Hermes™ IoT Development Platform Manufacturing Instructions

1 Pre-Requisites

The following pre-requisites are needed for the manufacturing and test of the Hermes IoT Development Platform.

1.1 LCD Backlight Circuit Test Adapter

Build this test adapter using the circuit shown in Figure 1.

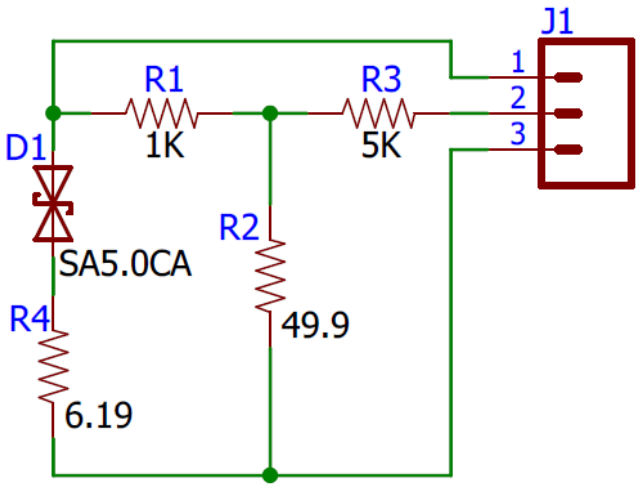

Figure 1 LCD Backlight Circuit Test Adapter Schematic

The J1 connector plugs into Hermes main board J31 connector. Therefore J1 must be a 0.1” 3x1 header connector. R4 must be at least a quarter-watt resistor. D1 is a TVS diode from Littelfuse®. Figure 2 shows an example of the implementation of this adapter.

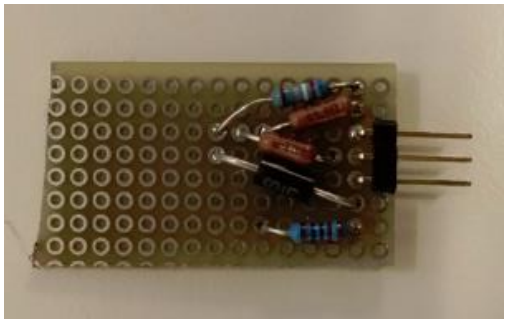

Figure 2 LCD Backlight Circuit Test Adapter Example

1.2 Hermes Main Board Test Adapter

Build this adapter using the circuit shown in Figure 3.

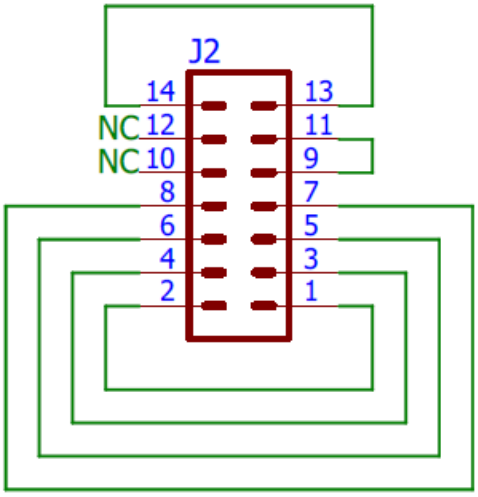

Figure 3 Hermes Main Board Test Adapter Schematic

The J2 connector plugs into Hermes main board J39 connector. Therefore J2 must be a 0.1” 7x2 socket connector. Figure 4 shows an example of the implementation of this adapter.

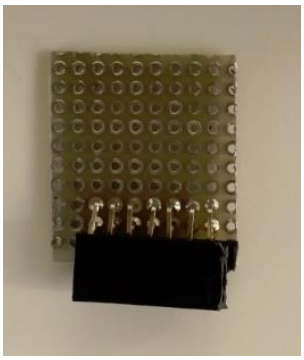

Figure 4 Hermes Main Board Test Adapter Example

1.3 Test SD Card

There are two alternatives for the preparation of the Test SD Card:

1. Write the Test Image to the SD card
2. Manually prepare the SD card

1.3.1 Write the Test Image to the SD Card

1. Get a micro SD card of at least 8GB capacity. All the contents will be erased.

2. Download the following test image: **rfmicron-hermes-bbb-mfg-test-image-1.0.img.xz** located at: https://github.com/RFMicron/Hermes/blob/master/BeagleBone_Black_Images.md
3. Download an SD card image writer. A free open-source tool for Microsoft Windows is located at: https://sourceforge.net/projects/win32diskimager/.
4. Use the image writer tool to flash the micro SD card.

1.3.2 Manually Prepare the SD Card

1. Use a sample of the Hermes Platform micro SD release card as a baseline for the preparation of this card. The preparation of the release card is described in 3.5.2.
2. Connect the SD card to a Linux computer. It could be a BeagleBone Black. But don't boot from the SD card.
3. Most modern Linux distributions will automatically mount the file system. If not, then it has to be mounted manually. This procedure assumes the mounting point is at: `/media/rootfs`
4. Enable the SD card for booting. The Hermes Platform SD card is a flasher card by default. Using a text editor open the file `/media/rootfs/boot/uEnv.txt` with root privileges and comment the last line by adding a pound sign (#) symbol at the beginning of the line. Save the file.
5. Download the test program `TestHermesA` from https://github.com/RFMicron/Hermes/tree/master/MfgTestSource/TestHermesA. This program can be built using the source code located in the same folder. A Qt cross-compiler environment is used to build the test program. The description of this development environment can be found at: IN008F10 Hermes Qt Cross-Compiler Setup Instructions.pdf.
6. Copy the test program to the `/home/debian/TestHermesA` directory. This can be done with the following commands:
   a. `sudo mkdir /media/rootfs/home/debian/TestHermesA`
   b. `sudo chown 1000:1000 /media/rootfs/home/debian/TestHermesA`
   c. `sudo cp TestHermesA /media/rootfs/home/debian/TestHermesA`
   d. `sudo chown 1000:1000 /media/rootfs/home/debian/TestHermesA/TestHermesA`
   e. `sudo chmod 755 /media/rootfs/home/debian/TestHermesA/TestHermesA`
7. Schedule the test program to start automatically after boot time using the following command:
   a. `sudo sh -c "echo '@reboot /home/debian/TestHermesA/TestHermesA &>/dev/null &' > /media/rootfs/var/spool/cron/crontabs/debian"`
8. Change the user id and group id of the debian crontab file to user equals debian and group equals crontab. Also change the privileges. This can be done with the following commands:
   a. `sudo chown 1000:102 /media/rootfs/var/spool/cron/crontabs/debian`
   b. `sudo chmod 600 /media/rootfs/var/spool/cron/crontabs/debian`

