PXI Tsunami in Semiconductor ATE
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Agenda

• Geotest background

• Semiconductor market and trends

• PXI for semiconductor test
  – PXI background & market
  – Trends and applications for semiconductor ATE
Geotest – Part of The Marvin Group

- Established in 1963, the Marvin Group is an aerospace firm with five main divisions, all located in Southern California
- Privately owned U. S. corporation
- Over $350M in sales in 2011 and a current funded backlog of over $1.6B USD
- More than 1000 employees
- Established supplier to the commercial and military aerospace markets world-wide
Geotest Products

- **PXI Products**
  - Over 200 PXI and PXIe products including chassis, controllers, and mixed signal test instruments
  - Specialized, ATE-focused products and custom instrumentation

- **Preconfigured PXI systems for functional and semiconductor test applications**

- **Software Products**
  - Test Executive (ATEasy), Lasar Post Processor (DtifEasy), Digital vector editor (DIOEasy), analog waveform editor (WaveEasy)
Geotest’s PXI Product Portfolio

Measurement & Switching

Chassis & Power Supply

Stimuli Instruments

Software Packages

Other Resources

Digital Resources

High voltage pin electronics

Digital I/O with PMU

High Speed Digital I/O

FPGA Instrument

Applications

Silicon Valley Test Conference 2012
Semiconductor Market & Trends

• OEMs, packaging / test vendors & fabless semiconductor vendors need to lower test costs
• Test share of IC cost continues to decline
• PXI capabilities: Flexible and cost effective solutions for digital, mixed-signal, and RF test
## Semiconductor Test Requirements

<table>
<thead>
<tr>
<th>Tests Requirements</th>
<th>Prototype, Pilot Phase, Design Verification Tests, Failure Analysis</th>
<th>Production Test: Test for process induced faults</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functional</strong></td>
<td>Extensive, multiple files / vectors</td>
<td>Limited, test time constrained</td>
</tr>
<tr>
<td><strong>DC parametric</strong></td>
<td>Limited or complete test, depending on customer / application</td>
<td>All pins checked for DC parameters</td>
</tr>
<tr>
<td><strong>Test throughput</strong></td>
<td>Minutes to hours, single device testing</td>
<td>Seconds, may require multi-site testing</td>
</tr>
<tr>
<td><strong>Devices tested / characterized</strong></td>
<td>10’s to 1000’s</td>
<td>1000’s to millions</td>
</tr>
<tr>
<td><strong>Test system &amp; cost</strong></td>
<td>In-house or PXI-based $50K - $100K typical</td>
<td>Production IC Test System $500K and up</td>
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- **PXI Components & Systems**
- **“Big Iron” ATE**
Why PXI for Semiconductor ATE?

- Cost effective
- Product capabilities: high performance instrumentation and bus bandwidth
- Flexible & robust open architecture
- Wide market adoption – drives product development and pricing
PXI Market

PXI/PXIe Test and Measurement Market:
Revenues (World), 2010 and 2015

- PXI market is growing: 16.9% CAGR, 2010 – 2015
- Over 50 PXISA members and >1500 PXI products
- The dominant card modular instrumentation standard
PXI & PXI Express Architecture

- PXI
- PXI Express
- PXI System Controller
- PXIe System Timing Controller
- PXIe Peripheral
- Hybrid Peripheral
- PXI Peripheral
- 100 MHz Differential CLK
- SYNC100
- 10 MHz CLK
- Differential Star Triggers
- PCI Express Bus
- PCIe / PCI Bridge
- PCI Bus
- PXI Trigger Bus (8 TTL Triggers)
PXI Architecture – A Robust Standard for ATE

- **Timing / Synchronization**
  - Triggering and clocking resources for coherent mixed signal testing

- **Bus bandwidth**
  - 2 GB/s data rate per slot
  - Peer to peer communication for high speed data processing

- **Software – Flexibility & Open Architecture**
  - Windows based environment supports many APIs - COM, VB, LabVIEW, .Net, C, etc.
  - Users can select from off the shelf test executives or create their own
  - Third party and OEM software tools for importing and converting digital test vectors – i.e. STIL, WGL, VCD
PXI Products for Semiconductor ATE - Digital Test

• Multiple vendors offering performance digital instrumentation
• 200 MHz vector rate with PMU per pin and per pin programmability
• High channel density: 32 channels per card, 512 channels in a single 3U PXI chassis
• Cost effective: $250 / channel
• User FPGA cards for custom interfaces
PXI Digital Instrumentation for Parametric and Functional Test

- Combining the digital and PMU:
  - Faster test time
  - Lower cost
  - Eliminates switching

Digital Instrument
• 100MHz

PMU or SMU (Source / Measure Unit)

Multiplexer / Switch

DUT

-2 to +7 Drive / Sense
Terminations: PU / PD
3 state drive
Real time compare

Power Supply

GX5295

Silicon Valley Test Workshop

Silicon Valley Test Conference 2012
Semiconductor Test –
Using PXI Instrumentation

• Verify functionality
  – Generate or import test vectors
  – Test vectors can be large (megabytes) - requires deep memory

