



**Future Technology Devices International Ltd.**

## **Application Note**

**AN\_147**

# **Vinculum-II Using Bulk Only Mass Storage (BOMS) Class Devices Example**

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**This application note illustrates the capabilities of the Vinculum II VNC2 by using a simple application example called "Hello World" that connects and stores data to a USB flash drive.**

**The techniques used in this application note are applicable to the whole range of VNC2-based modules**

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## 1 Introduction

This application note illustrates the capabilities of the Vinculum-II VNC2 by using a simple application example called "Hello World". The application illustrates how to connect a USB flash drive (BOMS class) to a Vinculum II VNC2. The application allows a user to create a new text file on a USB flash drive which is connected to USB2 (USB Host 2) of the VNC2 daughterboard plugged on the V2-Eval board and a string "Hello World" is continuously written to the file.

The supplied example code is used with the VNC2 V2-EVAL customer evaluation board with a 64-pin VNC2 based daughterboard.

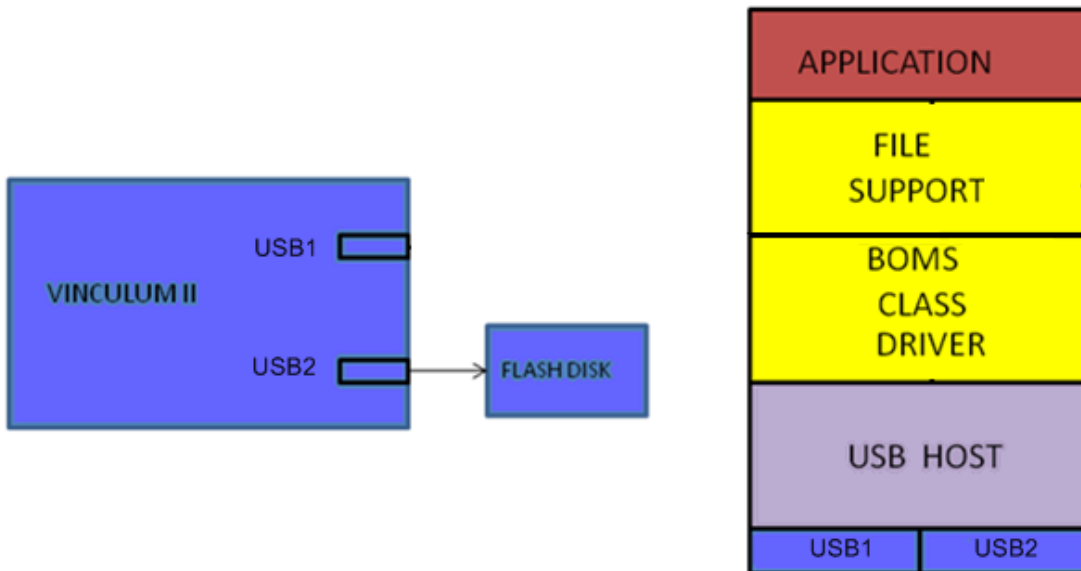
Any software code examples given in this document are for information only and are not supported by FTDI.

### 1.1 Overview

This application note gives details of how to interface the Vinculum-II VNC2 device and store data to a USB flash drive (BOMS class). The document firstly describes the layout of the "Hello World" application. It then describes the hardware setup and software structure of the "Hello World" application. Additionally it illustrates the libraries (VOS Kernel Services, device drivers and runtime libraries) and outlines the general structure of the application. This is followed by how to open and build the application and how to load the "Hello World" application ROM file onto the VNC2 device. Lastly there are instructions on how to run the application.

## 2 "Hello World" Application Layout

Figure 2.1 illustrates the layout of the "Hello World" application which consists of the file support block (FAT File System), BOMS class driver block and USB host block (USB1 and USB2). The USB flash drive is connected to the USB2 (USB Host1) of the 64-pin VNC2 daughterboard plugged on the V2-Eval board.



**Figure 2.1 – Application Layout**

The application requires the following device drivers:

The File Support block is layered on top of the BOMS driver. The File support communicates with the device file structure and provides file, directory and disk functions (format, open, read, write and close) to an application.

