DVK512 User Manual

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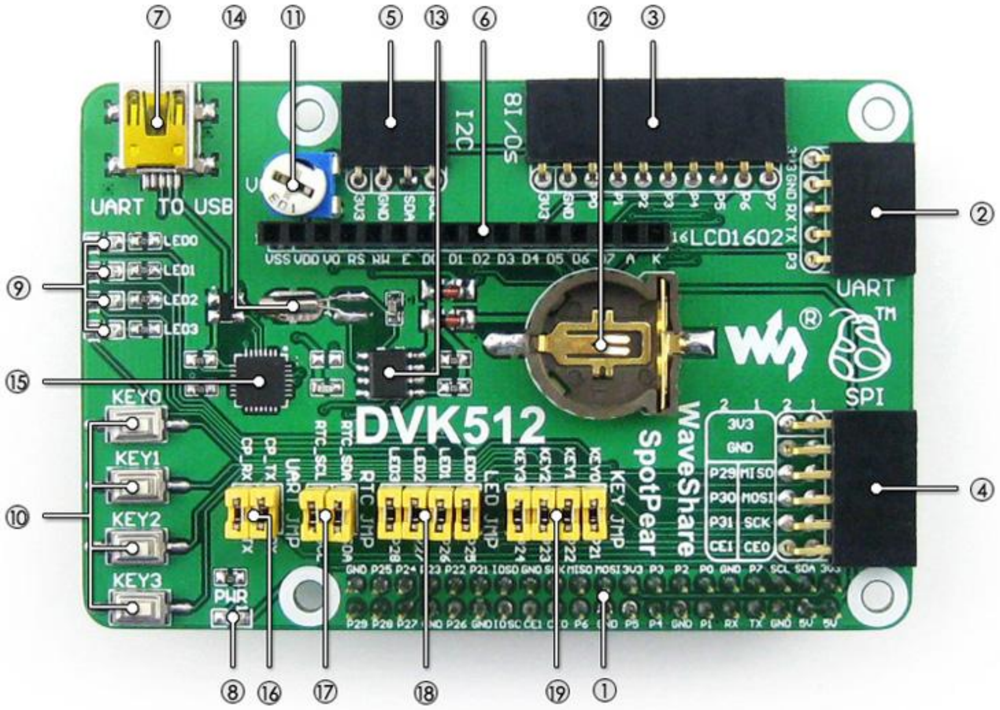
Revision History

Revision	Date	Description
V1.0	Aug. 18, 2014	Initial revision
V1.1	Nov. 13, 2014	Figures and tables update
V2.1	Nov. 27, 2014	Major update
V2.2	Dec. 03, 2014	Amendment
V2.3	Dec. 18, 2014	3.5inch LCD update
V2.4	Jan. 01, 2015	Amend Chap. 2.13

Overview

DVK512 is an expansion board designed for Raspberry Pi Model B+, integrates various components and interfaces for connecting external accessory boards. It's ideal for Raspberry Pi Model B+ evaluation and development.



1. **Pinheaders for connecting with the RPi**
2. **UART interface:** easily connects to UART modules such as RS232, RS485, USB TO UART, etc.
3. **8I/Os interface:** easily connects to modules controlled by I/Os, such as 8 Push Buttons, Logic Level Converter, Mix Board, etc.
4. **SPI interface:** easily connects to SPI modules such as AT45DBXX Dataflash, L3G4200D Board, etc.
5. **I2C interface:** easily connects to I2C modules such as PCF8574 Expansion Board, PCF8563 RTC Board, LSM303DLHC Board, etc.
6. **Character LCD interface:** for connecting character LCDs like LCD1602
7. **USB connector:** USB TO UART, supported by onboard converter CP2102
8. **Power indicator**
9. **User LEDs**
10. **User Keys**
11. **Potentiometer:** for LCD1602 contrast adjustment
12. **RTC battery holder**
13. **PCF8563:** onboard RTC chip
14. **32.768K crystal:** RTC crystal
15. **CP2102:** onboard USB TO UART chip, for debugging
16. **CP2102 jumper**
17. **RTC jumper**
18. **User LEDs jumper**
19. **User Keys jumper**

Contents

1. Basic operations

1.1 System image file programming

1) Run the CD provided with the module. Then, find out the file with the expansion name .img under the directory of IMAGE and copy it to your PC (For the latest system image file, please login the website: http://www.waveshare.net/wiki/DVK512).
2) Format your TF card with the SDFormatter.exe.
   Notices: The capability of TF card in used here should be more than 4GB. In this operation, a TF card reader is also required, which has to be purchased separately.
   3) Start the Win32DiskImager.exe, and select the system image file copied into your PC, then, click the button **Write** to program the system image file.

