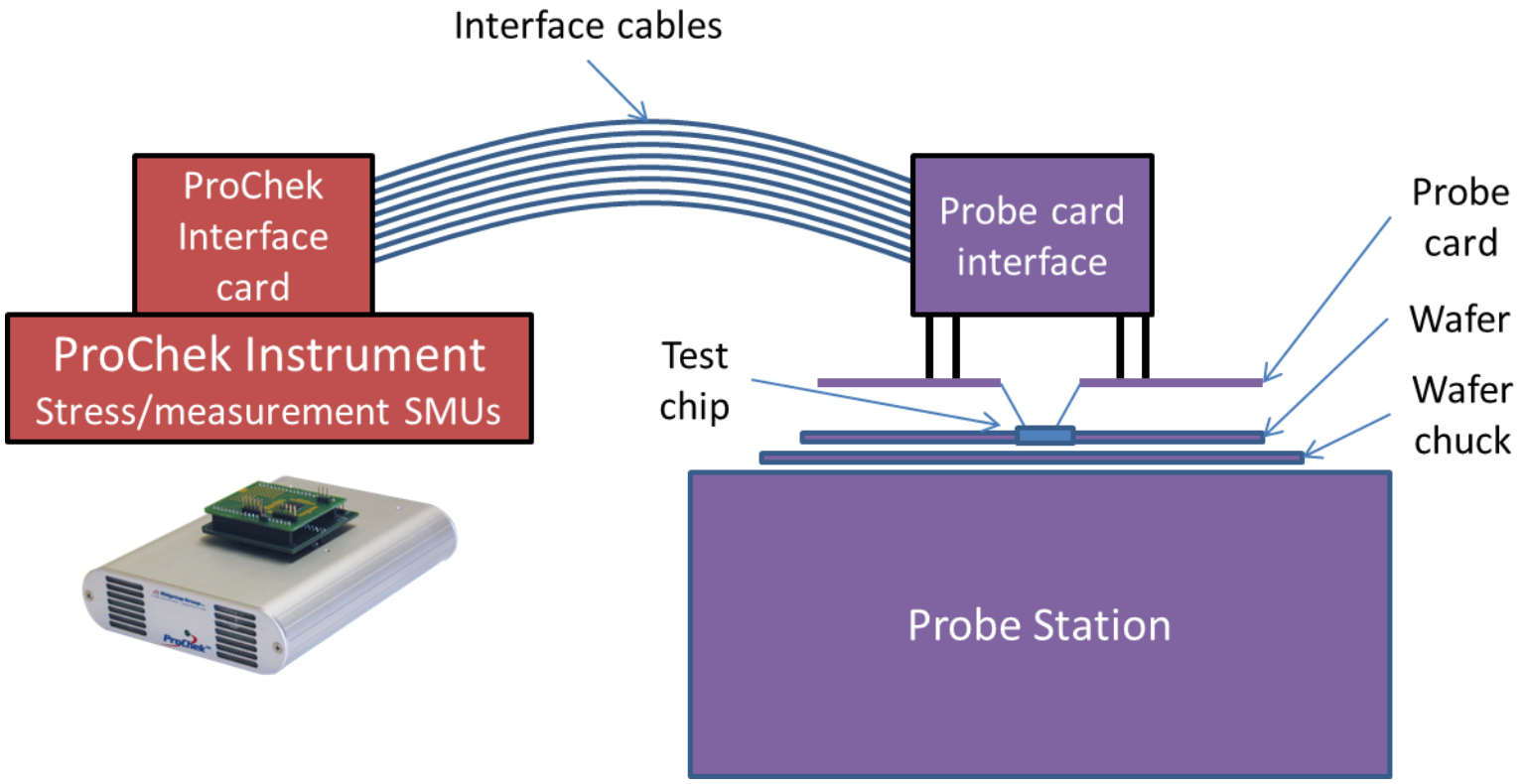
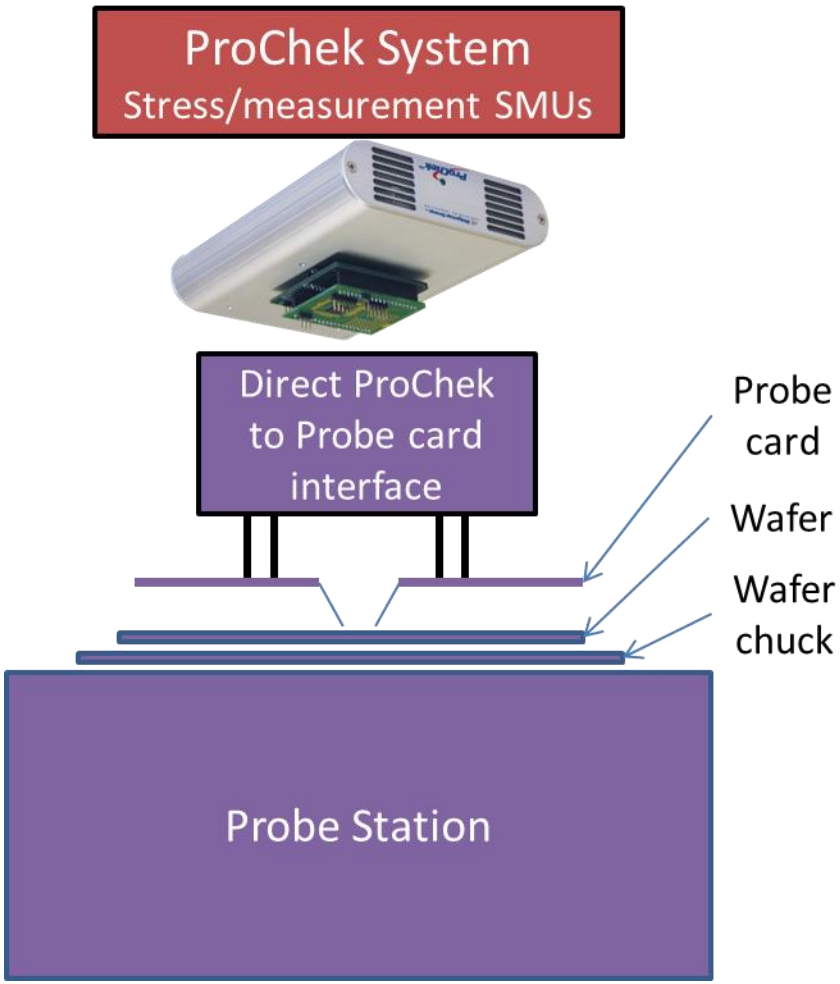
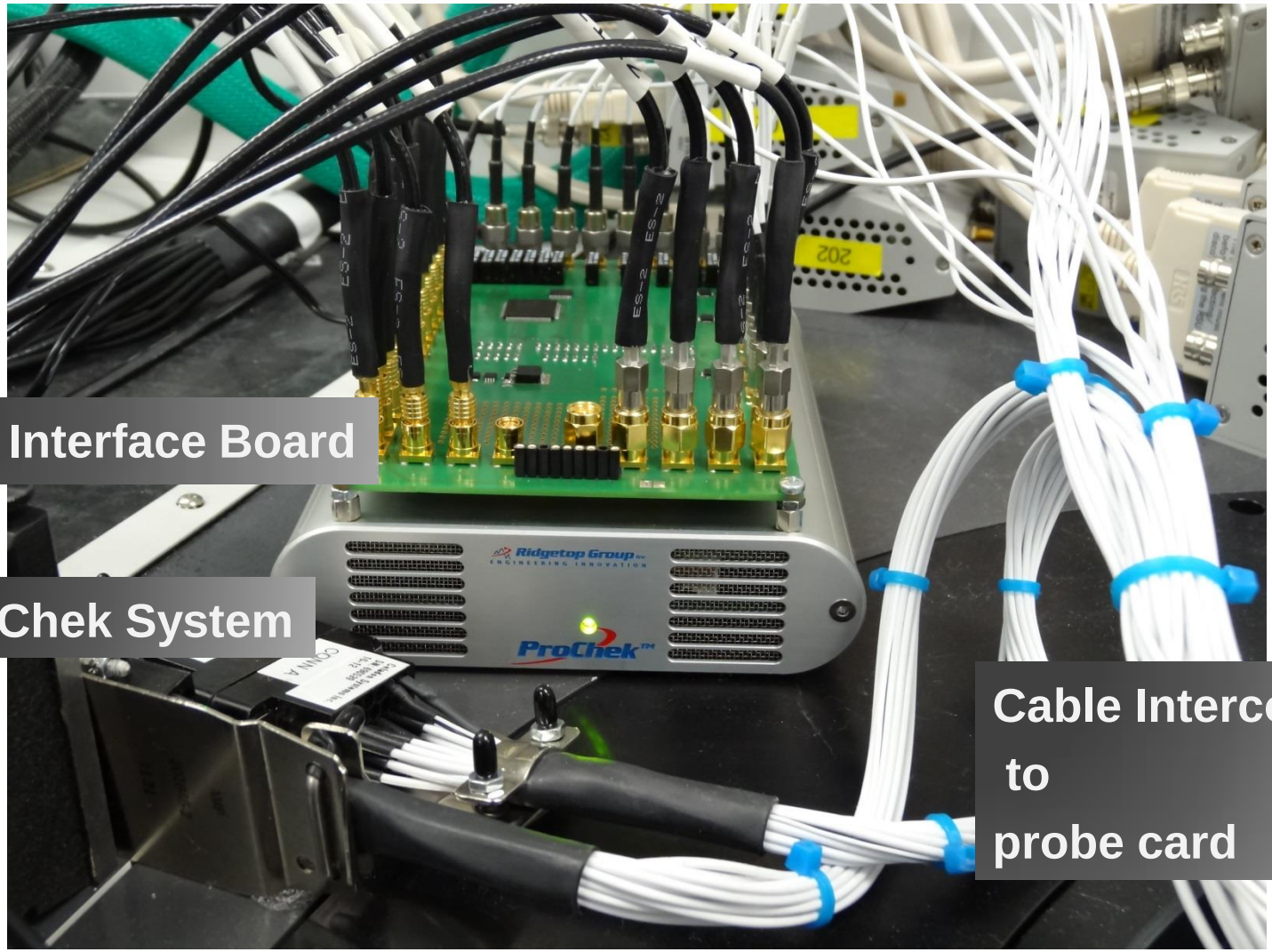
ProChek WLR Application



