ULE Starter Kit User's Manual

Revision 1.0

Document Objective: Instruct IoT device designers how to leverage the ULE Starter Kit to empower their low-power sensor and control applications with ULE wireless connectivity

Revision History

Revision	Date	Author	Description
1.0	June 2015	Levi	Baseline Release

Table Of Contents

1. Introduction

1.1 Other Documents

A. DHX91 DHAN Module Data Sheet (Downloadable from DSP Group Website)
B. HAN-FUN Protocol (Downloadable from www.ulealliance.org)

1.2 Target Audience

The Starter Kit and this User's Manual are targeting those customers familiar with running IoT applications on a particular microcontroller (with a spare UART Interface!) and now are interested in adding ULE wireless connectivity capability via the DHAN module. That said, the DHAN module can be used for standalone (single-processor) applications and also can interface with an external microcontroller via I^2C or SPI interfaces. If any of these use cases interest you, please don't hesitate to contact DSP Group at the link shown below. "Ditto" for those interested in developing new ULE Controller or Gateway devices. We can get you started with these applications as well!

http://www.dspg.com/dhan-module/

1.3 Starter Kit Basics: A bit about DECT-ULE

DECT-ULE uses a star topology. Each DECT-ULE system contains only one device at the hub of the star. This hub is typically the gateway to the WAN. In DECT cordless this hub is called the Base Station. In the IoT context, the hub is called a ULE Controller. The points of the star are traditional DECT cordless handsets and ULE Nodes or Devices – they can be integrated into a single system. Thousands of ULE Devices can be associated with a single ULE Controller.

This Starter Kit incorporates a ULE Controller (BS Device) and a ULE Node (Device). The ULE Controller includes a graphical interface for control and status reporting. It does not provide a means to connect to the WAN. The Starter Kit promotes development of ULE Node applications per the ULE Standard. Once completed and certified, your ULE Node can operate in any setting within range of a certified ULE Controller. The ULE Controller is a common element in many gateways and over-the-top boxes that populate our homes and offices.

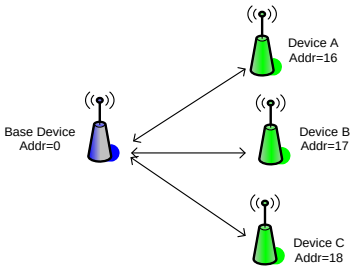


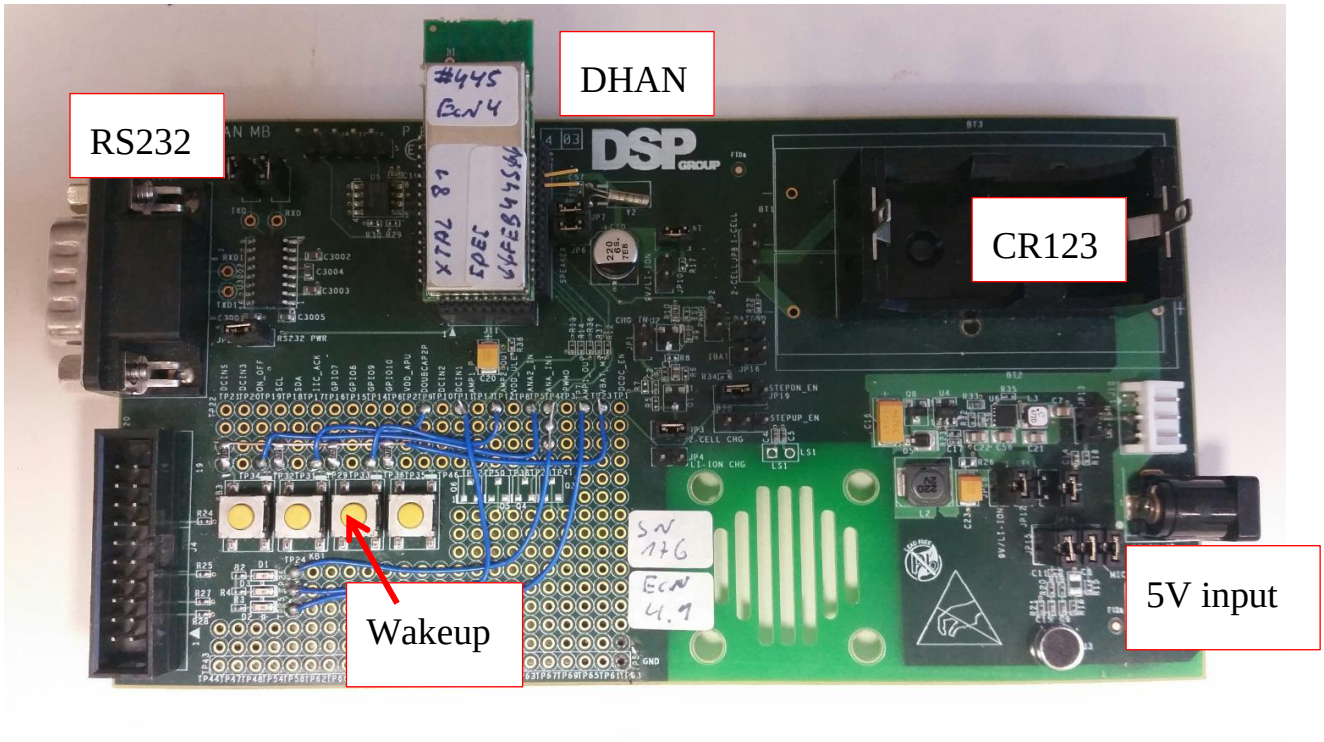
Figure 1-1: Star Topology

1.4 Starter Kit Hardware

1.4.1 DHX91 EVB (= ULE Node)

The DHX91 EVB includes a DHAN Module (a custom version with printed antenna), several push buttons, LEDs and access to vital IO pins that facilitate simple application emulation. The EVB can be powered using the AC transformer outputting 5V (supplied with the Kit) or using a CR123A battery. The EVB is delivered configured for this latter case. See the jumper configuration below for both cases. It is suggested to initially power up the EVB with a 3V power supply clipped to the battery holder to get feedback regarding the current drain.

The EVB can function as a standalone demo device (Step 1 below) or as a development tool to be interfaced via RS232 to a PC (Step 2 below) or via UART to an external controller (Step 3 below).

