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User Interfaces in LabVIEW

Company Overview

MANUFACTURING AUTOMATION & INTELLIGENCE

TEST & MEASUREMENT AUTOMATION

CUSTOM SOFTWARE & HARDWARE DEVELOPMENT

MICROSOFT CONSULTING SERVICES

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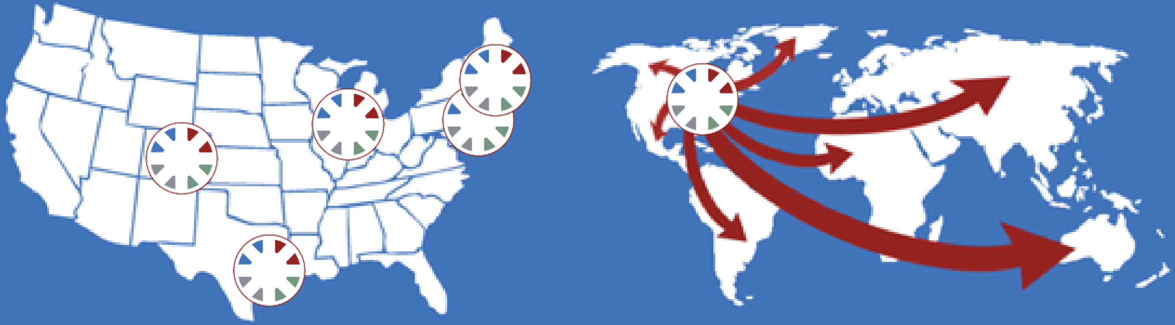

Established in 1996, offices in New York, Boston, Chicago, Denver and Houston

75+

employees & growing

Industries Served:

- Automotive
- Bio-medical
- Chemical and Food Processing
- Defense
- Electronics/Semiconductor
- Fuel Cells/Alternative Energy
- Hydraulics
- Laboratory Testing
- Machine Tool
- Material Handling
- Medical Devices
- Packaging
- Pharmaceutical
- Printing & Textiles

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Certifications

NATIONAL INSTRUMENTS Silver Alliance Partner

Vision Specialty

NATIONAL INSTRUMENTS LabVIEW CERTIFIED DEVELOPER

NATIONAL INSTRUMENTS LabVIEW CERTIFIED ARCHITECT

NATIONAL INSTRUMENTS Certified Professional Instructor

csia CERTIFIED

CERTIFIED VISION PROFESSIONAL aia CVP ADVANCED

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Goal

Explore how to we make LabVIEW UIs look:

- Comfortable
- Easy to use
- Intuitive
- Familiar
- Attractive

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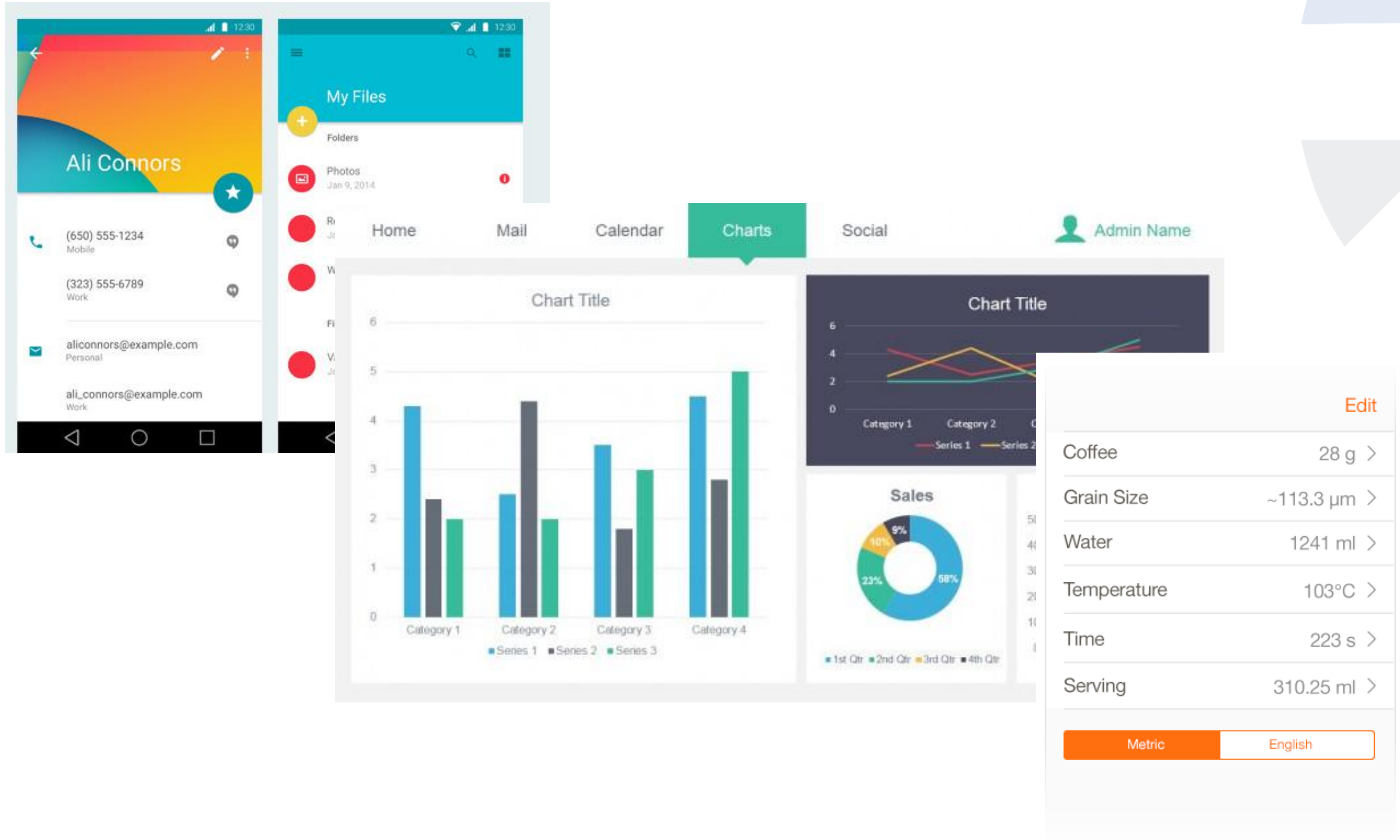
Alternate Title:
"Click Better! The LabVIEW UI Story"

Modern User Interface Design



Coffee	28 g
Grain Size	~113.3 µm
Water	1241 ml
Temperature	103°C
Time	223 s
Serving	310.25 ml

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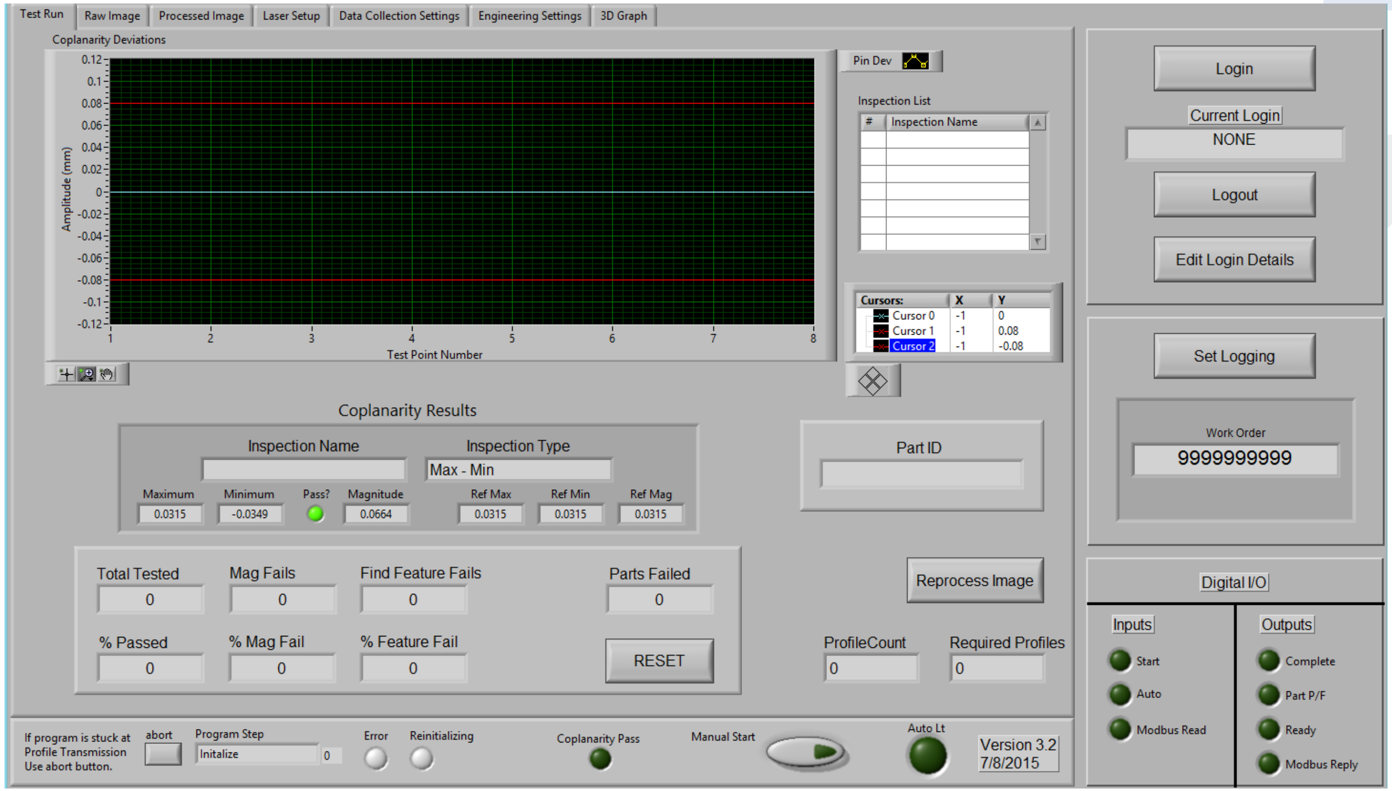
Typical LabVIEW User Interface



Test Run | Raw Image | Processed Image | Laser Setup | Data Collection Settings | Engineering Settings | 3D Graph

Coplanarity Deviations

Amplitude (mm): 0.12, 0.1, 0.08, 0.06, 0.04, 0.02, 0, -0.02, -0.04, -0.06, -0.08, -0.1, -0.12

Test Point Number: 1, 2, 3, 4, 5, 6, 7, 8

Pin Dev

Inspection List

#	Inspection Name

Cursors:	X	Y
Cursor 0	-1	0
Cursor 1	-1	0.08
Cursor 2	-1	-0.08

Login

Current Login: NONE

Logout

Edit Login Details

Set Logging

Work Order: 9999999999

Coplanarity Results

Inspection Name:

