

Raspberry Pi Datalogger

9/17/2016

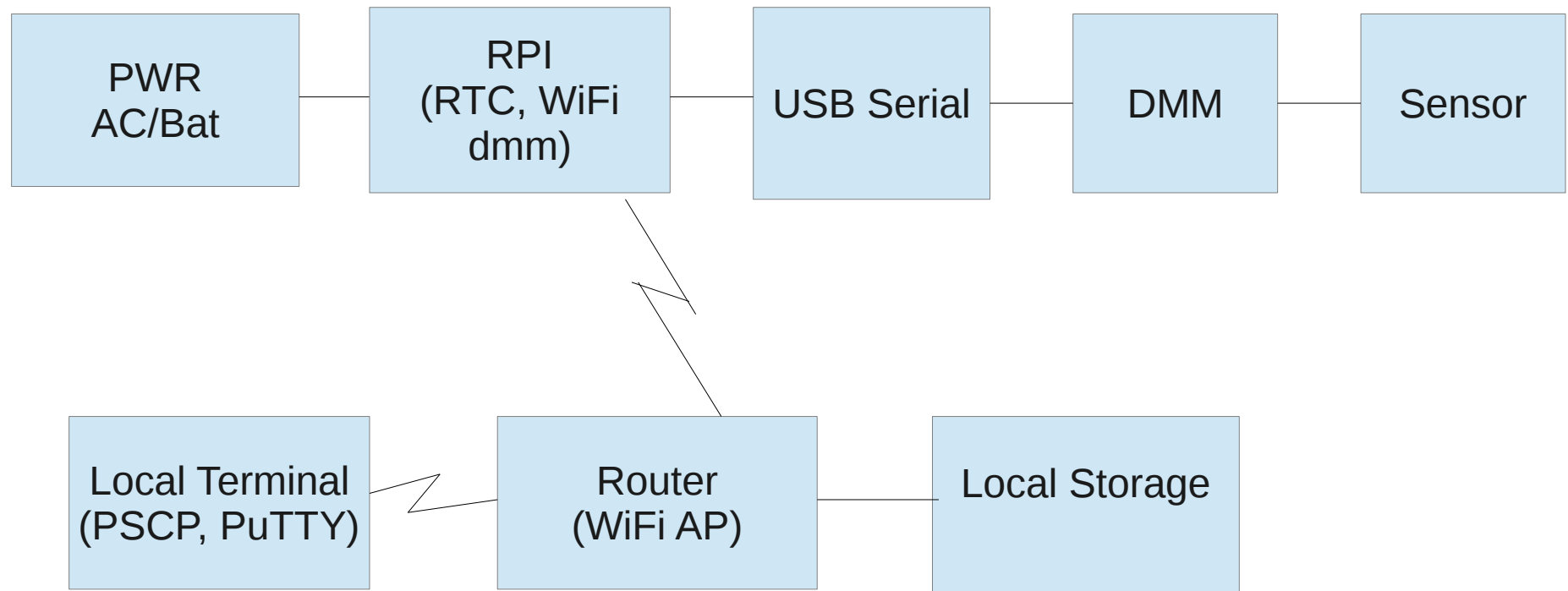
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Presentation and Source at:
<https://groups.yahoo.com/neo/groups/dallasrpi/files>
Raspberry Pi Datalogger 2016-0917.zip

Introduction

- Connect Raspberry Pi 2 Model B (RPI) to various Radio Shack Digital Multimeters (DMM).
- Configure software to get meter readings every T seconds
- Include timestamps from RPI Real Time Clock (RTC)
- Save Comma Seperated Variable (CSV) records to file
- Remote terminal to control RPI
- Enable data file copy to remote terminal during capture

Datalogger Block Diagram



RPI, Battery, Serial



Three Radio Shack DMM Models

	Micronta Radio Shack 22-182	Radio Shack 22-812	Radio Shack 2200087
circa	1992	2002	2015
interface	RS-232	RS-232	USB
Frame format	14 Ascii Char	Binary, LED segment	Binary, LED segment
Linux Open source basis	dvm.exe [dvm]	zmeter-0.1.3.tgz [zmeter]	2200087-Serial-Protocol.git [rs87]
language	c	c	Python

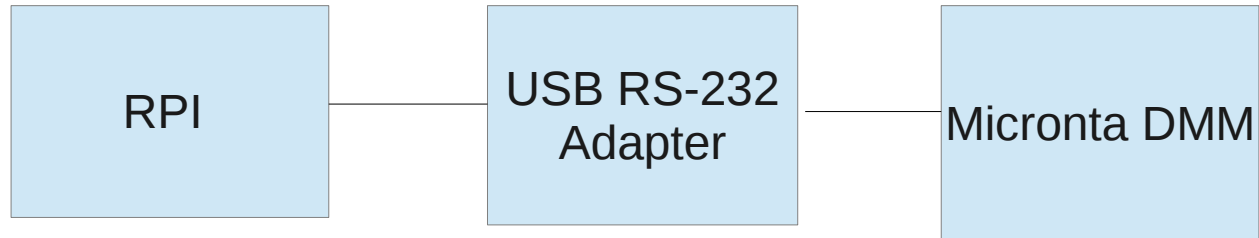


rpi datalogger 2016-0917

Example Application

- Monitor house and air conditioning power consumption
- Correlate with weather and attic temp data
- Do reflective shingles matter?

