XMC4500 USB Host Virtual COM Port (VCOM) Example

Getting Started V1.0

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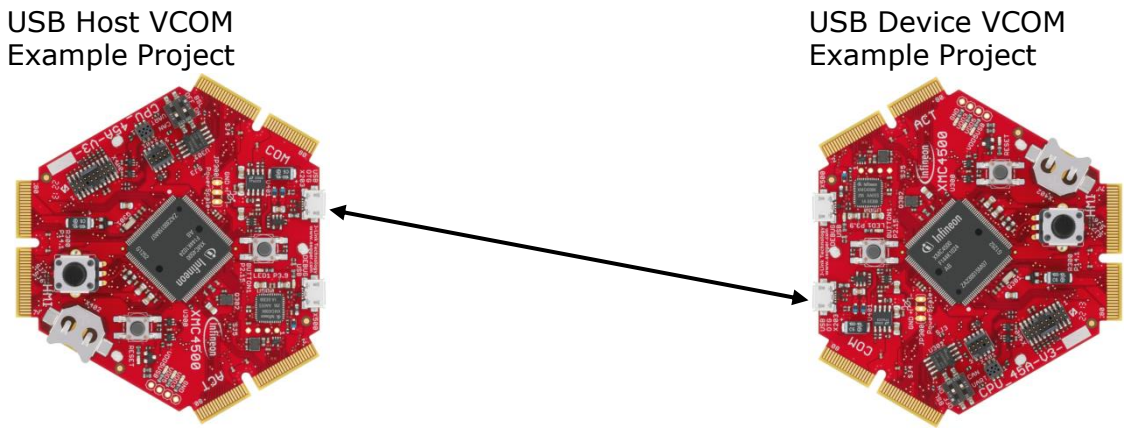
Overview



- This example demonstrates the implementation of USB host virtual COM (VCOM) port functionality. It is based on the free LUFA USB host stack implementation which is ported to XMC4500 family and provided within this example.
- Within this documentation you will be guided through all the building blocks of a typical USB host VCOM application on the XMC4500 family. You will be able to connect a VCOM device to the host and perform data transfers access to and from the device.
- As a result you will be enabled to implement your own USB host VCOM functionality on the XMC4500 family.

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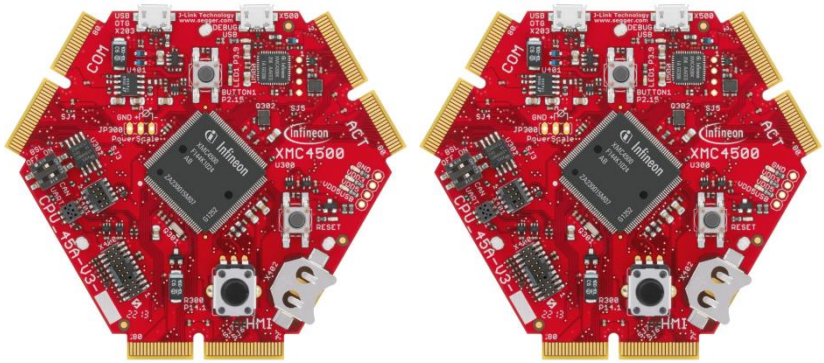
Requirements - hardware



Two XMC4500 General Purpose CPU_45A-V3 boards

- One will behave as a USB host and another will behave as a USB device



USB cable micro-A plug to micro-B plug for host example



USB cable micro-B plug to standard-A plug for debugging and serial port terminal

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Requirements – hardware and software



- Windows laptop
- DAVE™ installed

- DAVE ™ (v4.1.4 or Higher, usage of latest version is recommended)
- Download DAVE™ free of charge

  Link : DAVE™ 4 Download
- Download USB device VCOM app from DAVE™
- Serial port terminal software like Tera Term