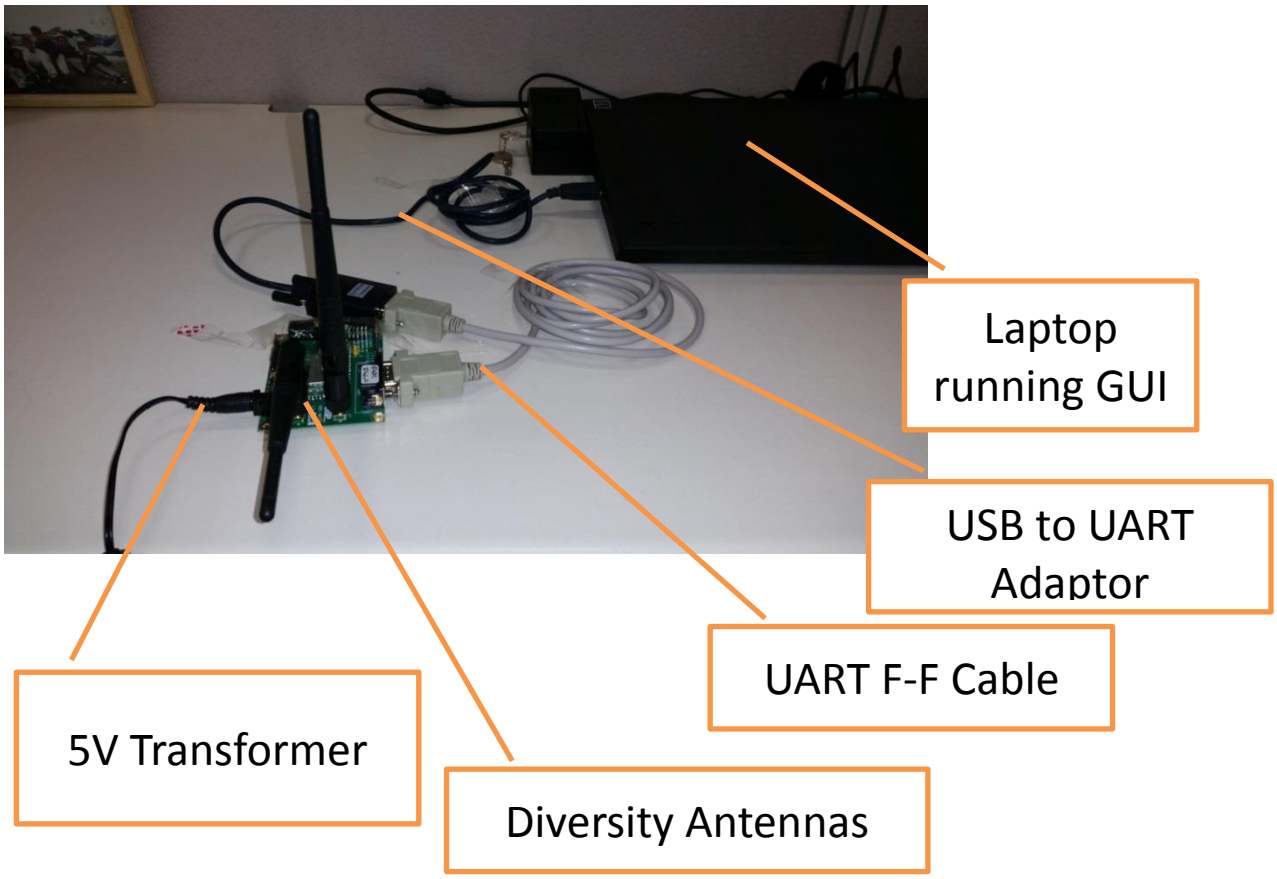


	CR123A	5V
JP3	ON	OFF
JP4	OFF	ON
JP5	ON	OFF
JP8	OFF	OFF
JP10	OFF	ON
JP11	ON	ON
JP12	OFF	OFF
JP13	OFF	OFF
JP18	OFF	ON
JP19	OFF	Left position
JP20	OFF	OFF

1.4.2 DCX81 CMBS UART (= ULE Controller)

This platform includes the DCX81 CMBS Module mounted on a ULE Controller motherboard. It is powered by the AC transformer supplied with the Kit. The Kit includes 2 antennas which are threaded on to the SMA connectors, and positioned as shown in the photo below. The connection between the Controller RS232 (UART I/F) connector and the PC USB port is also shown below.

The driver for the ST Lab adaptor (included in the Kit) usually loads on its own when it is plugged into the PC. If not, it can be copied from the CD included in the Kit. Once the driver is loaded you should be able to see a COM port opened in your PC Device Manager. You should note the COM port value as you will need it to run the DSPG Test Application SW which you have downloaded.



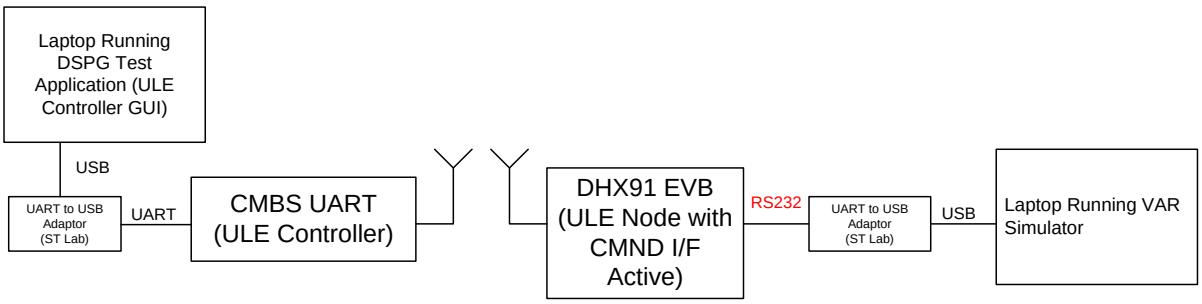
1.5 Starter Kit SW Tools (Downloaded from the website)

- VarCmndSimulatorSetup.msi – Installer for the GUI communicating (via USB/UART path) with the DHX91 ULE Node
- DSPG Test Application.exe – GUI for communicating (via USB/UART path) with the ULE CMBS Controller

2. Get your application up and running with ULE

Working through the steps below will enable the User to get an ULE Node application with basic ULE connectivity up and running. This section provides an overview of the 3 steps, with following sections elaborating Steps 1 and 2.

