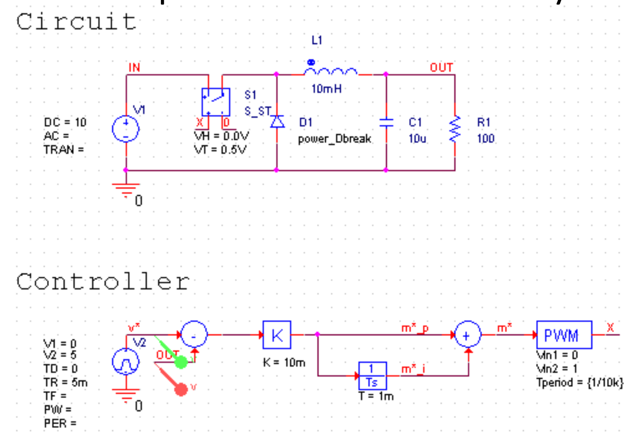
Introduction to ControlBlock Library for PSpice and LTspice Control Library



Features
- **Automatic time step adjustment** suitable for switching circuit
- Support for **discrete-time modeling** such as latch and sample & hold
- **Motor models and motor control elements** such as coordinate transformation

ControlBlock Library for PSpice and LTspice Control Library provide a set of control elements, that allows to **design the controller of a circuit by drawing a control block diagram** and simulate the circuit and the controller on PSpice/LTspice.

The libraries make it easier to **design a complicated controller which is difficult to implement with the built-in libraries** of PSpice/LTspice. And it makes the circuit simulator more useful **for circuit designers and controller designers.**

The libraries are designed to work fast. The automatic time step adjustment suitable for switching circuit is the most distinctive feature related to the fast analysis.

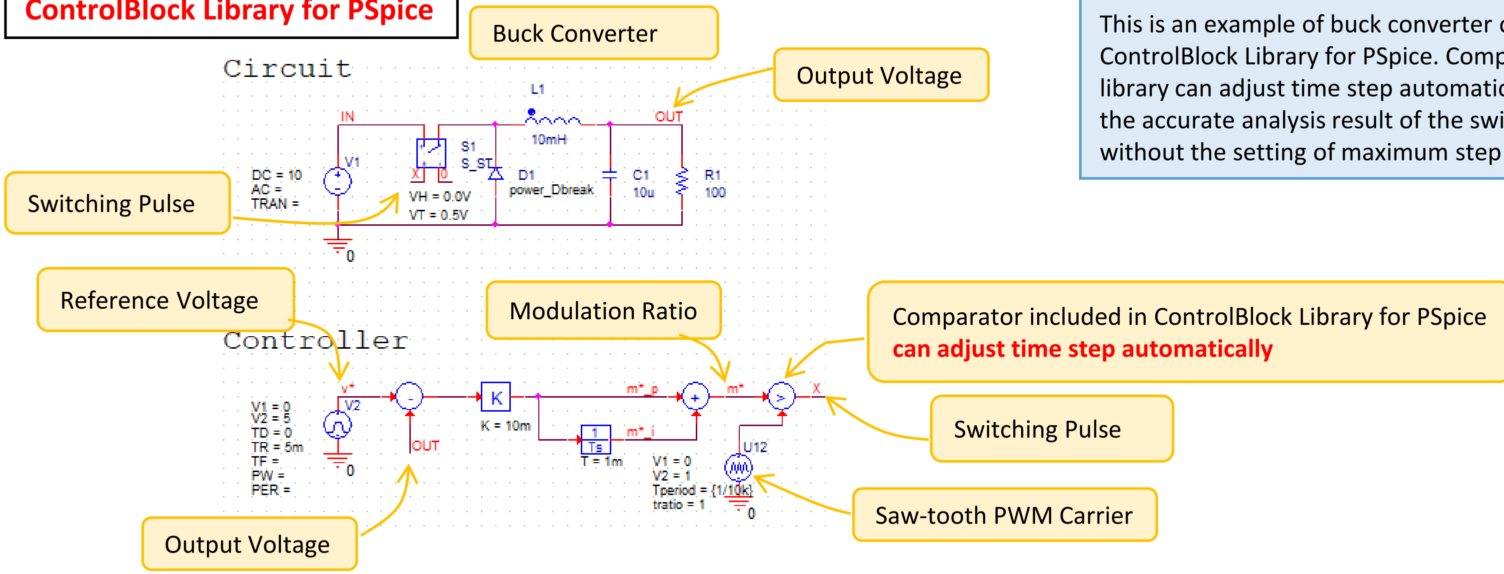
The libraries have **the interface similar to each other**. LTspice Control Library can be used free. Therefore, it is possible to try what you can do using the libraries with the free circuit simulator LTspice and the free library.

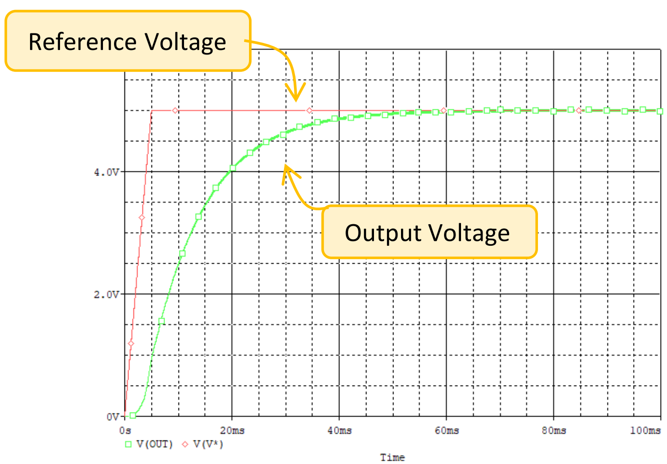
The libraries have a lot of examples which help you to get started. Some examples are shown later in this document.

Feature 1. Automatic time step adjustment suitable for switching circuit

ControlBlock Library for PSpice

This is an example of buck converter control using ControlBlock Library for PSpice. Comparator included in the library can adjust time step automatically. Therefore, it gives the accurate analysis result of the switching circuit faster without the setting of maximum step size.