USB RS-232 Adapter



- Get Raspbian to assign a file descriptor
- Adds ttyUSBx to Raspbian, e.g. ttyUSB0



Install USB RS232 Adapter on RPI

- * To install and run USB-Serial on RPI,:
- * disconnect USB-serial adapter to be used with a DMM
- * `$ lsusb`
 - * note: note serial adapters, if any, e.g. `ttyUSBx`
- * connect, for example, Micro Innovations USB-Serial adapter between RPI and DMM.
- * `$ lsusb`
 - * shows Prolific Tech PL2303 Serial
 - * note port as bus 001 device 009 ID 067b:2303
- * `$ dmesg`
 - * note for USB serial `idVendor=067b`, `idProduct=2303`, which confirms vendor and product.
- * `$ sudo modprobe usbserial vendor=0x067b product=0x2303`
 - * attaches USB-Serial adapter to linux kernel.
- * `$ dmesg`
 - * note last line: `usb 1-1.3: pl2303 converter now attached`
 - * as `ttyUSBx`, e.g. `ttyUSB0`
- *

Terminal showing ttyUSB0

```
pi@raspberrypi ~ $ lsusb
```

```
...
```

```
Bus 001 Device 012: ID 067b:2303 Prolific Technology, Inc. PL2303 Serial Port
```

```
...
```

```
pi@raspberrypi ~ $ dmesg
```

```
...
```

```
[17978.437686] usb 1-1.3: New USB device found, idVendor=067b,  
idProduct=2303
```

```
...
```

```
pi@raspberrypi ~ $ sudo modprobe usbserial vendor=0x067b, product=0x2303
```

```
pi@raspberrypi ~ $ dmesg
```

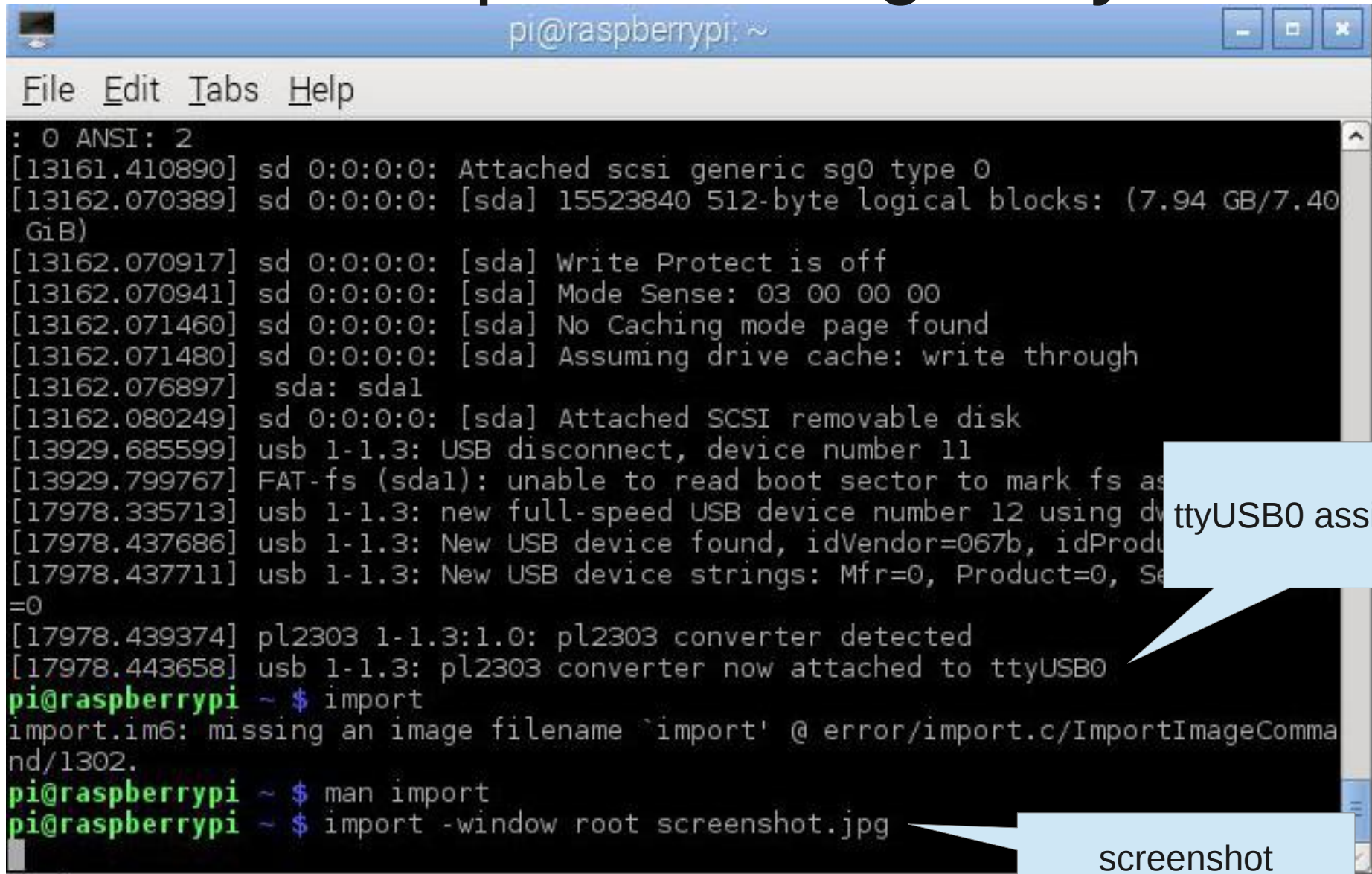
```
...
```

```
[17978.439374] pl2303 1-1.3:1.0: pl2303 converter detected
```

```
[17978.443658] usb 1-1.3: pl2303 converter now attached to ttyUSB0
```

```
pi@raspberrypi ~ $
```

