Programming the Campbell 21X

Pacific Gas and Electric Company -
Pacific Energy Center

Figure 1: Campbell 21X

This application note introduces the programming of the Campbell Scientific 21X Datalogger. It is not intended to replace the user's manual, rather, it has been written to assist the user in using the Campbell while in the field and to familiarize the user with existing available software for writing Campbell programs. Sample programs (annotated) are available for download. Campbell Scientific supplies a laminated card with the entire CR21x instruction set.

This application note is divided into the following sections:

- **Basic Number pad Instructions:** Introduction to the basics of using the Campbell without a computer interface.

- **Programs Available for Download**: Download the annotated program code.

- **Using Edlog: Edlog is a DOS application for writing Campbell code.**

- **Using GraphTerm:** Graph Term is a DOS application for communicating with the Campbell for uploading programs written in Edlog, downloading data and viewing real time readings.

What is not covered in this application note:

- wiring sensors (other than a thermocouple) to the 21x

- principles of measurement

Basic Number Pad Instructions

1. **Turn on Campbell and wait for a few seconds for "HELLO" display.** Once the logger displays a series of 1's, begin programming. Shorter programs can be entered into the Campbell using the number keypad, however, it is recommended using Edlog for writing longer programs.

   NOTE: If unit battery is left on for an extended period of time, battery failure is likely. To maintain battery life, keep unit charged (plugged in when not in use).

The program below is short enough to be entered through the number pad. We recommend doing this tutorial using the number pad and the Edlog software.

Figure 3 provides some useful number pad entries:

Code	Explanation
* 1 A -	Enter "write/edit program" mode. To scan through the lines of code, use A to advance to the next line and B to back up to the previous one.
* 0 -	Compile the current program, and begin (or resume) logging. The digital display will change to : LOG1. Remember that each time you make changes to the program, you must recompile it.
* 6 A -	View realtime readings (view input locations). To verify that the logger and the sensors are working properly, viewing the input locations can be useful. To scan through the different input locations, use A to advance to the next location and B to back up to the previous one.
# D -	While editing the program code, you can delete program instructions with the # D command. To change option codes, you do not need to delete them, simply type in the new value.
D -	While editing the program code, a decimal is entered using the D key.
# -	While in program editing mode, the # key will erase the digit just entered.
* 7 -	Scroll through collected final storage data. Use A to advance to next point, use B to back up to previous data point.

Figure 3: Keypad shortcut entries

Warning! Switching the Campbell off will erase the program and all collected data!

Programs Available for Download from the Energy Center

The .pdf files below are Adobe Acrobat files which have the program code and notes explaining the code and how to modify for specific applications. They are available for download at the PEC website. The .dld files should be used only in Edlog.

- **Daylight Factor Measurements using Li-Cor Photometers** - This program is used to evaluate a building design in terms of its ability to utilize available daylight to light its interior spaces. The program collects daylight factors (percentages of available light). Physical models are normally used to collect daylight factor information, but data on real spaces are also possible. For more information about conducting daylighting studies, consult our Daylighting Photometry fact sheet.

- **Temperature Measurements with Thermocouples** - This program is used to collect temperature data using a copper/constantan thermocouple. Similar to the daylight factor program above, it is modifiable to collect data at a specific time interval or at the push of a button and for use with three other types of thermocouple wire.

Using the Edlog Software to Program the Campbell

Edlog is a DOS application used to write programs for the Campbell Scientific datalogger, reducing or eliminating the need for the keypad. Graph Term (GT) is used to send the program to the logger and to view realtime data from more than one channel at a time. Graph Term is discussed in the next section.

1. **In DOS, go to the subdirectory where the application is stored.** On the Tool Lending Library's computers, the application can be found at in the c:\cs2 subdirectory. To get to the c:\cs2 subdirectory, type "cd cs2" from the c:\ prompt, If c:\ prompt does not come into view, type "cd.." until the root directory appears.

2. **Enter the application by typing** *edlog*, **followed by a space and the name of the program at the c:\cs2 prompt.** Enter the type of logger; the PEC have CR10, 21X, or CR7. Type 21X. If this is an existing file, the logger will go straight to the editor.

