Silicon Turnkey Solutions

Burn-in capabilities
• Why Changes to Burn In
  – Next Gen Processing
  – High complexity
  – Reduced voltage
  – Feature size
  – Power dissipation
  – Multi functional blocks
Silicon Turnkey Solutions Early Burn-in capabilities

- Conventional chamber based Burn-in & test system
  - Enhanced performance with STS methodology - backplane
  - Overcome Improper temperature control
  - Eliminate Noise from fans and power supplies, glitches
  - GOOBI, conclusion BI causes more damage without regulation of DUT
  - Slew Rate Management
**Conventional Chamber Based Burn-in System**

**Burn In Equipment**
- High noise/glitch suppression mechanism for power supplies, oven and utilities
- Precision Power Supplies
- Solid State Relays
- Output Monitoring
- Deep Test Pattern Depth
- High fault coverage using 128 independent I/O channels + 16 Hi-Z
- Minimal Interruption; Direct failure correlation

**Ovens (Isuzu-Soyokaze, Hastest, EDA, AEHR-PBC4)**
- Customized for 4 – 6 boards maximum
- Customized air flow
- Low noise, no glitch, no contactors
  
  Un-interrupted ovens for Life tests
CONVENTIONAL BURN-IN BOARDS

Design

- Impedance Control: 15 to 100 OHMS
- Resistance, capacitance and delay control
- Trace width consideration (up to 3 Mil)
- Differential pair routing with skew tuning

Maintenance

- Frequent real-time check of all sockets and components

Specifications

- Four to five power supplies maximum per board
- 40 Amps maximum per board
- Boards rated up to 150C
CONVENTIONAL BURN-IN BOARDS continued

Vector Depth

- 128 driven channels
- 16 Bits or Tri-state availability
- Up to 32 M Bit depth for each pin
- 20 MHz and 32 MHz free running clocks
- Driver capable of 10 MHz Master clock
Conventional Power Supplies

- Solid State Power Supplies With GPIB Control
- Ultra-high Full Scale Accuracy
- Minimum Noise and Ripple
- Ultra Accurate Regulation
STS Burn-in Next Generation capabilities

- MCC chamber based Burn-in & test system
  - Sophisticated and expensive burn-in system
  - Hardware investment
  - Capital equipment investment
# MCC chamber based Burn-in & test system

High power burn-in system (HPB-5B)

## Specification

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital I/O Channels</td>
<td>128</td>
</tr>
<tr>
<td>Programmable voltage regulators</td>
<td>11</td>
</tr>
<tr>
<td>Max current</td>
<td>800A per board</td>
</tr>
<tr>
<td>Continuous heat sink temp monitor</td>
<td>Yes</td>
</tr>
<tr>
<td>Continuous junction temp monitor</td>
<td>Yes</td>
</tr>
<tr>
<td>Power supply regulation</td>
<td>Yes</td>
</tr>
<tr>
<td>Continuous voltage monitor</td>
<td>Yes</td>
</tr>
<tr>
<td>Max positions per board</td>
<td>24</td>
</tr>
<tr>
<td>Max power</td>
<td>150W</td>
</tr>
</tbody>
</table>
Limitations of MCC chambers based Burn-in & test system

- System power supply instabilities
- On-board parallel power - DUT to DUT variations
- Device thermal management – board level only
- Device to board contact integrity challenges
- Limitation at dynamic functional exercise
- Long lead-times for high temperature hardware
- Inability to monitoring high speed signals in situ
- Capacity constraints - limited scalability
- Fixed MEGA chamber – ergonomically unfriendly
**STS Third Generation capabilities**

- **Burn-in & test system still needed improvement: Fresh Look**
  - ✓ Concept change from heating DUT to managing the DUT
  - ✓ Force cool to get acceleration
  - ✓ 45nm DUT already at 125C, Historic DUT 55C use condition
  - ✓ Challenge:
    - ✓ How to bring output monitoring to BI
    - ✓ Guaranteed exercise and NOT overstressing
    - ✓ Historically 10K transistors, now packages have 5-10B transistors
    - ✓ 1 billion combinations on the chip, evaluate weakest link
    - ✓ How to bring high power, low voltage, high frequency, massive level of functional blocks into BI
    - ✓ Fault grading on the chip
Innovative Thermal Controller 360 (ITC360) based Burn-in system

Salient Features

- Bench based dynamic thermo electric Cooling and Heating for each DUT
- Rapid response thermal management, real time to each DUT
- No barriers dynamic exercise, Speed, Vector depth and loops
- Standard Commercial burn-in Sockets
- Eliminate Noise and inductive glitches
- High speed signals to the DUT
- Regulate Case, Ambient and the Junction
Active Monitoring and Thermal Regulation

- Conductive thermal regulation
  Provides accurate regulation & quick response time
- Thermal Plate provides stable board temperature
- Each DUT junction temperature ($T_j$) is regulated
  - $T_j$ sensed thru thermal diode on device
  - $T_j$ heated or cooled via Thermal Regulator (TR)
  - $T_j$ controlled to +/- 1°C
ITC360 Features & Benefits