9. Remove the script file hermesRunOnceScript. Use the following command:
   a. `sudo rm /media/rootfs/home/debian/hermesRunOnceScript.rc`
10. Make sure all file editing operations are committed before disconnecting the SD card. This can be done by executing the **sync** command and following the proper unmount procedure according to the Linux distribution.

2 Incoming Inspection

2.1 LCD Touchscreen

2.1.1 Verify Label

Verify that the label on the back of the LCD touchscreen is:

NHD-7.0-800480EF-ATXV#-CTP_REV15. A photo of the label is shown in Figure 5.

Figure 5 LCD Touchscreen Revision Label

The revision has to be Rev15 or newer. Earlier revisions work at a lower LED current level and would be instantly damaged if they were connected to the Hermes board.

2.2 BeagleBone Black Computer

2.2.1 Verify USB Cable

The BeagleBone Black box includes a USB cable. This cable must be included in the final Hermes package.

3 Components Preparation

3.1 Aluminum Block

3.1.1 Clean Aluminum Block

Clean the aluminum block two main surfaces using Arctic Silver Arcticlean Surface Purifier. Alcohol can be used as a substitute.

3.2 Tag Reader Module

3.2.1 Remove Power Connector P1

Desolder the power connector P1 shown in Figure 6.

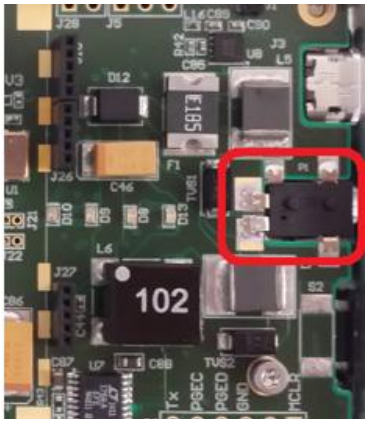

Figure 6 Tag Reader P1 Connector

3.2.2 Bypass Radon's Fuse

Use wire AWG 24 or thicker to solder a bypass on top of the fuse F1 as shown in Figure 7.

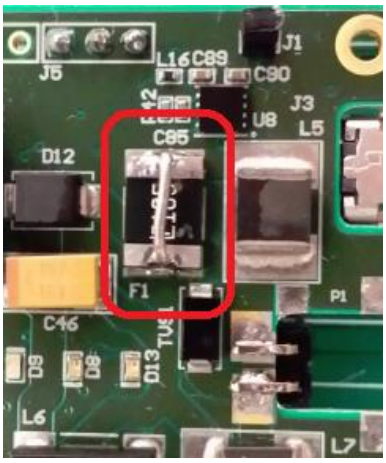

Figure 7 Tag Reader F1 Fuse

3.2.3 Install Headers

Solder connector headers J5, J6 and P1 shown in Figure 8.

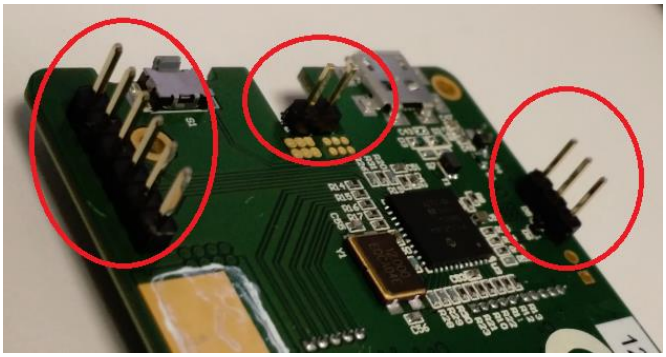

Figure 8 Tag Reader J5, J6 and P1 Connector Headers.

3.2.4 Place Jumper J1

Place a jumper between the terminals of the Tag Reader's J1 header shown in Figure 9.

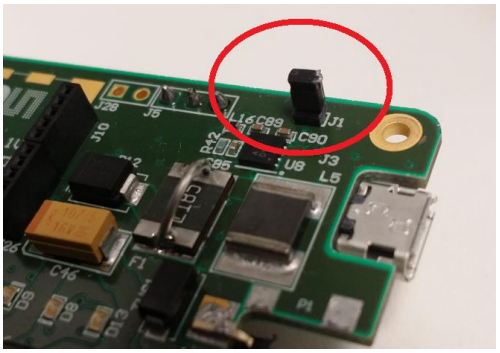

Figure 9 Tag Reader J1 Header

3.2.5 Clean Bottom Surface

Clean the part of the Tag Reader's bottom surface that it is going to make contact with the aluminum block. Use Arctic Silver Arcticlean Surface Purifier. Alcohol can be used as a substitute. Figure 10 shows the contact area between the Tag Reader and the aluminum block.

