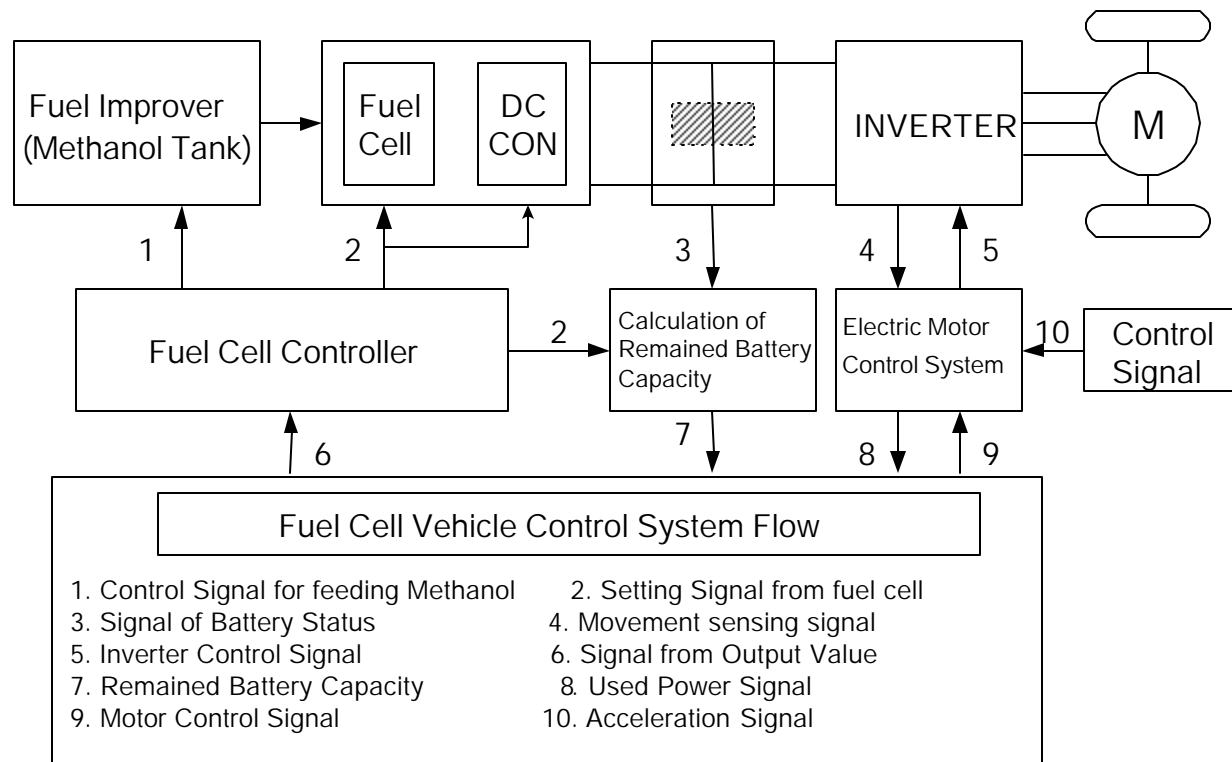


Simulation of Battery Charging System for Hybrid Vehicle Using Simplorer

Korea Institute of Energy Research
Soo-Bin Han Ph.D.