   A screen similar to ***Figure 4*** will appear.
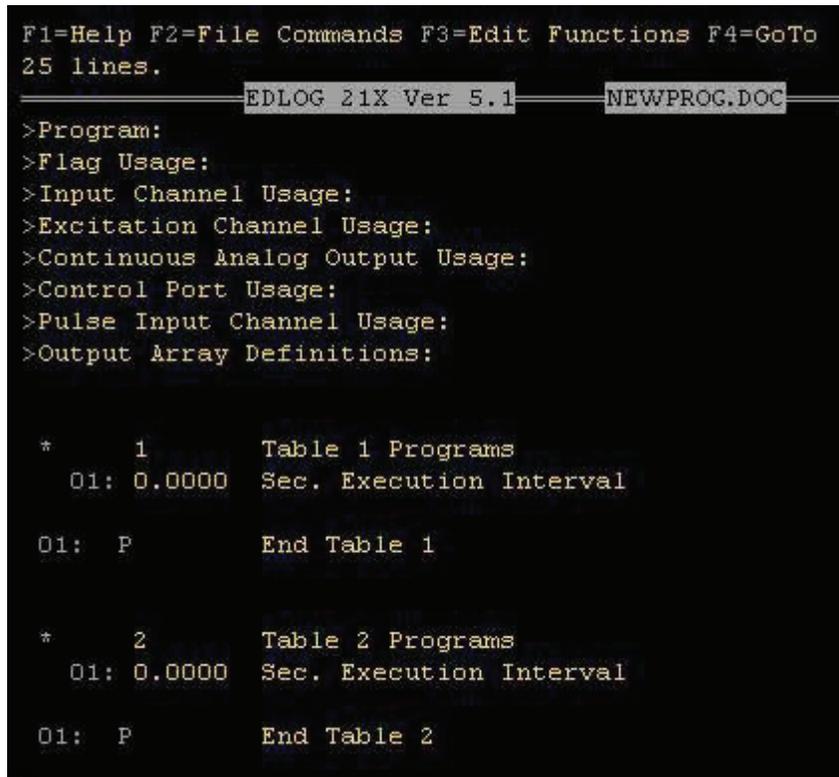

```
F1=Help F2=File Commands F3=Edit Functions F4=GoTo
25 lines.
======================EDLOG 21X Ver 5.1============NEWPROG.DOC=====
>Program:
>Flag Usage:
>Input Channel Usage:
>Excitation Channel Usage:
>Continuous Analog Output Usage:
>Control Port Usage:
>Pulse Input Channel Usage:
>Output Array Definitions:


   *     1        Table 1 Programs
     01: 0.0000   Sec. Execution Interval

 01:  P           End Table 1


   *     2        Table 2 Programs
     01: 0.0000   Sec. Execution Interval

 01:  P           End Table 2
```

Figure 4: *Edlog program*

- The cursor will be at the location where the "Seconds" execution interval is. For this tutorial, enter a short program which will collect data for three variables: the logger's panel temperature, temperature from one thermocouple sensor and the logger's battery voltage.

- As the programming is entered, Edlog will add or update the comments to the right of the program code. For example, in option code 1 or program instruction P78, Edlog will automatically insert "High Resolution" when "1" is entered. If changed to 0, Edlog will update it to read "Low Resolution".

3. **Helpful Edlog tips**:

- To delete an instruction hold down the <ctrl> key and hit <k>. Then type <y>.

- In the programs in *Figure 5*, notice that the locations are labeled (i.e. program line 02, option code 1 is labeled as "battery V"). To insert a location label, go to that line in the program, hold down the <ctrl> key and type <L>.

- At the top of the screen, enter the location label of 9 characters or less. When finished, hit <enter> and continue entering the program.

*	1 Table	1 Programs
	01: 1	Sec. Execution Interval
01:	P78 Resolution	
	01: 1	High Resolution
02:	P10 Battery Voltage	
	01: 4	Loc : [battery V]
03:	P17 Panel Temperature	
	01: 1	Loc : [paneltemp]
04:	P13 Thermocouple Temp (SE)	
	01: 1	Reps
	02: 1	5 mV Slow Range
	03: 1	IN Chan
	04: 1	Type T (Copper-Constantan)
	05: 1	Ref Temp Loc
	06: 2	Loc: [thermocpl]
	07: 1.8	Mult
	08: 32	Offset
05:	P92 If Time is	
	01: 0000	Minutes into a
	02: 10	minute interval
	03: 30	Do
06:	P86: Do	
	01: 10	Set high Flag 0 (output)
07:	P77 Realtime	
	01: 0110	Day, Hour-Minute
08:	P71 Average	
	01: 3	Reps
	02: 1	Loc: paneltemp

Figure 5: Program table

- Once the program has been entered, type <ESC> or <F2> and type <S> to save the file. For this example, let's call this file "newfile". Once saved, exit Edlog by typing <Q>. To return to editing the program, type <E>.