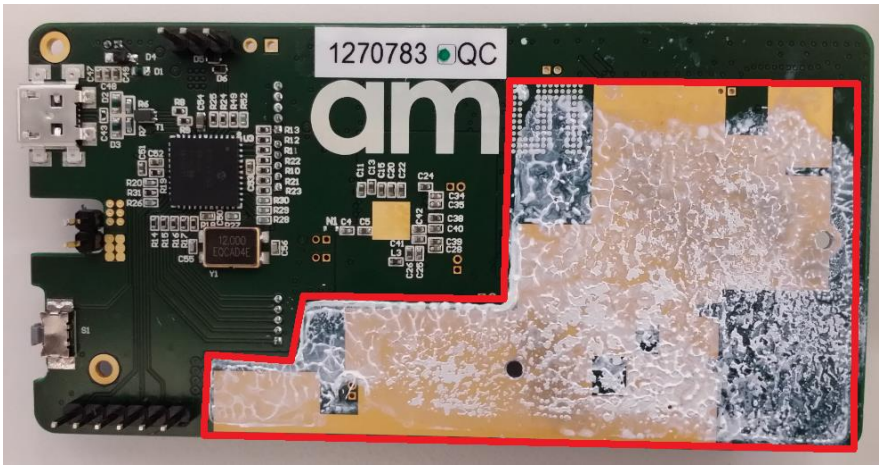

Figure 10 Tag Reader's Contact Area with Aluminum Block

3.3 BeagleBone Black Computer

3.3.1 Place Adapter Headers

Place the adapter headers according to the picture shown in Figure 11.

1. Place the 6-position header on the BeagleBone's J1 header.
2. Place the two 46-position headers on the BeagleBone's P8 and P9 connectors.

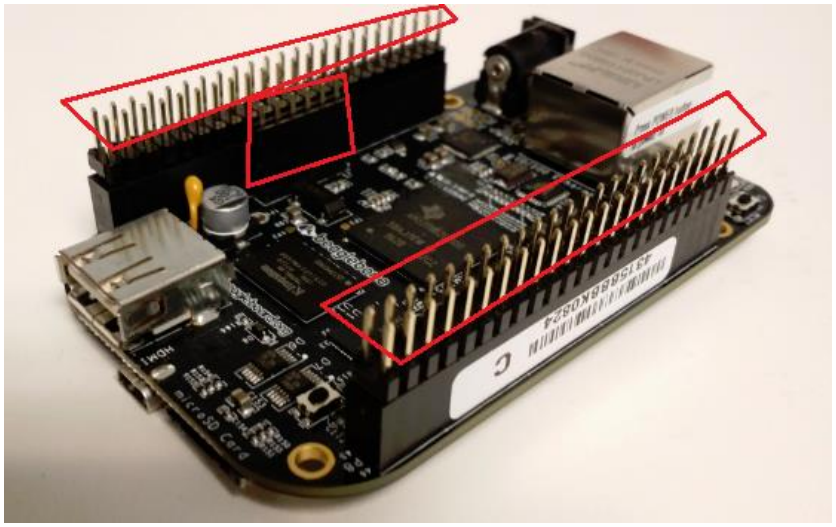

Figure 11 BeagleBone Black Adapter Headers

3.4 LCD Touchscreen

3.4.1 Place double sided tape on the back of the flat cables.

Use the 0.5” tape specified in the Bill of Materials (3M model ½-5-9088). Place the tape according to the pictures shown in Figure 12 and Figure 13.

Figure 12 Tape Location on the Back of the LCD Data Flat Cable

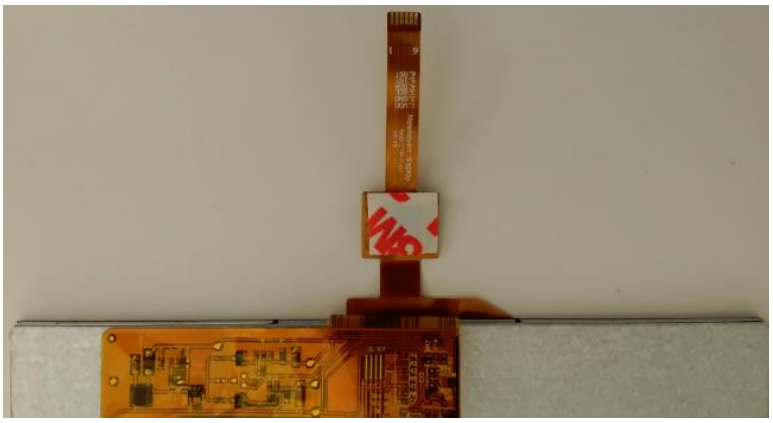

Figure 13 Tape Location on the Back of the Touchscreen Flat Cable

3.5 SD Card

3.5.1 Unpack SD Card

Perform a cut on the top side of the package following the dotted line on the back side of the package as shown in Figure 14.

Figure 14 Back Side of SD Card Package

Pull the plastic container out of the cardboard package through the slit at the top as shown in Figure 15.

Figure 15 SD Card Plastic Container Out of the Package

Get the micro SD card out of the plastic container and keep the plastic container and the cardboard package. This is because at the end of the manufacturing process the card will be packed within its original package and shipped inside the box containing the final product.

3.5.2 Write Image File to SD Card

1. Download the following Hermes released BBB image: **rfmicron-hermes-bbb-release-image-1.0.img.xz** located at: https://github.com/RFMicron/Hermes/blob/master/BeagleBone_Black_Images.md.
2. Download an SD card image writer. A free open-source tool for Microsoft Windows is located at: https://sourceforge.net/projects/win32diskimager/.
3. Use the image writer tool to flash the micro SD card.

The previous process can be tedious when it has to be performed on multiple SD cards. A card duplicator can be used to streamline the process. The following example applies to the SD card duplicator SDShark-7T-BK from VINPOWER DIGITAL shown in Figure 16. A batch of seven SD cards can be duplicated using the following instructions:

1. Power on the duplicator by pressing the power button and wait for it to be ready. Figure 17 shows the screen when it is ready.
2. Press the F1 button.
3. Load the source SD card in the slot number one. **IMPORTANT: the SD card contact pins must be facing up (the card label must be facing down).**
4. Load the other slots as needed. The full content of these cards will be overwritten.

5. The duplicator will start the process automatically.
6. At the end of the process the duplicator will beep.
7. Press the **ESC** button.
8. Unload the cards.
9. To duplicate more cards go back to step number 2.
10. To end the session press the **F4** button and wait for the following message to show up: **Shutdown Press Enter to Shutdown**.
11. Press the **ENT** button and wait for the following message: **System Checking OK! Ready to Power Off.**
12. Power down the duplicator by pressing the power button.

