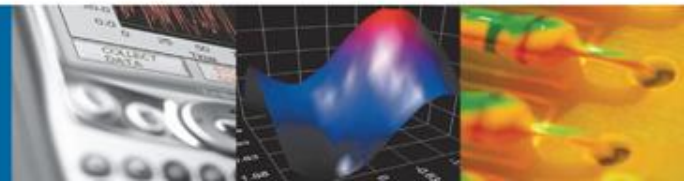


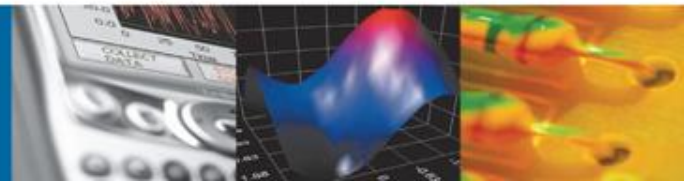
Deploying and Customizing NI LabVIEW Embedded Technologies

2009 NI Technical Symposium



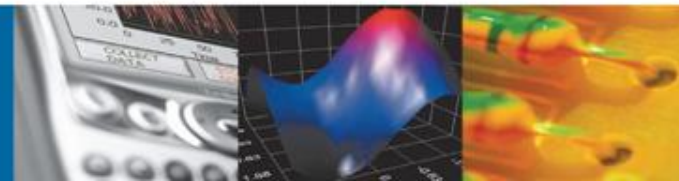
Agenda

- Customizing Embedded Systems
 - Custom I/O with NI C Series
 - NI Single-Board RIO Daughter Cards
- User Interface Options
- Custom Hardware with ARM Microcontrollers

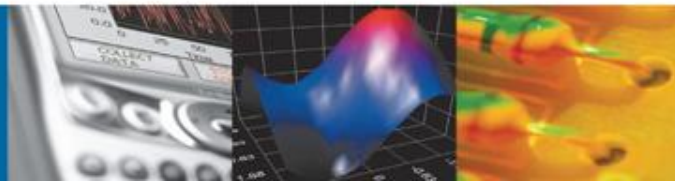


LabVIEW Targets for Embedded Design

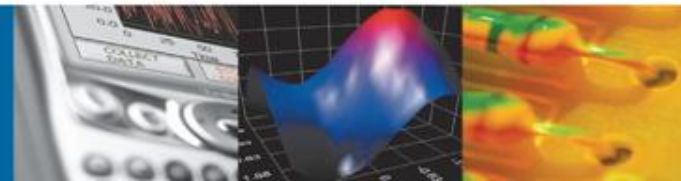
- NI CompactRIO
- NI Single-Board RIO
- NI FlexRIO
- Touch Panel PCs
- Microprocessors/controllers
 - ARM, ADI Blackfin
 - Any 32-bit Microprocessor
- PC/104, SBC, PC, or PXI
 - LabVIEW/LabVIEW Real-Time
 - Windows Mobile/CE/XP/Xpe
 - Linux



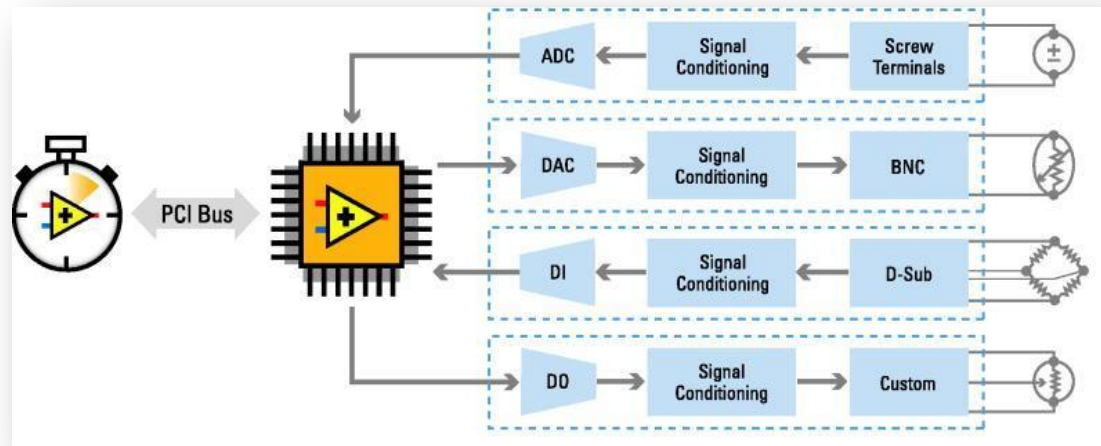
	CompactRIO	NI Single-Board RIO	LabVIEW Embedded Module for ARM Microcontrollers	LabVIEW Embedded Module for ADI Blackfin Processors	LabVIEW μ Processor
Development Risk/Effort	Integrated software and hardware	Integrated software and hardware	User responsible for integration	User responsible for integration	User must define and code for all hardware integration
Power/Size	7 to 15 W typical	7 to 10 W typical	Various	Various	Various
FPGA	Y	Y	N	N	N
Available I/O	COTS modules Third-party, custom modules	110 digital I/O lines COTS modules Third-party, custom modules	Some on-chip I/O	Custom I/O	Custom I/O
I/O Integration	Built-in driver software	Built-in driver software	Some software drivers	Some software drivers	User responsible for drivers



	CompactRIO	NI Single-Board RIO	LabVIEW Embedded Module for ARM Microcontrollers	LabVIEW Embedded Module for ADI Blackfin Processors	LabVIEW μ Processor
Maturity	Industry-proven	CompactRIO architecture	Fewer users	Fewer users	Few users
Processing Power	667 MHz Power PC Virtex-5 FPGA	400 MHz Power PC Spartan 3 FPGA	Performance varies	Performance varies	Depends on processor
Ratings and Certification	Shock/vibration, temp, CE, UL,	Same components as CompactRIO	Various	Various	Various
Tech Support	One source	One source	More difficult to troubleshoot	More difficult to troubleshoot	More difficult to troubleshoot
Software Toolkits	LabVIEW Control Design and Simulation, LabVIEW Statechart	LabVIEW Control Design and Simulation, LabVIEW Statechart	Limited toolkits	Limited toolkits	Limited toolkits



NI Reconfigurable I/O Deployment Options



LabVIEW



PXI RIO

**AUTOMATED
TEST**



PCI RIO

PC-BASED



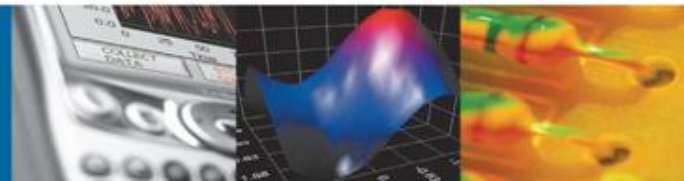
CompactRIO

INDUSTRIAL



NI Single-Board RIO

BOARD-LEVEL



Using the CompactRIO Module Developer Kit to Create Your Own C Series Module

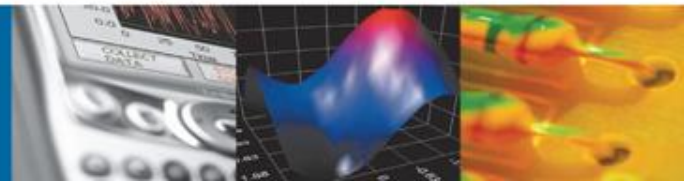


Resellers

- NI alliance product distribution
- Vertical market suppliers

Users

- Research/teaching
- Hobbyists
- Vertical systems suppliers (VAR)



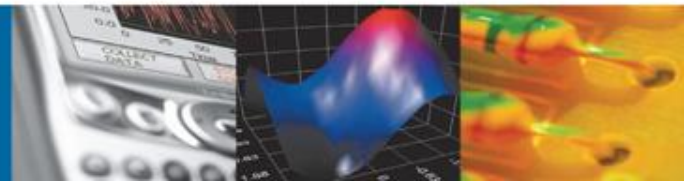
▪ MDK Base \$995 USD

- Installer EULA for internal use only
 - Access to private forum support on ni.com
 - Sample module shells with connectors
-
- Certification to CompactRIO electrical specification testing **\$1,295 USD**