  Link : http://ttssh2.osdn.jp/

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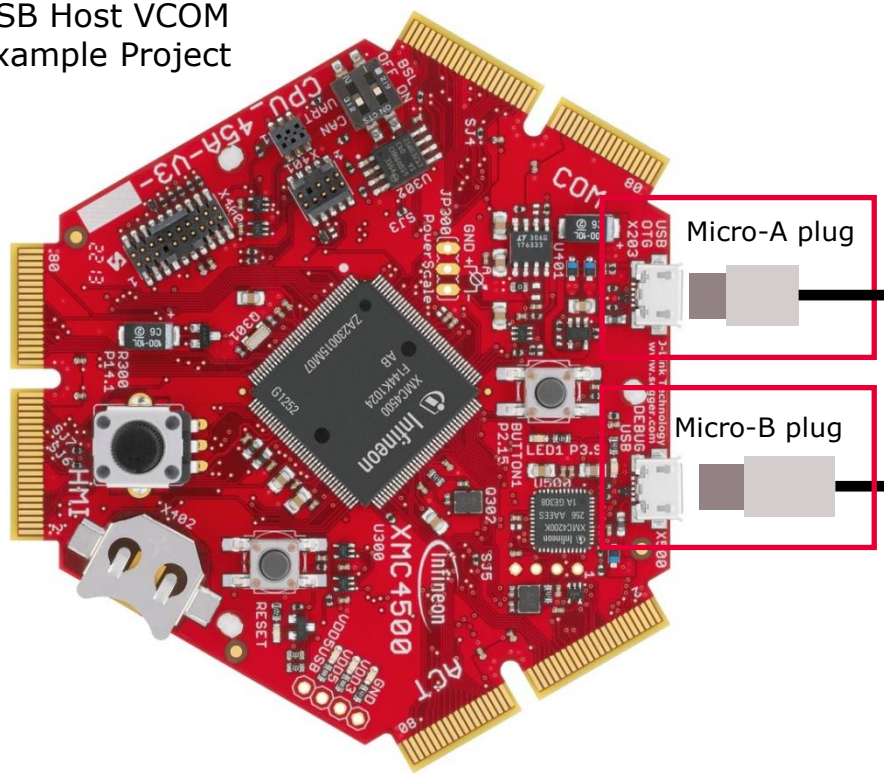
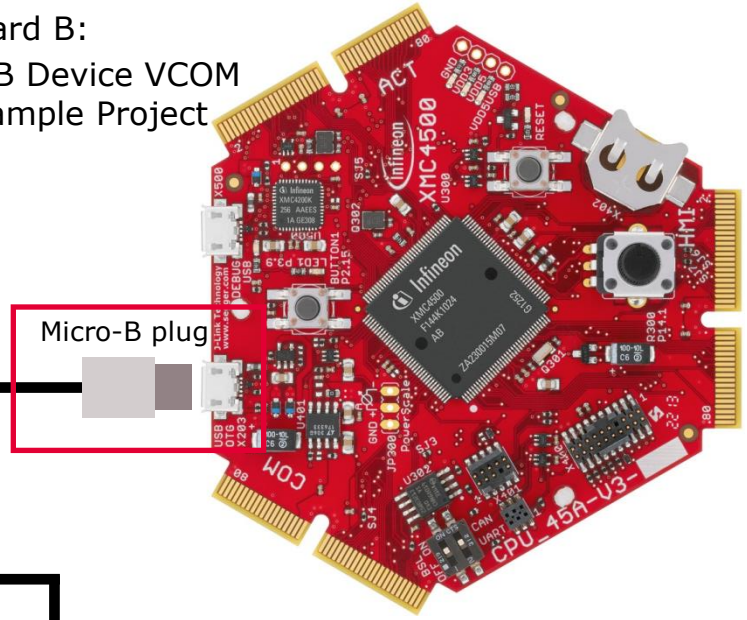
Setup - hardware

Board A:
USB Host VCOM
Example Project



Board B:
USB Device VCOM
Example Project



Std-A plug

Windows laptop running DAVE™ and serial communication terminal



- Ensure proper cable types
- Connect cables to the correct ports

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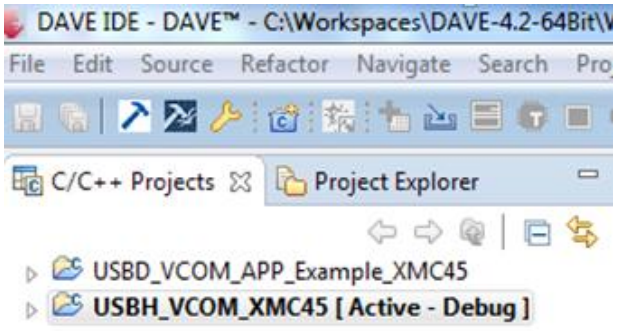
Setup - software



- To successfully run this USB HOST VCOM Demo a second XMC4500 CPU board (Board B) is required.
- This board has to be programmed with the flash image created form the USBD_VCOM_APP_Example_XMC45 project *)
  - This example can also be downloaded/ imported from the DAVE example repository via DAVE or from this web site; use key word "VCOM_Device"
- Your DAVE workspace should include the two projects as shown left
- USBD_VCOM_APP_Example_XMC45 project needs to programmed into board B using the DAVE debugger or any other Flash tool

*) following other example projects and related boards can be used instead:

- USBLIB_VIRTUALSERIAL_XMC45 running on XMC4500 relax kit
- USBD_VCOM_XMC47 running on XMC4700 relax kit

