Automate Stack 1.1 Demo

User Guide

FPGA-UG-02129-1.0

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## Acronyms in This Document

A list of acronyms used in this document.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>BLDC</td>
<td>Brushless Direct Current</td>
</tr>
<tr>
<td>FPGA</td>
<td>Field-Programmable Gate Array</td>
</tr>
<tr>
<td>HDMI</td>
<td>High Definition Multimedia Interface</td>
</tr>
<tr>
<td>LED</td>
<td>Light-emitting diode</td>
</tr>
<tr>
<td>PDM</td>
<td>Predictive Maintenance</td>
</tr>
<tr>
<td>PHY</td>
<td>Physical Layer</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver - Transmitter</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
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</table>
1. Introduction

This document describes the process of running the basic Lattice Automate Stack 1.1 Demo. The demo supports two chains of nodes, which can be connected to one main system board. The nodes are synchronized if the number of nodes are the same in the both chains. The main board is connected to the Raspberry Pi.

This basic demo includes:
- Raspberry Pi – Communication between Server and Client
- Main System and Node System
  - Main System – Used for host communication; host to node communication and PDM
  - Node System – Used for motor control and PDM data collection

2. Hardware and Software Requirements

2.1. Hardware Requirements

This demonstration requires the following hardware components:
- PC running Windows 10 Operating System of 1920 × 1080 resolution, 100% dpi
- Raspberry Pi 4 Model B with micro SD card.
- Type-C cable with 5 V adapter for power connection in Raspberry Pi
- Micro HDMI to standard HDMI cable for Raspberry Pi monitor connection
- Two Certus-NX Versa Evaluation Boards with 12 V power adapters (one each for Main and Node systems, more Nodes can be added)
- USB Type-A (UART) cable for programming the bit stream and binary files and connecting the Raspberry Pi to the Main System
- Ethernet Cables for connecting Main to Nodes
- One (or more) BLDC Motors (GB 42 BLS 24V 5000 RPM or BLY171S-24V-4000)
- One (or more) Trenz Motor Driver boards (TEP0002-2 or TEP0002-3) control boards
- 24 V-2.0 Amp DC Power Supplies for motors
- Monitor with HDMI support
- Keyboard and mouse, if required

2.2. Software Requirements

The following software programs are available at www.latticesemi.com/en/Products/DesignSoftwareAndIP

The software programs are available for download only if you log in at www.latticesemi.com
- Lattice Radiant™ software version 3.0 or later.
- Lattice Propel™ SDK 2.0 or later
- Lattice Propel Builder 2.0 or later
- Lattice Radiant Programmer 3.0 or later
- Lattice Automate™ 1.1 Test Application Software
3. Test Setup

3.1. System Block Diagram

![System Block Diagram]

Figure 3.1. Block Diagram
3.2. Hardware Setup

3.2.1. Hardware Connection

- Raspberry Pi 4 Model B with micro-SD card
- USB Type-C cable with 5V adapter for power connection in Raspberry Pi
- Lattice Certus™-NX Versa Evaluation Board with 12 V power adapters
- USB Type-A (UART) cable for connecting the Raspberry Pi to the Lattice Certus NX Versa Evaluation Board
- Ethernet cables for Main to Node connection
- Ethernet or Wi-Fi for network connection at the client and server
- DC power supply with 24 V and 2.0 A current minimum requirement
- Four BLDC Motors
- Four Trenz TEP0002 Motor Driver boards
- Micro HDMI to standard HDMI cable for Raspberry Pi monitor connection
4. **Automate Stack Demo Package Directory Structure**

The directory structure of the Automate Stack Demo Package is listed below.

4.1. **Automate Stack Demonstration Files**

**Downloadable Demo Files**

- FPGA System On Chip (SOC) Bit file
  - Main System (soc_main_system_impl_1.bit)
  - Node System (soc_node_impl_1.bit)
- Firmware Binary Files
  - Main System (riscv_pdm_.bin)
  - Node System (c_node_system.bin)
  - Other Files
  - OPCUA_Server_v0_1_3
  - GUI_Installer_v0_1_3
  - Docklight Script File (Lattice_Automate_stack_1_1_Docklight.ptp)

**Project Files**

- Main System
  - soc_main_system_impl_1
  - Predictive_TFLite_code
- Node System
  - soc_node
  - c_node_system

Below is the brief description of the main directories.

