# Need for Improved Validation Process of New Test Infrastructure

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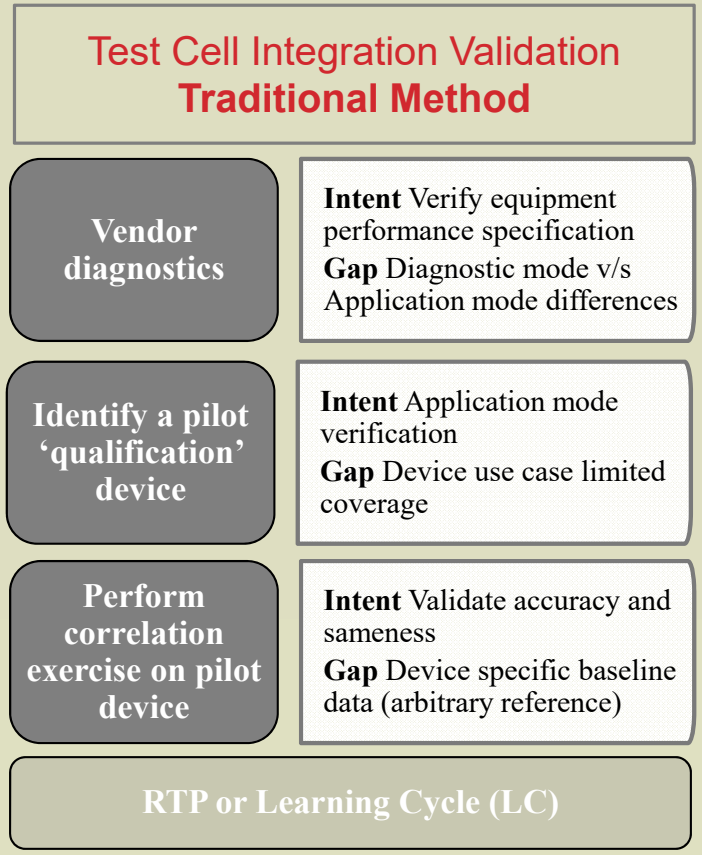
# Introduction

**The test user community utilizes many methods to validate new test cell performance:**

- Blind trust of vendor diagnostics.
- Run a handful of specific qualification devices.
- Run every known device application.
- Create and run process corner devices.
- Create and run specific applications to test instrument specification corners.
- Create and run specific applications to test system performance and reliability.
- Perform some combination of the above.



# New Validation Motivation | Why evolve?

- Problem Statement:
  - Traditional methods cause revenue loss in the volume ramp phase driven by problem identification and resolution.
- Issues seen from traditional process:
  - **Device (typically new technology) availability** delays
  - Device release to production (RTP) dependent on 1st pass, **no learning cycle** margin
  - Coverage gaps
    - **Missed** operational **corners**
    - **Post qualification tool updates**
    - Reliability **issues during production**
    - **Increased cost** of maintenance
    - Increased **total cost ownership**

| Failure | Root-Cause | Major Action | Who |
|---|---|---|---|
| Full Board device fails | Bad / Loose connection between TEB and PEB due to vibration | Vendor provide seismic mounts and install instructions to factory | Vendor |
| Incomplete Run | Step Time-Out TEB ECC VGEN Error | Fix with Firmware | Vendor |
| Heater Wire Reliability Issues | Heater wire too long causing contact with BIB | Vendor reduce wire length and tighten length tolerance | Vendor |
| Device not reaching required Tj | Inconsistent BIB airflow and over-efficient heatsink | Install airfoils for BIBs | Factory |
| Stuck pins because the spring melted into the plastic | High transition current between steps | Fix with Firmware | Vendor |

BI Losses Through A System Ramp

- Test Cell validation evolution is desired to fully understand the system **performance** ahead of large scale deployment thereby avoiding costly issues while testing across a **range of devices, fab processes,** and/or **factory requirements.**

# Example Gaps | Underqualified BI Systems

| Historical Issue | Impact | Detectability | |
|---|---|---|---|
| | | Pilot Device Qual | Evolved Validation |
| Airflow non-uniformity causes heating/cooling issues during high-power burn-in. | Lost burn-in capacity | NO | YES |
| Excessive ripple when some high voltage supplies run at low end of capable range. | Burn-in test instability | NOT COMPREHENSIVE | YES |
| Insufficient driver cabinet cooling when all slots run at high load. | Oven down-time increased | NOT COMPREHENSIVE | YES (full oven-worth HW needed) |
| Inaccurate and drifting output voltage when 5v supply set to max setpoint (5.00v). | Device temperature controller resets; failed burn-in runs | NO | YES |
| Oven I/O performing inconsistently at high data speeds. | Programs fail after oven OS update | NO | YES (limited by receiver capability) |