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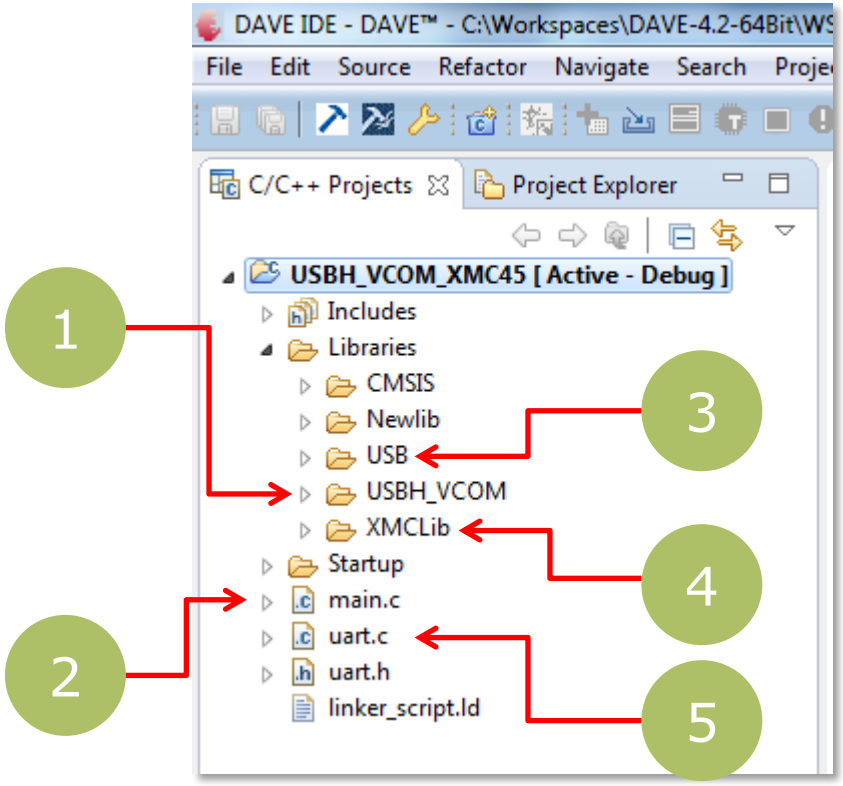
Folder structure of the USB Host VCOM demo project: USBH_VCOM_XMC45



1. VCOM application code implementing USB data transmit and receive
2. The main file implementing the application task and echo data on UART
3. Free LUFA USB stack, CDC-ACM class and glue layer for XMC low level driver
4. XMCLib folder contains USB low level driver in file xmc_usb.c
5. Code for redirecting data to UART

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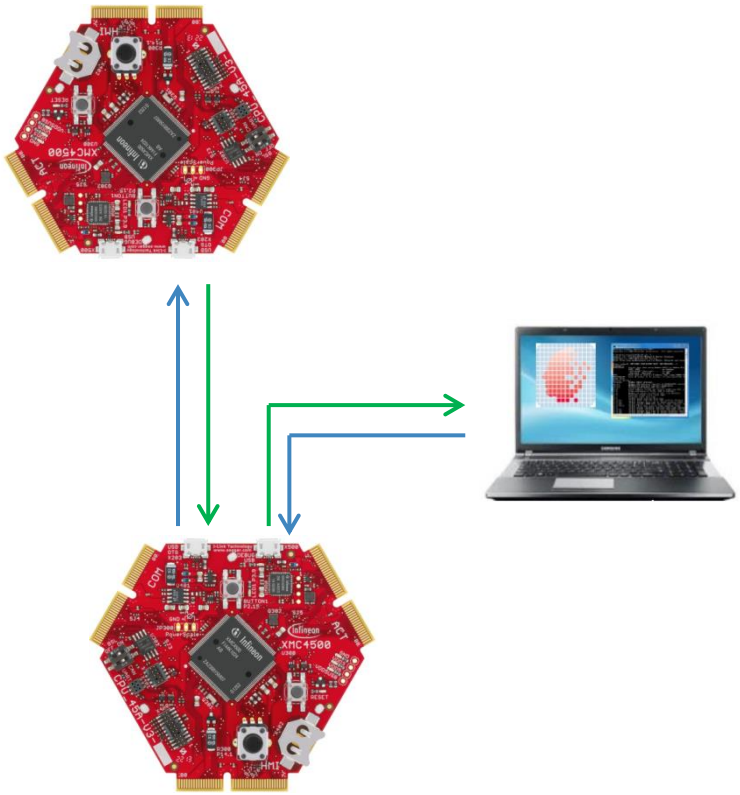
Example application behavior

Board B:
USB Device VCOM
Example Project



Board A:
USB Host VCOM Example Project
(Example application)

- Board A is initialized as a USB host and provides VBUS on the USB port. This board runs host VCOM software.
- Board B is initialized as USB device. This board runs VCOM device software.
- When successfully enumerated, USB host recognizes the connected device as a CDC-ACM capable device (VCOM)
- First, Board A -USB host- receives data from Windows laptop (via the VCOM channel of the debugger) running serial terminal software like Tera Term; Board A sends data to the device XMC4500 of Board B
- Board B as USB device loops back the received data via the USB connection to Board A
- Board A loops back the date via the VCOM channel of the debugger to the PC ; the data is shown in the terminal software of the PC

