Processor-in-the-loop tutorial

Fernand Diaz Franco

Advisor: Dr. Chris Edrington

Energy Conversion and Integration Thrust (EC&I)

Center for Advanced Power Systems
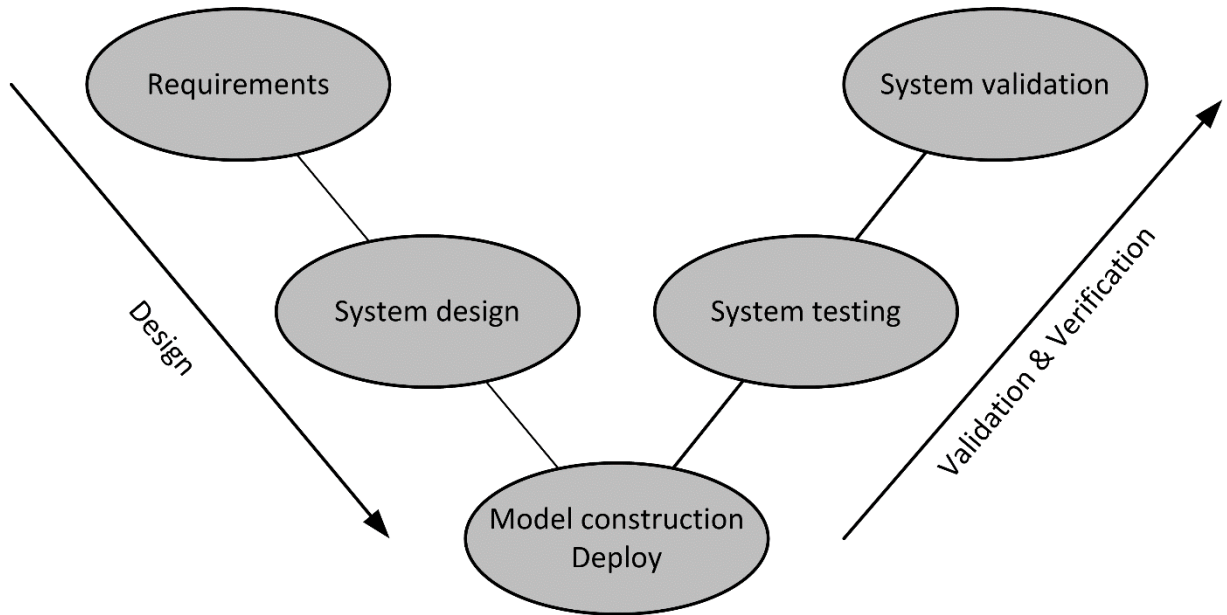
COLCIENCIAS
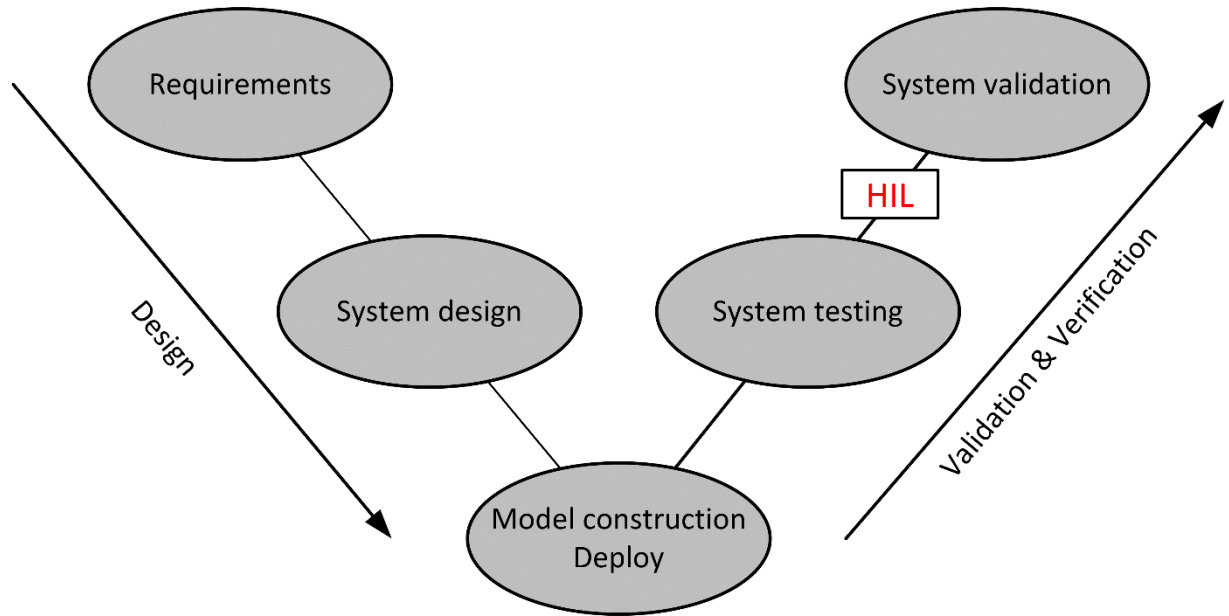
FULBRIGHT
COLOMBIA

