Thank you for attending NIWeek 2017.
A software-centric platform that accelerates the development and increases the productivity of test, measurement, and control systems.
NXP Semiconductors

Key Facts and Figures
Operations in 33 countries
More than 100 facilities
Approx. 31,000 employees
60+ years of experience in semiconductors
Headquarters: Eindhoven, The Netherlands

Product Portfolio
Microcontrollers and Processors
Identification and Security
Interface and Connectivity
Media and Audio Processing
Power Management
RF
Sensors
Software and Tools
System Solutions
NXP Automotive SW V&V

Team
- Serve automotive software teams since 2007
- Development and maintenance of test infrastructure for auto testing of hardware dependent software components (drivers)
- Definition of test methodologies and strategies
- Complete fully automated AUTOSAR MCAL testing
- Small and efficient team

Equipment
- Automated Test Equipment (ATE) Gen2
- Flexible FPGA based solution
  - Commercial grade tool for reliable testing
  - FPGA I/O, Analog I/O, CAN, LIN, FlexRay
  - Designed for future auto software needs

Use NI PXI RIO for Top Flexibility
Partner with the Best
Continuous Improvement

Build Fast and Execute Reliably
## Example of NXP Automotive Device (MPC5748G)

<table>
<thead>
<tr>
<th>Channels/Modules</th>
<th>Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>CAN</td>
<td>Enhanced FlexCAN3 module</td>
</tr>
<tr>
<td>18</td>
<td>LIN</td>
<td>Serial communication interface module</td>
</tr>
<tr>
<td>1</td>
<td>FlexRay</td>
<td>Dual-channel FlexRay Controller</td>
</tr>
<tr>
<td>6</td>
<td>SPI</td>
<td>Serial Peripheral interface module</td>
</tr>
<tr>
<td>4</td>
<td>I²C</td>
<td>Four inter-IC communication interface module</td>
</tr>
<tr>
<td>3</td>
<td>SAI</td>
<td>Synchronous Audio Interface</td>
</tr>
<tr>
<td>2</td>
<td>ADC</td>
<td>Analog-to-digital converters</td>
</tr>
<tr>
<td>96</td>
<td>eMIOS</td>
<td>Configurable Enhanced Modular Input Output Subsystem (eMIOS) channels (input capture, output compare, and pulse width modulation)</td>
</tr>
</tbody>
</table>

**Package Dependent**

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPIO</td>
<td></td>
</tr>
</tbody>
</table>
Alternate Pin Functions on NXP Microcontrollers

- CAN_0_TX
- LIN_0_TX
- GPIO_67
- PWM_0
- ...

- CAN_1_TX
- LIN_1_TX
- GPIO_77
- PWM_10
- ...

Non-Blocking Cross-Connect

ITA | Receiver

Receiver | PXI

- CAN Interface
  NI PXI-8513/2
- LIN Interface
  NI PXI-8516/2
- FlexRay Interface
  NI PXI-8517/2
- Digital Waveform Generator/Analyzer
  NI PXI-6541
Manual Testing... 😞

Life Without FPGA... 😞
Automotive Software ATE Gen2

Reliable tool for repeatable fully automated testing of hardware dependent software components designed for the future
V&V Software Use Cases

Test Developer

Tester develops and executes test locally

Build Cluster

Build cluster executes test on developer’s machine

ATE Gen2

Tester executes test on remote ATE

Build cluster executes test on remote ATE
Same Hardware for Test Development and Execution

<table>
<thead>
<tr>
<th>Module</th>
<th>Test Development</th>
<th>Test Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>AO</td>
<td>NI PCI 6723</td>
<td>= NI PXI 6723</td>
</tr>
<tr>
<td>CAN</td>
<td>NI PCI 8513/2</td>
<td>= NI PXI 8513/2</td>
</tr>
<tr>
<td>LIN</td>
<td>NI PCI 8516/2</td>
<td>= NI PXI 8516/2</td>
</tr>
<tr>
<td>FlexRay</td>
<td>NI PCI 8517/2</td>
<td>= NI PXI 8517/2</td>
</tr>
</tbody>
</table>
NXP Auto Software V&V ATE Gen2