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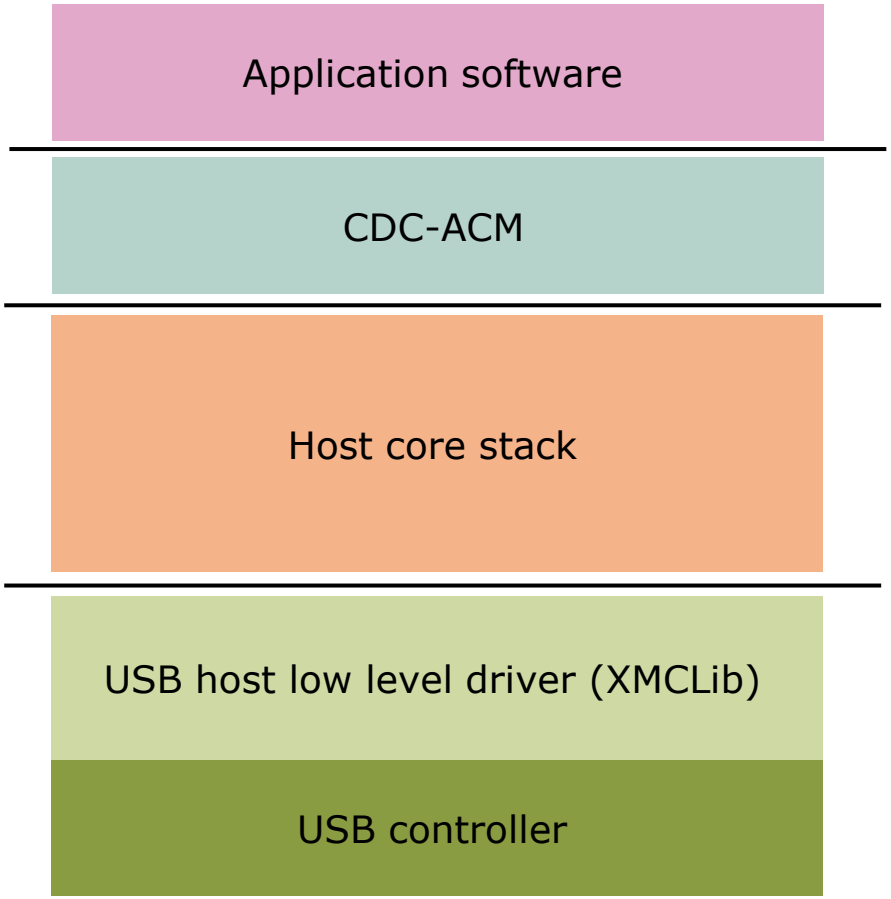
Simplified example application architecture



CDC_ACM send, receive data and notification interface

Bulk and interrupt pipe APIs

Low level driver based on USB host CMSIS API

USB stack and CDC-ACM sub-class implementation is based on a freely available stack known as LUFA

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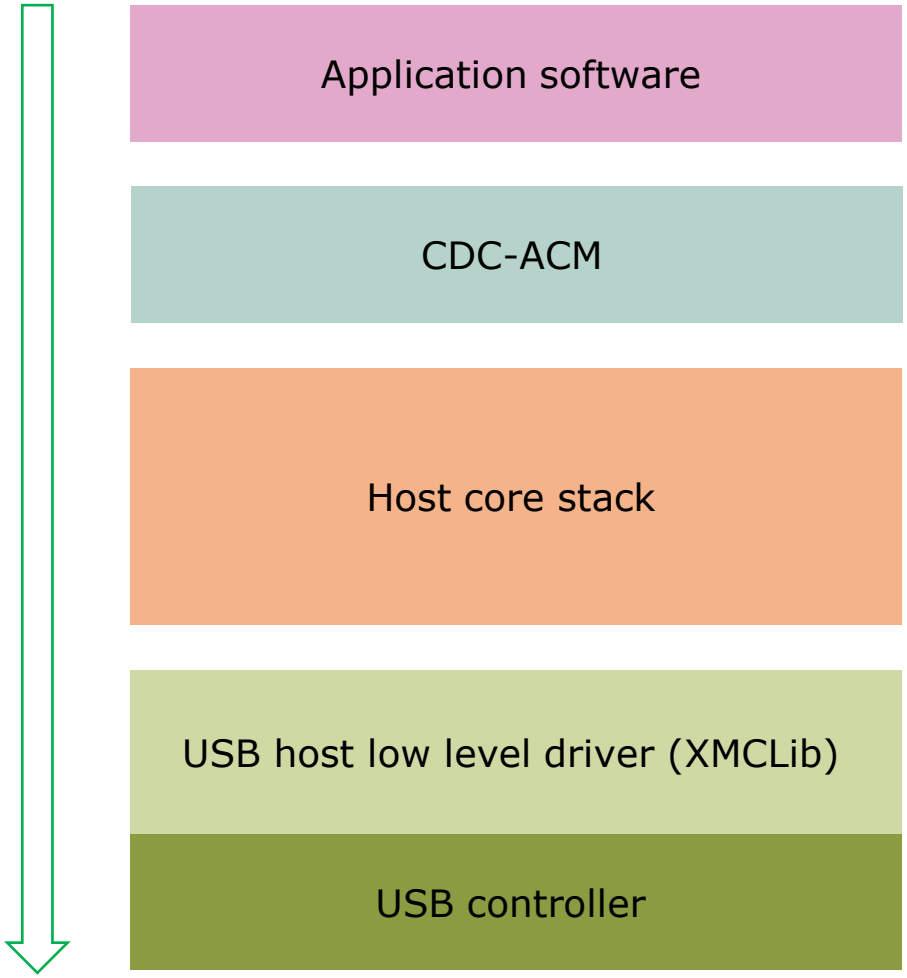
Example application data flow



Application software transfers byte received over UART to the CDC-ACM layer using send and receive APIs