Inspection Type: Max - Min

Maximum	Minimum	Pass?	Magnitude	Ref Max	Ref Min	Ref Mag
0.0315	-0.0349	●	0.0664	0.0315	0.0315	0.0315

Part ID:

Total Tested	Mag Fails	Find Feature Fails	Parts Failed
0	0	0	0

% Passed	% Mag Fail	% Feature Fail
0	0	0

RESET

Reprocess Image

ProfileCount: 0

Required Profiles: 0

Digital I/O

Inputs: Start, Auto, Modbus Read

Outputs: Complete, Part P/F, Ready, Modbus Reply

If program is stuck at Profile Transmission Use abort button.

abort

Program Step: Initalize 0

Error

Reinitializing

Coplanarity Pass

Manual Start

Auto Lt

Version 3.2
7/8/2015

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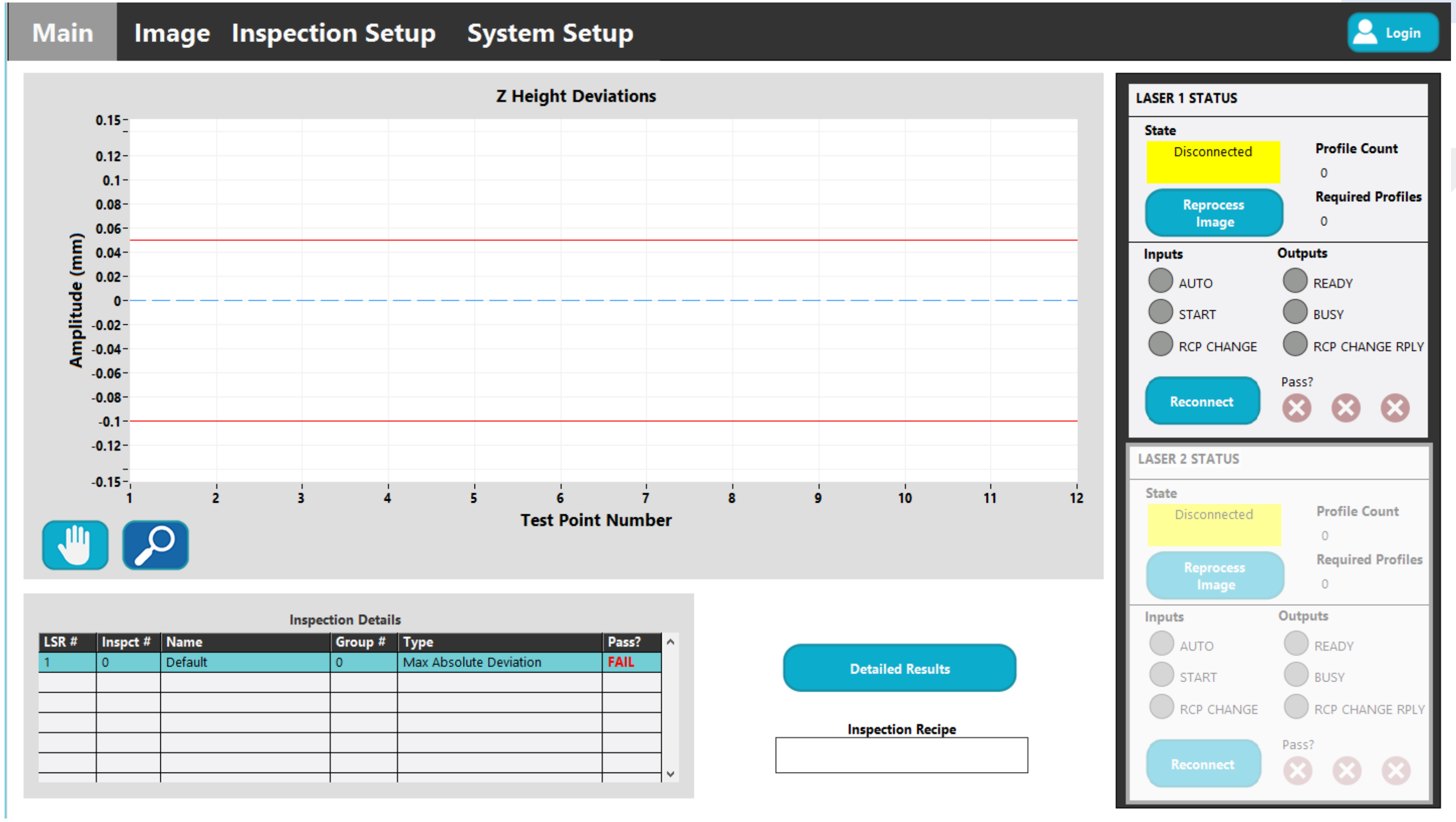
~~Typical LabVIEW~~ User Interface



Inspection Details

LSR #	Inspct #	Name	Group #	Type	Pass?
1	0	Default	0	Max Absolute Deviation	FAIL

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Agenda

- Definitions and principles
- Better controls/indicators
- Typedefs – strictly speaking
- Screen navigation
- Dialogs – Dia-dos and dia-don'ts
- Resizable interfaces
- Technical considerations
- Style tips and tricks

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Definitions

User Interface = the things you click on or look at to work with your software

User Experience = the rage you feel when your software is hard to use

UI Principles

- Don’t overcrowd screens
- Keep fonts, colors, and styles consistent
- Don’t use colors that burn the user’s face off
- No gradients
- Keep text readable
- Align controls/indicators

Think about it ahead of time… don’t wing it. Plan it like you plan the program’s business logic.

Better Controls/Indicators

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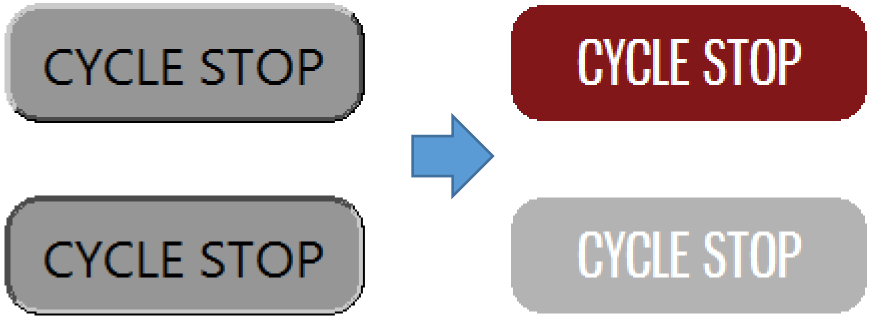
Classic is the New Modern

Customizing classic controls makes them look awesome:



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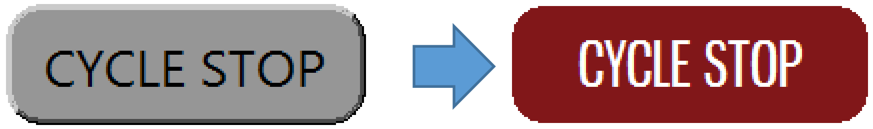
Change background/foreground colors

Convoluted process to customize the control:

1. Place a classic button on the front panel
2. Paint the control using the paint brush tool
3. Using the paintbrush tool, right-click near the border of the control, then press SPACEBAR
4. Click the transparent "T" in the upper right corner
5. Repeat for the other Boolean state



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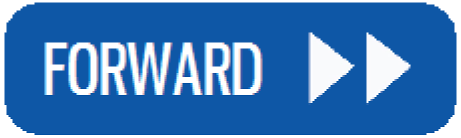
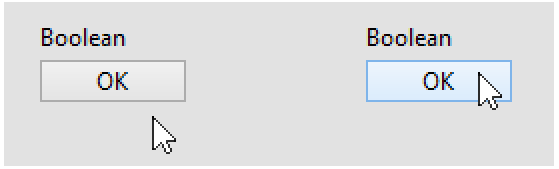
Add custom graphics

1. Right click on the button and select Advanced ➔ Customize.
2. Go to Edit ➔ Import Picture from Clipboard and select and image to import.
3. Right click the button and select import picture from clipboard (True, False, Decal).
4. To reposition the graphic, change to Customize Mode (Ctrl – M)



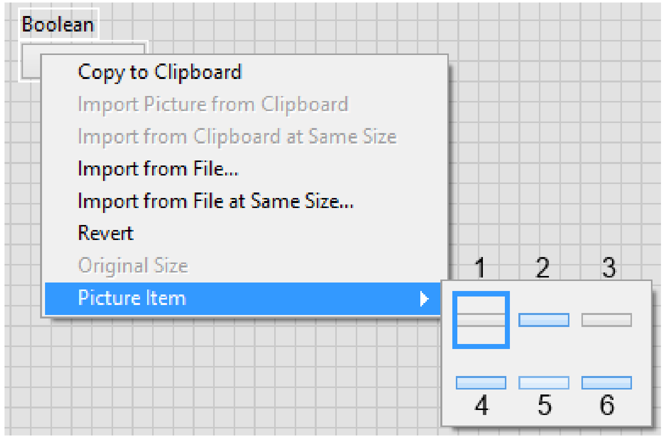
An Aside on System Buttons

- System buttons are the only style that supports hovering
- Colors can be changed by customizing the button as shown previously.