- It is necessary to compile the program if entered the program using the number pad. To compile the program, enter * 0.

Graph Term Software

Figure 6: Optically Isolated RS232 Interface Cable

Graph Term is a DOS application that allows a computer to communicate with the logger. It can be used to upload the Edlog programs into the Campbell datalogger and to view real-time data. To view real time data using the number pad and the LCD display on the Campbell, enter * 1 A. Then use the A and B keys to scroll forward or back between input locations.

Programming using GraphTerm

1. **To launch GraphTerm type "gt" at the <c:\cs2> prompt.** Enter the Station Name; the same name as the Edlog file (newfile). If this is the first time that the specified Station Name is used, a new screen will appear prompting new variables.

   - The only variables to change are the Datalogger Type, which should be 21X and the Communications Adapter, which should be set to the COM port dedicated to the 9-pin serial port for the computer. For the Tool Lending Library computers, this will be COM port 1. For some desktop computers, COM 1 is dedicated to the mouse and COM port 2 is dedicated to the 9-pin serial port. If COM1 does not work, try COM2.

     To change value of the datalogger type or the COM port setting, use the <space> bar to toggle through the possibilities and the arrows to move from one field to another. Once your variables are set, enter <ctr+P> . This will save the settings.

2. **Connect logger with the RS232 Interface cable to the computer.**

3. *Send the program from the computer to the logger.* From the GraphTerm Options menu, select <D>. While the program is being sent, the display on the Campbell LCD will change. Once the program has been sent to the logger, the screen will display ***Downloading Completed***.

   The Campbell display should now read LOG1:

Figure 7: GraphTerm Options

4. **Press <esc> to return to the GraphTerm Options menu.**

5. **To view real-time readings, select <M> for Monitor Input Locations.** The display will change to show the current values of Input Locations 1 through 11.

   - To change the Locations which are displayed, type <L>. Specify which Locations will be displayed in 3 possible columns, each for 3 possible graphs. For example, to display locations 1, 2, 3, 4 and 10, enter 1..4, 10.

   - Each column has a maximum of 11 locations. A maximum of 3 columns (or 33 locations) can be monitored for real-time readings.

Figure 8: Real-time Monitoring

6. **Set the upper and lower limits for the graph (discussed below).** If the values will be above 0.0, then change the minimum to 0. Once all changes have been made, enter <S>. This will save the changes and exit back to the Monitor Input Locations screen.

7. **To view a "stripchart" graph, type <G>.** This screen shows not only the real-time readings, but it also a graph of the variables as they change with every execution interval.

8. **Exit GraphTerm by typing <Q> from the GraphTerm Options menu, after verifying logger is working and the sensors are sending reasonable signals.**

9. **Disconnect logger and place in location for data logging.**

Downloading Data

Use **GraphTerm** to verify that the logger is collecting data and to export data to the computer.

1. **Reconnect the logger to the computer and return to the GraphTerm Options menu.**

2. **Type <U> to collect uncollected data.** The program will automatically create a new file with the ".dat" (for data) suffix. The new file is a "comma-delimited" text file. When opening the file in a spreadsheet application, specify how the data points are separated. Newer spreadsheet applications will recognize the file type automatically.

   - In the spreadsheet application, the file will be six columns and multiple rows. From left to right, the columns will be: program number, Julian day of the year (i.e. January 1st is 1, January 2nd is 2, Feb 1 is 32,etc..), time (hour, minute) and locations 1 through 3 (panel temperature, thermocouple temperature, battery voltage as specified in the Edlog program). Format of the time stamps may need to be changed in Excel.

3. **Check the final storage values using the number pad on the Campbell 21X**. To scroll through the final storage data, enter * 7. Viewing the data is a bit trickier here. Using the A and the B buttons, scroll through the final storage values. The first data string (as also seen in Excel) might look like: 106, 191, 246, 22.912, 71.556, 10.285 corresponding to the program number, day of the year, time, panel temperature in °C, thermocouple temperature °F, and battery voltage. You can scroll through a few data sets to verify that data is being collected.