Fuel Cell Vehicle Control System Flow



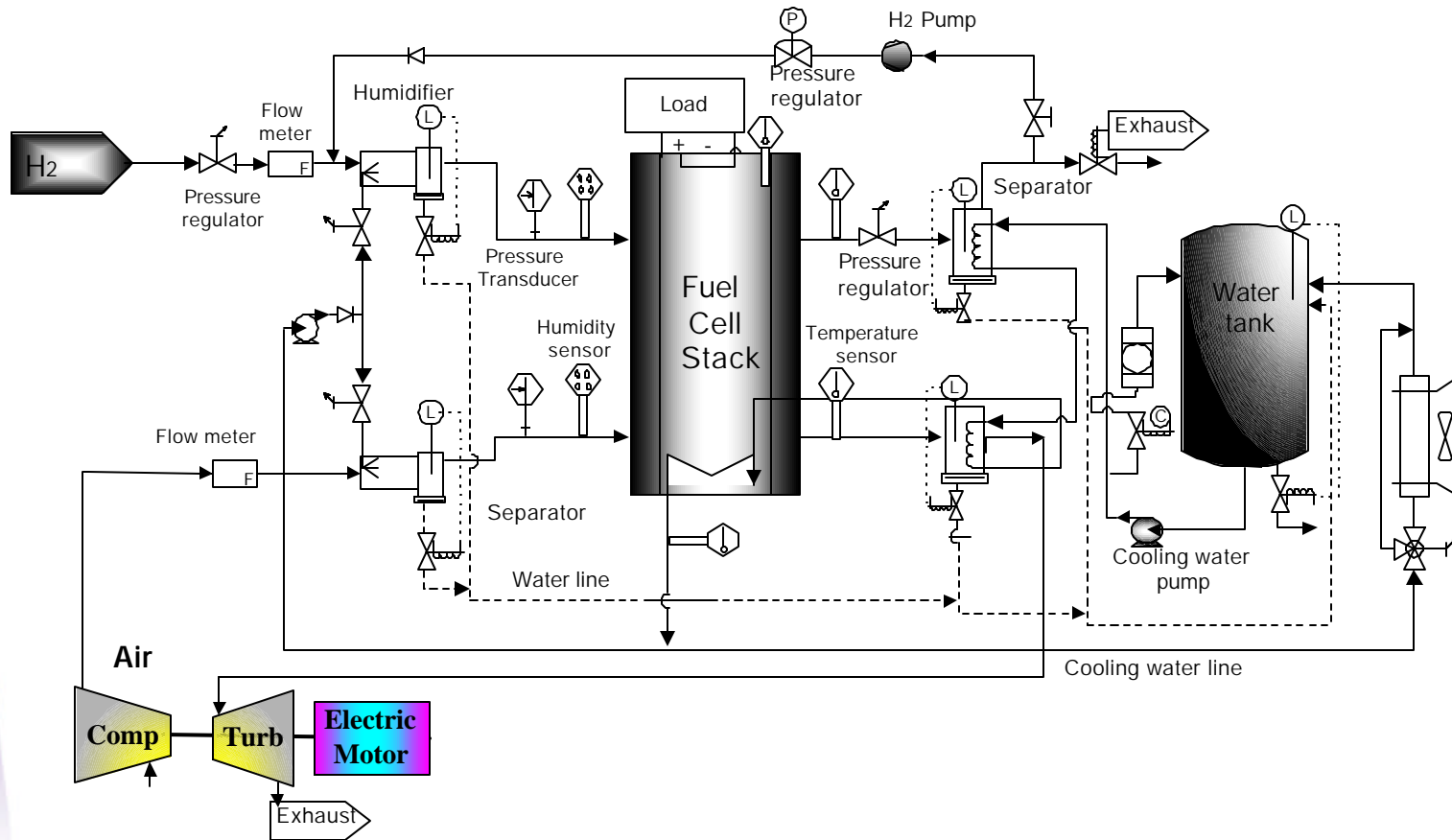
Simulation Problem for FC-HEV

- ◆ Fuel Cell
- ◆ DC/DC Converter
- ◆ Battery
- ◆ Running mode change
- ◆ Power command

Fuel Cell Modeling

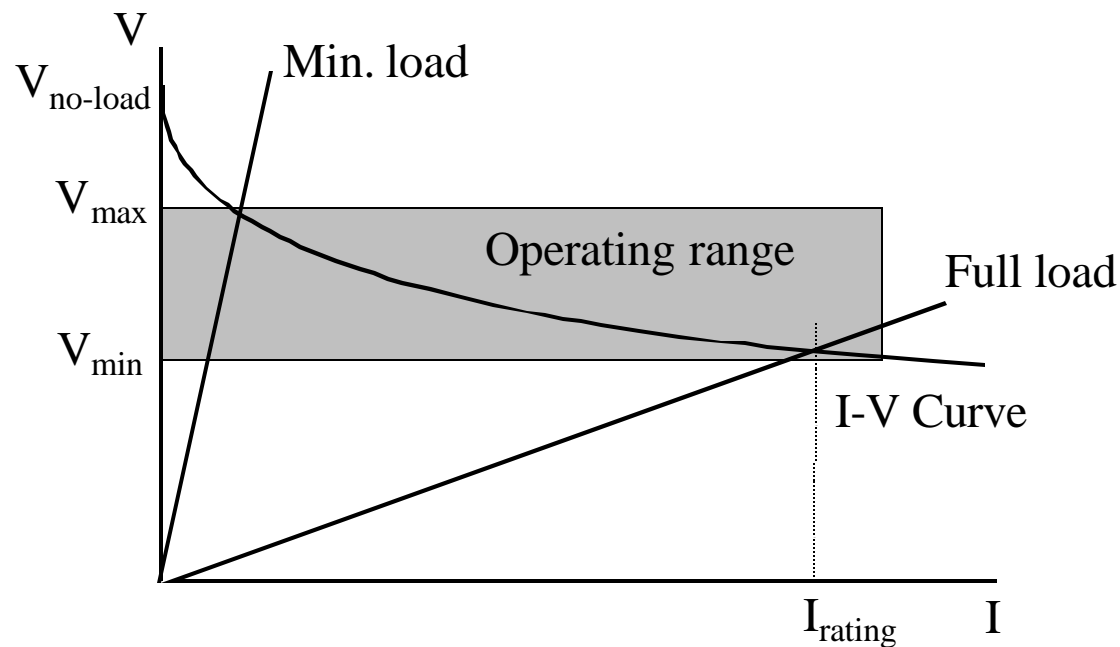
- ◆ Complete system model : Programming language
- ◆ Using I-V curve by measured values
 - Look up table or Approximation
- ◆ First test: Supposing Arbitrary Time varying voltage source

Fuel Cell Stack: complex system



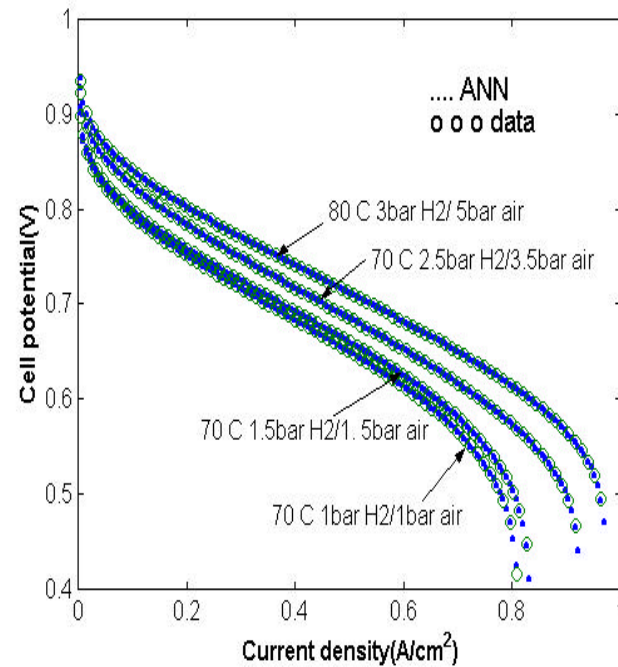
Fuel Cell I-V Characteristics

- Large Voltage fluctuation: less than 50% without load
- Low voltage High Current Characteristic: 0.6V/300A