About EC&I

Focus

Design, modeling, simulation, and experimentation of various energy conversion apparatus.
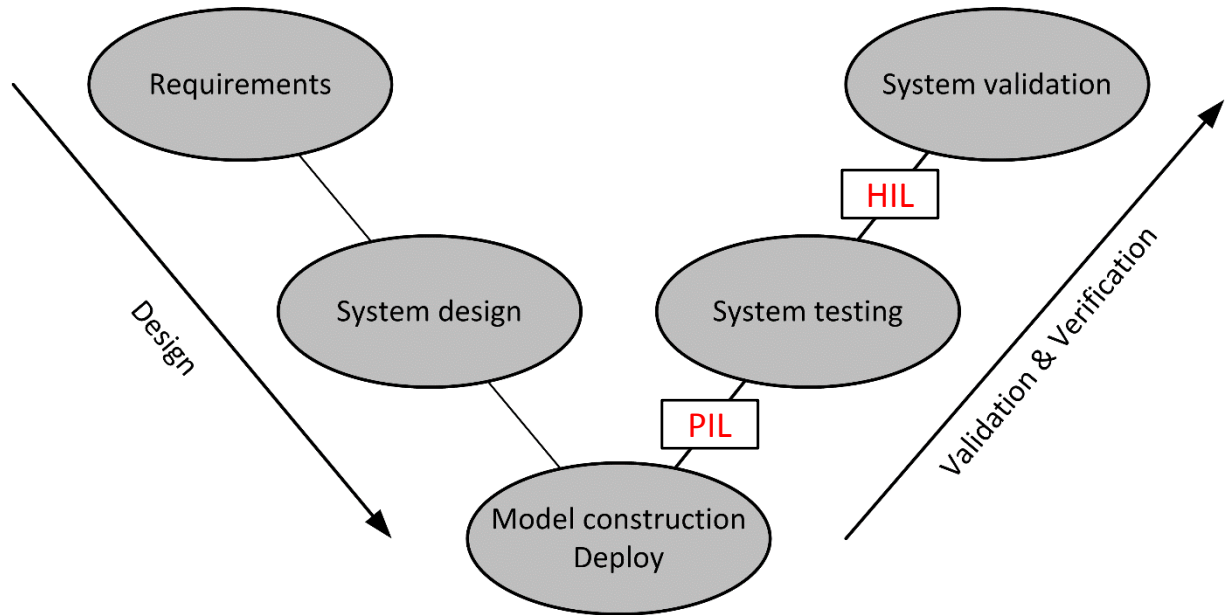
Sequential Design and Validation Phases