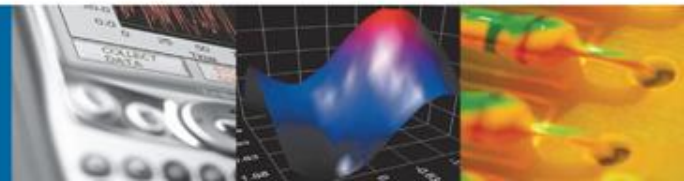
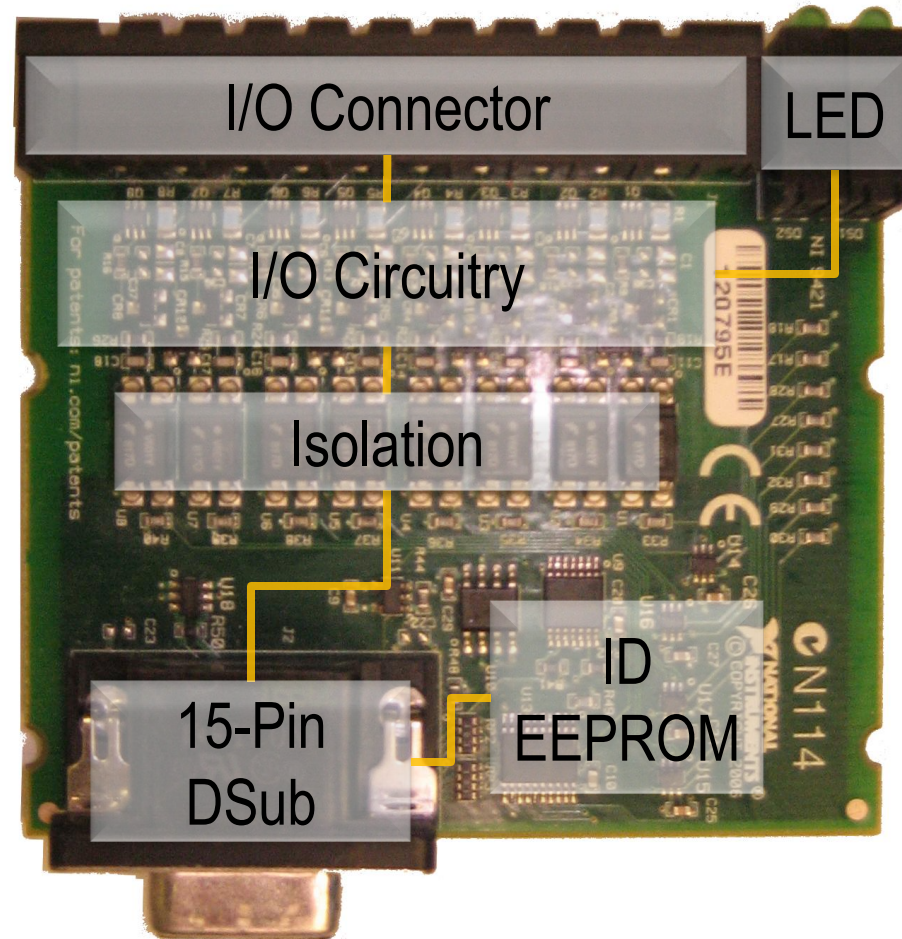


▪ MDK Developer Suite \$2,995 USD

- Installer EULA and required signed distribution agreement
- Access to product support engineering and private Web forum on ni.com
- Sample module shells with connectors
- Certification to CompactRIO electrical specification testing

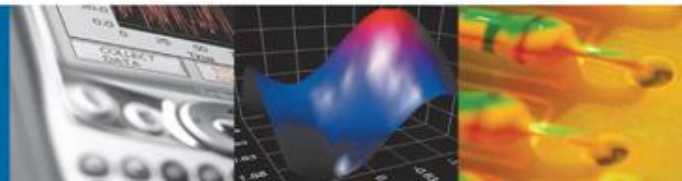
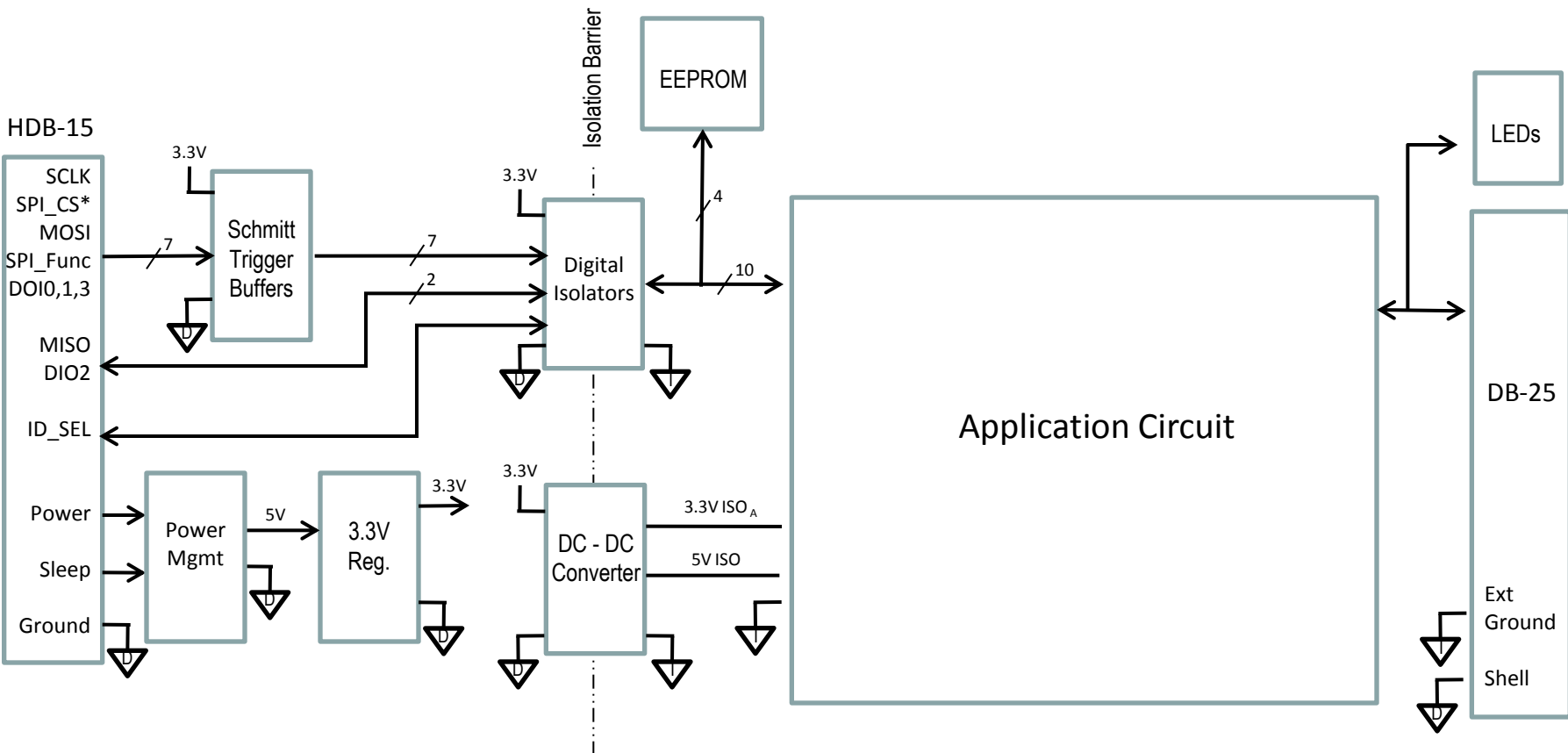


What Is Inside Most C Series Modules?



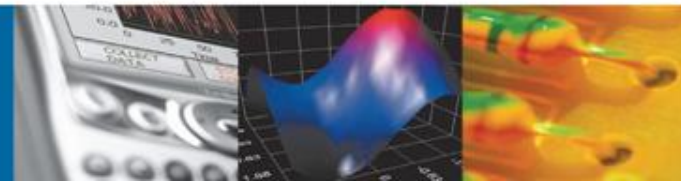
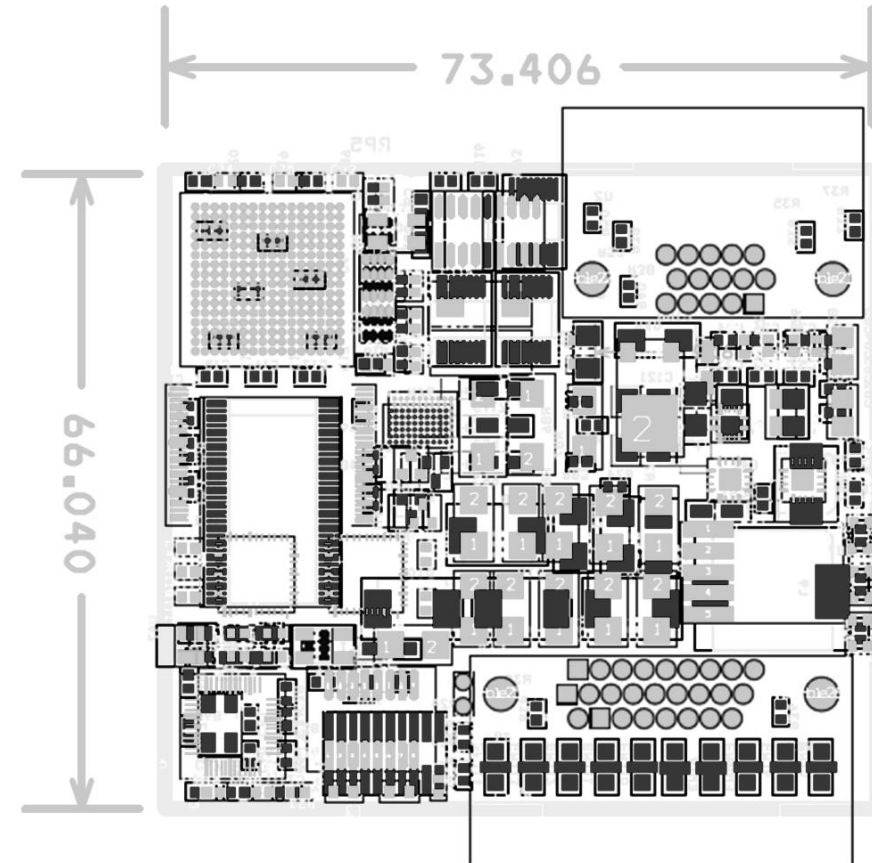
Example Module Circuit Reference Design