\$ sudo modprobe assigns ttyUSB0



```
pi@raspberrypi: ~
File Edit Tabs Help
: 0 ANSI: 2
[13161.410890] sd 0:0:0:0: Attached scsi generic sg0 type 0
[13162.070389] sd 0:0:0:0: [sda] 15523840 512-byte logical blocks: (7.94 GB/7.40
GiB)
[13162.070917] sd 0:0:0:0: [sda] Write Protect is off
[13162.070941] sd 0:0:0:0: [sda] Mode Sense: 03 00 00 00
[13162.071460] sd 0:0:0:0: [sda] No Caching mode page found
[13162.071480] sd 0:0:0:0: [sda] Assuming drive cache: write through
[13162.076897] sda: sda1
[13162.080249] sd 0:0:0:0: [sda] Attached SCSI removable disk
[13929.685599] usb 1-1.3: USB disconnect, device number 11
[13929.799767] FAT-fs (sda1): unable to read boot sector to mark fs as
[17978.335713] usb 1-1.3: new full-speed USB device number 12 using dw
[17978.437686] usb 1-1.3: New USB device found, idVendor=067b, idProdu
[17978.437711] usb 1-1.3: New USB device strings: Mfr=0, Product=0, Se
=0
[17978.439374] pl2303 1-1.3:1.0: pl2303 converter detected
[17978.443658] usb 1-1.3: pl2303 converter now attached to ttyUSB0
pi@raspberrypi ~ $ import
import.im6: missing an image filename `import' @ error/import.c/ImportImageComma
nd/1302.
pi@raspberrypi ~ $ man import
pi@raspberrypi ~ $ import -window root screenshot.jpg
```

dmm.c

```
/* dmm -- digital multimeter Micronta (Radio Shack 22-182)
*
* Description:
* A simple program to read a value from the Micronta (Radio Shack 22-182)
* digital multimeter, DMM, every sec_per_sample seconds.
* The program dmm is adapted from
* Radio Shack DMM with RS-232 [dvm]. Output is sent to stdout and
* to daily datalog file[date].txt.
* To exit and close open files, press "enter" key
* and wait for next sample. If dmm seems to hang waiting for data from
* DMM, press "COM" key on DMM to start communication. After data starts
* press "COM" again to keep from getting corrupted data frames.
*
* Configuration:
* Micronta (Radio Shack 22-182) Digital Multimeter (DMM) connected to
* Raspberry Pi (RPI) 2 Model B running Rasperian NOOBS (Debian). The DMM
* is connected to the RPI via a Micro Innovations USB-Serial adapter.
*/
```

DMM.C Outline

```
open tty port
set tty parameters 1200,7,2,n
while not kbhit()
    get date
    open datafile yymmdd.txt append
    purge ttyUSB0 buffer
    purge dmm meter buffer
    get time
    write timestamp to datafile
    read dmm sample
    parse dmm sample
    write sample to datafile
    close datafile
purge stdin
close ttyUSB0
```