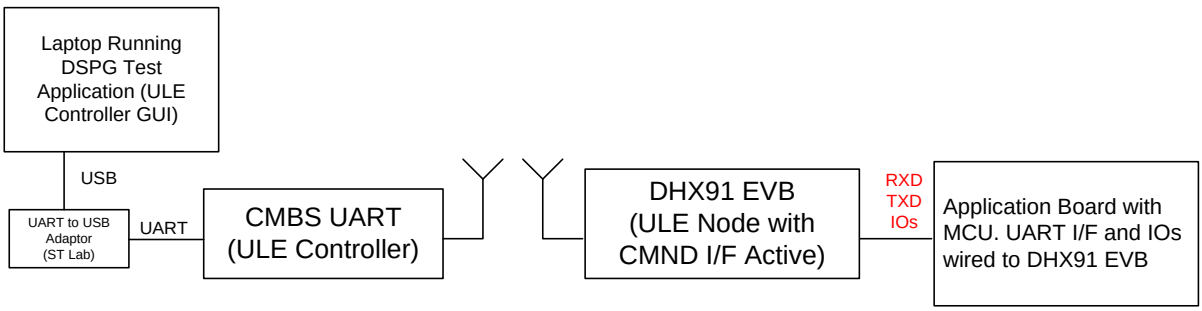
2.1 Step 1: ULE Node with the DHX91 ULE EVB & VAR Simulation Tool



Here the ULE Node application is running on the PC using the VAR simulator you have downloaded. (Note: Both sides of the link can run on the same computer). In this setup the User will learn how to:

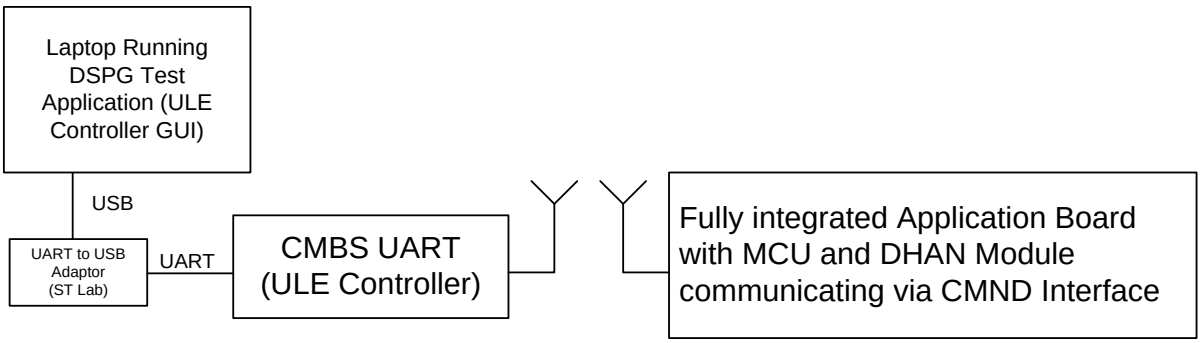
- Install and run VAR simulator on the Node side and the Controller GUI simulator on the Controller side
- Register the ULE Node, modify the operating frequency to comply with local regulations
- Use the VAR simulator to trigger events and send maintenance messages (=Keep Alive) that can be monitored at the Controller GUI
- Copy the basic transactions at the CMND I/F so that they can easily be transplanted from the simulator to the code running on the User's application MCU.

2.2 Step 2: ULE Node with the DHX91 ULE EVB wired to your MCU



ULE transactions have been embedded into the Application SW and their effectiveness can now be validated. User will be able to register (=pair) his ULE Node Application with the ULE Controller, send maintenance (= Keep Alive) and simple Alarm/Event messages, turn actuators ON-OFF, send battery and RSSI status over to the Controller.

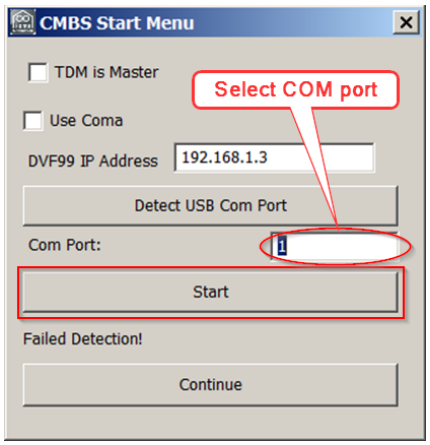
2.3 Step 3: ULE Node with DHAN Module mounted on your application



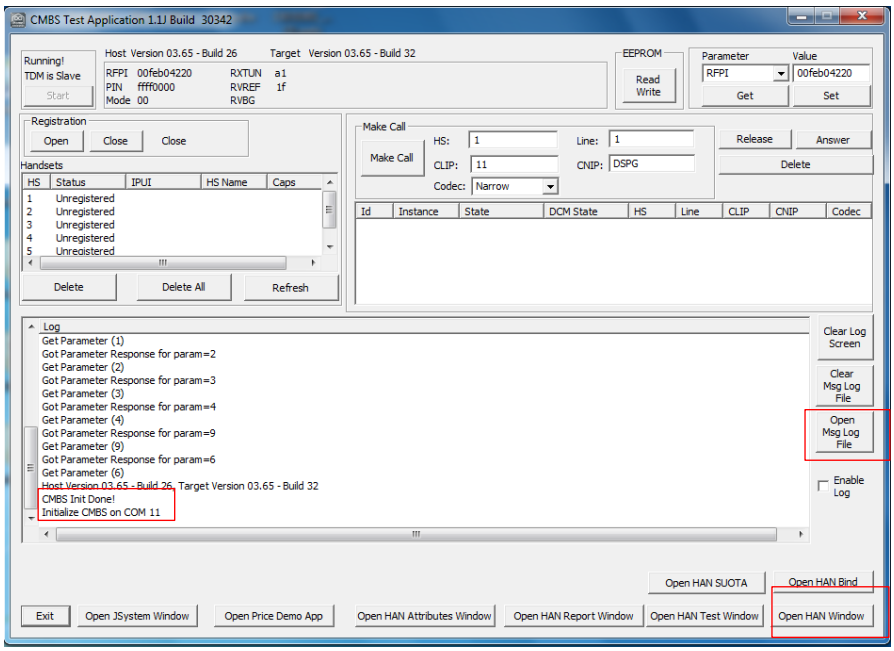
The User designs an application board which integrates a favorite MCU, sensors/switches, the DHAN module and a 2GHz antenna. Prior to designing this application board, the User should discuss application needs and constraints with DSP Group to insure that the application schematic is optimal as well as receiving the SW training and detailed documentation needed to create an full-fledged application.