# Method | Traditional v/s Need

| Traditional Method | |
|---|---|
| Vendor diagnostics | Verify equipment performance to specification |
| Identify a pilot 'qualification' device | Stress limits of key specifications |
| Perform correlation exercise on pilot device | Baseline data can be from bench or an already qualified test system |
| RTP or Learning Cycle (LC) | |

| Gaps in Current Method | |
|---|---|
| Vendor diagnostics | Insufficient for all use cases.<br>How do we fill this gap? |
| Identify diagnostic gaps related to user needs | What drives or limits performance?<br>Identify corners, performance extents |
| Identify performance validation (PV) methods for each aspect of integration | Develop application(s) that utilizes system to test the identified diag gaps. |
| Develop and execute validation plan using PV methods above | Real-time tracking of issues and lessons learned.<br>Vendor collaboration problem solving |
| Review the results and complete verification or LC | |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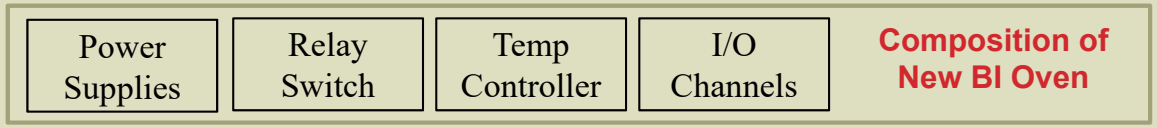
# Application Validation Example | Burn-In Systems

**Identify composition of the complete test system**

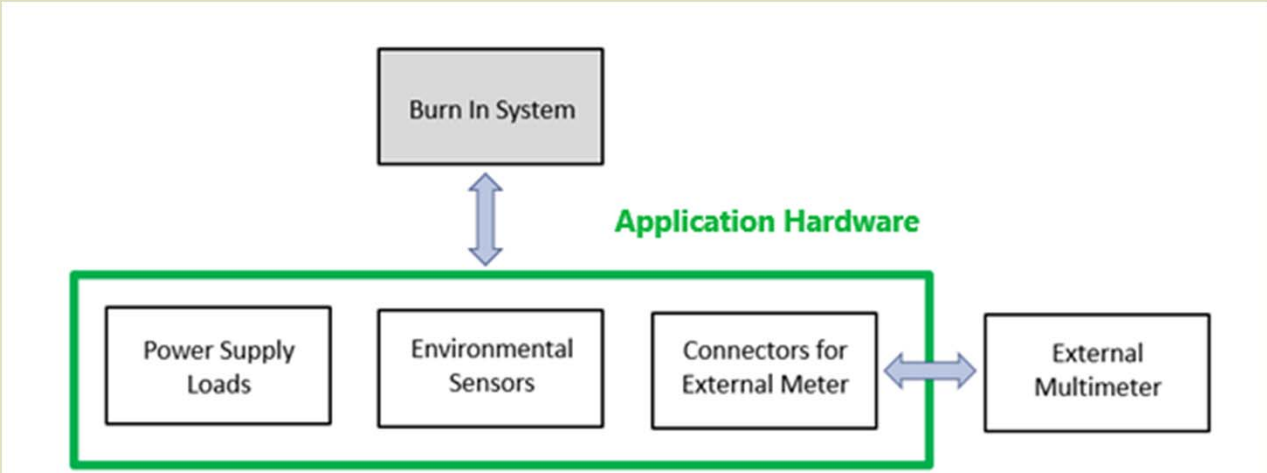
**Define Test Plan and Develop application(s) that utilizes system to test the identified diag gaps**




**Application Board Capabilities:**

- Measure supplies
  - Fully calibrated by an external meter
  - Test full ranges to specification & generate logs
- Load supplies
  - Tests maximum power of all supplies
- Test I/O channels
- Test airflow rate
- Test temperature
  - Verifies oven controller accuracy
- Design customizable to perform tests under different conditions for new hardware checkout