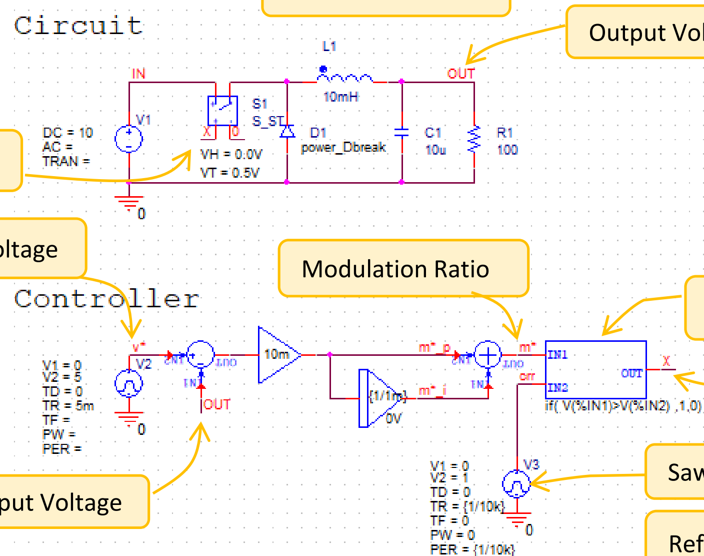




Maximum step size: **null**
Analysis result: **accurate**
Analysis elapsed time: **8s**

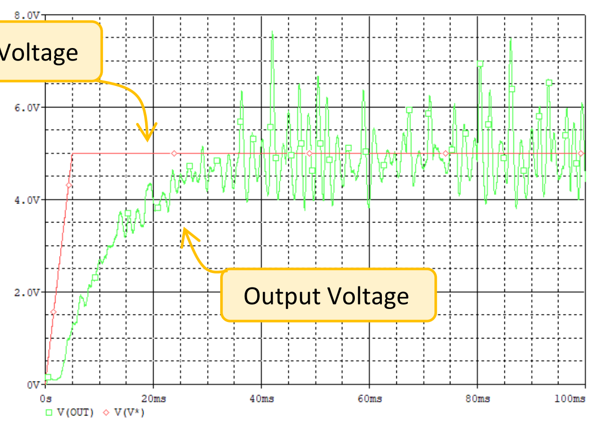
Feature 1. Automatic time step adjustment suitable for switching circuit

Built-in library of PSpice

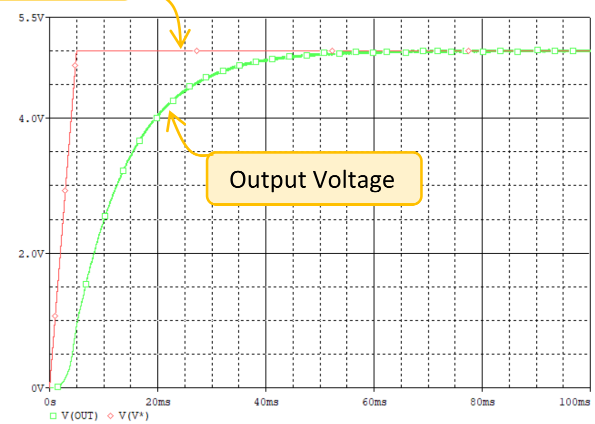


This is an example of buck converter control using the built-in library of PSpice. Comparator using the library can NOT adjust time step. It is required an appropriate maximum step size for each switching circuit in simulation settings. When maximum step size is not specified or too big, it gives an inaccurate analysis result because of the pulse width variation and missing some pulse. Smaller maximum step size brings more accurate result but longer analysis time.

Reference Voltage



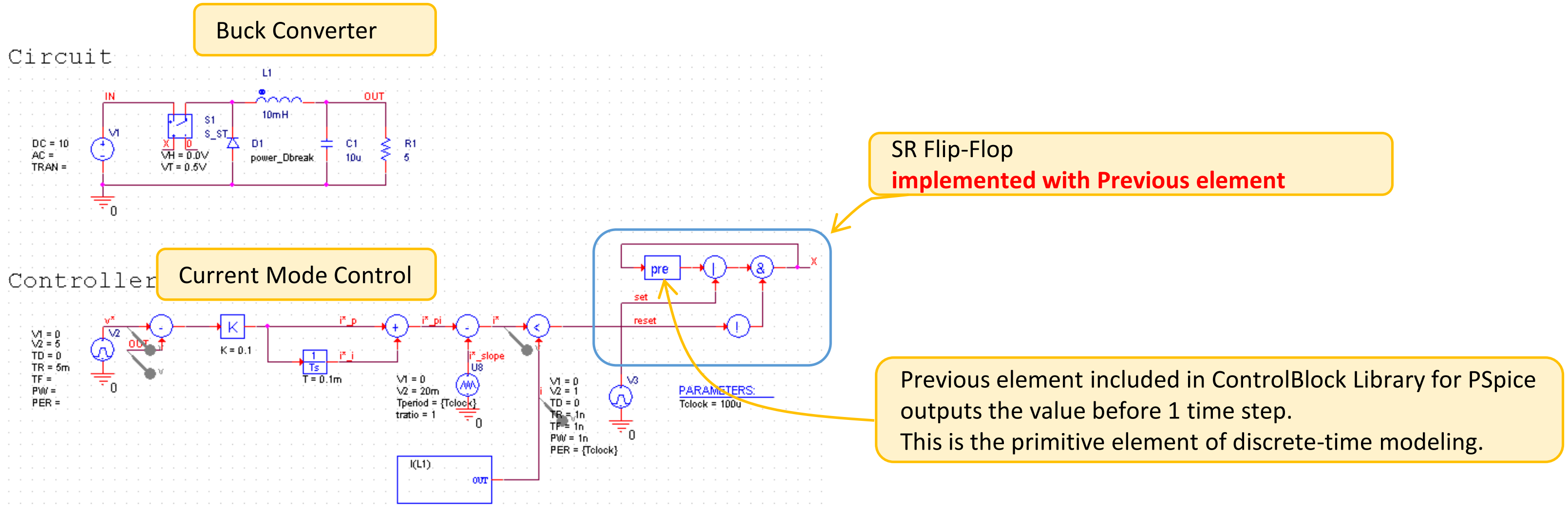
Maximum step size: **null**
Analysis result: **inaccurate**
Analysis elapsed time: **2s**

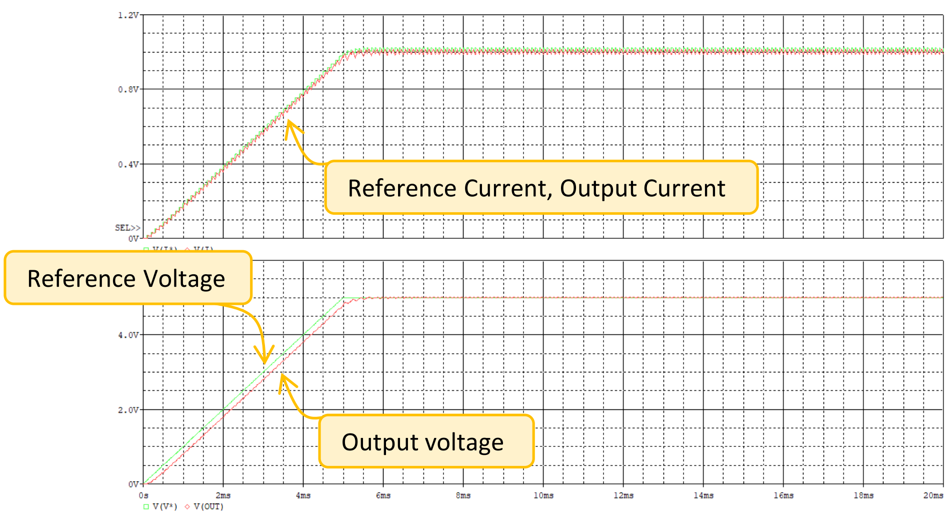


Maximum step size: **0.1us**
Analysis result: **accurate**
Analysis elapsed time: **29s**