Figure 16 SD Card Duplicator SDShark-7T-BK from VINPOWER DIGITAL

Figure 17 SD Card Duplicator Ready Screen

4 Main PCB Population

4.1 Solder Components

Solder all the components specified in the BOM.

4.2 Defluxing and PCB Cleaning

Defluxing is the cleaning process designed to remove solder flux and by-products from the PCB assembly. PCB cleaning typically includes de-fluxing, but it may also include removing impurities from the board assembly such as solder balls, dirt, dust, organic materials, and other contaminants. The previous processes can be performed manually or using an automated cleaning machine. The chosen alternative must ensure that it will not cause any damage, corrosion or discoloration to the PCB, including the silkscreen and the installed parts. The board has a significant number of surface mount components, therefore it is important to ensure a thorough drying process. Also, the Hermes main PCB does not perform low level measurements and it does not have high-impedance analog circuits. Therefore there is no need to provide a cleaning process that ensures a very high level of PCB surface impedance. Finally, it's important to clarify that the final product does not have an enclosure, so end users will handle the PCB with their bare hands. The cleaning processes are mostly needed for cosmetic, presentation and usability reasons.

4.3 Install Board Standoffs

Install the 6 standoffs. Review the designator column in the Bill of Materials for the specific parts. Figure 18 shows one of the standoff installations.

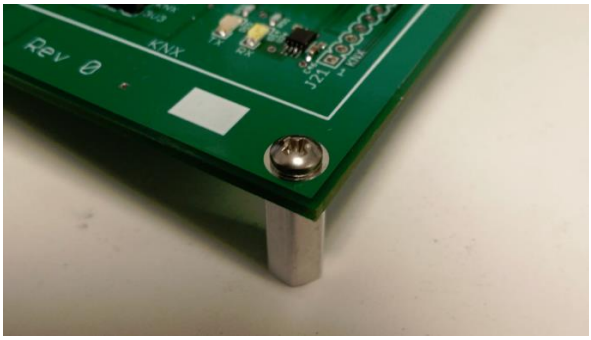

Figure 18 PCB Lower Right Corner Standoff

5 Main Modules Installation

5.1 BeagleBone Black Computer

Align the BeagleBone Black module upside down with the main board footprint and slowly press and verify at the same time that the BeagleBone's J1 connector is inserting into the

Figure 19 BeagleBone Black Assembly

on-board J1 socket connector. Keep inserting the module until the adapter headers in between the header connectors are not visible as shown in Figure 19.

5.2 Tag Reader Module

5.2.1 Place the Double Sided Thermal Tape

For this operation use the double-sided thermal tape specified in the Bill of Materials. The thermal tape must cover all the thermal vias indicated in Figure 20. Covering the screw holes is not important. Therefore it is optional to create two notches for the screws that might facilitate the screws insertion. The tape must be kept within the onboard footprint with a 0.1” tolerance. There shall not be any tape beyond the footprint.

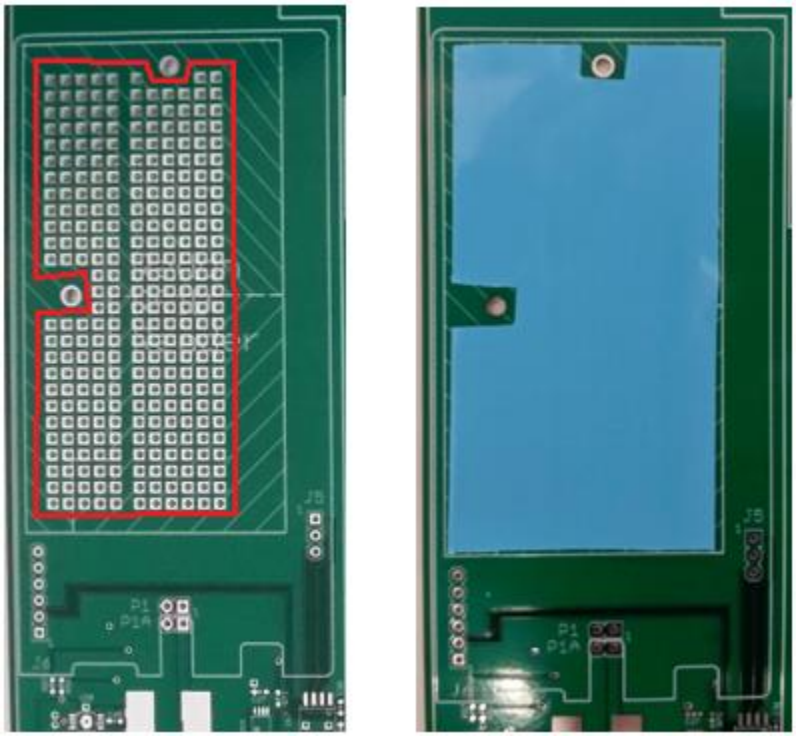

Figure 20 Tag Reader Thermal Tape Area

5.2.2 Heat Dissipation Aluminum Block Installation

Remove the top liner of the double side thermal tape and place the aluminum block on top of the footprint. Secure the aluminum block using the two screws under the main board as shown in Figure 21.

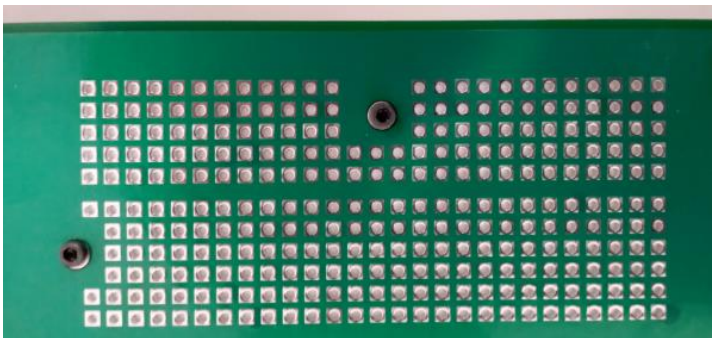

Figure 21 Aluminum Block Screws under the PCB

5.2.3 Prepare the Aluminum Block's Top Surface

Clean the aluminum block's top surface using Arctic Silver Arcticlean Surface Purifier. Alcohol can be used as a substitute. Then apply about 0.2 milliliters of the Arctic Silver Ceramique 2 Tri-Linear Ceramic Thermal compound as shown in Figure 22.