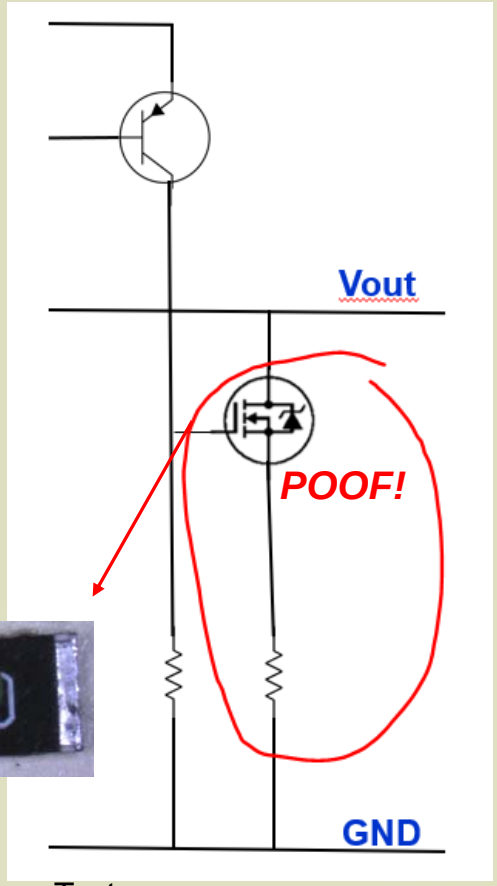
**Test System Block Diagram**



# Findings | Roadmap Burn-In System Deployment

Review the results and complete verification or LC

- Issue identified with Application Diagnostic and not identified by Vendor Diagnostic
  - Insufficient power supply discharge circuitry power handling **at higher voltage end of range**
  - Power supply **slew slower than previous generation hardware**
- Result
  - Testing was continued with an **improved discharge circuit revised by the vendor** with only minor delays
  - Understanding of slew range prevented extensive program rewrites and an update of the specification



# Impact | Roadmap Burn-In System Deployment

- Application diagnostics lead to 3 vendor learning cycles (LC)
  - **11 co-dependent changes** pre-release
  - **Two pilot products** (traditional method) showed **no findings** with Rev A power supply (PS)
- Changes were made to
  - Supply circuit: Higher dissipation
  - Supply-to-supply and supply-to-ground short circuit protection : More Robust
  - Firmware (FW) : Better Monitoring
  - User Interface Software (SW): Updated
  - Specification change : Maximum allowable power supply capacitor

LC1 : Vendor implements FW only fix → LC2 : Vendor implements HW only fix → LC3 : Vendor Implements HW+FW fix → Scalability across existing fleet

| Vendor Deliverable | PS Rev A, Adapter A Rev A | PS Rev A, Adapter A Rev A, SW, FW Update | PS Rev B, Adapter A Rev B | PS Rev B, Adapter A Rev B, SW, FW Update | PS Rev B, **Adapter H** SW, FW Update |
|---|---|---|---|---|---|
| Application Diagnostic | **Gen3** | **Gen3** | **Gen3** | **Gen3** | **Gen2** Backward Compatibility |
| Pilot H | | | | | |
| Pilot A | | | | | |

Traditional Method 'Pass'