Feature 2. Support for discrete-time modeling

PSpice





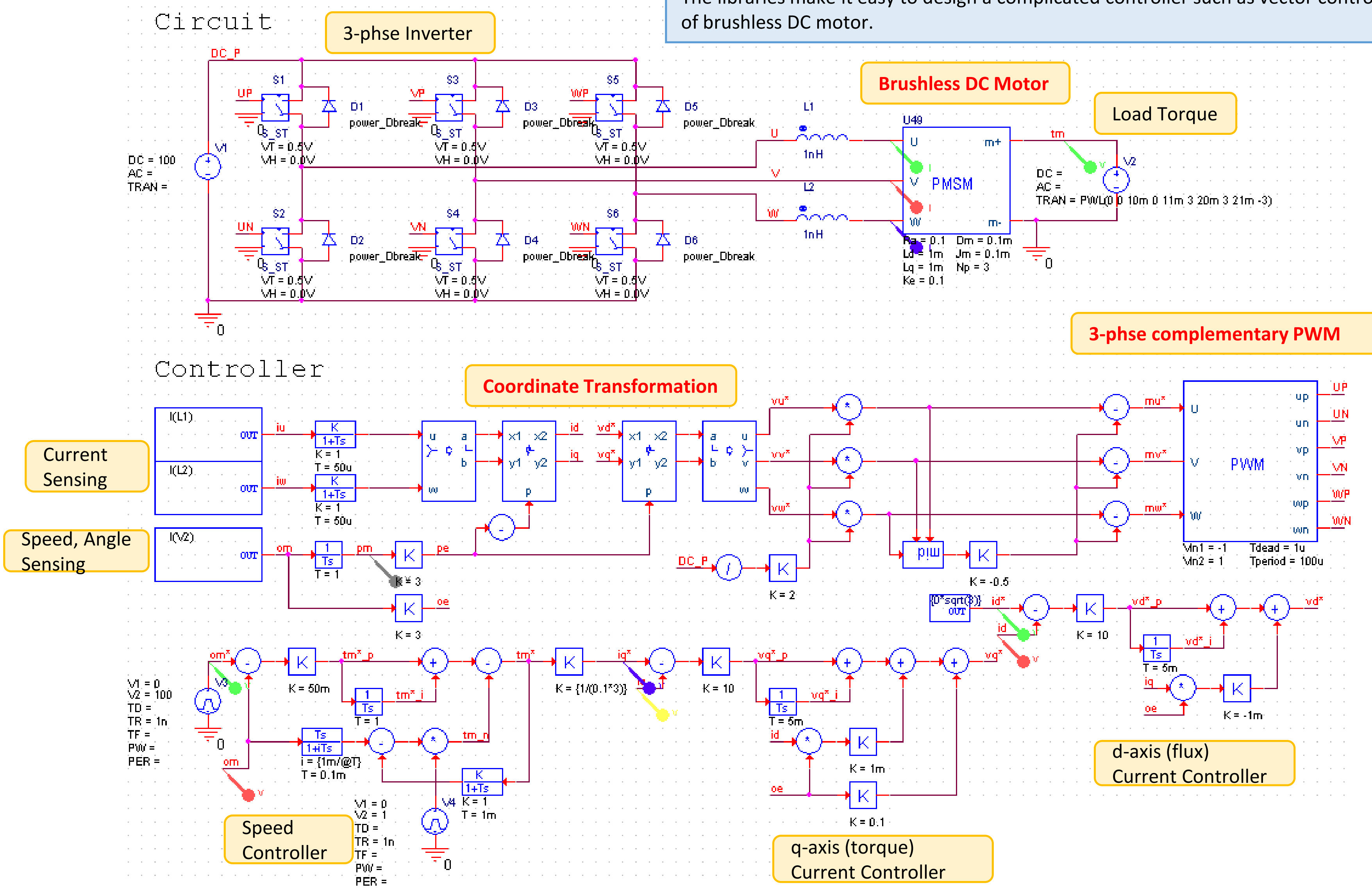
The libraries support discrete-time modeling such as latch and sample & hold. Previous element included in Discrete group of the library is the primitive element of discrete-time modeling. this element outputs the value before 1 time step. It allows to design a complex discrete-time modeling by combining Previous element with others.

This is an example of buck converter using peak current mode control which has SR Flip-Flop implemented with Previous element.

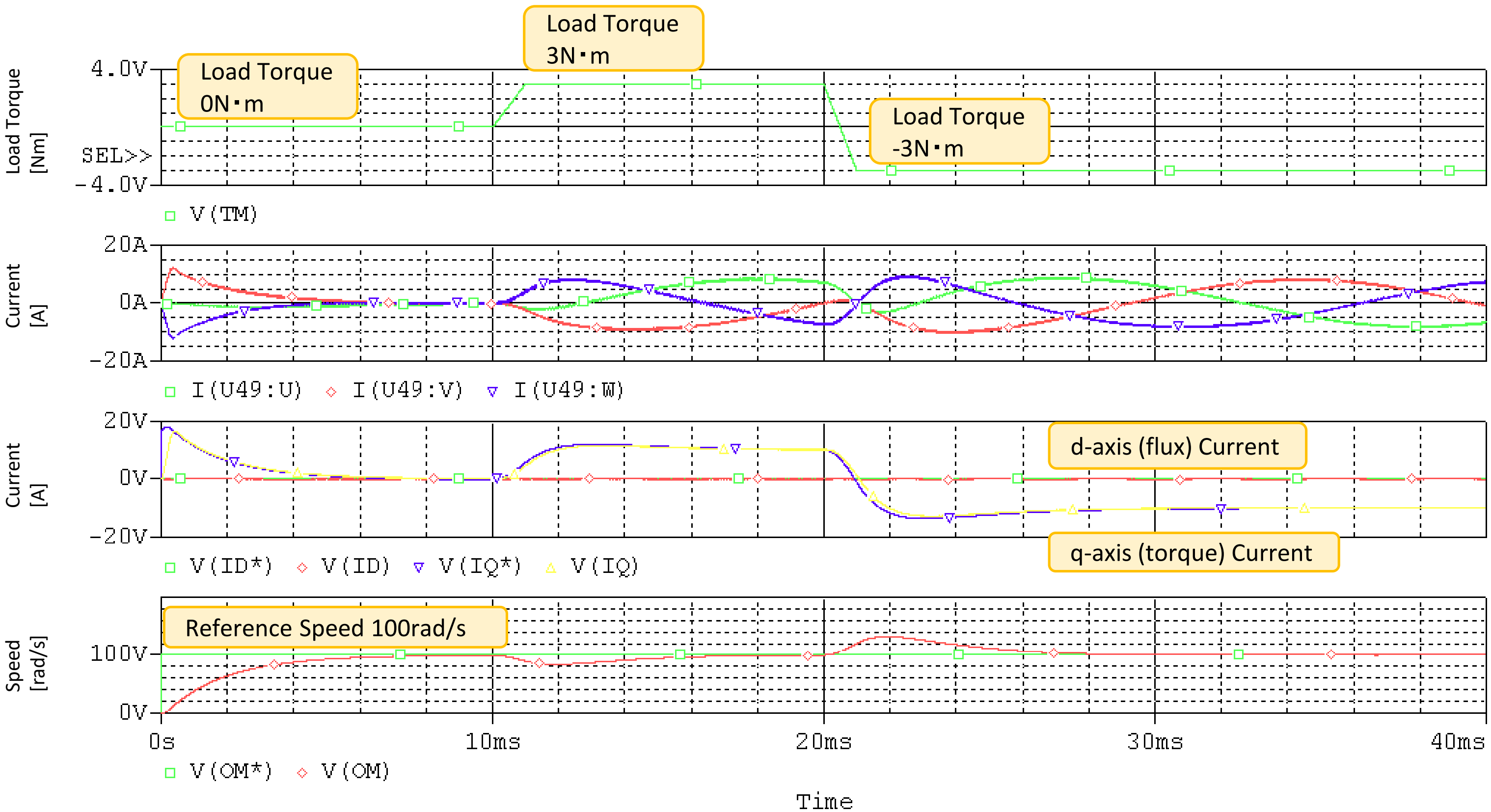
PSpice has built-in digital elements (U elements), and SR Flip-Flop is provided as the one of U elements. U elements are analyzed as a digital signal system different from analog elements. If U elements are used correctly, it is possible to simulate fast. But the usability of U elements is unusual for users familiar with analog elements.