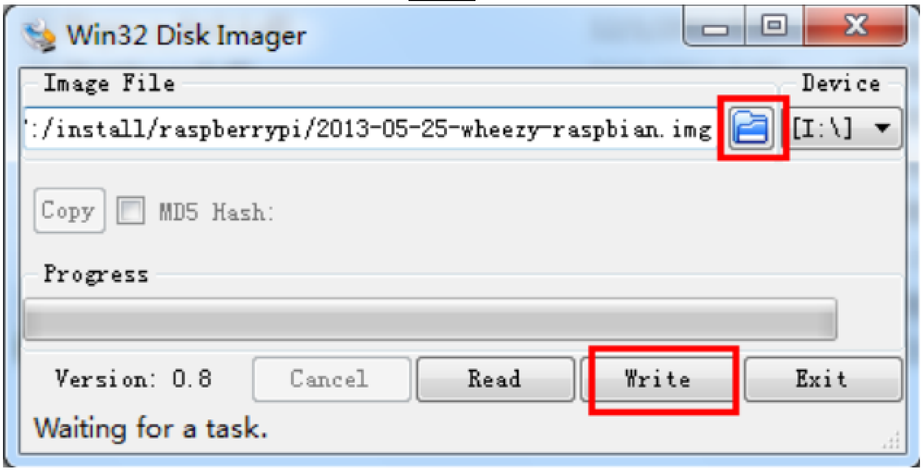


Figure 1: Programming the system image file with Win32DiskImager.exe

1.2 Serial debugging environment deploying

1) Connect your PC to the UART TO USB interface on DVK512 via a mini USB cable;
   Notices: The USB part of the UART TO USB interface applied by DVK512 is a mini USB interface, while the one on Raspberry Pi board is a micro USB interface. Please take a note.
2) Install the cp2102_driver;
3) Start the software PuTTY.exe, and configure the following parameters:
   - Serial line: it is used to select corresponding serial port. The serial port in used can be check by Device Manager.
   - Speed: it is used to set the Baud rate: 115200.
   - Connection type: this option should be set to Serial.

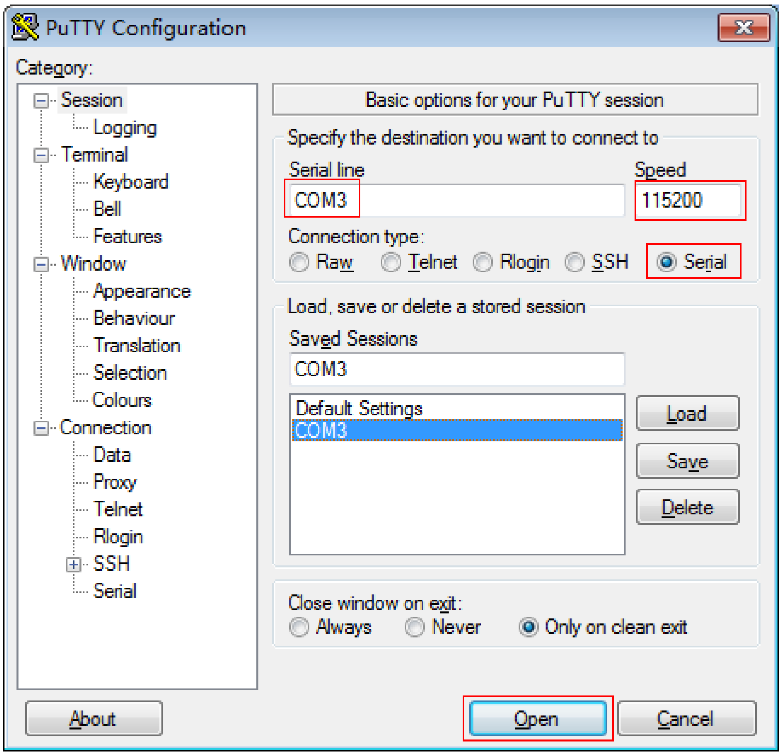


Figure 2: PuTTY settings

4) And then, click the button **Open**.
5) After the system is started up, you should input following information: User name: pi and Password: raspberry. Then, you can enter the serial terminal to communicate with the Raspberry Pi.

   Notices: In this document, the software PuTTY is always used to control the Raspberry Pi via serial port communication, unless otherwise specified. When a serial port is used for Raspberry Pi terminal debugging, it cannot service as a common serial port any more, since it is occupied by system debugging function. For more information, please refer to Section 1.3 and Section 1.4.

1.3 Debugging function disable (Serial port services as common serial port

After programming the system image file described above, you may find that the serial port is set as terminal debugging output by default. In this case, you should input corresponding commands on the terminal to disable the debugging function of the serial port.

1) When using a LCD displayer, you should enter following command to disable the debugging function of the serial port:

   root@raspberrypi:/# DIS_UART-LCD
2) When using a HDMI displayer, you should enter following command to disable the debugging function of the serial port:

   root@raspberrypi:/# DIS_UART-HDMI

   Notices: After executing any one of the commands above, the system will

reboot automatically. After it rebooted, the terminal debugging function will be disabled and the serial port will work as a common IO. However, you will not be able to enter the terminal of the Pi via the serial port communication any more. In this case, you can use SSH or connecting an external displayer to the Pi to enter LXterninal.

3) Start a serial monitor (such as TCP232), and set the Baud rate: 115200. Then, enter the terminal and input:
   root@raspberrypi:/# UART_Test
   Then, a string of character will be displayed in the serial monitor.
4) The data transmitted by the serial monitor will be displayed in the serial monitor.
   Notices: Raspberry Pi can still transmit and receive data by running the serial sample application, even though its debugging function of the serial port is disabled. When the Raspberry Pi receives serial data from your PC, the received data will be returned to PC and displayed in serial software.
5) Press the keys Ctrl+C on external keyboard to end the configuration.

1.4 Debugging function enable

If you need to enable the debugging function of the serial port again, please following the steps described below:

1) When using a LCD displayer, you should enter following command to enable the debugging function of the serial port:
   root@raspberrypi:/# EN_UART-LCD
2) When using a HDMI displayer, you should enter following command to enable the debugging function of the serial port:
   root@raspberrypi:/# EN_UART-HDMI

1.5 How to work with a 3.5-inch LCD displayer

1) Power off the system, and connect a 3.5-inch LCD displayer to the Pi, as Figure 3 shows.