- Automate Stack Demonstration – the parent folder for all files with the following subfolders.
  - Images – contains the FPGA images (bit files) and binary images(firmware) for both main system and node.
  - Project – contains the whole project package and files for both main system and node. The FPGA project can be accessed in the soc_main_system/soc_node section and firmware project can be accessed in the c_main_system/c_node section.
  - Documentation – contains the user guide for the project.
5. **Checking the Hardware System**

To check the hardware system:

1. Check that all hardware are connected properly as indicated in the Hardware Connection section.
2. Program the boards.
3. Power cycle the boards.
4. Reset the main board.
5. For the Raspberry Pi connections and installation process refer to Appendix A. Setting up Raspberry Pi.
6. For application installation, refer Appendix C. Installing the Application (Client End).
7. To start the server, refer to the Running the OPCUA Server section.
8. To launch the user interface/application, refer the Starting the Application in Windows PC section.
6. Running the OPCUA Server

Notes:
- For Raspberry Pi board bring up, refer to Appendix A. Setting up Raspberry Pi.
- To modify and rebuild the OPCUA Server, refer to Appendix B. Compiling the OPCUA Server

To run the server (Server End)
1. Open the terminal.
2. Use the cd command to navigate to the /OPCUA_ServerApp_v0_1_3/bin folder.
3. Run the command below.

   ./server to start the server

Figure 6.1. Server

4. The server starts.

   Figure 6.2. Running Server

If the USB connection to the Main System is missing or if the Main System is powered down, then the server will exit with an error message.
7. Running the Motor through Test Application Software (Client Side)

This section provides the procedure for running the motor through Graphical User Interface/Test Application.

Notes:
- For Lattice Automate Stack 1.1 Application Installation, refer to Appendix C. Installing the Application (Client End).
- For generating the bit and binary files, refer Appendix D. Generating the Automate Stack 1.1 Bit File and Binary File
- Make sure that the Main system and each Node is programmed before running the Lattice Automate Stack 1.1 setup. Refer to Appendix E. Programming the Automate Stack on LFD2NX SPI FLASH

7.1. Starting the Application in Windows PC

To start the application:
1. Open the Lattice Automate Stack 1.1 application.

![Figure 7.1. User Login]

2. Enter the following username and password:
   - Username – lattice
   - Password – lattice
3. The Dashboard page opens.

![Figure 7.2. Dashboard]
7.2. Connecting to the Server

To connect to the server:

1. Click the System Configuration tab.

![Figure 7.3. System Configuration](image)

2. Enter the IP Address on the IP Address field.
   
   **Note:** IP Address should be from the Raspberry Pi setup.

3. Click Apply.

4. The Update Successfully prompt appears.

5. Click Connect.

6. The IP address is updated on top of the address bar.

![Figure 7.4. IP Address Bar](image)
7.3. Selecting the Chain

To select the chain:

1. Choose Select Chain and select Both.

Figure 7.5. Select Chain

2. Both chains are displayed

Figure 7.6. Both Chains

3. Choose Chain and select Chain1.

Figure 7.7. Select Chain 1
4. A single chain is displayed.

![Image](432x541.png)

**Figure 7.8. Single Chain**

### 7.4. Configuring the Motor

To configure the motor:

1. Click the **Motor Configuration** tab
2. Select the number of nodes.

![Image](432x541.png)

**Figure 7.9. Motor Configuration**

3. Click **Default**.
4. Click **Update**.
5. If any values are changed from the default values, a message prompt appears. Click Yes to confirm the update.

![Figure 7.10. Confirmation Pop up](image)

6. The user authentication opens.

7. Enter the following username and password:
   - Username – lattice
   - Password – lattice

8. Click Login.

![Figure 7.11. Authentication page](image)

9. A message confirming successful update is displayed. Click OK.

![Figure 7.12. Updated Configuration](image)
7.5. Setting the Target RPM from the Dashboard Page.

1. Click the Dashboard tab.
2. In Target RPM enter 120.
   
   **Note:** Target RPM value should not be more than the Maximum RPM value in the Motor Configuration page.

   ![Figure 7.13. Set Target RPM](image)

3. Click Start Update.
4. After RPM lock is achieved, the Node LEDs turns green.

   ![Figure 7.14. RPM Lock Achieved Status](image)

5. To stop the motor, click Stop
   
   In case of an emergency or to withdraw the current from the motor, click Power Off.
7.6. Checking Motor Status

1. Click the Motor Status tab.
2. In Target RPM, enter 120.
3. Click Start/Update.

![Figure 7.15. Target RPM](image)

4. The meter gauge is updated to 120 RPM. It is also updated to 120 RPM on the Target RPM bar.
5. Set Target RPM to 1000 and click Start/Update to update the RPM speed.
6. The meter gauge is updated to 1000 RPM. It is also updated to 1000 RPM on the Target RPM bar.
7. To stop the motor, click Stop.
8. Click Power Off to remove power from the motor.

7.7. Controlling Forward/Reverse Rotation

1. Click the Motor Status tab.
2. In Rotation, select Forward.
3. In Target RPM, enter 1000.
4. Click Start/Update.
5. Wait for the RPM Lock Status to turn green.
6. In Rotation, select Reverse.