- Burn-in at rated voltages & speed
  - No need to lower power or reduce frequencies

- Open-air implementation
  - Enables significantly lower hardware costs
  - Facilitates real-time in situ monitoring access

- Full dynamic burn-in capability
  - Via National Instruments hardware

- Implementation flexibility for unique requirements
  - Not constrained by physical chamber

- Modular design
  - Expandable for greater capacity or future needs
  - Reduced carbon footprint (less power, smaller, etc.)
Drivers & Pattern Depth

Drivers

– Custom STS drivers
– Designed to accommodate burn-in conditions with:
  Low voltage, High Current, High Frequency
– Monolithic driver (buffer) circuitry with tri-state capability (Elantec-El-7156)
– 15nSec switching rise and fall times
– 0.5nSec rise/fall time driver to driver mismatch
– Designed for 1.0 to 3.3V Vih BI applications
– 50mA Channel per driver

Pattern Depth

– 16M vector depth across 128 channels + 16 Hi-z
– 32M vector depth across 96 channels + 8 Hi-z
NATIONAL INSTRUMENTS – AWG Arbitrary Waveform Generator

Used to generate vector stimulus and frequency input stimulus to the DUT.
Significant Benefits

- Valuable Level II (board level) reliability data
- Wide array of instrumentation
  - Application specific depending on stress requirements
- Direct probe access for high speed instruments
- Full design flexibility & scalability up to boards
- Significant cost savings
  - Standard sockets, cables and connectors
- Faster time-to-market
  - Standard component lead times
ITC360 Value Proposition

- Full dynamic burn-in capability
- Regulated accurate burn-in conditions
- Significant overall cost savings (~50%)
- Valuable development time savings (~6 weeks)
- Flexibility & accessibility
ITC360 Value Proposition continued

- Bringing Intelligence to Burn In
- Post BI analysis
- Pre and Post Delta Computation
- Device level thermal footprint change
- Extensive high frequency, dynamic exercise of the chip
- Stimulus generation
- P/S control at DUT, not to the BI board
- Validity of BI is looking for signal change at ATE
- Not Go/No GO
- Peak performance, timing peak power. Full Throttle changes
Temperature Sensing Diode Calibration

<table>
<thead>
<tr>
<th>Device</th>
<th>TILERA GX72 1847L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>FCBGA</td>
</tr>
<tr>
<td>Customer</td>
<td>Tilera Corporation</td>
</tr>
</tbody>
</table>

Prepared exclusively for TILERA
Real Time Ti Monitor and regulation
Real Time Capture of a ‘Thermal Runaway’
## ITC360 and HPB-5 Comparison Specifications & Capabilities

<table>
<thead>
<tr>
<th></th>
<th>ITC360</th>
<th>HPB-5B</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max number of DUTs</td>
<td>Unlimited</td>
<td>384</td>
<td></td>
</tr>
<tr>
<td>Max power per DUT</td>
<td>250&gt; Watts</td>
<td>150 Watts</td>
<td></td>
</tr>
<tr>
<td>Max current per board</td>
<td>1,000&gt; Amps</td>
<td>800 Amps</td>
<td></td>
</tr>
<tr>
<td>T_j regulation</td>
<td>125°C (+/- 1°C)</td>
<td>125°C</td>
<td></td>
</tr>
<tr>
<td>Regulated power</td>
<td>Yes (Each DUT)</td>
<td>NO</td>
<td>ITC360 offer Rapid Heating &amp; Cooling of each DUT independently</td>
</tr>
<tr>
<td>Heating &amp; Cooling per DUT</td>
<td>Yes</td>
<td>NO</td>
<td>ITC360 Monitors the Temperature of each device independently</td>
</tr>
<tr>
<td>Direct DUT signal access</td>
<td>Yes</td>
<td>NO</td>
<td>ITC360 Monitors the Signal access of each device independently</td>
</tr>
<tr>
<td>Digital I/O Channels per board</td>
<td>128</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>Max vector pattern depth</td>
<td>64M per channel</td>
<td>8M per channel</td>
<td></td>
</tr>
<tr>
<td>Infinite vector looping</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>High-speed differentials</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>RF inputs</td>
<td>Yes</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Socketless board option</td>
<td>Yes</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>On-the-fly timing sets</td>
<td>Yes (unlimited)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Digital Frequency</td>
<td>550 MHz</td>
<td>10Mhz</td>
<td>ITC360: AT speed available</td>
</tr>
<tr>
<td>System-level protocol option</td>
<td>Yes via NI hardware</td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>
The Director of the United States Patent and Trademark Office

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, or importing into the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b).

See the Maintenance Fee Notice on the inside of the cover.

Signature: Michelle K. Lee

Deputy Director of the United States Patent and Trademark Office
Silicon Turnkey Solutions
Marti McCurdy
1804 McCarthy Blvd
Milpitas, CA  95035
408-904-0251
mmccurdy@sts-usa.com