Figure 3: Connection between a Raspberry Pi Model B+ and a 3.5-inch LCD displayer

2) Apply the system image described in Section 1.1, and power up the Pi.
3) Enter the following commands for touch screen calibration:

   pi@raspberrypi:/$ su pi

   pi@raspberrypi:/$ DISPLAY=:0.0 xinput_calibrator
4) After running these commands, there will be a prompt for four-point calibration shown in the LCD screen. Click the points one by one to finish the touch calibration. Then, the new calibration data will be displayed in the terminal, as Figure 4 shows. Please get these data for future use.

```
pi@raspberrypi:~$ su pi
Password:
pi@raspberrypi:~$ DISPLAY=:0.0 xinput_calibrator
Calibrating EVDEV driver for "ADS7846 Touchscreen" id=6
        current calibration values (from XInput): min_x=160, max_x=3723 and min_
y=3896, max_y=181

Doing dynamic recalibration:
        Setting new calibration data: 126, 3734, 3892, 199


--> Making the calibration permanent <--
  copy the snippet below into '/etc/X11/xorg.conf.d/99-calibration.conf'
Section "InputClass"
        Identifier      "calibration"
        MatchProduct    "ADS7846 Touchscreen"
        Option  "Calibration"   "126 3734 3892 199"
EndSection
```

Figure 4: The calibration data displayed in the terminal

5) Enter the following command to edit 99-calibration.conf:

   pi@raspberrypi:/$ sudo nano /etc/X11/xorg.conf.d/99-calibration.conf

```
Section "InputClass"
        Identifier      "calibration"
        MatchProduct    "ADS7846 Touchscreen"
        Option  "Calibration"   "160 3723 3896 181"
        Option  "SwapAxes"      "1"
EndSection
```

Figure 5: Editing 99-calibration.conf

6) Modify the data marked with red box in the Figure 5 to the new calibration data displayed in the step 4), as Figure 6 shows.

```
Section "InputClass"
        Identifier       "calibration"
        MatchProduct     "ADS7846 Touchscreen"
        Option   "Calibration"   "126 3734 3892 199"
        Option   "SwapAxes"      "1"
EndSection
```

Figure 6: Modifying the data of Option "Calibration"

7) Press the keys Ctrl+X, and select the option Y to save the modification.
8) The modification will be valid after rebooting the system. Enter the following command for system rebooting:
   pi@raspberrypi:/$ sudo reboot
   Notices: In case of inaccurate touch, please perform screen calibration again and reboot the system.

1.6 3.5-inch LCD display switch to HDMI display

1) The default boot mode of the system image described in the Section 1.1 selects 3.5-inch LCD display. And there will be no output from the external HDMI displayer if you apply one under this mode. In case that you want to use HDMI display, please execute the following commands:
   pi@raspberrypi:/$ sudo su
   root@raspberrypi:/# HDMI-SYS-SHOW
2) The system will load the driver (wait several minutes). And the Raspberry Pi will reboot automatically, when the driver download finished. After the module rebooted, waiting more than 30 seconds, there will be information display on the HDMI screen. And then, you will enter into Startx interface.

1.7 HDMI display switch to 3.5-inch LCD display

1) Enter the terminal, and input:
   pi@raspberrypi:/$ sudo su
   root@raspberrypi:/# LCD35-SYS-SHOW
2) The system will load the driver (wait several minutes). And the Raspberry Pi will reboot automatically, when the driver download finished. After the module rebooted, waiting more than 30 seconds, there will be information display on the HDMI screen. And then, you will enter into Startx interface.

1.8 API source code

The API source code referred in this document can be found under the directory: /home/pi/DVK512 (Since this directory is located in the system image file described in Section 1.1, you should enter the Raspbian to find it).

2. DVK512 and expansion function Demos

Before performing any operations described in this section, you should connect DVK512 to RPi with onboard pin headers, unless otherwise specified.

2.1 LED Demo

1) Enter the terminal, and input:
   root@ raspberrypi:/# LED_Test
2) The 4 LEDs will light up one by one;
3) Press the keys Ctrl+C to end the demo.

2.2 Key Demo

1) Enter the terminal, and input:
   root@ raspberrypi:/# KEY_Test
2) The terminal will show whether there is key-press.

2.3 8-channel Logic Level Convertor Demo

1) Connect the 8-channel Logic Level Converter to the onboard 8I/Os interface, as Figure 7 shows (Notices: The VCCA pin header on the Logic Level Converter should be connected to the 3V3 pin header of the 8I/Os connector on DVK512).

Logic Level Converter	DVK512
VCCB	5V
GND	GND
B0	LED0
B1	LED2
B3	LED3
B4	KEY0
B5	KEY1
B6	KEY2
B7	DEY3