7. Click Start/Update.
8. The motor slows down to a minimum RPM then starts rotating counter clockwise and speeds up to 1000 RPM.
   
   **Note:** In case of an emergency or to remove power from the motor, click Power Off.
7.8. Capturing PDM Data

7.8.1. Collecting PDM Data

To collect PDM Data:

1. Click the Motor Status tab.
2. In Target RPM, enter a value between 1400 and 1800.
3. Click Start/Update. Wait until the RPM is locked.
4. Click Collect PDM Data. Wait for the PDM data capture process to complete.
5. Check the PDM image on the screen.
   The Motor Status indicates the following
   - Yellow – Unknown
   - Green – Good
   - Red – Bad
   To clear the result, click **Clear Status**.

6. To fetch the previous images, click **Browse**.

   ![Figure 7.20. Collect PDM Data](image)
   **Figure 7.20. Collect PDM Data**

7. To zoom-in or zoom-out the size of PDM image, click and drag the zoom bar slider.

   ![Figure 7.21. Zoom In and Zoom Out](image)
   **Figure 7.21. Zoom In and Zoom Out**
7.8.2. Using Batch Mode

To use batch mode:

1. Follow the steps in the Collecting PDM Data section.
2. Click the System Configuration tab.
   - Set the Path Name to a folder to hold the data files
   - Set the Number of PDM Files to the desired number (default is 100)
   - Set the PDM File Name to the root file name. The system auto increments a counter starting at 000 and appends it to the file name.

3. Click the Motor Status tab.
4. To collect multiple images, under Batch Mode, click Start.
   Wait for the process to be 100% completed.

5. After collecting the multiple images, click Stop.
6. The PDM data files are placed in a subfolder based on the Node.
Appendix A. Setting up Raspberry Pi

A.1. Formatting the SD Card

If the Raspberry Pi kit came with an SD card with the Raspian operating system already installed, then skip to the Start up the Raspberry Pi section. Otherwise, to format the SD Card:

1. Insert your micro SD card into the USB card reader and plug it into your PC.
2. Download the SD card formatter from https://www.sdcard.org/downloads/formatter/sd-memory-card-formatter-for-windows-download/

3. Click Accept to download the file.
4. Unzip the downloaded file and install the SD Card Formatter application.
5. Open the SD Card Formatter 5.0.1 setup.
6. Choose Quick format and click Format.

Figure A.1. SD Card Installation
A.2. Setting Up Raspberry Pi Imager

To set up Raspberry Pi Imager:

2. Open the downloaded `imager_1.6.2.exe` file.

3. Click Install.
4. When the process is completed, click Finish.

In the Raspberry Pi Imager, select Raspberry Pi OS (32 bit) under Operating System.
5. Select Mass Storage Device Media under SD Card.

6. Click Write.
7. When the Raspberry Pi Imager completes the writing process, a Write Successful message appears. You can remove your SD card.

![Figure A.7. SD Card Write Process Successful](image)

**Figure A.7. SD Card Write Process Successful**

A.3. **Start up the Raspberry Pi (Server End)**

To start up the Raspberry Pi on the server:

1. Insert the SD card into the Raspberry Pi slot.
2. Connect the Ethernet cable into the Ethernet port and a router or switch.
3. Connect the Micro HDMI cable between the Raspberry Pi and the Monitor.
4. Connect the Type-C power cable into the Type-C port.
5. Connect the mouse and keyboard into the USB 3.0 port, if required.

![Figure A.8. Raspberry Pi Setup Image](image)

**Figure A.8. Raspberry Pi Setup Image**
6. Power ON the monitor and Raspberry Pi.
7. After a few seconds, the Raspberry Pi OS desktop appears.

![Raspberry Pi OS Desktop](image)

**Figure A.9. Raspberry Pi OS Desktop**

8. When you start your Raspberry Pi for the first time, the Welcome to Raspberry Pi application appears and guides you through the initial setup. Click **Next**.

![Welcome to Raspberry Pi](image)

**Figure A.10. Initial Step**

9. Select your **Country**, **Language**, and **Timezone** and click **Next**.

![Country, Language, and Timezone Selection](image)

**Figure A.11. Country, Language, and Timezone Selection**
10. Enter a new password and click **Next**.

![Change Password](image)

**Figure A.12. Change Password**

11. The wizard checks for updates to the Raspberry Pi OS and installs them.

![Software Update](image)

**Figure A.13. Software Update**

13. Click **Restart** to complete the setup process.

![Setup Complete](image)

**Figure A.14. Setup Complete**
Appendix B. Compiling the OPCUA Server

B.1. Creating the File

The OPCUA_ServerApp_v0_1_3.zip archive contains both a functional Server executable file as well as all the files needed to rebuild the Server. The archive can be extracted into a directory of choice in either a PC or the Raspberry Pi. If using a PC, then a file transfer utility such as WinSCP can be used to move the entire directory structure over to the Raspberry Pi.