www.tangentblue.com



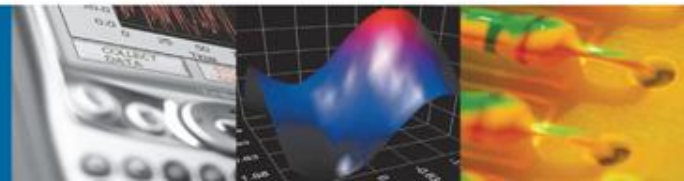
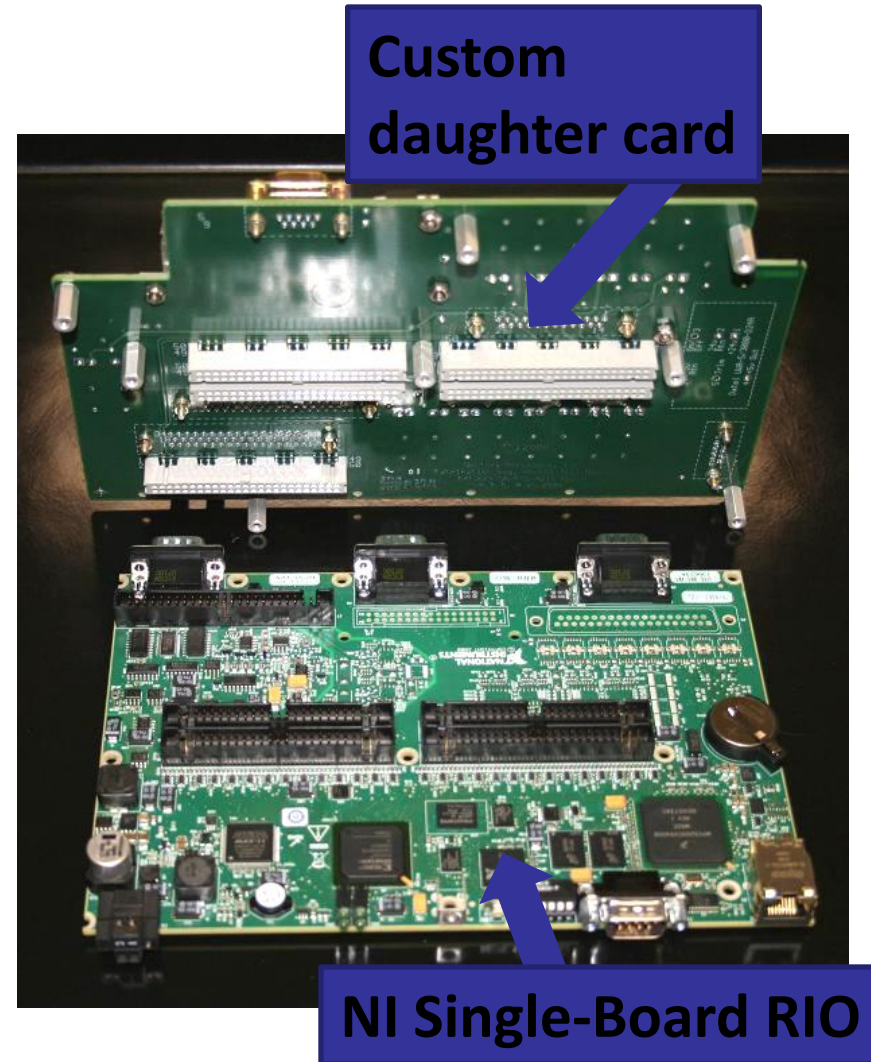
Get Free PCB Templates and Dimensions

- Use NI Multisim to simulate your analog circuits
- Use NI Ultiboard for board layout
- Use third-party tools such as PCB123 and small order board services

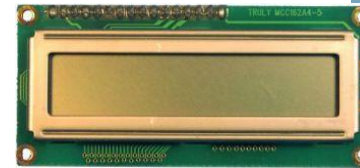


Customization Options for NI Single-Board RIO

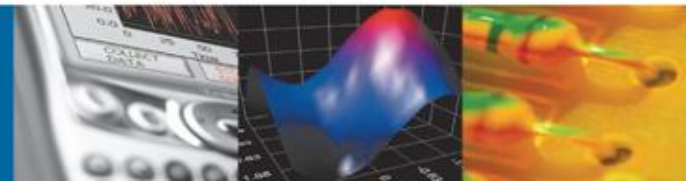
- Online resource templates for schematics and layout within Ultiboard



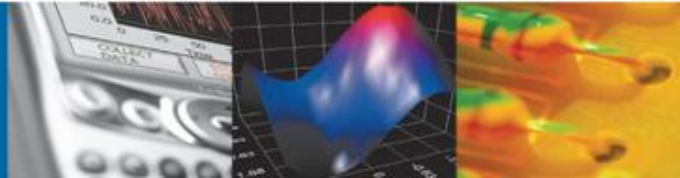
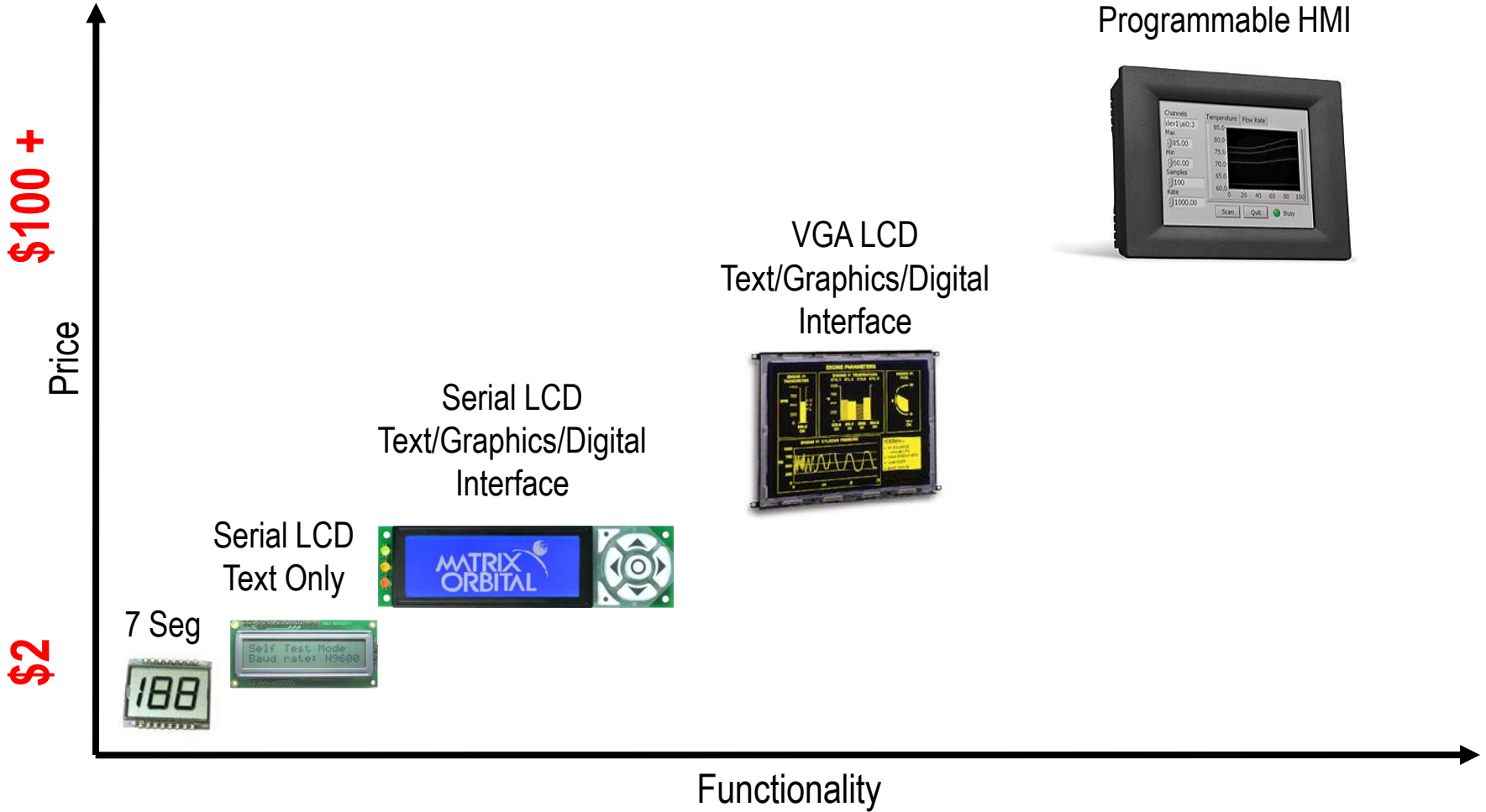
Embedded Displays



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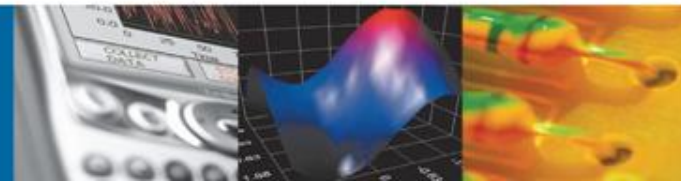