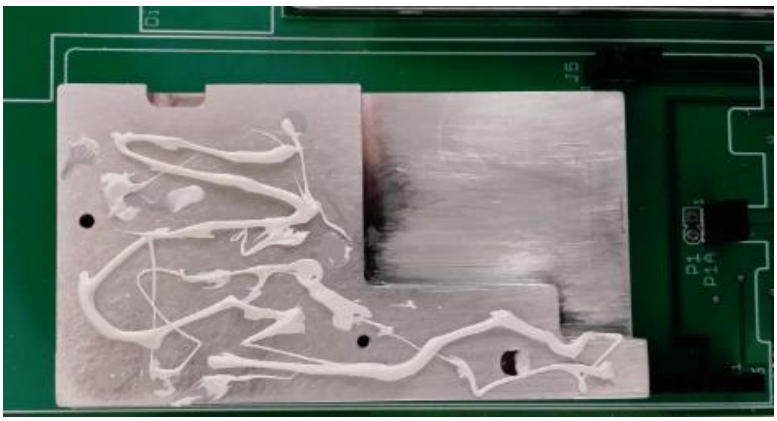

Figure 22 Thermal Compound Application

Next, spread the thermal paste evenly across the aluminum block top surface as shown in Figure 23.

Clean all the overflown paste on the sides of the thermal block using Arctic Silver Arcticlean Surface Purifier.

Figure 23 Thermal Paste Spread Layer

5.2.4 Install the Tag Reader Module

Install the tag reader module and verify that the three headers are properly connected. Then install the two screws. Do not overtight the screws. Next, clean the thermal compound that may have overflown on the sides of the aluminum block and on the tag reader around the J9 connector holes. Thermal paste will likely overflow through J9 because this connector is not populated. Finally, connect the two RF jumper cables on the tag reader module first (J7 and J14) and then to the main PCB (J14 and J13) as shown in Figure 24.

Figure 24 Tag Reader Module Installation

5.3 KNX Module

5.3.1 Install KNX Module's Right Angle Connector

Install the right angle connector as shown in Figure 25.

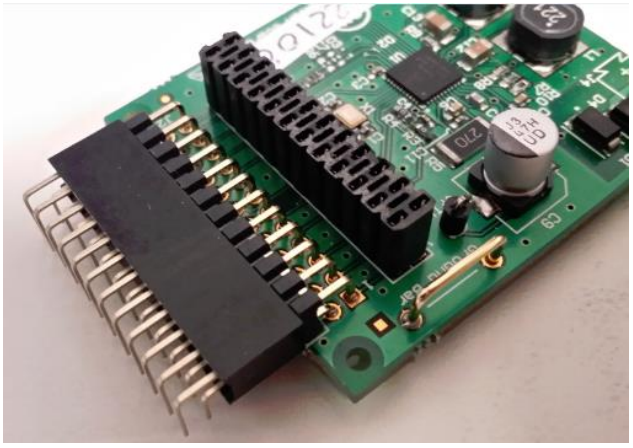

Figure 25 KNX Module Right Angle Connector

5.3.2 Install KNX Module's Standoff

Install the one standoff as shown in Figure 26.

Figure 26 KNX Module Standoff

5.3.3 KNX Module Installation

Align the pins of the right angle connector with the main PCB's J2 connector and gently press the KNX module until it is fully inserted as shown in Figure 27.

Figure 27 KNX Module Installation

5.3.4 Secure KNX Module

Secure the KNX module by driving a screw from the back of the main PCB and screwing it into the KNX module's standoff as shown in Figure 28. Do not overtight the screw.

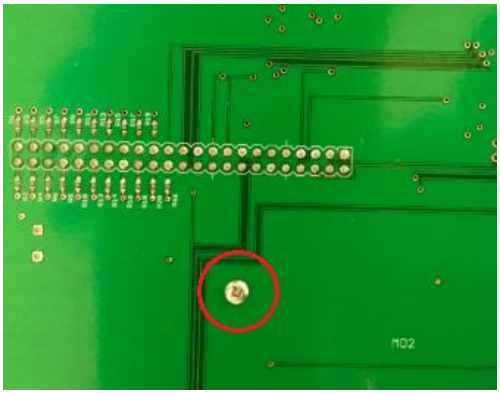

Figure 28 KNX Module Screw in the Back of the Main PCB

5.4 XBee Module Installation

Align the XBee module over its footprint in the main PCB and gently plug it into the socket connectors as shown in Figure 29. Make sure the module is fully seated.

Figure 29 XBee Module Installation

6 Test Phase I and EEPROM Programming

There are two main objectives for this step in the manufacturing process. The first one is to perform a round of electrical tests and the second one is to program the onboard EEPROM **if and only if** all the tests passed. The test program performs the following tests:

1. BeagleBone Black current consumption
2. LCD backlight circuit voltage when it is disabled
3. LCD backlight circuit voltage when it is enabled
4. Tag reader current consumption when it is disabled
5. Tag reader current consumption when it is enabled

It's important to clarify that this test phase is performed **BEFORE** the LCD installation.

6.1 Connect Test Adapters

Place the LCD backlight circuit test adapter in J31 with the components facing towards the front of the board as shown in Figure 30.