ProChek WLR Application



ProChek WLR Application



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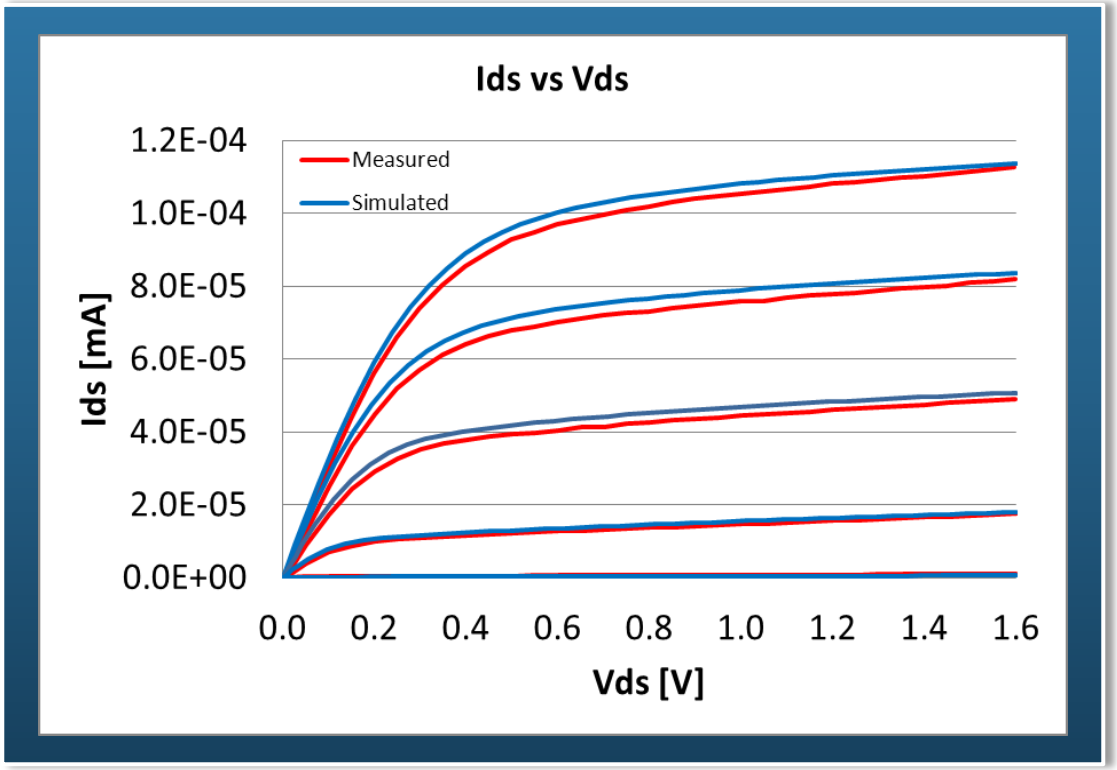
Technology (PDK) Verification