- ATE Receiver With Signal Conditioning and Switching Electronics
- Removable DUT Tray with Interface Test Adapter (ITA)
- National Instruments PXI Chassis with FPGA and Other Modular Instruments
- Standard 19” Cabinet
- 8U for Additional 19” Rack Mountable Instruments and Optional Build Computer
V&V ATE Gen2 Receiver

- Power Supply Module
- Analog Signal Conditioning
- Receiver Control
- Media Interface Connectors
- Media Interface Modules
- 3-Way Switches
Interface Test Adapter (ITA)

- CAN, LIN, and FlexRay high speed (~ 10 MHz) digital signals
- FPGA RIO digital and mixed signals (< 10 MHz)
- Analog Output Signals
- Prototyping area with dedicated power and control SPI lines
- Power supplies, aux signals and relays
- High speed digital analyzer and generator (> 10 MHz)
Receiver and Interface Test Adapter (ITA) Assembly

- ATE Receiver
- Removable Tray
- ITA
Typical NXP Auto Software Test Bench Configuration (S32K)
More NXP Auto Software Test Bench Configurations

MPC5746C (Calypso 3M)

MPC5748G (Calypso 6M)

S32R274 (Racercunner Ultra)
FPGA Digital I/O and Media Module Subsystem

**PXI | Receiver**

- **Receiver Control**
- **CAN Interface Module**
  - CAN: NI PXI-8513/2
- **LIN Interface Module**
  - LIN: NI PXI-8516/2
- **FlexRay Interface Module 1**
  - FlexRay: NI PXI-8517/2
- **FlexRay Interface Module 2**

**Receiver | ITA**

- **DIO_0..81**
- **DIO_82..169**
- **TR1_0..7**
- **TR2_0..7**
- **TR3_0..7**
- **TR4_0..7**

**3-Way Switch**

- **SW_Mi = On:** Route media interface to ITA
- **SW_B = On:** Route ITA to bus and FPGA
- **SW_Mb = On:** Route media interface to bus and FPGA

**Bus Line**

- **To Media Interface Module**
- **To ITA**
Signal Routing – Media Interface to DIO

NI PXI-7842R

FPGA 0
NI PXI-7842R

FPGA 1
NI PXI-7842R

CAN
NI PXI-8513/2

LIN
NI PXI-8516/2

PXI | Receiver

3-Way Switch

CAN Interface Module

LIN Interface Module

Receiver | ITA

LIN_PHY

LIN_RXD, LIN_TXD

LIN_RXD, LIN_TXD

DIO_0..81

DIO_82..169

TR1_0..7

TR2_0..7

tᵦ = 55ns

3-Way Switch

Media Interface to ITA

Media interface to Bus Line

Bus Line to ITA
Signal Routing – Media Interface to ITA

**FPGA 0**
NI PXI-7842R

**FPGA 1**
NI PXI-7842R

**CAN**
NI PXI-8513/2

**LIN**
NI PXI-8516/2

**FPGA 0** to **FPGA 1**:
- **DIO_0..81**
- **DIO_82..169**

**FPGA 0** to **LIN Interface Module**:
- **TR1_0..7**

**FPGA 1** to **LIN Interface Module**:
- **TR2_0..7**

**LIN Interface Module**

**CAN Interface Module**

**3-Way Switch**
- **SWMI** Media Interface to ITA
- **SWMB** Media interface to Bus Line
- **SWBI** Bus Line to ITA
Signal Routing – FPGA to ITA

**PXI | Receiver**
- FPGA 0
  - NI PXI-7842R
- FPGA 1
  - NI PXI-7842R
- CAN
  - NI PXI-8513/2
- LIN
  - NI PXI-8516/2

**Receiver | ITA**
- DIO_0..81
- DIO_82..169
- TR1_0..7
- TR2_0..7

3-Way Switch
- SW_M
- SW_MI
- SW_BB

Media Interface to ITA
Media interface to Bus Line
Bus Line to ITA
Mixed Signal, High-Speed DIO, and C/T Subsystems

