IV and Lifetime software

Introduction

The iPV Solar Cell Test software from infinityPV controls and collect IV data for solar cells using the infinityPV SMU line of instruments. Most of our SMU instruments have multiple channels that can be multiplexed, whereby many different solar cells to be connected and measured at the same time.

The program has two different measurement modes that can be selected independently for each available channel: single IV scan or time study. The first mode is intended for standard characterization of solar cells, while the second mode will record IV scans at a selected interval and is intended for time study of solar cells.

Safety

The user must read and follow instructions for use of the specific infinityPV instrument controlled by the application.

Installing the software

Download the software through www.infinityPV.com/products/software/iv-software

The software is developed and tested on a Windows 10 PC and requires installing a third-party driver before use. (https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers).

Operation

Connect the infinityPV SMU instrument to the PC before starting the program. If no instrument is available, you can still use the program in a demo mode. This can be useful for learning how to use the program.

Start the iPV Solar Cell Test program by clicking the icon on the desktop or from the program list.

Figure 1. Program icon for iPV Solar Cell Test software

A dialog form will then appear (see figure 2) where the user can select the connection and instrument or a demo mode.
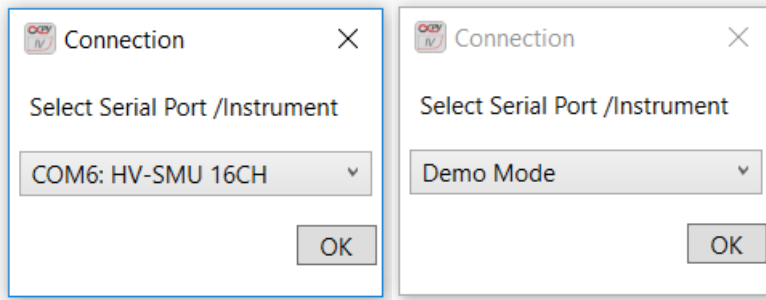
Figure 2. Dialog to select serial port connection and instrument.

When clicking the OK button, the main window of the program will appear (see figure 3).

Main window

The main window has a menu bar with different tabs in top section (figure 3), where measurements can be started and parameters for IV scans can be set. In the bottom left of the main window is the IV graph window where the IV traces will be displayed, and the bottom right are two lists; one showing the IV parameters of IV scans completed for the selected channel and one giving an overview of the different channels.
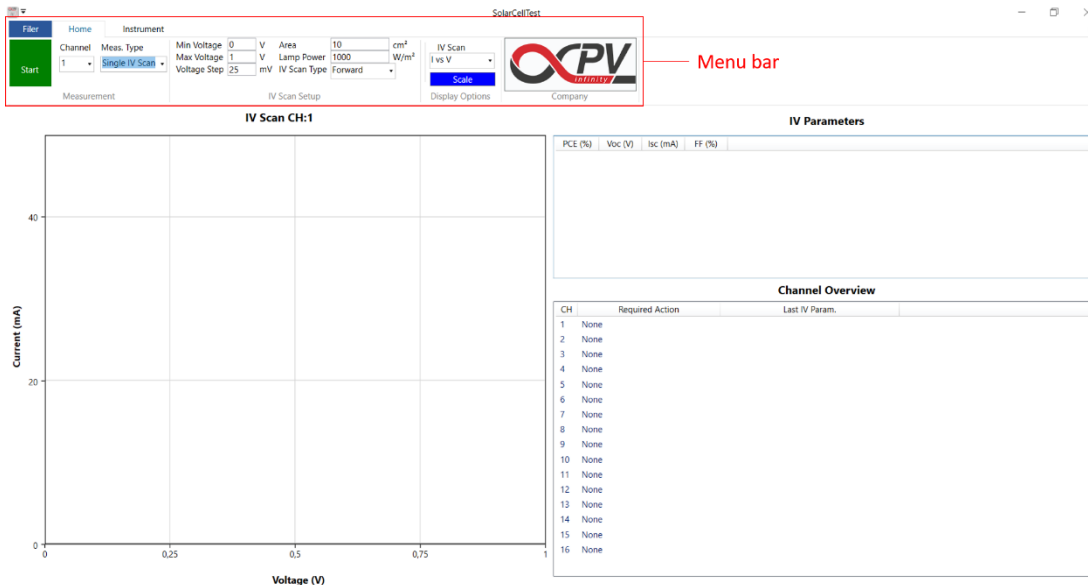

