

Topic 3:
Design, implementation and programming of the
Seven-Segment LED Display Interface
for the Slow Control System MPD-NICA,
on the NImyRIO and LabView platforms.¹

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3 Seven-Segment LED Display

Displays based on seven LED segments arranged in an “8” pattern provide a simple means to display numbers 0 to 9 and some letters of the alphabet. Figure 3.1 shows the NImyRIO StarterKit seven-segment display.

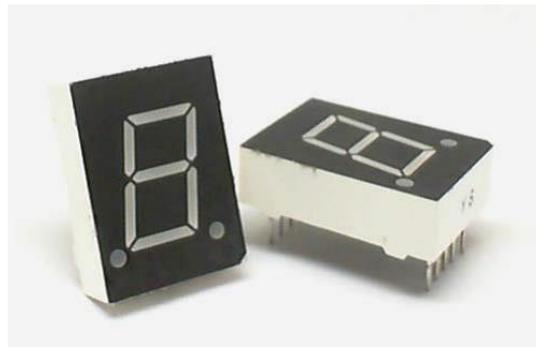


Figure 3-1: NImyRIO StarterKit seven-segment display

3.1 Learning Objectives:

After completing the activities in this chapter you will be able to:

- [a] Describe the array of LEDs wired with a common-anode connection,
- [b] Design the interface circuit by applying knowledge of the DIO output resistance, source voltage, LED voltage-current characteristic, and
- [c] Recognize that blue LEDs may be direct connected to the NImyRIO DIO without current-limiting resistors.

3.2 Component Demonstration

Follow these steps to demonstrate correct operation of the seven-segment LED component.

¹ Developed on the basis of educational materials: National Instruments, IBM, Reichle & De-Massari, Microsoft, Warsaw University of Technology, Joint Nuclear Institute Research

3.2.1 Select these parts:

- [a] Seven-segment LED display,
<http://www.sparkfun.com/datasheets/Components/LED/YSD-160AB3C-8.pdf>
- [b] Breadboard
- [c] Jumper wires, M-F (9x)

3.2.2 Build the interface circuit:

Refer to the pin diagram and recommended breadboard layout shown in Figure 3.2.

TIP: Use the resistor color code for the DIO wire colors, e.g., black (0) for B/DIO0, brown (1) for B/DIO1, and so on.

The interface circuit requires nine connections to NImyRIO-MXP Connector-B (see Figure 3. 2.):

- [a] Common anode (CA) → B/+3,3V (pin 33)
- [b] Segment a → B/DIO0 (pin 11)
- [c] Segment b → B/DIO1 (pin 13)
- [d] Segment c → B/DIO2 (pin 15)
- [e] Segment d → B/DIO3 (pin 17)
- [f] Segment e → B/DIO4 (pin 19)
- [g] Segment f → B/DIO5 (pin 21)
- [h] Segment g → B/DIO6 (pin 23)
- [i] Decimal point → B/DIO7 (pin 25)

3.2.3 Run the demonstration VI:

- [a] Download
<http://www.ni.com/academic/myrio/project-guide-vis.zip>
- [b] if you have not done so previously and unpack the contents to a convenient location,
- [c] Open the project Seven-Segment LED demo.lvproj contained in the subfolder Seven-Segment LED demo,
- [d] Expand the hierarchy button (a plus sign) for the myRIO item and then open Main.vi by double-clicking,
- [e] Confirm that NImyRIO is connected to your computer, and
- [f] Run the VI either by clicking the Run button on the toolbar or by pressing Ctrl+R.
- [g] Expect to see a “Deployment Process” window showing how the project compiles and deploys (downloads) to NImyRIO before the VI starts running.

NOTE: You may wish to select the “Close on successful completion” option to make the VI start automatically.

3.2.4 Expected results:

Toggle the eight front-panel switches to activate and deactivate each segment a through g as well as the decimal point; refer again to Figure 3.2 on the facing page to see the standard labeling scheme for the segments. Activating the front-panel switch should cause the corresponding segment to light.