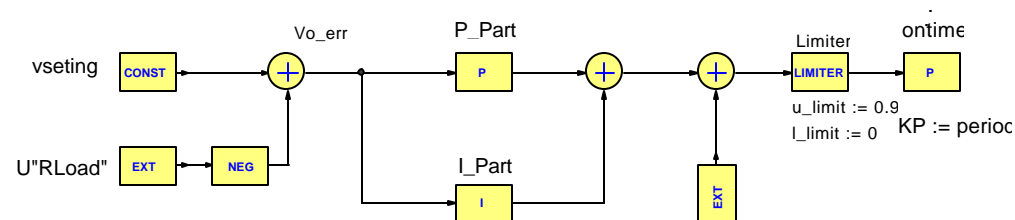
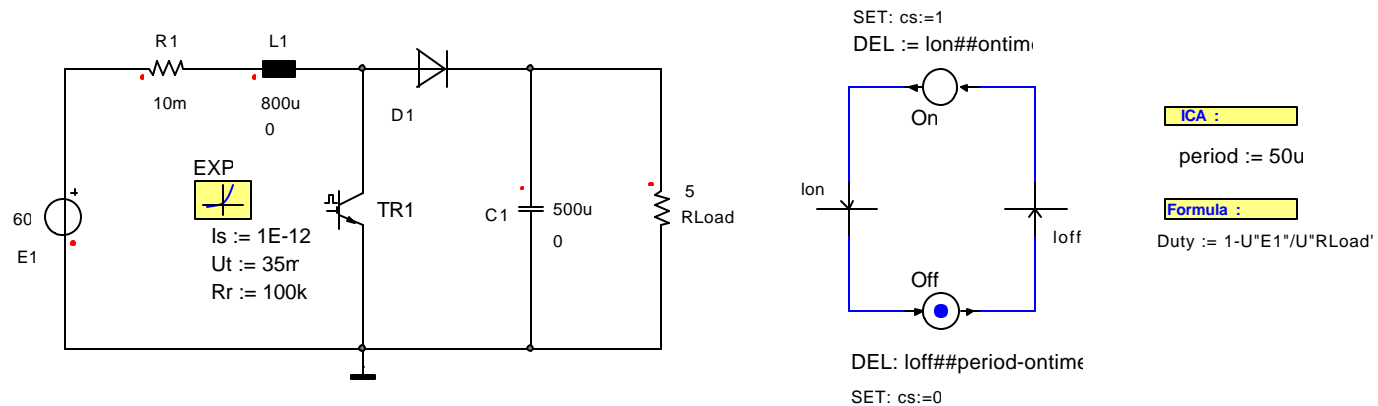
Real Fuel Cell I-V Characteristics

- I-V Characteristic varying by Many parameter



Boost Converter Control:

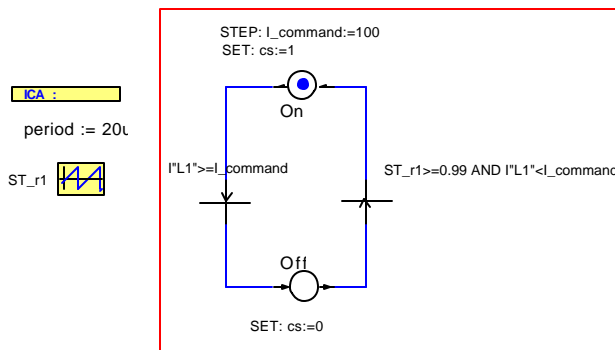
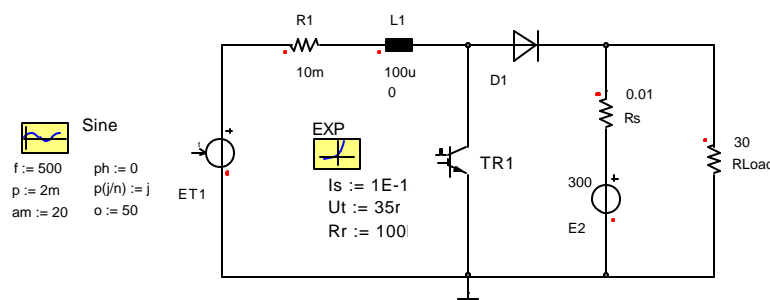
- Voltage mode control for load



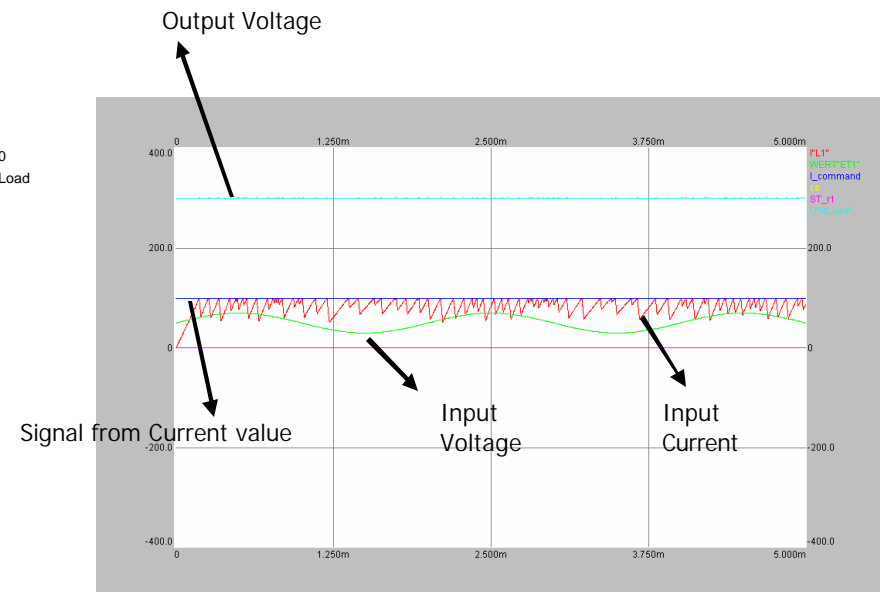
Boost Converter Control:

- Load is close electrically from source :
Current mode control

Fuel Cell → Variable voltage source, Battery → Voltage Source
Running Mode → Fixed resistance load, command → const

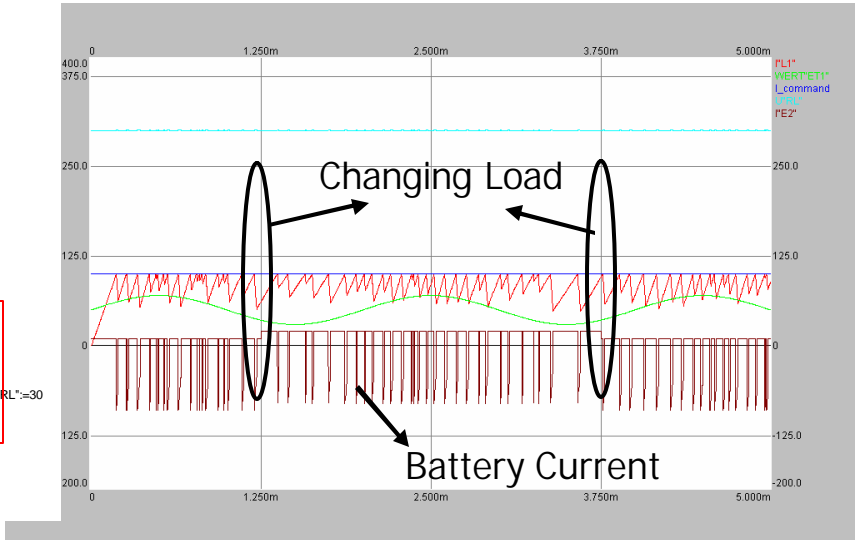
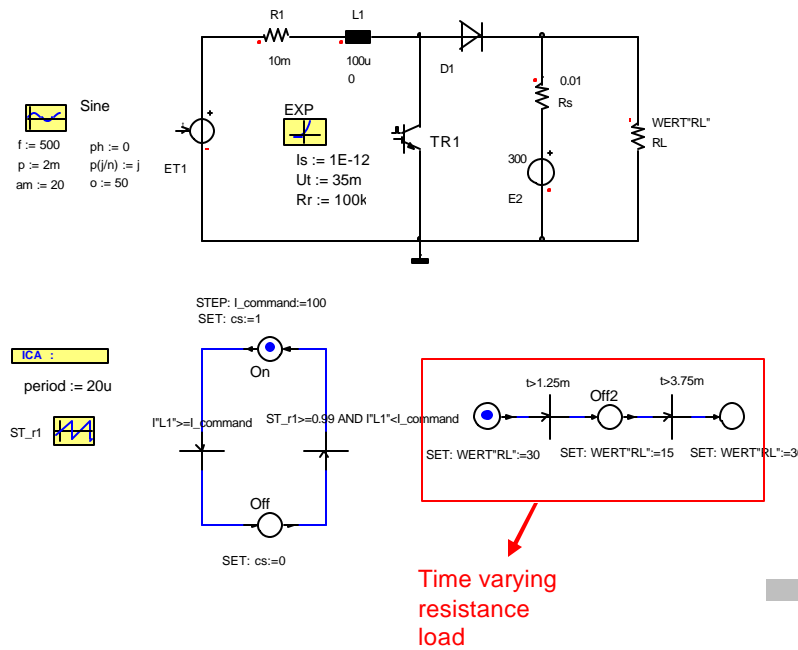


Current Mode Control



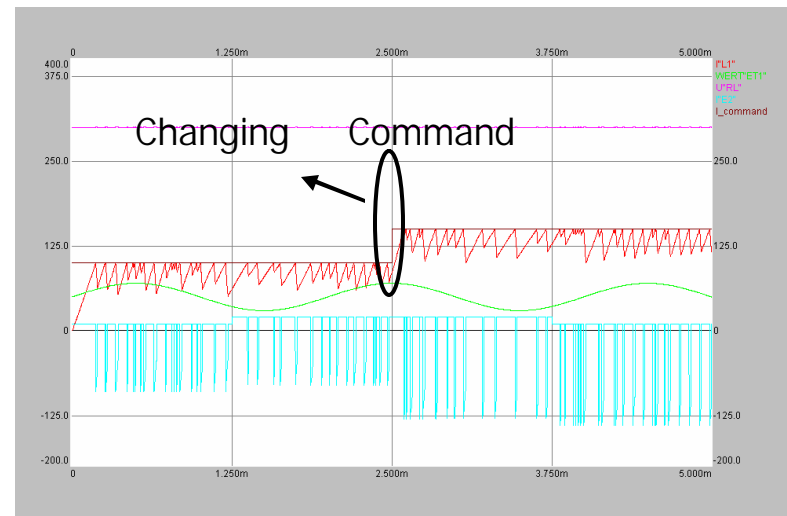
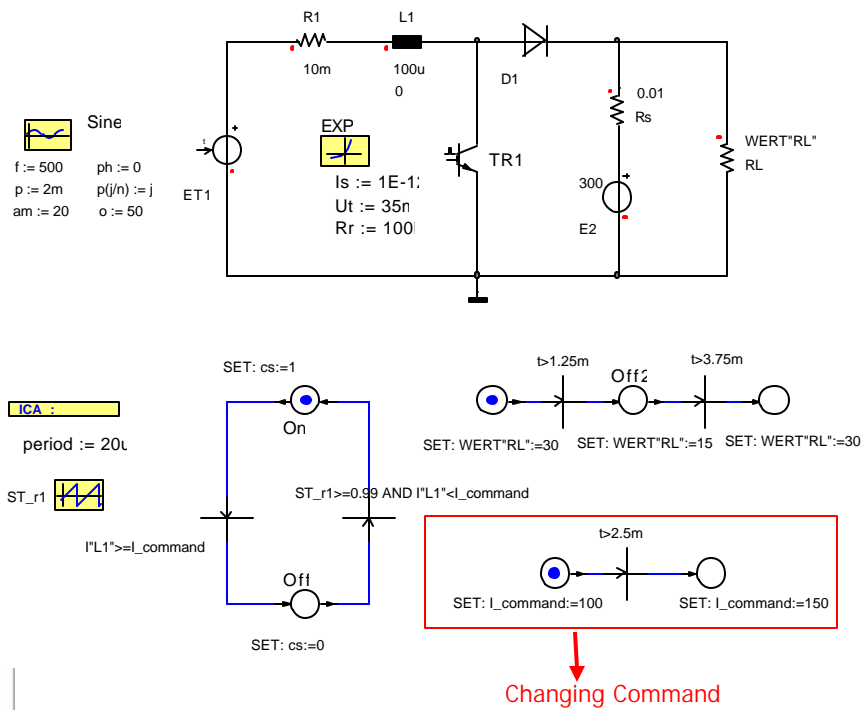
Boost Converter Control:

Fuel Cell → Variable voltage source, Battery → Voltage Source
 Running Mode → Time varying resistance load, command → const



Boost Converter Control:

Fuel Cell → Variable voltage source, Battery → Voltage Source
 Running Mode → Time varying resistance load, **command** → **Variable**

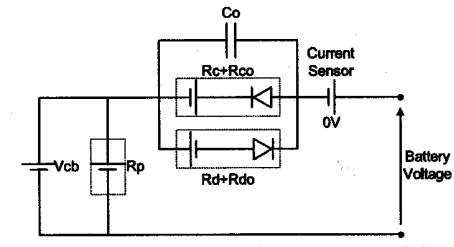
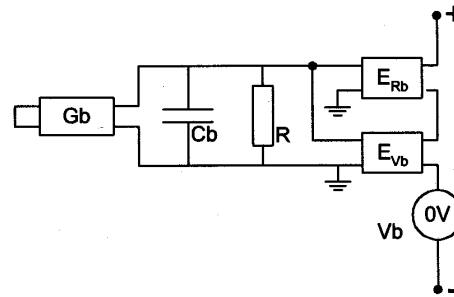
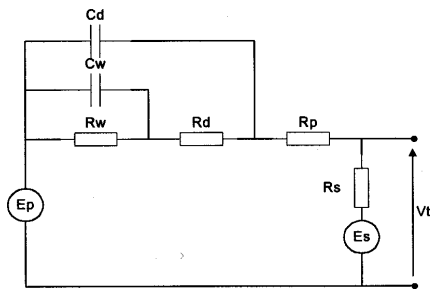
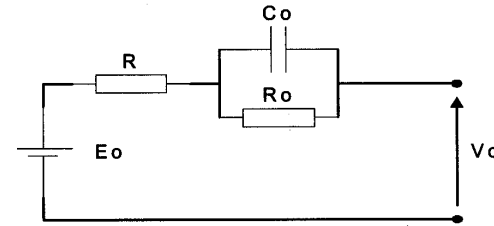
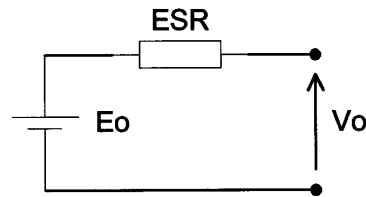


Battery Modeling

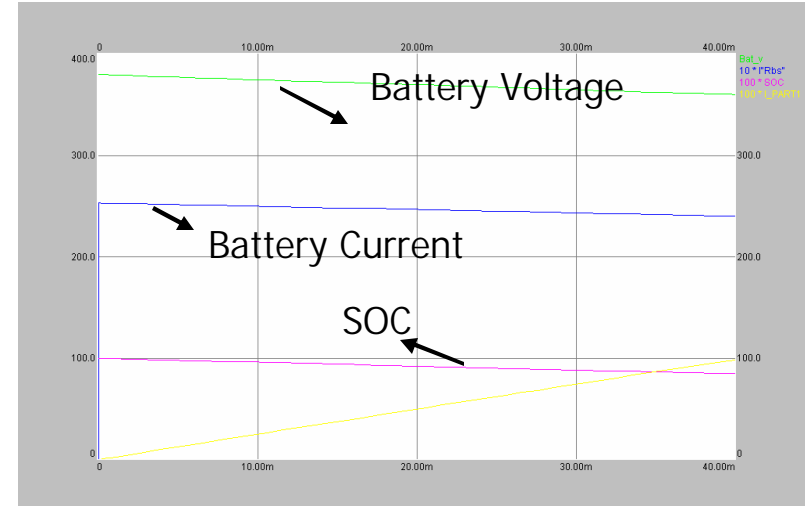
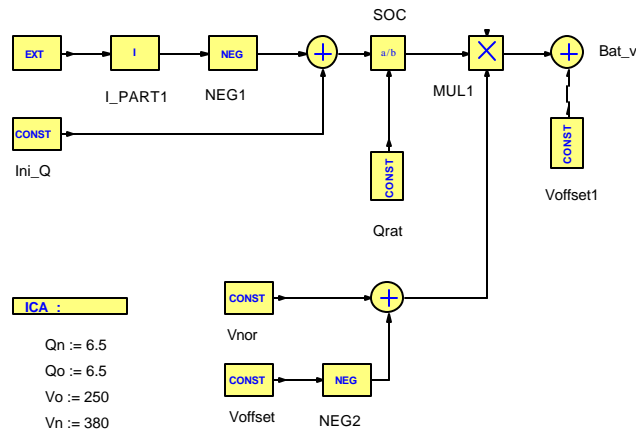
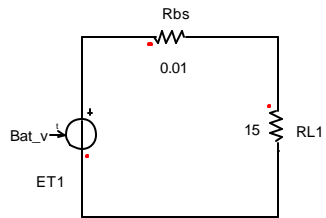
- Method of depending parameters
 - Node Voltage of Fuel cell is changing by current profile
 - Important parameters : State of Charge(SOC), Temperature