CDC-ACM layer transfers the data to the host core stack. It also prepares to receive any notification messages on the interrupt endpoint

Host stack manages connections and enumeration. Provides mechanisms to transfers data through pipes

Low level driver based on USB host CMSIS API

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Application – overview of main.c

main.c

```
48  */
49 int main(void)
50 {
51   uint8_t USBHostState;
52   int8_t ReceivedByte;
53   uint8_t *RxPtr;
54   uint32_t Rxlen;
55   uint32_t uart_data_count;
56
57
58   /*Configure USB and CPU clocks*/
59   ClockSetup();
60   /*Initialize UART channel*/
61   UART_init();
62   /*Select VBUS pin as P3.2*/
63   XMC_USBH_Select_VBUS(XMC_GPIO_PORT3, 2U);
64   /* Initializes the USB host driver. */
65   USB_Init_Host(&USBVCH_CB);
66
67   /*LED pin to indicate USB status*/
68   XMC_GPIO_SetMode(XMC_GPIO_PORT3, 9, XMC_GPIO_MODE_OUTPUT_PUSH_PULL);
69   XMC_GPIO_SetOutputHigh(XMC_GPIO_PORT3, 9);
70
```

1

2

3

1 Clock setup for XMC4500

2 Select VBUS pin P3.2

3 Initialize USB host

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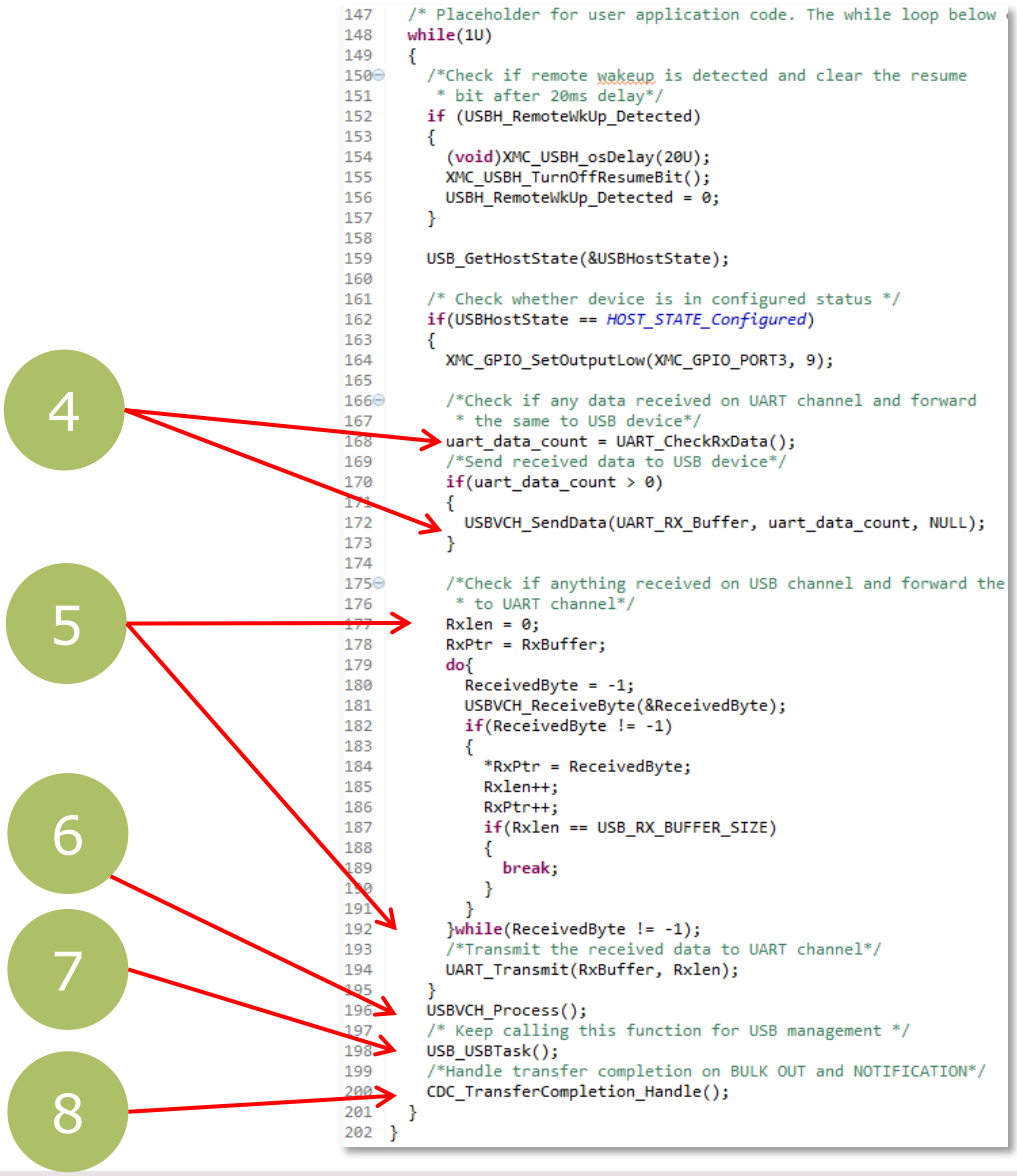
Application – overview of main.c




```
147   /* Placeholder for user application code. The while loop below
148   while(1U)
149   {
150     /*Check if remote wakeup is detected and clear the resume
151      * bit after 20ms delay*/
152     if (USBH_RemoteWkUp_Detected)
153     {
154       (void)XMC_USBH_osDelay(20U);
155       XMC_USBH_TurnOffResumeBit();
156       USBH_RemoteWkUp_Detected = 0;
157     }
158
159     USB_GetHostState(&USBHostState);
160
161     /* Check whether device is in configured status */
162     if(USBHostState == HOST_STATE_Configured)
163     {
164       XMC_GPIO_SetOutputLow(XMC_GPIO_PORT3, 9);
165
166       /*Check if any data received on UART channel and forward
167        * the same to USB device*/
168       uart_data_count = UART_CheckRxData();
169       /*Send received data to USB device*/
170       if(uart_data_count > 0)
171       {
172         USBVCH_SendData(UART_RX_Buffer, uart_data_count, NULL);
173       }
174
175       /*Check if anything received on USB channel and forward the
176        * to UART channel*/
177       Rxlen = 0;
178       RxPtr = RxBuffer;
179       do{
180         ReceivedByte = -1;
181         USBVCH_ReceiveByte(&ReceivedByte);
182         if(ReceivedByte != -1)
183         {
184           *RxPtr = ReceivedByte;
185           Rxlen++;
186           RxPtr++;
187           if(Rxlen == USB_RX_BUFFER_SIZE)
188           {
189             break;
190           }
191         }
192       }while(ReceivedByte != -1);
193       /*Transmit the received data to UART channel*/
194       UART_Transmit(RxBuffer, Rxlen);
195     }
196     USBVCH_Process();
197     /* Keep calling this function for USB management */
198     USB_USBTask();
199     /*Handle transfer completion on BULK OUT and NOTIFICATION*/
200     CDC_TransferCompletion_Handle();
201   }
202 }
```