3. Getting the ULE Controller Up and Running

After connecting the ULE Controller (= DCX81 CMBS UART) as depicted in a previous section (and confirming via your Device Manager that a new COM port is up and running!), you should run the DSPG Test Application executable you have downloaded. The window below will pop up and you should enter the appropriate value:

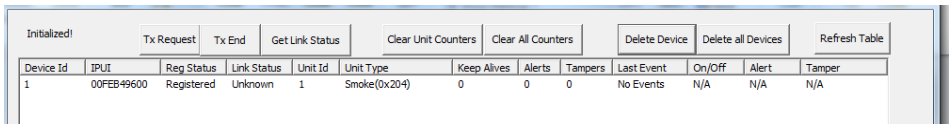


A Graphical User Interface will pop up as below and the log window should indicate that the initialization was successfully completed ("CMBS Init Done!).



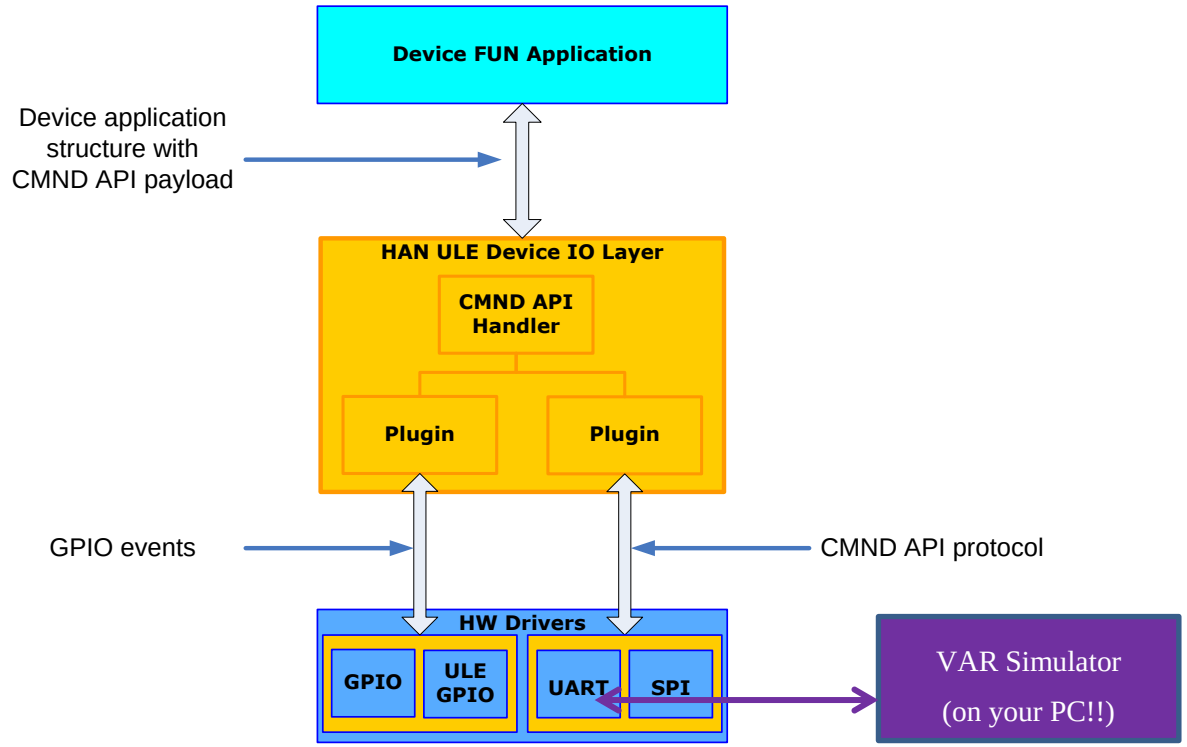
The log window shown above is an abbreviated version of the incoming/outgoing flow of information at the CMBS UART Interface. A more detailed (message) log is recorded in a file that can be opened from the button indicated above. This file is located in the same directory as the DSPG Test Application.exe file.

Click on the "Open HAN Window" button in the lower right and note that a "Smoke" device is registered to your Controller, as shown below. This is because the EVB ULE Node in your Starter Kit has already been registered to the ULE Controller and has been programmed as a Smoke device. A bit later you will delete this registration and can run through the pairing (=registration) exercise yourself!



4. Running the ULE Node using the VAR application

Time to get the ULE node up and running with the VAR simulator. This simulator converses with the UART Driver loaded in the DHAN module at an interface called the CMND API. The VAR simulates your MCU's communication with the CMND - so this is means to learn about this communication pipe as well as grasp the overall connectivity scheme of ULE.



4.1 Hardware Setup

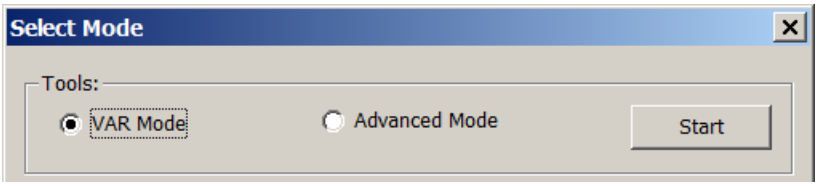
Power up the DHX91 ULE EVB. If you are using a Power Supply with metering, you should observe ~28mA. Now connect the EVB RS232 port to the PC USB port using the USB2UART Cable and UART2UART adaptor provided in the Starter Kit. As before, query your Windows Device Manager for the # of this added COM port!

