Topic 5:
Design, implementation and programming of the **DIP Switch Interface** for the Slow Control System MPD-NICA, on the NImyRIO and LabView platforms.[1]

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5 DIP Switches

DIP switches bundle multiple SPST switches together into a single component; "DIP" stands for "dual in-line package," the standard IC package style that is breadboard compatible, and "SPST" means "single pole, single throw," the simplest possible switch type. Figure 5.1 pictures two popular DIP switch styles: a standard DIP switch containing eight SPST switches and a 16-position rotary DIP switch that manipulates the open-and-closed states of four SPST switches in a binary sequence.

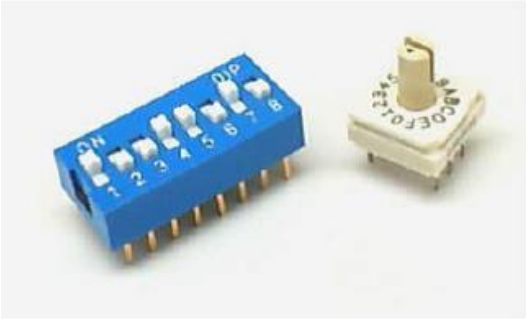

Figure 5-1; NImyRIO StarterKit DIP Switches: DIP Switch (blue) and 16 position rotary DIP switch.

5.1 Learning Objectives:

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

Describe the following concepts related to switches and the NImyRIO interface:

[a] DIP switch bundles N SPST switches into a single component with each switch appearing as a short circuit in one position and as an open circuit in the other,
[b] 2^N-position rotary switch bundles N SPST switches into a single component; rotating the dial create a binary sequence of open-closed switch states,
[c] Interface a switch on any of the NImyRIO connectors without using additional components by using the DIO internal pull resistors (pull-up on MXP connectors, pull-down on MSP connector),

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

[d] Interpret the combined switch open-closed patterns as an integer numerical value, binary array, and individual bit fields.

5.2 Component Demonstration

Follow these steps to demonstrate correct operation of the DIP switches.

5.2.1 Select these parts from the NI myRIO Starter Kit:

[a] DIP switch,

http://www.resonswitch.com/p_rs_rsr.htm

[b] Rotary DIP switch,

http://www.mantech.co.za/datasheets/products/ERD1-5.pdf

[c] Breadboard
[d] Jumper wires, M-F (14x)
[e] Small screwdriver

5.2.2 Build the interface circuit:

Refer to the schematic diagram and recommended breadboard layout shown in Figure 5.2 on the facing page. The interface circuit for the DIP switches requires five connections to NImyRIO MXP Connector A and nine connections to Connector B (see Figure A.1 Appendix)

[a] DIP Switch 8 → B/DIO0 (pin 11)
[b] DIP Switch 7 → B/DIO1 (pin 13)
[c] DIP Switch 6 → B/DIO2 (pin 15)
[d] DIP Switch 5 → B/DIO3 (pin 17)
[e] DIP Switch 4 → B/DIO4 (pin 19)
[f] DIP Switch 3 → B/DIO5 (pin 21)
[g] DIP Switch 2 → B/DIO6 (pin 23)
[h] DIP Switch 1 → B/DIO7 (pin 25)
[i] DIP Switch common → B/GND (pin 8)
[j] Rotary DIP 1 → A/DIO0 (pin 11)
[k] Rotary DIP 2 → A/DIO1 (pin 13)
[l] Rotary DIP 4 → A/DIO2 (pin 15)
[m] Rotary DIP 8 → A/DIO3 (pin 17)
[n] Rotary DIP C (common) → A/GND (pin 20)

5.2.3 Run the demonstration VI:

[a] Download

http://www.ni.com/academic/myrio/project-guide-vis.zip

if you have not done so previously and unpack the contents to a convenient location,

[b] Open the project DIP Switches demo.lvproj contained in the subfolder DIP Switches demo,
[c] Expand the hierarchy button (a plus sign) for the myRIO item and then open Main.vi by double-clicking,
[d] Confirm that NImyRIO is connected to your computer, and Run the VI either by clicking the Run button on the toolbar or by pressing Ctrl+R.

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.

5.2.4 Expected results:

The demo VI displays the individual switch states of the two DIP switches. An open switch appears as a high state because both MXP connectors A and B include pull-up resistors on each DIO.