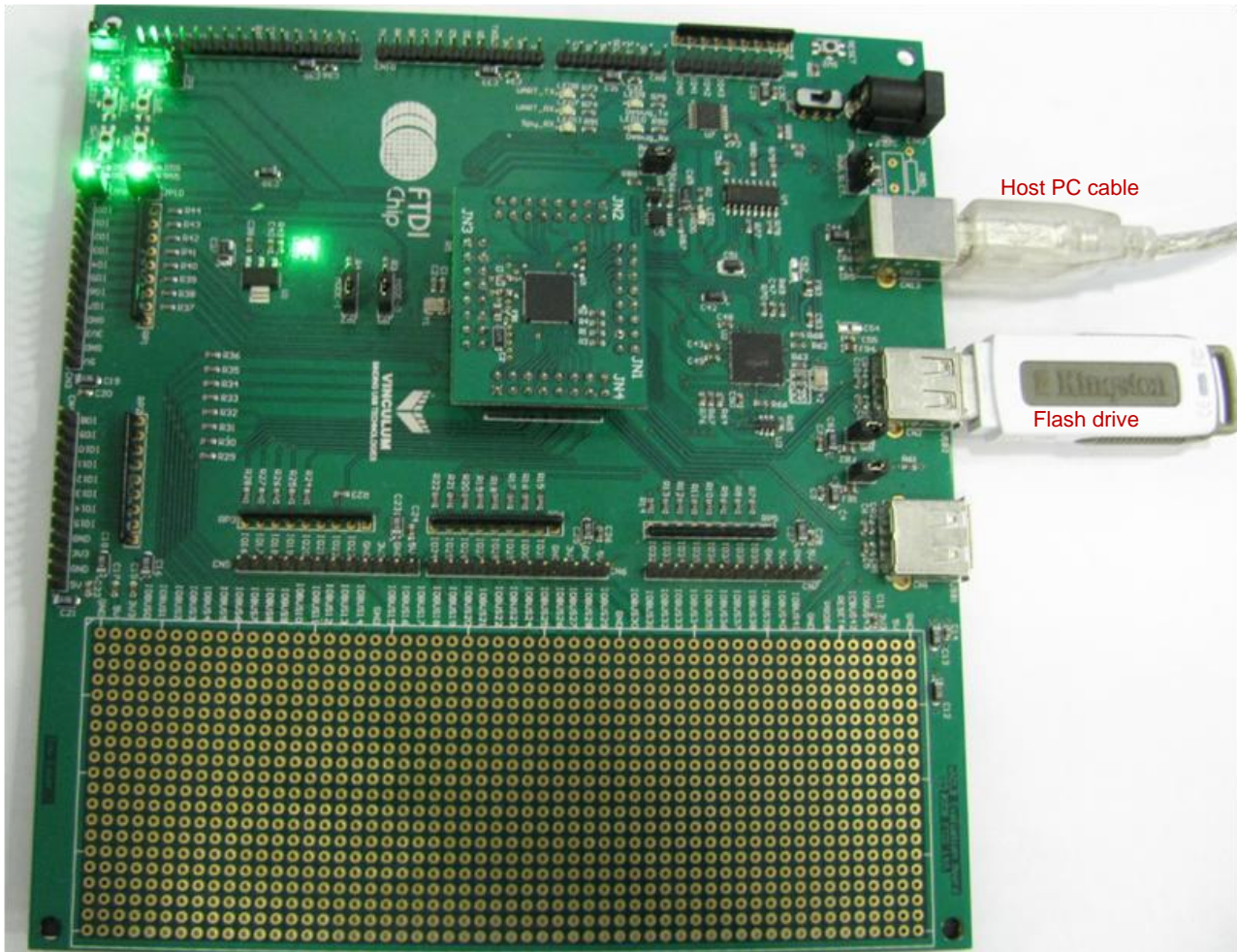
BOMS class driver is layered on top of the USB Host driver. The BOMS driver communicates with a mass storage class of USB device and provides access to the data on a USB drive. It also manages reading and writing data to sectors and clusters on disk

The USB Host acts as an interface to the USB flash drive. It performs device enumeration and adds transactions and reports transaction status.

### 3 Hardware Setup

The “Hello World” application demonstration requires a Host PC, VNC2 customer evaluation board V2-Eval, VNC2 64 pin QFN daughterboard, a FAT-formatted USB flash drive and USB 2.0 compliant A-B cable to connect the Host PC and the V2-Eval debugger port. This demonstration also works with the VNC2 48-pin QFN daughterboard.

Figure 3.1 shows the hardware set-up of the “Hello World” application demonstration:



**Figure 3.1 – Hardware Setup**

## 4 Software

This section explains how the “Hello World” application source code is structured. The application C code is available as a free download with the [Vinculum-II Toolchain Installer](#) from the FTDI website. The [Vinculum-II Toolchain IDE](#) is designed to support the development of user firmware applications for the FTDI [Vinculum-II](#) programmable USB Host / Slave controller devices. The tool suite is a royalty-free, ‘C’ based Integrated Development Environment (IDE), which comes complete with compiler, linker and hardware debug tools.

The code for this application must be compiled with the [Vinculum-II Toolchain IDE Compiler](#) (VinIDE compiler) before being programmed into the VNC2. The compiler translates source code from C program (high-level programming language) to [Vinculum II](#) instructions (assembly language).

On the Host PC with the Vinculum II Toolchain, installation of the FTDI device driver is required for the FT4232H which is connected to the VNC2 debugger port. Please refer to [FTDI website](#) for driver installation.

For further details please see [AN\\_142 Vinculum II Toolchain Getting Started Guide](#) and [AN\\_145 Vinculum-II Toolchain Installation Guide](#).

### 4.1 Header Files

The “Hello World” application consists of HelloWorld.h file that contains declarations of functions, constant values and all global variable declarations that are used throughout the application. The HelloWorld.h file defines:

#### The size of the stack memory the application thread needs.

```
#define SIZEOF_FIRMWARE_TASK_MEMORY 0x1000
```

#### Number of device interfaces that are used within the application.

```
#define NUMBER_OF_DEVICES      3      total number of device interfaces
#define VOS_DEV_USB_HOST      0      devices serviced on order 0, 1,2,3,4, 0, 1, 2....
#define VOS_DEV_BOMS          1
#define VOS_DEV_GPIO          2
```

Please refer to [AN\\_142 Vinculum II Toolchain Getting Started Guide](#) for further details.