4.2 Installing the VAR Simulator

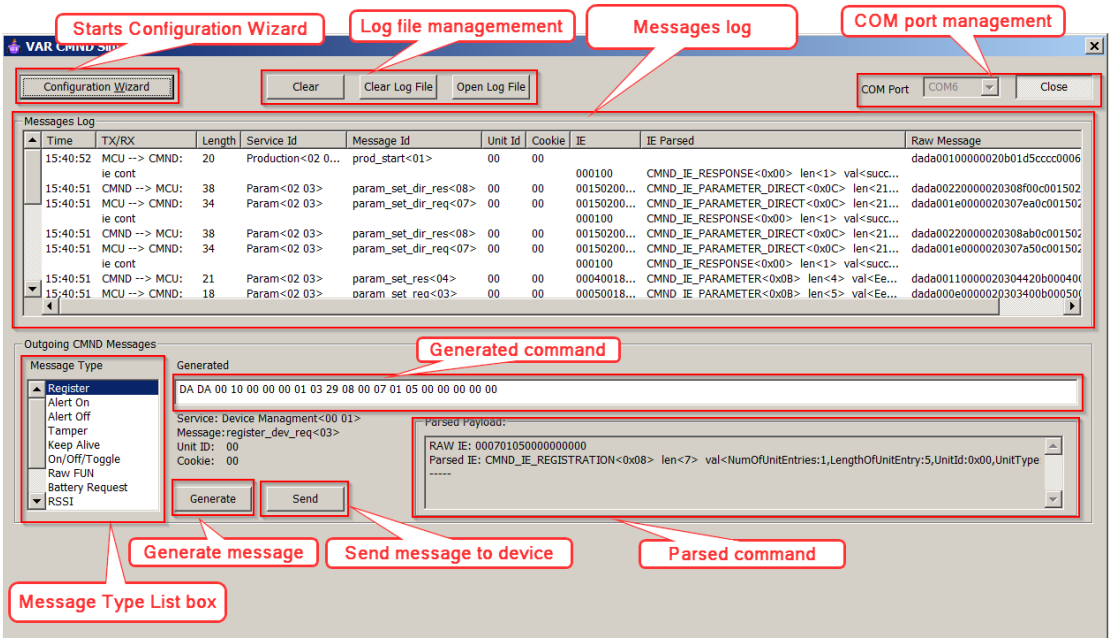
Run the VarCmndSimulatorSetup.msi and follow instructions to generate the VarCmndSimulator.exe file.

4.3 Running the VarCmndSimulator.exe

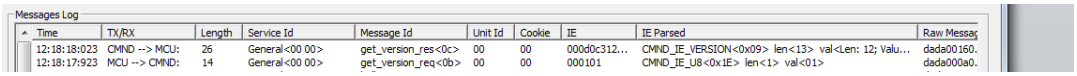
Run the VarCmndSimulator.exe file and choose the VAR Mode.



The window below will pop. Configure the COM port (upper right) with appropriate value and click "Open"



Go to the "Message Type" window, pull down "Get Version", hit "Generate Message" button then "Send". You should see the "req" and "resp" between the VAR (=MCU) and the DHAN (=CMND), as shown below.



NOTE: Please avoid running the Configuration Wizard (upper left). If this button is accidentally depressed, press Cancel and you will return to the Main Var window above.

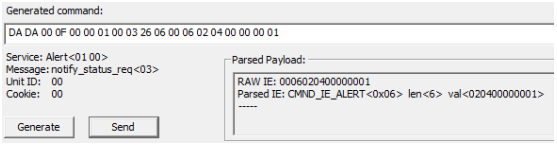
4.4 Messages from ULE Node to Controller

The Alert On, Alert Off, Tamper, Keep Alive, On/Off/Toggle, Raw Fun messages are all items that are sent over the link from the Node to the Controller. To send any of these messages you:

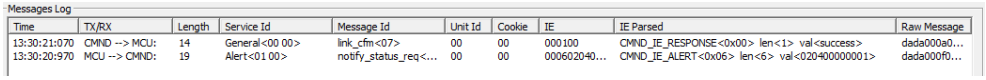
1) Select Message
2) Click Generate Button and note command generated
3) Press the Send button. This should generate an MCU < -- > CMND exchange in the VAR log window and an incoming message in the Controller GUI log window

Alert On example is shown below:

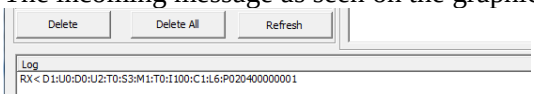
1) The command generated by the VAR



2) The MCU < --- > CMND exchange on the Node Side. The CMND informs the MCU that it received an ACK from the ULE Controller



3) The incoming message as seen on the graphical Log on the ULE Controller side:



4) The incoming message as seen parsed in the Log File on the ULE Controller side (This *.txt file is located in the same directory as the DSPG Test Application.exe file):

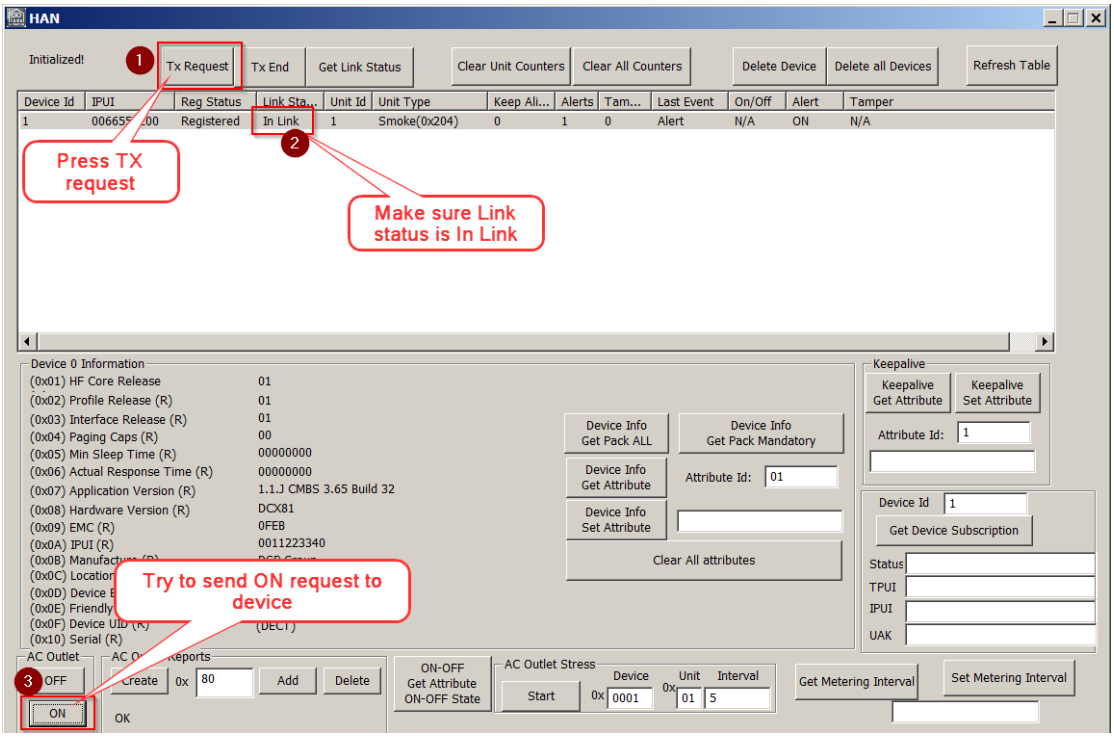
```
28-05-2015  13:40:03:607 (1432809603607)
Target ---> Host:   29 00 00 00 16 30 21 00 00 30 17 00 01 00 00 00 00 02 00 00 00 03 01 00 00 01
01 06 00 02 04 00 00 00 01 00 0F 02 00 A5 FC
{CMBS_EV_DSR_HAN_MSG_RECV(12310)}
  <CMBS_IE_HAN_MSG(12288)>:
    Src: (type = 0, dev_id = 1, un_id = 0)
    Dst: (type = 0, dev_id = 0, un_id = 2)
    Transport : 0
    Msg Sequence : 3, Message Type : 1
    IF Type : 0, IF Id : 0x100, IF Member : 1
    Data Len: 6
     2    4    0    0    0    1
```