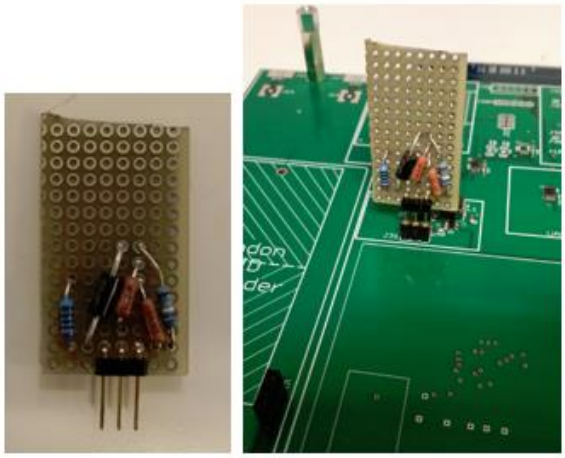

Figure 30 LCD Backlight Circuit Test Adapter Connection

Place the Hermes main board test adapter in J28 with the connector side facing towards the front of the board as shown in Figure 31.

Figure 31 Hermes Main Board Test Adapter Connection

6.2 Insert Test SD Card

Make sure the Hermes board is powered off. Then insert the test SD card into the BeagleBone's card reader connector as shown in Figure 32. RFMicron uses a PNY green and grey test SD card in its test procedure.

Figure 32 Test SD Card Insertion

6.3 Start the Test

Start the test by plugging in the power adapter into the main board's power connector as shown in Figure 33.

Verify that the Power LED turns on and the Heartbeat LED will start blinking after about 15 seconds. The User LED should be off as shown in Figure 34.

The test is undergoing while the Heartbeat LED is blinking. If all the tests pass then the test procedure will last about twenty seconds. At the end of the test the Heartbeat LED will stop

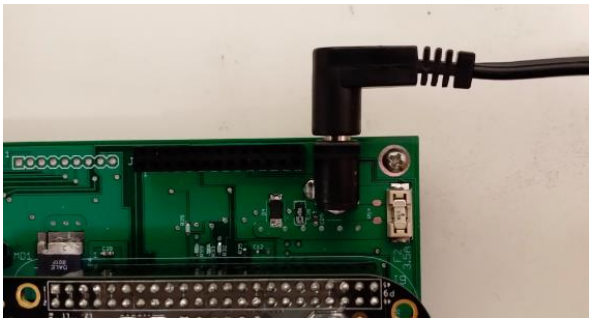

Figure 33 Power Adapter Connection

blinking and the User LED will show the test result. If the User LED is on it means that the test passed, if the User LED is off it means that the test failed.

Figure 34 LED Indicator during Testing

6.4 Turn the Power Off

Turn off the power by clicking once the Power Button (S1) shown in Figure 35. Wait a few seconds till the Power LED turns off. Then it is safe to unplug the power adapter.

Figure 35 Power Button

WARNING: Unplugging the power adapter while the main board LEDs and the BeagleBone Black LEDs are showing activity can cause permanent hardware damage to the BeagleBone Black module.

In the unlikely case that the BeagleBone module does not power off then the power off should be forced by pressing the Power Button (S1) and leaving it pressed for about ten seconds. This time the BeagleBone has to power off. If it doesn't power off it means that the BeagleBone Black module is faulty.

6.5 Remove Test Adapters

It is safe to remove the two test adapters after turning the power off.

7 LCD Touchscreen Installation

7.1 Place the Double Sided Tape

Place the double sided tape according to the picture shown in Figure 36. There shall not be any tape beyond the LCD footprint or into the board's cut out. The distance between the tape and the footprint should not be larger than 0.2 inches. After applying the tape there should not be any exposed pads or vias within the LCD footprint.

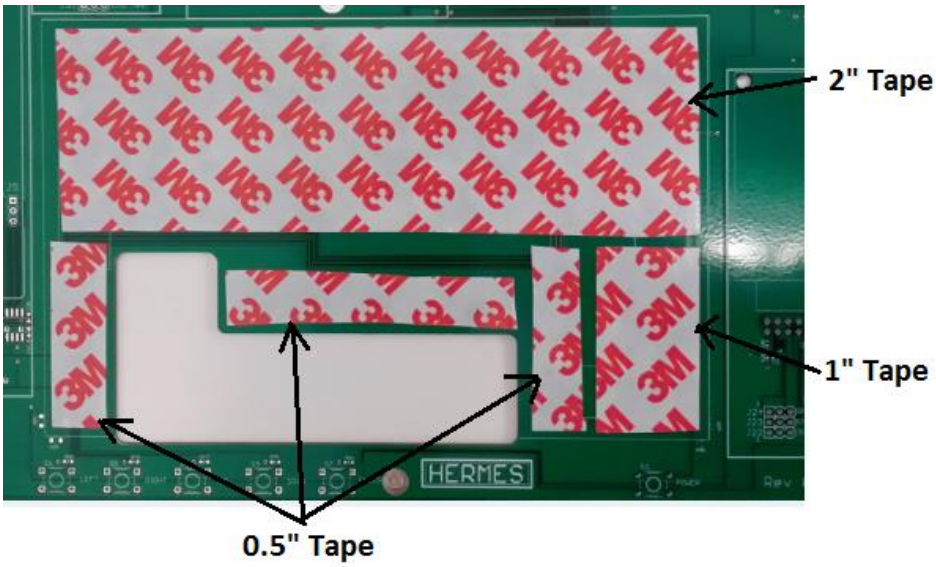

Figure 36 LCD Mounting Tape Location

7.2 Install LCD Touchscreen

Align the LCD touchscreen over the board footprint and press firmly using a soft flat surface that could be a book. Do not apply excessive force with the fingertips in any location of the touchscreen.

7.3 Connect the LCD Flat Cable

Remove the liner from the double sided tape attached to the flat cable but first align the cable with the connector and then gently press over the tape area. Finally proceed to insert the cable in the connector as shown in Figure 37.

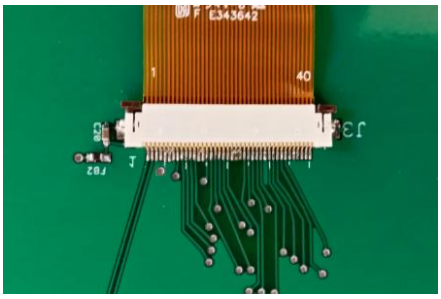

Figure 37 LCD Flat Cable Connection

7.4 Connect the Touchscreen Flat Ribbon Cable

Remove the liner from the double sided tape attached to the flat cable but first align the cable with the connector and then gently press over the tape area. Finally proceed to insert the cable in the connector as shown in Figure 38.