Figure 3. Main window of the program with menu bar on top, IV graph window and lists for IV parameters of completed IV scans.

Menu bar

Pressing the "File" button, located in the menu bar, opens the file menu (see figure 4) from where the user can open previously stored IV scan files, a time study, or save an IV scan file. IV scans measured during a time study is automatically stored in a user defined data folder.
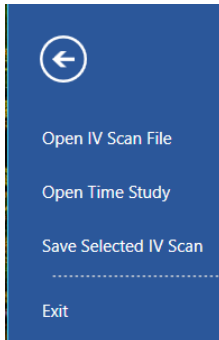

Figure 4. File menu

Home Tab

The Home tab is organized in three sections: Measurement, IV Scan Setup and Display Options (see figure 4).

Measurement

The "Start" button initiates the defined IV measurements. For channels where the measurement type is time study it is disabled until the user have gone through the time study setup.

The channel for an IV measurement or a time study is selected from the drop-down box marked "Channel" (see figure 5) in the measurement section. When several channels are used simultaneously this also allows the user to switch between viewing the IV scans and data obtained for each of them.

Each channel has two measurement modes: "Single IV Scan" or "Time Study" that can be selected from the drop-down box marked "Meas. Type" (see figure 5).
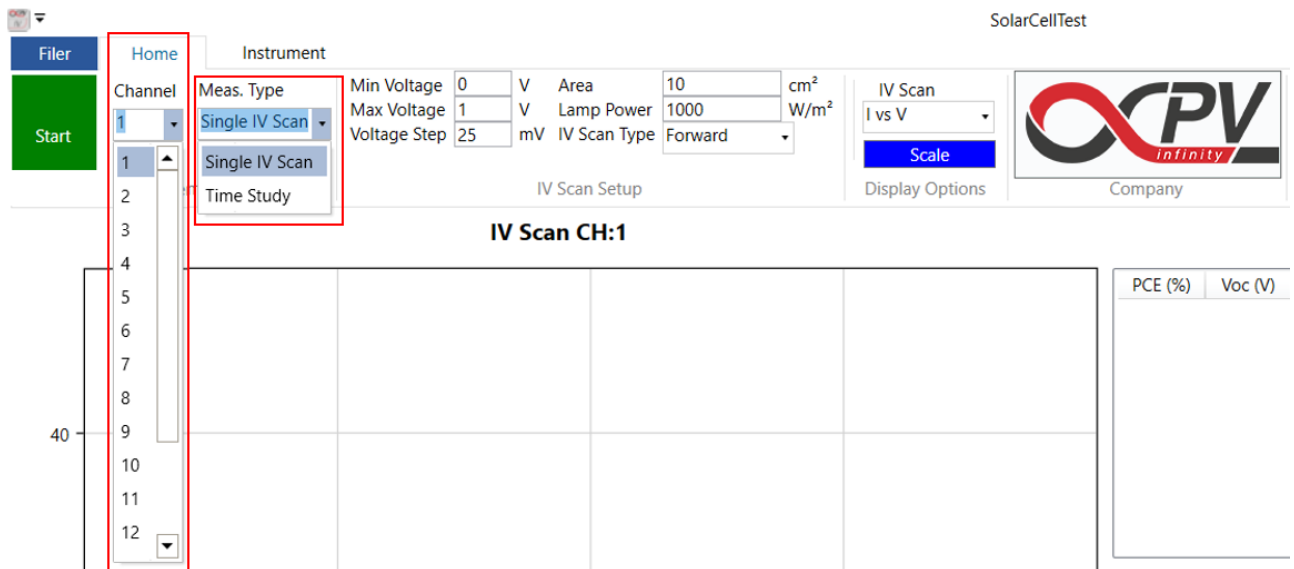
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Figure 5. Channel and measurement type selection.

