

TechTip:

Raspberry Pi Data Acquisition using MCC DAQ and Third-Party Linux Drivers

Introduction

The Raspberry Pi® is a single-board computer that plugs into a monitor and keyboard and runs the Linux® kernel-based operating system. With a cost of less than \$40, the Raspberry Pi provides a cost-effective way to perform data acquisition.

MCC supports the Raspberry Pi in three different ways

- Raspberry Pi HATs (/DAQ-HAT.aspx) (Hardware Attached on Top)
- UL for Linux (/daq-software/UL-for-Linux-Support.aspx)® - MCC supported open source driver with support for C/C++® and Python™
- 3rd Party Linux support (/daq-software/Linux-Support.aspx) – Open-source driver with support for C/C++ maintained by Dr. Warren Jasper

This paper focuses on using Dr. Warren Jasper's open-source driver that allows users to acquire data from most Measurement Computing USB, Ethernet, and Bluetooth™ DAQ devices. For information on using UL for Linux, please see the TechTip – Raspberry Pi Data Acquisition Using Universal Library for Linux (/TechTips/TechTip-10.aspx).

Objective

Acquire data from an MCC DAQ device using a test application installed on a Raspberry Pi computer.

This document provides information about how to perform the following tasks:

- Format an SD card
- Install an operating system onto the Raspberry Pi
- Configure Raspberry Pi options
- Install Linux drivers
- Install MCC DAQ third-party drivers and compile MCC Linux test apps
- Run an MCC Linux test app

Intended Audience

This document is intended for application developers familiar with MCC DAQ devices who are interested in acquiring data on a Linux platform using a Raspberry Pi.

Equipment

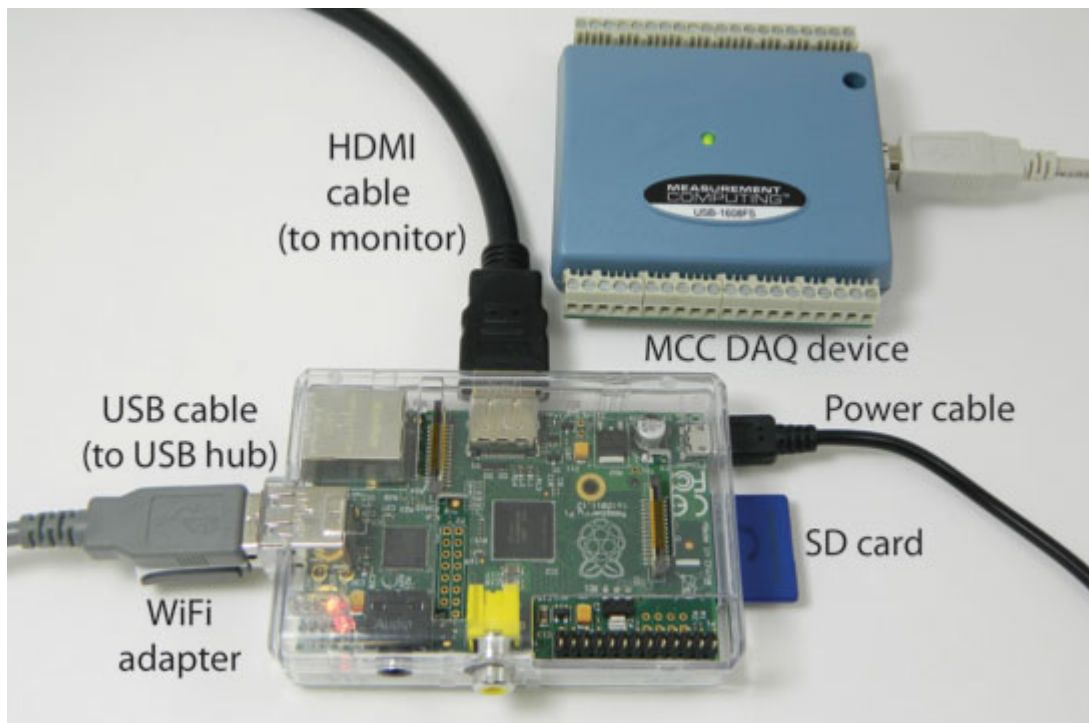
The following equipment is needed to perform the exercises:

- Raspberry Pi single-board computer – I'm using model B, but you can use any Raspberry Pi model
- SD card (8 GB or higher)
- PC or Mac® with internet access
- Ethernet® cable or wireless adapter
- Monitor or television and HDMI cable
- Power supply
- Mouse or trackball
- Keyboard
- MCC DAQ device – I'm using a USB-1608FS to perform the tasks

Click here (</MCC-Linux-Support-Selection.aspx>) for a listing of MCC DAQ devices supported under Linux® and compatible with Raspberry Pi.