Sequential Design and Validation Phases
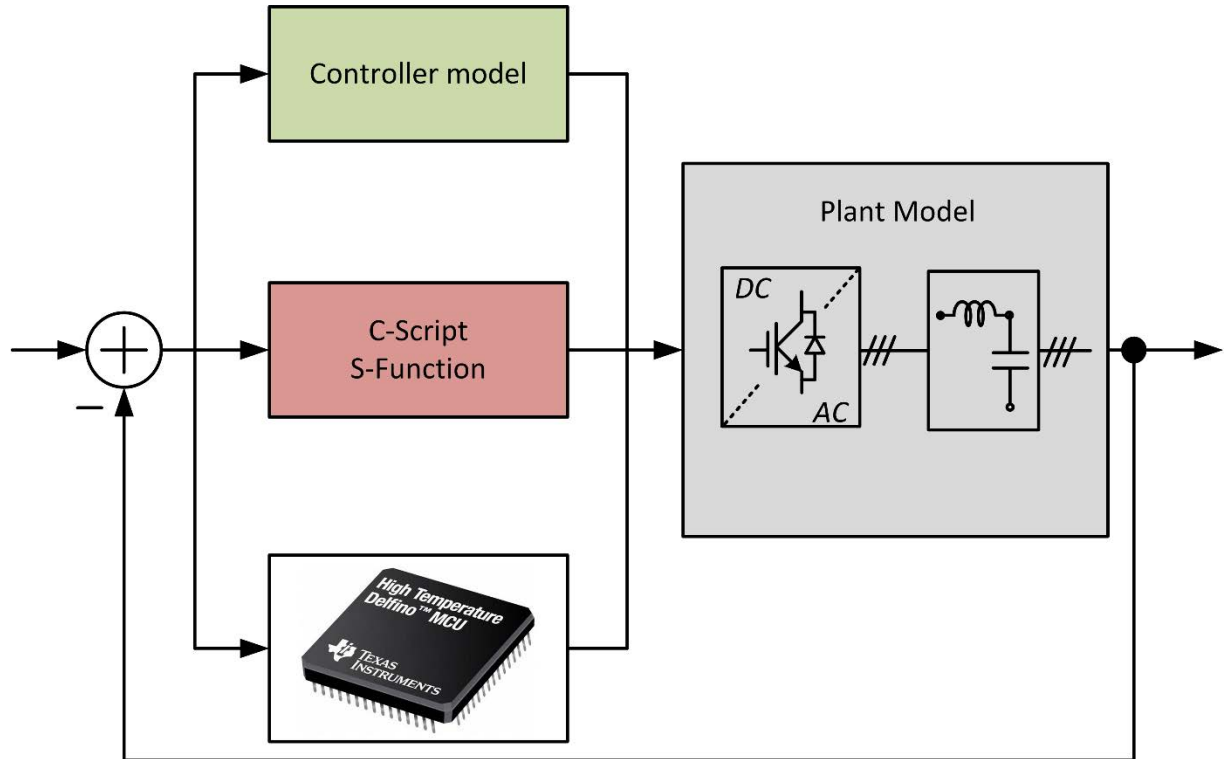
Sequential Design and Validation Phases