Range of Embedded Displays



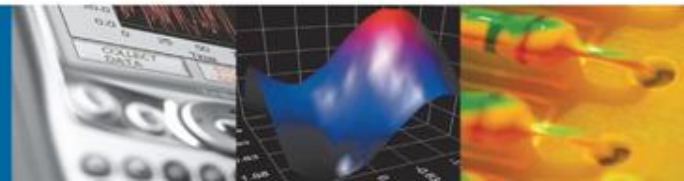
Display Hardware Considerations

- **Screen size** required for effective representation of user interface
 - 6 in., 12 in.
- **OS** support for HMI functionality
 - Windows CE, Windows XP Embedded, other, none
- **Memory** reliability and size
 - Solid state, rotating disk
- **Safety ratings** depending on operating conditions
 - NEMA, IP 65
- **Run-time licenses** for software that runs on the HMI hardware
 - Built-in, separate purchase, free



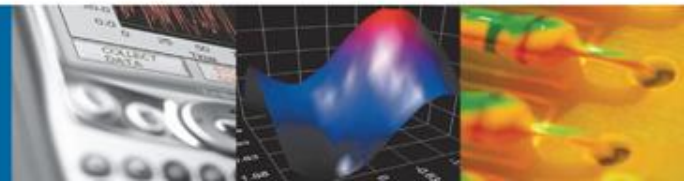
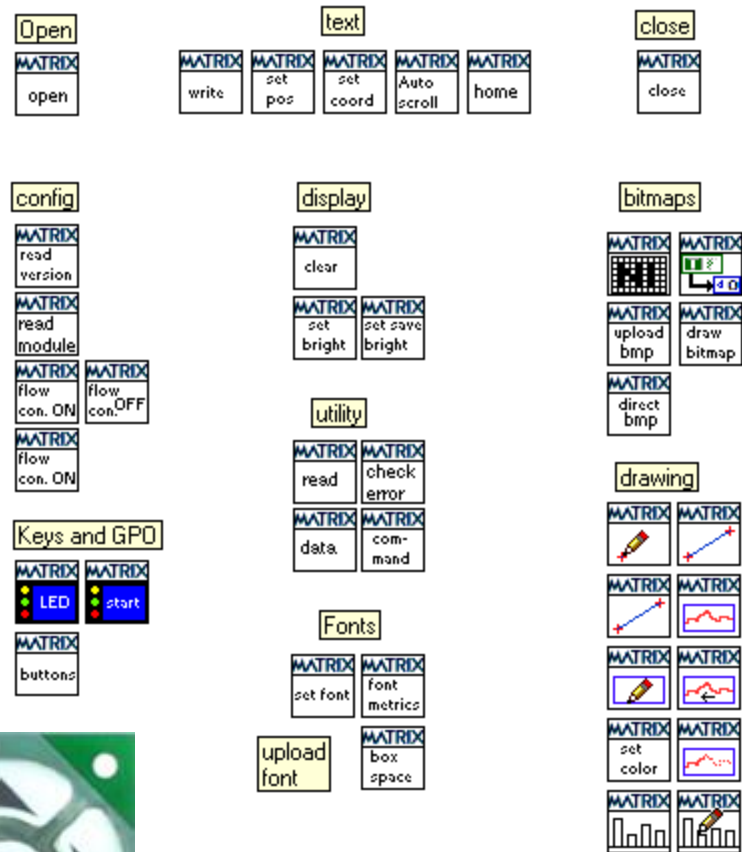
Simple Low-Cost LCD Displays

- Most primitive
 - Text-only displays
 - Some incorporate user input via buttons
- Use cases
 - Device status
 - Primitive menus and user configuration
 - Debugging
- Serial: many different serial microprocessors
- Digital: two dominant (98% market)
 - HD44780 (FPGA IP available at ni.com/ipnet)
 - LM018L



Serial LCDs

- 50+ serial display options
 - Alphanumeric and graphics
 - LCD and VFD
 - \$30 to \$200 USD
 - Extended temperature available
 - LabVIEW drivers for some modules

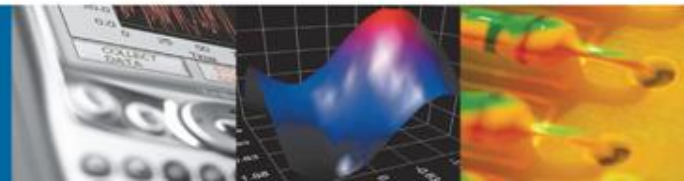


Reach Inc.

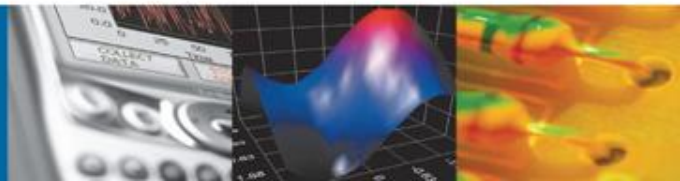
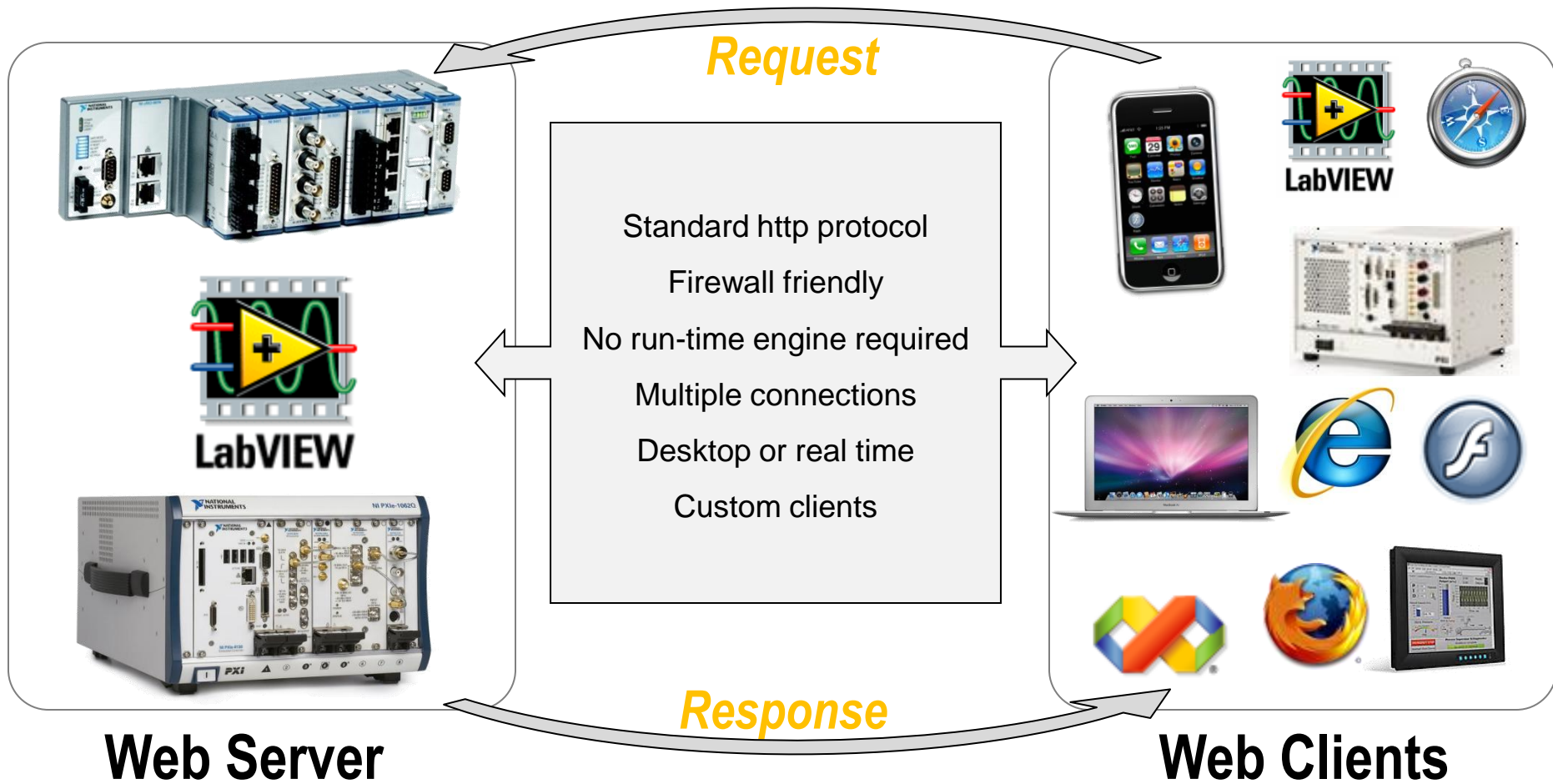
SLCD Controller Board



- Color touch screen through serial port
- Serial communication interface and API library
- Outputs to “many” QVGA LCD displays (320 by 240)
- Upload bit maps and overlay text with serial commands

