

# INSTRUCTIONS for DEMO30x.py SAMPLE SOFTWARE For Model 301, 302, EMF2 and EMF6

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## 1) Getting Started

Demo30x.py Sample Software supports Lawson Labs USB Data Acquisition Systems including the Model 301, Model 302, Model 302EXP, EMF2, or EMF6. A Windows XP, or later, computer with at least one USB port is required. Demo30x.py uses LL\_USB.dll and the Lawson Labs USB windows drivers, either 32 or 64 bit, which are documented elsewhere. Similar sample code for LINUX is available at [http://www.lawsonlabs.com/specExternal301\\_Developer.html#30xPythonWin](http://www.lawsonlabs.com/specExternal301_Developer.html#30xPythonWin).

If you have a Model 301 or EMF2, the analog outputs and input channels 2, 3, 4, & 5 are not available. Channels 0, 1, 6 and 7 are the same for all. The EMF6 has all the input channels, but no analog outputs or digital input/output.

## 2) Hardware Installation

The data systems are supplied with wall-mount power supplies. If the power supply is of the interchangeable plug variety, install the appropriate mains plug first. *Be certain it snaps all the way into place, or a shock hazard will result when the removable plug stays behind in the outlet.*

Plug in the power supply at the outlet and at the data system end.

The USB cable plugs into both the data system and the host. Remember that each physical USB connector is treated individually, so you will need to install the drivers for each physical USB port. It is easy to get unexpected behavior if you unintentionally plug into a different USB jack. If the drivers are installed on all the physical USB ports, it will no longer matter which you use.

Make a note of the USB Device number of your data system. It is written on the USB controller chip, and on the bottom of the case, if you have an optional enclosure.

### 3) Software Installation

The sample code is tested with Python 2.7. Libraries required are datetime, time, msvcrt, arrays, ctypes, os, threading, and curses. Screen size is set to 140 x 53 for text.

Make a folder for your project and place the .py code, LL\_USB2k.dll and the LL\_USB.cfg file there. Your data output files will be written to a subfolder called scanLog. The configuration file is compatible with files written by other LLI USB sample code. Note that the configuration file saves only a minimum of information. You can add whatever other settings to the file that would be convenient.

Links to assist installation of python2.7:

info (about, downloads, documentation, community, etc.)

<https://www.python.org/download/releases/2.7/>

get the Microsoft Installer (msi):

<https://www.python.org/ftp/python/2.7/python-2.7.msi>

and run it to install python-2.7 on your system

**download pip:** (needed to install curses library below):

<http://stackoverflow.com/questions/4750806/how-do-i-install-pip-on-windows>

Search there for "Python 2 ≤ 2.7.8 and Python 3 ≤ 3.3" for download.

**Install pip:**

[https://pip.pypa.io/en/stable/installing/#do-i-need-to-install-pip:](https://pip.pypa.io/en/stable/installing/#do-i-need-to-install-pip)

Download [get-pip.py](#), being careful to save it as a .py file rather than .txt.

Then, run it from the command prompt:

```
python get-pip.py
```

You may need an "as administrator" command prompt.

Follow [Start a Command Prompt as an Administrator](#) (Microsoft TechNet).

...\Scripts\pip.exe must be in PATH environment variable in order to use pip from the command line (see 'Alternative Instructions' for adding to your PATH).

**download curses:**

<http://www.lfd.uci.edu/~gohlke/pythonlibs/>

search at that URL for 2.2-cp27-none-win32.whl

[curses-2.2-cp27-none-win32.whl](#)

**install curses:**

Put the file into python folder.