### 4.2 FTDI Files

Device drivers, Kernel Services and Runtimes libraries are provided by the [Vinculum-II Toolchain Installer](#) in the form of archive files. Each archive file has a corresponding header file that defines its API, providing information on functions and data structures that are contained within the archive files. Both the header files and archive files are included in the “Hello World” application.

The String runtime libraries contain string manipulation functions and the Kernel Services provides overall control of the device drivers. The Device drivers are: USB Host driver, the BOMS driver, FAT driver and the GPIO driver which is used for the V2-Eval board LEDs.

Please refer to [AN\\_142 Vinculum II Toolchain Getting Started Guide](#) for further details.

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## 4.3 “Hello World” Application Code

The application consists of HelloWorld.c file that contains Drivers includes section which has declarations of the Kernel services, Runtime libraries and Driver header files. It also contains the Setup section which includes a main function. The main function acts as an entry point each time application is run. It initializes the Kernel and drivers, configures IOs, creates a thread and starts the scheduler. And lastly, a thread section which contains firmware code to control the VNC2 device.

### 4.3.1 Drivers Includes Section

**Include statements for all header files:**

```
#include "vos.h"

#include "USBHost.h"

#include "USB.h"

#include "BOMS.h"

#include "FAT.h"

#include "GPIO.h"

#include "string.h"

#include "HelloWorld.h"
```

**Declarations:**

```
VOS_HANDLE    hUsb2,

              hBoms,

              hGpio;

vos_tcb_t     *tcbFirmware;

fat_context   fatContext;

unsigned char *tx_buf = "Hello World! \r\n";

void firmware (void);
```

### 4.3.2 Setup Section - Main Function

The Setup section takes care of initialization of the Kernel, CPU clock frequency, Device drivers, IO configuration, create application thread and start kernel scheduler.

#### **Initialization of the kernel for the number of devices being used, the time slice for each thread (Quantum) and the interval for timer interrupts (tick)**

```
vos_init(10, VOS_TICK_INTERVAL, NUMBER_OF_DEVICES);
```

#### **Initialization of the CPU clock frequency, the default clock frequency for the CPU is 48MHz:**

```
vos_set_clock_frequency(VOS_48MHZ_CLOCK_FREQUENCY);
```

The device can also operate at 24MHz or 12MHz for lower power apps.

#### **VN2 IOMux configuration – this matching signals to physical pins:**

```
vos_iomux_define_output(12,IOMUX_OUT_GPIO_PORT_A_1);//LED3,GPIO port A bit 1 to pin 12
vos_iomux_define_output(13,IOMUX_OUT_GPIO_PORT_A_2); //LED4,GPIO port A bit 2 to pin 13
vos_iomux_define_output(29,IOMUX_OUT_GPIO_PORT_A_5); //LED5, GPIO port A bit 5 to pin 29
vos_iomux_define_output(31,IOMUX_OUT_GPIO_PORT_A_6); //LED6, GPIO port A bit 6 to pin 31
vos_iomux_define_output(39,IOMUX_OUT_UART_TXD); //UART Tx, // UART to V2EVAL board pins
vos_iomux_define_input(40,IOMUX_IN_UART_RXD); //UART Rx
vos_iomux_define_output(41,IOMUX_OUT_UART_RTS_N); //UART RTS#
vos_iomux_define_input(42,IOMUX_IN_UART_CTS_N); //UART CTS#
```

#### **Initialization of the USBHost driver:**

```
usbhost_init(-1, VOS_DEV_USB_HOST, &usb_ctx);
```

#### **Initialization of the BOMs driver:**

```
boms_init(VOS_DEV_BOMS);
```

#### **Initialization of the GPIO driver:**

```
gpioCtx.port_identifier = GPIO_PORT_A;
gpio_init(VOS_DEV_GPIO,&gpioCtx);
```

#### **Initialization of the FAT driver:**

```
fat_init();
```

#### **Create the application thread:**

```
tcbFirmware = vos_create_thread(29, SIZEOF_FIRMWARE_TASK_MEMORY, firmware, 0);
```

#### **Start the scheduler:**

```
vos_start_scheduler();
```

Every application includes a vos\_start\_scheduler and should be the last instruction after all configuration is done.



### 4.3.3 Thread Section

This section contains firmware code to control the VNC2 device.

