Agilent

Using Linux® To Control the U2000 Series USB Power Sensors

Product Note
Controlling USBTMC Instruments from Linux

Most Agilent instruments are message-based, which means they are controlled through text commands, typically following the SCPI standard which is vendor-independent and interface-independent. Agilent devices with several I/O options use the same SCPI commands through all these interfaces.

Agilent advocates standard PC interfaces, especially LAN and USB. This benefits Linux users because there is no need to install proprietary interface drivers, which may not be available for a particular chosen Linux distribution and version. All Linux OS kernels support LAN and USB, so users are free to choose the Linux distribution that best fits their requirements and preferences.

U2000 Series USB power sensors conform to USB Test & Measurement Class (USBTMC) protocol. This simplifies instrument control considerably because such devices behave just like GPIB devices when communicating. Otherwise, the device needs to be controlled using either a vendor-provided driver, or programmed in USB RAW mode, which can be quite a challenge.

Low-level USB drivers are built into today’s Linux kernels to provide basic support for USB. However, these drivers do not provide a low-level programming interfaces to the user applications. In most cases, they are called by another kernel module that supports its corresponding device class.

A USB-based instrument such as one of the U2000 Series power sensors is an example of such a device. A few leading instrument vendors including Agilent cooperated to create a vendor-independent standard for USB instruments known as USBTMC, which most USB instruments today adhere to, especially those from Agilent.

This document describes for users the procedures for compiling and installing an example source code of a USBTMC kernel module. This is followed by examples of communication with the U2000 Series power sensors using common SCPI commands.
Compiling and Installing the USBTMC Kernel Driver

An example source code for USBTMC kernel driver in the form of a TAR archive is available at http://www.agilent.com/find/linux

Copy the TAR archive, usbtmc.tar, to an empty directory. Change to that directory and extract the files with:

tar -xvf usbtmc.tar

The extracted files will include driver source files and a makefile. Compile the driver using that makefile:

make

make will create a kernel object file, usbtmc.ko, which can be installed dynamically using the insmod(8) command:

insmod ./usbtmc.ko

Create device files under /dev by running the usbtmc_load script:

./usbtmc_load

There is an additional utility named usbtmc_ioctl for special instrument operations such as device clear. Compile using:

gcc usbtmc_ioctl.c -o usbtmc_ioctl

Figure 1 Compilation and installation of the USBTMC kernel driver
**Using the USBTMC Driver**

The example USBTMC driver dynamically assigns the next unused minor number to each USBTMC device following the order in which the USB core notifies the driver of the existence of new USB devices. To communicate with an instrument, we need to know which minor number the device is issued.

In the example USBTMC driver, minor number 0 has been reserved for communication with the USBTMC driver itself. Therefore, to know which device is assigned to what minor number, read from minor number 0 using:

```
cat /dev/usbtmc0
```

This will list the product serial number, manufacturer ID, and minor number of each device as shown in Figure 2.

SCPI commands are sent to a device by redirecting the command string to its device file. For example, the first USBTMC device may be preset default values with:

```
echo SYST:PRES DEF>/dev/usbtmc1
```

See Figure 3.

Similar to reading from the minor 0, cat is used to read from other USBTMC devices:

```
echo *IDN?>/dev/usbtmc1
```

followed by:

```
cat /dev/usbtmc1
```

This will print the ID of the device as shown in Figure 4.
Using the USBTMC Driver (continued)

Figures 5, 6, and 7 use the example to show how to make a quick power measurement for a 1 GHz signal of 3 dBm.

An internal zeroing process is performed on the power sensor using:

```
echo CAL:ZERO:TYPE INT
```

```
echo CAL >/dev/usbtmc1
```

See Figure 5.

Enter the power sensor’s frequency of 1 GHz with:

```
echo SENS:FREQ 1GHZ >/dev/usbtmc1
```

See Figure 6.

Set a query to the power measurement with:

```
echo FETCH? >/dev/usbtmc1
```

See Figure 7.

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**Figure 5** To perform internal zeroing on the power sensor

**Figure 6** To enter the power sensor’s frequency

**Figure 7** To query the power measurement
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