Note: The executable permission may have to be set for the server file in the bin folder.

To create the file:

1. Open the terminal.
2. Unzip the bundle.
3. Run the command below.
   ```
   unzip OPCUA_ServerApp_v0_1_3.zip
   ```
4. Run the command below.
   ```
   cd OPCUA_ServerApp_v0_1_3/
   ```
5. Go to the Scripts directory and run the command below.
   ```
   cd Scripts/
   ```
6. Run the command below for compilation.
   ```
   make -j4
   ```

   ![Figure B.1. Compilation](image)

7. To remove the all objects and binary files, if necessary, run the command below.
   ```
   make clean
   ```

   ![Figure B.2. Make Clean](image)

B.2. Running the Server

To run the server:

1. After the make clean or make -j4 process, go to the `OPCUA_Server/Scripts` directory.
2. Go to the `bin` directory.
3. Write the command below.
   ```
   cd ..
   ```
4. To start the server, write the command below.
   ```
   ./server
   ```

The server starts.
Figure B.3. Running the Server
Appendix C. Installing the Application (Client End)

**Note:** The installation process is performed on a separate PC and not on the Raspberry Pi system.

To install the application on the client computer:

1. Go to the installer folder.
2. Click the setup file to install the application.

![Installer directory](image)

**Figure C.1. Installer directory**

3. The installation wizard welcome page appears. Click Next.

![Installation Wizard Welcome Page](image)

**Figure C.2. Installation Wizard Welcome Page**

4. The target location is shown in the Destination Folder page. Click Next.
5. In the Ready to Install the Program page, click Install.
6. When the Installation is completed, click **Finish**.

![Figure C.5. Installation Completed](image)

Figure C.5. Installation Completed
Appendix D. Generating the Automate Stack 1.1 Bit File and Binary File

D.1. Generating the .bit File

To generate the .bit file:

1. Launch the Lattice Radiant software and open the generated Lattice Radiant project.
2. In the Device Selector dialog box, select the following options:
   - Family – LFD2NX
   - Device – LFD2NX-40
   - Operating Condition – Industrial
   - Package – CABGA256
   - Performance Grade – 8_High-Performance_1.0V
   - Part Number – LFD2NX-40-8BG256C

   ![Device Selector](image)

   Figure D.1. Lattice Radiant Device Selector

4. Change Frequency (MHz) to 150 MHz.
Figure D.2. Strategy for Build Generation

5. Select **Synthesis Design > Map Design** (not required for main system) > **Map Timing Analysis**.

6. In **Speed for Hold Analysis** and in **Speed for Setup Analysis**, select **8_High-Performance_1.0V**.

Figure D.3. Map Analysis Setting

7. Select **Synthesis Design > Place & Route** (not required for main system)

8. Select **Prioritize Hold Correction Over Setup Performance**.

9. In **Set Speed Grade for Hold Optimization** and in **Set Speed Grade for Setup Optimization**, select **8_High-Performance_1.0V** (not required for main system)
Select Synthesis Design > Place & Route > Place & Route Timing Analysis (not required for main system).

In Speed for Hold Analysis and in Speed for Setup Analysis, select 8_High-Performance_1.0V (not required for main system).

Note: Use the same PDC if the FPGA is same otherwise update PDC file as per FPGA pins.

Open Device Constraint Editor.

Click the Global button.
14. In Global constraint, set **Clock** to **90 MHz**.

<table>
<thead>
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<td>CONFIGIO_VOLTAGE_BANK1</td>
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**Figure D.7. Global Constraints**

15. Click **Run all** to generate the bit file.
16. To update, generate a new project from Lattice Propel™.
17. Initialize Data memory with the generated **Data.mem** file in the debug folder of C project.
18. Validate and generate SGE.
19. Open the Lattice Radiant tool from the Propel user interface.
20. Select **FPGA** and update constraint.
21. Click on **Run all** to generate the bit file.
D.2. Generating the Binary

To generate the binary:

1. Double click Lattice Propel SDK 2.0 to open the dialogue box as shown in fig. 63

![Figure D.8. Select Directory](image)

2. To select the workspace, browse to the template location
   \( C:\lscc\propel\2.0\templates\Automate\main_system. \)
3. Click Launch.

![Figure D.9. Import Project](image)

4. Click Import to import firmware project template.
5. Select Existing Project in Workspace under General and click Next.
6. Select the root directory and browse for template location.
7. Select the project as shown in Figure D.11 and click Finish.
8. Right-click on the firmware project folder `TF_lite_RiscV_Acc` and select **Build Configurations > Clean All** to clean the project before building.