Customizing a System Button

1. Make a new control and add a system button
2. Click the wrench button to customize
3. Right-click the button ➔ Picture item


Boolean
Copy to Clipboard
Import Picture from Clipboard
Import from Clipboard at Same Size
Import from File...
Import from File at Same Size...
Revert
Original Size
Picture Item
1
2
3
4
5
6

1: FALSE, not hovering	2: TRUE, not hovering	3: FALSE, button down
4: TRUE, button down	5: FALSE, hovering	6: TRUE, hovering

https://www.dmcinfo.com/latest-thinking/blog/id/8868/labview-interface-boolean-graphics

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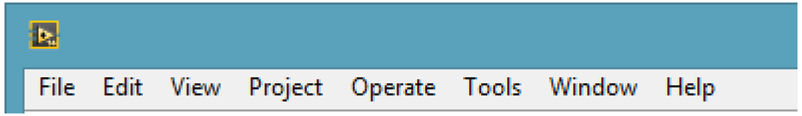
Menu Bars

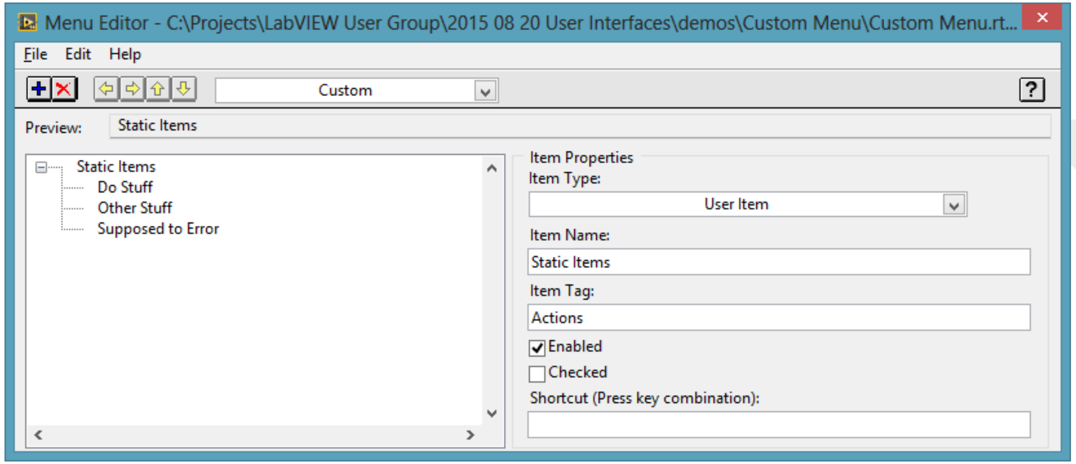
Create a clean, Windows-style UI using menu bars



Caveat: not appropriate for a touchscreen

How to add Static Menu Bars

1. Go to Edit ➔ Run Time Menu
2. Change drop down to “Custom”
3. Add your own structure and options for the menu.
4. Save .rtm file in the same directory as the VI.
5. Handle events from the menu items in an event structure.


Menu Editor - C:\Projects\LabVIEW User Group\2015 08 20 User Interfaces\demos\Custom Menu\Custom Menu.rt...

Custom

Preview: Static Items

Static Items
- Do Stuff
- Other Stuff
- Supposed to Error

Item Properties
Item Type: User Item
Item Name: Static Items
Item Tag: Actions
[✓] Enabled
[ ] Checked
Shortcut (Press key combination):

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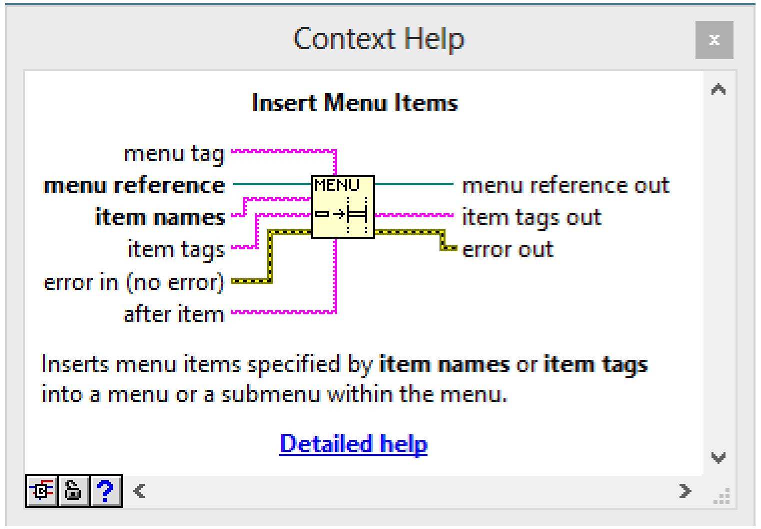
How to add Dynamic Menu Bars

1. Obtain a reference to the vi's menu bar.
2. Use "Insert Menu Items" to dynamically add menu items and sub menu items.



Inserts menu items specified by **item names** or **item tags** into a menu or a submenu within the menu.

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Menu Bar Demo

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Typedefs – Strictly Speaking

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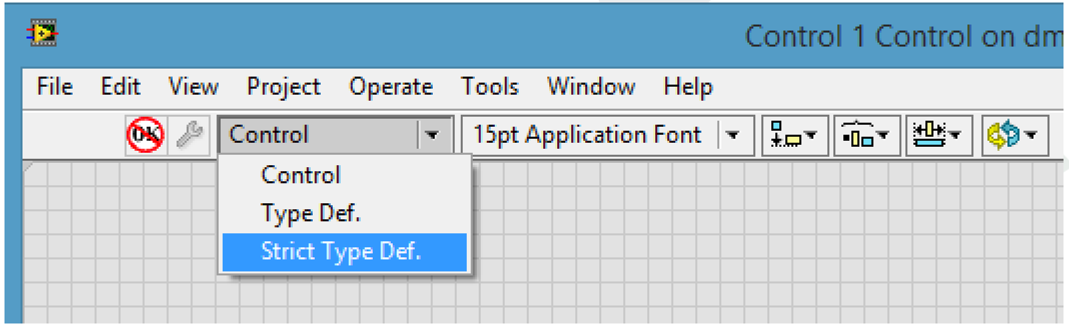
Types of Controls

- Control
- Type Def
- Strict Type Def



All are saved as *.ctl files

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Control

- Good for pretty buttons that you want to be able to reuse
- Each one is its own unique snowflake
  - Can be customized independently
  - Only the data type is important
- Won’t update globally

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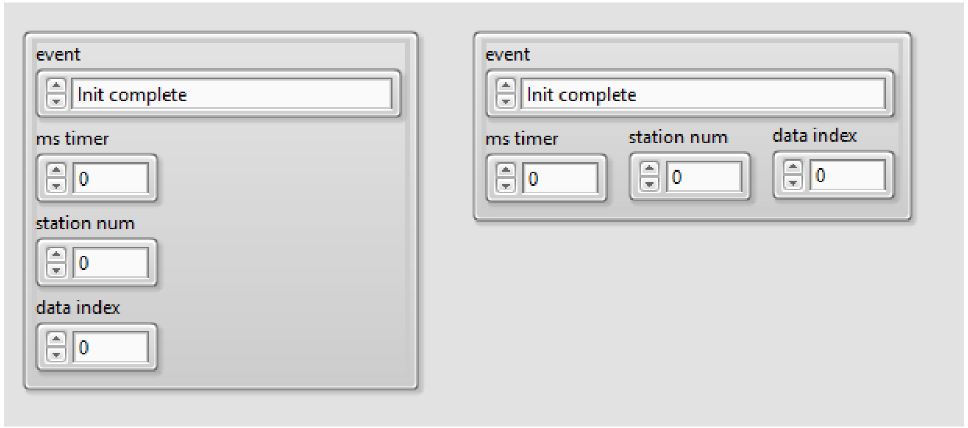
Type Def

- Only the data type is important
- Each instance does update when the data type changes
- The visible properties do *not* update



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Strict Type Def

- Data type and visible properties are important
- All instances change when the typedef changes, including graphical properties
- Every instance has to look the same
- Visual properties cannot be changed programmatically
  - Value can be set
  - Cannot change colors, etc.

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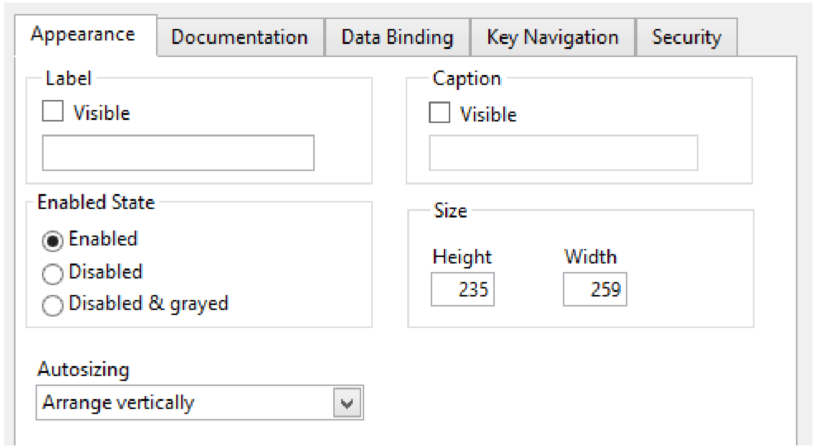
Strict Typedef Limitations

- Strict typedefs can be very limiting
- May cause issues for RT systems, since it has UI info embedded

Typedef


Appearance | Documentation | Data Binding | Key Navigation | Security

Label
Visible

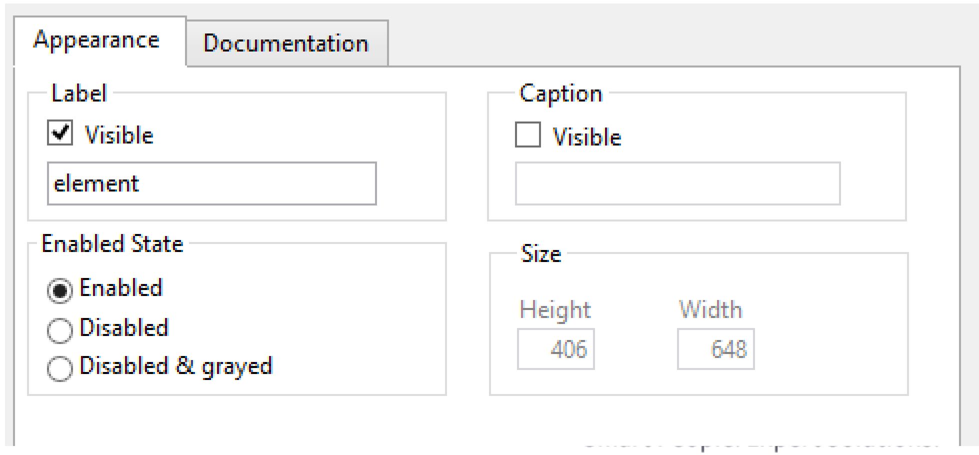
Caption
Visible

Enabled State
[✓ Enabled]
Disabled
Disabled & grayed

Size
Height 235
Width 259

Autosizing
Arrange vertically

Strict Typedef


Appearance | Documentation

Label
[✓ Visible]
element

Caption
Visible

Enabled State
[✓ Enabled]
Disabled
Disabled & grayed

Size
Height 406
Width 648

Propagating Typedef Changes

Say you have several instances of a typedef and your code changes something programmatically. You can still propagate changes to all instances:

1. Change it to a strict typedef (your VI will be broken)
2. Make your changes to the strict typedef
3. Apply changes, so all instances get the new look
4. Change back to a typedef (VI should be OK)