IV scan setup

In the "IV Scan Setup" section changes view depending on the measurement mode chosen for the selected channel (see figure 6). In both modes the minimum and maximum voltages and the voltage step can be set within limits set by the connected instrument (e.g. 0-40 V for the LV-SMU and 0-1000 V for the HV-SMU). To calculate the PCE correctly the user must specify the active area and lamp intensity. IV scans can be performed in three modes: forward, reverse and forward-then-reverse selected from the IV Scan Type drop-down list.

When the measurement mode for the selected channel is a time study the "IV Scan Setup" section also contains a button for further setup of the time study (see Time Study Measurements paragraph) and an interval box for setting the time between measurements.
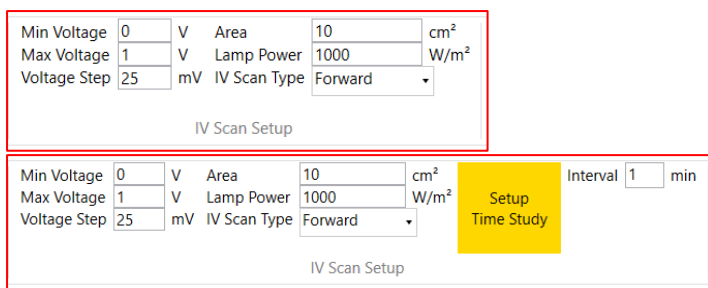

Figure 6. The IV scan setup section in single IV scan mode (left) and in time study mode (right).

Display options

In the "Display Options" section (see figure 7) the IV scan graph window can be set to display four different graph types: I vs V, J vs V, P vs V and log(I) vs V (where I = current [mA], V = voltage [V], J = current density [mA/cm²], P = power [mWatt] or the logarithm of the current versus the applied voltage).

If the selected channel is set to time study a second display option for the time study graph is shown where the user can also set four display types: power conversion efficiency (PCE), open circuit voltage (Voc), short circuit current (Isc) or fill factor (FF) versus time.

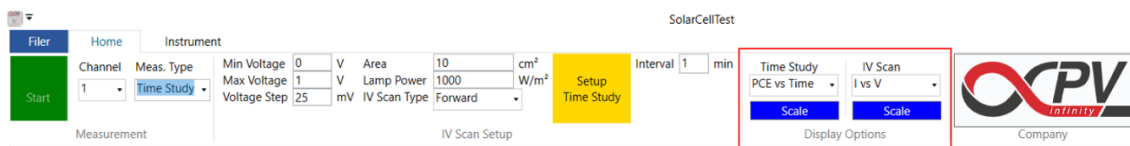Both graph windows can be auto scaled using the "Scale" buttons.

Figure 7. Display options

Instrument Tab

The instrument tab has two sections: connection and current range (see figure 8). In the first section the COM port and SMU instrument type connected is displayed. The current range section lets the user select between two current ranges if available for the instrument.
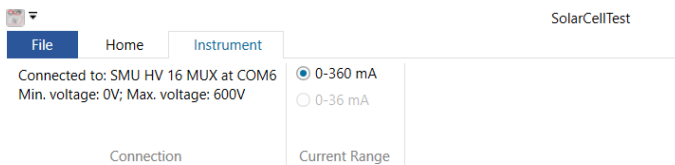
Figure 8. Instrument tab.

Time study measurements

Before initiating a time study the setup must be completed. The process is started by clicking the yellow setup time study button in the IV scan setup section (see figure 9).

A setup dialog will appear where a data folder must be selected for storing IV files and a summary file.