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**PXI | Receiver**

- AI_0..7
- A0_0..7
- DIO_0..7
- DIO_8..15
- DIO_16..23
- A0_8..31
- AO_0..7
- DIO_8..15
- DIO_16..23
- AO_0..7
- AO_8..15
- DIO_0..7
- DIO_8..15
- DIO_16..23
- AO_0..7
- AO_8..15
- DIO_8..15
- DIO_16..23

**Receiver | ITA**

- AI_0..7
- A0_0..7
- DIO_0..7
- DIO_8..15
- DIO_16..23
- A0_0..7
- AO_0..7
- DIO_0..7
- DIO_8..15
- DIO_16..23
- A0_8..31
- AO_0..7
- DIO_8..15
- DIO_16..23
- A0_8..31
- AO_0..7

---

**PXI | Receiver**

- AI_0..7
- A0_0..7
- DIO_0..7
- DIO_8..15
- DIO_16..23
- A0_0..7
- AO_0..7
- DIO_0..7
- DIO_8..15
- DIO_16..23
- A0_8..31
- AO_0..7
- DIO_8..15
- DIO_16..23

**Receiver | ITA**

- HSDIO_0..31
- PFI_1..3
- CLK
- STB
- CT_OUT_0..7
- CT_SRC_0..7
- CT_GATE_0..7
- P0.0..P0.7
- AUX
- AUX_0..22

---

**FPGA 0**

- NI PXI-7842R

**FPGA 1**

- NI PXI-7842R

**Analog Output**

- NI PXI-6723

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**NI PXI-6541**

**NI PXI-6602**

**NI PXI-6723**
FPGA Soft-Instruments

DIO Port 82 + 88 Lines
Cross Point 8 x 1:82 (RIO 0)
            8 x 1:88 (RIO 1)
SPI (Master/Slave) 8 Channels
I²C (Master/Slave) 8 Channels
I²S (Master/Slave) 8 Channels
SCI 8 Channels
Counter/Timer 16 Channels
PWM Analyzer 16 Channels

...
FPGA Software Architecture

Bus Lines
8
DIO Lines
82
Receiver Control
6

Host Communication and Instrument Configuration

SPI
Master/Slave
4 Units

I2C
Master/Slave
4 Units

I2S
Master/Slave
4 Units

I2C
Master/Slave
4 Units

SCI
4 Units

Counter/Timer
8 Units

PWM Analyzer
8 Channels

Logic Analyzer
4 Channels

ATE Receiver Control

DXA

PXI Host

8 @ 200 MHz
6 @ 100 MHz
82 @ 40 MHz

Bus Lines
8
DIO Lines
82

National Instruments

Bus Lines
8
DIO and Cross Point
8
DIO Lines
82
Common Interface for Loadable Bit Files

NI PXI Reconfigurable I/O Module

- PXI Host
- DMA
- Host Communication and Instrument Configuration
  - SPI Master/Slave 4 Units
  - I2C Master/Slave 4 Units
  - I2S Master/Slave 4 Units
  - Counter/Timer 8 Units
  - PWM Analyzer 8 Channels
  - SCI 4 Units
- DIO and Cross Point
  - 8 Bus Lines
  - 82 DIO Lines
FPGA Based Built-In Logic Analyzer
For Hardware Debugging of Remote ATE

NI PXI Reconfigurable I/O Module

- PXI Host
- DMA
- Host Communication and Instrument Configuration
- SPI Master/Slave 4 Units
- I2C Master/Slave 4 Units
- I2S Master/Slave 4 Units
- Counter/Timer 8 Units
- PWM Analyzer 8 Channels
- SCI 4 Units
- DIO and Cross Point
  - 8 DIO Lines
  - 82 Bus Lines
- ATE Receiver Control
- Logic Analyzer

NI PXI Reconfigurable I/O Module
V&V Philosophy

- Take It Off the Shelf and Define It With Software
- Keep the Team Small
- Remember System Maintenance
"The most cost-effective way to build a reliable test system is to combine commercial off-the-shelf components with simple, custom-built parts"

- Petr Pomkla, NXP Semiconductors
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