Outline

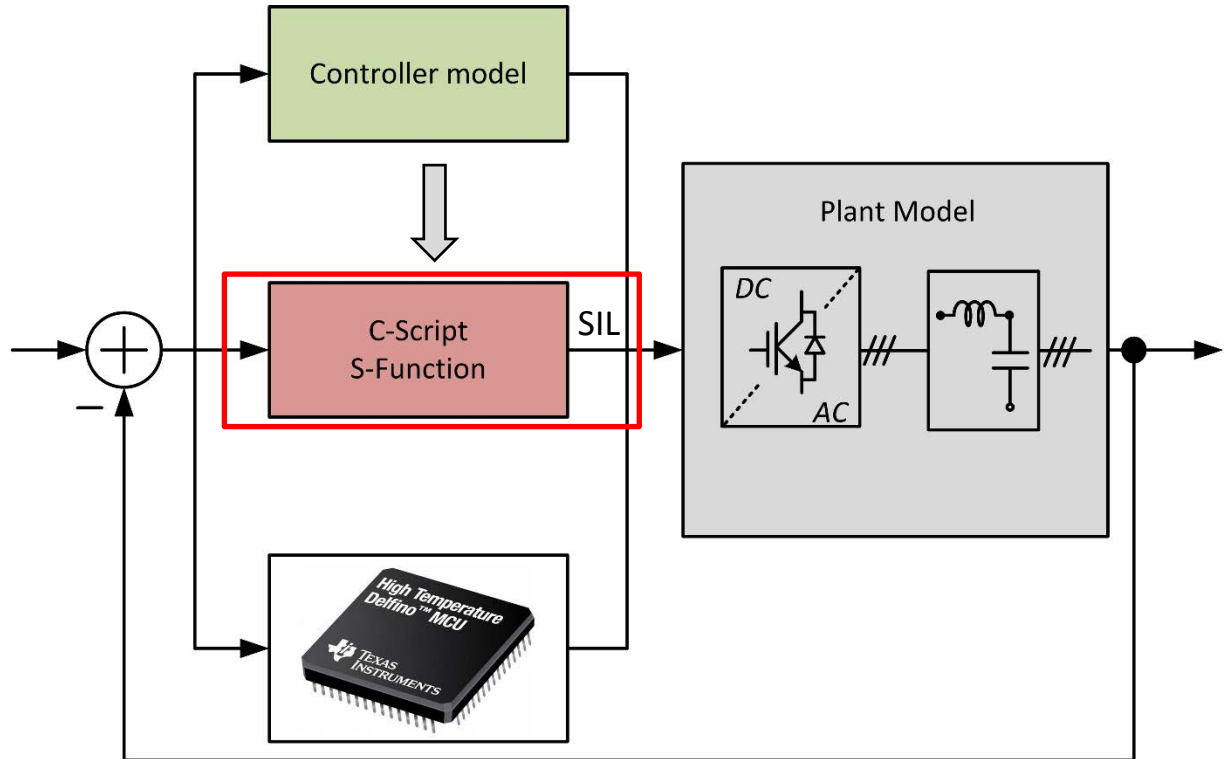- Concepts SIL – PIL

- PIL key aspects
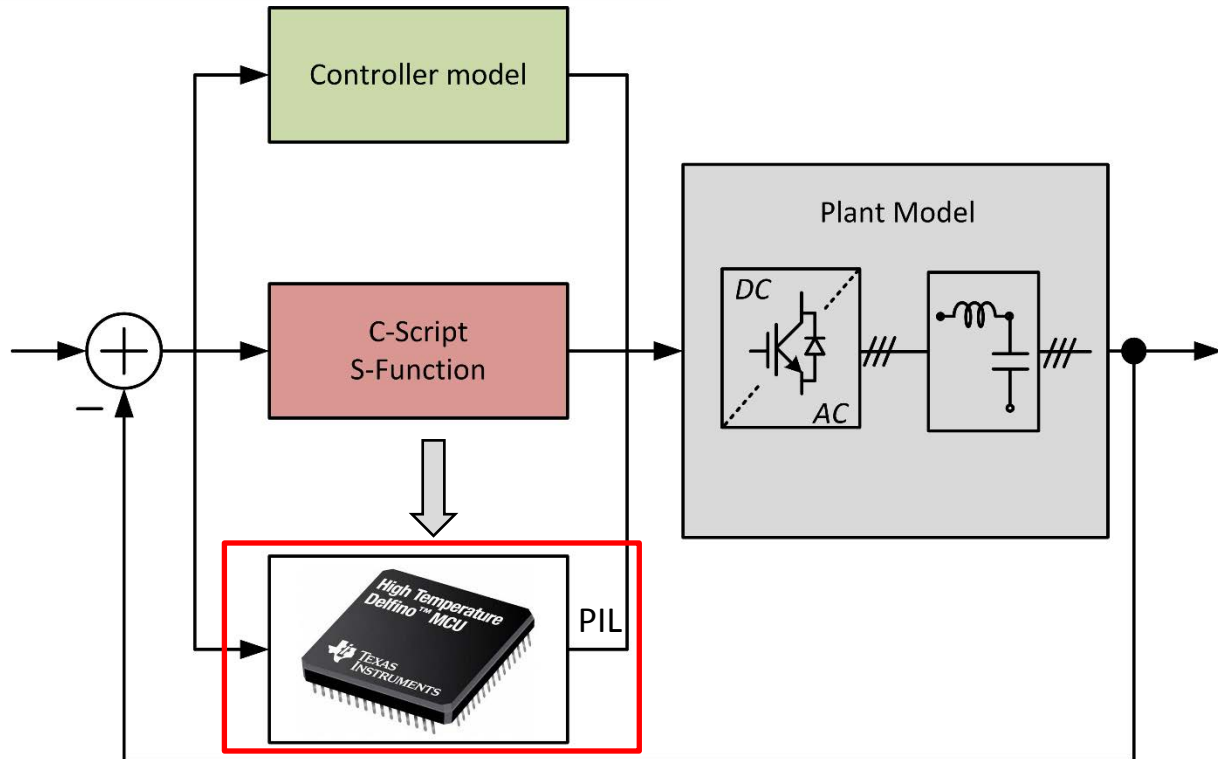