![Figure D.12. Build Configurations](image)

9. When the process is 100% completed, the result appears on console.

![Figure D.13. Build Completed](image)

11:12:27 Build finished. 0 errors, 1 warnings. (took 36.729ms)
10. Right click on `TF_lite_RiscV_Acc` and select `Build Configurations > Build All` to build the project.

![Build All](image1)

**Figure D.14. Build All**

11. When the process is 100% completed, the result appears on console.

![Completing the Process](image2)

**Figure D.15. Completing the Process**
Appendix E. Programming the Automate Stack on LFD2NX SPI FLASH

E.1. Main System Programming

This section provides the procedure for programming the SPI Flash on the Certus-NX Versa Evaluation Board for the Main system.

There are two different files that should be programmed into the SPI Flash. These files are programmed to the same SPI Flash, but at different addresses:

- Bitstream (FPGA SOC Design)
- Binary (RISC V Firmware)

To program the SPI Flash in Radiant Programmer:

1. Connect the Certus-NX Versa Evaluation Board to the PC using a USB cable.
2. Start Lattice Radiant Programmer. In the Getting Started dialog box, select Create a new blank project.
3. Click OK.
4. In the Lattice Radiant Programmer main interface, select LFD2NX for Device Family and LFD2NX-40 for Device or detect automatically as shown in Figure E.3.
5. Right-click and select **Device Properties**.

6. Select the options below:
   
   **Under Device Operation:**
   - Target Memory – External SPI Flash Memory (SPI FLASH)
   - Port Interface – JTAG2SPI
   - Access Mode – Direct Programming
   - Operation – Erase all
   
   **Under SPI Flash Options:**
   - Family – SPI Serial Flash
   - Vendor – Micron
   - Device – MT25QU128
   - Package – 8-pin SOP2

**Note:** Before programming, it is necessary to erase the flash memory.
7. Click OK.
8. Click the Program Device icon. This erases the flash memory.
10. Select the options below.
    Under Device Operation:
    • Target Memory – External SPI Flash Memory (SPI FLASH)
    • Port Interface – JTAG2SPI
    • Access Mode – Direct Programming
    • Operation – Erase, Program, Verify
    Under SPI Flash Options:
    • Family – SPI Serial Flash
    • Vendor – Micron
    • Device – MT25QU128
    • Package – 8-pin SOP2
11. To program the bitstream file, under Programming Options, select the soc_main_system_impl_1.bit bitstream file in Programming file.
12. Click Load from File to update the Data file size (Bytes) value.
13. Ensure that the following addresses are correct:
    • Start Address (Hex) – 0x00000000
    • End Address (Hex) – 0x000F0000
14. Click the Program Device icon.

15. To program the firmware, under Programming Options, select the `c_main_system.bin` binary file.

16. Ensure that the following addresses are correct:
   - Start Address (Hex) – 0x00100000
   - End Address (Hex) – 0x00200000
17. Click the Program Device icon.
18. Power cycle the Certus-NX Versa Evaluation Board.

E.2. Node System Programming

This section provides the procedure for programming the SPI Flash on the Certus-NX Versa Evaluation Board for Node Systems. There are two different files that should be programmed into the SPI Flash. These files are programmed to the same SPI Flash, but at different addresses:

- Bitstream
- Binary

To program the SPI Flash in Lattice Radiant Programmer:
1. Connect the Certus-NX Versa Evaluation Board to the PC using a USB cable.
2. Start the Lattice Radiant Programmer tool.
3. In the Getting Started dialog box, select Create a new blank project.
4. Click OK.
5. In the Lattice Radiant Programmer main interface, select **LFD2NX** for **Device Family** and **LFD2NX-40** for **Device**.
Figure E.11. Lattice Radiant Programmer- Device Operation

6. Apply the settings below:
   Under Device Operation:
   - Target Memory – External SPI Flash Memory
   - Port Interface – SPI
   - Access Mode – Direct Programming
   - Operation – Erase, Program, Verify
   Under SPI Flash Options:
   - Family – SPI Serial Flash
   - Vendor – Micron
   - Device – MT25QU128
   - Package – 8-pin SOP2

7. To program the bitstream file, under Programming Options, select the soc_node_impl_1.bit bitstream file in Programming file.
Figure E.12. Lattice Radiant Programmer – Node SOC Flash Settings

8. Click **Load from File** to update the **Data file size (Bytes)** value.
9. Ensure that the following addresses are correct:
   - **Start Address (Hex)** – 0x00000000
   - **End Address (Hex)** – 0x00100000
10. Click the **Program Device** icon.
11. To program the firmware, under **Programming Options**, select the `c_node_system.bin` binary file.
12. Ensure that the following addresses are correct:
   - **Start Address (Hex)** – 0x00140000
   - **End Address (Hex)** – 0x00240000
13. Click the **Program Device** icon.
14. After programming, power cycle each Certus NX board and press the reset switch (SW3) on the Main System board last.

