

Agilent

Using Linux[®] To Control the U2000 Series USB Power Sensors

Product Note



Agilent Technologies

Controlling USBTMC Instruments from Linux

Most Agilent instrument 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 instruments 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:

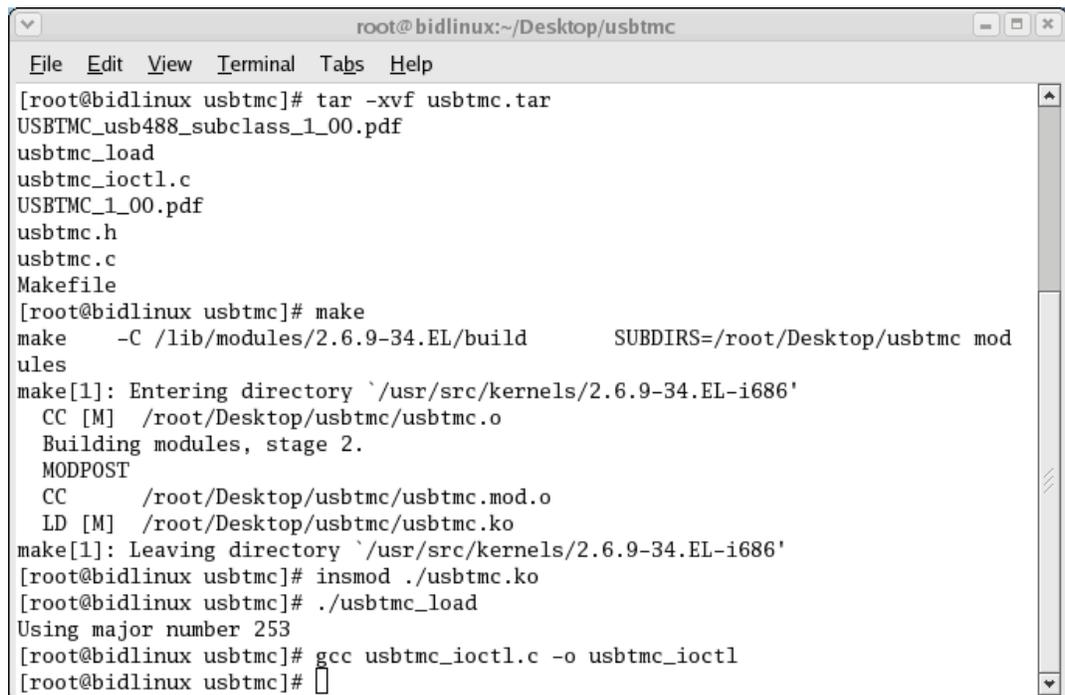
```
insmod ./usbtmc.ko
```

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
```



```
root@bidlinux:~/Desktop/usbtmc
File Edit View Terminal Tabs Help
[root@bidlinux usbtmc]# tar -xvf usbtmc.tar
USBTMC_usb488_subclass_1_00.pdf
usbtmc_load
usbtmc_ioctl.c
USBTMC_1_00.pdf
usbtmc.h
usbtmc.c
Makefile
[root@bidlinux usbtmc]# make
make -C /lib/modules/2.6.9-34.EL/build SUBDIRS=/root/Desktop/usbtmc modules
make[1]: Entering directory `/usr/src/kernels/2.6.9-34.EL-i686'
  CC [M] /root/Desktop/usbtmc/usbtmc.o
  Building modules, stage 2.
  MODPOST
  CC /root/Desktop/usbtmc/usbtmc.mod.o
  LD [M] /root/Desktop/usbtmc/usbtmc.ko
make[1]: Leaving directory `/usr/src/kernels/2.6.9-34.EL-i686'
[root@bidlinux usbtmc]# insmod ./usbtmc.ko
[root@bidlinux usbtmc]# ./usbtmc_load
Using major number 253
[root@bidlinux usbtmc]# gcc usbtmc_ioctl.c -o usbtmc_ioctl
[root@bidlinux usbtmc]#
```

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.

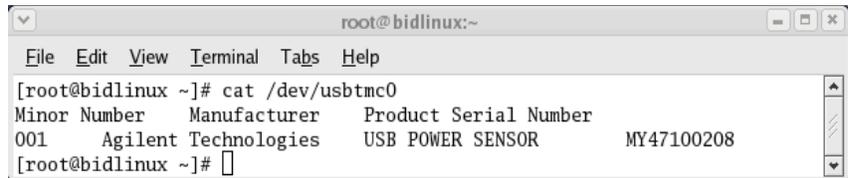
Similar to reading from the minor 0, cat is used to read from other USBTMC devices:

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

followed by:

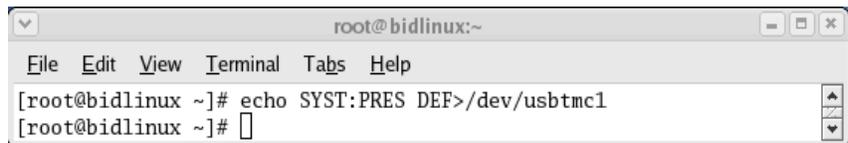
```
cat /dev/usbtmc1
```

This will print the ID of the device as shown in Figure 4.



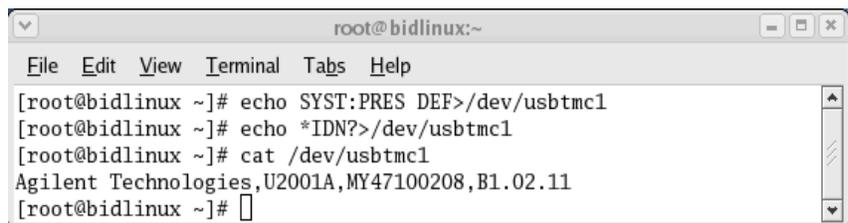
```
root@bidlinux:~  
File Edit View Terminal Tabs Help  
[root@bidlinux ~]# cat /dev/usbtmc0  
Minor Number  Manufacturer  Product Serial Number  
001      Agilent Technologies  USB POWER SENSOR      MY47100208  
[root@bidlinux ~]#
```

Figure 2 List of USBTMC devices attached