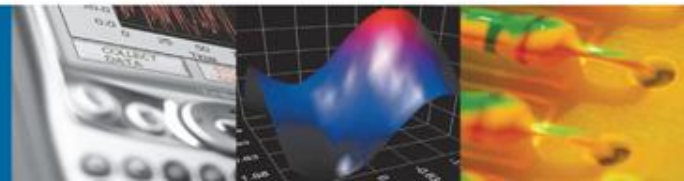


Use LabVIEW Web Services for HMIs



LabVIEW Touch Panel Module

- Add-on to LabVIEW for building programmable HMIs
 - Ability to deploy to Windows CE and XPe HMI hardware
 - Target NI and third-party touch panels
- Familiar LabVIEW development environment
 - Rich user interface
 - Advanced control and analysis
 - Ability to use programming structures



NI Single-Board RIO and Intel Atom PC Module Adapter

- Methone is an adapter board combining NI Single-Board RIO and a COM Express Intel Atom PC a angle-board computer
- Methone attaches directly to NI Single-Board RIO allowing FPGA digital I/O and/or Ethernet communication
- Run LabVIEW for Windows, Linux, or any other PC-based application on the COM Express PC module

The Methone adapter includes:

- COM Express PC Module connector
- 26-pin connector to NI Single-Board RIO FPGA with IEEE1284 and GPIO
- Three double USB connectors
- 1G Ethernet connector with magnetics
- VGA connector
- J1LI flat panel connector (option)
- Two RS232 D-sub9
- SATA connector for 2,5" hard drive
- Keyboard/mouse connector
- Line in/out connector
- 12 V DC input connector powers both NI Single-Board RIO, COM, and Methone

Included software:

- NI Single-Board RIO FPGA interface to COM Express Module



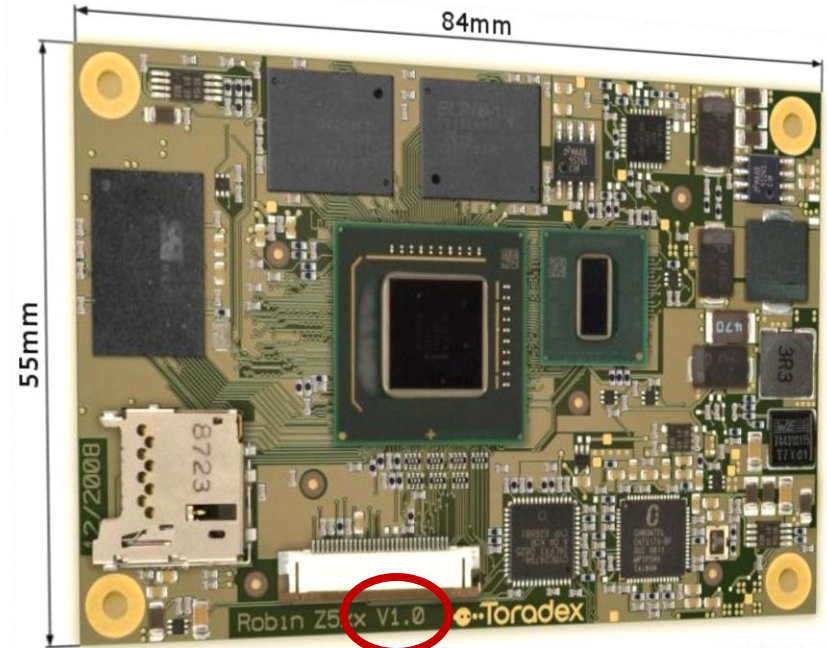
Robin COM Express™ Module

Robins are embedded COM Express™ computer modules based on the Intel® Atom™ Z530 (1.6 GHz) and Z510 (1.1 GHz) processors and the Intel® US15W

Robin Z530

- Intel® Atom™ Z530 (1.6 GHz)
- Hub US15W
- MPEG2/HD/H.2.61 Decoder
- 512 MB on-board DDR2
- 2 Gbyte SSD Solid State Disk
- PCI Express 1 (optional +1)
- GLAN
- HD-Audio
- SATA
- USB 480Mbit 7x
- MicroSD Slot onboard
- SDIO 3x
- VGA/TV out
- LPC
- LVDS
- SMB
- I²C
- GPIO 8x
- optional SDVO
- WinXP, XPE, Vista, CE5/6, WePOS, Linux, VxWorks
- Type 1 COM Express™ Pin out

www.toradex.com



**Coming soon:
New Robin**
with 1 Gbyte Ram
4 Gbyte SSD

ADIS1620X

Programmable Accelerometers/Inclinometers

Performance

- Accurate to 0.1°
- Non Linearity: 0.1% of FS
- 14-bit digital data

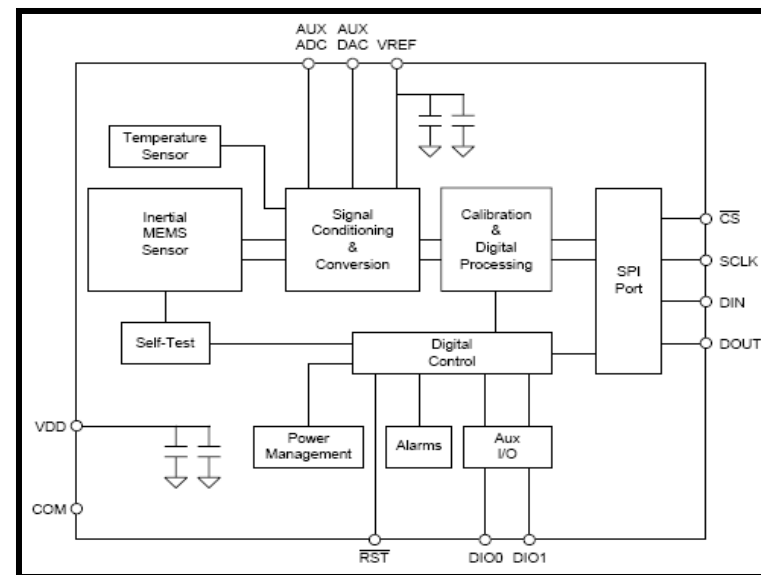
Programmability

- Digital Filtering
- Sample Rate
- Dual Alarms

Ease of Use

- No Additional Motion Test Required
- SPI Interface
- AutoNull to System Axis
- Embedded Temp Sensor Included
- Digital Self Test

*Dual Axis, Dual Mode Horizontal or Vertical Mount
Dual Axis, Horizontal Mount
Vertical Mount Inclination Only*



Applications

- ◆ Platform Control, Stabilization, and Alignment
- ◆ Tilt Sensing, Inclinometers, Leveling
- ◆ Motion/Position Measurement
- ◆ Monitor/Alarm devices (security, medical, safety)
- ◆ Navigation
- ◆ Robotics

Range

±30°, ±180°
±1.7g

Sensitivity

0.025°/LSB

Shock
Survivability

3500 g

Supply

3.0 to 3.6V

Turn-on Time

150ms / 2.5ms

Package

9.2mm LGA

Temperature

-40°C to +125°C

Using Methone as a Display Front End

Development PC

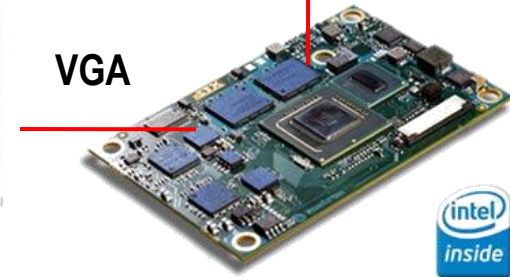
- LabVIEW Real-Time
- LabVIEW FPGA
- LabVIEW Touch Panel