Figure E.13. Lattice Radiant Programmer- Node Firmware Flash Settings

Figure E.14. Reset Button
Appendix F. Debugging Using Docklight

You do not need the Raspberry-Pi board or any server or client setup to run basic demo from Docklight. The Docklight tool is available on the web.

Docklight can be used as host for debugging. It supports UART protocol with various standard baud rates. Send each command manually to demonstrate any functionality of the system. It supports same UART packet type as user interface. Brief explanation of UART request and response packets is explained in further sections of this Appendix. The Lattice_Automate_Stack_1_1_Docklight.ptp basic docklight script is provided with the demo package. Explanation of basic command is given in further sections of this Appendix. You can add more commands in .ptp file based on requirement.

Basic minimal list of procedures are also defined in this Appendix run basic demo from docklight.

Here are basic steps to run demonstration using docklight:

1. The Certus-NX Versa Evaluation Boards should be programmed with appropriate executable files as given in Appendix E. Programming the Automate Stack on LFD2NX SPI FLASH
2. The Docklight tool should be installed in host PC.
3. Hardware should be connected properly as shown in Figure F.1.

4. Open the Docklight application.
5. Open the Docklight script *Lattice_Automate_Stack_1_1_Docklight.ptp*.

![Docklight Default Screen](Figure F.2. Docklight Default Screen)

6. Select the UART communication port. For FTDI based USB systems, this is the even numbered COM port as shown in Figure F.4.

7. In **Baud Rate**, select **9600**.

![Select COM Port and Baud Rate](Figure F.4. Select COM Port and Baud Rate)
8. Click **Run** in the Docklight.

![Docklight V2.3 - Project: Lattice_Automate_Stack_1_1_Docklight](image)

**Figure F.5. Run Button**

9. Press the reset (SW3) on the Main System board as shown in **Figure F.6**.

![Figure F.6. Reset the Main Board](image)

10. System initialization appears in the ASCII tab as shown in **Figure F.7**.

![System Initialization](image)

**Figure F.7. System Initialization**

11. If the UART commands are understood, skip ahead to the **Steps to Demonstrate Basic Functionality** section.

**F.2. UART Command’s Description**

This section provides the UART read/write request and response commands.
Write Request Command (TX):

CC 77 10 00 00 01 00 00 18 00 19 00 01 00 00 00
CMD LEN Read write Address Data

CC 77 : Magic No. For Command packet

CMD Len: 2 byte for packet length

Data Write: 0x00000100
Data Read: 0x00000200

Address: Address to Write or Read

Data: Data will be present from byte position 12(index 12)

Write Response Command (RX):

AA 88 0C 00 00 01 00 00 00 00 00 00 00
Packet Length Response Packet Error/No Error

AA 88 : Magic Word

Packet Length: 2 byte of packet length

Response Packet Code:
Data Write Response: 0x00000100
Data Read Response: 0x00000200

Error/ No Error :
No Error: 0x00000000
Error: 0x00000001

Read Request Command (TX):

CC 77 0C 00 00 02 00 00 18 00 19 00
CMD LEN Read write Address

CC 77 : Magic No. For Command packet

CMD Len: 2 byte for packet length

Data Write: 0x00000100
Data Read: 0x00000200
Address: Address to Write or Read

Data: Data will be present from byte position 12 (index 12)

Read Response Command (RX):

AA 88 10 00 00 02 00 00 D0 00 00 00 00 00 00 00
Packet Length Response Packet Error / No Error Data

AA 88 : Magic Word
Packet Length: 2 byte of packet length

Response Packet Code:
Data Write Response: 0x00000100
Data Read Response: 0x00000200

Error/ No Error :
No Error: 0x00000000
Error: 0x00000001

F.3. Commands
The configuration settings for the motor are applied to control the motor.

Main System Commands – to Enable Different Mode
A. CHAIN_1_SELECT : Chain 1 of nodes select, set by the user.
   Command: CC 77 10 00 00 01 00 00 18 00 19 00 01 00 00 00
B. CHAIN_2_SELECT : Chain 2 of nodes select, set by the user.
   Command: CC 77 10 00 00 01 00 00 18 00 19 00 02 00 00 00
C. CHAIN_1_NODE_SELECT : Node select from chain 1, set by the user.
   Command: CC 77 10 00 00 01 00 00 04 00 19 00 01 00 00 00
   Note: This Command is only for Chain 1 and Node 1
D. CHAIN_2_NODE_SELECT : Node select from chain 2, set by the user.
   Command: CC 77 10 00 00 01 00 00 1C 00 19 00 01 00 00 00
E. ALL_CHAIN_TX_ENABLE : Both chain of nodes select, set by the user.
   Command: CC 77 10 00 00 01 00 00 20 00 19 00 01 00 00 00
F. SINGLE_CHAIN_TX_ENABLE : one by one chain select mode enable, set by the user.
   Command: CC 77 10 00 00 01 00 00 20 00 19 00 00 00 00 00
G. PDM_NORMAL_PACKET_ENABLE : PDM normal packet enable, set by the user.
   Command: CC 77 10 00 00 01 00 00 24 00 19 00 00 00 00 00
H. PDM_EXTENDED_PACKET_ENABLE : PDM extended packet enable, set by the user.
   Command: CC 77 10 00 00 01 00 00 24 00 19 00 01 00 00 00
I. MOTOR_STATUS_READ_MAIN_SYSTEM : Motor status read from main system register bank, set by the user.
MOTOR Config Command