Table 1: Pin relationships between Logic Level Converter and DVK512

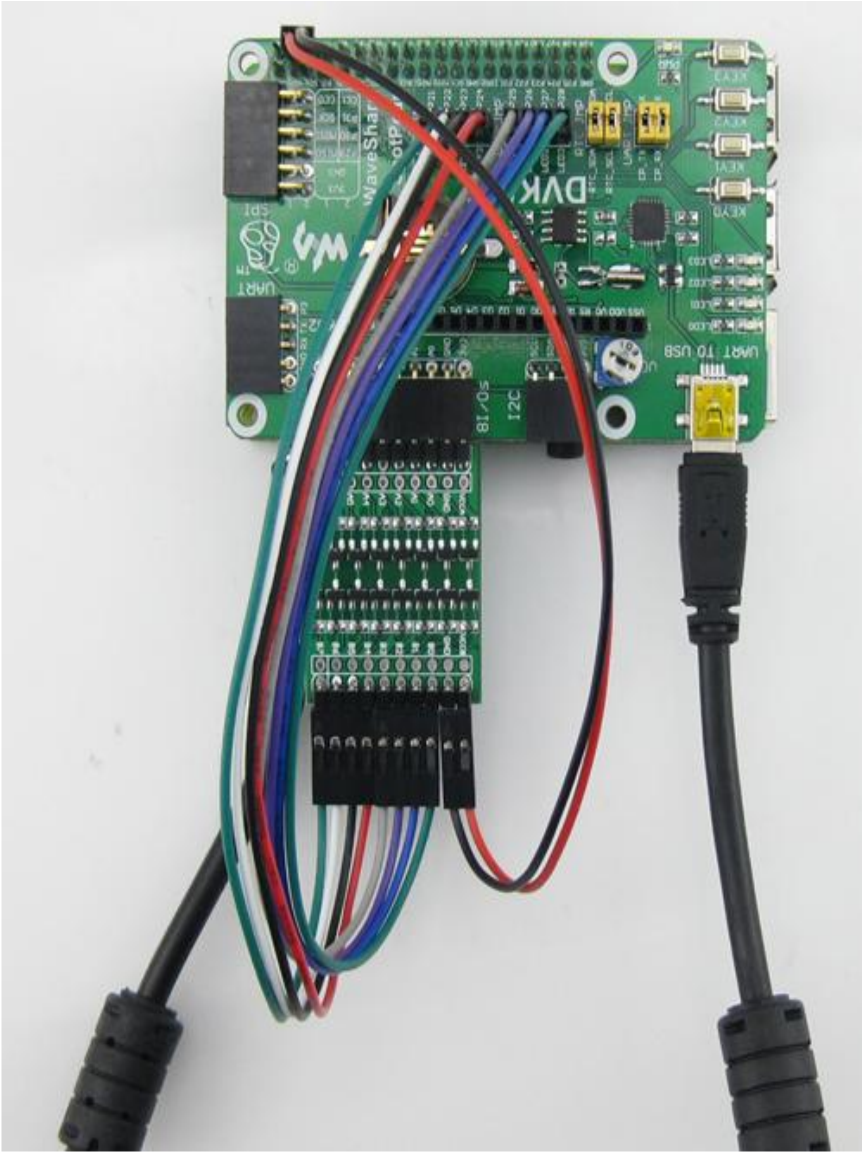


Figure 7: The connection between Logic Level Converter and DVK512

2) Enter the terminal, and input:
   root@ raspberrypi:/# 8-LOGIC
3) Press the KEY0-KEY3 on the DVK512, and the relative LED will light up.
4) Press the keys Ctrl+C to end the demo.

2.4 Joystick Demo

1) Connect the Mix Board to the 8I/Os interface;
2) Enter the terminal, and input:
   root@ raspberrypi:/# JOYSTICK_Test
3) Press or move the joystick, the terminal will show the action
   Notices: When using the 3.5 inch LCD displayer, the LCD displayer will disturb PO value read from the joystick, while the joystick program will disturb the LCD touch as well.

2.5 Buzzer and PWM

1) Connect the Mix Board to the 8I/Os interface;
2) Enter the terminal, and input:
   root@ raspberrypi:/# Buzzer_PWM_Test
3) The buzzer on the Mix Board will sound with a decreasing volume, until no sound.

2.6 DS18B20 Demo

1) Connect the Mix Board to the 8I/Os interface;
2) Insert the DS18B20 to the ON-WIRE interface on Mix Board, as Figure 8 shows.

Figure 8: Inserting the DS18B20 to the ON-WIRE interface on Mix Board

Dangerous: Please make sure the DS18B20 is connected correctly. The DS18B20 in wrong connection may generate a high temperature more than 100℃ which may cause injuries when you touch it. Figure 8 shows the correct connection between the DS18B20 and the Mix Board, in which the DS18B20 should be

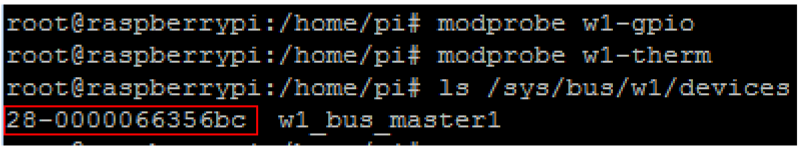
placed according to the shape of the icon shown on the ONE-WIRE interface of Mix Board.

3) Enter the terminal, and input:

root@ raspberrypi:/# modprobe w1-gpio

root@ raspberrypi:/# modprobe w1-therm

root@ raspberrypi:/# ls /sys/bus/w1/devices



```
root@raspberrypi:/home/pi# modprobe w1-gpio
root@raspberrypi:/home/pi# modprobe w1-therm
root@raspberrypi:/home/pi# ls /sys/bus/w1/devices
28-0000066356bc  w1_bus_master1
```

4) You will see a string like 28-0000066356bc, get the last 7 numbers and letters (They are different for each DS18B20. In this example, it is 66356bc).
5) Enter the terminal, and input:

root@ raspberrypi:/# DS18B20_Test 66356bc

6) The terminal will display the current temperature information.

2.7 Infrared remote control

1) Connect the Mix Board to the 8I/Os interface;
2) Connect the infrared receiver to the IRM interface on Mix Board, as Figure 9 shows.

