LEGO

Tools for Hybrid Integration

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Abstract

Performance of printed devices depends on the geometry, but is also affected by processing steps of other components integrated onto the same substrate. Since different designs use different devices, process stack, models and design rules must be dynamically determined. In this work we propose and demonstrate an experimental design flow to allow efficient design of hybrid and printed electronic circuits.

Introduction

A major difference between printed and traditional electronics is how components are handled. In printed electronics the manufacturing of components have to be integrated into one manufacturing flow, but unlike silicon integrated circuits, the exact processing steps will vary from one design to the next. One example is when integrating sensors, where the specific sensor material will be unique to the sensor used.

For designers this introduces challenges but also new opportunities. Since device performance depend on the geometry of each component it is possible to fine tune devices for optimal system performance. However, this requires the designer to not only to master the circuit design, but also have a deep understanding of the manufacturing process.

To simplify the work and allow the designer to focus on design and less on the physical impelementation, a new design flow and way to represent device libraries is proposed.

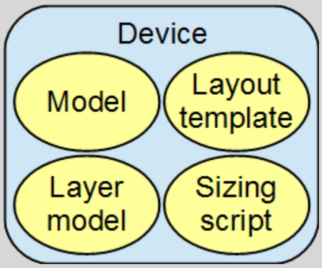

Fig 1. Device model including dynamic layermap information and sizing script

Hybrid system integration

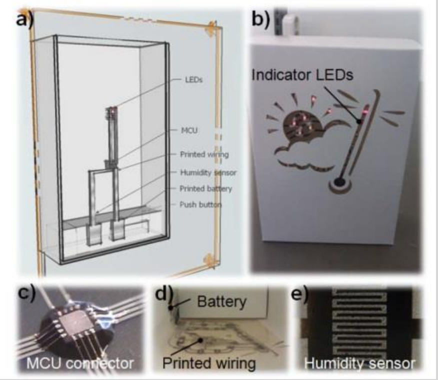

Fig 2. Example hybrid system a) Basic principle b) Final assembly c) Ink-jjet connected MCU d) Battery and wiring e) Printed humidity sensor

Fig. 2 shows an example circuit manufactured using hybrid integration and printed components [1]. In this design the performance of the hymidity sensor will depend on the annealing of the metal ink used to connect the mircrocontroller. Due to the relatively high resistivity of the printed conductors, the designer must also do a careful layout in order to not affect the sensor reading.

Dynamic Layer Map

In the proposed design flow targeting printed electronics and hybrid integration, the device library captures not only the device simulation model and layout template, but also a layer model containing information on layers used by the device (Fig. 1). Layers may be common layers shared with other devices, such as metal conductors, or special layers required for the specific device such as a sensor material. The layer model also contain information on design rules.

The device library can also use a sizing scripts to allow physical dimensions to be calculated from a high level specification, for example the nominal resistance of a sensor element. This is especially useful in a research environment where the sensor materials, and therefore the exact dimensions, differ between product generations.

Proposed design flow

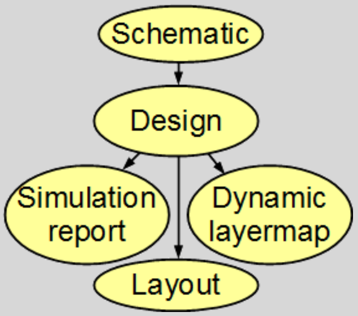

Fig 3. System hardware block diagram

In the proposed design flow (Fig. 3), designers capture the design using schematic entry. Possibly device parameters are tuned using the sizing scripts. Based on the devices used, a dynamic layermap is generated along with the layout and simulation report.

Fig. 4 shows a screenshot of an experimental software prototype.

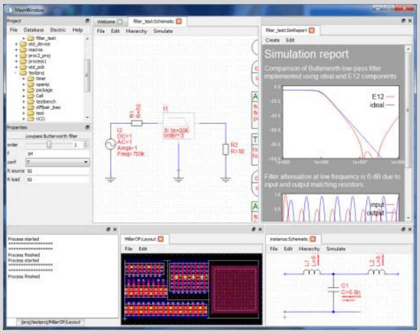

Fig 4. Screenshot of experimental software

References

[1] Mantysalo, M.; Xie, L.; Jonsson, F.; Feng, Y.; Cabezas, A. L. & Zheng, L.-R. (2012), "*System integration of smart packages using printed electronics*", in 'Electronic Components and Technology Conference (ECTC), 2012 IEEE 62nd', IEEE, , pp. 997--1002.

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