dmm.exe terminal screenshot

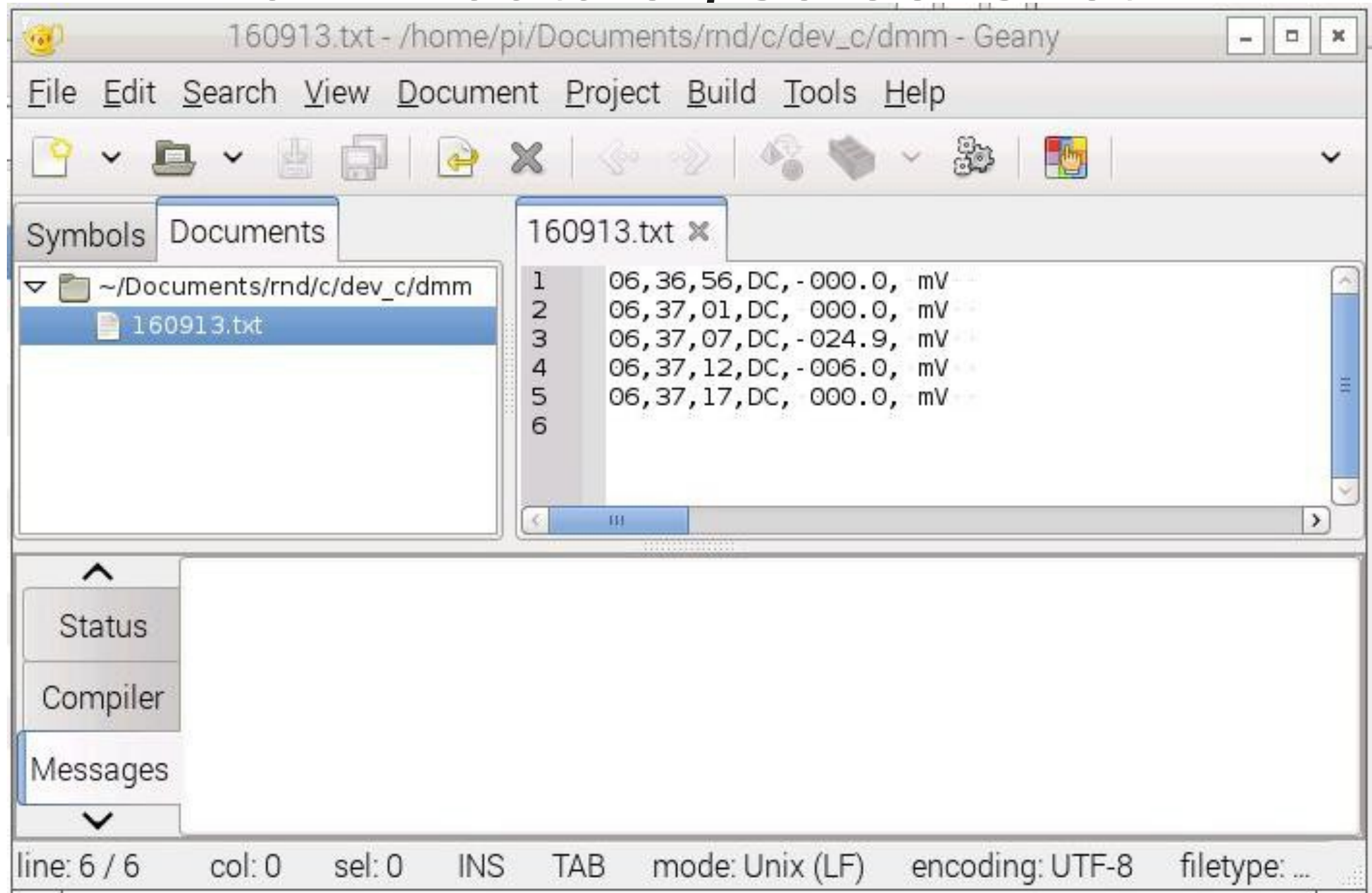
```
pi@raspberrypi: ~/Documents/rnd/c/dev_c/dmm
File Edit Tabs Help
index 0x0002: -19
[74611.094186] ax88179_178a 1-1.3.1:1.0 eth1 (unregistered): Failed to write reg
index 0x0001: -19
[74611.094209] ax88179_178a 1-1.3.1:1.0 eth1 (unregistered): Failed to write reg
index 0x0002: -19
[74619.484199] usb 1-1.3: new full-speed USB device number 34 using dwc_otg
[74619.586131] usb 1-1.3: New USB device found, idVendor=067b, idProduct=
[74619.586156] usb 1-1.3: New USB device strings: Mfr=0, Product=0, S
=0
[74619.587532] pl2303 1-1.3:1.0: pl2303 converter detected
[74619.591568] usb 1-1.3: pl2303 converter now attached to ttyUSB0
pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $ ./dmm.exe /dev/ttyUSB0 5
dmm -- digital multimeter Micronta ver: 2016-0817draft
usage: ./dmm.exe /dev/ttyUSB0 [int sec_per_sample]
Seconds per sample: 5
press 'enter' key to exit
06,36,56, DC-000.0 mV
06,37,01, DC 000.0 mV
06,37,07, DC-024.9 mV
06,37,12, DC-006.0 mV
06,37,17, DC 000.0 mV
pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $ import -window root screenshot.jpg
```

dvm.c (orig) → dmm.c (Scott)

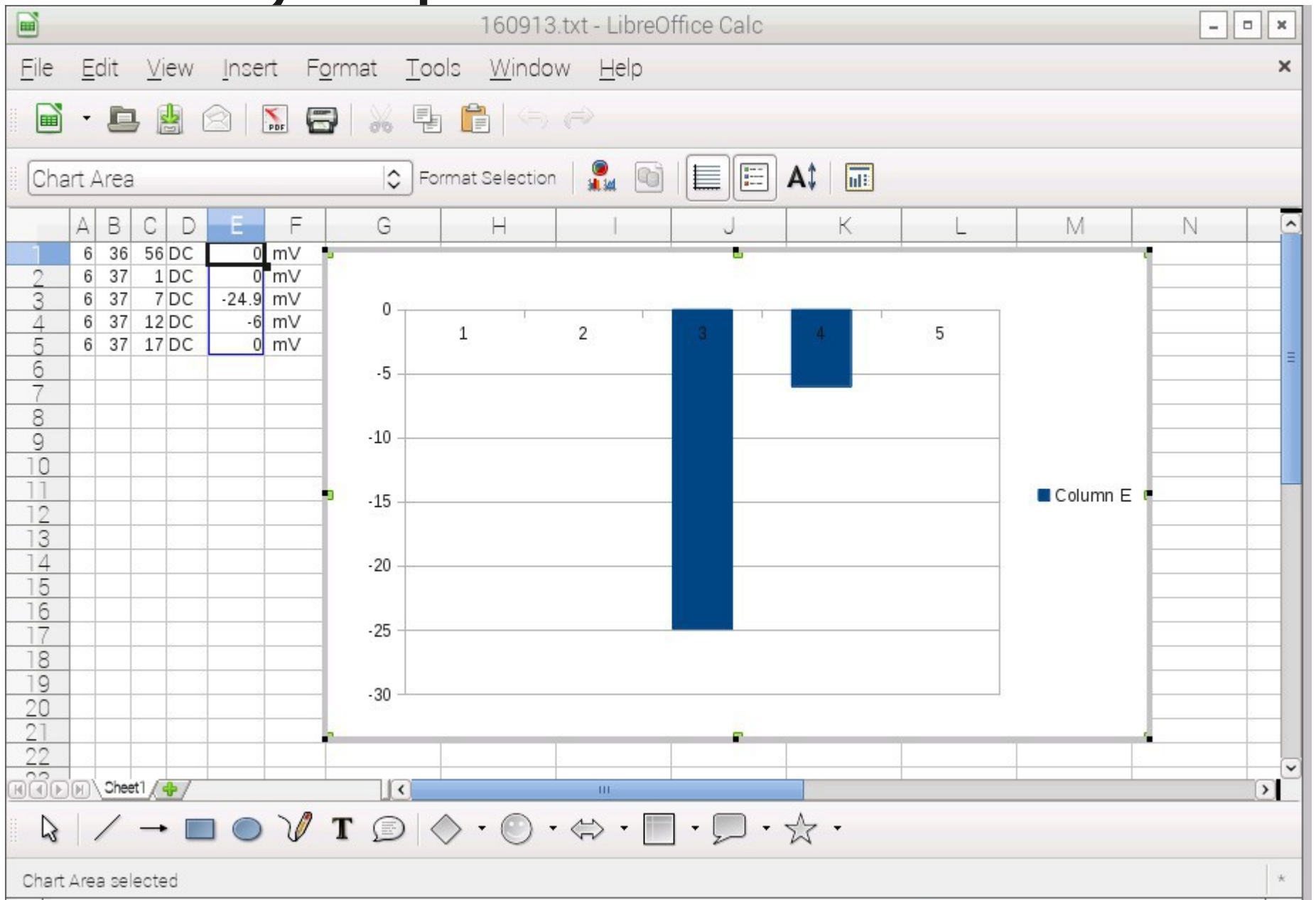
/* Change log:

- * 2016-0816, Scott Marin, changed write c to printf c for DMM readings.
- * Added date and time stamps [time][kr2] in semi Virtual Weather Station
- * [vsw] format. Enabled daily datalog file (yymmdd.txt) in comma
- * separated variable (csv) format that LibreOffice Calc reads and plots.
- * Incorporated substring function [mid], similar to Basic MID\$ function,
- * to break DMM data frame into type, value, and units fields. Added
- * optional command line parameter to set sample period, sec_per_sample.
- * FIXME02, dmm requires pressing "COM" on DMM to start samples and
- * pressing "COM" again, i.e. "COM" off, to avoid corrupting samples.
- *
- * 2016-0815, Scott Marin, Changed name to dmm. Added stdlib.h to resolve
- * implicit declaration warnings. Added kbhit() to do a non-blocking
- * test of a keyboard hit and to break the capture loop when an
- * "enter" key is pressed [kbhit]. Added tcflush statement to
- * resolve FIXME01 buffer issue. Added sec_per_sample constant
- * and set to 10 sec, which works well for debug and recording.
- *
- * 2016-0813, Scott Marin, adapted from
- * <http://www.linuxtoys.org/dvm/dvm.html> [dvm]
- * for Raspberry Pi (RPI) 2 Model B running Raspbian NOOBS (Debian)
- * and using gcc 4.6 compiler. 5ea warnings exit() implicit declaration
- * -- ignored. dvm working.
- * FIXME01, buffer issue in that output follows input after many samples.
- */