ProChek's measured results closely matches test data provided by the foundry

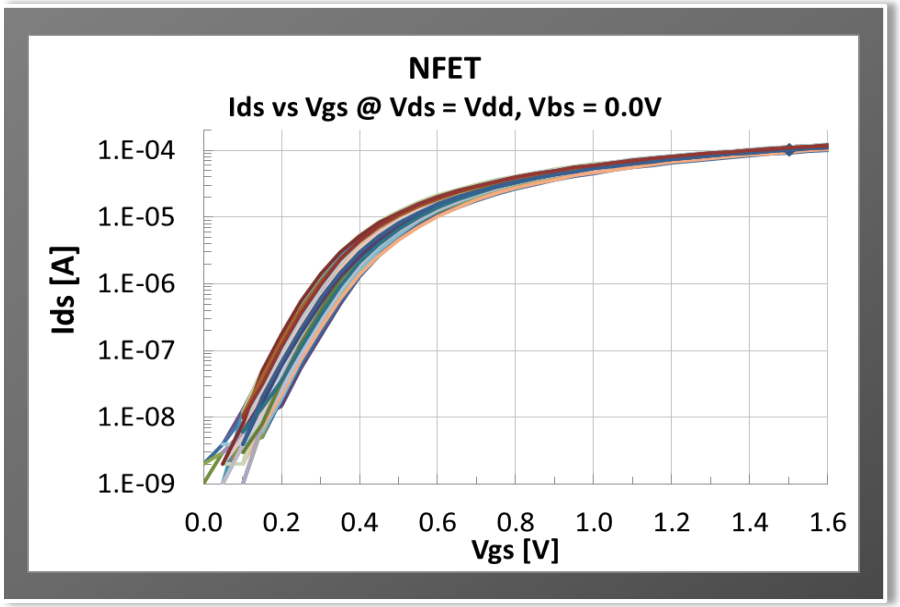
ProChek measures parameters, devices, and conditions NOT provided by the foundry



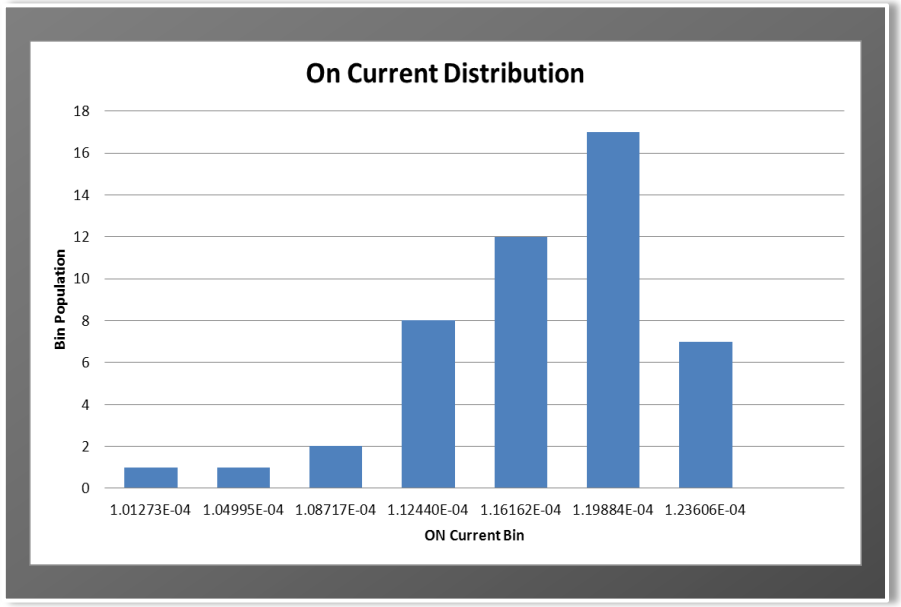
Ids – Vds measurements and simulations in the IBM BICMOS8HP process for different Vgs, from 0.3 to 1.5 V.

Device Characterization

- 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.