With the rotary DIP switch dial at Position 0 all A/DIO state indicators should be active; turn the dial counter-clockwise one click to Position F and all indicator should be dark. Try clicking through the remaining positions and observe the binary sequence, remembering that the switches appear active-low.

Try each of the eight switches on the DIP switch and confirm that you can individually activate the indicators for A/DIO state. Is the switch open or closed in the "up" position?

Click the Stop button or press the escape key to stop the VI and to reset NImyRIO; a myRIO reset causes all of the digital I/O pins to revert to input mode.

5.2.5 Troubleshooting tips:

Not seeing the expected results? Confirm the following points:

[a] Glowing power indicator LED on NImyRIO,
[b] Black Run button on the toolbar signifying that the VI is in runmode,
[c] Correct MXP connector terminals—ensure that you are using both Connectors A and B and that you have the correct pin connections,
[d] Connecting wires link all eight of the lower pins of the DIP switch to ground.

5.3 Interface Theory

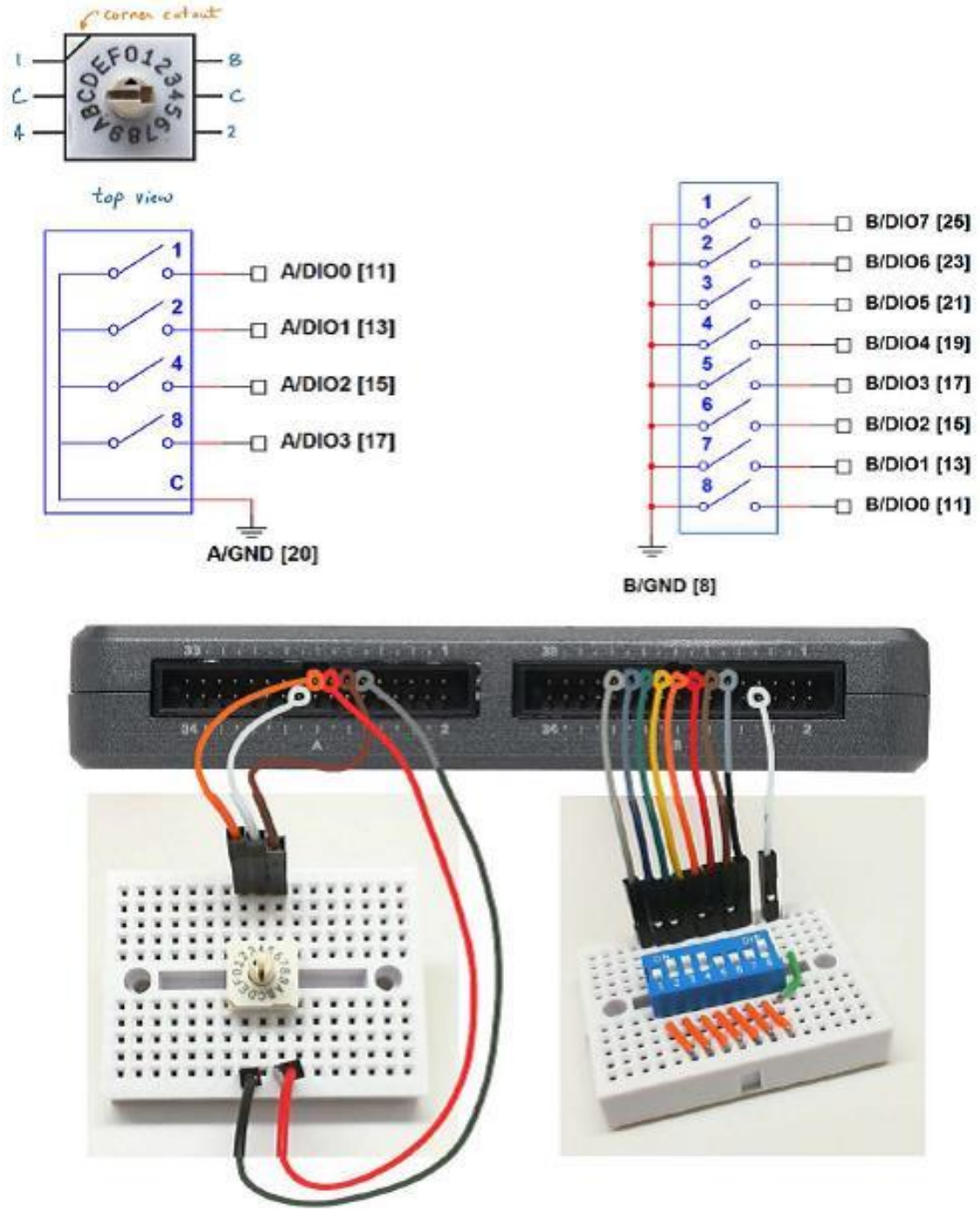

Figure 5-2; Demonstration circuit for DIP switches: schematic diagram, recommended breadboard layout, and connection to NImyRIO MXP Connectors A and B.