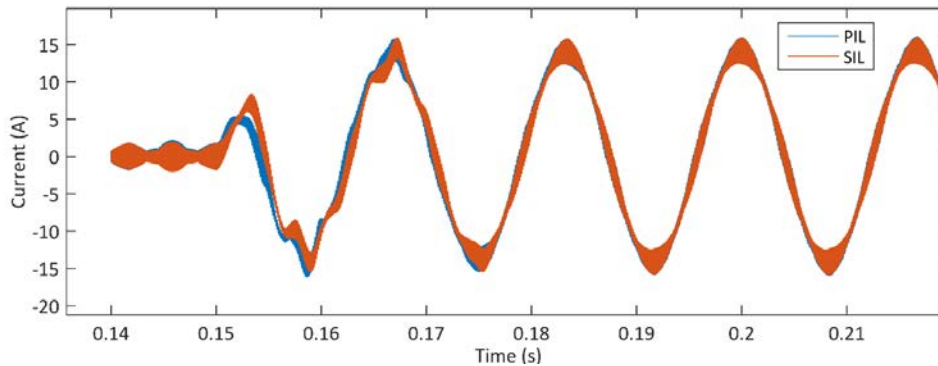
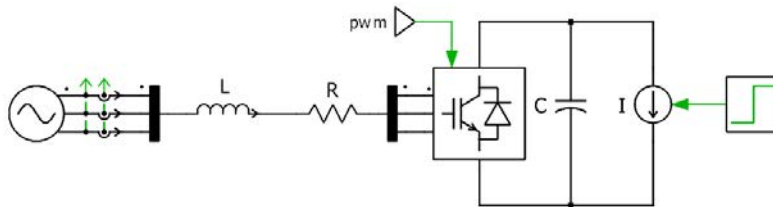- Implementation