```
root@bidlinux:~  
File Edit View Terminal Tabs Help  
[root@bidlinux ~]# echo SYST:PRES DEF>/dev/usbtmc1  
[root@bidlinux ~]#
```

Figure 3 To preset the first USBTMC device



```
root@bidlinux:~  
File Edit View Terminal Tabs Help  
[root@bidlinux ~]# echo SYST:PRES DEF>/dev/usbtmc1  
[root@bidlinux ~]# echo *IDN?>/dev/usbtmc1  
[root@bidlinux ~]# cat /dev/usbtmc1  
Agilent Technologies,U2001A,MY47100208,B1.02.11  
[root@bidlinux ~]#
```

Figure 4 To obtain device ID

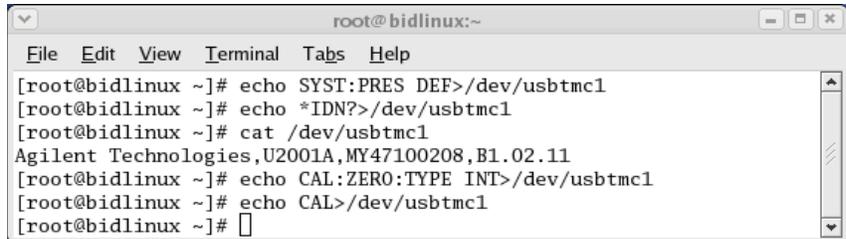
Using the USBTMC Driver (continued)

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.



```
root@bidlinux:~  
File Edit View Terminal Tabs Help  
[root@bidlinux ~]# echo SYST:PRES DEF>/dev/usbtmc1  
[root@bidlinux ~]# echo *IDN?>/dev/usbtmc1  
[root@bidlinux ~]# cat /dev/usbtmc1  
Agilent Technologies,U2001A,MY47100208,B1.02.11  
[root@bidlinux ~]# echo CAL:ZERO:TYPE INT>/dev/usbtmc1  
[root@bidlinux ~]# echo CAL>/dev/usbtmc1  
[root@bidlinux ~]#
```

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

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

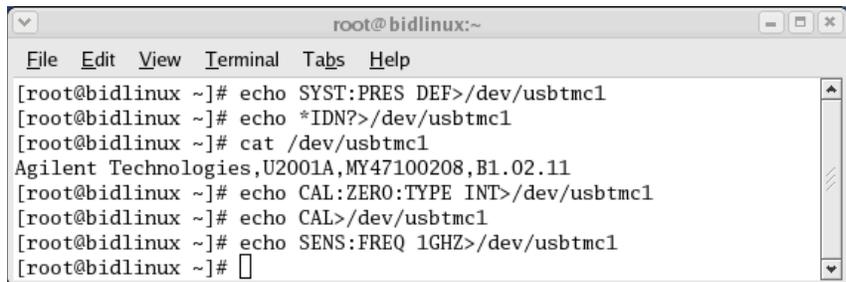
See Figure 6.

Set a query to the power measurement with:

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

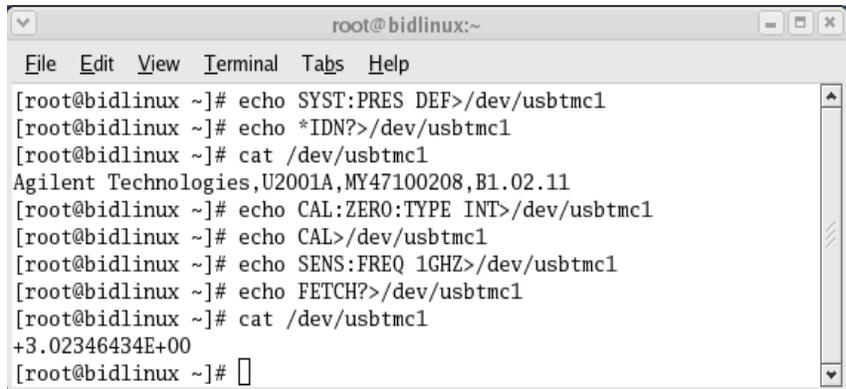
See Figure 7.

Figure 5 To perform internal zeroing on the power sensor