Ethernet

← Shared Variables

VGA



LVDS
Touch Panel

NI Single-Board RIO Digital I/O

Set Motor Speed →

← Motor On Acknowledgement

Real-Time
Motor Control

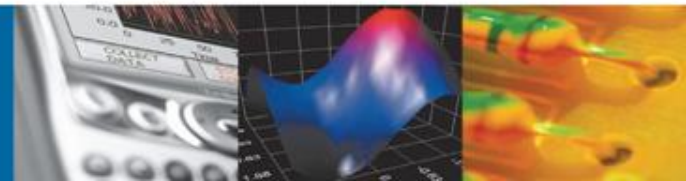


NI FPGA IPNet
ADI MEMS Inclinometers



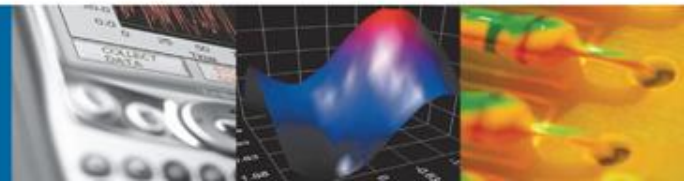
Windows XP OS

NI Real-Time OS + FPGA



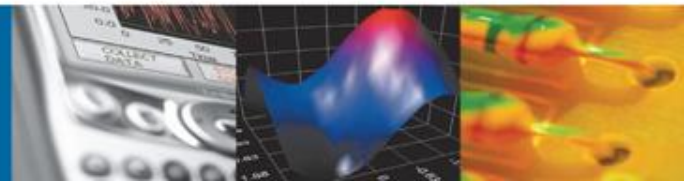
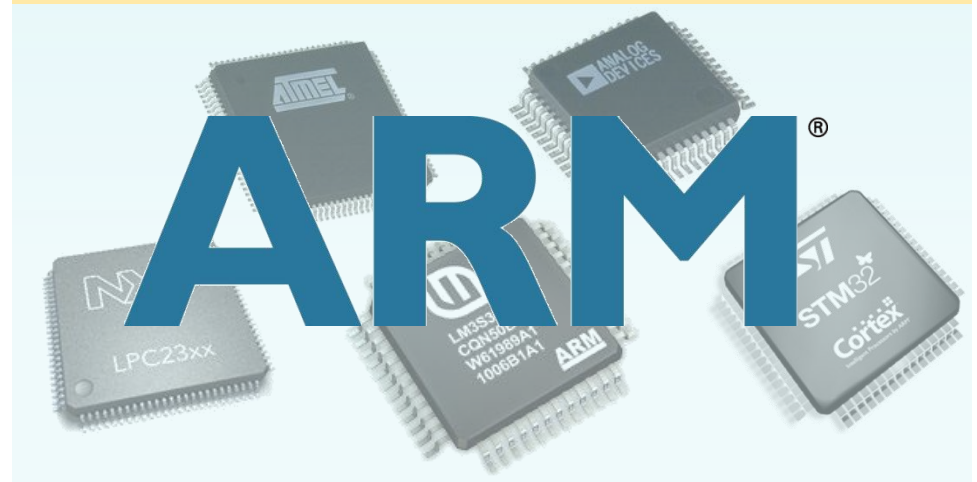
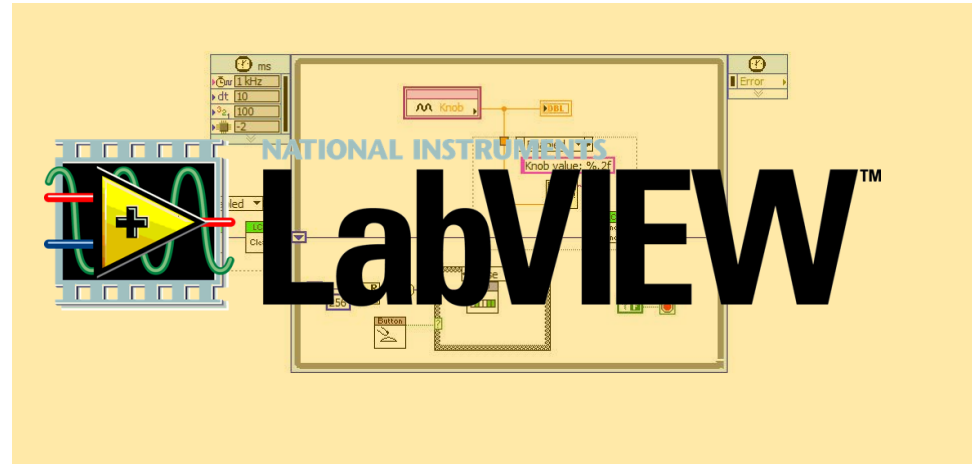
Demo

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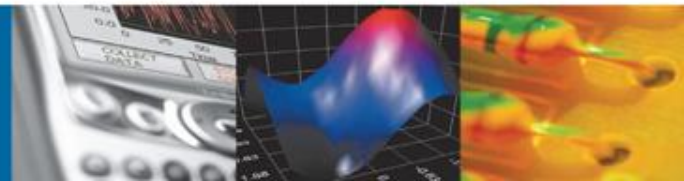
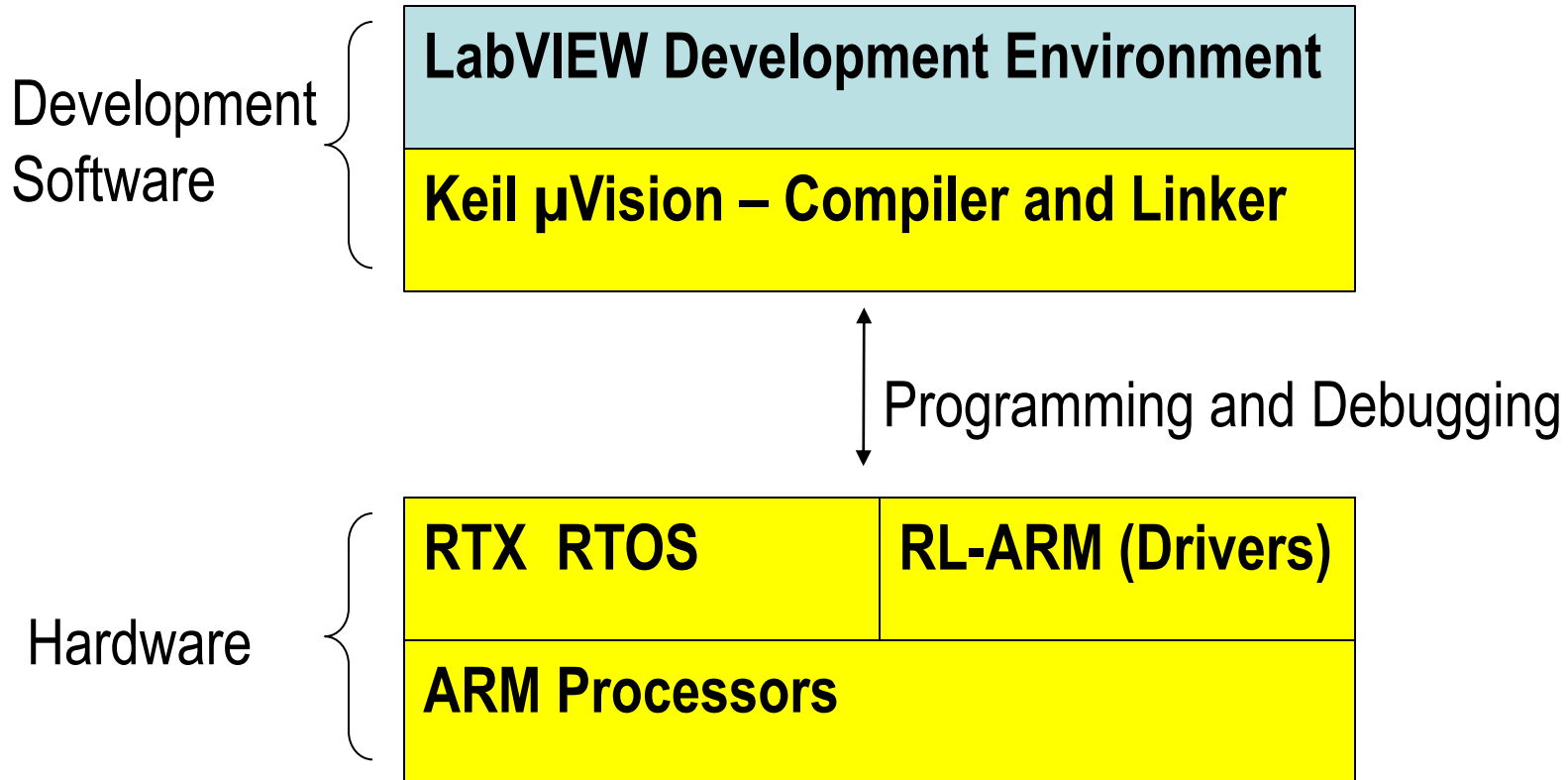


LabVIEW Embedded Module for ARM Microcontrollers

- More than 260 supported processors
- Integrated drivers for analog, digital, and communications
- Desktop simulation support for software development



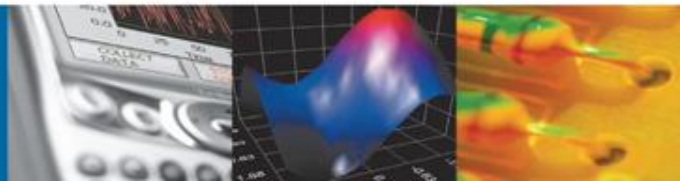
ARM Development Environment



The image displays the LabVIEW development environment for an MCB2300 motor control system. It consists of three main windows:

- Project Explorer - Untitled Project 1.lvproj**: Shows the project structure with folders for 'My Computer', 'Dependencies', 'Build Specifications', and 'MCB2300'. Under 'MCB2300', there are sub-folders for 'Digital Output' (OverThreshold (LED1), LED2), 'Analog Input' (Position (AID)), 'PWM Output' (PWM Output), and 'Motor (PWM1)'. A 'Pick and Place.vi' file is also listed.
- Processor Status**: Shows the system status:
 - µVision Status: Ready
 - µVision Application: Unknown
 - Processor Status: Not in debug mode
 - Exception Status: Not in debug mode
 - Location: Not in debug mode
- Pick and Place.vi Block Diagram on Untitled Project 1.lvproj/MCB2300 ***: Contains two sub-diagrams:
 - Control Loop**: A loop with a 1 kHz refresh rate and 20 dt. It features a 'Position' input, a 'NextPosition(x, y)' calculation block, and a 'Motor' output. An 'OverThreshold' block is also present.
 - UI Loop**: A loop with a 1 kHz refresh rate, 100 dt, and 50 iterations. It includes 'Moving' and 'Comm Failure' status indicators, and a 'TOP' block.