Multi-Screen Applications

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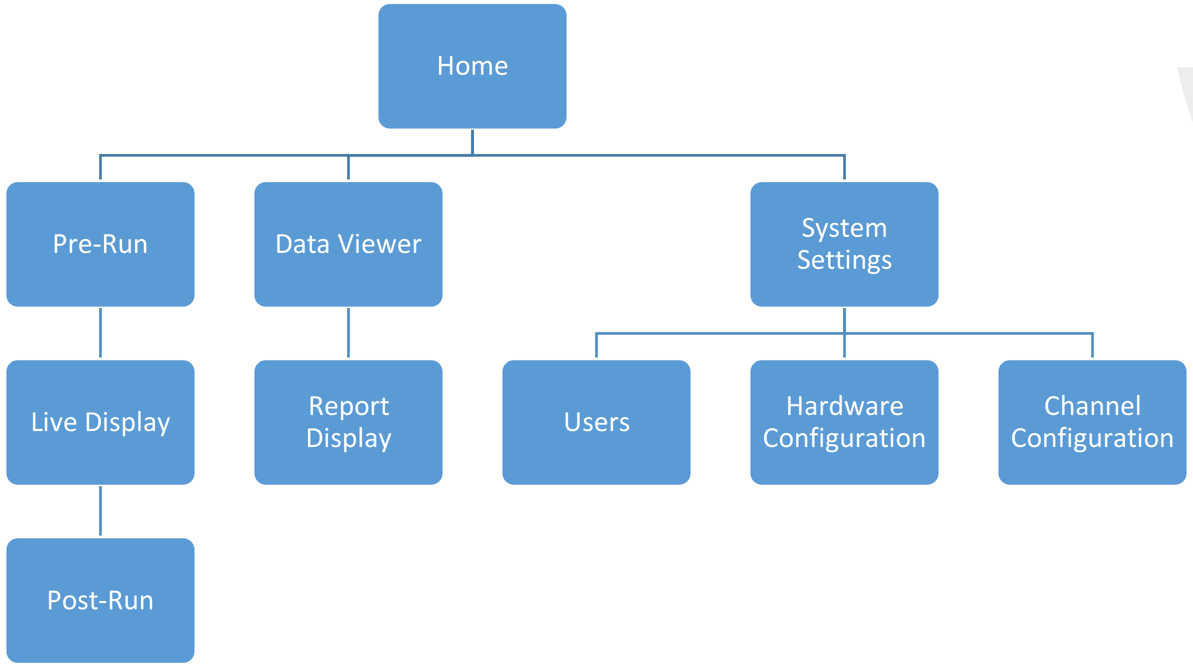
Multi-Screen (View) Challenges

- How will the user navigate?
  - Provide clear, intuitive direction
- How do you keep the UI responsive?
- How do you lay out the screens?
- How do you manage the increased code complexity?

Interface Specification Outline



Option 1: Tab Controls

Pros:

- Screens can be separated by tab
- Single supporting thread can assist with navigation
- Tabs have useful sizing/snapping features

Cons:

- Does not scale well beyond 5 (or so) screens
- Supporting code can be very monolithic, results in huge complex event structures, hard to add new features

Example: Using Tabs

Option 2: Subpanels

Pros:

- Allow for more modular code, loading individual VIs into supervisory interface
- Allows for more feature rich screens, without monolithic thread support

Cons:

- Requires careful application architecture to implement
- Must be very aware of VI state and reentrancy settings, can leave threads running in background inadvertently
- Requires well defined communication design pattern to allow effective sequencing of screens.

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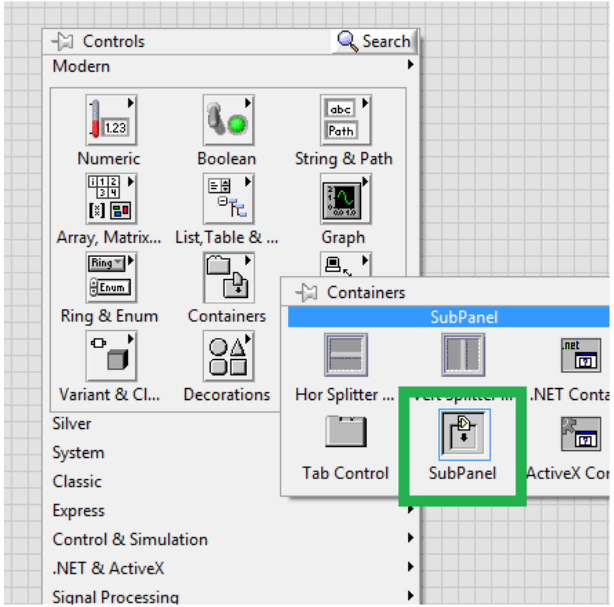
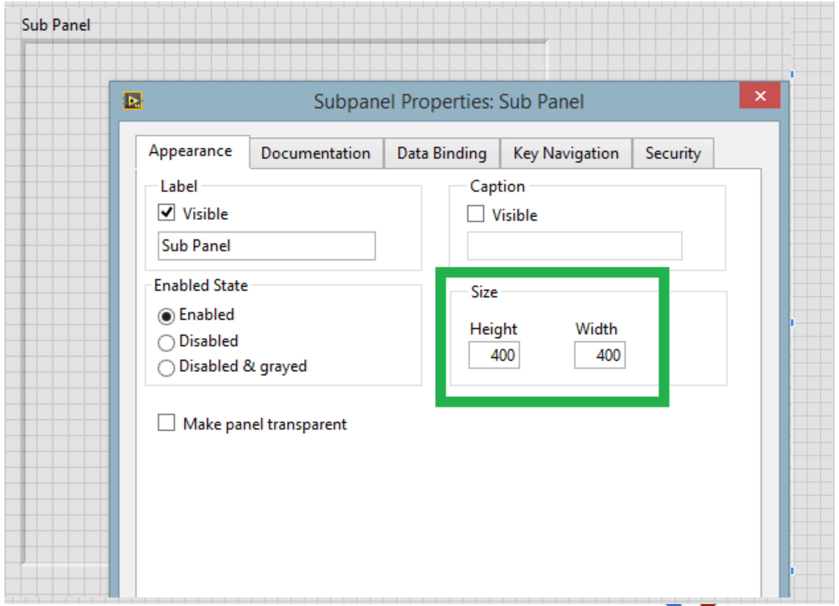
Example, Using Subpanels

Add Subpanel to Front Panel




Sub Panel

Subpanel Properties: Sub Panel

Appearance | Documentation | Data Binding | Key Navigation | Security

Label
- [✓] Visible
- Sub Panel

Caption
- [ ] Visible

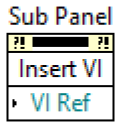
Enabled State
- (●) Enabled
- ( ) Disabled
- ( ) Disabled & grayed

Size
- Height: 400
- Width: 400

- [ ] Make panel transparent

Example, Using Subpanels

Subpanel property node is added to block diagram automatically:



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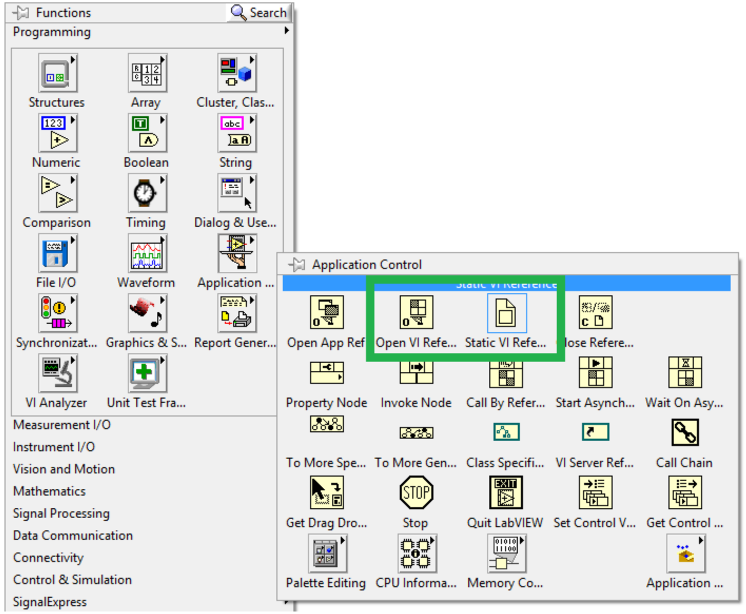
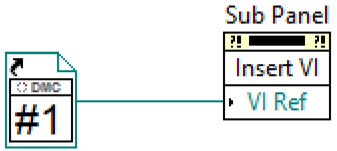
Example, Using Subpanels

Simply connect a reference to the VI you want in the subpanel





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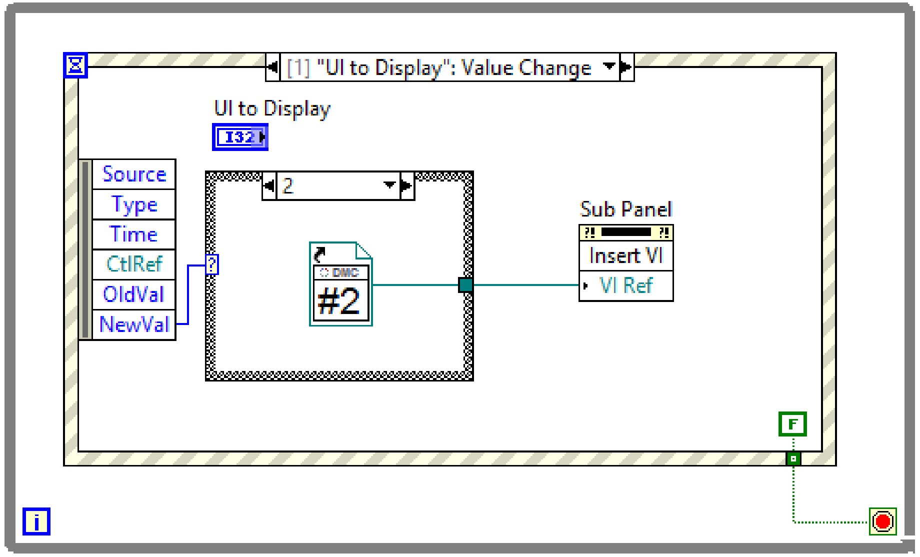
Example, Using Subpanels

Add a mechanism for switching between different VIs



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Subpanel Demo

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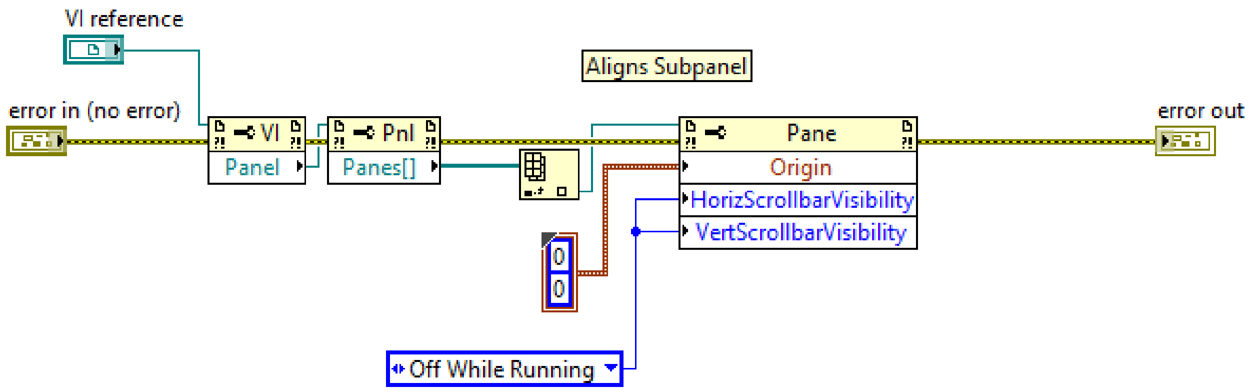
Subpanel Recommendations