The user can choose to be notified before each IV measurement. The default is no notification in which case the measurement will start automatically. When the notify option is selected, the user will see a "required action" in the "Channel Overview" list in the main window and must select the appropriate channel and press the start button to initiate the measurement each time it is due.

The measurement scheduling can either be a simple interval (default) or a custom schedule where a list for the date and time for each IV scan is set up. This later option may be appropriate for longer intervals that are unevenly spaced in time.

Figure 9. Time study setup.

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File formats

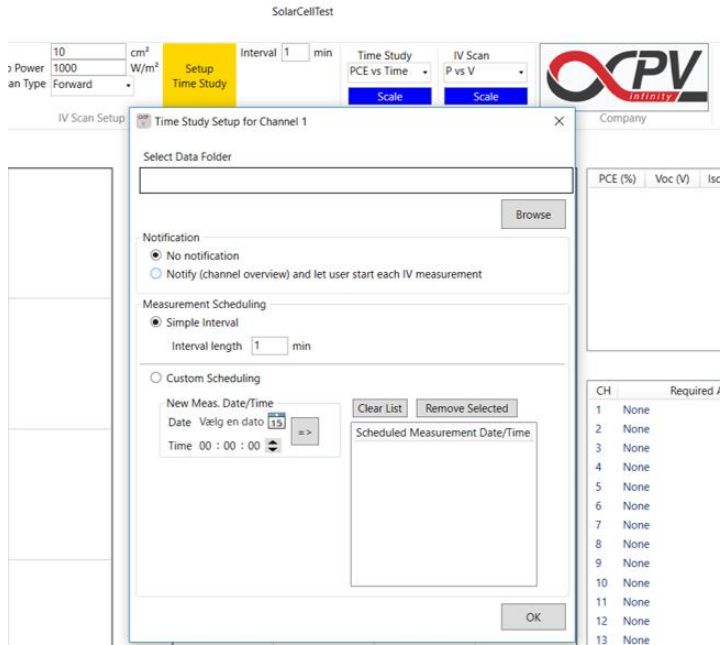The measured IV data can be saved as a text fil (txt) together with the sample information (see figure 10). When performing a time study all the IV files and a summary file will be stored in the selected folder. The Summary fill contains the IV trace parameters and the elapsed time of the IV measurement (figure 10). The obtained and stored data can easily be transferred to another program for further postprocessing.
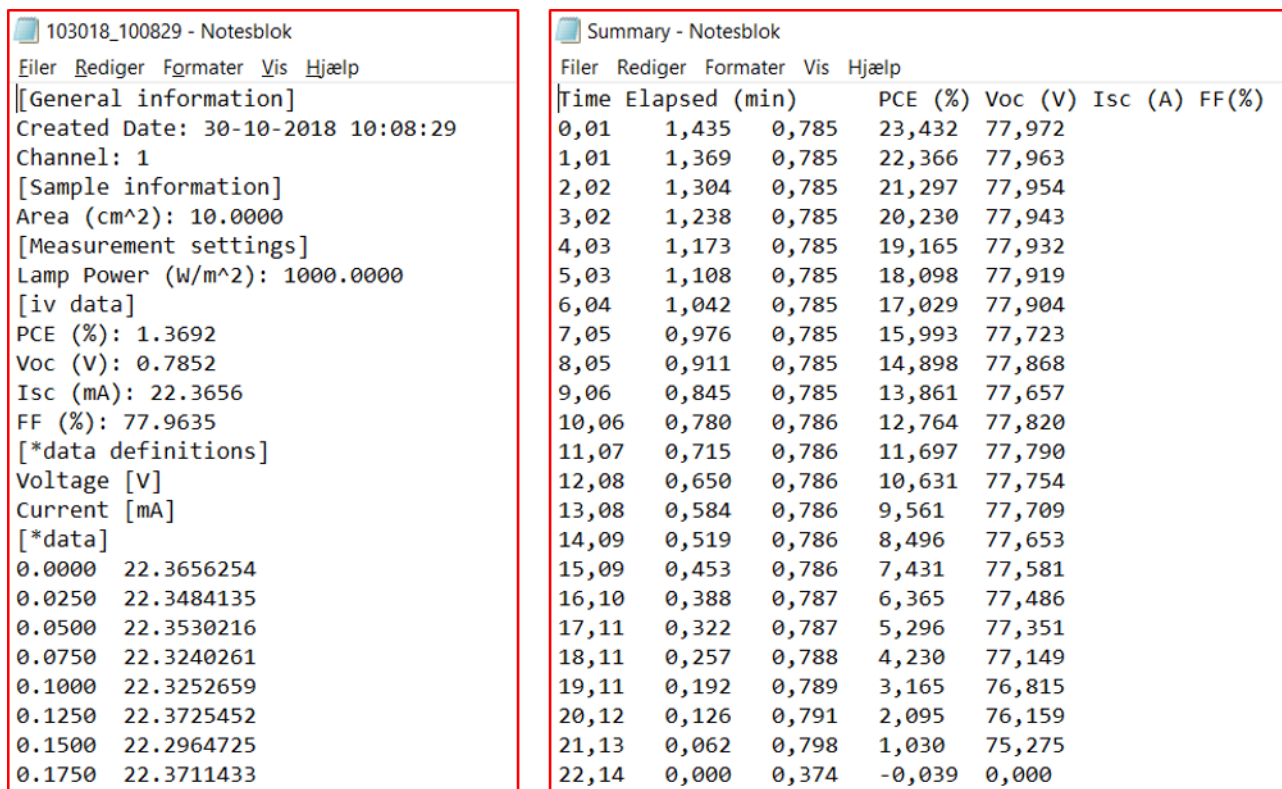
```
103018_100829 - Notesblok
Filer  Rediger  Formater  Vis  Hjælp
[General information]
Created Date: 30-10-2018 10:08:29
Channel: 1
[Sample information]
Area (cm^2): 10.0000
[Measurement settings]
Lamp Power (W/m^2): 1000.0000