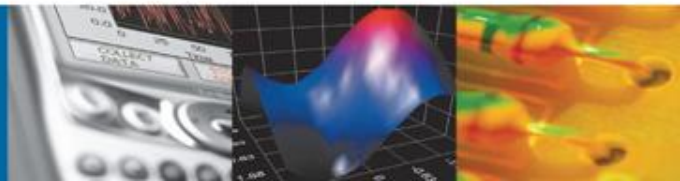
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Timed Loop

- Multithreaded programming

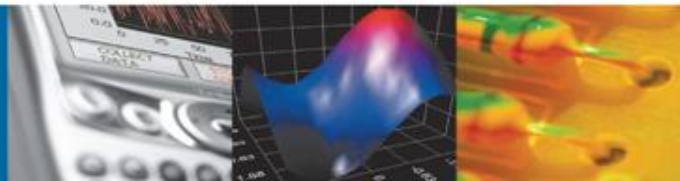
The screenshot displays two parallel loops in a LabVIEW block diagram. The top loop, labeled "Control Loop", is a timed loop with a 1 kHz clock rate and a 20ms delay. It contains a "Position" input block, a "NextPosition(x, y)" function block, and a "Motor" output block. The bottom loop, labeled "UI Loop", is also a timed loop with a 1 kHz clock rate and a 50ms delay. It contains a "Moving" input block, a "Comm Failure" output block, and a "400ms" delay block. Both loops have an "Error" indicator on the right side. The background shows the LabVIEW Project Explorer and the "Pick and Place.vi Block Diagram" window.



The screenshot displays the LabVIEW development environment. On the left, the Project Explorer shows a project named 'Untitled Project 1.lvproj' with a sub-project 'MCB2300' containing various peripheral drivers like 'Digital Output', 'Analog Input', and 'Motor'. The main workspace is divided into two block diagrams: 'Control Loop' and 'UI Loop'. The 'Control Loop' diagram features a 'Motor' block connected to a 'NextPosition(x, y)' function block, which is also connected to an 'OverThreshold' block. The 'UI Loop' diagram shows a sequence of blocks: a '400' constant, a 'TCP' block, a 'Moving' indicator, another 'TCP' block, a 'Comm Failure' indicator, and a final 'TCP' block. A 'Processor Status' window is open in the bottom left, showing the status of the uVision application and processor.

Peripheral Drivers

- TCP/IP, UDP, Serial, Display, I²C, SPI, File System

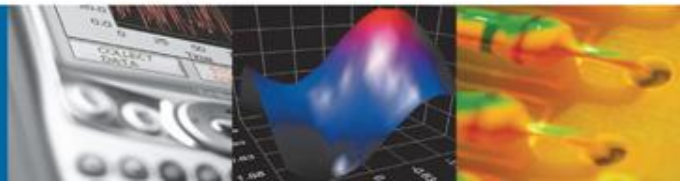


The image displays the LabVIEW development environment. On the left, the Project Explorer shows a project named 'Untitled Project 1.lvproj' with a sub-project 'MCB2300'. The sub-project contains several components: Digital Output (OverThreshold (LED1), LED2), Analog Input (Position (A10)), PWM Output, Motor (PWM1), and Pick and Place.vi. Below this is the Processor Status window, which shows the μ Vision Status as 'Ready', the μ Vision Application as 'Unknown', and the Processor Status as 'Not in debug mode'. The main window shows the 'Pick and Place.vi Block Diagram on Untitled Project 1.lvproj/MCB2300'. The block diagram features a 'Control Loop' sub-block with a 'Position' input, a 'Motor' output, and a code block containing the following text:

```
int y;  
//calculate next position  
NextPosition(x, y);
```

The block diagram also includes a 'Comm Failure' block and a '400' block. A yellow box highlights the text 'Integration with KEIL μ Vision' and a list of features:

- Cycle-accurate simulation
- Advanced debugging



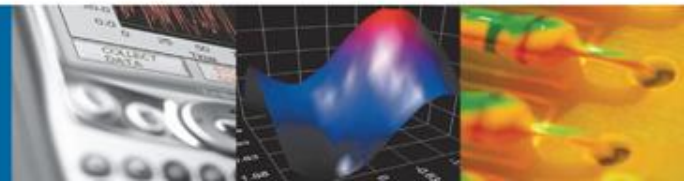
The image displays the LabVIEW development environment. On the left is the Project Explorer for 'Untitled Project 1.lvproj', showing a tree structure with folders like 'My Computer', 'Dependencies', 'Build Specifications', and 'MCB2300'. The main window shows the 'Pick and Place.vi Block Diagram on Untitled Project 1.lvproj/MCB2300'. It features two diagrams. The top diagram, titled 'Control Loop', includes a 'Position' block, a 'Motor' block, and an 'Inline C Node' containing the following code:

```
int y;  
//calculate next position  
NextPosition(x, y);
```

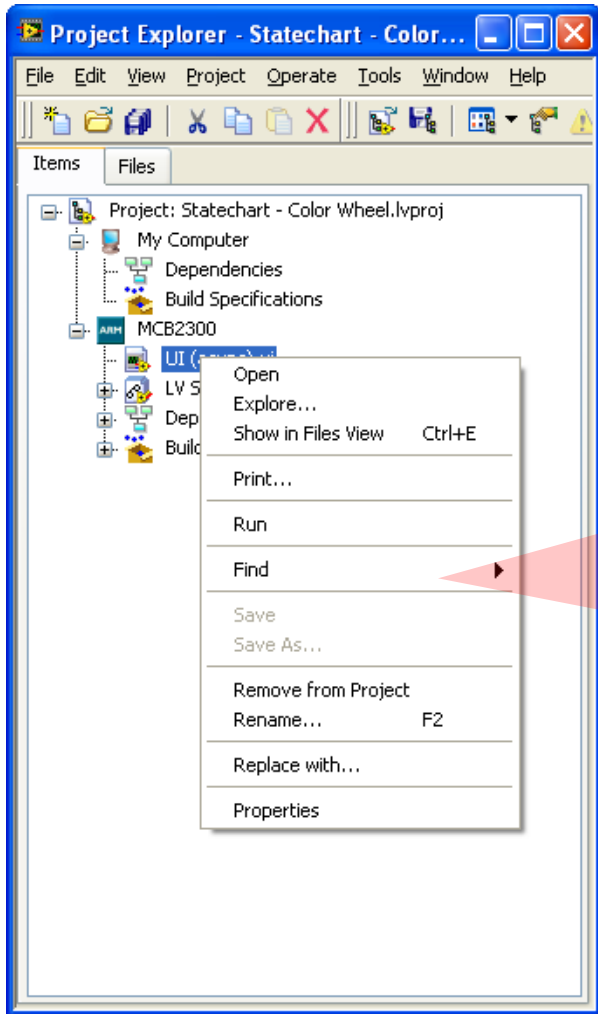
The bottom diagram is a state machine with states 'Moving' and 'Comm Failure', connected by transitions and containing various control blocks like '400' and 'TOP'. A yellow callout box is overlaid on the top diagram.

Inline C Node

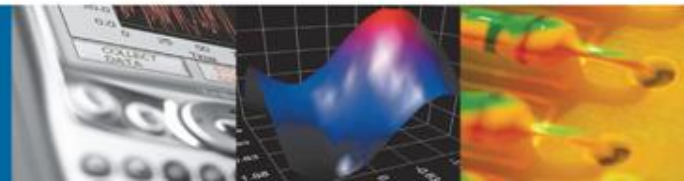
- Combine graphical and text code in one diagram