Feature 3. Motor models and motor control elements

The libraries make it easy to design a complicated controller such as vector control of brushless DC motor.



Feature 3. Motor models and motor control elements



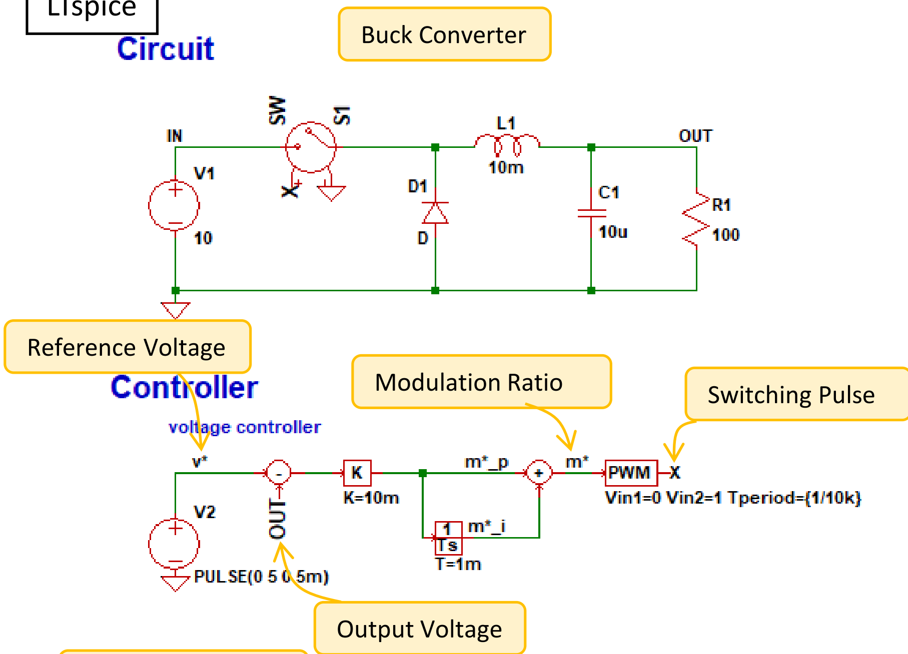
Examples

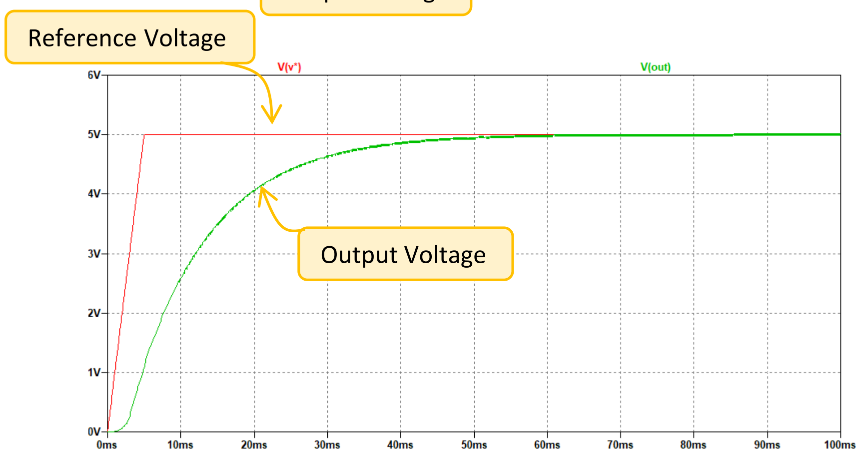
1. Buck Converter Control (DC-DCConverter/BuckConverter)
2. Boost Converter Control (DC-DCConverter/BoostConverter)
3. CCM PFC Control (AC-DCConverter/CCM-PFC)
4. CRM PFC Control (AC-DCConverter/CRM-PFC)
5. 3-Phase Inverter Control (DC-ACConverter/3PhaseInverter)
6. DC Motor Speed Control (MotorDrive/DCMotorSpeedControl)
7. Brushless DC Motor Vector Control (MotorDrive/PMSMVectorControl)
8. Brushless DC Motor 120 Degree Drive With Hall Sensors (MotorDirve/PMSM120DegreeDriveWithHallSensors)
9. Solar Cell MPPT Using Perturb & Observe Method (SolarCell/SolarCellMPPTUsingP&OMethod_Boost)

Example 1. Buck Converter Control

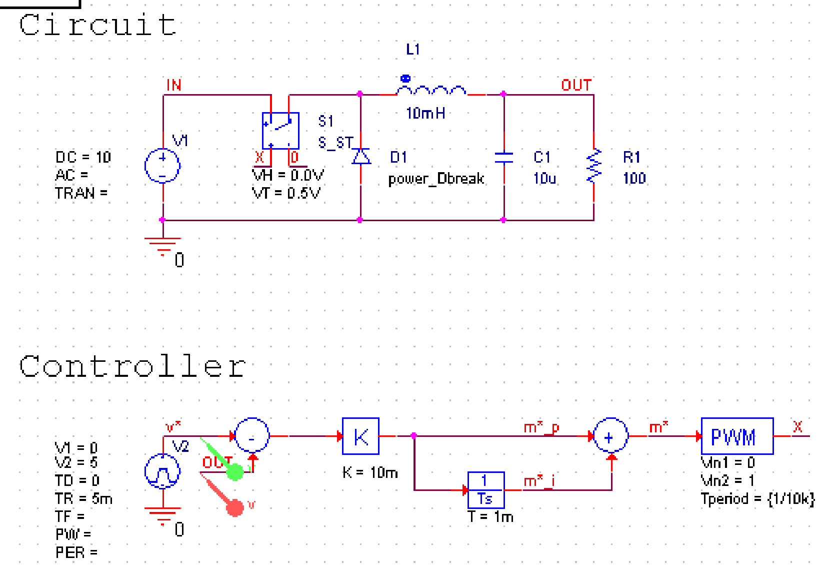
This is an example of buck converter which steps down voltage from 10V input to 5V output.