#### Opens the handle to the devices:

```
hsb = vos_dev_open(VOS_DEV_USB_HOST2);  
  
hGpio = vos_dev_open(VOS_DEV_GPIO);  
  
hBoms = vos_dev_open(VOS_DEV_BOMS);  
  
fatContext = fat_open(hBoms, 0, NULL);  
  
fat_fileOpen(fatContext, &FILE, "HelloWorld.TXT", FILE_MODE_APPEND | FILE_MODE_PLUS);
```

#### Finds BOMS class device:

```
hc_iocb_class.dev_class = USB_CLASS_MASS_STORAGE;  
  
hc_iocb_class.dev_subclass = USB_SUBCLASS_MASS_STORAGE_SCSI;  
  
hc_iocb_class.dev_protocol = USB_PROTOCOL_MASS_STORAGE_BOMS;
```

#### Finds first hub device:

```
hc_iocb.ioctl_code = VOS_IOCTL_USBHOST_DEVICE_FIND_HANDLE_BY_CLASS;  
  
hc_iocb.handle.dif = NULL;  
  
hc_iocb.set = &hc_iocb_class;  
  
hc_iocb.get = &ifDev2;
```

#### Attach BOMS class to the USB Host and FAT class to the BOMS:

```
boms_att.hc_handle = hUsb;  
  
boms_att.ifDev = ifDev2;  
  
boms_iocb.ioctl_code = MSI_IOCTL_BOMS_ATTACH;  
  
boms_iocb.set = &boms_att;  
  
boms_iocb.get = NULL;  
  
bomsStatus = vos_dev_ioctl(hBoms, &boms_iocb);
```

#### Write to the file:

```
fat_fileWrite(&FILE, (unsigned long)(strlen(tx_buf)), tx_buf, NULL, NULL);
```

#### Closes the handle to the devices:

```
status = fat_fileClose(&FILE);  
  
fat_close(fatContext);  
  
vos_dev_close(hBoms);
```

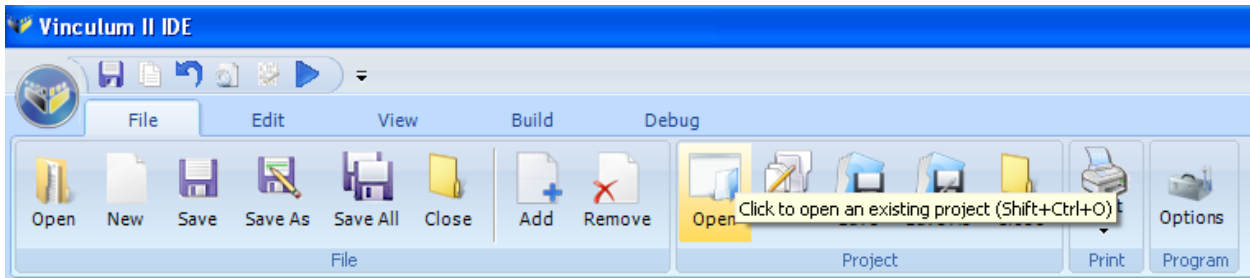
Please refer to [AN\\_142 Vinculum II Toolchain Getting Started Guide](#) for further details.

## 5 Opening the Application

Following the [Vinculum-II Toolchain](#) installation process, by default, the [Vinculum-II Toolchain IDE](#) is located within the *Program Files/FTDI/Vinculum II Tool Chain* directory on the local hard disk; there will also be a start menu shortcut created, under the *FTDI/Vinculum II Tool Chain* folder heading. The Vinculum-II Toolchain Installer can be downloaded free from the [FTDI website](#).

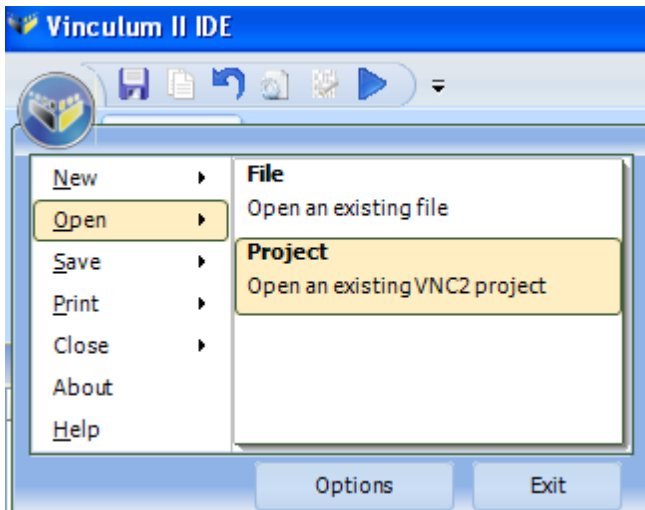
Following a successful installation of the Vinculum-II Toolchain, launch the application by double clicking on Vinculum-II Toolchain icon on the desktop. The "Hello World" application will be saved within *My Documents* folder of your PC.

Select *File* tab within the toolbar and click *Open* under the *Project* group (see Figure 5.1).