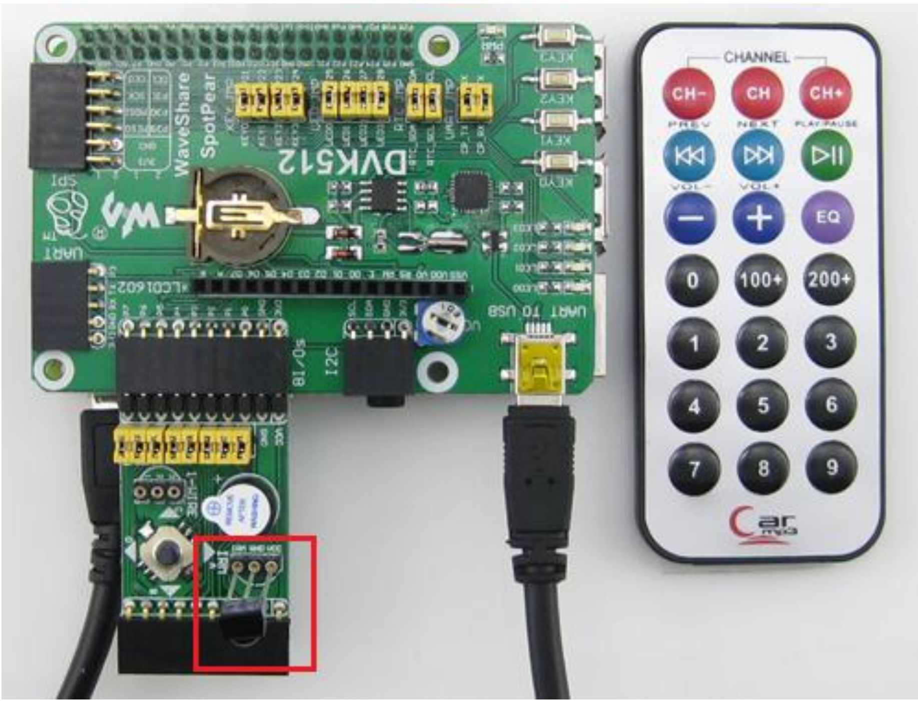


Figure 9: Connecting the infrared receiver to the IRM interface on Mix Board

Notices: The infrared receiver should be placed according to the shape of the icon shown on the IRM interface of Mix Board, as Figure 9 shows.

3) Enter the terminal, and input:

root@ raspberrypi:/# IRM

4) Press any key on the infrared remote controller provided by Waveshare. The terminal will display the decoded infrared signal in hexadecimal format, as Figure 10 shows.

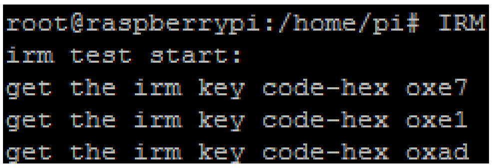


Figure 10: Terminal displays the key pressed on the infrared remote controller

5) Press the keys Ctrl+C to end the demo.

2.8 LCD1602 Demo

1) Insert the LCD1602 into the LCD1602 interface on DVK512, as Figure 11 shows.

Figure 11: Inserting the LCD1602 into the LCD1602 interface on DVK512

2) Enter the terminal, and input:

root@ raspberrypi:/# LCD1602_Test

3) LCD1602 will display relative information. If there is nothing shown, please adjust the potentiometer on the LCD1602. The red box in Figure 11 shows the position of the potentiometer.

2.9 PCF8563 RTC Demo

1) Set the jumpers on DVK512:
   - Connect RTC_SDA to SDA
   - Connect RTC_SCL to SCL

2) Enter the terminal, and input:

root@ raspberrypi:/# i2cdetect –y 1

3) Then, you will see the device address of PCF8563 connected to Raspberry Pi B+ module. Here, the device address of PCF8563 is 51, indicating that the PCF8563

is detected by Raspberry Pi.

```
root@raspberrypi:/home/pi# i2cdetect -y 1
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- UU -- -- -- --
40: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- 51 -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- -- --
```

Figure 12: PCF8563 is detected by Raspberry Pi B+ module

4) Enter the terminal, and input:

root@ raspberrypi:/# modprobe i2c-dev

root@ raspberrypi:/# echo pcf8563 0x51 > /sys/class/i2c-adapter/i2c-1/new_device

root@ raspberrypi:/# hwclock –r (Read out the time info from the connected I2C RTC hardware)

root@ raspberrypi:/# hwclock –w (Write the time info of Raspbian into PCF8563)

root@ raspberrypi:/# hwclock –r (Read out the time info from the I2C RTC hardware once more. Now the time info of the Raspbian and the PCF8563 has been synchronized.)

root@ raspberrypi:/# hwclock –s (Synchronize the time of Raspbian and hardware RCT)

2.10 PCF8591 AD Demo

1) Connect the PCF8591 module to the I2C interface on DVK512;
2) Connect the pins AIN0 and AD0 on the PCF8591 together via a cable, as Figure 13 shows.