Alert Off, Tamper, Keep Alive, On/Off/Toggle work similarly to the example above.

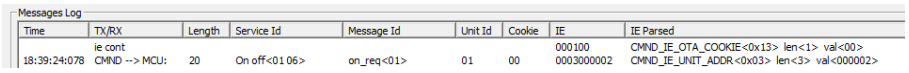
4.5 Messages from the ULE Controller to the ULE Node

To send a message from the Controller to the Node:

1) Press the Tx Request button on upper left in HAN Window of Controller GUI. You should observe Link Status as "Requesting".
2) Now you need to wake up the ULE Node and have it respond to this Link Request by triggering an event from the VAR simulator (eg Keep Alive, Tamper, Alert). You will see the Link Status on the ULE Controller change to "In Link". The ULE Node is now available for an incoming message from the Controller
3) Let's pretend that the ULE Node is an AC Outlet and send it an ON command from the Controller GUI, HAN Window (Lower Left as shown below)



4) Now check the VAR Log window and you will notice the report of an incoming ON message:



4.6 Place the ULE Node in Hibernate and Wake it Up

The ULE Node has several options (configurable via EEPROM) for entering and exiting hibernation. The Node in your Starter Kit has been configured to enter hibernation upon command from the MCU (the SLEEP message in the VAR window) and exit via the Wakeup button (AMP_OUT2 from the DHAN) on the DHX91 EVB (see the photo in the earlier section). Let's try it!

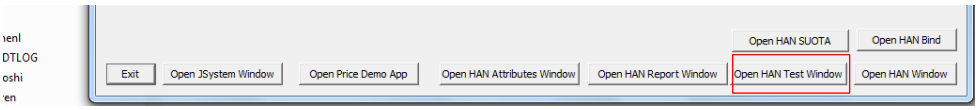
a) Prior to entering Sleep/Hibernate you see ~28mA on your Node Power Supply
b) Generate and Send the Sleep Command
c) You should drop down to ~4µA
d) Now hit the Wakeup Button and note the return to 28mA!

4.7 Changing the Frequency Band for your Region

Your Starter Kit has been shipped to you operating the European DECT Band (1880-1900MHz). In this section instructions are given to reconfigure your system to operate in the DECT band allocated by your local regulator:

Step 1: Steps 2-6 are for modifying the ULE Node Band setting. This setting will take effect upon powering down then up the Node.

Step 2: Go the ULE Controller GUI Main Window and Open HAN Test Window

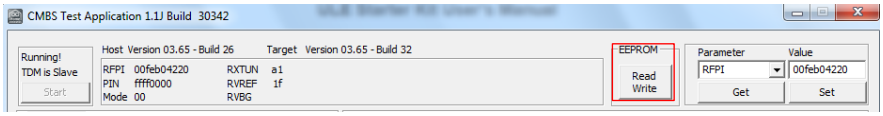


Step 3: Click the Tx Request Button in the HAN Test Window – Link Status should show "requested"

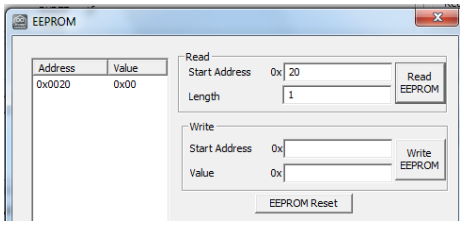
Step 4: Go the VAR Window and Send Tamper – Link Status in HAN Test Window should now indicate "In Link" – as shown below

Step 5: Enter Value Length and Start address, Value for your Region (see table below, example given is for transitioning to US) and hit "Set" button. Confirm change with the Get button. Now power Down the Node

Step 6: Now for the ULE Controller Side. Close the HAN Test Window and return to the Main Window and Click on the EEPROM Read/Write button at upper right



Step 7: You will get the EU value of 0x00. Now go to Write section and enter 0x20 for Start Adress and Value of region – 0x01 in case of the US. Hit the Write EEPROM and Confirm change with the Read EEPROM. Power Down and Up the Controller



Step 8: Power Up the Node and send a Tamper message to the Controller. Confirm that it succeeds!!