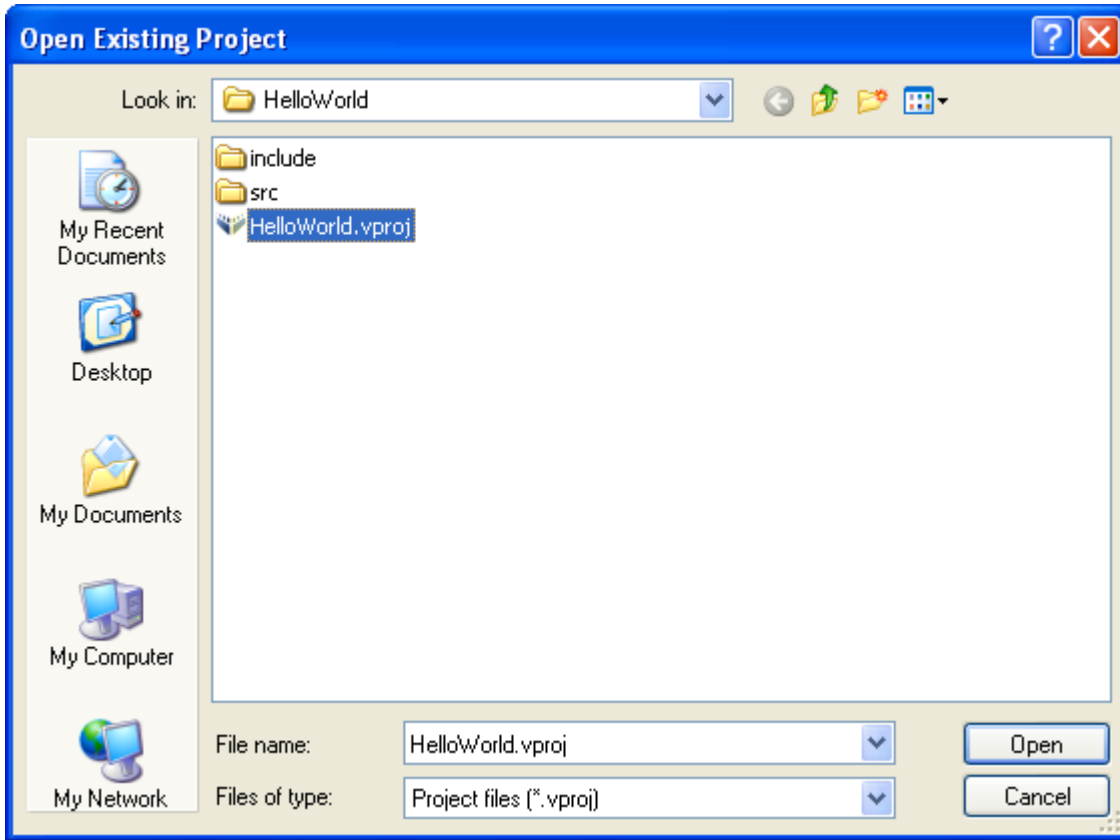
**Figure 5.1 – Opening Project Using File Tab**

Alternatively, go to the circular Vinculum button and click *Open->Project*



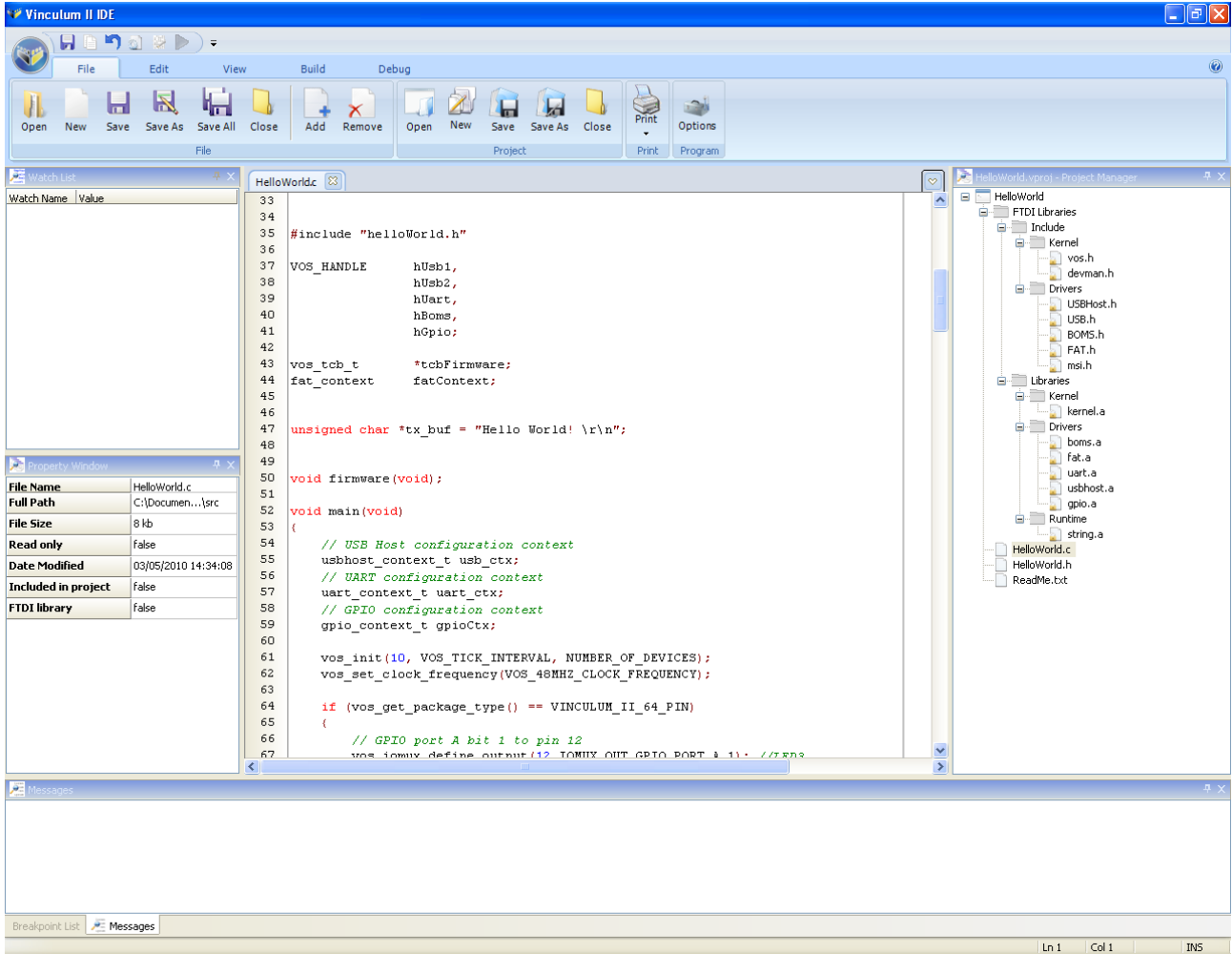
**Figure 5.2 – Opening Project Using Circular Vinculum Button**