5.3.1 Interface circuit:

Each SPST switch in the standard DIP switch appears either as an open circuit or as a short circuit depending on the switch position "up" or "down." The 16-position rotary switch opens all four SPST switches at Position 0 and then applies an ascending binary sequence to switch closings as the dial rotates clockwise. The DIP switches may connect directly to the digital input without any additional components because of the internal pull resistors on the NImyRIO DIO lines.

Each DIP switch can be interpreted by software in a number of different ways, including: single integer numerical value, single Boolean array pattern, and groups of binary patterns or numerical values called bit fields.

Study the video Pushbutton Interfacing Theory (4:24)

https://www.youtube.com/watch?v=e7UcL5Ycpho&feature=youtu.be

to learn about the DIO pull resistors and how to properly connect a single SPST switch for pull-up resistors (MXP Connectors A and B) and for pull-down resistors (MSP Connector C). Each of the SPST switches on the standard DIP switch must have one terminal tied either low to ground (for pull-up resistors) or high to the power supply (for pull-down resistors); it is customary to tie all of the terminals on a given side, but you could use any pattern that you like.

Study the video ***DIP Switch Interfacing Theory*** (7:16)

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

to learn more about the DIP switch and the rotary DIP switch, especially various ways that you can interpret the switch patterns as meaningful information in software.

5.3.2 LabVIEW programming:

Study the video ***Run-Time Selectable I/O Channels*** (1:54)

https://www.youtube.com/watch?v=uJW7CaL6L5c&feature=youtu.be

to learn how to use the low-level ***Digital Input VIs*** to select the DIP switch connector pins from the front panel instead of editing the VI itself.

5.4 Basic Modifications

Study the video ***DIP Switch Demo Walk-Through*** (2:30)

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

to learn the design principles of ***DIP Switches demo***, and then try making these modifications to the block diagram of ***Main.vi***:

[a] Display the DIP switch pattern as an 8-bit unsigned integer (UINT8 data type) using the right-most switch as the least-significant bit (LSB) and the "down" position as logical 0.

[b] Display the DIP switch pattern as three distinct fields as follows: Field 1 (bits 2:0) = 3-bit integer, Field 2 (bits 6:3) = 4-bit integer, and Field 3 = single-bit Boolean.

[c] Display the 16-position rotary DIP switch pattern as a 4-bit integer displayed in both decimal and in hexadecimal.

[d] Move either or both of the DIP switches to the MSP Connector C (remember, these have pulldown resistors) and repeat some of the previous exercises. Use a single strategically-placed "NOT" gate to avoid changing other parts of the block diagram. Also remember to connect the DIP switch common terminal to C/+5V (pin 20).

5.5 For More Information

[a] 2-Wire Controlled Digital DIP Switch by Maxim Integrated s An electronic replacement for mechanical DIP switches, the DS3904 contains microcontroller-controlled non-volatile variable resistors that offer smaller footprint, higher reliability, and lower cost:

http://www.maximintegrated.com/app-notes/index.mvp/id/238

Bibliography:

[b] www.jinr.ru
[c] www.ni.com
[d] www.nica.if.pw.edu.pl
[e] The Multi-Purpose Detector – MPD to Study Heavy Ion Collisions at NICA; (CDR Conceptual Design Report) Version 1.4; Project leaders: A. N. Sissakian, A. S. Sorin, V. D. Kekelidze.
[f] http://www.resonswitch.com/p_rs_rsr.htm
[g] http://www.mantech.co.za/datasheets/products/ERD1-5.pdf
[h] http://www.ni.com/academic/myrio/project-guide-vis.zip
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[j] https://www.youtube.com/watch?v=KNzEyRwcPIg&feature=youtu.be
[k] https://www.youtube.com/watch?v=uJW7CaL6L5c&feature=youtu.be
[l] https://www.youtube.com/watch?v=ZMyYRSsQCac&feature=youtu.be
[m] http://www.maximintegrated.com/app-notes/index.mvp/id/238