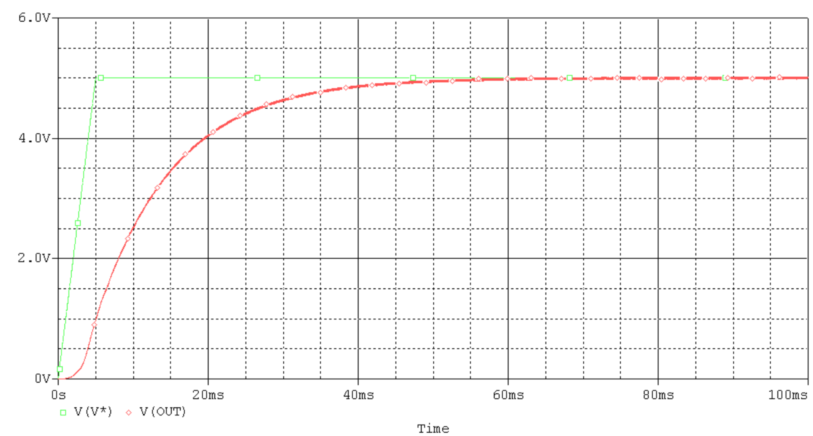
LTspice





PSpice

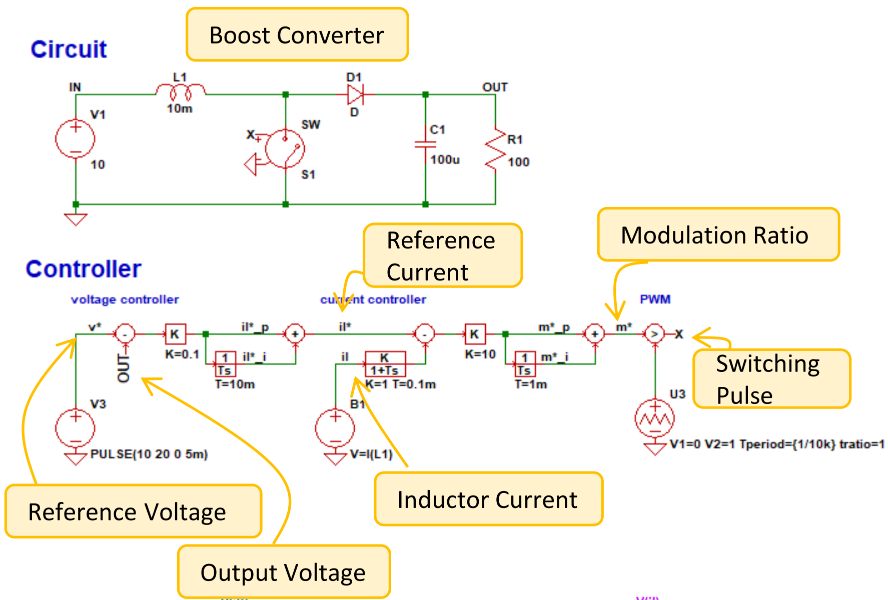


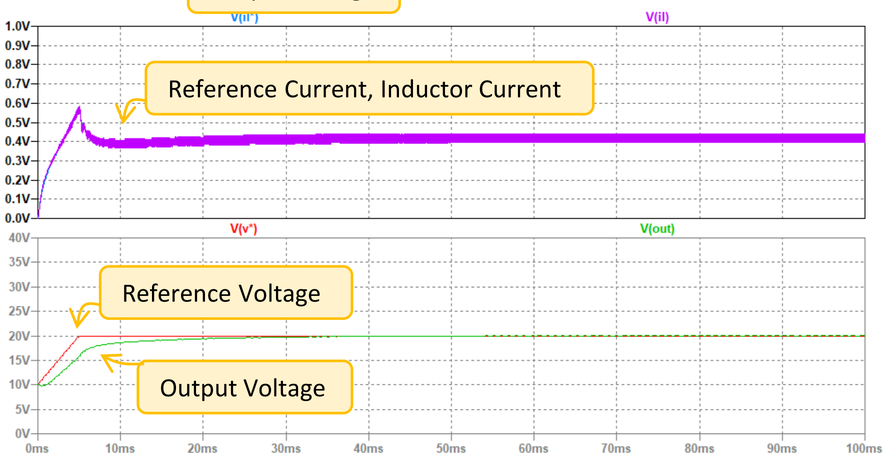


Example 2. Boost Converter Control

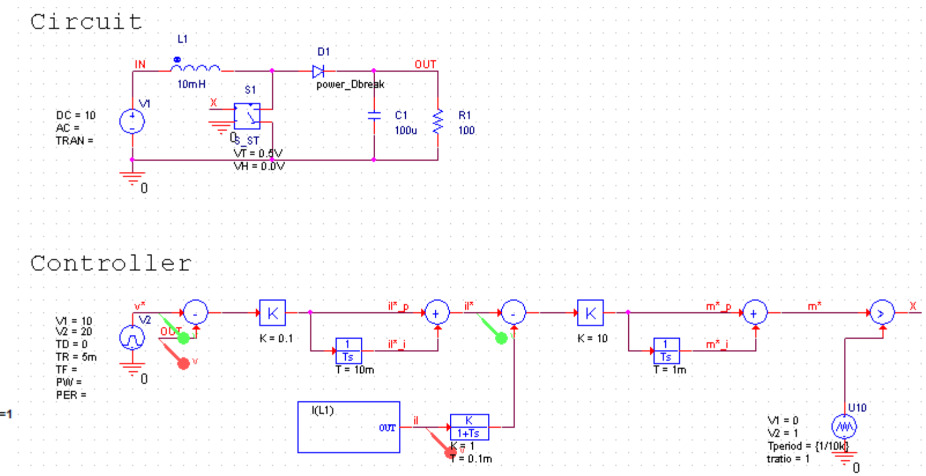
This is an example of boost converter which steps up voltage from 10V input to 20V output.