This will result in the *Open Existing Project* dialog box (see Figure 5.3) appearing. Browse to *My Documents* and find the folder *FTDI/Firmware/Samples/1.0.4/General*. Within this will be a folder called *HelloWorld* containing a file *HelloWorld.vproj* (vproj is the file extension used by all VNC2 project files) double click the file to open the “Hello World” Application within the [Vinculum-II Toolchain IDE](#).



**Figure 5.3 – Opening Existing Project Window**

To open the “Hello World” application project click the *Open* button and the application project opens within the VNC2 Toolchain IDE (Figure 5.4).

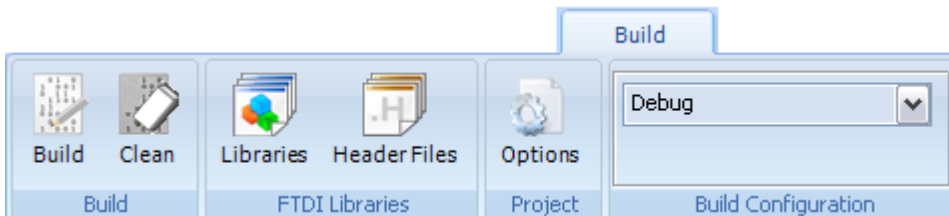


**Figure 5.4 – VNC2 Toolchain IDE Window**

## 6 Building the Application

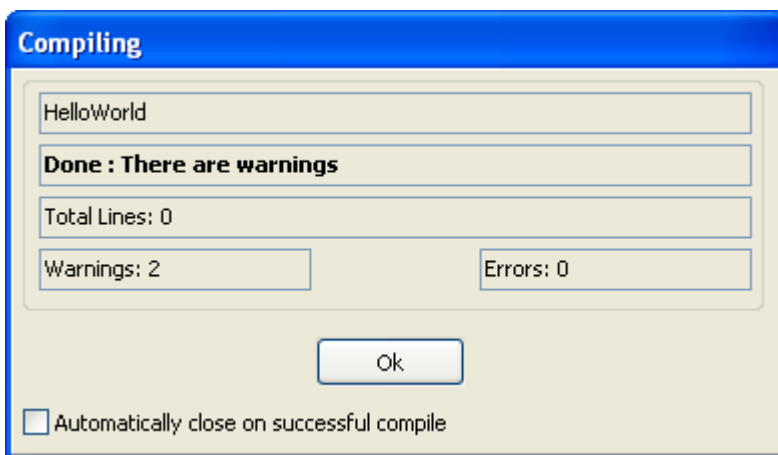
This section contains step-by-step instructions for building the “Hello World” application. Once an application is opened, it is necessary to clean and build the application to delete files from a previous build. This build also creates an executable file for VNC2.

To build the application, select *Build* tab within the toolbar and click *Clean* and then *Build* under the *Build* group (see Figure 6.1).



**Figure 6.1 – Building Project**

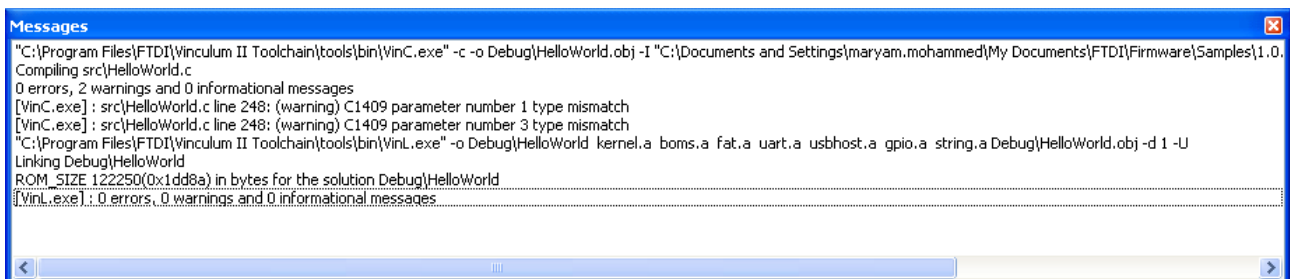
Clicking *Clean* will delete the object and ROM file to ensure only new files are generated. Following *Clean*, click *Build* to have the [Vinculum-II Toolchain IDE Compiler](#) compile, assemble and link the source code into a file format (ROM file) that can be loaded onto the VNC2 device. This pops up a *Compiling* dialog box (Figure 7.2) which shows a number of warnings and compilation errors (if there are any).