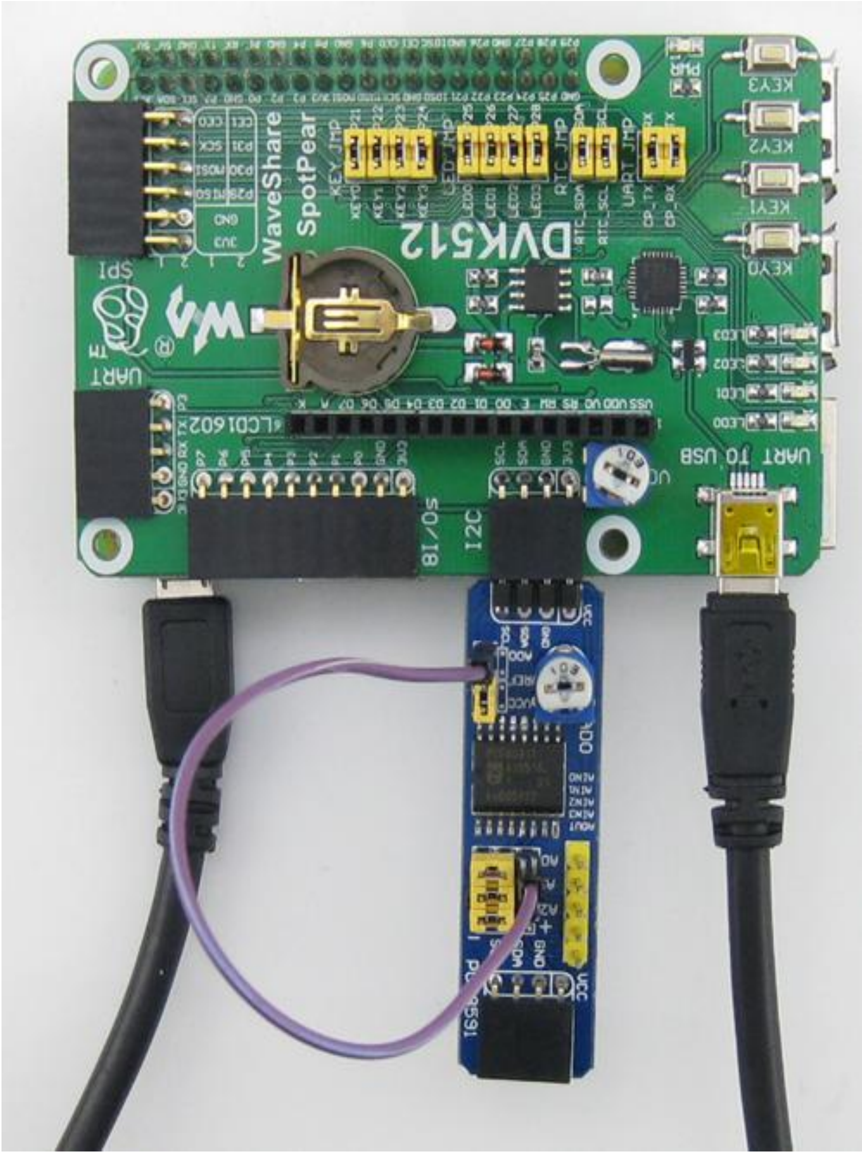


Figure 13: connecting the pins AIN0 and AD0 together

3) Enter the terminal, and input:

   root@ raspberrypi:/# pcf8591-ADC

4) The terminal will display the AD values read from ADC0-ADC3 (corresponding to the pins AIN0-AIN3 on PCF8591), as Figure 14 shows.

```
root@raspberrypi:/home/pi# PCF8591-ADC
start..........
adc0:  2.36 adc1:  1.33 adc2:  0.00 adc3:  0.00
adc0:  2.36 adc1:  1.32 adc2:  0.00 adc3:  0.00
adc0:  2.36 adc1:  1.32 adc2:  0.00 adc3:  0.00
adc0:  2.36 adc1:  1.33 adc2:  0.00 adc3:  0.00
adc0:  2.36 adc1:  1.33 adc2:  0.00 adc3:  0.00
adc0:  2.36 adc1:  1.32 adc2:  0.00 adc3:  0.00
adc0:  2.36 adc1:  1.32 adc2:  0.00 adc3:  0.00
adc0:  2.36 adc1:  1.33 adc2:  0.00 adc3:  0.00
adc0:  2.36 adc1:  1.33 adc2:  0.00 adc3:  0.00
```

Figure 14: Displaying the AD values read from ADC0-ADC3

2.11 PCF8591 DA Demo

1) Connect the PCF8591 module to the I2C interface on DVK512;
2) Connect the Pin AOUT on PCF8591 to the LED pin header on DVK512, as Figure 15 shows.