Click the Stop button or press the escape key to stop the VI and to reset NImyRIO.

3.2.5 Troubleshooting tips:

Not seeing the expected results? Confirm the following points:

- [a] Glowing power indicator LED on NlmyRIO,
- [b] Black “Run” button on the toolbar signifying that the VI is in runmode,
- [c] Correct wiring—ensure that your wiring order is correct and that you have started at B/DI00 (pin 11),
- [d] Ensure that the seven-segment LED common anode (CA) terminal connects to the power supply B/+3,3V (pin 33).

3.3 Interface Theory

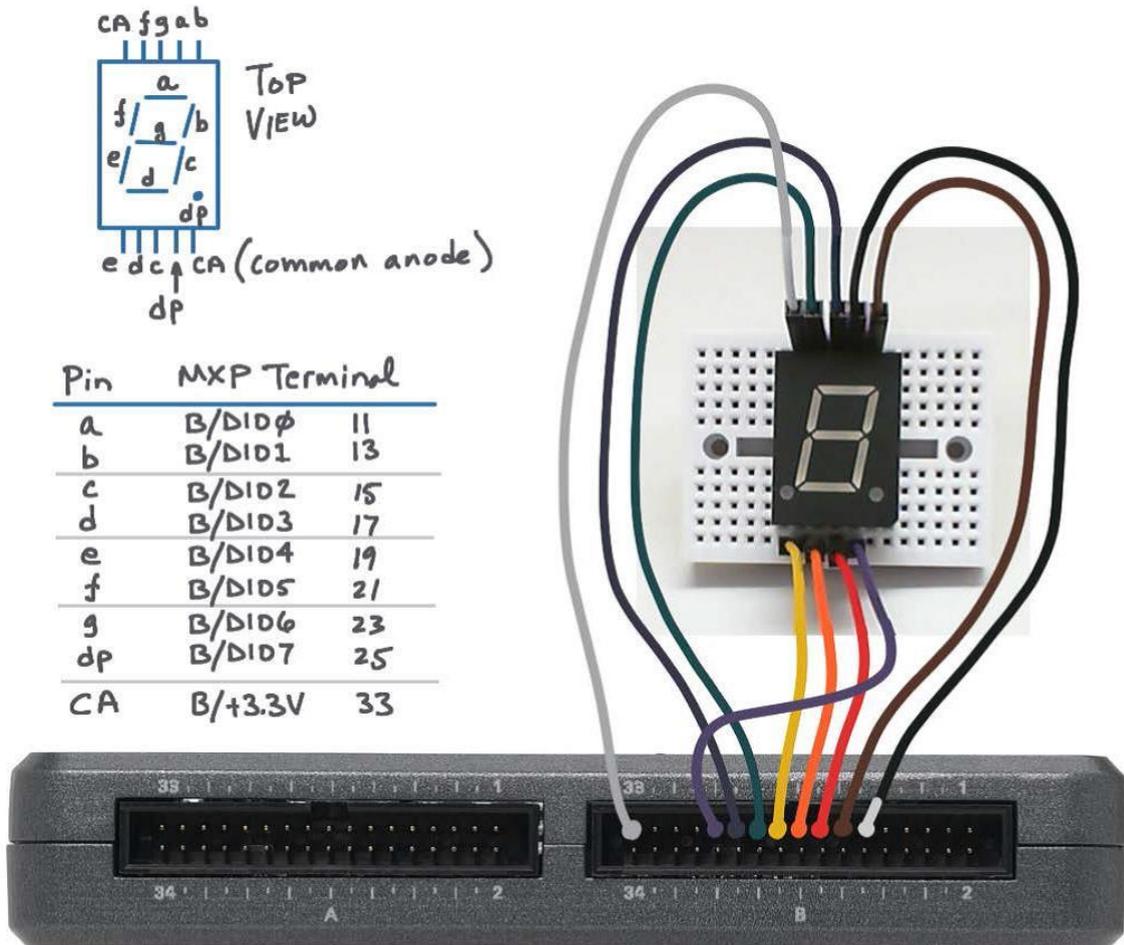


Figure 3-2; Demonstration circuit for seven-segment display: pin diagram, recommended breadboard layout, and connection to eight digital I/O terminals on NlmyRIO MXP Connector B.