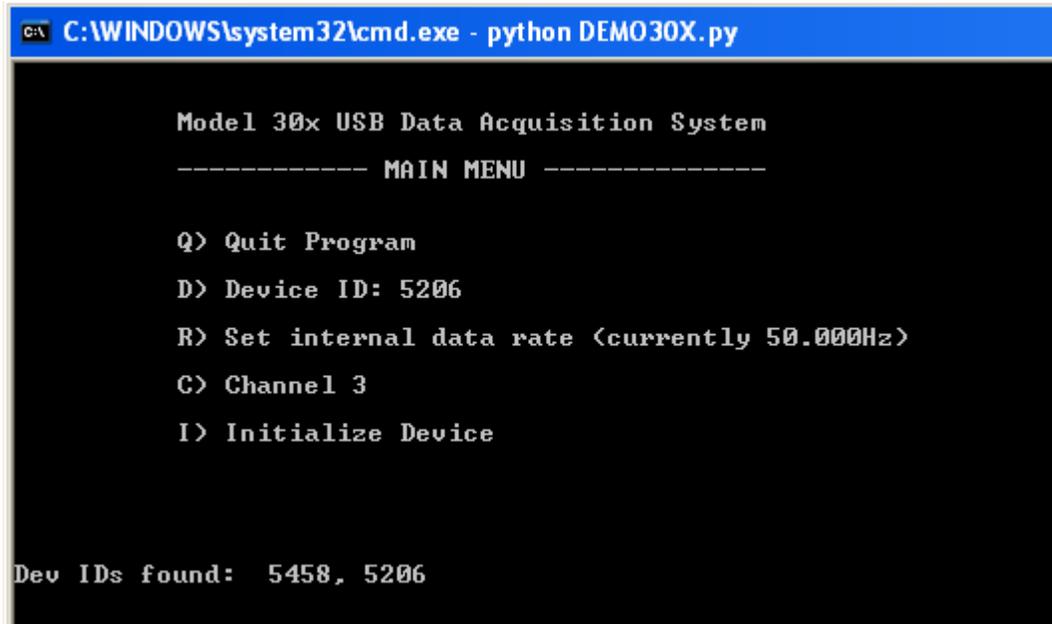
Install using pip. pip must be in the path, or in the current folder.

Use the command:

```
python pip install curses-2.2-cp27-none-win32.whl
```

## 4) Operation

### A. Main Menu



```
C:\WINDOWS\system32\cmd.exe - python DEMO30X.py

Model 30x USB Data Acquisition System
----- MAIN MENU -----

Q) Quit Program
D) Device ID: 5206
R) Set internal data rate (currently 50.000Hz)
C) Channel 3
I) Initialize Device

Dev IDs found: 5458, 5206
```

Run Demo30xV1.py. You should see the menu above on your screen. A single keystroke will activate the Menu options. Function that requires user input will display a prompt and wait for your entry. User input must be followed by pressing the <ENTER> key in the main keyboard area. The <ENTER> key on the numeric keypad will not be recognized. Entries are not case-sensitive.

Q) Enter Q to quit.

D) Enter Device ID number. Available devices are shown at the bottom left of the screen.

R) The Internal Data Rate loaded from the LL\_USB.cfg configuration file will be shown here. If you change the Internal Data Rate, the new rate will be sent when you initialize. It is displayed here because it is stored in the configuration file. You can always change the Internal Data Rate later.

NOTE: The rate may be adjusted to some nearby value. Because the available rates are divisions of a crystal-controlled oscillator, only integer multiples of the crystal's period are achievable.