- Use a tab control that is set to the same size as the subpanel
  - Helps lay out the subpaneled VI
- Programmatically align the front panel of the subpaneled VI with the origin



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Intermission

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Dialogs – Dia-dos and Dia-don’ts

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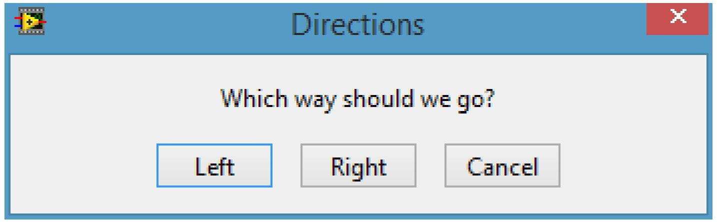
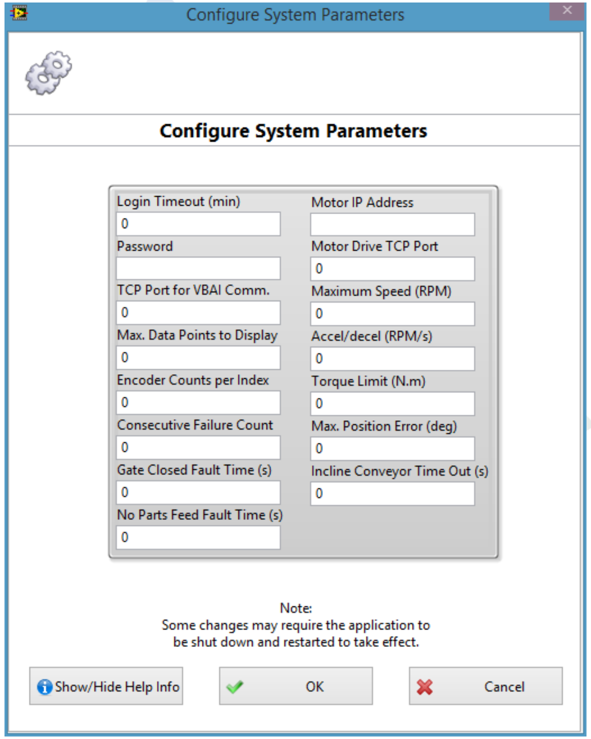
Dialog Boxes

- Used to:
  - Communicate important information to the user
  - Get the user's attention
  - Collect data from the user


Directions

Which way should we go?


Configure System Parameters

Configure System Parameters

Login Timeout (min): 0	Motor IP Address:
Password:	Motor Drive TCP Port: 0
TCP Port for VBAI Comm.: 0	Maximum Speed (RPM): 0
Max. Data Points to Display: 0	Accel/decel (RPM/s): 0
Encoder Counts per Index: 0	Torque Limit (N.m): 0
Consecutive Failure Count: 0	Max. Position Error (deg): 0
Gate Closed Fault Time (s): 0	Incline Conveyor Time Out (s): 0
No Parts Feed Fault Time (s): 0	

Note:
Some changes may require the application to be shut down and restarted to take effect.

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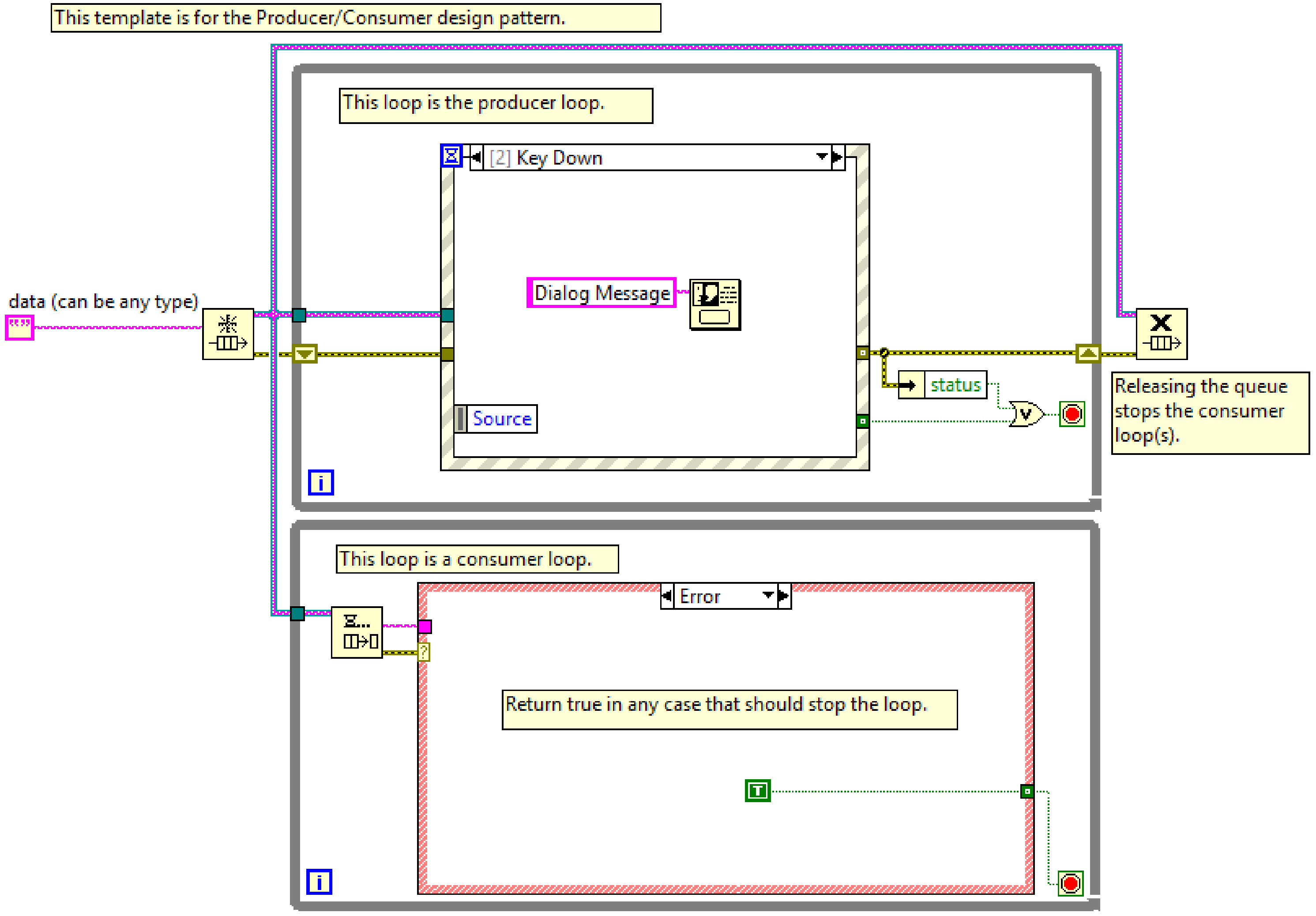

This template is for the Producer/Consumer design pattern.

This loop is the producer loop.

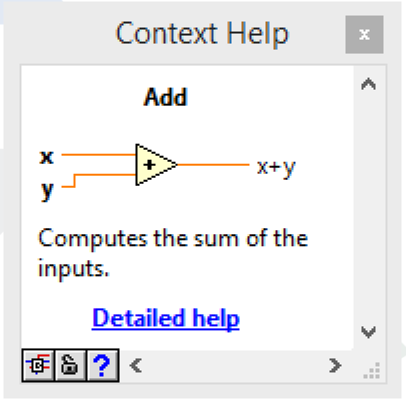
Releasing the queue stops the consumer loop(s).

This loop is a consumer loop.

Return true in any case that should stop the loop.

Floating vs. Modal

- Modal dialogs will…
  - Stay on top of all other windows
  - Be the only window with which the user can interact
- Floating dialogs will…
  - Stay on top of all other non-floating windows
  - Allow the user to interact with all visible windows
- Context help window is floating



Add

Computes the sum of the inputs.

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Dia-dos

- Make sure you need a dialog
- Put all blocking dialogs into a UI loop
- Provide a mechanism for data from dialog to be used
- Think about how it communicates with the rest of the application
- Use a reasonable timeout if the response is time-sensitive
- Make your own modal dialogs to match application style
- Output a Boolean to indicate whether or not the user canceled

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Dia-don'ts

- Block execution of your control or data acquisition loop
- Create modal dialogs that won't close
- Create dialogs that write to global variables
- Make a one-button dialog without considering other ways to display the same status
- Use menus in dialogs

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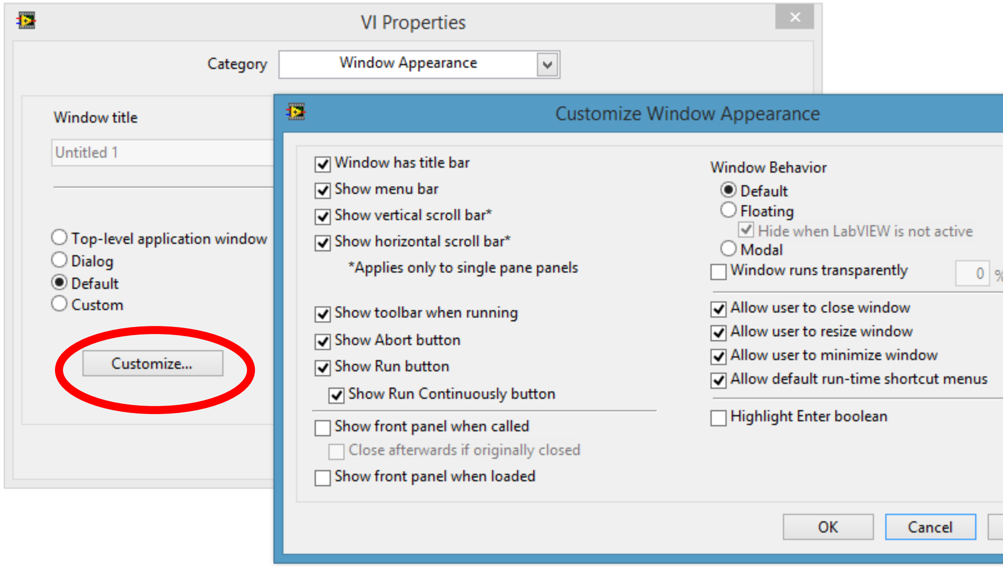
Window Behaviors

- Window Behavior
  - Default
  - Floating
  - Modal
- Execution mode
  - Asynchronous
  - Synchronous



VI Properties

Category: Window Appearance

Window title: Untitled 1

- ( ) Top-level application window
- ( ) Dialog
- (●) Default
- ( ) Custom

Customize...