4. Receive data from UART and send to USB
5. Receive data from USB and send to UART
6. Fetch descriptors and match it to CDC-ACM sub-class and start notification pipe and bulk IN pipe
7. Manage connection events and initiate enumeration
8. Manage transfer completion events

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Application – configure time delay API

- The USB stack uses timing delay of the order of several tens of milliseconds to comply with the specification
- Port the time delay API if required. In the example code, SysTick timer is used
- Ensure timer is calibrated

USB_Glue.c

```
622  uint8_t XMC_USBH_osDelay(uint32_t MS)
623  {
624    USBH_GLUE_StartTimer(MS);
625    while(USBH_GLUE_IsTimerRunning());
626
627    return 0;
628  }
```


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Application - callbacks

› Application registers for the following event callbacks

USB_Glue.h

```
106 /*Structure has members to interface the LUFA stack with
107  * class implementation and the application*/
108 typedef struct USBH_GLUE_APP_IF
109 {
110   USBH_Port_Event_Handler_cb PortEventHandler;        /*Callback function to be executed on
111                                                         occurance of a port event*/
112   USBH_Pipe_Event_Handler_cb PipeEventHandler;        /*Callback function to be executed on
113                                                         occurance of a pipe event*/
114   USBH_EnumerationComplete_cb EnumerationCompleteCb;  /*Callback function to be executed after
115                                                         device enumeration is complete*/
116   /*Following function pointers will be called from the implementation of certain LUFA APIs*/
117   USBH_BytesInPipe GetBytesInPipe;                    /*Function will be executed when a call
118                                                         to LUFA API Pipe_BytesInPipe is made.*/
119
120   USBH_PipeRead GetReadByte;                          /*Function will be executed when a call
121                                                         to LUFA API Pipe_Read_8 is made.*/
122
123   USBH_PipeIsINReceived IsINReceived;                 /*Function will be executed when a call
124                                                         to LUFA API Pipe_IsINReceived is made.*/
125 }USBH_GLUE_APP_IF_t;
```


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Application – Implement and register required callbacks

1 Implement call back function

1

```
157  /*Callback function executed on port interrupt*/
158  void CDC_USB_PortCb(uint8_t port, uint32_t event)
159  {
160    if(event & XMC_USBH_EVENT_DISCONNECT)
161    {
162      XMC_GPIO_SetOutputHigh(XMC_GPIO_PORT3, 9);
163      Driver_USBH0.PipeDelete(USBHost_Pipe_State[0].pipe_handle);
164      Driver_USBH0.PipeDelete(USBHost_Pipe_State[1].pipe_handle);
165      Driver_USBH0.PipeDelete(USBHost_Pipe_State[2].pipe_handle);
166      Driver_USBH0.PipeDelete(USBHost_Pipe_State[3].pipe_handle);
167        /*Reset the data handling indices*/
168      USBH_VCOM_RX_cur_index = 0;
169      USBH_VCOM_RX_prev_index = 0;
170    }
171    if(event & XMC_USBH_EVENT_REMOTE_WAKEUP)
172    {
173      /*This flag is set to remember the occurrence of remote wakeup event and
174       * to return from ISR immediately. This helps to time a 20ms delay in
175       * the context of the application main loop rather than inside the ISR context.
176       * The reason for this is that the example uses a timer interrupt whose priority is
177       * lower than the USB interrupt and therefore would result in a deadlock.*/
178      USBH_RemoteWkUp_Detected = 1;
179    }
180  }
```