4.7.1 Offset 0x204 (Node) and Offset 0x20 (Controller) Values for changing Frequency Band

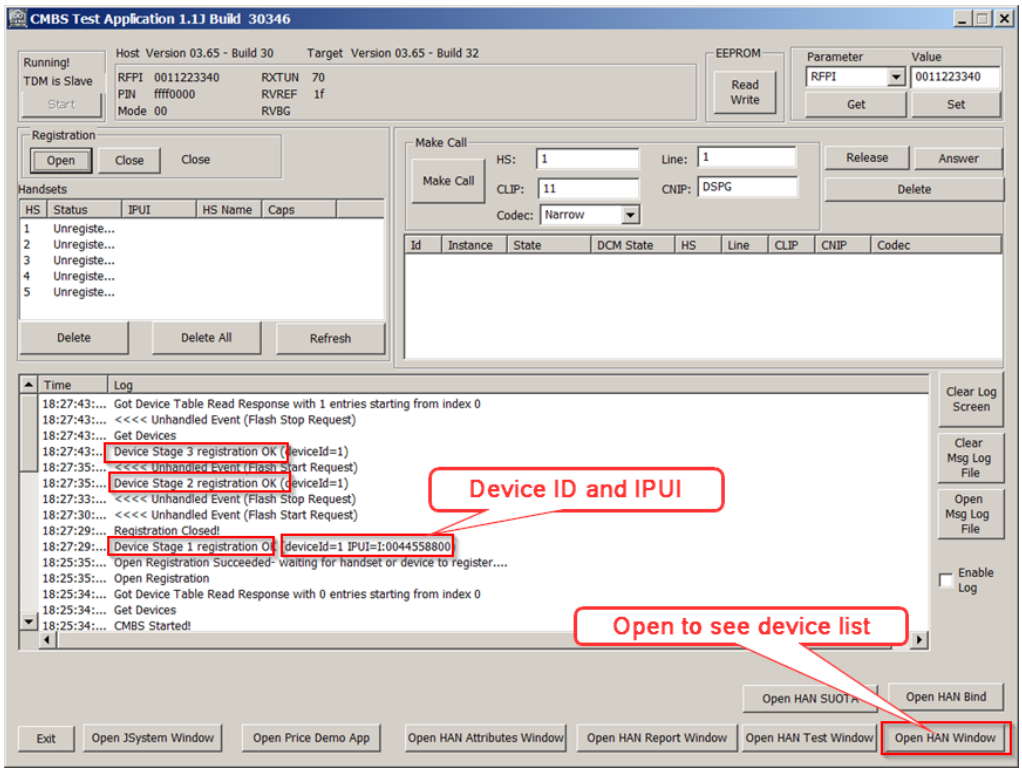
EU	Latin America	Korea	US (DECT6.0)	Thaiwan	Brazil	Japan	Argentina
0x0	0x7	0xB	0x1	0x9	0xE	0x12	0x8

Thiland							
0xF							

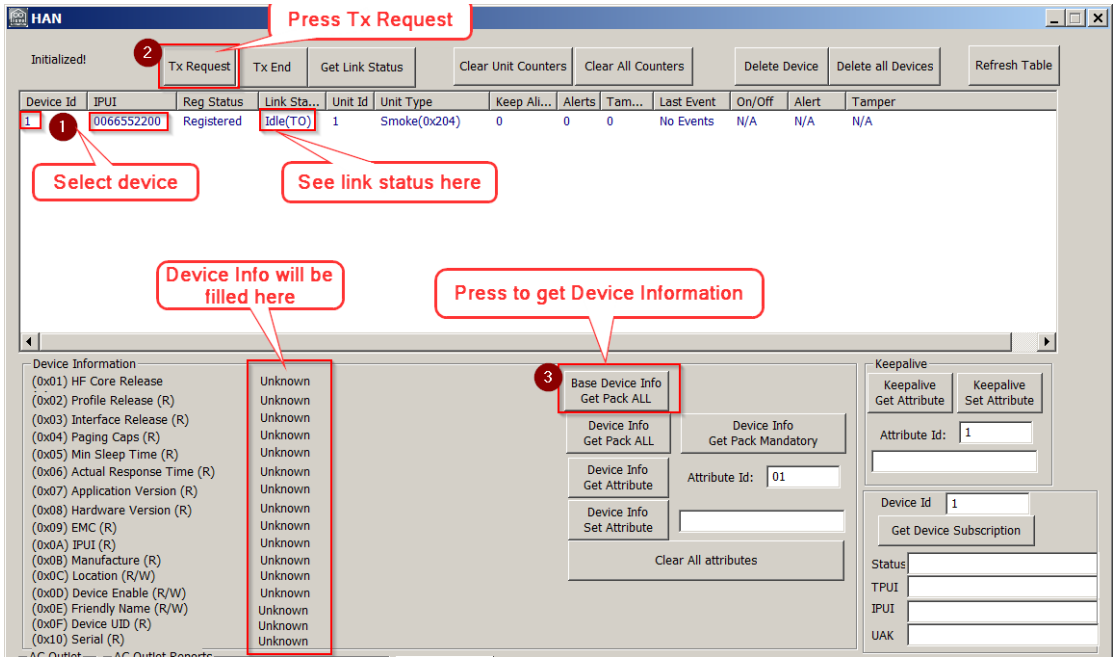
4.8 Registering the ULE Node to the ULE Controller

Ready to take some risk and De-register the ULE Node from the Controller and Re-register it?

a) Go to the ULE Controller HAN Window, select the Smoke Detector and hit the "Delete Device" button. The Smoke will now disappear from the list
b) Power down the ULE Node (you can leave the VAR running!!). Power Back On!!
c) Go the VAR simulator on the Node side, generate and send the Registration Command
d) Go the Controller side and press Open in the Registration window on the upper left
e) Note the 3-Stages of the registration process scroll in the Controller Log



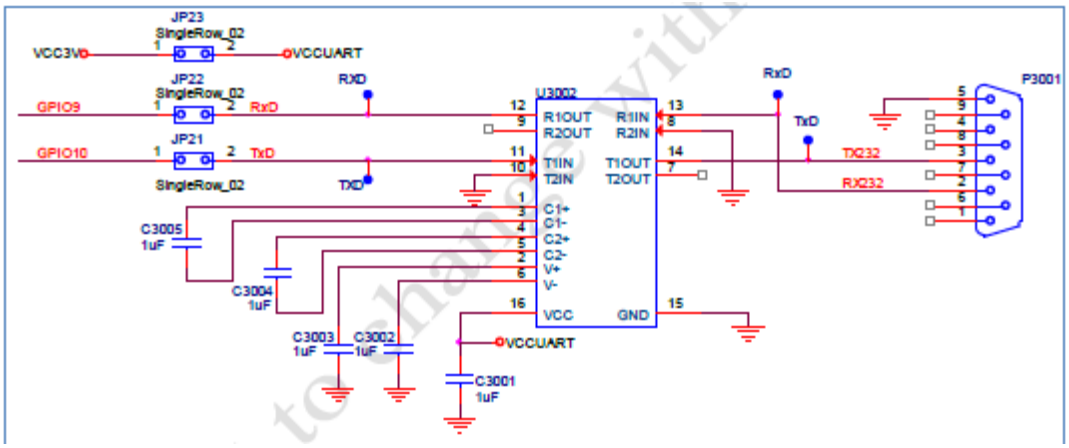
To see list of devices press Open HAN window button.