**Figure 6.2 – Compiling Window**

If the “Hello World” application source code is not altered, the application should successfully build with no compilation errors or warnings (see Figure 7.2).

This shows that the HelloWorld.ROM file has been successfully created. Additional information is also sent by the compiler and linker to the *Message Window* at the bottom of the IDE main window (see Figure 6.3). Ensure there are no errors.



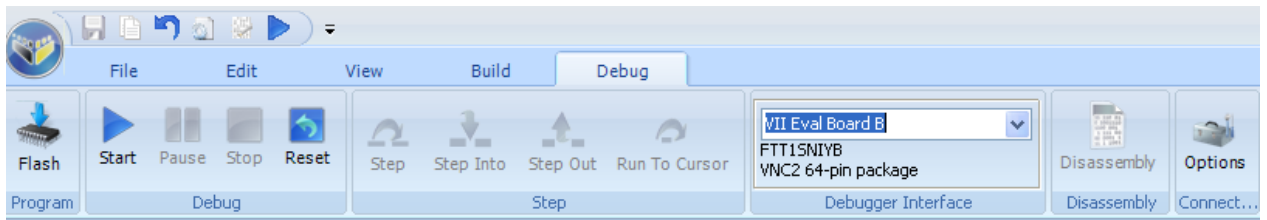
**Figure 6.3 – Message Window**

## 7 Flashing or Programming the VNC2

In order to program the “Hello World” application into the VNC2 device, it is necessary to plug the 64 pin QFN daughter-board onto the VNC2 daughter-board connector – J1, J2, J3 and J4 and connect the V2-Eval board debugger port to the development Host PC using the USB A-B cable.

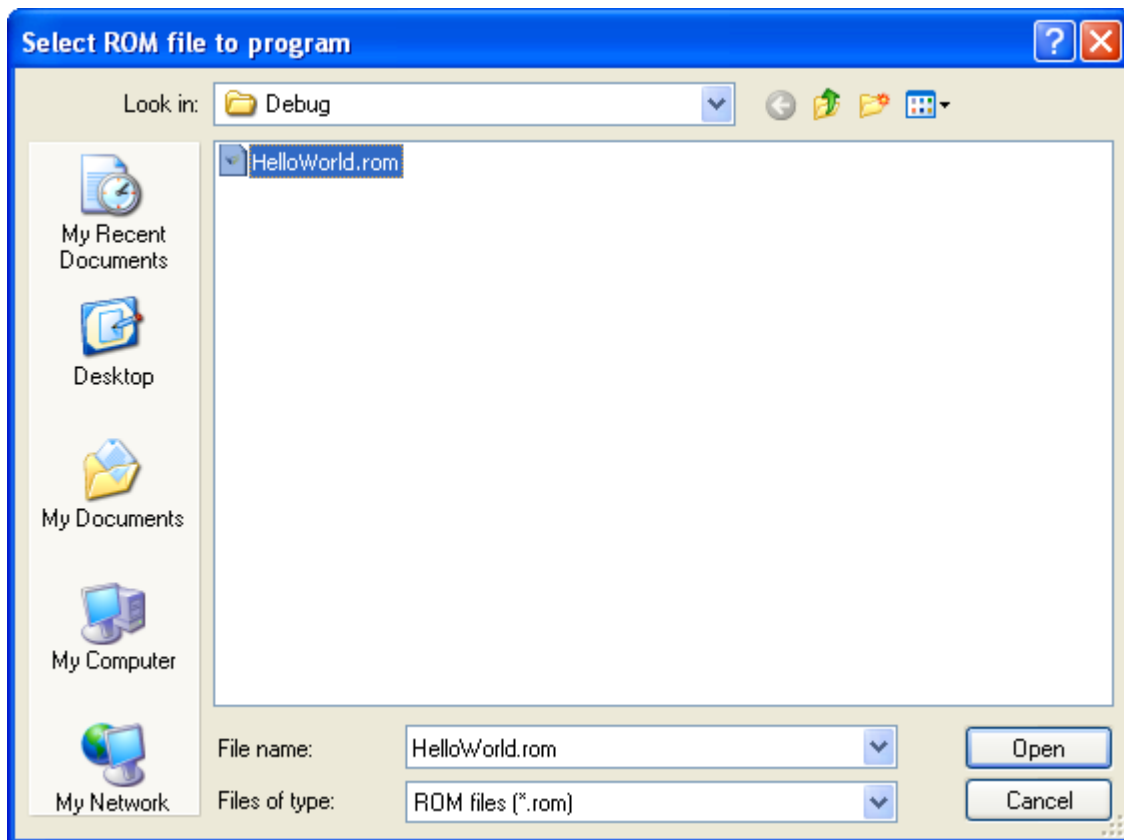
When the V2-Eval board is connected, switch it ON using SW1 (located just below the black power supply socket). The Host PC may attempt to install FTDI drivers for the FT4232H connected to the debugger port. Please visit [FTDI website](http://www.ftdi.com) and download the necessary driver which matches your operating system.