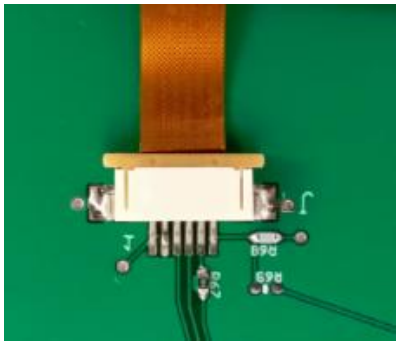

Figure 38 Touchscreen Flat Cable Connection

8 Install the Wi-Fi Module

Insert the Wi-Fi USB module into the BeagleBone's USB Host connector as shown in Figure 39.

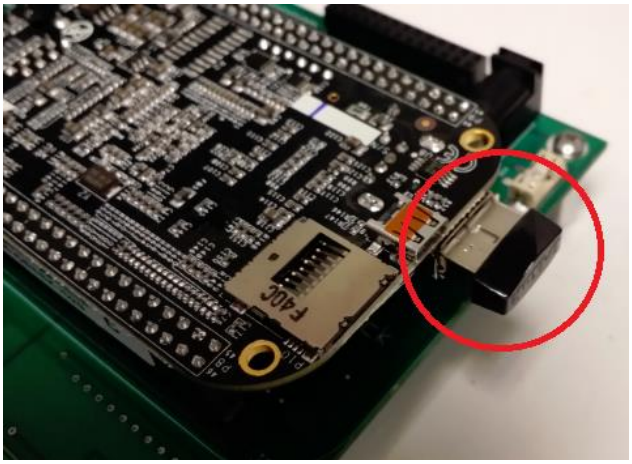

Figure 39 Wi-Fi Module Connection

9 BeagleBone's eMMC Programming

9.1 eMMC Programming

Use the Hermes Platform SD card to program the onboard eMMC. This is the card that was prepared with the production image and that it is going to be shipped as part of the Hermes kit. Place the SD card into the BeagleBone's card reader as shown in Figure 40.

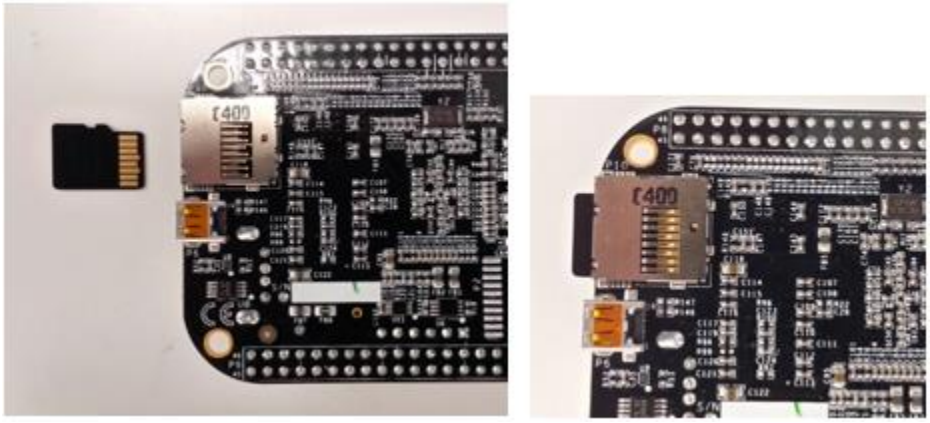

Figure 40 SD Card Connection to the BeagleBone

Connect the power adapter and after a few seconds the BeagleBone's LEDs will begin blinking right to left and left to right continuously for about fourteen minutes. At the end of this process the BeagleBone will turn off itself and it will turn off all the LEDs. At this moment it is safe to disconnect the power adapter and remove the SD Card.

If the LEDs don't start flashing from left to right and right to left continuously within a minute after applying power it means that something is wrong. It is probably a faulty BeagleBone module. In this case turn the Hermes board off by pressing the power button (S1) continuously for about ten seconds until all LEDs turn off. At this moment it is safe to disconnect the power adapter and remove the SD card.

9.2 SD Card Packaging

Place the SD card back into its original plastic container. Then slide the plastic container into its original cardboard package. This package will be placed inside the box containing the final product.

9.3 eMMC Programming Verification

Connect the power adapter to the Hermes board. Then wait about ten minutes for the Linux Debian screen to show up as shown in Figure 41. Make sure the Hermes icon is present in the top left side of the screen.

Figure 41 BeagleBone Black Initial Screen

9.3.1 Wi-Fi Operation Verification

Open the Wicd Network Manager using the launching icon shown in Figure 42. Then verify that the nearby Wi-Fi networks show up in the list as shown in Figure 43.