3.3.1 Interface circuit:

Each of the seven line segments as well as the decimal point is an individual LED, each with its own anode and cathode. To conserve the number of electrical connections on the display all of the eight anodes are tied together and brought out as the “common anode” pin. Study the video Seven-Segment LED Interfacing Theory (4:41):

<https://www.youtube.com/watch?v=P0ER0VXvfSw&feature=youtu.be>

to learn about the voltage-current characteristics of the individual LED segment, why the segment controls are active-low, and why no current-limiting resistors are required for this particular device.

3.3.2 LabVIEW programming:

Study the video *Digital Output Express VI* (2:21),

<https://www.youtube.com/watch?v=Y8mKdsMAqrU&feature=youtu.be>

to learn how to access all of the available digital outputs with the NImyRIO Digital Output Express VI, including single output, multiple outputs, and choice of connector.

In addition, study the video *Digital Output Low-Level VIs* (4:35),

<https://www.youtube.com/watch?v=WvnlG3ffqY&feature=youtu.be>

to learn how to access and use the lower-level code created by the Express VI to connect Boolean arrays directly to the digital outputs, i.e., as a bus.

3.4 Basic Modifications

Study the video *Seven-Segment LED Demo Walk-Through* (2:03),

https://www.youtube.com/watch?v=eiyOo_k9KI0&feature=youtu.be

to learn the design principles of 7-segment

LED demo.lvproj, and then try making these modifications to *Main.vi*:

- [a] Maintain the same behaviour, but convert the *Digital Output Express VI* to its underlying code, and then connect the array-style front panel control directly to the Write VI from the NImyRIO Advanced I/O → Digital I/O subpalette. Also create a front-panel control to make user-selectable digital I/O channels.
- [b] Display a numerical (integer) front-panel control value as its corresponding pattern on the seven-segment display; a case structure with Boolean array constants works nicely here:
<http://cnx.org/content/m14766/latest/?collection=col110440>
- [c] Display the values 0 to 9 and a dash for values greater than 9 (bonus points for a hexadecimal display to include values A to F).
- [d] Create a rotating chase sequence in which a single active segment appears to move around the periphery of the display. Make the speed adjustable, and also include a control to reverse the direction of rotation. Consider a single Boolean array constant connected to Rotate 1D Array in the Programming → Array subpalette.

TIP: Use Quick Drop (Ctrl+Space) to search for a programming element by name.

3.5 Integrated Project Ideas

Now that you know how to use the seven-segment display consider integrating it with other devices to create a complete system, for example:

- [a] NTP Clock (Topic 42)

3.6 For More Information

- [a] 7-Segment Display - LED (Blue) by SparkFun... Need more display digits? This is the same (or very similar) product:

<http://www.sparkfun.com/products/9191>

- [b] World's Simplest Font by Twyman Enterprises... TrueType font for seven-segment displays; use this font and your favorite wordprocessor to quickly translate your text phrases into suitable segment patterns:

<http://www.twyman.org.uk/Fonts>

- [c] Nixie Tubes and Projects by Neonixie... Before seven segment displays you would have used nixie tubes; see:

http://en.m.wikipedia.org/wiki/Nixie_tube

- [d] for the origin of "nixie." You can buy nixie tubes and related projects here:

<http://neonixie.com>

Bibliography:

- [a] www.jinr.ru
[b] www.ni.com
[c] www.nica.if.pw.edu.pl
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[e] <http://www.sparkfun.com/datasheets/Components/LED/YSD-160AB3C-8.pdf>
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[o] <http://neonixie.com>