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Application – Implement and register required callbacks

2

```
31 /*Callback functions to be called from USB glue layer*/
32 USBH_GLUE_APP_IF_t USBVCH_CB =
33 {
34     .GetBytesInPipe = USBVCH_Pipe_BytesInPipe,
35     .GetReadByte = USBVCH_Pipe_Read_8,
36     .IsINReceived = USBVCH_Pipe_IsINReceived,
37     .PipeEventHandler = USBH_VCOM_Rx_Data_Handler,
38     .PortEventHandler = CDC_USB_PortCb
39 };
```

3

```
49 int main(void)
50 {
51   uint8_t USBHostState;
52   int8_t ReceivedByte;
53   uint8_t *RxPtr;
54   uint32_t Rxlen;
55   uint32_t uart_data_count;
56
57
58   /*Configure USB and CPU clocks*/
59   ClockSetup();
60   /*Initialize UART channel*/
61   UART_init();
62   /*Select VBUS pin as P3.2*/
63   XMC_USBH_Select_VBUS(XMC_GPIO_PORT3, 2U);
64   /* Initializes the USB host driver. */
65   USB_Init_Host(&USBVCH_CB);
66
```

2 Register call back function

3 Call initialization function

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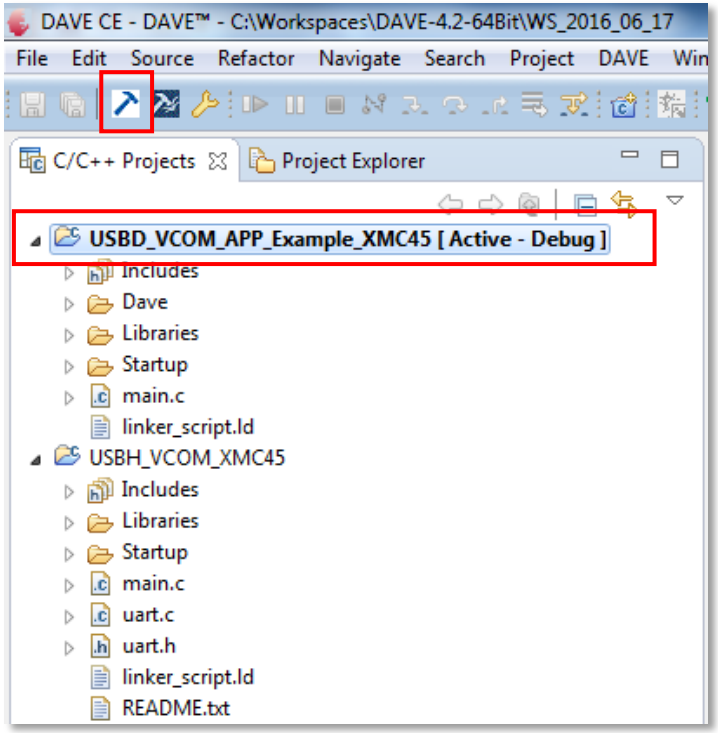
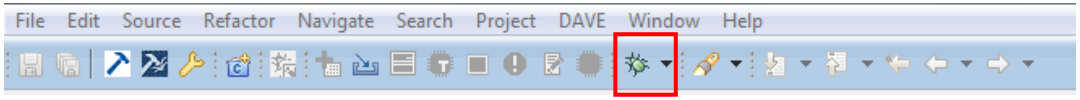
How to test – build and download device project



1

1. Make the device project 'Active' and build **device project**
2. Download image into **Board B**. Image now resides in flash memory
3. Terminate the debugger and **Reset Board B** to start executing the image



2

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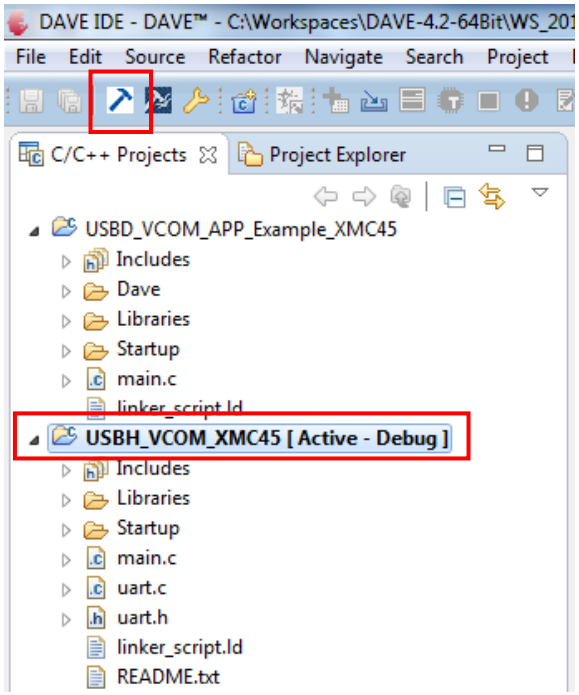
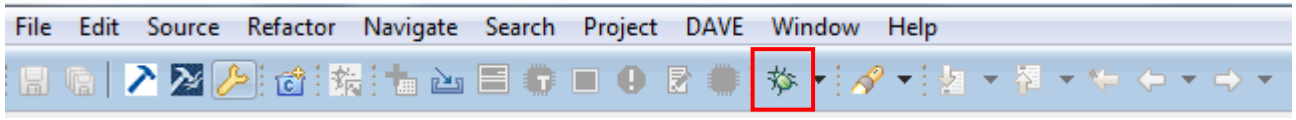
How to test – build and download host project