Customize Window Appearance

- [✓] Window has title bar
- [✓] Show menu bar
- [✓] Show vertical scroll bar*
- [✓] Show horizontal scroll bar*
- *Applies only to single pane panels
- [✓] Show toolbar when running
- [✓] Show Abort button
- [✓] Show Run button
- [✓] Show Run Continuously button
- [ ] Show front panel when called
- [ ] Close afterwards if originally closed
- [ ] Show front panel when loaded

Window Behavior

- (●) Default
- ( ) Floating
- [✓] Hide when LabVIEW is not active
- ( ) Modal
- [ ] Window runs transparently 0
- [✓] Allow user to close window
- [✓] Allow user to resize window
- [✓] Allow user to minimize window
- [✓] Allow default run-time shortcut menus
- [ ] Highlight Enter boolean

OK Cancel

Start Asynchronous Call

Starts an asynchronous call to the VI indicated by the **reference** input. Depending on how you prepare **reference** for asynchronous execution with the Open VI Reference function, you can either ignore the VI after calling it or collect its outputs at a later time with the Wait On Asynchronous Call node.

Detailed help

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Resizing Interfaces

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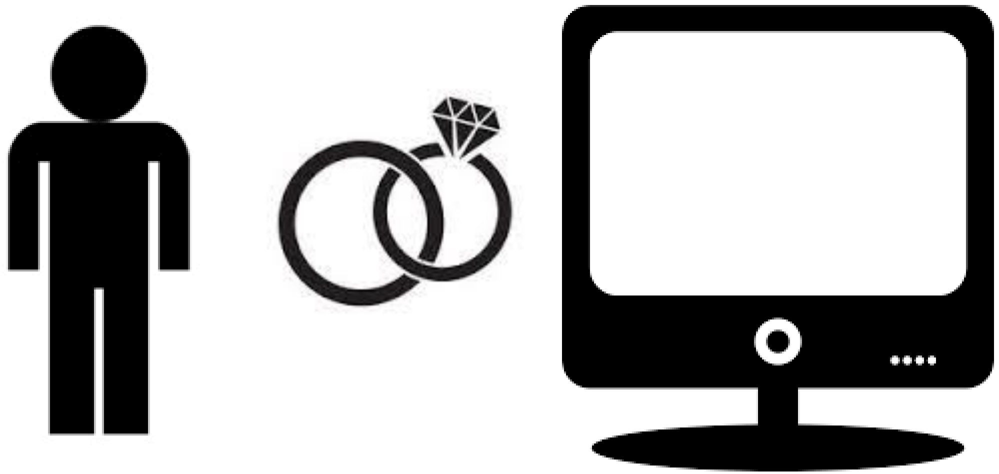
Committing to a Monitor Size Forever

- Ideally, avoid resizing interfaces
- Often, it's simplest to figure out what the monitor resolution is, then size things appropriately


This is a man committing to his monitor. FOREVER.

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Panes

- If you absolutely MUST allow resizing, try panes
  - Use splitters to create a hierarchy of panes
  - Right-click splitters to set how the panes move
  - "Splitter Sticks Right" ➔ The splitter moves and sticks with the pane on the right
  - Set controls to be fit to their pane or to scale with their pane
  - Set a minimum VI size

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Pane Demo

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Front Panel Layout Tool

- Available from the NI Community/VIPM
- Save the front panel state as-is and associates it with a keyword
- Define several layouts for different monitor sizes
- At runtime, decide which configuration to use

Technical Considerations

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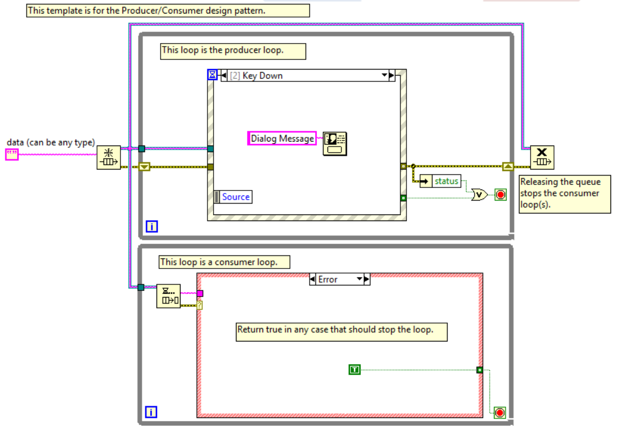
UI Loop

- What is the UI loop?
  - Common architectural component
  - Event structure in a while loop
- Why should I have one?
  - This is the loop that SHOULD wait on UI events, NOT your main processing loop
  - Don't do any other processing here… keep the UI responsive
  - Main processing loops should continue executing independent of user interaction


This template is for the Producer/Consumer design pattern.

This loop is the producer loop.

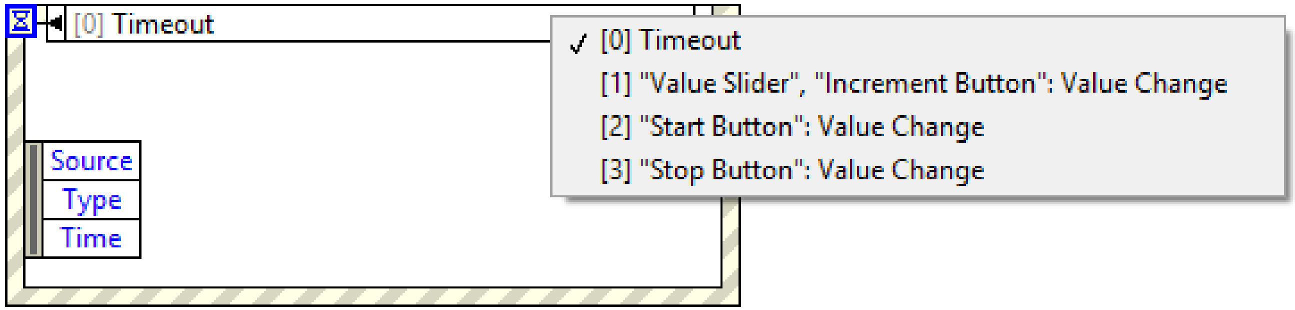
Releasing the queue stops the consumer loop(s).

This loop is a consumer loop.

Return true in any case that should stop the loop.

Event Structures

- Has multiple cases to handle direct interactions from the user interface
- Only one event case can execute for a single event
- A single event case can handle multiple events


[0] Timeout
Source
Type
Time
✓ [0] Timeout
[1] "Value Slider", "Increment Button": Value Change
[2] "Start Button": Value Change
[3] "Stop Button": Value Change

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Fonts

- Default system fonts can and will change between operating systems or versions of Windows
- Be wary of the default Windows zoom level (125%)
- Explicitly set the fonts you use on the front panel, instead of relying on the "System", "Dialog" or "Application" fonts
- It's easy to use third-party fonts, BUT it's hard to include in an installer

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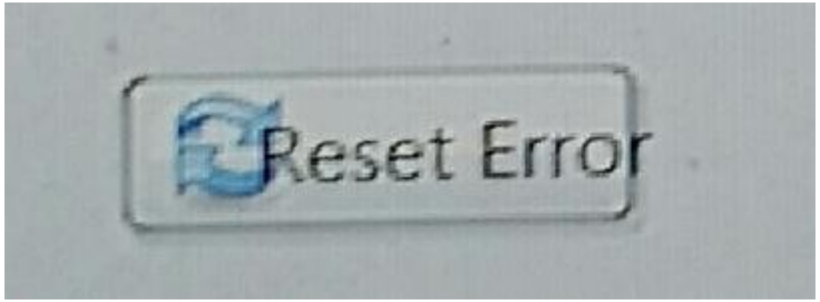
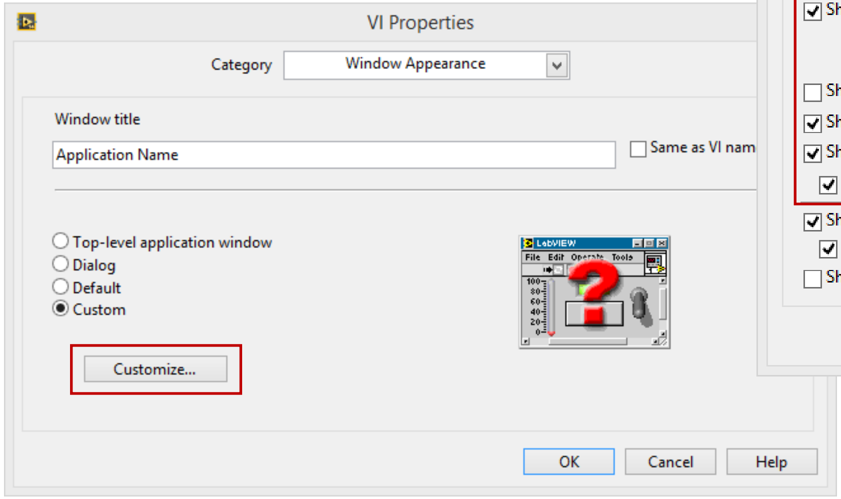
Be Careful with Fonts



Toolbars

When running an EXE, no one wants to see the LabVIEW "Run" or "Abort" buttons. Hide them!



VI Properties

Category: Window Appearance

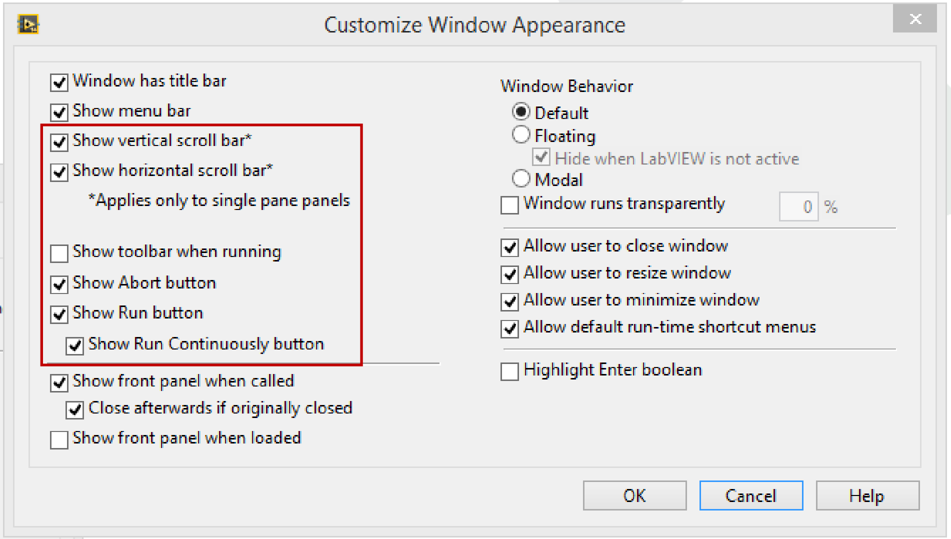
Window title: Application Name

- [ ] Same as VI nam

- ○ Top-level application window
- ○ Dialog
- ○ Default
- ● Custom

Customize...