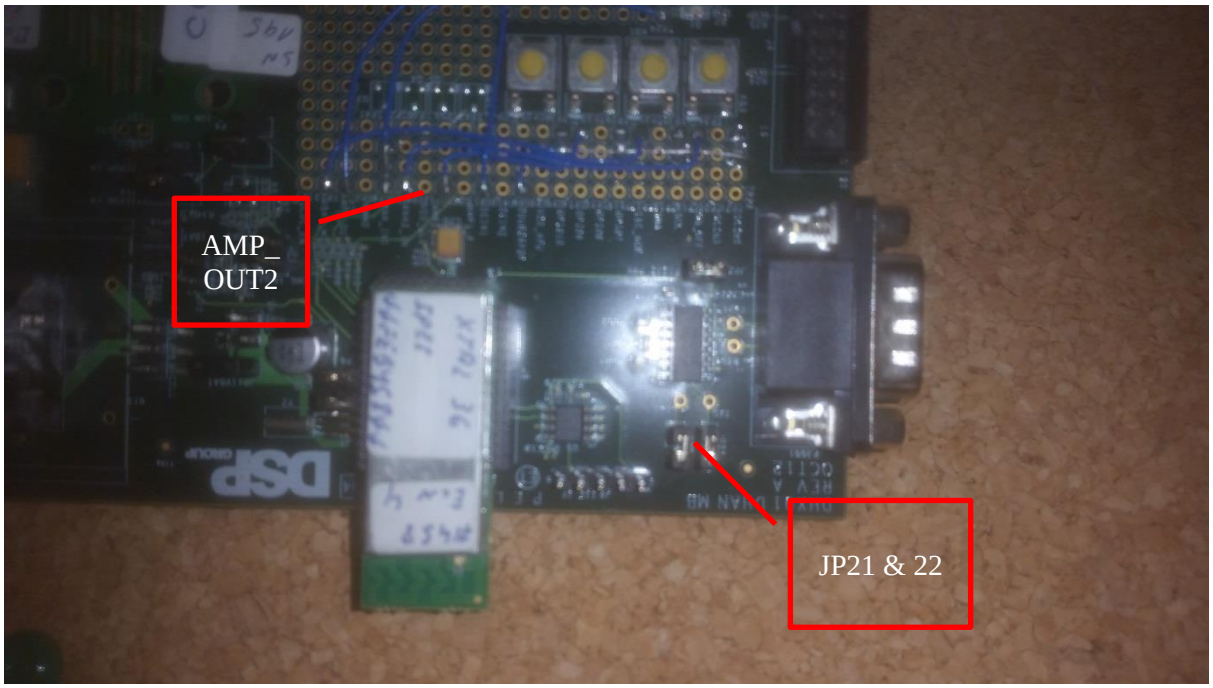
5. Interfacing the DHX91 EVB ULE Node to your MCU

Now you are ready to drive the ULE Node with YOUR MCU. You will need to bypass the RS232 connector and IC on the EVB and configure your UART driver for appropriate protocol – both described below. You can also reconnect the AMP2_OUT from the Wakeup Button and connect to an IO from your MCU for triggering wakeup of the ULE Node.

5.1 UART connection on the DHX91 EVB



Remove JP21,22 and connect RxD and TxD from external MCU to GPIO9 and GPIO10



5.2 Configuration of UART Communication

UART protocol settings are as follows:

- Baud rate: 115200K bps (configurable)
- Data: 8 bit
- Parity bit: None
- Stop bit: 1 bit
- Network byte order: Big Endian

Flow control: Enable/Disable (at compilation time, optional). Recovery from message loss should be done in higher layers.

5.3 IO, Push Button and LED Schematic of DHX91 EVB

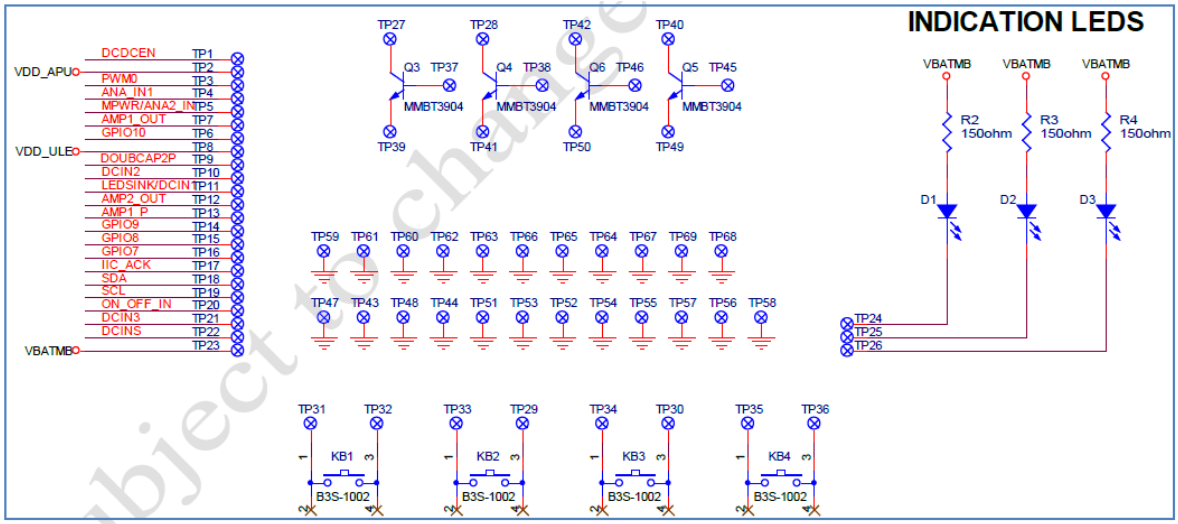


Figure 2-14: Development Area

5.4 Modifying the Application SW for ULE

By cutting and pasting the commands (into your App SW) from the VAR "Generate" window (shown once again below) you should be able to repeat all the connectivity exercises from the previous section, this time with your MCU in control!