dmm datalog screenshot



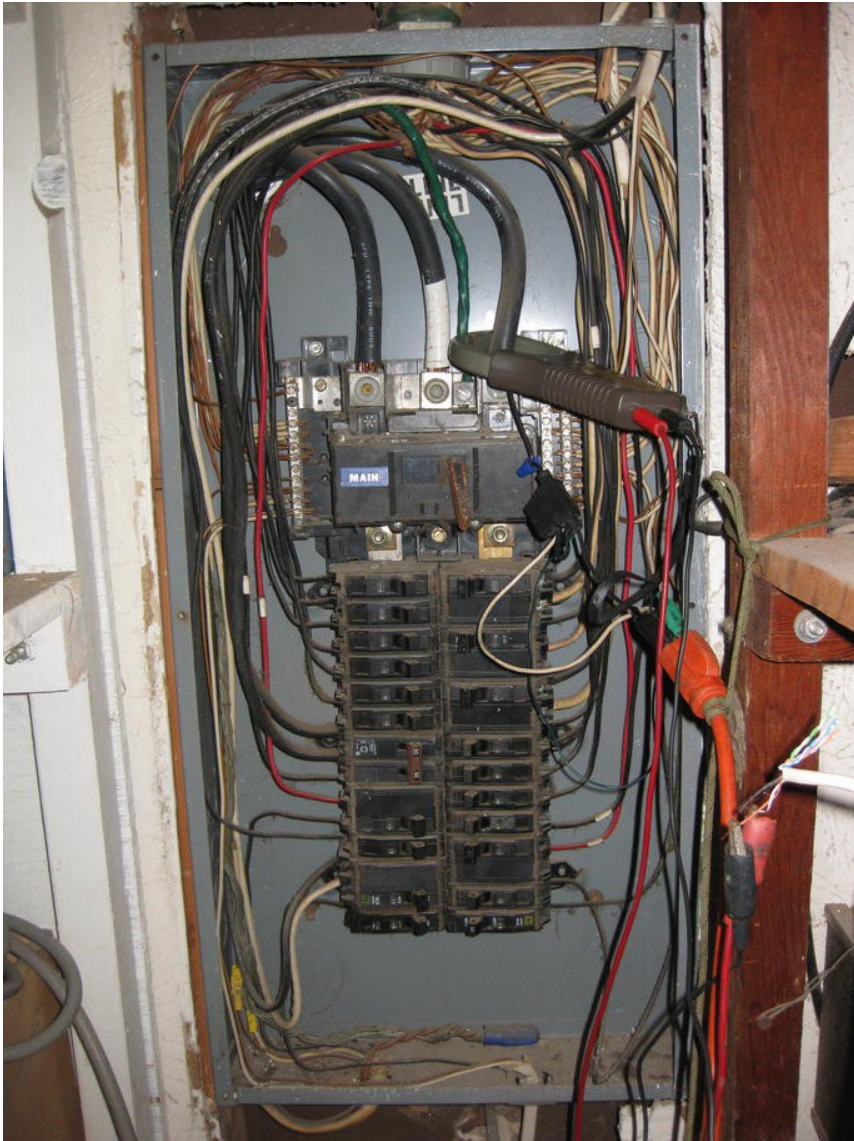
Directly import DMM datafile into



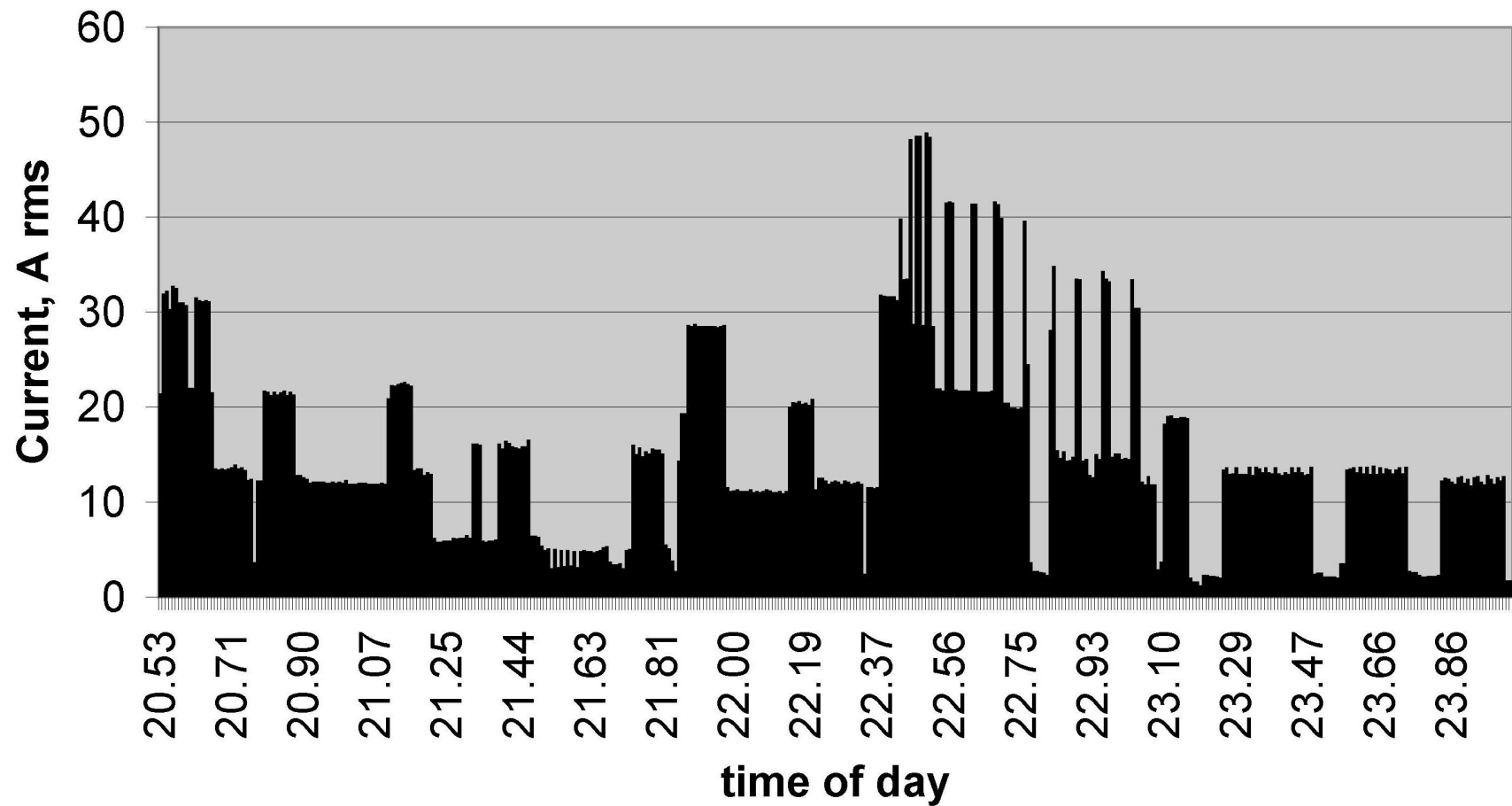
Real World Data

- House Current, 131 Skyline Dr, Murphy, TX
- Clamp-on current transformer on right leg of 240 V feed between TXU meter and main circuit breaker
- Micronta DMM 100 ft away connected by cat5e pair terminated at DMM with 10k ohm resistor in parallel with .22 uF capacitor.
- ~3 hrs of data collected at 30 sec/sample
- 50 amp peaks around 22:00 due to dish washer, dryer, cloths washer, and air conditioning.