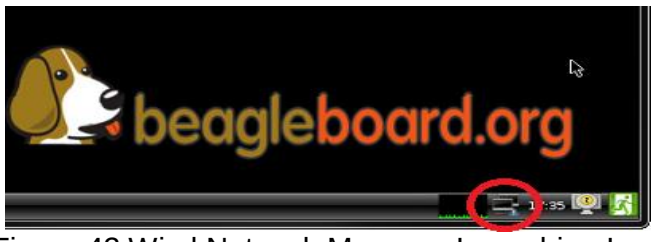

Figure 42 Wicd Network Manager Launching Icon

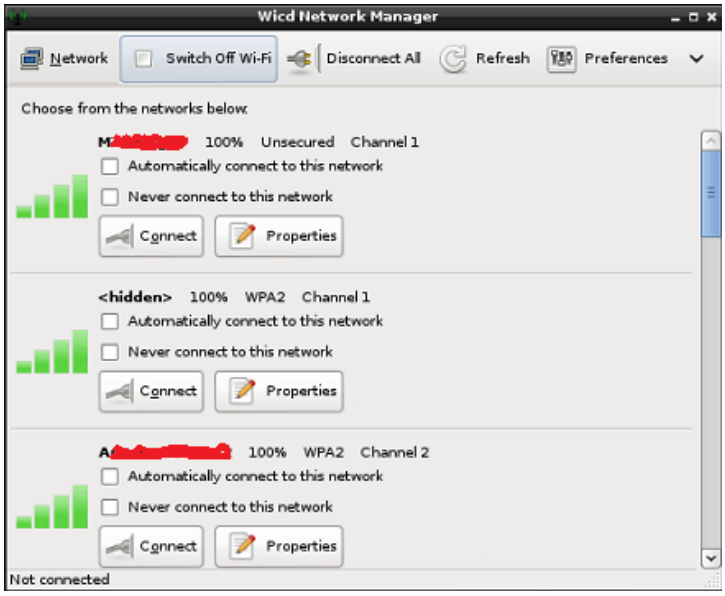

Figure 43 Wicd Network Manager

Keep the power on if the next operation is the Tag Reader Firmware Programming. Otherwise turn the power off by pressing the power button (S1) or through the GUI using the Logout LXDE Session dialog that can be launched using the icon in the lower left corner of the screen as shown in Figure 44. Then press the **Shutdown** button.

Figure 44 Logout LXDE Session Dialog Launcher Icon

10 Tag Reader Firmware Programming

For this procedure use the PICkit-3 Programmer provided by RFMicron. If there is need to prepare a new PICkit-3 Programmer then follow the instructions from the documentation located at: https://github.com/RFMicron/Hermes/tree/master/SoftwareDocs.

Connect the programmer to a USB power source. Ensure that the “Power” LED is on. The “Active” LED blinks once to indicate the unit is in Programmer-To-Go mode and ready to program. Launch the Hermes Demo application so that power is applied to the Reader. When the Reader is on, the blue LED on the Reader’s board is on. Connect the programmer to the J40 header of the Hermes board as shown in Figure 45 and make sure the pins are aligned as shown in Figure 46. Press the programmer’s push button to begin programming. During the programming operation, the programmer “Status” LED will turn

Figure 45 PICkit-3 Programmer Connection

orange and remain lit continuously while the operation takes place. When the programming operation is complete, the programmer will provide feedback on the operation via the unit's LEDs. A green "Status" LED indicates a successful operation. Red indicates a programming failure. See Microchip's PICkit-3 Programmer/Debugger User's Guide for feedback codes.

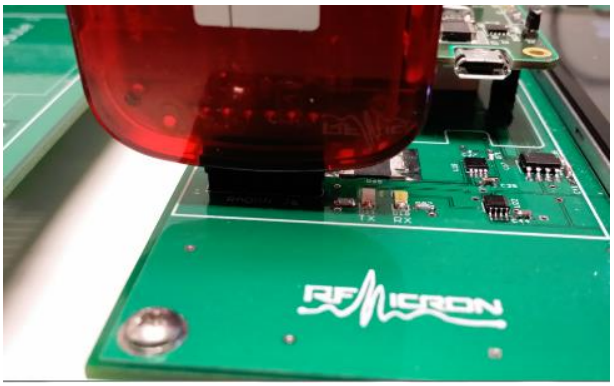

Figure 46 PICkit-3 Programmer Pin Alignment

11 Final Jumper Settings

Table 1 specifies the default jumper settings and Figure 47 shows their location in the board.

Table 1 Default Jumper Settings

Connector(s)	Jumper Settings
J10, J25, J38	Jumper between pin 1 and the other position floating
J15	Jumper between pin 2 and the other position floating

	Jumper between pin 4 and the other position floating Jumper between pin 6 and the other position floating
J16, J35	Jumper between pin 3 and the other position floating Jumper between pin 4 and the other position floating
J22, J23, J24	Jumper between pin J22-1 and J23-1 Jumper between pin J22-2 and J23-2 Jumper between pin J22-3 and J23-3
J28	Jumper between pin 1 and the other position floating Jumper between pin 3 and the other position floating Jumper between pin 5 and the other position floating Jumper between pin 7 and the other position floating
J36	Jumper between pin 2 and pin 3
J41	Jumper between pin 1 and the other position floating Jumper between pin 3 and the other position floating

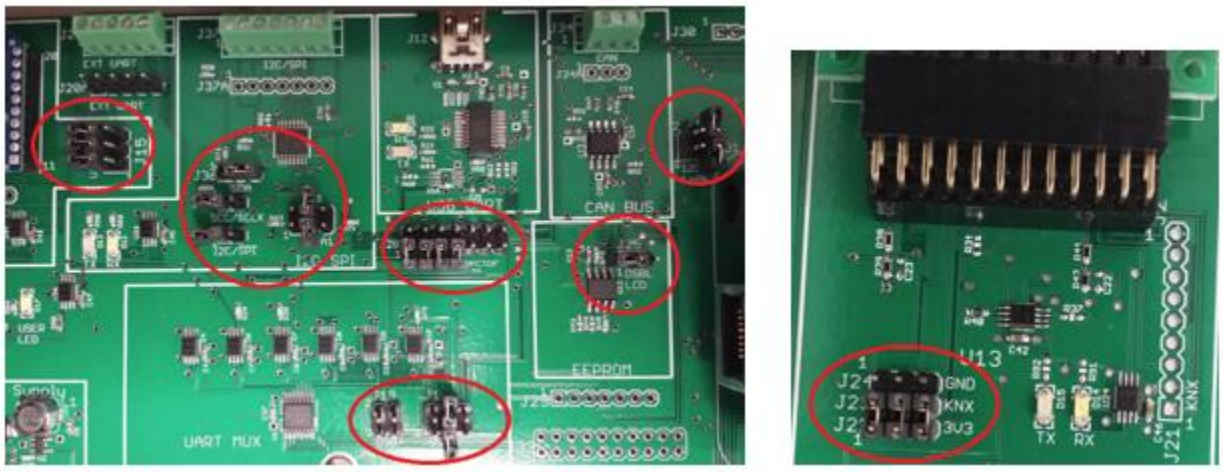

Figure 47 Default Jumper Settings

12 Packing

Follow the packing instructions.

13 Notices

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