Improved Release

**Legend** Failure | Pass | N/A

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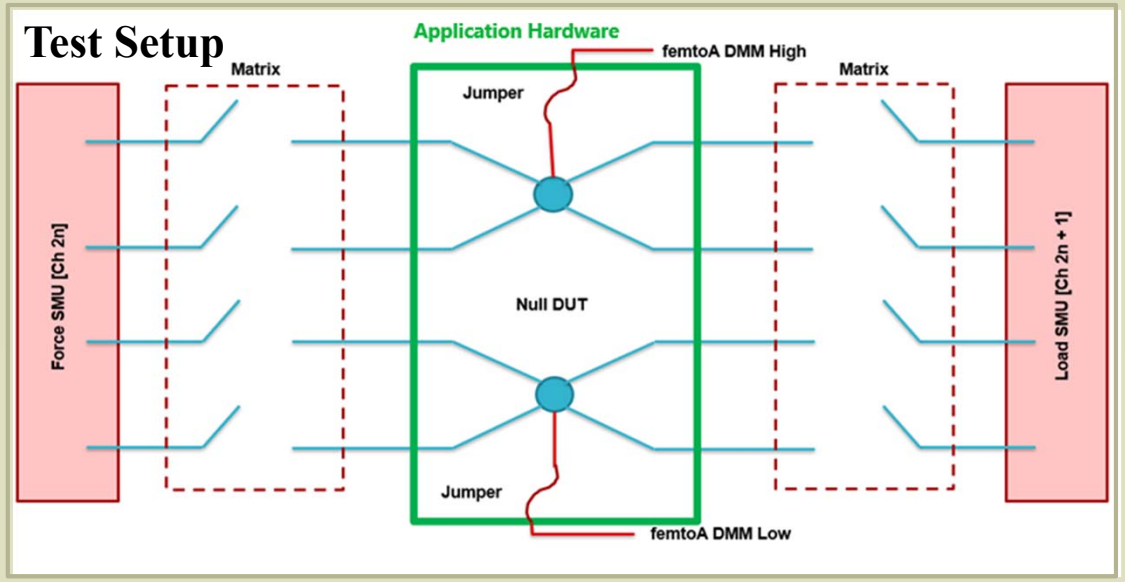
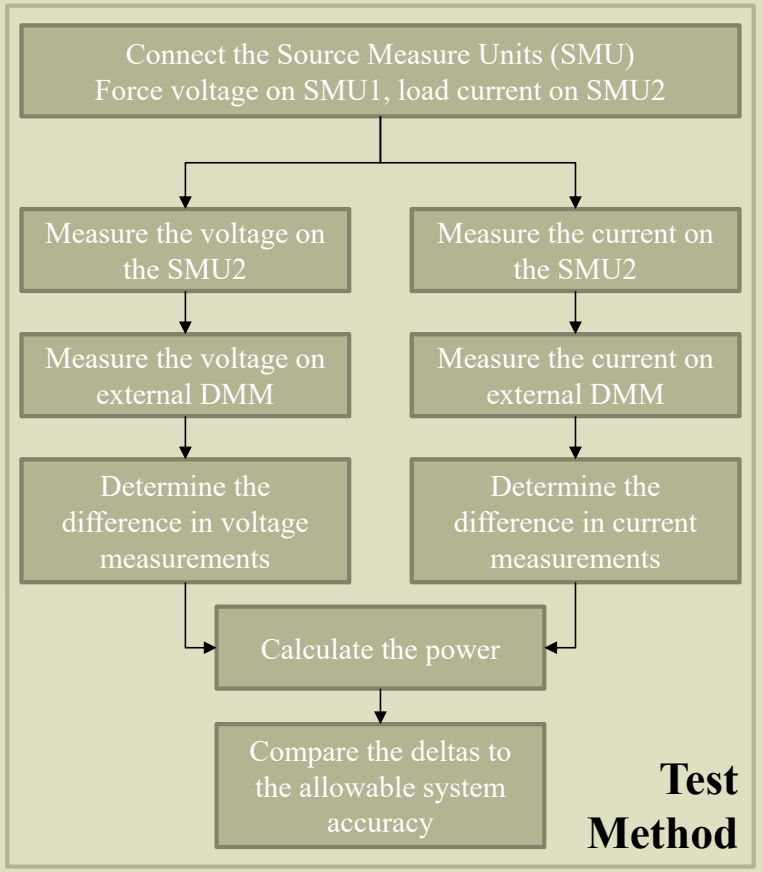
# Application Diagnostic Technique Reuse | Tester

- Validation plan for the roadmap tester
- Uses a combination of all known methods
  - Adds **NIST traceable** cross calibration & very low leakage noise floor checks
  - Application Diag tests power supply voltage, current, & power max's