Go back into the IDE and select *Debug* tab within the toolbar and click drop-down menu in the *Debugger Interface* which initiates the IDE to search for connected devices. This will automatically select the debugger interface of the FTDI V2-Eval board (see Figure 7.1). Port B of the FT4232H on the V2-Eval board is connected to the VNC2 debug port.



**Figure 7.1 – Debugger Interface**

Program the flash memory of the VNC2 by selecting the *Flash* button from the *Debug* tab, *Select ROM file to program* dialog box (see Figure 7.2) will open showing the HelloWorld.ROM image file that was built earlier, select this file and click open



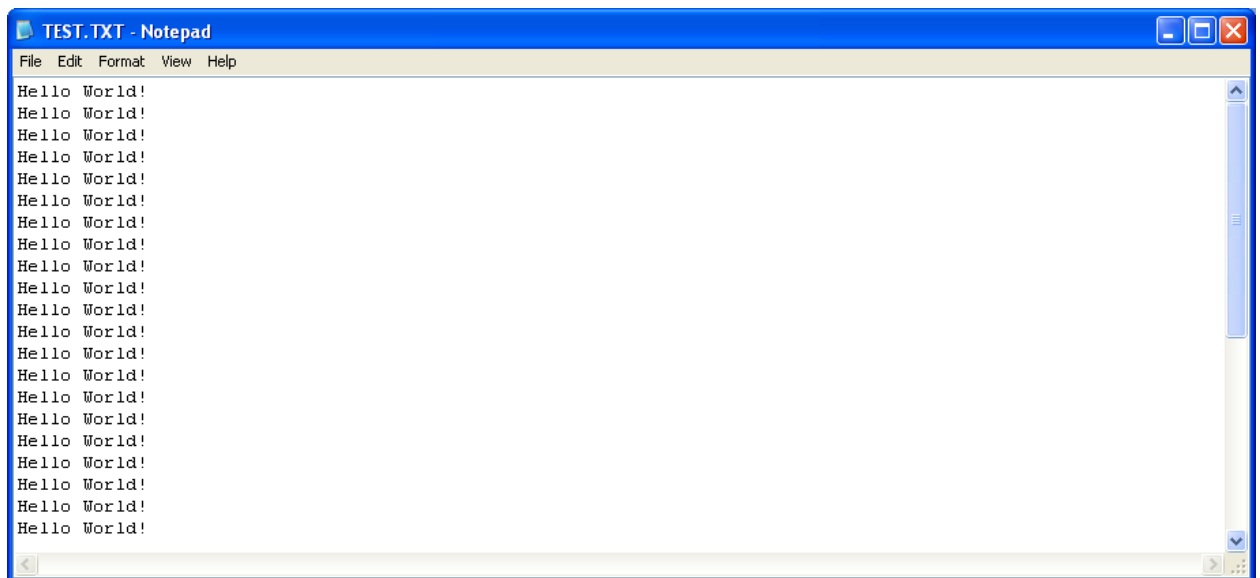
**Figure 7.2 – Select ROM File to Program Window**

The LED9 and LED10 located on the V2-Eval board will flash. The VinIDE will now program the VNC2 flash and a *Flashing Rom* progressing bar will appear to indicate progress and disappear after successfully completing the VNC2 programming. Additional information is shown within the *Message Window* at the bottom of the IDE main window.

## 8 Operation

The following sequence is required to run the “Hello World” application demonstration:

1. Apply power to the V2-Eval board
2. Connect the USB flash drive to USB2 of the V2-Eval board
3. LED3 located on the V2-Eval board should flash sequentially. This indicates that the USB device connected to USB2 has not been enumerated. The VNC2 device waits for the RESET button to be pressed using the SW2 switch on the V2-Eval board.
4. Press the RESET button switch (SW2) to manually reset the V2-Eval board.
5. The VNC2 will detect the RESET and the USB Flash connected to the V2-Eval board will be enumerated.
6. The LED3 on the V2-Eval board should now stay ON which indicates the completion of the USB device enumeration
7. A new text file will be created and a string “Hello World” will be written continuously until the V2-Eval board is turned OFF, unplugged from the Host PC or the USB flash is removed from the V2-Eval board. Ensure that the V2-Eval board is turned OFF before removing the flash drive. Remove the flash drive from the board and insert it into the Host PC to open the created text file (see Figure 8.1).



**Figure 8.1 – “Hello World” Text File Displayed**

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## Appendix B – References

[AN\\_145: Vinculum-II Toolchain Installation Guide](#)

[AN\\_142: Vinculum-II Tool Chain Getting Started Guide](#)

[AN\\_137: Vinculum-II IO Cell Description](#)

[AN\\_138: Vinculum-II Debug Interface Description](#)

[AN\\_139: Vinculum-II IO Mux Explained](#)

[AN\\_140: Vinculum-II PWM Example](#)

[AN\\_144: VINCULUM-II IO Mux Configuration Utility User Guide](#)



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## Appendix C – Revision History

Revision	Changes	Date
1.0	Initial Release	2010-06-11