A. NODE_LED_ON : Node LED ON configuration, set by the user.
Command: CC 77 10 00 00 01 00 00 54 40 18 00 00 00 00

B. NODE_LED_OFF : Node LED OFF configuration, set by the user.
Command: CC 77 10 00 00 01 00 00 54 40 18 00 FF FF FF FF

C. MIN_RPM : Minimum rpm limit of motor, set by the user.
Command: CC 77 10 00 00 01 00 00 00 40 18 00 78 00 04 96

D. MAX_RPM : Maximum rpm limit of motor, set by the user.
Command: CC 77 10 00 00 01 00 00 04 40 18 00 10 0E 00 00

E. RPM_PI_KI : Configuration of motor, set by the user.
Command: CC 77 10 00 00 01 00 00 08 40 18 00 80 00 00 08

F. RPM_PI_KP : Configuration of motor, set by the user.
Command: CC 77 10 00 00 01 00 00 00 40 18 00 78 00 00 00

G. TARGET_RPM 120 : Target rpm on which the motor is to run, set by the user.
Command: CC 77 10 00 00 01 00 00 1C 40 18 00 78 00 00 00

H. TARGET_RPM 500 : Target rpm on which the motor is to run, set by the user.
Command: CC 77 10 00 00 01 00 00 1C 40 18 00 78 00 00 00

I. TARGET_RPM 1000 : Target rpm on which the motor is to run, set by the user.
Command: CC 77 10 00 00 01 00 00 1C 40 18 00 78 00 00 00

J. TARGET_RPM 1500 : Target rpm on which the motor is to run, set by the user.
Command: CC 77 10 00 00 01 00 00 1C 40 18 00 78 00 00 00

K. TARGET_RPM 1800 : Target rpm on which the motor is to run, set by the user.
Command: CC 77 10 00 00 01 00 00 1C 40 18 00 78 00 00 00

L. PI_RESET : Configuration of motor, set by the user.
Command: CC 77 10 00 00 01 00 00 18 40 18 00 00 00 00 01

M. STROBE_FUNCTION : Strobe function configuration, set by the user.
Command: CC 77 10 00 00 01 00 00 18 40 18 00 80 01 00 00

N. MOTOR_POWER (38%) : Motor power configuration, set by the user.
Command: CC 77 10 00 00 01 00 00 14 40 18 00 80 01 00 00

O. MOTOR_POWER(10%) : Motor power configuration, set by the user.
Command: CC 77 10 00 00 01 00 00 14 40 18 00 80 01 00 00

P. MOTOR_START : Motor start configuration of motor, set by the user.
Command: CC 77 10 00 00 01 00 00 18 40 18 00 00 00 10

Q. MOTOR_STOP : Motor stop configuration of motor, set by the user.
Command: CC 77 10 00 00 01 00 00 18 40 18 00 00 00 00

R. MOTOR_POWER_OFF : Motor power off configuration of motor, set by the user.
Command: CC 77 10 00 00 01 00 00 18 40 18 00 00 00 00

S. PDM_OFFSET : PDM offset configuration, set by the user.
Command: CC 77 10 00 00 01 00 00 18 40 18 00 00 00 00

T. PDM_PEAK_DETECT : PDM peak detect configuration, set by the user.
U. PDM_START : PDM start configuration, set by the user.

Command: CC 77 10 00 00 01 00 00 30 40 18 00 02 0F C8 00

Motor Status Command
A. PDM_READY_CHECK : PDM Ready check configuration, set by the user.

Command: CC 77 0C 00 00 02 00 00 38 40 18 00 40 0F C8 00

B. PDM_LOCK_CHECK : PDM lock check configuration, set by the user.

Command: CC 77 0C 00 00 02 00 00 2C 40 18 00 40 0F C8 00

PDM Data Fetched Command
A. PDM_DATA_FETCHED : PDM data fetched configuration, set by the user.

Command: CC 77 10 00 00 01 00 00 0C 00 19 00 00 00 00 00
00 - 1st node
01 - 2nd node
02 - 3rd node and so on

F.4. Steps to Demonstrate Basic Functionality

To demonstrate basic functionality:

1. Basic Communication test
   a. Select the Chain.
   b. Select the node for Motor Control
   c. Send LED ON and OFF commands.