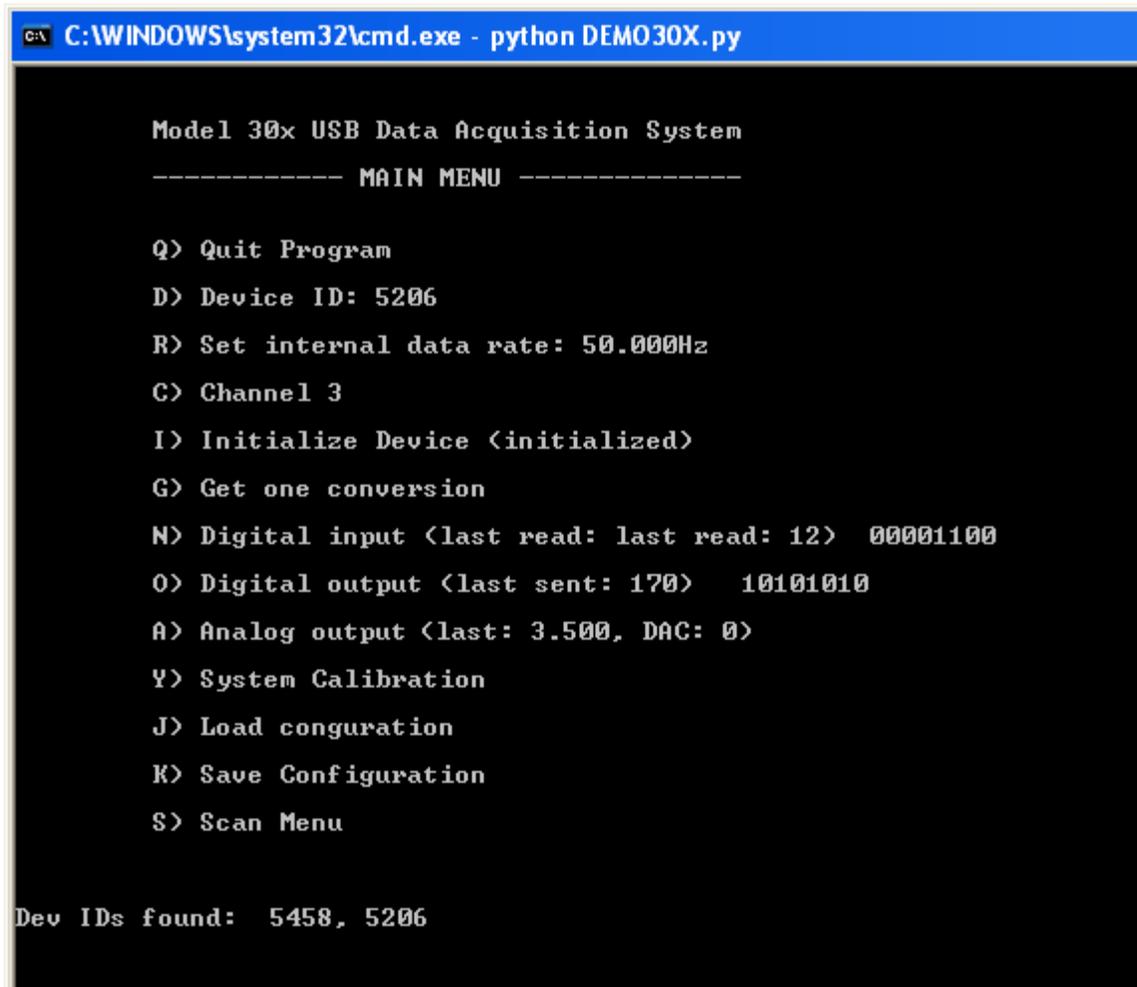
C) Enter an A/D channel number. This channel will be selected for polled operation and for single channel scanning. Like the Internal Data Rate, it is displayed here because it is stored in the configuration file. You can always change it later.

I) Initialize the data system. Initializing establishes communication and performs calibration of the data system. Once Initialized, the data acquisition system is unavailable to other

applications. You must initialize before proceeding.

## B. Main Menu After Initialization

Once initialized, more options appear on the Main Menu. The Main Menu screen will also show if a device has been disconnected or lost power.



```
C:\WINDOWS\system32\cmd.exe - python DEMO30X.py

Model 30x USB Data Acquisition System
----- MAIN MENU -----

Q) Quit Program
D) Device ID: 5206
R) Set internal data rate: 50.000Hz
C) Channel 3
I) Initialize Device (initialized)
G) Get one conversion
N) Digital input (last read: last read: 12) 00001100
O) Digital output (last sent: 170) 10101010
A) Analog output (last: 3.500, DAC: 0)
Y) System Calibration
J) Load configuration
K) Save Configuration
S) Scan Menu

Dev IDs found: 5458, 5206
```

Additional menu choices and extra information on the Internal Data Rate

R) The Internal Data Rate setting is crucial for noise reduction. Normally, it should be set to line frequency. Increasing the rate increases the maximum frequency that you can digitize. For best effective resolution, run at line frequency. Higher rates should be used in conjunction with a running average. Particular combinations of Internal Data Rate and running average will still reject line frequency noise. See <http://www.lawsonlabs.com/HowtoMinimizeNoise.pdf> for a detailed discussion.