1

1. Make the host project 'Active', build and download **host project** into **Board A**
2. Start debugger
3. Start the execution by pressing the run button



2



3

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How to test

1. Keep the USB connection ton the debugger of Board A and the PC and keep the debugger running

2. Open serial port terminal software on Windows laptop (example Tera Term)
   - See next slide how to locate associated COM port

3. Configure the terminal software for 19200 baud rate, 8 bit data, 1 stop bit, no parity

4. Type some characters. The typed characters will be looped back and visible on the terminal.

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Finding associated COM port on Windows

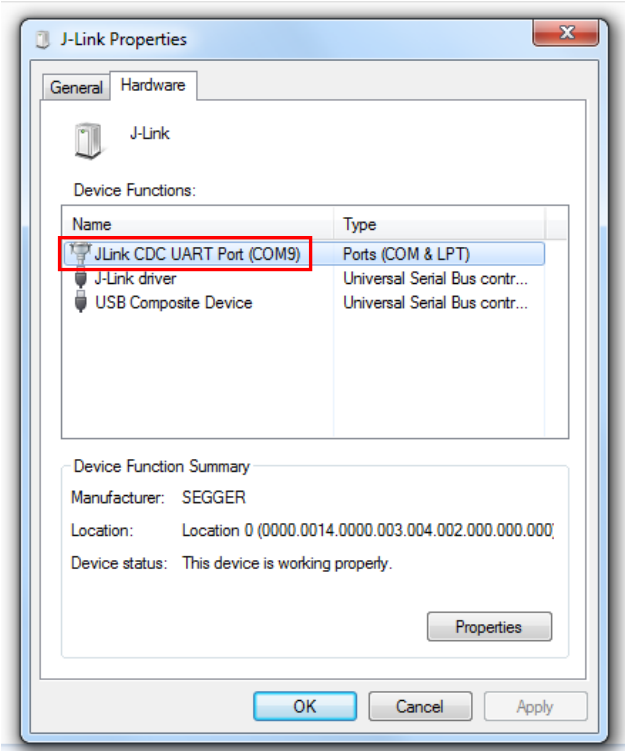
1



2

1 Open Control Panel -> Hardware and Sound -> Devices and Printers

2 Right click on J-Link and select Properties, then select Hardware tab. COM port is indicated.



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Supported features

- ACM Requests – SetControlLineState, SetLineCoding, SendBreak
- Only ACM Notification - Serial State is implemented

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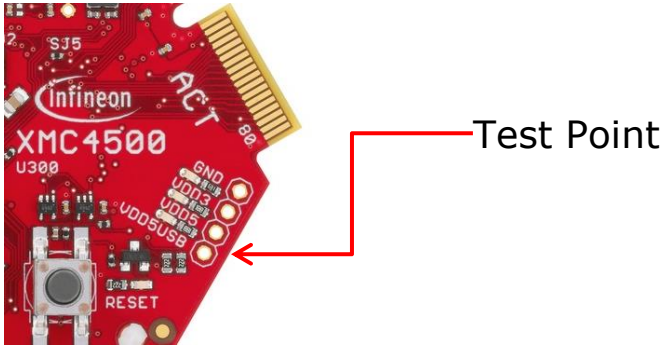
Debug Hints

- Check VBUS is available and within permissible range (4.4V to 5.25V) on the USB host port receptacle. Lower VBUS voltages due to excessive current draw may cause USB devices to disconnect intermittently or fail enumeration. Try connecting a different USB device.



- Long cables may cause malfunction due to signal quality issues. Use short cables if possible.
- Check if XMC4500 VCOM device example application (Board B) is running properly by connecting device to a Windows host running Tera Term. XMC4500 device will loop back characters typed on terminal.

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Further reading

- USB specifications and Micro-USB cables and connectors specification

  http://www.usb.org/developers/docs/usb20_docs/

- Communication devices class specifications
  - Class definitions for communication devices v1.2
  - Communications class, subclass specifications for PSTN devices

  http://www.usb.org/developers/docs/devclass_docs/

- CMSIS USB host API specification

  https://www.keil.com/pack/doc/CMSIS/Driver/html/group__usb__interface__gr.html

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Further reading

- LUFA USB stack

  http://www.fourwalledcubicle.com/index.php

- Books
  - USB Complete: The Developer's Guide, Jan Axelson
  - USB Embedded Hosts, Jan Axelson

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Limitations

- Hubs are not supported
- Over current protection is not supported
- DMA Transfers are not supported
- Low level driver does not support isochronous transfers

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