A multi-tool measurement software

Axel Fischer und Felix Kaschura GbR

29.09.20 @ virtual MOS-AK workshop, THM Gießen
Introduction

- SweepMe! is a spin-off from IAPP, TU Dresden
- Founders: Axel Fischer and Felix Kaschura
- Background: organic semiconductor physics & electronics
- **October 2019:** SweepMe! is available worldwide
Introduction

- Network analyzer
- Oscilloscope
- Parameter analyzer
- LCR meter
- Wafer prober
- Signal generator
- SMU
Introduction

Instruments are combined in various ways:

- Network analyzer
- Oscilloscope
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- LCR meter
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- SMU
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Introduction

Instruments are combined in various ways:

Network analyzer

Oscilloscope

Parameter analyzer

LCR meter

Wafer prober

SMU

Signal generator
Can we organize all instruments in a modular way?
Gameplay
Gameplay

<table>
<thead>
<tr>
<th>Measurement tree</th>
<th>Value</th>
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<tbody>
<tr>
<td>WaferProber</td>
<td>Nucleus</td>
</tr>
<tr>
<td>SMU Gate</td>
<td>HP 415x CH1</td>
</tr>
<tr>
<td>SMU Drain</td>
<td>HP 415x CH2</td>
</tr>
<tr>
<td>SMU PD</td>
<td>Keithley26xx Ch A</td>
</tr>
<tr>
<td>Signal</td>
<td>33220A</td>
</tr>
<tr>
<td>Scope</td>
<td>HMO3004</td>
</tr>
</tbody>
</table>
**Gameplay**

- Combine different devices & interfaces
- Quickly create nested for-loops
- Add modules at higher or lower level
**Gameplay**

**Pseudo code:**

for each position of WaferProber:
  for each voltage of SMU Gate:
    for each voltage of SMU Drain:
      for each voltage of SMU PD:
        apply set values
        call all measurement values

for each value of Signal:
  for each value of Scope:
    apply set values
    call all measurement values
Gameplay

Main program
Gameplay

Module
Gameplay

Driver („Device class“)
Final look
Final look

- Use Widgets, like **Plot**, **Monitor**, **Image** to create dashboard like interfaces
- Widgets can be created & configured during the measurement
## Program structure

<table>
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<tr>
<th>Main</th>
<th><strong>Features:</strong></th>
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| Free | - creating program procedures  
- provide Widgets to visualize data  
- save and restore settings  
- load new content & manage versions |

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| - extending the functionality of the free content  
- sold per computer unit |
| **Customized modules:** |
| - programmed for a single customer with special requirements |
| **External modules:** |
| - created by a third-party developer |

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- control program procedure  
- basic measurements |

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Open source| - small code snippets  
- instrument communication  
- shared across all users  
- can be contributed by users |
Program structure

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https://test.pypi.org/project/pysweepme/
Generic driver structure

- A Device Class allows you to implement any instrument via an open interface.

- It is **python** and thus many third party packages can be used.

- Put your code into semantic functions like:
  - "initialize"
  - "apply"
  - "measure"
  - "call"
  - ...

```python
class Device(EmptyDevice):
    def __init__(self):
        EmptyDevice.__init__(self)
        self.shortname = "Mouse"
        self.variables = ["x", "y", "x_press", "y_press", "left_clicked", "Right_clicked"]
        self.units = ["px", "px", "px", "px", "", ""]
        self.plottype = [True, True, True, True, False, False] # define if it can be plotted
        self.savetype = [True, True, True, True, True, True] # define if it can be saved
        self.width = win32api.GetSystemMetrics(0)
        self.height = win32api.GetSystemMetrics(1)

    def measure(self):
        try:
            self.x, self.y = win32api.GetCursorPos()
        except:
            self.x, self.y = float('nan'), float('nan')
            # catches an exception if the TaskManager is opened and probably no cursor exists

        self.ButtonLeft = win32api.GetKeyState(0x01)
        self.ButtonRight = win32api.GetKeyState(0x02)

    def process_data(self):
        self.y = self.height-self.y-1 # makes a plot that directly corresponds to the cursor position

        if self.ButtonLeft < 0:
            self.x_press = self.x
            self.y_press = self.y
        else:
            self.x_press = float('nan')
            self.y_press = float('nan')
```
Version manager

• Download new versions of modules or devices

• Activate & deactivate content

• Switch between versions to test new features

• In future: Create a „virtual environment“
A simple sequence to take an IV curve: **SMU module + MakeFile**
Example:

- A second **SMU** can be added by drag&drop
Example:

- Three SMUs are used for a transistor measurement
Example:

- A **Loop** is used to repeat things
Example:

- Putting everything into a **WaferProber** module results in a wafer test
Example:

- And we can do it for every **Temperature**...
Example: Scientific publications

**Vertical organic permeable dual-base transistors for logic circuits**
Erjuan Guo, Zhongbin Wu, Ghader Darbandy, Shen Xing, Shu-Jen Wang, Alexander Tahn, Michael Göbel, Alexander Kloes, Karl Leo, Hans Kleemann
Nature Communications (2020)

**Effect of the Degree of the Gate-Dielectric Surface Roughness on the Performance of Bottom-Gate Organic Thin-Film Transistors**
Michael Geiger, Rachana Acharya, Eric Reutter, Thomas Ferschke, Ute Zschieschang, Jürgen Weis, Jens Pflaum, Hagen Klauk, Ralf Thomas Weitz

**Experimental proof of Joule heating-induced switched-back regions in OLEDs**
Anton Kirch, Axel Fischer, Matthias Liero, Jürgen Fuhrmann, Annegret Glitzky, Sebastian Reineke
Light: Science & Applications (2020)

**Inside or outside: Evaluation of the efficiency enhancement of OLEDs with applied external scattering layers**
Pen Yao Ang, Paul-Anton Will, Simone Lenk, Axel Fischer, Sebastian Reineke
Scientific Reports (2019)

**Introducing pinMOS Memory: A Novel, Nonvolatile Organic Memory Device**
Yichu Zheng, Axel Fischer, Michael Sawatzki, Duy Dai Hoan, Matthias Liero, Annegret Glitzky, Sebastian Reineke, Stefan C.B. Mannsfeld

**Precise patterning of organic semiconductors by reactive ion etching**
Marco Höppner, David Knepe, Hans Kleemann, Karl Leo
Organic Electronics (2019)

more on sweep-me.net/scientific_publications/
Example: Self-heating in OLEDs

Experimental proof of Joule heating-induced switched-back regions in OLEDs
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Example: Capacitive memory

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<td>Hold</td>
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*Advanced Functional Materials (2019)*
Services & users

What we offer?

• A platform on which content is shared across institutes to decrease costs and time.
• Programming „bottom-up“: Start with small settings and extend them anytime.
• We can support you by creating settings, new drivers or custom modules.
• We provide add-on modules for those who want to create complex procedures.

Find a list of our reference users online:
https://sweep-me.net/our_users
Thank you!

![SweepMe Logo]

LinkedIn: sweepme
Twitter: sweep_me_net

www: sweep-me.net

email: contact@sweep-me.net
Why we need agile software...

THE LIFE OF A SOFTWARE ENGINEER.

CLEAN SLATE. SOLID FOUNDATIONS. THIS TIME I WILL BUILD THINGS THE RIGHT WAY.

MUCH LATER...

OH MY. I’VE DONE IT AGAIN, HAVEN’T I?

by Manu Cornet (bonkersworld.net)