Breaker panel, current probe



**House Current, 131 Skyline, 9/14/2016,
247 Vrms, 30 Sec/sample, 12.9 kVAhr**



Remote Terminal access to RPI data

Remote Terminal: “B2” ASUS T100 Win10

Software:

- PuTTY – free Secure Shell (SSH) client
 - RFC4253, Jan 2006
 - secure transport
 - alternative to telnet
 - pairs with RPI Raspbian SSH server
 - starts in windows
 - runs in a command window

- PSCP – PuTTY secure copy client
 - uses SSH
 - runs in MS-DOS command window
 - requires PSCP.exe to be in DOS path

Remotely launch dmm.exe on RPI

RPI terminal:

```
$ ifconfig
```

Note RPI IP address, e.g. 192.168.1.112

RT:

click PuTTY icon

enter RPI IP address, e.g. 192.168.1.112

logon to RPI

```
$ cd ~/Documents/rnd/c/dev_c/dmm
```

turn on dmm

```
$ ./dmm.exe /dev/ttyUSB0 10
```

note data samples

<--| Enter to end dmm.exe

```
$ exit
```

exit PuTTY

launch MS-DOS command window

On RPI, get RPI IP address

```
pi@raspberrypi: ~/Documents/rnd/c/dev_c/dmm
File Edit Tabs Help

UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:5337 errors:0 dropped:5 overruns:0 frame:0
TX packets:4219 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:977081 (954.1 KiB) TX bytes:2780784 (2.6 MiB)

pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $ ifconfig -s
Iface MTU Met RX-OK RX-ERR RX-DRP RX-OVR TX-OK TX-ERR TX-DRP TX-OVR Flg
eth0 1500 0 3237 0 0 0 614 0 0 0 0 B
lo 65536 0 336 0 0 0 336 0 0 0 0 L
wlan0 1500 0 5340 0 5 0 4221 0 0 0 0 B

pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $ ifconfig wlan0
wlan0 Link encap:Ethernet Hwaddr 74:da:38:58:b1:06
inet addr:192.168.1.112 Bcast:192.168.1.255 Mask:255.255.255.0
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:5340 errors:0 dropped:5 overruns:0 frame:0
TX packets:4221 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:977351 (954.4 KiB) TX bytes:2780980 (2.6 MiB)

pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $
```

On RT, Putty Command Window

enter RPI user name & password

```
pi@raspberrypi: ~/Documents/rnd/c/dev_c/dmm
login as: pi
pi@192.168.1.112's password:
Linux raspberrypi 3.18.7-v7+ #755 SMP PREEMPT Thu Feb 12 17:20:48 GMT 2016; root@raspberrypi:~# ls -l
1
The programs included with the Debian GNU/Linux system are free software; the
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Sep 14 08:22:59 2016 from b2.ds
pi@raspberrypi ~ $ cd ~/Documents/rnd/c/dev_c/dmm
pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $ ls
160816.txt 160820.txt 160823.txt 160825.txt 160914.txt dmm.exe
160817.txt 160822.txt 160824.txt 160913.txt dmm.c
pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $
```