- Conclusions

SIL – PIL

SIL – PIL

SIL – PIL

Discrepancy on SIL – PIL

Processor-in-the-loop

MATLAB
SIMULINK

plexim

dSPACE

PSIM

Control Hardware-in-the-loop

Analog, digital,
bus interface

Processor-in-the-loop

Control Hardware-in-the-loop

Analog, digital, bus interface

Real Time Simulator | I/O ↔ ECU

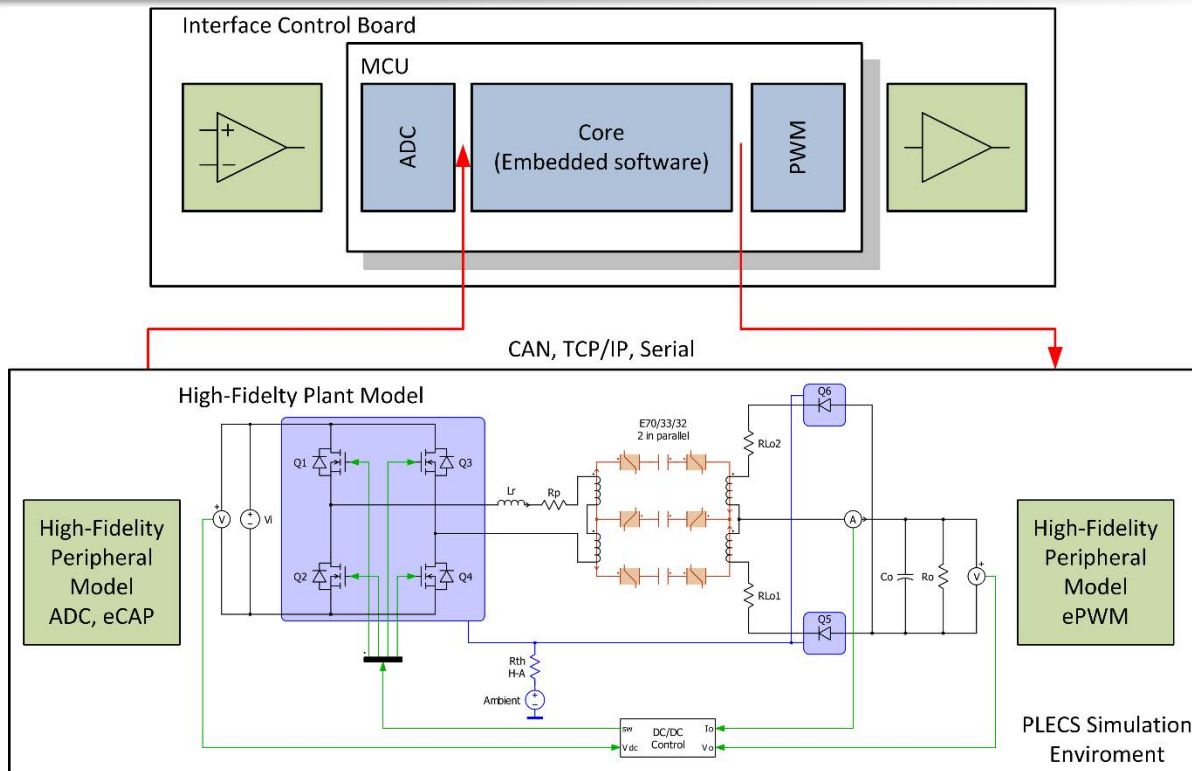## Processor-in-the-loop

Bus Interface

ECU

MATLAB SIMULINK

plexim

dSPACE

PSIM
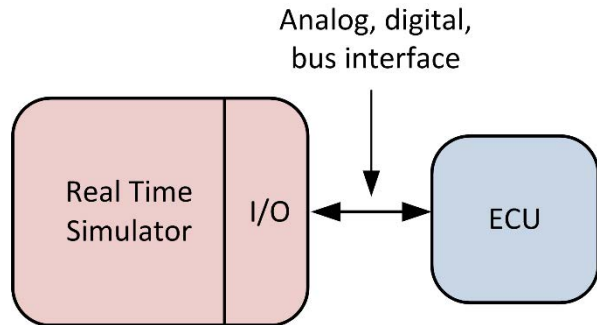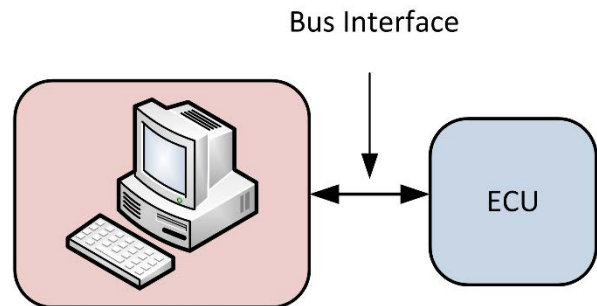
Processor-in-the-loop

Main Advantages of PIL

- Reduce cost compared with HIL
- Arbitrary test-probes
- Effects of the fixed point calculation in code
- Pseudo real-time execution facilitates debugging
- WBG based power converters with high frequency