[iv data]
PCE (%): 1.3692
Voc (V): 0.7852
Isc (mA): 22.3656
FF (%): 77.9635
[*data definitions]
Voltage [V]
Current [mA]
[*data]
0.0000  22.3656254
0.0250  22.3484135
0.0500  22.3530216
0.0750  22.3240261
0.1000  22.3252659
0.1250  22.3725452
0.1500  22.2964725
0.1750  22.3711433
```

```
Summary - Notesblok
Filer  Rediger  Formater  Vis  Hjælp
Time Elapsed (min)      PCE (%) Voc (V) Isc (A) FF(%)
0,01    1,435   0,785   23,432  77,972
1,01    1,369   0,785   22,366  77,963
2,02    1,304   0,785   21,297  77,954
3,02    1,238   0,785   20,230  77,943
4,03    1,173   0,785   19,165  77,932
5,03    1,108   0,785   18,098  77,919
6,04    1,042   0,785   17,029  77,904
7,05    0,976   0,785   15,993  77,723
8,05    0,911   0,785   14,898  77,868
9,06    0,845   0,785   13,861  77,657
10,06   0,780   0,786   12,764  77,820
11,07   0,715   0,786   11,697  77,790
12,08   0,650   0,786   10,631  77,754
13,08   0,584   0,786   9,561   77,709
14,09   0,519   0,786   8,496   77,653
15,09   0,453   0,786   7,431   77,581
16,10   0,388   0,787   6,365   77,486
17,11   0,322   0,787   5,296   77,351
18,11   0,257   0,788   4,230   77,149
19,11   0,192   0,789   3,165   76,815
20,12   0,126   0,791   2,095   76,159
21,13   0,062   0,798   1,030   75,275
22,14   0,000   0,374   -0,039  0,000
```

Figure 10. Left: Data output from IV measurements. Right: IV summary obtained from a time study.

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