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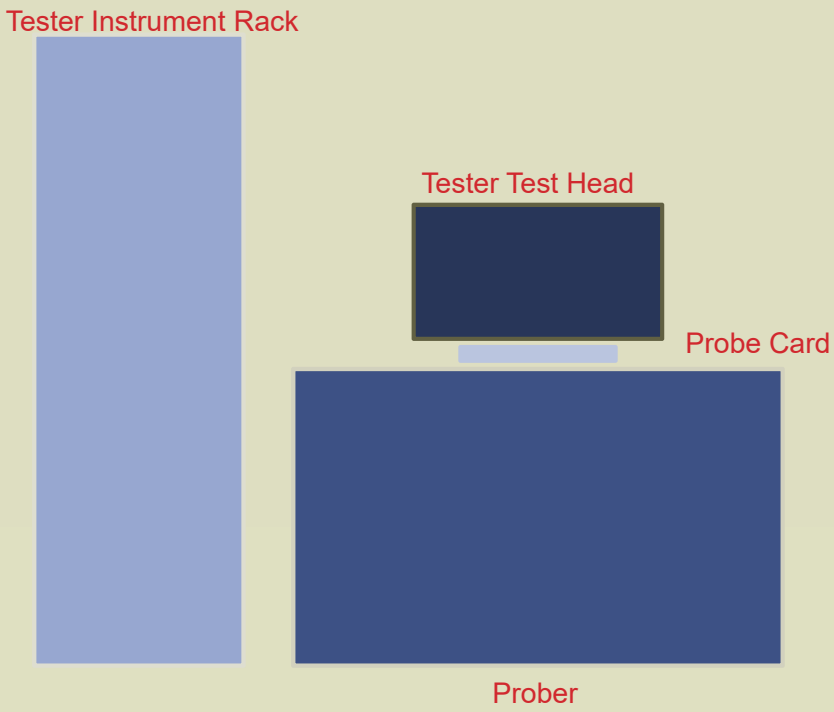
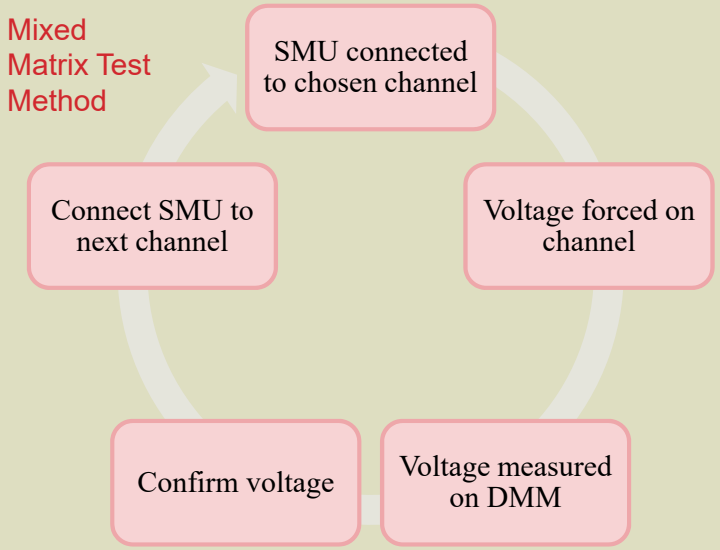
# Application Validation Evolution | Test Cell Noise Floor

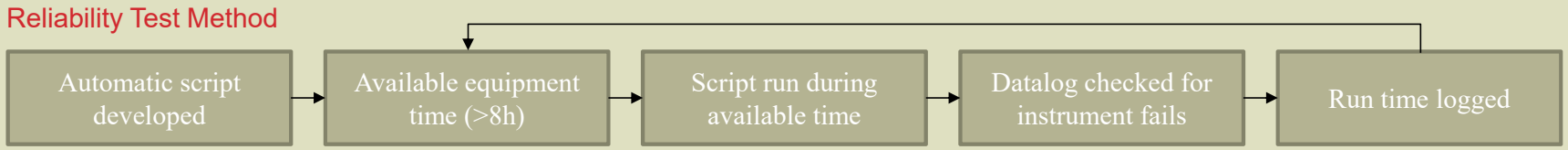
- Test procedure for leakage (Noise Floor) **validation of entire Parametric Test Cell** as opposed to just the resources
- **NIST traceable** sub-femtoamp meter to be used to provide the range & accuracy needed to validate the system noise floor
- Includes **lessons learned** from past parametric validations
- Probe card noise may be measured separately and then deducted from the measured test cell noise



# Application Technique Reuse | Tester Matrix Reliability

- Validation plan for the relay matrix is broken into two tests
  - Mixed matrix test of all matrix combinations
  - Reliability test to check performance of matrix over time
  - Technique includes lessons learned from burn in validation



# Application Diagnostic Benefits Summary

- Test system hardware and software **issues** identified and **corrected prior** to device **ramp** at vendor's expense.
- Application Diagnostic is **independent of device** performance**.**
- **Replacement** of **roadmap** tester(s) is **easier** due to test cell performance understanding.
- **Application Diagnostic** leverages **lessons learned** and includes **NIST** traceability, **Reliability** performance, and **Safety** adherence.
- Provides **vendor** with **Diagnostic gaps** understanding.


**Credit: Bill Watterson**

# Conclusion | How to Standardize

- The more comprehensive validation delivers **higher quality** production test systems while also **saving** both **time and money.**
- Can we **Standardize** better Validation techniques for **acceptance** and Roadmap **implementation** across the Tester Industry?

| Advantage | Time Saved | Money Saved |
|---|---|---|
| Identifying and correcting infrastructure problems prior to system acceptance and release to factories | ✓ | ✓ |
| Validation hardware can be reused to perform acceptance testing on all future systems in the fleet | ✓ | ✓ |
| Standardizing the validation process for test infrastructure | ✓ | |
| Validate test cell integration and all capabilities of the system and subcomponents not limited to pilot devices | | ✓ |

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