Well suited for development, verification and validation

RP with PIL

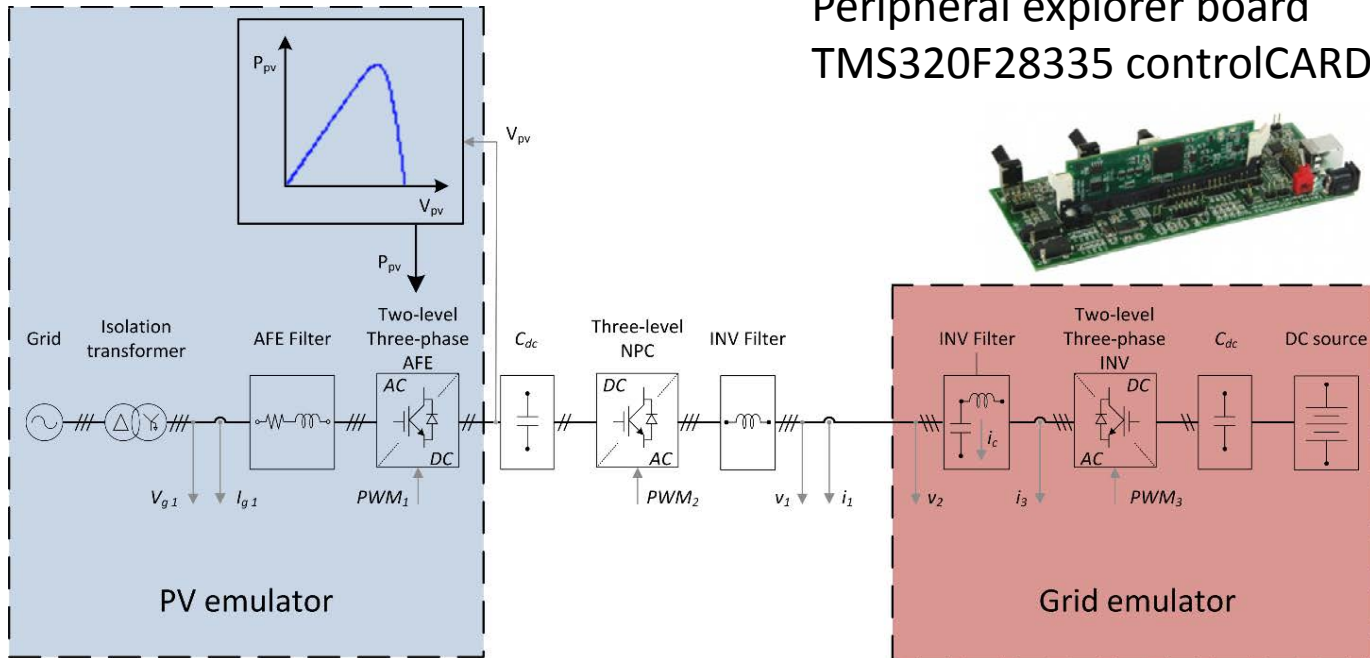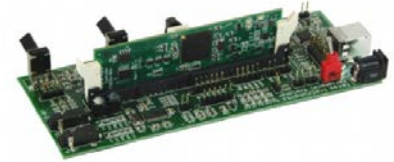| Control design	Code generation		Verification
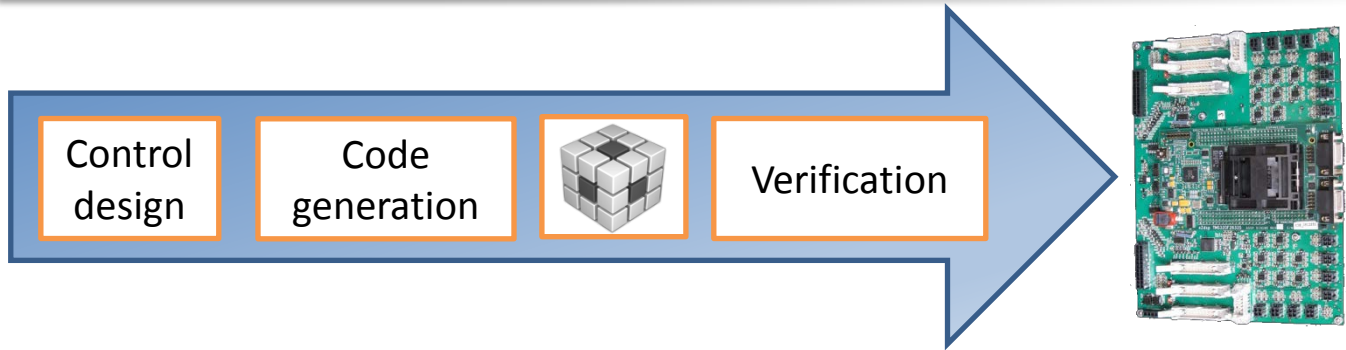
Embedded code and the simulation
software require initial configuration