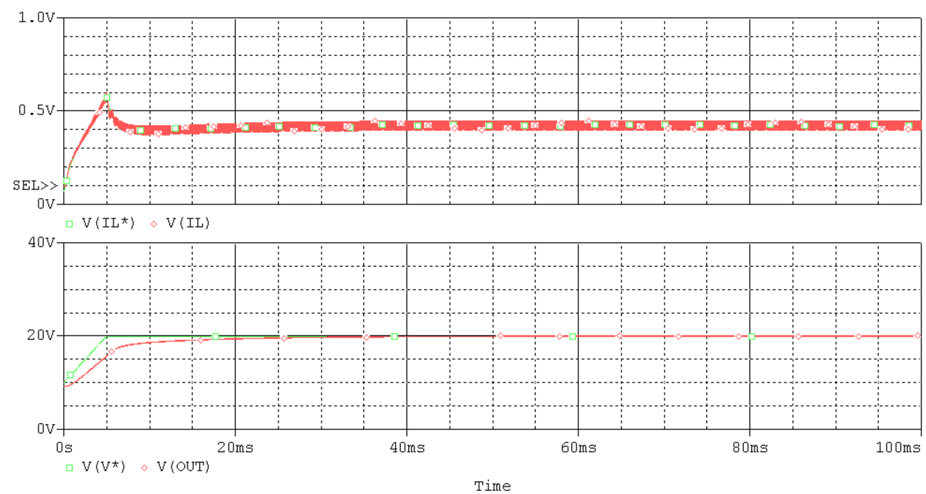
LTspice





PSpice

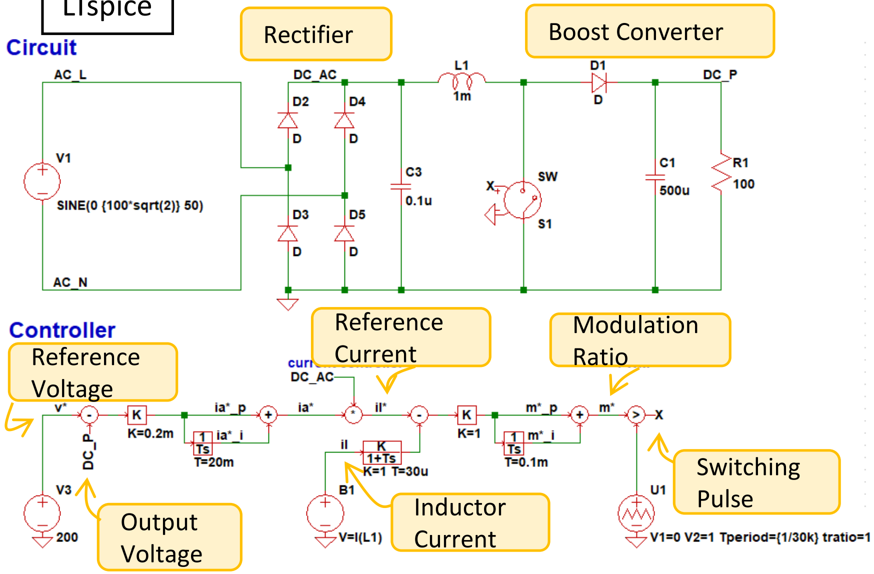


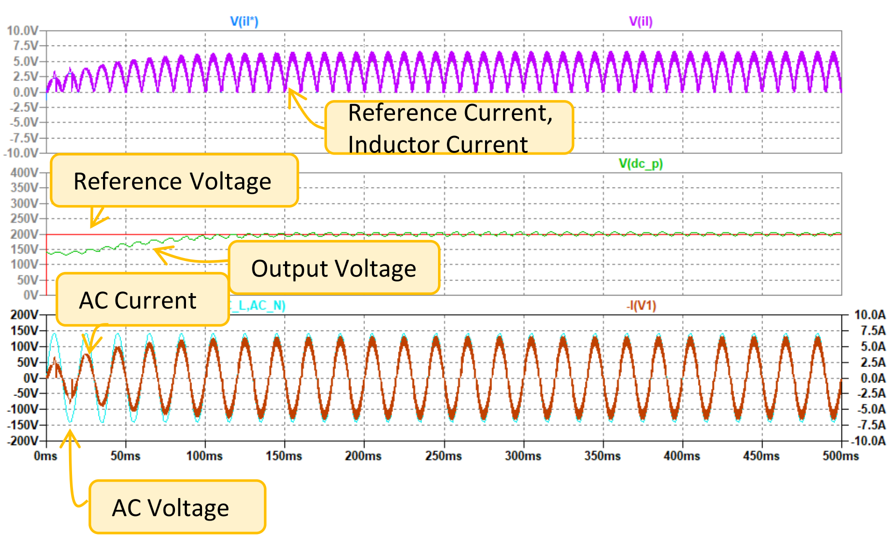


Example 3. CCM PFC Control

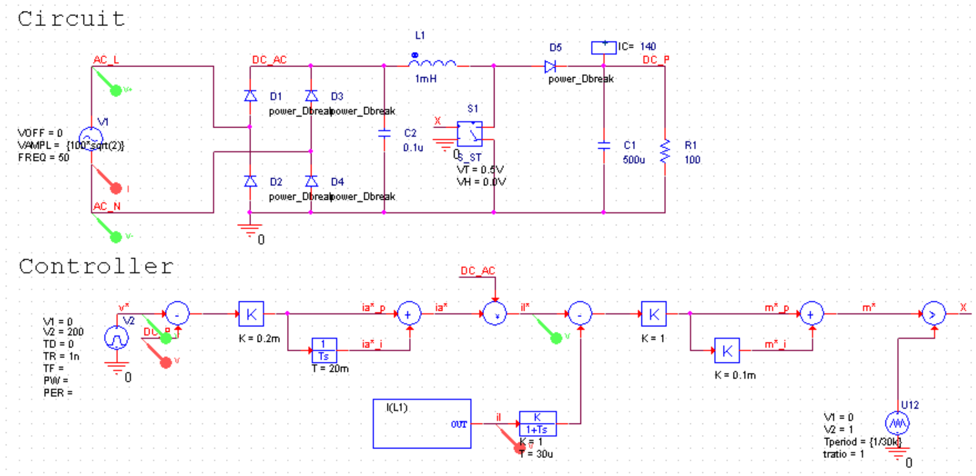
This is an example of Continuous Conduction Mode Power Factor Correction which controls voltage from AC 100V input to DC 200V output.