OK | Cancel | Help



Customize Window Appearance

- [✓] Window has title bar
- [✓] Show menu bar
- [✓] Show vertical scroll bar*
- [✓] Show horizontal scroll bar*
  - *Applies only to single pane panels
- [ ] Show toolbar when running
- [✓] Show Abort button
- [✓] Show Run button
  - [✓] Show Run Continuously button
- [✓] Show front panel when called
  - [✓] Close afterwards if originally closed
- [ ] Show front panel when loaded

Window Behavior
- ● Default
- ○ Floating
  - [✓] Hide when LabVIEW is not active
- ○ Modal
- [ ] Window runs transparently 0 %
- [✓] Allow user to close window
- [✓] Allow user to resize window
- [✓] Allow user to minimize window
- [✓] Allow default run-time shortcut menus
- [ ] Highlight Enter boolean

OK | Cancel | Help

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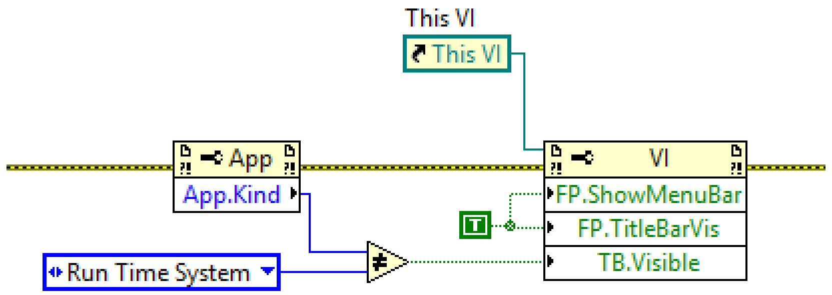
Setting Toolbars Programmatically

- Set it so the toolbars are visible in the development environment
- Hide them if the App.Kind property is executable



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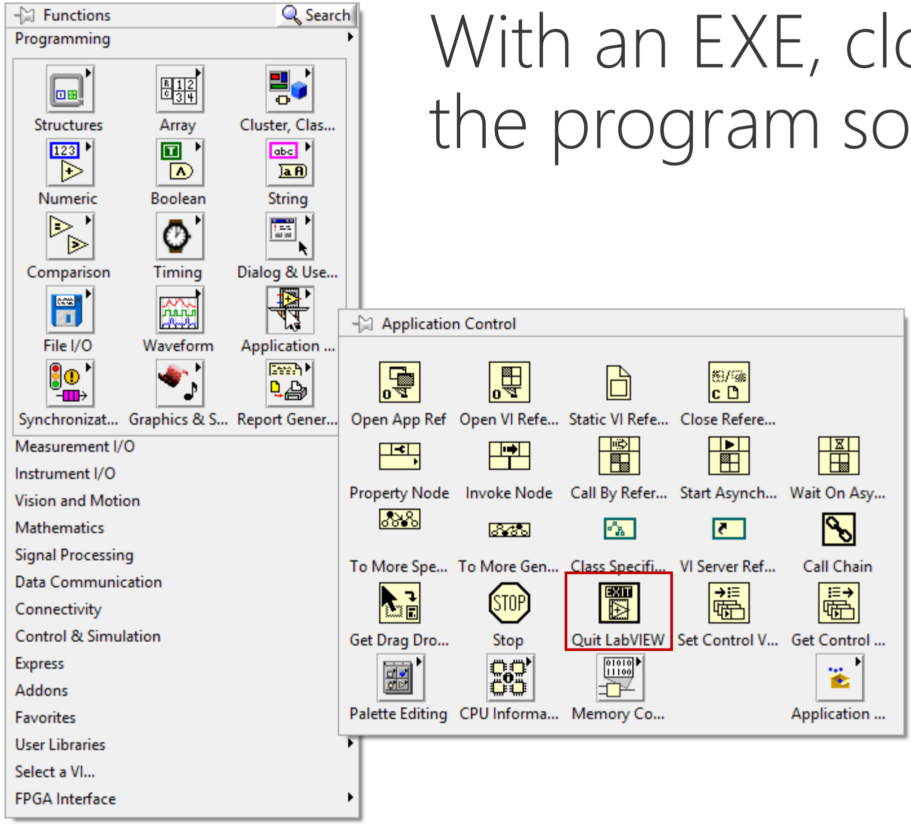
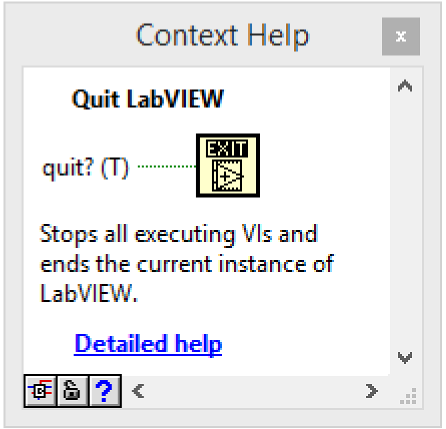
Closing the Application

With an EXE, close labview at the end of the program so the VI doesn't just sit there.




Context Help

Quit LabVIEW

quit? (T)

Stops all executing VIs and ends the current instance of LabVIEW.

Detailed help

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XControls

- XControls have dynamic run-time and edit-time behavior that is defined by VIs that run in the background
- That sounds great…but is it?
  - Seems cool, really brittle
  - Hard to debug
  - Need a really good reason to use it

Style Tips and Tricks

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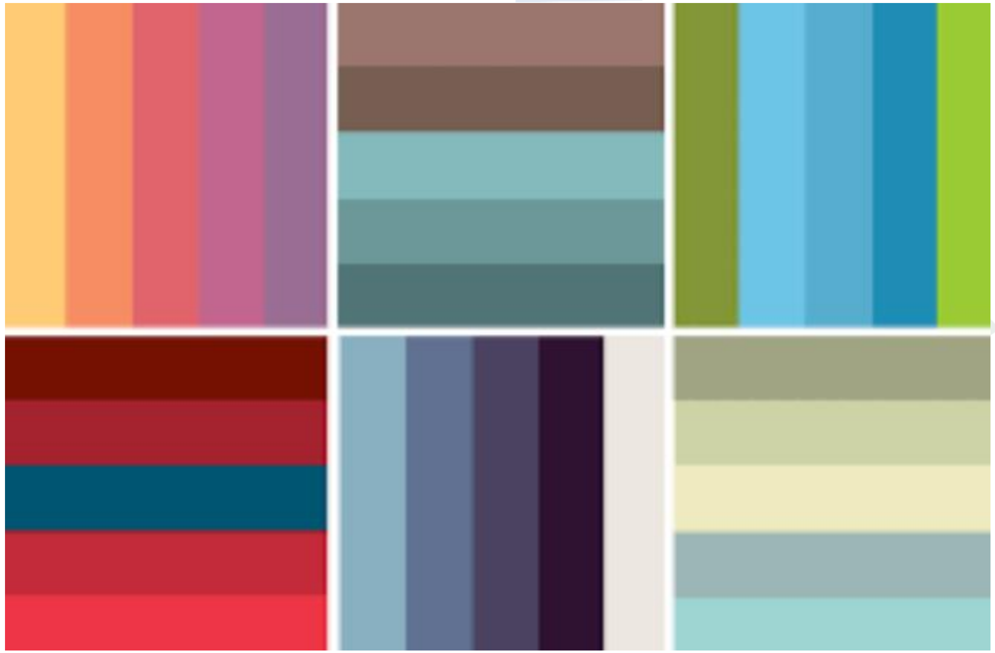
Color Palette Basics

- Easy inspiration online
- Think clean design
- Use readable text colors with good contrast

Key colors:

Red = bad/stop

Green = OK/continue



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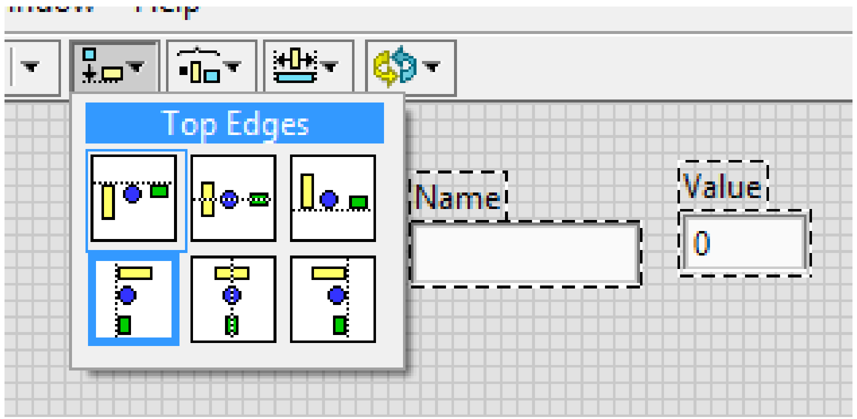
Align/Distribute Tools

Please use these to organize, space and align objects.



Sometimes have to move or hide the label before trying to align items for a clean look.

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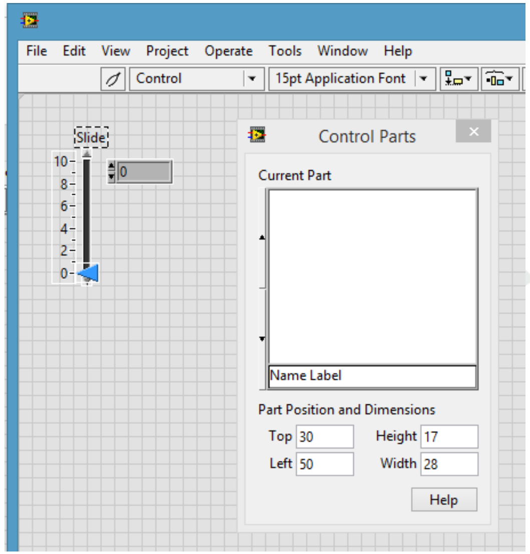
Control Parts Window

- Right-click a control/indicator ➔ Advanced ➔ Customize
- Select Window ➔ Show Parts Window
- Cycle through each customizable part of the control
- Enjoy the terrible UI on a useful UI tool!