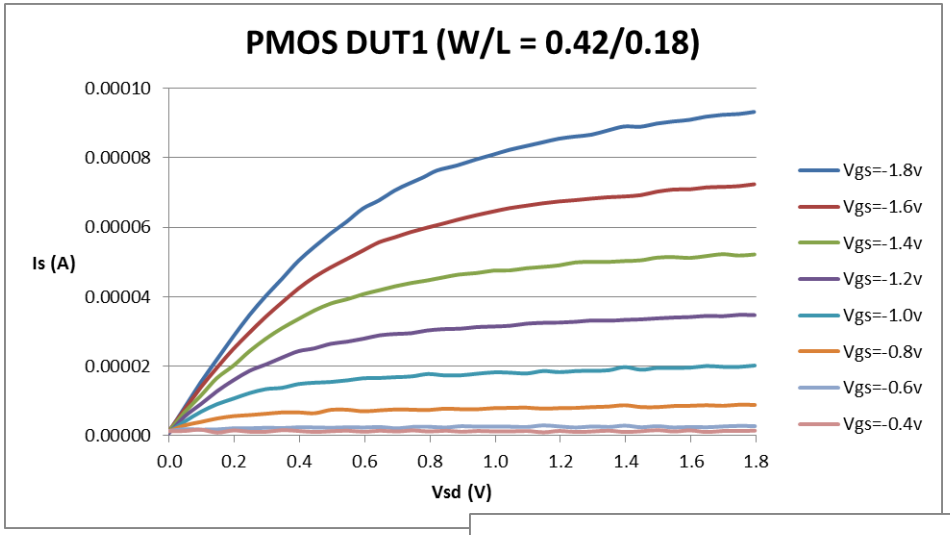


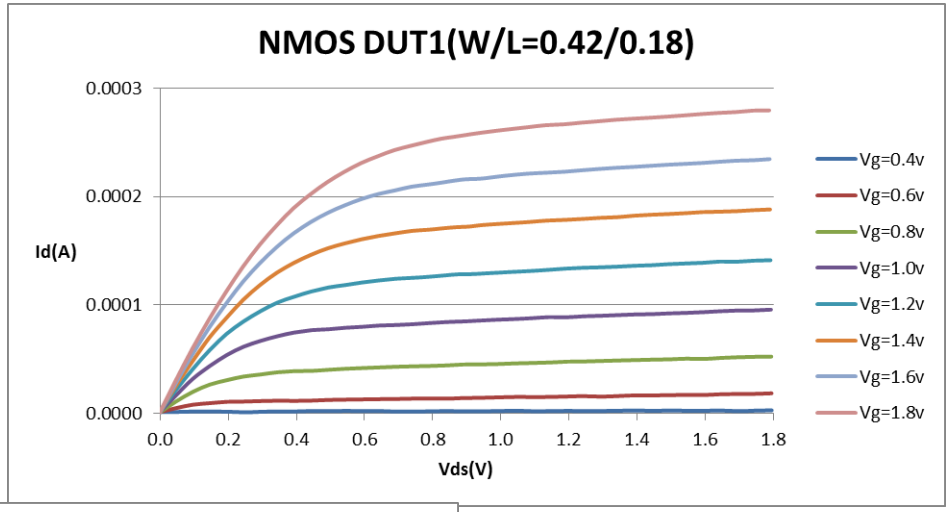
Ids Vds curves for 48 NFET DUTs

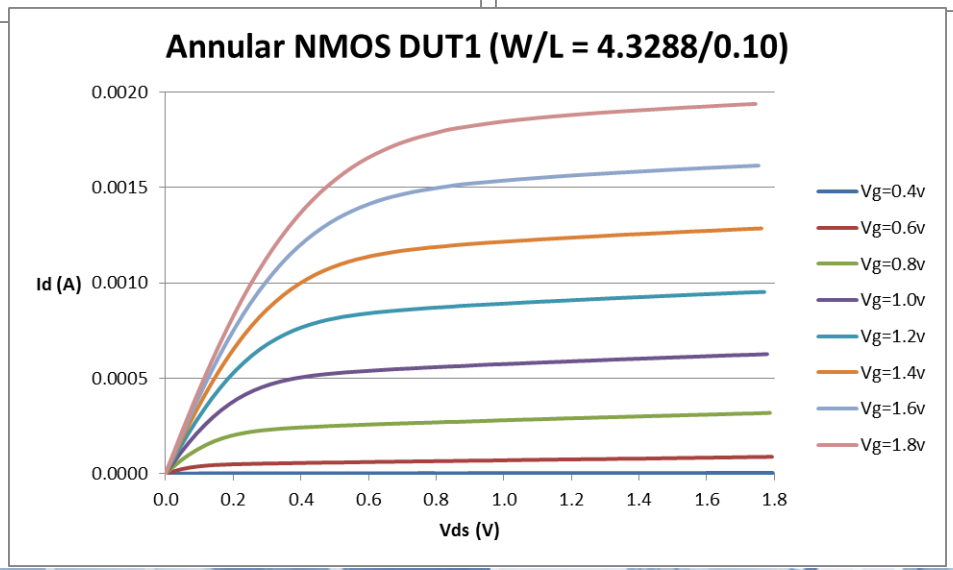


Distribution of On Current in 48 NFET DUTs

Device Characterization – ONC18







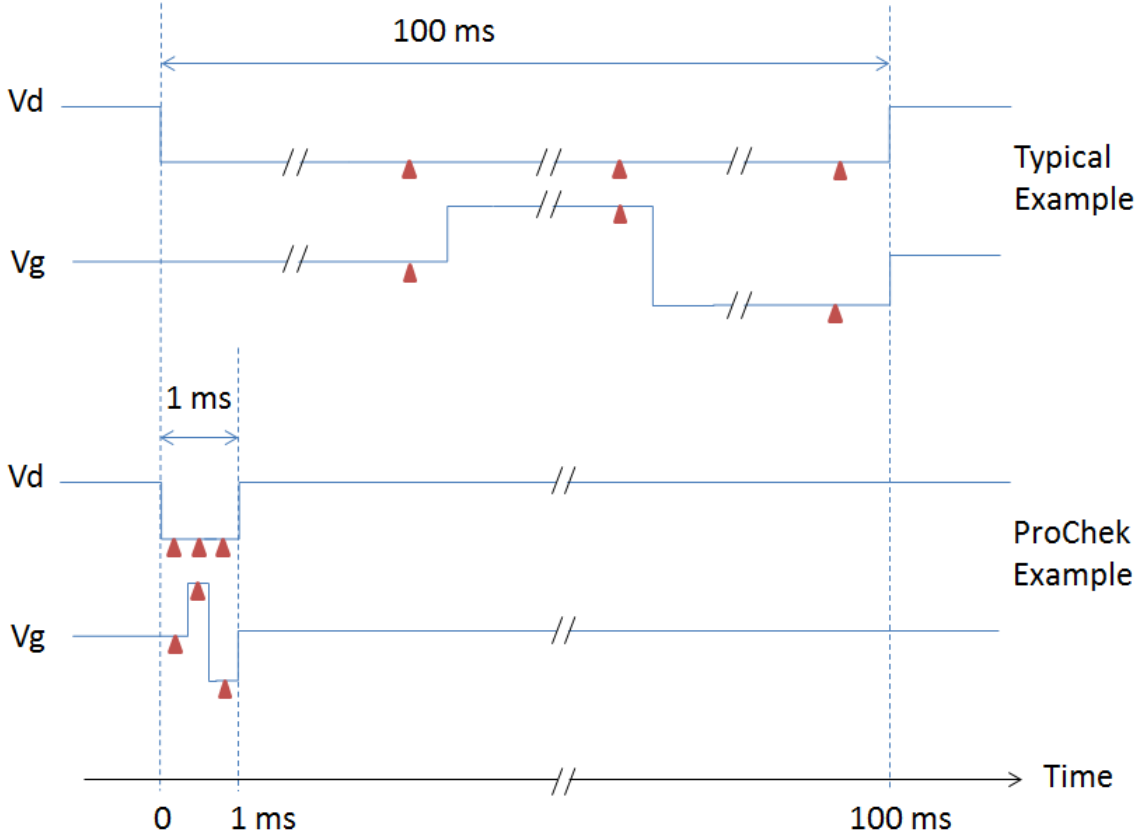
ProChek Capabilities

- ProChek can make voltage / current measurements
  - at a 10µs interval (100KHz rate)
  - Collecting up to 500 values per measurement point and per instrument
  - All measurements are running concurrent
- ProChek's fast voltmeter can make voltage measurements
  - at 500ns intervals (2MHz rate)
  - Collecting up to 20K values per measurement point