Use of a self-powered USB hub is recommended to connect the peripherals to the Raspberry Pi.

The image below shows the Raspberry Pi configuration used to perform these exercises.



Note that a keyboard and mouse are connected to the USB hub but are not shown in the above photo.

Install an Operating System

You must install an operating system onto the Raspberry Pi before it can be used. I am installing Raspbian, which is a free operating system based on Debian that is optimized for the Raspberry Pi hardware. I am using NOOBS (New Out Of the Box Software) to install Raspbian. NOOBS is an operating system install manager for the Raspberry Pi.

You use an SD card to transfer NOOBS onto the Raspberry Pi. The SD card must be formatted to remove all information. The following procedures show you how to perform these steps.

Watch the Video! Go to <http://www.raspberrypi.org/help/noobs-setup/> (<http://www.raspberrypi.org/help/noobs-setup/>) to see a video showing how to format the SD card, download NOOBS, and install the Raspbian OS onto the Raspberry Pi.

Format the SD card

Perform the following steps to format the SD card:

1. Go to www.sdcard.org (<http://www.sdcard.org>) and click **Download**.
2. Scroll to the page bottom and select the SD formatter for Windows or Mac, and then save the download on the computer.
3. Install the SD card into your PC or MAC, and run the **setup.exe** SD formatter executable.

Install the operating system onto the Raspberry Pi

Perform the following steps to download NOOBS and install an OS onto the Raspberry Pi:

1. Go to www.raspberrypi.org (<http://www.raspberrypi.org>) and click **Downloads**.
Under the NOOBS section click **Download Zip** and save the file to your PC or Mac.
2. Expand the zip file and copy all files to the SD Card.
3. Remove the SD card from your PC or Mac, and install it into the Raspberry Pi.
4. Connect the monitor, keyboard, mouse, and power.
Connecting power will boot the Raspberry Pi.
The Raspberry Pi Logo displays, followed by a NOOBS dialog box which shows a list of operating systems to install.
5. Check the **Raspbian** checkbox and click **Install**, then select **Yes** on the **Confirm** dialog box to install.
A dialog box notifies you when installation is complete.
6. Click **OK**; the Raspberry Pi starts loading Raspbian.
If this is the first time booting Raspbian, a **Setup Options** menu appears. Use the keyboard arrow keys to navigate the menu.
7. Set the configuration options, such as the language and regional settings to match your location.
8. Tap **<Finish>** and press **<Enter>** when done setting configuration options.
The command prompt displays `pi@raspberrypi~$`
Congratulations! You have now installed the Raspberry Pi operating system.

Login information

Each time you boot up the Raspberry Pi you are prompted for the following login information:

```
raspberrypi login: pi
```

```
password: raspberry
```

The command prompt displays `pi@raspberrypi~$`

Verify Internet Access

Before you download the MCC drivers for the Raspberry Pi, verify that the Raspberry Pi can access the internet. You can connect an Ethernet cable or connect a USB WiFi adapter to connect with a wireless network. I am using a WiFi adapter.

1. Double-click the **WiFi Config** icon on the desktop to start the wireless configuration program. The **Adapter:** field lists the name of the USB wireless adapter (for example **wlan0**); the **Network:** field is empty.
2. Click **Scan** to list the available wireless networks.
3. Double click on the service set identifier (SSID) network name to which you want to connect.
4. Verify the **Authentication** and **Encryption** fields on the connection window, and enter the password in the **PSK** (pre-shared key) field.
5. Click **Add**.
The configuration program automatically connects to the newly configured network.
6. Cycle the device power to reboot the Raspberry Pi and enter the login information above.

After logging in, the command prompt displays `pi@raspberrypi~$`.

Update the Raspberry Pi Package List

To ensure that you have the latest Raspberry P package installed, enter the following code.

```
sudo apt-get update
```

Download the Third-Party MCC Linux drivers

Third-party MCC Linux drivers for Raspberry Pi are available for USB, Bluetooth, and Ethernet devices, and are stored on GitHub. Navigate to the GitHub repository and download the latest driver suite.

1. Go to the GitHub web page that hosts the Raspberry Pi drivers.
https://github.com/wjasper/Linux_Drivers (https://github.com/wjasper/Linux_Drivers)
2. Click the **Download** button and select **Download Zip**.
3. Install the unzip utility using the command:

```
sudo apt-get install unzip
```
4. In the terminal window, navigate to the download directory (using the `cd` command), and unzip the driver files to the `home/pi` directory:

```
unzip Linux_Drivers-master.zip -d ~pi
```

These third-party drivers are periodically updated to add support for additional devices.

