Adopting the PXI Architecture for Semiconductor Test Applications

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Agenda

• Marvin Test Solutions background

• Semiconductor market and trends

• PXI for semiconductor test
  – PXI background & market
  – System power requirements
  – UUT interfacing
  – Software
  – Digital subsystem requirements
Marvin Test Solutions
New Name / Same Aim

- Formerly Geotest – Marvin Test Systems
  - Simplified name strengthens the company’s association to The Marvin Group, known for its 50-year history in aerospace, and our focus on test solutions

- Continued focus providing innovative products and solutions, coupled with the excellent, long-term support we are known for

- Vertically integrated test company that addresses test challenges without compromise
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 $380M in sales in 2012 and a current funded backlog of over $1.6B USD

• More than 1200 employees

• Established supplier to the commercial and military aerospace markets world-wide
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)
  – Importing & converting STIL, WGL, VDC/EVCD files (DIOEasy-FIT)
  – Vector editor (DIOEasy)
  – Analog waveform editor (WaveEasy)
  – Lasar Post Processor (DtifEasy)
PXI Product Portfolio

Other Resources

Measurement & Switching
Chassis & Power Supply
Stimuli Instruments
Software Packages

Digital Resources

High voltage pin electronics
Digital I/O with PMU
High Speed Digital I/O
FPGA Instrument

Applications

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Semiconductor Market & Trends

- OEMs, packaging / test vendors & fabless semiconductor vendors need to lower their test costs
- Test share of IC cost continues to decline
- PXI capabilities: Flexible and cost effective solutions for digital, mixed-signal, and RF test
<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>
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</thead>
<tbody>
<tr>
<td><strong>Functional</strong></td>
<td>Extensive, multiple files / vectors</td>
<td>Limited, test time constrained</td>
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<tr>
<td>DC parametric</td>
<td>Limited or complete test, depending on customer / application</td>
<td>All pins checked for DC parameters</td>
</tr>
<tr>
<td>Performance vs. power supply, temperature and data rate</td>
<td>Extensive</td>
<td>Limited, “corner cases” checked at ambient temperature only</td>
</tr>
<tr>
<td>Test throughput</td>
<td>Minutes to hours, single device testing</td>
<td>Seconds, may require multi-site testing</td>
</tr>
<tr>
<td>Devices tested / characterized</td>
<td>10’s to 1000’s</td>
<td>1000’s to millions</td>
</tr>
<tr>
<td>Test system &amp; cost</td>
<td>PXI-based ATE $50K - $100K typical</td>
<td>Production IC Test System $500K and up</td>
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Primary focus
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 Growth

- >18% CAGR from 2010 – 2017
- $1B in revenue by 2017

Frost and Sullivan, 2011
% growth based on 2010 as base year
PXI Architecture – A Robust Standard for ATE

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

• **Flexible / high performance architecture**
  - 2 GB/s data rate per slot
  - Peer to peer communication for high speed data processing
  - High power / high density platform - “high functional density”

• **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 digital test vectors – i.e. STIL, WGL, VCD
PXI & PXI Express Architecture

PXI Express

PXI Express System Controller
PXI Express Timing Controller
PXI Express Peripheral
Hybrid Peripheral
PXI Peripheral

Star Trigger

SYNC100
100 MHz Differential CLK
10 MHz CLK

Differential Star Triggers

PCI Express Bus
PCI Bus
PXI Trigger Bus (8 TTL Triggers)

SYNC Control

PCI Express / PCI Bridge
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PXI System Power

• PXI is limited to 30 watts per slot – True or False?
  – A PXI chassis MUST supply AT LEAST 25.6 watts per slot
  – There is no specific limit about maximum dissipation or thermal management requirements for a PXI chassis!
  – The electrical limit for power per slot for a PXI card is 125 watts
    ✓ The challenge is thermal management