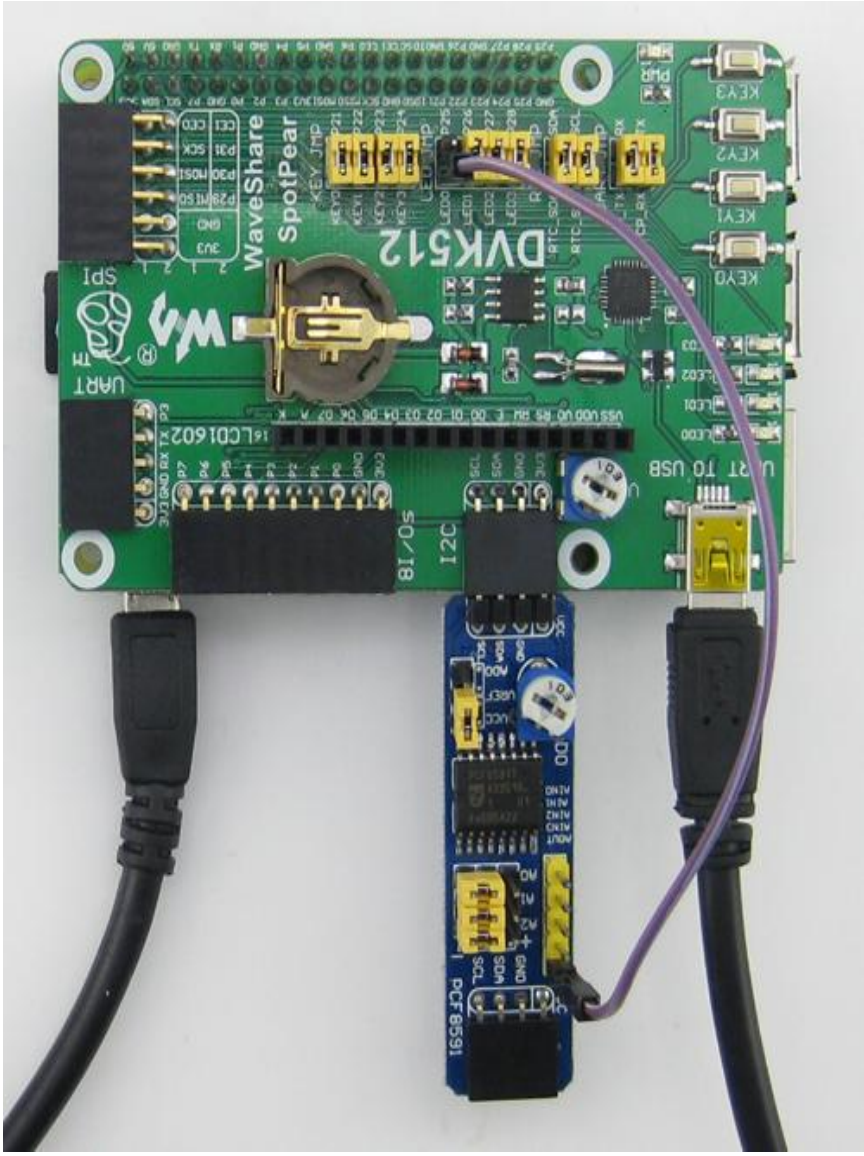


Figure 15: Connecting the Pin AOUT on PCF8591 to the LED pin header on DVK512

3) Enter the terminal, and input:
   root@ raspberrypi:/# pcf8591-DAC
4) The digital conversion value is displayed in the terminal. And the brightness of the LED indicator on DVK512 will change with the level variation on the pin AOUT.

2.12 Acceleration of Gravity and Magnetic Sensors LSM303DLHC

1) Connect the LSM303DLHC module to the I2C interface on DVK512, as Figure 16

shows.

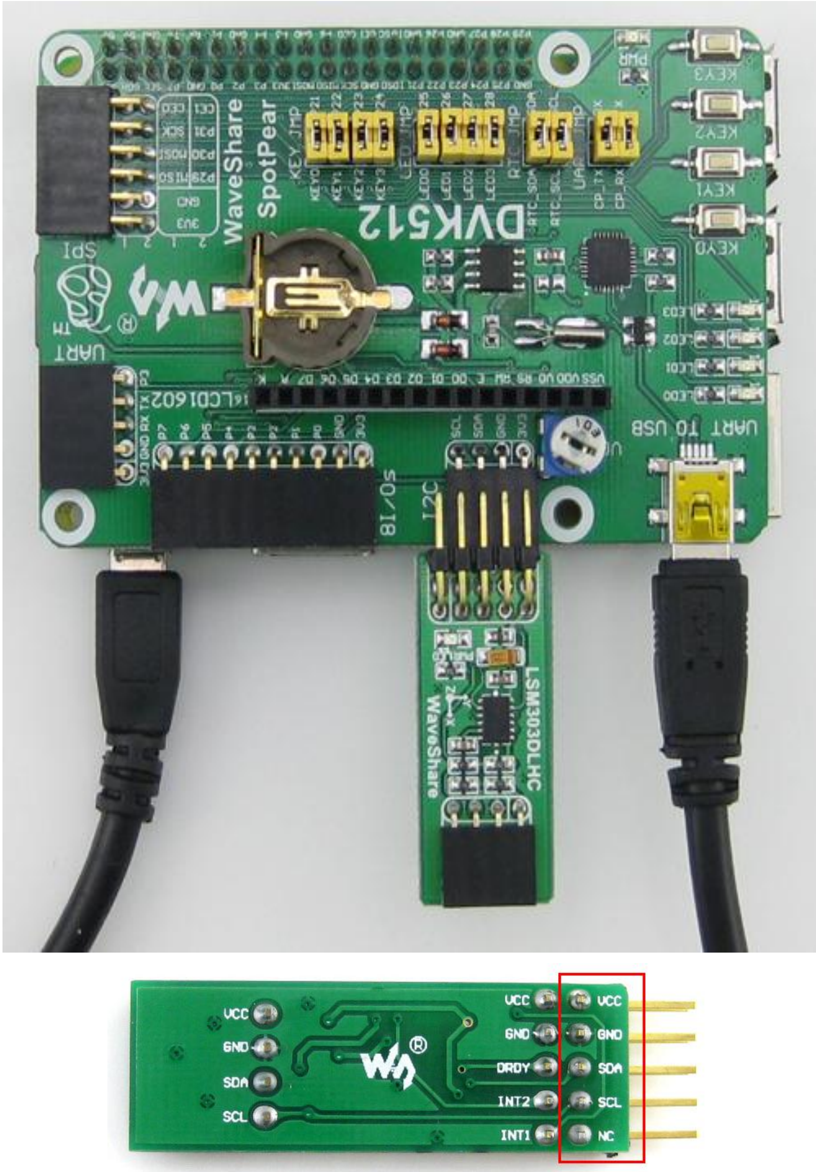


Figure 16: Connecting the LSM303DLHC module to the I2C interface on DVK512

Notices: LSM303DLHC module has two rows of pins, and the one connected to DVK512 contains the pins SDA and SCL.

2) Enter the terminal, and input:

   root@ raspberrypi:/# LSM303

3) The terminal will display the relative values read from acceleration of gravity and magnetic sensor, as Figure 17 shows.

```
********          LSM303DLHC        *********************
X_A=-0.320000 m/s^2
Y_A=0.280000 m/s^2
Z_A=10.200000 m/s^2
X_M=-332.394379 T
Y_M=-107.042252 T
Z_M=-247.887329 T
north=208.116699 degree
```

Figure 17: Relative values read from acceleration of gravity and magnetic sensor

2.13 Angular rate Sensor L3G4200D

Before performing the following operations, you should remove the 3.5-inch LCD displayer first.

1) Connect the L3G4200D to the SPI interface on DVK512;
2) Remove the 3.5-inch LCD displayer;
3) Connect a HDMI displayer to Raspberry Pi module (In here, you can also use SSH to build a connection to Raspberry Pi module);
4) Enter the terminal, and input:
   root@ raspberrypi:/# HDMI-SYS-SHOW (From 3.5-inch LCD display switch to HDMI display)
   Notices: The L3G4200D Board needs to use the SPI interface. However, if the system boots from LCD display mode, the SPI interface will be occupied by the LCD displayer. Therefore, you should remove the LCD, connect a HDMI displayer, and switch to HDMI display mode to release the SPI, before using the L3G4200D Board (For more detailed information, please refer to the Section 1.6).
5) The system will load the driver (wait several minutes). And the Raspberry Pi will reboot automatically, when the driver download finished. After the module rebooted, waiting more than 30 seconds, there will be information display on the HDMI screen. And then, you will enter into Startx interface;
6) Enter the terminal, and input:
   root@ raspberrypi:/# L3G4200D
7) The terminal will display the angular velocity values in three factors of x axis, y axis and z axis, respectively.