Click the device type below to go to the procedure for installing the driver:

- USB

- Bluetooth
- Ethernet

Install the USB Linux driver and compile the test programs

Before compiling the USB drivers, you must install additional packages required for communication with USB devices.

1. Download and install the development packages for both libusb and libudev.
libusb is a C library that provides generic access to USB devices.
`sudo apt-get install libusb-1.0-0 libusb-1.0-0-dev`
2. Copy the mcc USB rules file to the `/etc/udev/rules.d` directory, renaming it to `99-mcc.rules` (preventing an issue with the standard naming on the Raspberry Pi):
`sudo cp 61-mcc.rules /etc/udev/rules.d/99-mcc.rules`
3. Clone the hidapi GIT repository to the `home/pi` directory:
HIDAPI is required to interface with Human Interface Devices (HID).
`git clone git://github.com/signal11/hidapi.git`
4. Follow the instructions in the hidapi README.txt to install the hidapi library:
 - a. Install autotools, a suite of programming tools designed to assist in making source code packages portable to Unix-like systems.
The autotools package is required for building the hidapi library.
`sudo apt-get install libudev-dev libfox-1.6-dev autotools-dev autoconf automake libtool`
 - b. Compile the hidapi library:
`cd ~/pi/hidapi`
`./bootstrap`
`./configure`
`make`
`sudo make install`
5. Reboot the Raspberry Pi, and enter your login information when prompted.
6. Install the Linux drivers.
Enter the following code to install the USB drivers and compile the test apps:
`cd ~/pi/usb/mcc-libusb`
`make`
`sudo make install`
`sudo ldconfig`

Install the Bluetooth Linux driver and compile the test programs

Perform the procedure below to download the Bluetooth library and compile the Bluetooth driver.

Before performing this procedure, make sure you already downloaded the Bluetooth drivers using the Download the third-party MCC Linux drivers procedure.

1. Install the Bluetooth library.
To compile the Bluetooth library you need to add the `bluez-libs-devel` package.
`sudo apt-get install libbluetooth-dev bluez-tools`

2. Compile the Bluetooth driver.

```
cd ~pi/Bluetooth
make
sudo make install
```

Type ls to list all of the files.

3. Run an example test app with an MCC Bluetooth DAQ device.

- a. Plug in your MCC Bluetooth device.

- b. Enter the name of a test program exactly as it is written, for example:

```
./test-bth1208LS
```

The test app will display a list of tests that you can perform.

- c. Enter the letter of a command to execute.

Install the Ethernet Linux driver and compile the test programs

Perform the procedure below to compile the Ethernet driver.

Before performing this procedure, make sure you already downloaded the Ethernet drivers using the Download the third-party MCC Linux drivers procedure.

1. Compile the driver:

```
cd ~pi/Ethernet
make
sudo make install
```

Type ls to list all of the files. MCC Ethernet devices require a connection through a network router.

2. Run an example test app with an MCC Ethernet DAQ device.

- a. Plug in your MCC Ethernet device.

- b. Enter the name of a test program exactly as it is written, for example:

```
cd ~pi/usb
./test-E-1608<IP ADDR>
```

The test app will display a list of tests that you can perform.

- c. Enter the letter of a command to execute.

MCC Test Apps

MCC test apps are developed on Linux and are available for most MCC devices. The test apps acquire analog, counter, and digital data (as supported), test device functionality, and display device information.

Refer to the USB/mcc-libusb, Bluetooth, and Ethernet folders at https://github.com/wjasper/Linux_Drivers (https://github.com/wjasper/Linux_Drivers) for the name of each test app. The app name includes the name of the device that it is run with. Note that when a device is part of a Series, one test app applies to each device in the Series. When you run the app, enter the name *exactly* as it is listed.