• PXI performance digital:
  – 3U PXI digital I/O cards offer 32 channels with PMU
  – Maximum dissipation: 60 watts
  – High power PXI chassis provide the power and cooling for 512 I/O channels
Instrument / UUT Interface

• The challenge: Interfacing PXI instrumentation to a performance “ATE-like” test interface

• Requirements:
  – Controlled impedance
  – Modular / flexible / expandable, customer configurable
  – Accommodate digital, analog, RF

• Ability to retain existing investment in DUT or personality interface boards
Modular Receiver

Cabled / connectorized interface to receiver blocks

Modular pin blocks, field configurable

SMA Block (not installed)

GX5733 Fixture ID

GX5295 Expansion

User Power
Modular Receiver Details

- Configurable
- Can be upgraded in the field
- Supports up to 512 digital channels
- Blind mate RF option
- Handler compatible option

Item 1: VHDC pin block assembly
Item 2: Receiver plate
Item 3: Blank pin block
Item 4: Receiver frame
Item 5: SMA connector block
Item 6: DB78 pin block assembly
Item 7: DB25 (UUT power) pin block assembly
Load Board Example
Sentry DUT Board Converter
Software for Semiconductor Test

- Windows based PXI architecture supports a range of programming environments
  - C, C++, .NET
  - LabWindows
  - LabVIEW
  - ATEasy

- Specific semiconductor test tools:
  - Test library for DC parametric tests
  - Shmoo and I-V curve plotting
  - Digital vector importing for STIL, WGL, VCD, etc.
Semiconductor Test Software Features

- Device Pin and Pin group mapping capability – simplifies test program development and reuse
- Pre-defined DC Parametric tests – simplifies test program creation
  - Open and Shorts
  - Input Leakage (IIL, IIH)
  - Input Voltage Threshold (VIH, VIL)
  - Output Short Circuit (IOSH, IOSL)
  - Output Voltage Threshold (VOH, VOL)
  - Power Consumption (IDD, IDDQ)
- Shmoo test capability - Automated and Interactive
- I-V Curve test capability - Automated and interactive Tool
Digital Waveform Display & Edit

• Graphical interface and waveform display / edit / compare software tools

• File Import Option:
  – Import WGL, STIL, VCD/eVCD vectors
  – Pin Remapping capability
  – Include /Exclude pins
  – Automated conversion profiles

• Panel application offers interactive control of digital instruments
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

Power Supply

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

GX5295

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Next Generation Digital Instrumentation

• Timing per pin with multiple time sets
  – Simplifies vector import / conversion process
  – Enhanced capability for AC device characterization
  – Simplifies bus emulation / device timing
• Data formatting
• More flexible sequencer
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)
Other PXI Products: Analog & RF Instrumentation

- Multiple vendors producing high performance digitizers and waveform generators
- RF instrumentation
- SMUs & power supplies for DPS applications
Example PXI System

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
### Assessment Summary: Using PXI for Semiconductor ATE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Performance / Capability</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital test</td>
<td>Good, support for up to 512 channels in one chassis</td>
<td>Trend is to higher performance digital products with better timing resolution / performance &amp; lower cost</td>
</tr>
<tr>
<td>Analog</td>
<td>Good / Excellent, voltage output can be a limitation</td>
<td>Trend is to more features and performance</td>
</tr>
<tr>
<td>RF</td>
<td>Good / Excellent, processing moving to on-instrument</td>
<td>Products rival box instrumentation specs</td>
</tr>
<tr>
<td>Software tools</td>
<td>Fair / Good, closed vs. open architecture challenges suppliers</td>
<td>Vendors working to improve usability and efficiency of program development</td>
</tr>
<tr>
<td>SMU / DPS</td>
<td>Fair / Good, low current measurements are a challenge</td>
<td>Current capability is limiting for some applications</td>
</tr>
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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

• FA, verification and fabless semiconductor users see PXI as a viable, cost effective solution for ATE
Thank You!

• Discussion / Questions