NOTE: Do not confuse the Internal Data Rate with the scanning rate. The scanning rate is

determined by both the Internal Data Rate and the number of channels scanned.

G) Get one conversion displays the present voltage at the channel selected by option C.

N) N returns the digital input state. It is displayed as a decimal value from 0 to 255 and as an 8-bit binary byte with the most significant bit to the left. The inputs are active low, with pull-up resistors. Open inputs show as 1. If pulled down, an input will show as 0, active.

O) Prompts for the digital output word, 0 to 255. It is displayed in decimal and as an 8 bit binary byte with the most significant bit to the left. Active outputs are at 5 volts, shown as 1, and inactive outputs are at zero volts, shown as 0. Remember that the Model 301 has 8 digital out and 8 digital in, while the Model 302 has only 4 digital inputs, so the top 4 bits on a Model 302 are always 0.

Note: Digital and analog outputs will persist as long as the data system remains powered. When the software is restarted, the digital and analog outputs will be in an unknown state until they are explicitly set.

A) Analog output requires two entries. First is the analog output channel number, 0, 1 or 2. Press <ENTER> to confirm, then the voltage to send, usually 0 to 5 volts, with one mV resolution.

NOTE: The Model 302 has DAC jumpers for output channels 1 and 2. With a jumper in place, the output voltage range becomes +/- 5volts. Voltage out then equals  $(2 * \text{entry}) - 5$ .

Y) System calibration readjusts the data system to correct for any offset or gain drift. System calibration is always done at initialization and when stopping a scan (see next section). Due to settling times for channel changes, system calibration takes a few seconds to complete.

J) Load Configuration loads values from LL\_USB.cfg.

K) Save Configuration saves values to LL\_USB.cfg.

NOTE: The configuration file contains only a bare minimum three parameters. This is done in order to to be compatible with other sample code. Feel free to add other settings for your own purposes.

S) Pressing S brings up the Scan Menu. See the next section for details.

## C. Scan Menu

```
C:\WINDOWS\system32\cmd.exe - python DEMO30X.py

Model 30x USB Data Acquisition System
----- S C A N   M E N U -----

Q) Quit Program
B) Back to Main Menu
T) Scan Type MULTI-CHANNEL CAL DIGIN SCAN
N) Number of channels to scan: 7 (+ offset)
L) Log scan data to file OFF
C) Channel number for single-chan scans (currently: 3)
R) Set internal data rate (currently 50.000Hz)
   scan rate = internal data rate / (5 * numChans) = 1.250Hz
O) Digital output
A) Analog output
X) Screen display ON
U) Local average: 1
S) Start scan
```

Up to 8 channels can be scanned sequentially at a preset scanning rate that is derived from the Internal Data Rate and the number of channels being scanned. Analog and digital outputs can be updated during scanning without interrupting the flow of precisely-timed data.

B) Returns back to the Main Menu.

T) Entering T shows the selection of 6 scan types.

```
CMND_SINGLE_CHAN_SCAN = 1
CMND_MULTI_CHAN_SCAN = 2
CMND_MULTI_CHAN_CAL_SCAN = 3
CMND_SINGLE_CHAN_DIGIN_SCAN = 4
CMND_MULTI_CHAN_DIGIN_SCAN = 5
CMND_MULTI_CHAN_CAL_DIGIN_SCAN = 6

Enter scan type number: 6_
```

- 1) Single Channel scanning sets the number of data points to 1, and uses only the single, selected channel.

- 2) Multi-Channel scanning allows 1 to 8 channels to be scanned at a scanning rate of Internal Data Rate/ (5 \* number of scanned channels)
- 3) Multi-Channel Calibration scanning adds an offset channel at the end of each scan for active zero-drift suppression. The offset reading is subtracted from each the other channels.
- 4) Single Channel Digital Input scanning records a digital input value after each voltage reading and sends one analog and one digital data point for every scan
- 5) Multi-Channel Digital Input scanning records a digital input value after each scan and sends a digital input reading after each scan of voltages
- 6) Multi-Channel Calibration Digital Input scanning adds an offset channel as the last voltage reading in each scan for active zero-drift suppression. As in type 3, the offset reading is subtracted from each the other channels.