Navigate to folder of dmm.exe

note datalog files

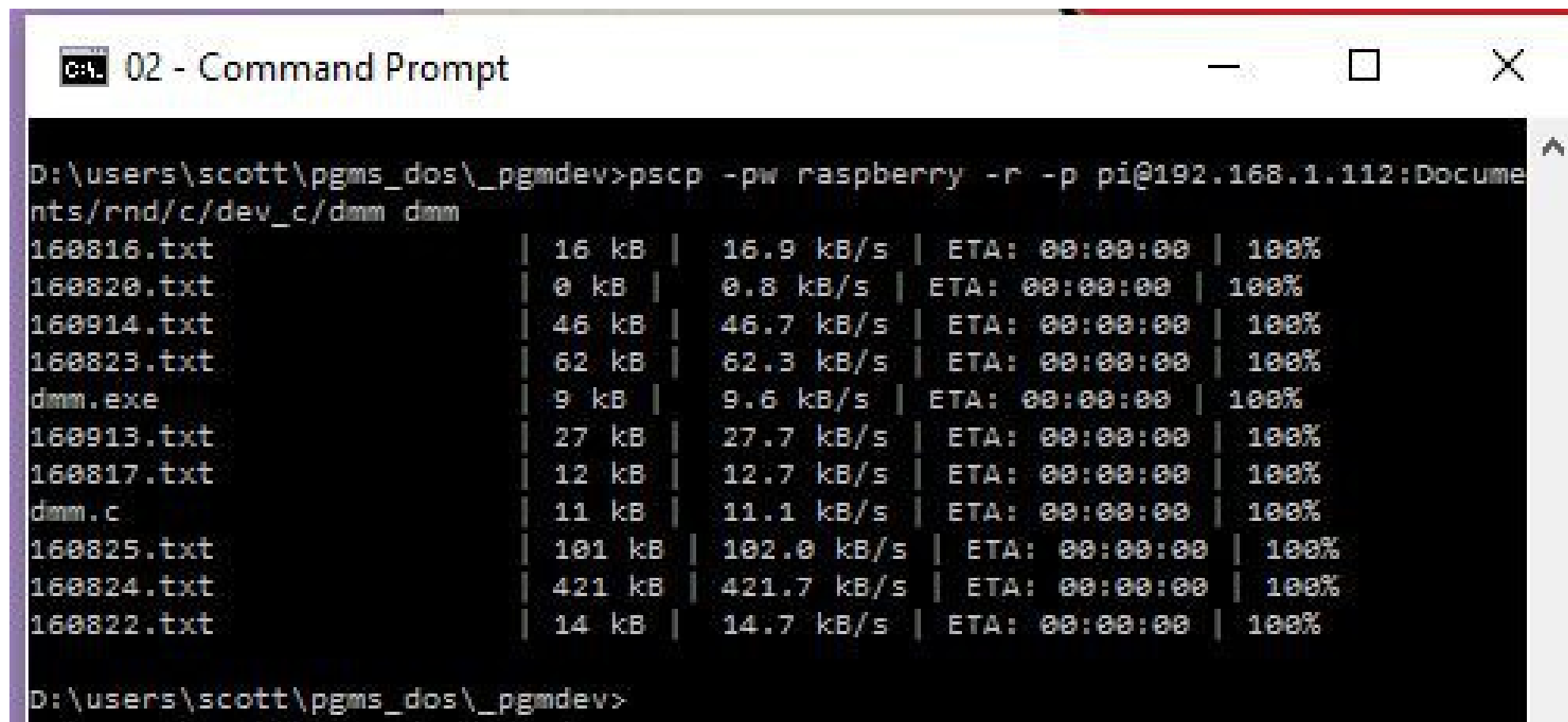
run dmm.exe via RT PuTTY

run dmm.exe using ttyUSB0 10 sec/sample

```
pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $ ./dmm.exe /dev/ttyUSB0 10
dmm -- digital multimeter Micronta 22-182 ver: 2016-0914
usage: ./dmm.exe /dev/ttyUSB0 [int sec_per_sample]
Seconds per sample: 10
press 'enter' key to exit
08,30,26, p002.0 mV
08,30,36, AC 002.0 mV
08,30,46, AC 002.0 mV
08,30,56, AC 002.0 mV
08,31,07, AC 001.9 mV
08,31,17, AC 001.9 mV

08,31,27, AC 001.9 mV
pi@raspberrypi ~/Documents/rnd/c/dev_c/dmm $
```


On RT, pscp from RPI to RT



```
02 - Command Prompt
D:\users\scott\pgms_dos\_pgmdev>pscp -pw raspberry -r -p pi@192.168.1.112:Documents/rnd/c/dev_c/dmm dmm
160816.txt | 16 kB | 16.9 kB/s | ETA: 00:00:00 | 100%
160820.txt | 0 kB | 0.8 kB/s | ETA: 00:00:00 | 100%
160914.txt | 46 kB | 46.7 kB/s | ETA: 00:00:00 | 100%
160823.txt | 62 kB | 62.3 kB/s | ETA: 00:00:00 | 100%
dmm.exe | 9 kB | 9.6 kB/s | ETA: 00:00:00 | 100%
160913.txt | 27 kB | 27.7 kB/s | ETA: 00:00:00 | 100%
160817.txt | 12 kB | 12.7 kB/s | ETA: 00:00:00 | 100%
dmm.c | 11 kB | 11.1 kB/s | ETA: 00:00:00 | 100%
160825.txt | 101 kB | 102.0 kB/s | ETA: 00:00:00 | 100%
160824.txt | 421 kB | 421.7 kB/s | ETA: 00:00:00 | 100%
160822.txt | 14 kB | 14.7 kB/s | ETA: 00:00:00 | 100%
D:\users\scott\pgms_dos\_pgmdev>
```

Future

- auto boot headless RPI (no screen, keyboard, and mouse)
- auto RPI WiFi connect
- RPI emails it's IP address to “phone home”
- auto start dmm.exe
- RT can see stdin, stop, or re-start dmm.exe

References

- **[dmm87]** Radio Shack 2200087 Digital Multimeter, <https://github.com/ddworken/2200087-Serial-Protocol>
- **[dvm]** Micronta Radio Shack 22-181 Digital Multimeter, <http://www.linuxtoys.org/dvm/dvm.html>. no copywrite, no license. Code seems to public but without a specific license.
- **[kbhit]** <http://cc.byexamples.com/2007/04/08/non-blocking-user-input-in-loop-without-ncurses>, no copywrite, no license. Code seems to public but without a specific license.
- **[kr2]** Brian Kernigahan and Dennis Richie, "The C Programming Language", 2nd ed., 1988.
- **[mid]** Substring in c programming, <http://www.programmingsimplified.com/c/source-code/c-substring>. Programming Simplified is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License. You are free to: Share — copy and redistribute the material in any medium or format. The licensor cannot revoke these freedoms as long as you follow the license terms.
- **[time]** https://www.gnu.org/software/libc/manual/html_node/Time-Functions-Example.html, Copyright 2016 Free Software Foundation, Inc. Verbatim copying and distribution of this entire article is permitted in any medium, provided this notice is preserved
- **[vws]** Virtual Weather Station, <http://www.ambientweather.com/software.html>
- **[zmeter]** Radio Shack 22-812 Digital Multimeter, <http://zmeter.sourceforge.net/>

Summary

- RPI, USB-RS232 adapter, and Micronta 22-182 Multimeter work good as a datalogger
- Install USB-RS232 adapter into Raspbian via terminal commands
- Run dmm.exe to capture data in csv format
- Graph data using, for example, LibreOffice Calc
- On Win10 remote terminal, use PuTTY to remotely run dmm.exe
- On Win10 remote terminal, use PSCP to transfer datalogs from RPI to RT while dmm.exe is running