```
root@bidlinux:~  
File Edit View Terminal Tabs Help  
[root@bidlinux ~]# echo SYST:PRES DEF>/dev/usbtmc1  
[root@bidlinux ~]# echo *IDN?>/dev/usbtmc1  
[root@bidlinux ~]# cat /dev/usbtmc1  
Agilent Technologies,U2001A,MY47100208,B1.02.11  
[root@bidlinux ~]# echo CAL:ZERO:TYPE INT>/dev/usbtmc1  
[root@bidlinux ~]# echo CAL>/dev/usbtmc1  
[root@bidlinux ~]# echo SENS:FREQ 1GHZ>/dev/usbtmc1  
[root@bidlinux ~]#
```

Figure 6 To enter the power sensor's frequency



```
root@bidlinux:~  
File Edit View Terminal Tabs Help  
[root@bidlinux ~]# echo SYST:PRES DEF>/dev/usbtmc1  
[root@bidlinux ~]# echo *IDN?>/dev/usbtmc1  
[root@bidlinux ~]# cat /dev/usbtmc1  
Agilent Technologies,U2001A,MY47100208,B1.02.11  
[root@bidlinux ~]# echo CAL:ZERO:TYPE INT>/dev/usbtmc1  
[root@bidlinux ~]# echo CAL>/dev/usbtmc1  
[root@bidlinux ~]# echo SENS:FREQ 1GHZ>/dev/usbtmc1  
[root@bidlinux ~]# echo FETCH?>/dev/usbtmc1  
[root@bidlinux ~]# cat /dev/usbtmc1  
+3.02346434E+00  
[root@bidlinux ~]#
```

Figure 7 To query the power measurement

Related Literature

[1] *Agilent AN 1465-30 Using Linux to Control USB Instruments, Application Note, Literature Number: 5989-6718EN*

[2] *Agilent AN 1465-27 Using Linux in Your Test Systems: Linux Basics, Application Note, Literature Number: 5989-6715EN*

Related Web Resources

[Linux Test Automation](#)



Agilent Email Updates

www.agilent.com/find/emailupdates
Get the latest information on the products and applications you select.



Agilent Direct

www.agilent.com/find/agilentdirect
Quickly choose and use your test equipment solutions with confidence.



www.agilent.com/find/open
Agilent Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Agilent offers open connectivity for a broad range of system-ready instruments, open industry software, PC-standard I/O and global support, which are combined to more easily integrate test system development.

Windows and Excel are the US registered trademarks of Microsoft Corporation in the United States and/or other countries.

Linux® is the registered trademark of Linus Torvalds in the U.S. and other countries.

Remove all doubt

Our repair and calibration services will get your equipment back to you, performing like new, when promised. You will get full value out of your Agilent equipment throughout its lifetime. Your equipment will be serviced by Agilent-trained technicians using the latest factory calibration procedures, automated repair diagnostics and genuine parts. You will always have the utmost confidence in your measurements.

Agilent offers a wide range of additional expert test and measurement services for your equipment, including initial start-up assistance, onsite education and training, as well as design, system integration, and project management.

For more information on repair and calibration services, go to:

www.agilent.com/find/removealldoubt

www.agilent.com

For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office. The complete list is available at:

www.agilent.com/find/contactus

Americas

Canada	(877) 894-4414
Latin America	305 269 7500
United States	(800) 829-4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Thailand	1 800 226 008

Europe & Middle East

Austria	0820 87 44 11
Belgium	32 (0) 2 404 93 40
Denmark	45 70 13 15 15
Finland	358 (0) 10 855 2100
France	0825 010 700*
	*0.125 €/minute
Germany	01805 24 6333**
	**0.14 €/minute
Ireland	1890 924 204
Israel	972-3-9288-504/544
Italy	39 02 92 60 8484
Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
Switzerland	0800 80 53 53
United Kingdom	44 (0) 118 9276201

Other European Countries:

www.agilent.com/find/contactus

Revised: March 27, 2008

Product specifications and descriptions in this document subject to change without notice.

© Agilent Technologies, Inc. 2008
Printed in USA, September 5, 2008
5989-8744EN



Agilent Technologies