NOTE: Multi-channel scans with only one active channel are allowed. The effect is to reduce the scanning rate by a factor of 5 compared to a single channel scan. That reduces the minimum scan rate on the first channel to 10 Hz.

N) Enter the number of channels to scan for a multi-channel scan. The offset channel for calibration scans is counted separately. Channels 6 and 7 are normally used for calibration. Scanning always starts with Channel 0 and proceeds incrementally up to the last included channel. The labels on some data systems, the EMF6 for example, are for channels 1 through 6, not 0 through 5. You need to add 1 to the programmer's channel number to get the end user's channel number.

NOTE: If you select a multi-channel non-calibration scan, channels 6 and 7 can be included, but no active zero suppression will occur.

The multi-channel channel count is stored separately, so you will still have your original setting if you switch to a single-channel scan, then back to a multi-channel scan.

After changing channel selections, scan types, or the Internal Data Rate, note that the scan interval will change according to the formula:

Internal Data Rate / (5 \* total number of scanned channels).

L) Pressing L toggles the log file on and off.

C) Channel selection is the same as on the Main Menu,

R) Rate here is the same as the Main Menu

O) Digital output here is the same as the Main Menu

A) Analog output here is the same as the Main Menu

X) Toggle the screen display on or off. This setting only takes effect during scanning.

V) Local averaging smooths the scan data. It is a running average, so it does not affect the

scan data rate, but it will reduce settling times and bandwidth. Valid values are 1 to 255 points to average. For Internal Data Rates above the line frequency, it is essential to pick the correct combination of Internal Data Rate, channel count, and averaging in order to preserve line frequency rejection. <http://www.lawsonlabs.com/HowtoMinimizeNoise.pdf>

S) Pressing "S" begins a scan. See the Scanning screen description below.

### D. Scanning Screen

Here is a sample of the output for a multi-channel calibration digital input scan when the screen display data is on.

```

C:\WINDOWS\system32\cmd.exe - python DEMO30X.py
E>End scan      O>digital Output      A>Analog output
Doing MULTI-CHANNEL CAL DIGIN SCAN :      Start Time: 10-23-17 13:10:55
scan#  Chan 0  DI  Chan 1  DI  Chan 2  DI  Chan 3  DI  Chan 4  DI  Chan 5  DI  Chan 6  DI  offset  DI  buff
0      -0.000016  0  -0.024855  0  -0.374315  0  3.510461  0  0.731843  0  0.772305  0  4.999995  0  0.000004  0  0
1      -0.000017  0  0.053153  0  -0.488152  0  3.510633  0  0.890768  0  0.878681  0  4.999995  0  0.000004  0  0
2      -0.000017  0  0.090370  0  -0.479732  0  3.510487  0  0.915979  0  0.876534  0  4.999995  0  0.000005  0  0
3      -0.000014  0  0.102752  0  -0.478368  0  3.510462  0  0.916450  0  0.911058  0  4.999995  0  0.000004  0  0
4      -0.000013  0  0.103118  0  -0.475851  0  3.510651  0  0.926509  0  0.875596  0  4.999995  0  0.000005  0  0
5      -0.000011  0  0.126216  0  -0.499263  0  3.510494  0  0.914555  0  0.921052  0  4.999995  0  0.000004  0  0
6      -0.000015  0  0.125198  0  -0.484589  0  3.510671  0  0.920894  0  0.879602  0  4.999995  0  0.000005  0  0
7      -0.000015  0  0.111561  0  -0.487399  0  3.510556  0  0.917165  0  0.921619  0  4.999990  0  0.000010  0  0
8      -0.000015  0  0.098624  0  -0.497165  0  3.510475  0  0.914657  0  0.868940  0  4.999990  0  0.000010  0  0
9      -0.000014  0  0.107706  0  -0.498638  0  3.510647  0  0.914722  0  0.890746  0  4.999990  0  0.000009  0  0
10     -0.000016  0  0.126851  0  -0.483053  0  3.510481  0  0.915518  0  0.863462  0  4.999990  0  0.000009  0  0
11     -0.000017  0  0.108378  0  -0.480795  0  3.510561  0  0.923715  0  0.924144  0  4.999990  0  0.000010  0  0
12     -0.000017  0  0.121074  0  -0.531046  0  3.510603  0  0.917988  0  0.866448  0  4.999992  0  0.000007  0  0
13     -0.000012  0  0.136402  0  -0.494277  0  3.510482  0  0.911234  0  0.872176  0  4.999990  0  0.000009  0  0
14     -0.000014  0  0.140984  0  -0.498944  0  3.510635  0  0.921299  0  0.921032  0  4.999992  0  0.000007  0  0
15     -0.000014  0  0.118077  0  -0.505227  0  3.510487  0  0.916283  0  0.905223  0  4.999990  0  0.000009  0  0
16     -0.000012  0  0.130048  0  -0.514114  0  3.510456  0  0.922828  0  0.895260  0  4.999990  0  0.000009  0  0
  