• Verify DC parameters
  – Opens / shorts test – verifies fixture / UUT connection
  – Input and output characteristics
  – Sink / source currents and voltages for all signal pins

• Maximize test throughput
  – Real-time compare for digital test
  – “Per-pin” DC measurement (parametric measurement unit or PMU)
Application – Device Characterization

V-I Curve Characterization & Output Loading Tests
- Parallel measurement
- Fast with PMU per pin

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PXI Products – Analog Instrumentation

• Multiple vendors producing high performance digitizers and waveform generators
• Time interval analyzer for jitter and fast frequency measurement
• SMUs & power supplies for DPS applications
PXI Products – RF Instrumentation

• Multiple vendors producing generators, analyzers and VNAs for communication test applications
  – Frequency support > 6 GHz
  – Digital modulation / analysis capabilities
PXI Systems for Semiconductor ATE

• Key features:
  – System power to support high channel count configuration (512 channels) – 60 watts /slot
  – Integrated receiver interface accepts DUT board fixtures
  – Open architecture – easy to reconfigure the system and receiver
  – Integrates with automated handlers
PXI System – 20 slot, 3U

Complete system for device test:
• User supply
• 64, 100 MHz digital channels (expandable to 512) with PMU per pin
• 64 static digital channels
• Vector conversion tools & test executive
• Receiver interface with self-test
• High power chassis

High Performance, Modular Integrated Receiver
Application Example

- Test a serial communication controller with high voltage isolation (2500V), used for smart grid applications
- Requirement: Lower cost, smaller footprint solution needed
- Test requirements:
  - Support 16 digital channels with PMU capability with vector rates of > 20 MHz
  - Tools to import and convert WGL vector files
  - Analog instrumentation
  - Characterization and production test
<table>
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<tr>
<th>Customer Requirement / Specification</th>
<th>PXI Based Solution</th>
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</thead>
<tbody>
<tr>
<td>1. 560V-2500V DC signal preferably without any external power supplies for transformer isolation and</td>
<td>12 bit PXI based ADC board and DAC board interfaced with custom bus based proprietary</td>
</tr>
<tr>
<td>functional testing</td>
<td>signal conditioning high voltage VI board</td>
</tr>
<tr>
<td>2. Multiple power supplies up to 5V, 5A</td>
<td>12 bit PXI based ADC board plus DAC board interfaced with custom bus based proprietary</td>
</tr>
<tr>
<td>3. 16 Digital channels with vectors pattern drive and strobe capability with data rate more than</td>
<td>Geotest GX5295, 32 DIO &amp; PMU card with 256MB of on board vector memory.</td>
</tr>
<tr>
<td>20MHZ and with deep memory for Functional testing.</td>
<td></td>
</tr>
<tr>
<td>4. 12 bit or better PMU for DC and parametric testing</td>
<td></td>
</tr>
<tr>
<td>5. Very low leakage current measurement in ‘pico Amps’.</td>
<td>PXI based 6.5 DMM with signal amplifier board.</td>
</tr>
<tr>
<td>6. 8 bit or better high speed digitizing capability with deep on board memory for skew and</td>
<td>PXI based 100MHZ, 100MS/s high speed digitizer</td>
</tr>
<tr>
<td>switching characteristics testing</td>
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Key Success Factors

• Test application required multiple digital channels with PMU
  ✓ The PXI digital instrument with per pin PMU offered a cost-effective solution

• Customer was looking to reduce size, power and cost of system
  ✓ PXI platform helped achieve these goals
  ✓ 3:1 size reduction, 3:1 power reduction, 3:1 cost reduction

• Customer was looking for a high throughput solution
  ✓ The driver and PMU performance were optimized to meet the customer’s requirements
### Summary: PXI Products for Semiconductor ATE

<table>
<thead>
<tr>
<th>PXI Product</th>
<th>Availability (# of products)</th>
<th>Performance / Features</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital</td>
<td>Excellent</td>
<td>Good</td>
<td>Trend is to higher performance digital products with better timing resolution / performance &amp; lower cost</td>
</tr>
<tr>
<td>Analog</td>
<td>Excellent</td>
<td>Good / Excellent</td>
<td>Trend is to more features and performance</td>
</tr>
<tr>
<td>RF</td>
<td>Good</td>
<td>Good / Excellent</td>
<td>Products rival box instrumentation specs</td>
</tr>
<tr>
<td>Software tools</td>
<td>Fair / Good</td>
<td>Good</td>
<td>Combination of OEM and 3rd party tools address program development needs today</td>
</tr>
<tr>
<td>SMU / DPS</td>
<td>Fair</td>
<td>Fair / Good</td>
<td>Current capability is limiting for some applications</td>
</tr>
</tbody>
</table>
Summary

• PXI products and systems offer a cost effective platform for semiconductor test
  – Open hardware and software architecture
  – Access to a broad portfolio of PXI products from multiple vendors

• Market acceptance and adoption of PXI is driving product advancements for semi and other markets

• PXI adoption is moving from augmenting ATE systems to being the core for ATE systems
Thank You!

• Discussion / Questions

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