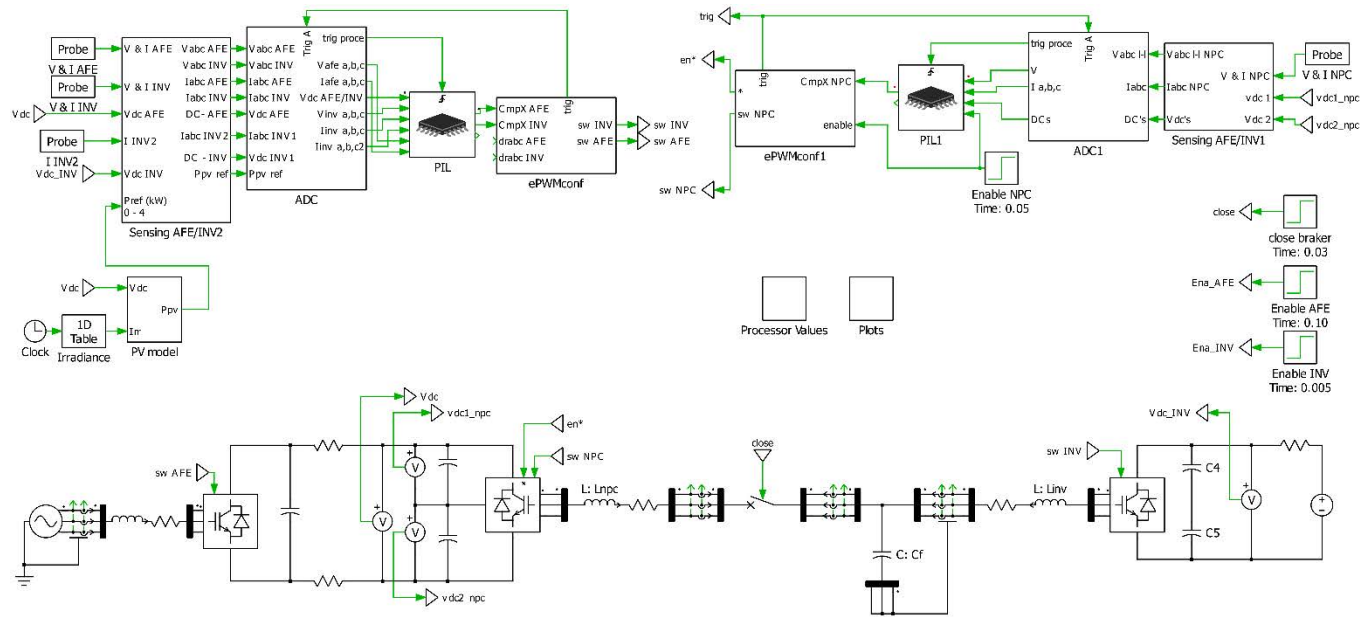Communication, variables to read and write, sample time definition

Implementation of PIL

Peripheral explorer board
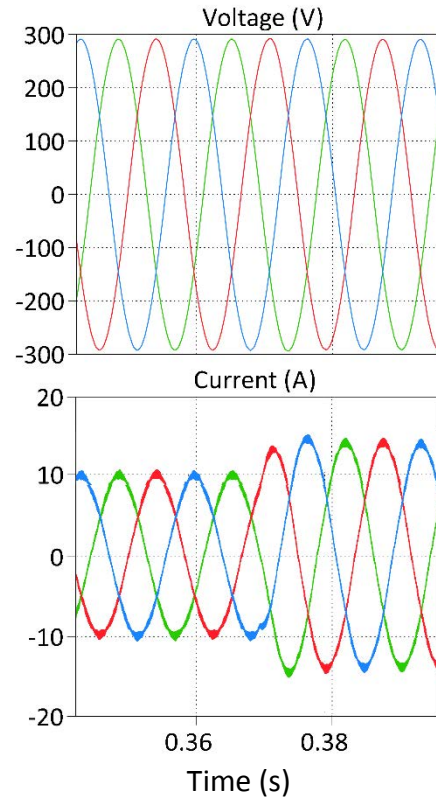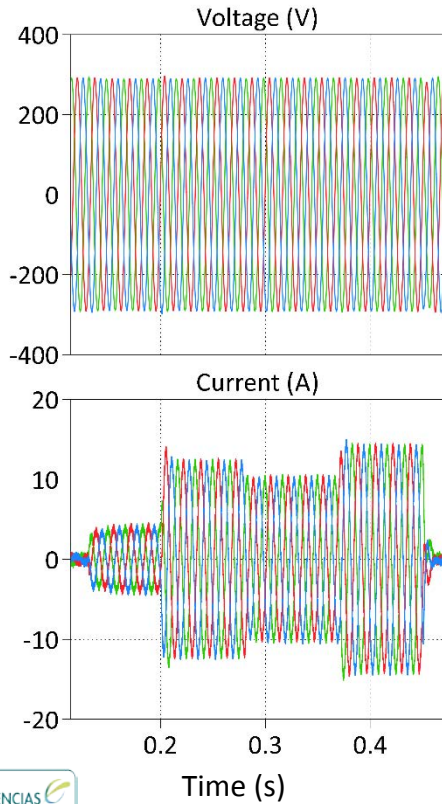TMS320F28335 controlCARD

PIL Implementation

Filter coefficients and regulator gains controlled in software

PIL Simulations

Conclusions

- PIL offers valuable information of the control hardware since it can take the advantage of the simulation environment to test upfront scenarios.

- PIL work is an excellent precursor to CHIL and could prove to be a good addition to the HIL design cycle.