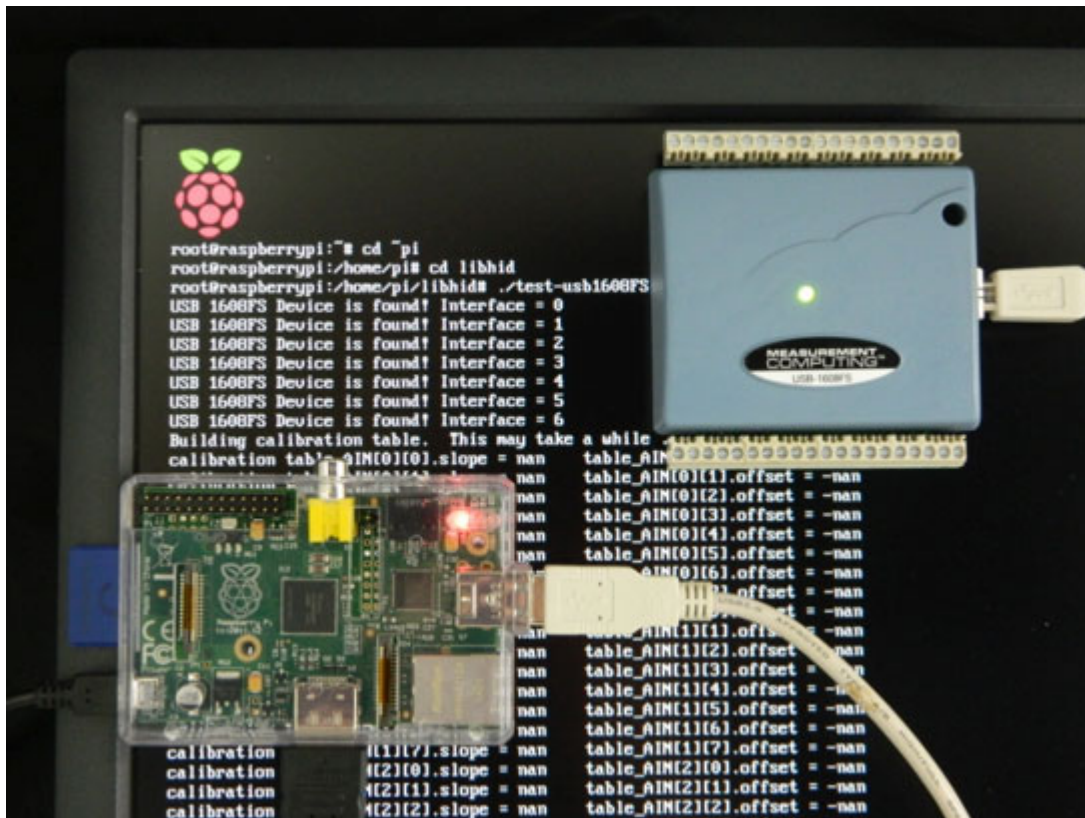
For example, when using a USB-1608GX-2AO, run the test app named "test-usb1608G".

Example: Running a Test App with an MCC USB DAQ Device and Raspberry Pi

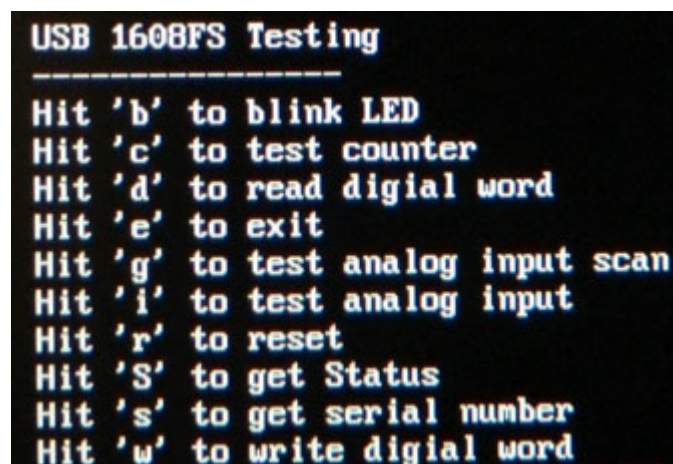
Go to the `mcc-libusb` directory to run the test app and enter the following commands at the `pi@raspberrypi~` command prompt. This example runs the test app for a USB-1608FS:

```
cd ~/mcc-libusb
./test-usb1608FS
```

The test app first detects the device and builds a calibration table that includes a slope and offset from the device analog inputs.



After the calibration table is built, the app displays a list of tests that you can perform.



Each task has a corresponding letter that you enter to run the task. Additional prompts appear if more information is needed, such as a channel number or frequency value. The task will run and the results display on the monitor.

More Information

Contact Measurement Computing Corporation if you have questions about acquiring data with the Raspberry Pi:

- **Knowledgebase:** kb.mccdaq.com (<http://kb.mccdaq.com/>)
- **Phone:** 508-946-5100
- **Fax:** 508-946-9500

For more information about the Raspberry Pi, go to www.raspberrypi.org (<http://www.raspberrypi.org>).

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Acknowledgement

A special thanks to Warren Jasper, PhD, PE, Professor and Textile Engineering Program Director at North Carolina State University. Dr. Jasper remains instrumental to the development and support of Linux drivers for Measurement Computing USB and PCI DAQ devices. We applaud his tireless efforts and dedication to the Linux community. Without his work and continued support, this article and application would not have been possible.

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