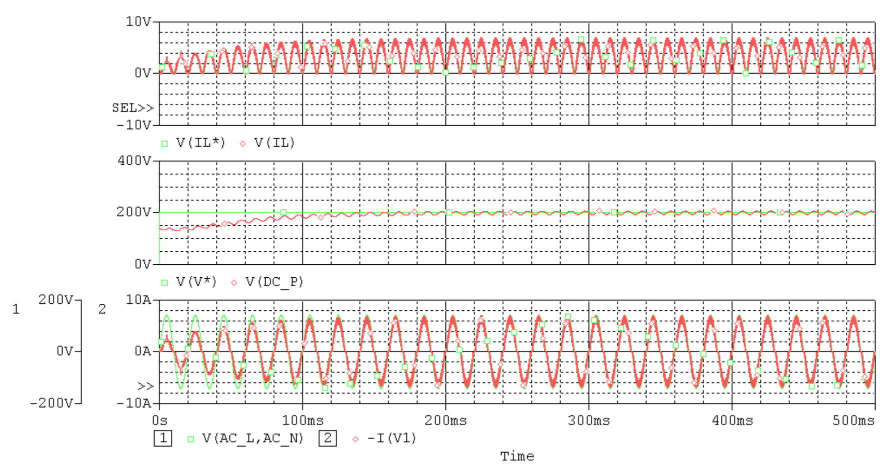
LTspice





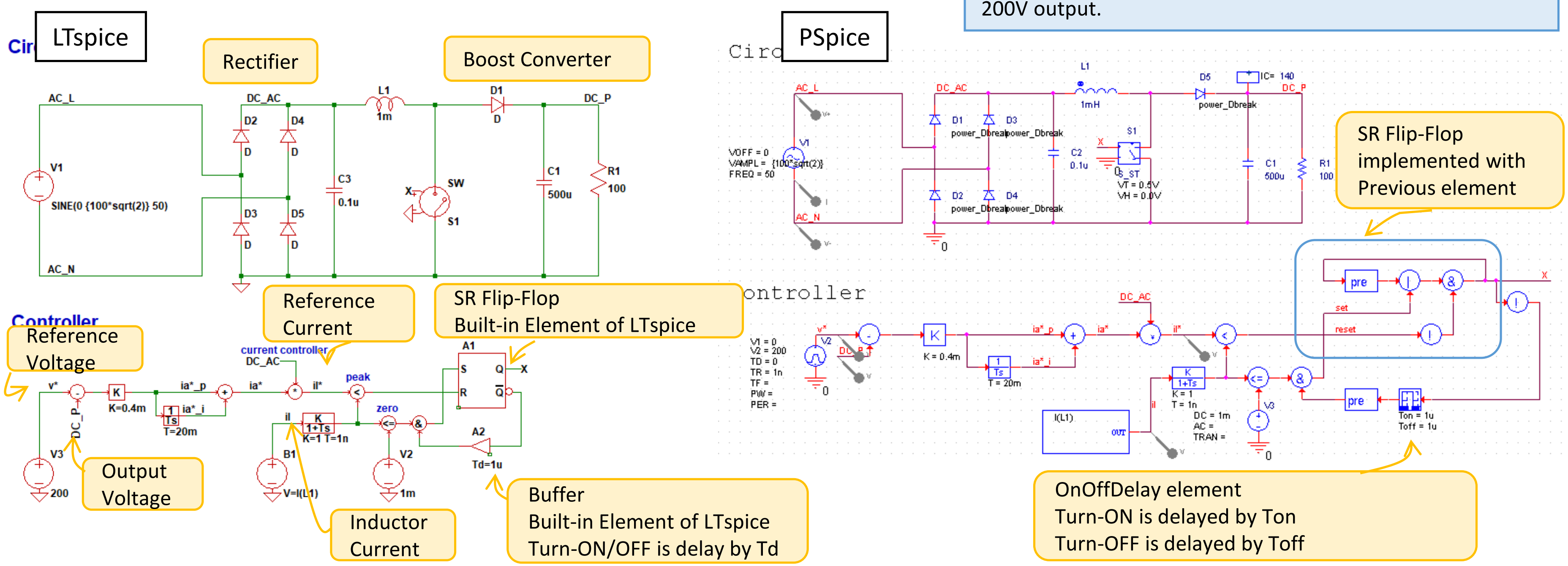
PSpice

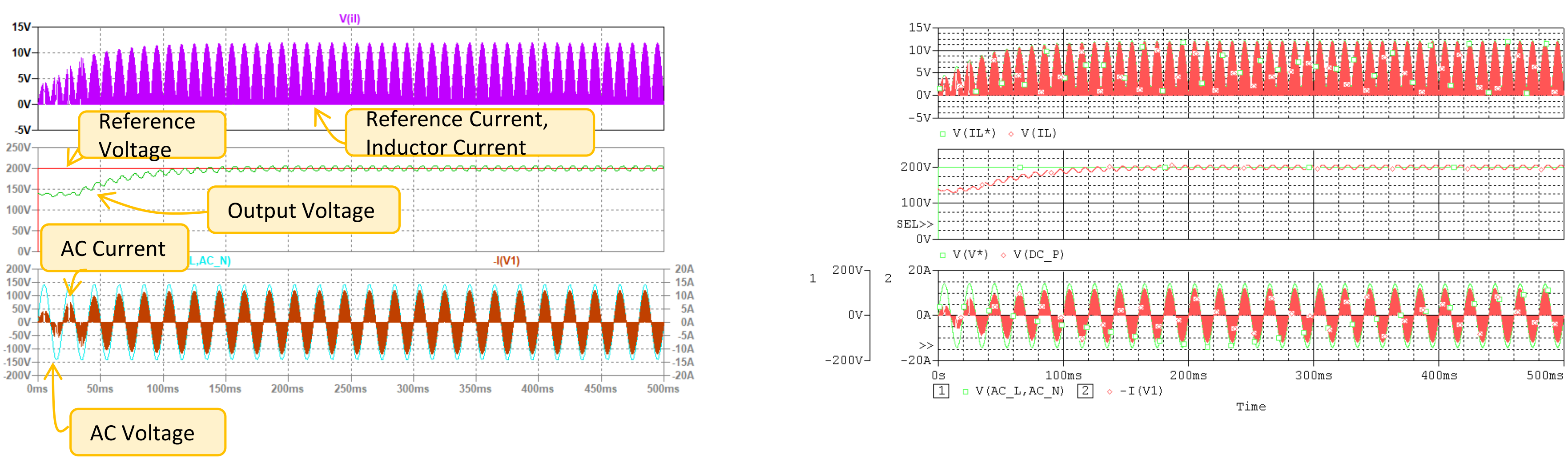




Example 4. CRM PFC Control

This is an example of Critical Conduction Mode Power Factor Correction which controls voltage from AC 100V input to DC 200V output.