- Method of LUT

Example Model for Method of depending parameters

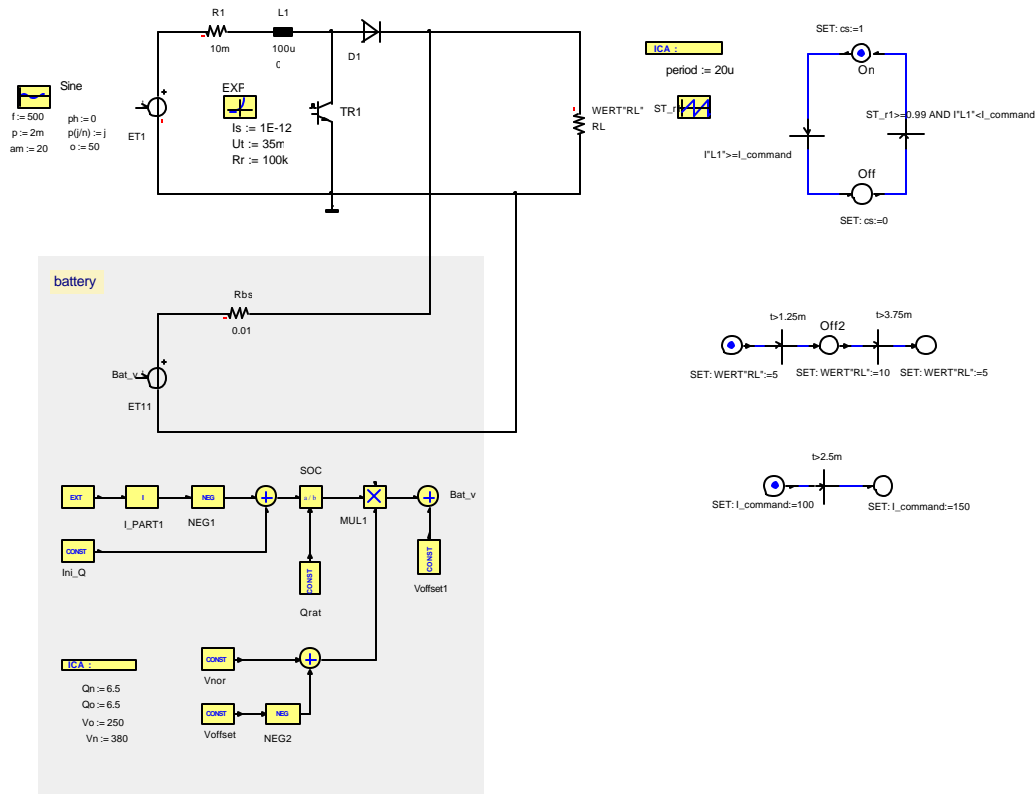


Battery model test

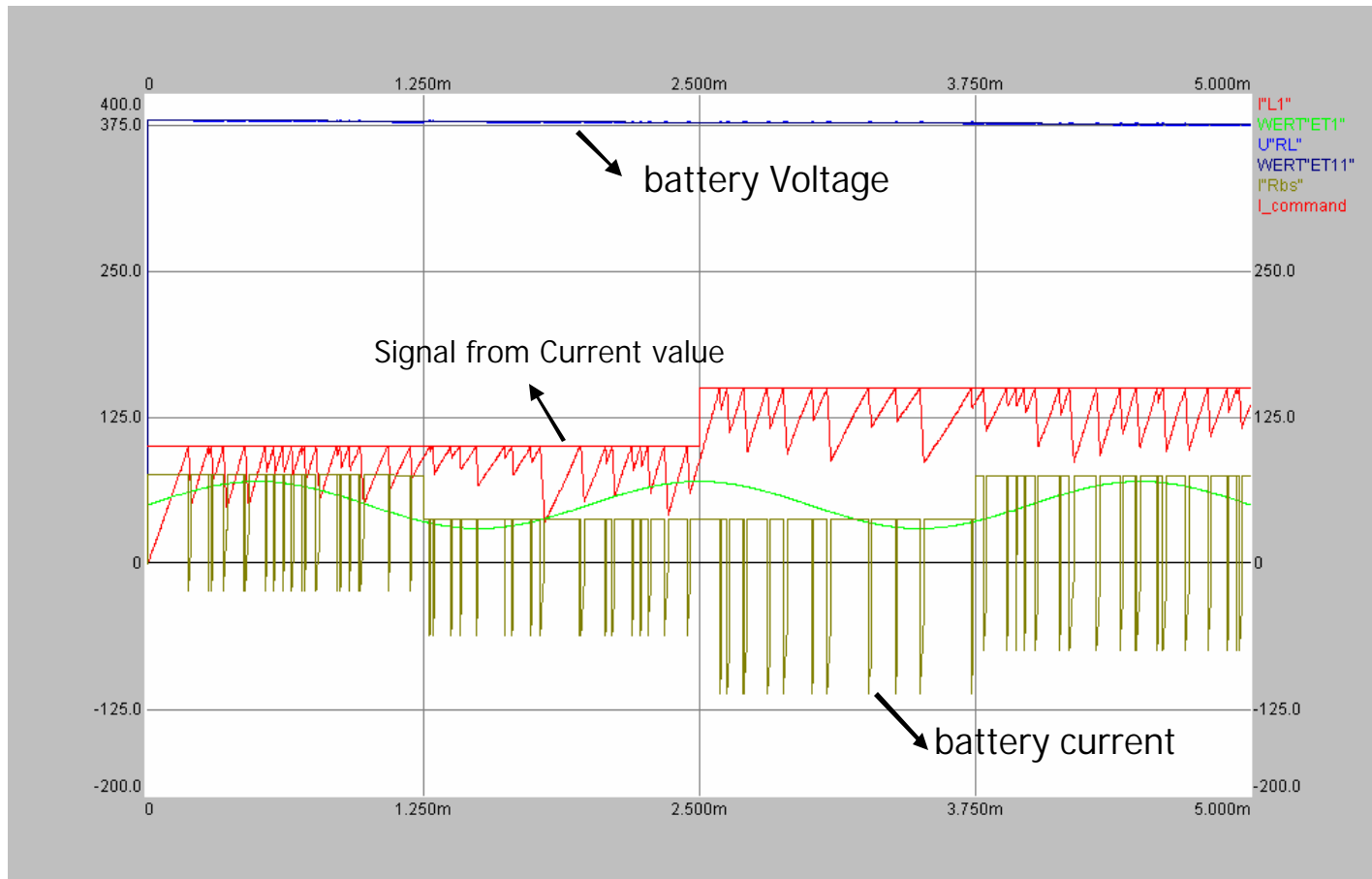


Boost Converter Control:

Fuel Cell → Variable voltage source, **Battery** → **Depending Soc**
Running Mode → Time varying resistance load, command → Variable

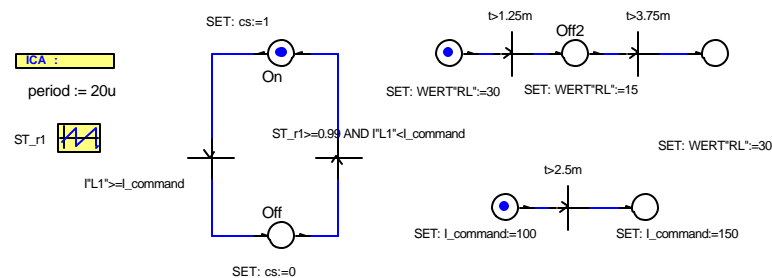
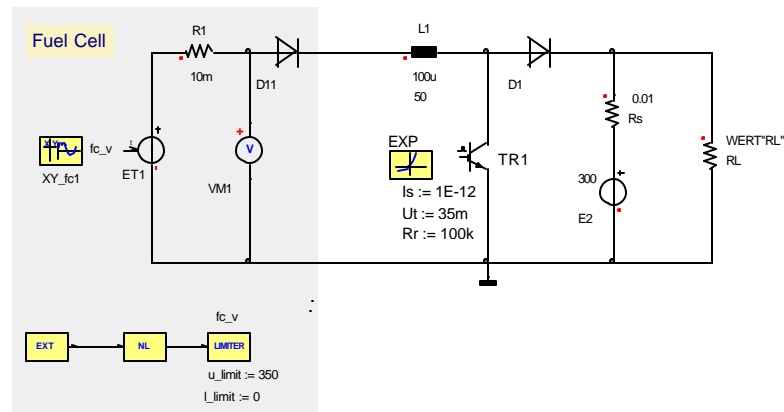


Boost Converter Control:

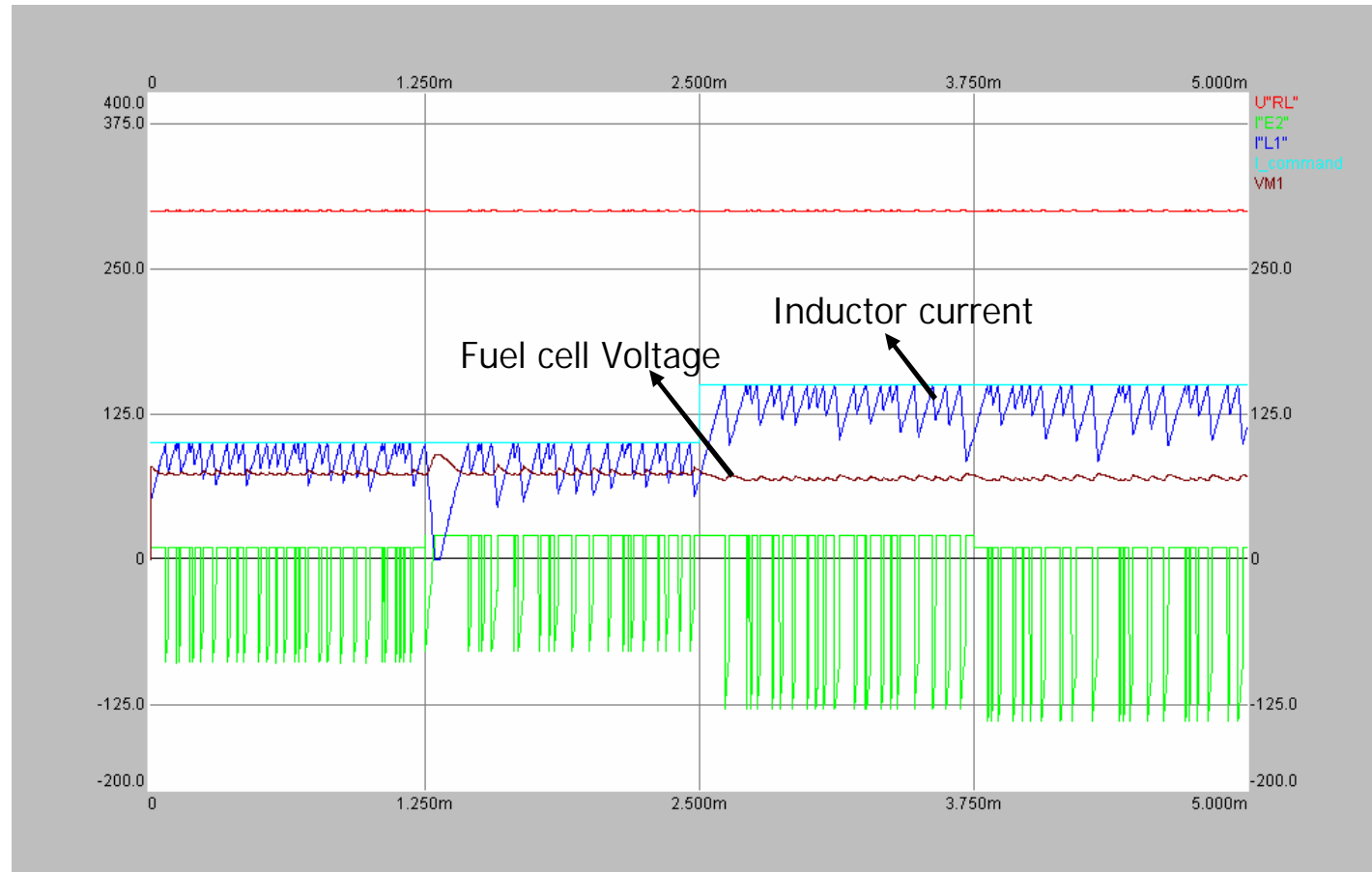


Boost Converter Control:

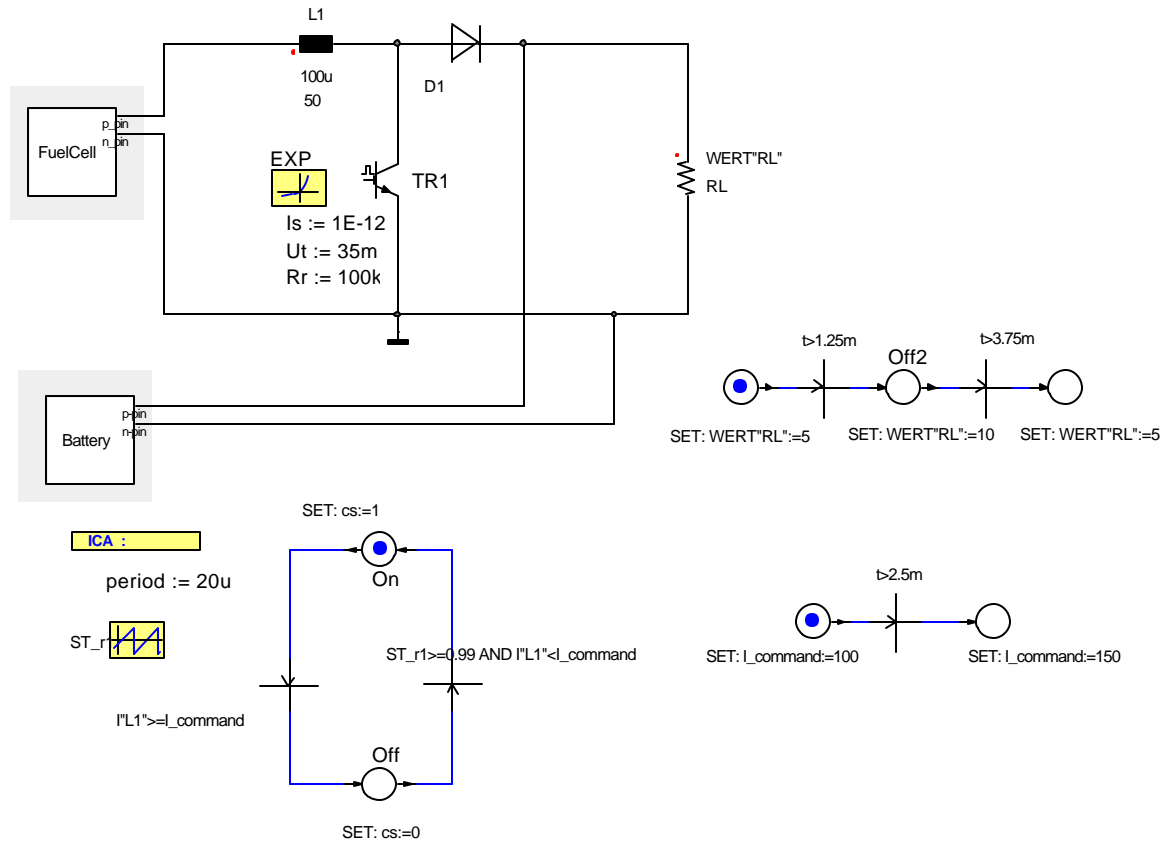
Fuel Cell → Making I-V Characteristic, Battery → Voltage Source
 Running Mode → Time varying resistance load, command → Variable



Boost Converter Control:



Hybrid system integration:



More Accurate

- Consideration of additional parameters for temperature of Fuel cell
And Battery
 - Using 3-D LUT or Coupling with external programs as
Matlab/simulink
- Testing of running for vehicle : Applying running pattern
by xy-table for load resistance
- Power command calculate for each running mode, then
Current control requested by external controller