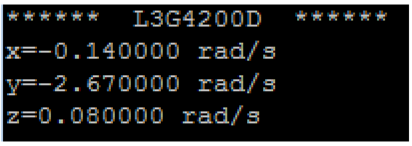


Figure 18: Angular velocity values

2.14 GPS Demo

1) In the default boot mode of the system image provided by Waveshare, the serial port works as terminal debugging output. In order to control peripherals via serial port communication, you should input corresponding commands on the terminal to disable the debugging function of the serial port.
   - When using a LCD displayer, you should enter following command to disable the debugging function of the serial port:
     root@raspberrypi:/# DIS_UART-LCD
   - When using a HDMI displayer, you should enter following command to disable the debugging function of the serial port:
     root@raspberrypi:/# DIS_UART-HDMI

Notices: For more detailed information, please refer to the Section 1.3.

2) The system reboots automatically. After it rebooted, the terminal debugging function is disabled and the serial port works as a common IO;
3) Insert a GPS module into the UART interface on DVK512, and remove the jumper wire from UART JMP, as Figure 19 shows.

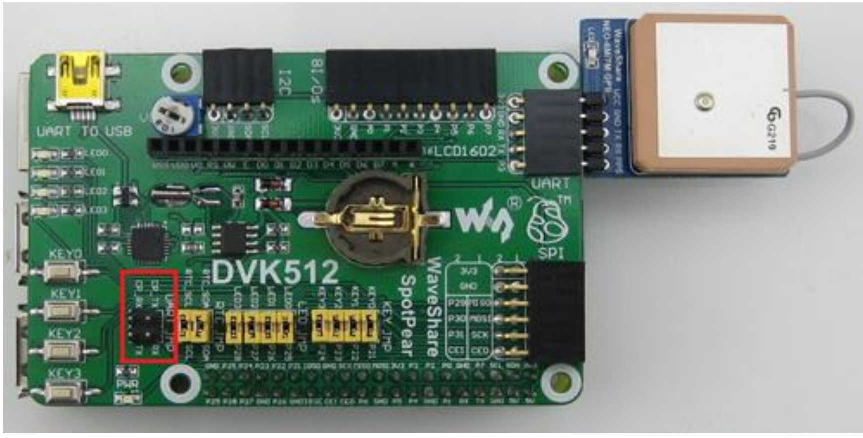


Figure 19: Removing the jumper wire from UART JMP

4) Enter the terminal, and input the following commands to set the Baud rate (The Baud rate will be restored to the default value: 115200, after the system rebooted).

   root@raspberrypi:/# stty -F /dev/ttyAMA0 38400

   root@raspberrypi:/# gpsd /dev/ttyAMA0 -F /var/run/gpsd.sock
5) Enter the terminal and input the following command to open the GPS software provided by the Linux system:

   root@raspberrypi:/# cgps -s
6) The terminal will display relative GPS position information.

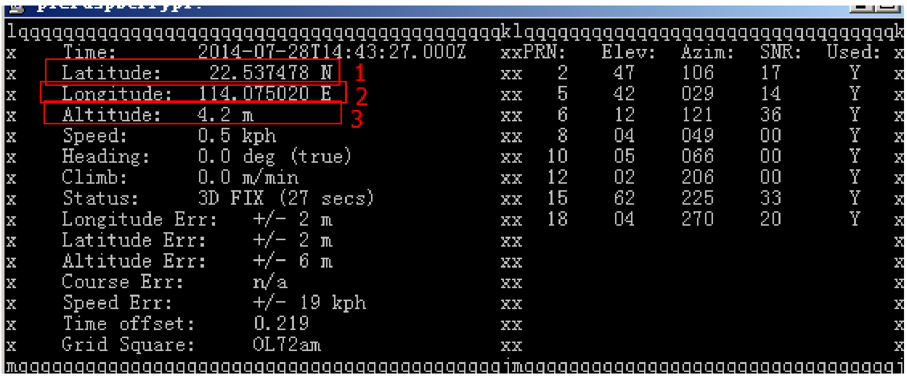


Figure 20: GPS position information

2.15 USB WIFI Demo

In this operation, we only need a USB WIFI module, but the DVK512 expansion board is in no used.

1) Enter the terminal, and input:

   root@ raspberrypi:/# iwlist wlan0 scan (Check the WIFI signal) root@ raspberrypi:/# nano /etc/network/interfaces (Edit the configuration info of the network card)

2) Configure the settings according to your WIFI environment condition:
auto lo// Use localhost
iface lo inet loopback
iface eth0 inet dhcp
auto wlan0// If there is a wlan device, use “wlan0” as device name
allow-hotplug wlan0 // The wlan device supports plug-and-play function
iface wlan0 inet dhcp// If there is a WLAN network card (wlan0) in used, use DHCP to get the IP address
wpa-ssid YourSSID // Connected SSID name, that is WIFI name
wpa-psk YourPSK// Authentication password, that is WIFI password
3) Press the keys Ctrl+X, and select the option Y to save the modification
4) Enter the terminal, and input:
root@ raspberrypi:/# /etc/init.d/networking restart (Restart the network)
root@ raspberrypi:/# ping www.waveshare.net (Test the connection statue)