2. Both Chain Communication
   a. Select any one chain number
   b. Select the nodes for selected chain.
   c. Send the command for selected node.
   d. Select another chain number
   e. Select node for another chain.
   f. Send command for another chain.
   g. Command will be sent to all the both chain

3. Motor Configuration Test
   a. Select the Chain.
   b. Select the node for Motor Control
   c. Send the Motor config command.

4. Motor Status Test
   a. Select the Chain.
   b. Select the node for Motor Control
   c. Send the motor Status command.

5. Motor Start Test
   a. Select the Chain.
   b. Select the node for Motor Control
   c. Send the PDM Offset command.
   d. Send the Min RPM command.
6. PDM Data Fetched Test

PDM Data can be fetched from one node at a time.

   a. Select the Chain.
   b. Select the node for Motor Control
   c. Send the Motor Start Test Command till the PI Reset and Strobe Function.
   d. Send the Target RPM 500 command then Strobe function command.

**Note:** Match the RPM Lock Status

   e. Send the Target RPM 1000 command then Strobe function command.

**Note:** Match the RPM Lock Status

   f. Send the Target RPM 1500 command then Strobe function command.

**Note:** Match the RPM Lock Status

   g. Send the Target RPM 1800 command then Strobe function command.

**Note:** Match the RPM Lock Status

   h. Send the Motor Start command then Strobe function command.
   i. Send the PDM Peak Detect command then Strobe Function command.
   j. Send the PDM Start command then Strobe Function command.
   k. Send the Motor Status command
   l. Send the PDM Data Fetched command
   m. Send the Motor Stop command.
   n. Wait for the PDM data response on Docklight

Then check bit for the health status. This takes around two nimutes. Do not send any command before getting health status response.
Appendix G. OpcUA Modeler (Server End)

G.1. OpcUA Modeler Installation

To install OpcUA Modeler:

1. Open the terminal in Raspberry Pi.
2. Run the command below.
   
   ```bash
   sudo apt install python3.6
   sudo apt-get install python3-pyqt5
   pip3 install opcua-modeler
   ```
3. To go to the directory, run the command below
   
   ```bash
   cd /usr/local/bin
   ```
4. To open the OPCUA Modeler run the command below.
   
   ```bash
   ./opcua-modeler
   ```

The OPCUA Modeler opens.

Notes:

- PyQT 5 is required.
- Python 3.6+ is required.

![Figure G.1. OPCUA Modeler](image-url)
G.2. OPCUA_Modeler: Creating a New Xml (Information Model)

To create a new xml model:

1. Go to Actions and Create a New Model.
2. Click NamespaceArray and create a new add space.

   The user interface contains the default information model like root, objects, types, views.

3. Provide the name MainSystem in Add space.

4. After add space, it shows in Value.
5. **NamespaceArray** are specified as variables, method and structure types.

6. Right click on the Objects and make a new object and give the name: node1

7. In the object, specified name space as **Mainsystem** and default object structure type as **BaseObjectType**.

8. Check **Auto Nodeid** to detect automatically.

9. To modify a setting, change it manually.
10. Click OK.

Figure G.6. Manual Selection of Node ID

Figure G.7. Add Variable
11. Now define a variable in Node1 objects then press the right click on Node1 and specify namespace, variable name (TargetRPM) and data type like integer, unsigned integer or boolean.

![Figure G.8. Define Variable](image)

12. In the Add Method dialog box, add MotorStart in Name.

13. Under Input, enter motorInput in Arg Name.

14. Under Output, enter motorOutput in Arg Name.

15. Click OK.

Input arguments sent by a client side and server provide output on the client side.

![Figure G.9. Add Method](image)
16. Node1 has the structure tree of information model.

To create a new information model for using Opcua-Modeler.

![Figure G.10. Opcua Modeler](image)

19. If any variables or method in xml information model using Opcua-Modeler then run ./xmlCmd_script.sh for register all variables and method callbacks in xml .c and .h file.

20. Xml .c and .h file generate Node set compiler.

21. This script is located in Scripts directory.

![Figure G.11. Xml Script](image)
Appendix H. CSV (Comma Separated Value) File

The CSV file is a text file, it contains a list of data separated by commas.

Figure H.1. CSV File

- The first column represents an address. This column contains an Address of (Main/Node) variable.
- The second column represents a Bitmask. This column contains a Bitmask of (Main/Node) variable.
- The third column represents a Shifting. This column contains a Shifting of (Main/Node) variable.
- The Nodeid column represents a Nodeid. This column contains all variable Nodeid of (Main/Node) variables.
Technical Support Assistance
Submit a technical support case through www.latticesemi.com/techsupport.
# Revision History

**Revision 1.0, December 2021**

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