Top	30	Height	17
Left	50	Width	28

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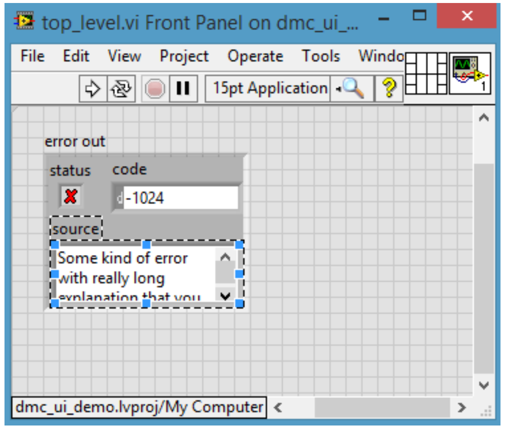
Control-M

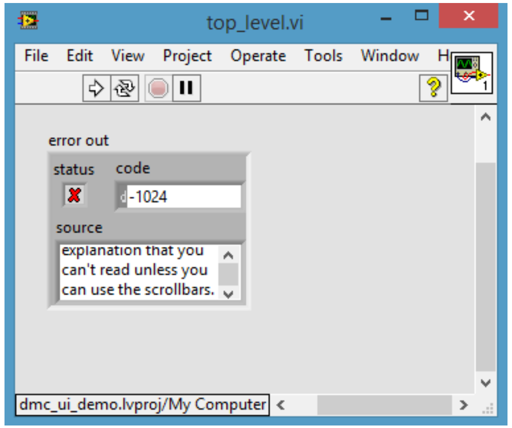
- Allows you to preview how a VI will look when it runs
- Removes overlay shadows
- Removes grid lines
- Mouse and keyboard navigation work as if it's running



top_level.vi Front Panel on dmc_ui_...
File Edit View Project Operate Tools Windo
15pt Application
error out
status
code
source
dmc_ui_demo.lvproj/My Computer

-1024

Some kind of error with really long explanation that you



top_level.vi
File Edit View Project Operate Tools Window H
error out
status
code
source
dmc_ui_demo.lvproj/My Computer

-1024

explanation that you can't read unless you can use the scrollbars.

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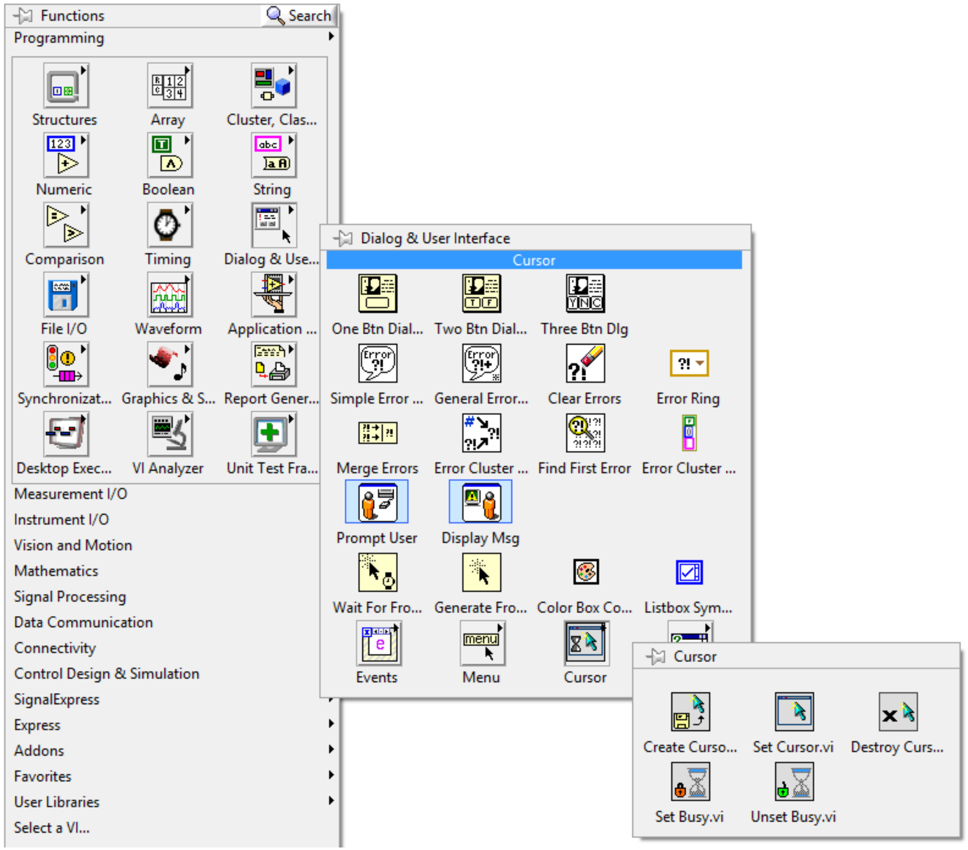
User Feedback

- It's comforting to the user to know that something is happening
- Using the cursor set/unset busy VIs can help
- Have a plan to unset in the event of an error or other problem!



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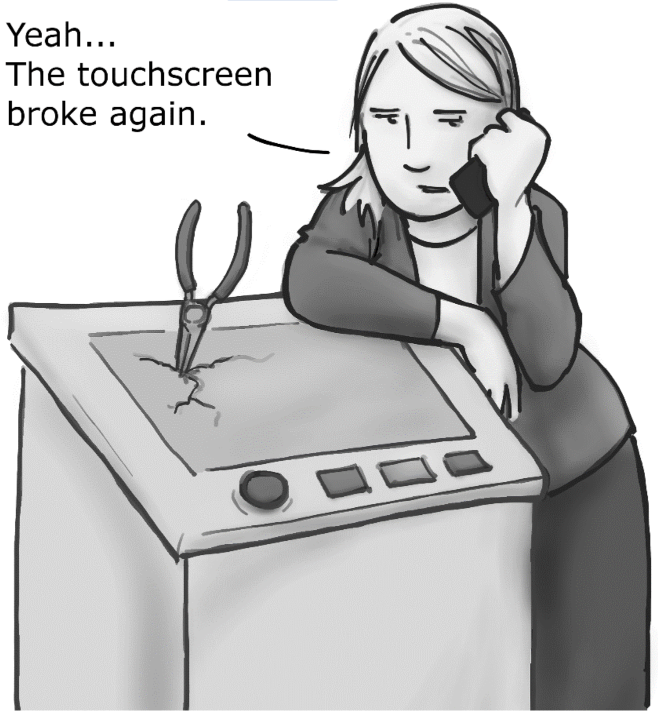
Touchscreen Design

- Touchscreens present unique challenges
  - Can be slow or unresponsive (especially resistive types)
  - Less dexterity than a mouse



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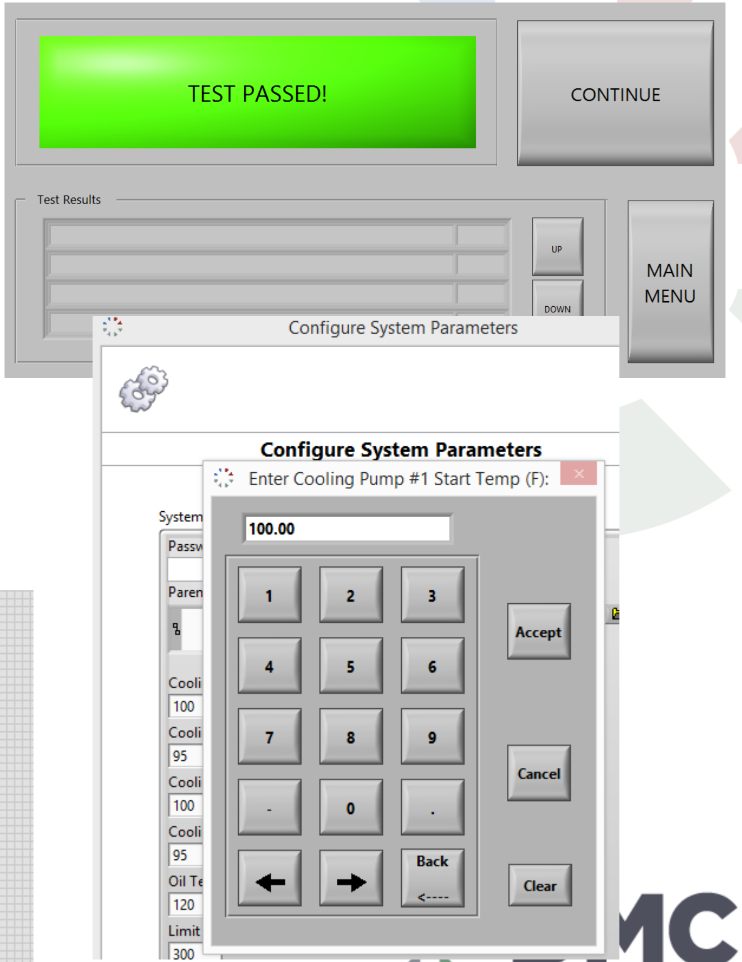
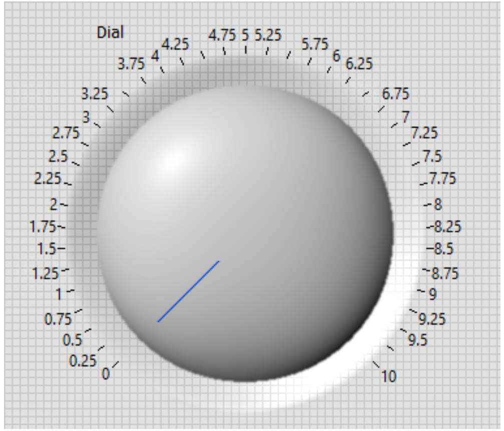
Touchscreen Design

But if they really do want one…

- Make buttons large enough for fat fingers
- Plan for user entry popups
- Remember: no tactile feedback



NO. Just don't…



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Working with a graphic designer?

- Be clear about what is realistic in LabVIEW
  - Available controls/indicators
  - Available shapes and animations
- They should focus on user needs and clarity
- They will be using their professional design tools (Illustrator, Inkscape, etc...), not LabVIEW
  - Cannot use vector graphics
  - PNGs with transparent backgrounds

Additional Resources

- NI Community UI Interest Group at https://decibel.ni.com/content/groups/ui
- Creating Quality UIs from NI Developer Days at https://decibel.ni.com/content/groups/ui/blog/2010/04/29/creating-quality-uis-with-ni-labview--developer-days-2010-presentation

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