```

The 43 most recent scans will cycle on the scanning screen. Each is identified with its scan number, starting from 0. Elapsed time can be obtained by multiplying the scan number by the scan interval. The local average is applied to the data.

If the scan is a digital input scan, a DI header designates a digital input value. If the scan is a calibration scan, the last voltage channel will be labeled "offset". The final column is the number of scans remaining in the input buffer. If you are keeping up with your data, it should be zero, or close to zero. During user input, scans will accumulate in the buffer. You should see the backlog quickly reduced after data entry is done. If you wait too long, the buffer will overflow, and scanning will be stopped.

A brief menu appears at the top of the screen showing the available commands. The scan type and starting time are also displayed. If the screen display is turned off, that, plus the header, is all that will show.

If logging is on, the same data that is printed to the screen is saved in a text file having a name matching the starting time and date. The log file is placed in a subfolder called scanLog.

NOTE: Extended scanning times can generate overlarge data files. You may want to close

and restart data files after they reach a certain size.

The scan will continue until stopped with a key press, E. Then, press <ENTER> to return to the Scan Menu. That extra key press provides an opportunity to look closely at the last of your data.

Any data file will be closed when the scan stops. A brief summary will be appended at the end of the data file. Here is a sample:

scan#	Chan 0	DI	Chan 1	DI	Chan 2	DI	offset	DI
0	0.000000	10	0.004603	10	-0.004619	10	-0.000005	10
1	-0.000001	10	0.004609	10	-0.004628	10	-0.000005	10
2	0.000000	10	0.004612	10	-0.004622	10	-0.000008	10
3	0.000002	10	0.004613	10	-0.004623	10	-0.000007	10
4	0.000002	10	0.004613	10	-0.004625	10	-0.000007	10
5	0.000002	10	0.004613	10	-0.004621	10	-0.000010	10
6	0.000002	10	0.004611	10	-0.004623	10	-0.000008	10
7	0.000000	10	0.004609	10	-0.004625	10	-0.000005	10
8	-0.000004	10	0.004609	10	-0.004627	10	-0.000005	10
9	0.000000	10	0.004609	10	-0.004627	10	-0.000005	10
10	0.000002	10	0.004614	10	-0.004625	10	-0.000008	10
11	-0.000005	10	0.004609	10	-0.004625	10	-0.000005	10
12	-0.000005	10	0.004609	10	-0.004627	10	-0.000001	10
13	-0.000002	10	0.004609	10	-0.004625	10	-0.000003	10
14	-0.000001	10	0.004611	10	-0.004628	10	-0.000002	10

Averaging: 1  
Internal Data Rate: 60.00  
Scan Rate: 3.000000  
Started: 10-19-17 17:13:16  
Finished: 10-19-17 17:13:22  
Elapsed: 5 seconds

Analog and digital outputs can be sent at any time during scanning (up to about 50 each second). If the scan is single-channel, the input channel can be changed on the fly, as well.

Please contact Lawson Labs at [lawsnlab@lawsonlabs.com](mailto:lawsnlab@lawsonlabs.com) or 610 725-8800 with questions or comments.