  - values can be linearly or logarithmically distributed over time
- Annealing function is designed to evaluate behaviors over time

ProChek Fast xBTI Support

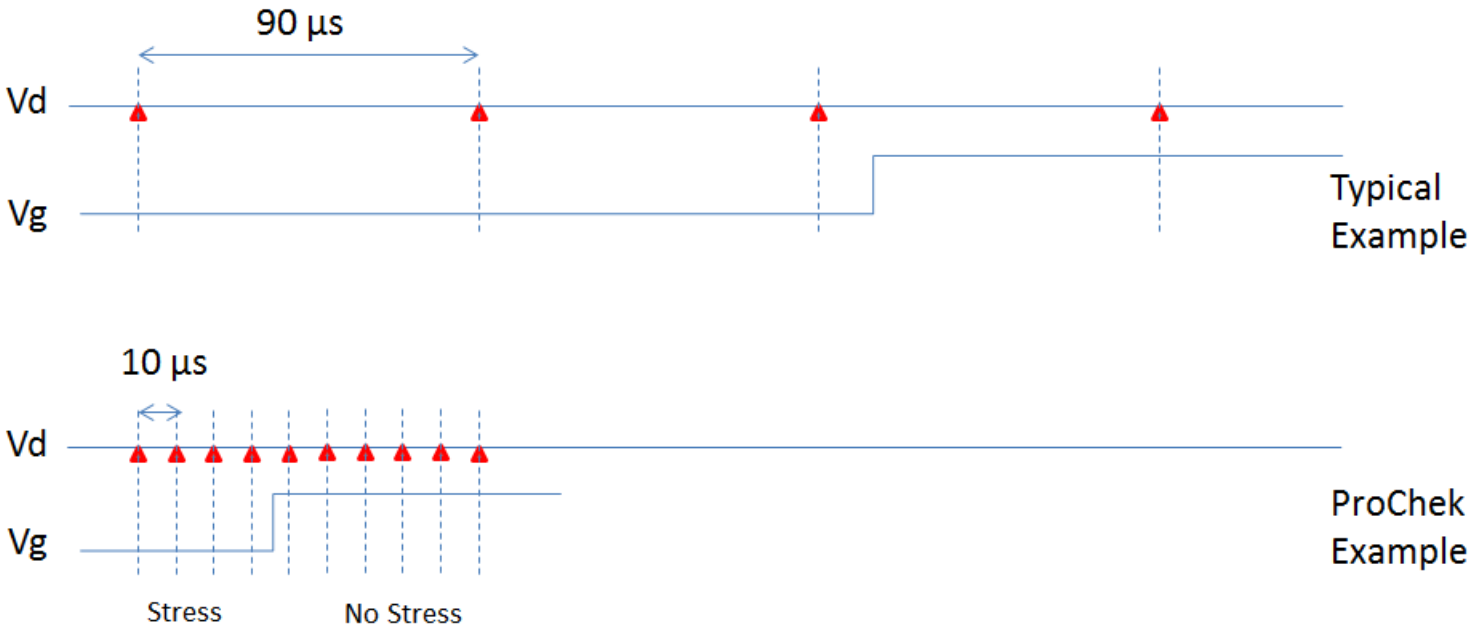
- FAST ?! – what do we mean ?
  - Ability to make measurements fast !
  - Ability to quickly bring the DUT into a state of degradation so that it shows xBTI effects !
  - Ability to observe short lived degradation effects cancelled by annealing effects !
  - Ability to make measurements
    - → very shortly after a DUT is switched from stress to measurement conditions
    - → before, during and after the transition from stress to measurement conditions