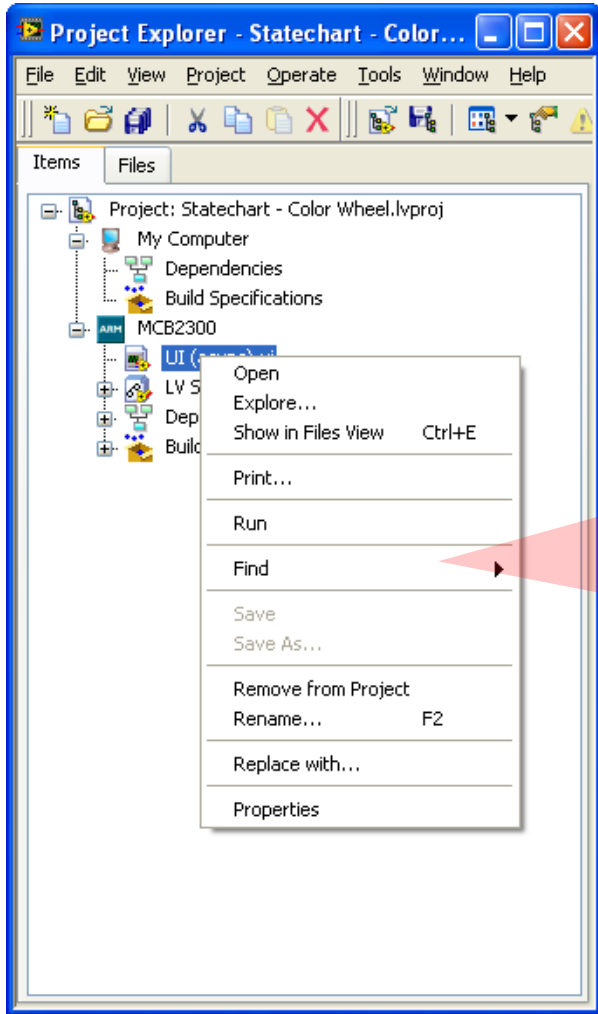
How It Works



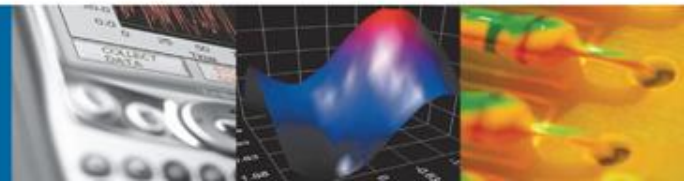
C Code Generation



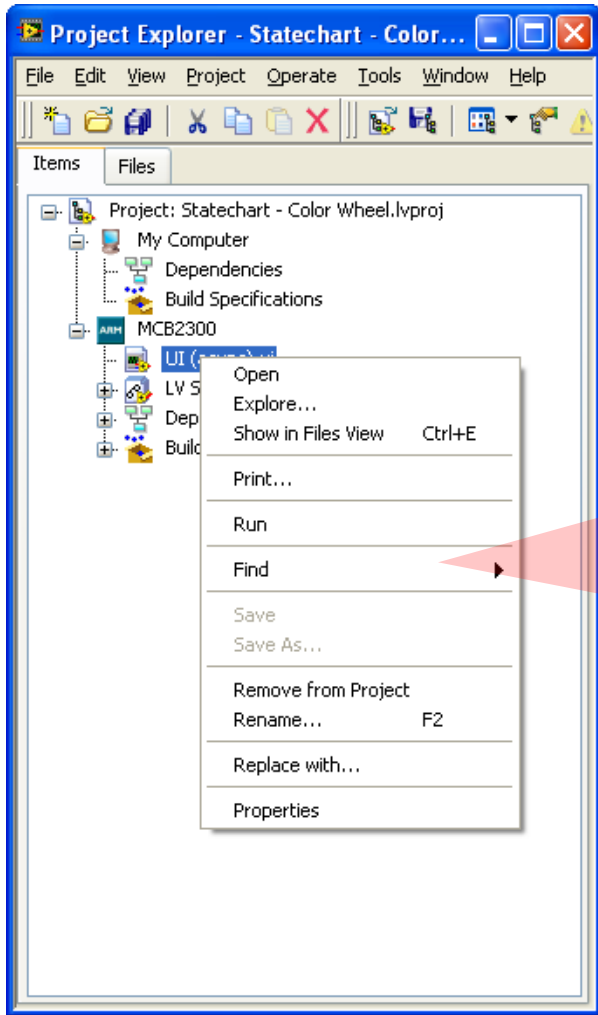
How It Works



Keil μ Vision

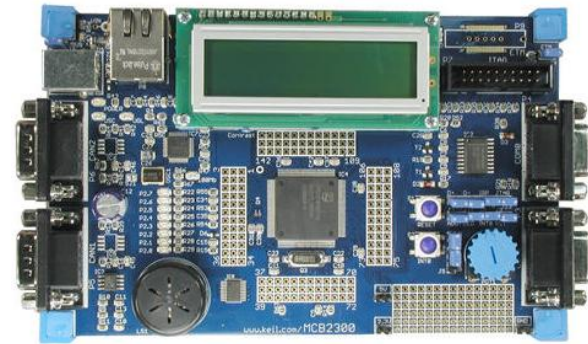


Deployment to Hardware

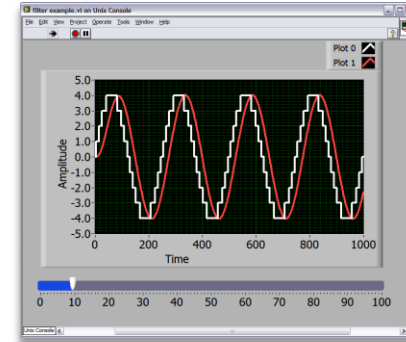
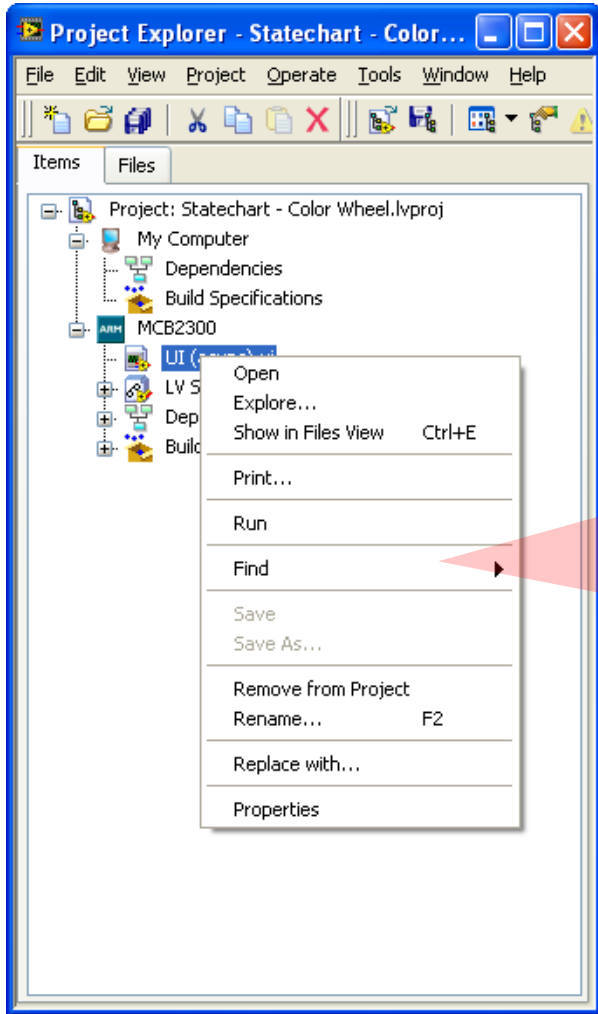


My_VI

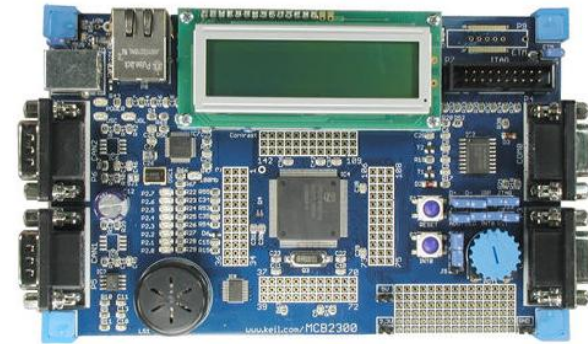
Download JTAG USB



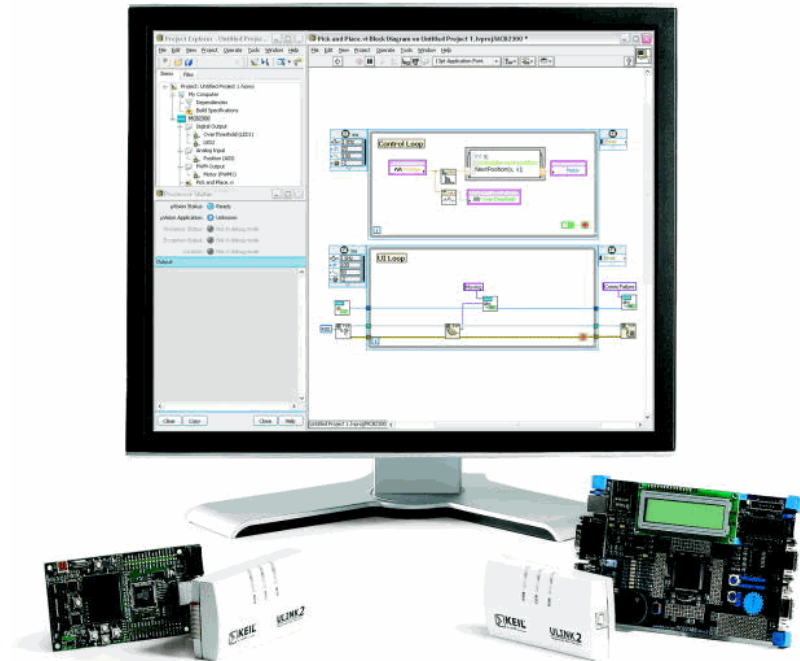
Real-Time Debugging



Debugging via TCP,
Serial, JTAG

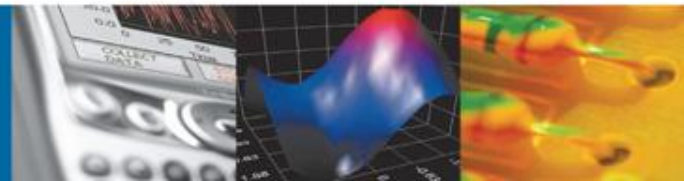


Development Kit



- Included
 - LabVIEW
 - LabVIEW Embedded Module for ARM Microcontrollers
 - ULINK2 USB/JTAG Adapter
 - Evaluation Board

Learn more at ni.com/arm



Where to Get More Information

Product Information

- ni.com/compactrio
- ni.com/singleboard
- www.prevas.com/sbRIO_methone.html
- ni.com/arm

Displays

- <http://zone.ni.com/devzone/cda/tut/p/id/7426>

Design Resources

- <http://zone.ni.com/devzone/cda/tut/p/id/2727>