ProChek xBTI support



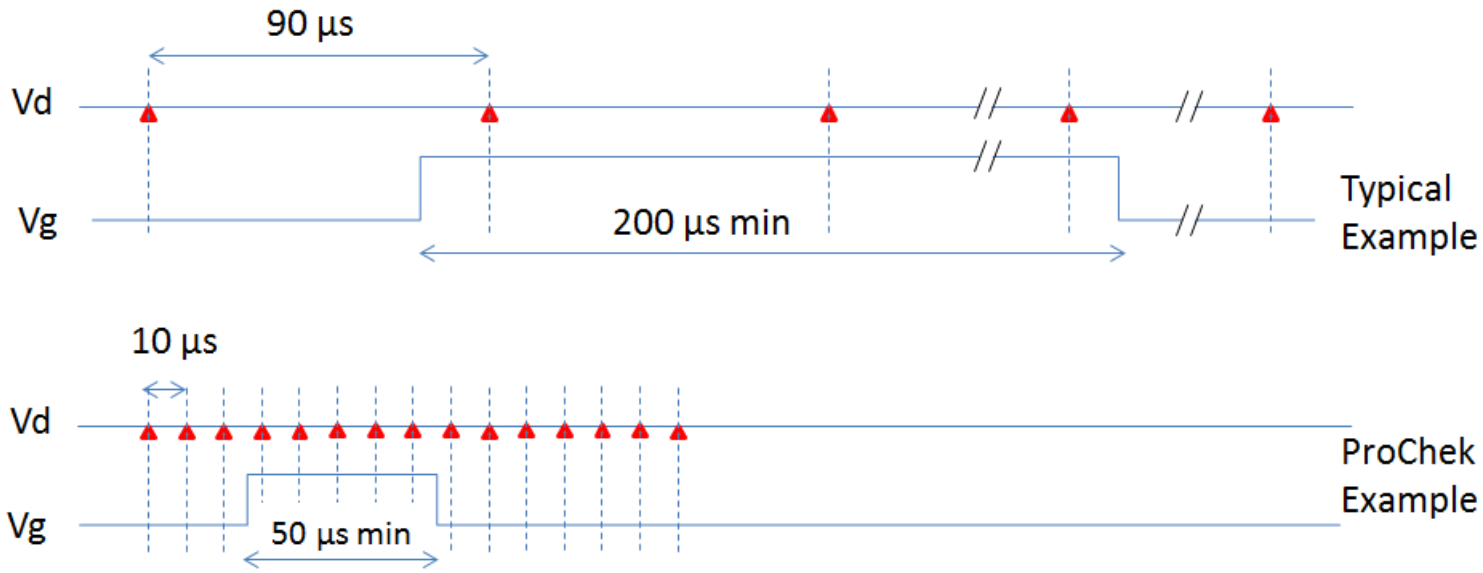
On-the-Fly Measurement Support

ProChek xBTI support



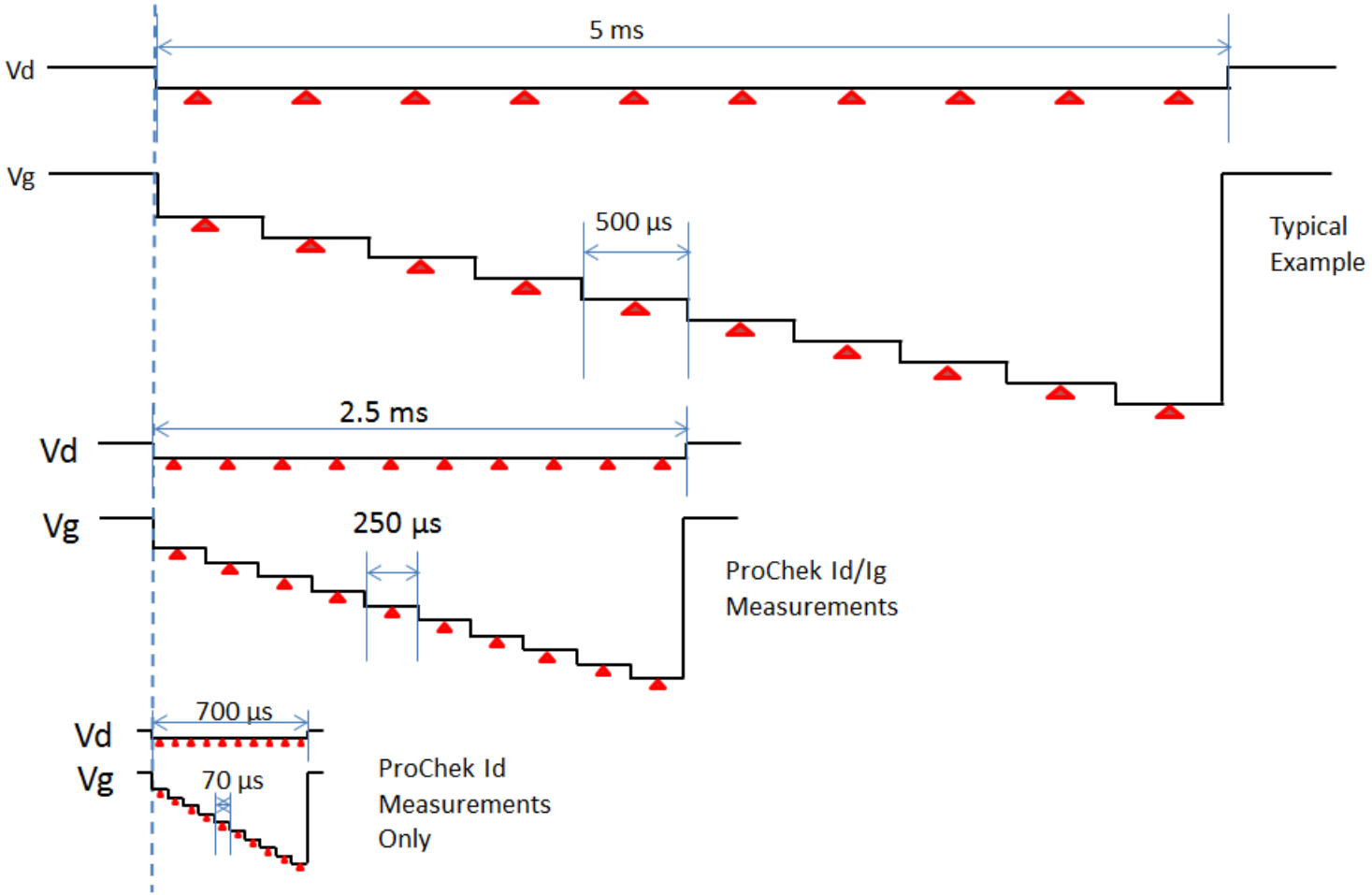
IDD only On-the-Fly Measurement Support

ProChek xBTI support



On-the-Fly Single Point Measurement Support

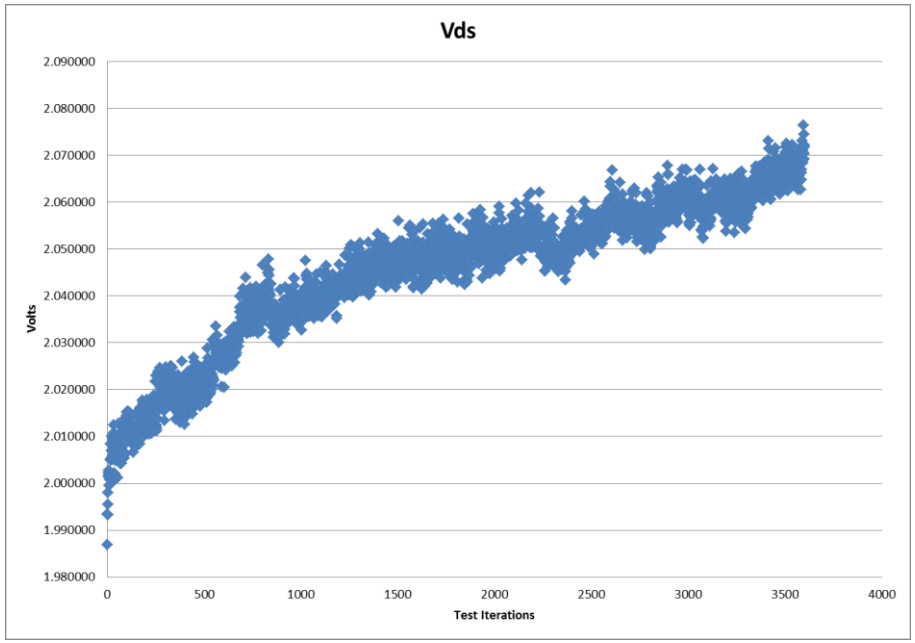
ProChek xBTI support

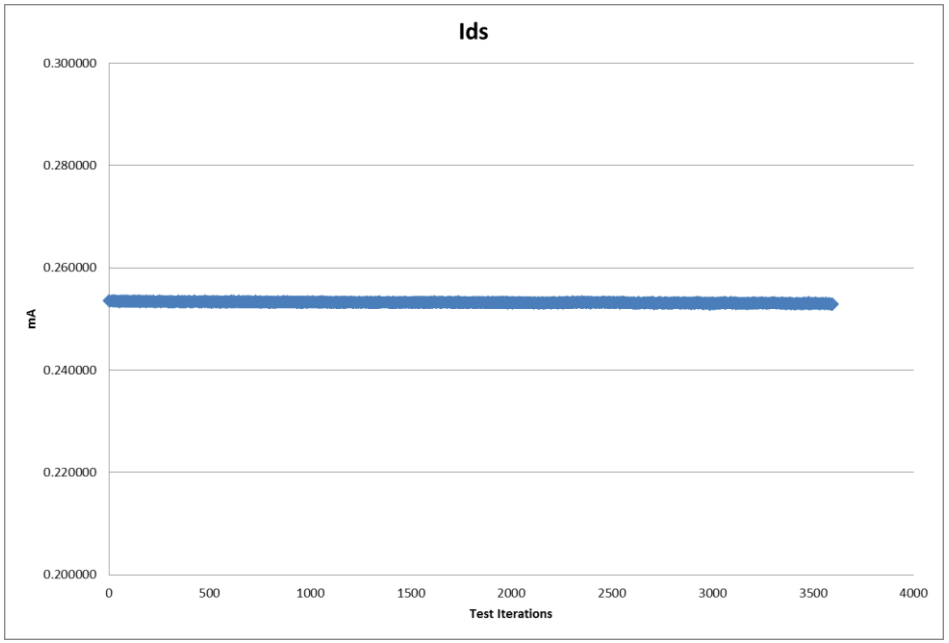


On-the-Fly Vth Measurement Support

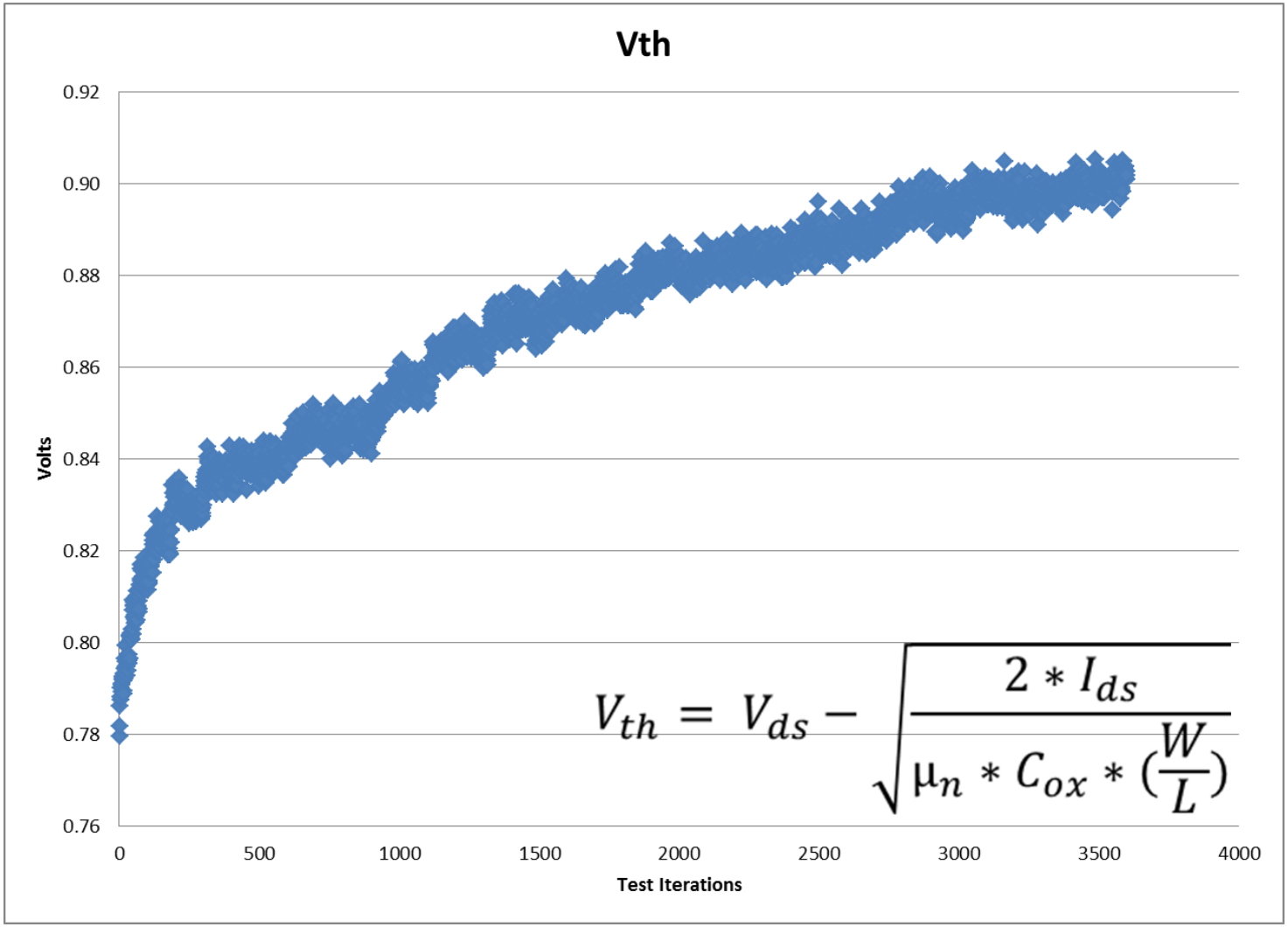
Vth Degradation Results

- Measurement of Vds whilst maintaining Ids constant (IBM9SF – 90nm techno) under voltage stress conditions





Vth Degradation Results



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- Configurable Platform
  - 4 slots serving Stress Resources or Low Resolution Measurement Instruments
  - 8 slots serving High Resolution Measurement Resources
  - Each slot can support up to 4 Resources
- Available Modules
  - 4-channel configurable SMU module
  - 2-channel configurable Voltmeter module
  - Test Structure control module
  - System control module

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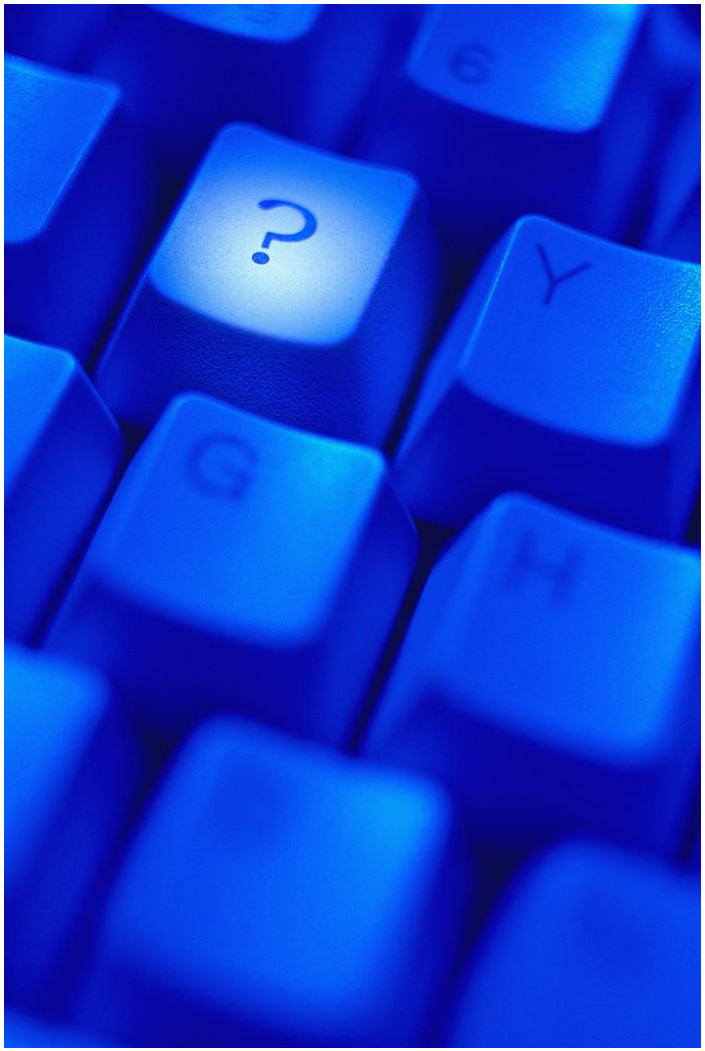
Summary

ProChek

Advanced, dedicated system for fabrication process characterization offering significant advantages to IC designers, process, and reliability engineers.

- Covers reliability concerns of modern nanotechnology processes, including radiation effects
- Covers qualification needs for new and immature processes
- Serving Wafer Level Tests without the need for additional equipment
- Significant cost and time savings



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

- E-mail follow-up questions & comments to:
  - mcpherson.reliability@yahoo.com
  - hans.manhaeve@ridgetop.eu

- Please fill out our brief feedback survey at https://www.surveymonkey.com/r/7MJDP2L

Thanks for your time and interest!

Thank you!

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