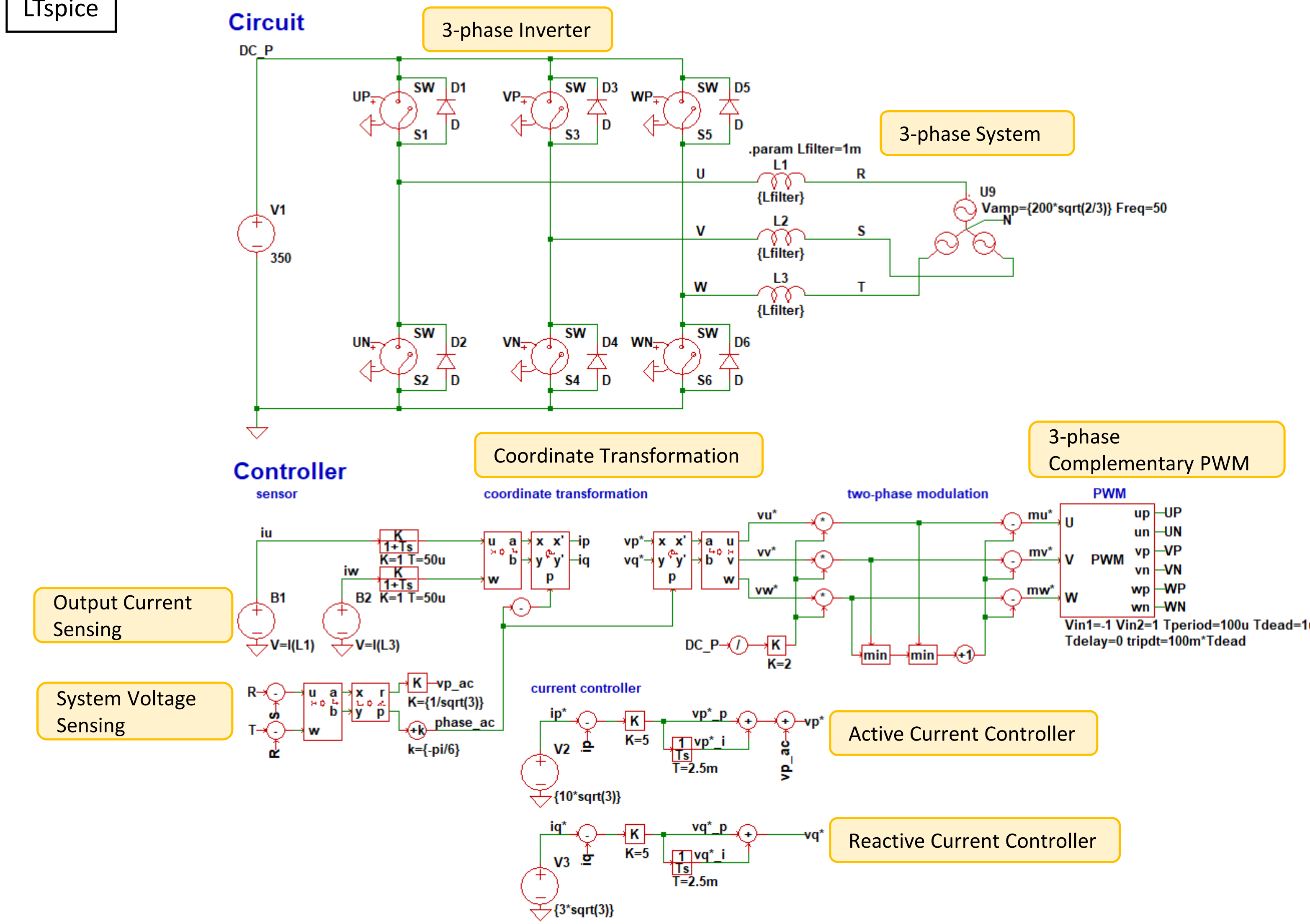




Example 5. 3-Phase Inverter Control

This is an example of 3-phase inverter which controls active current to 10√3 A and reactive current to 3√3 A.

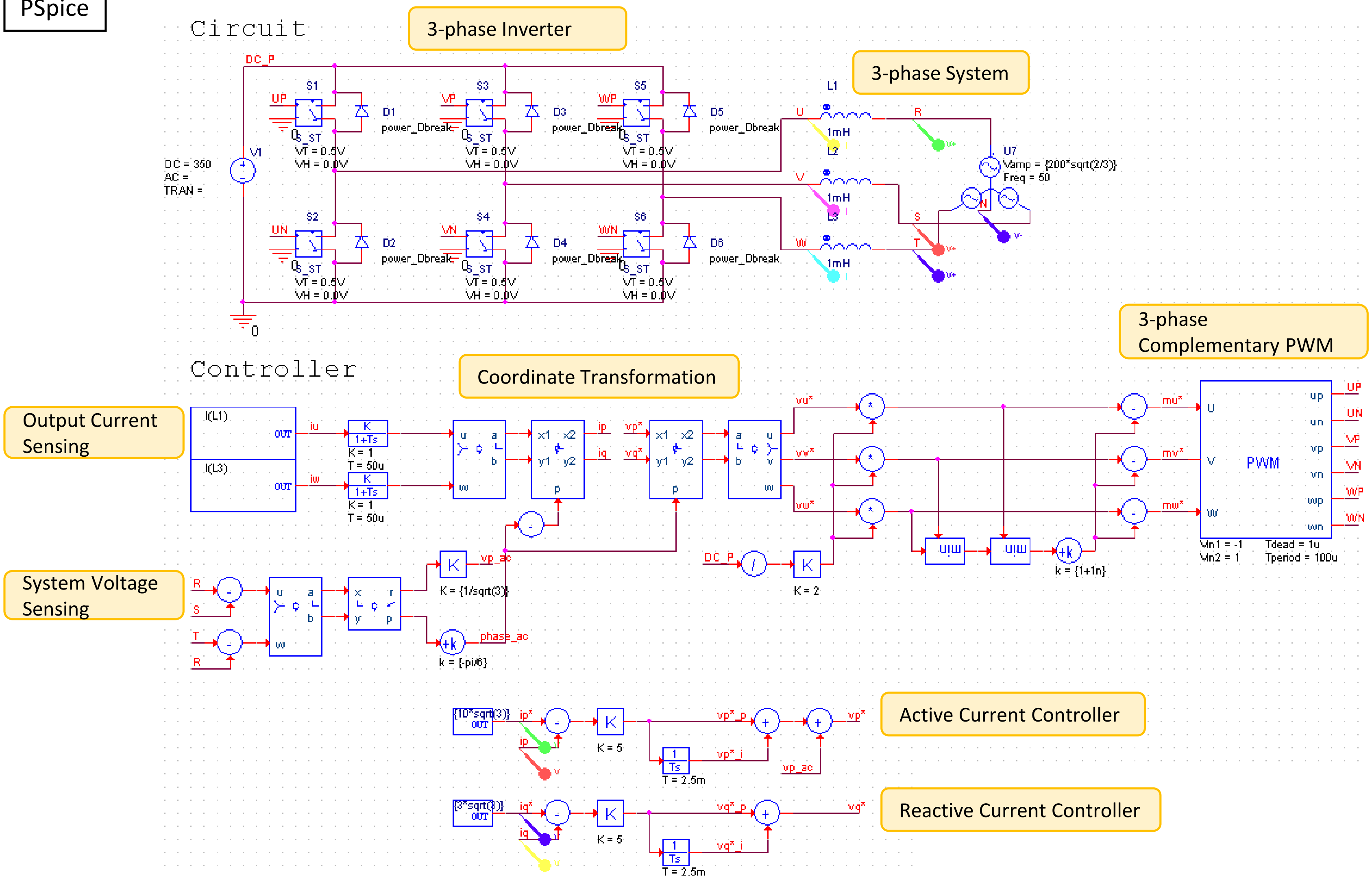
LTspice



Example 5. 3-Phase Inverter Control

This is an example of 3-phase inverter which controls active current to 10√3 A and reactive current to 3√3 A.

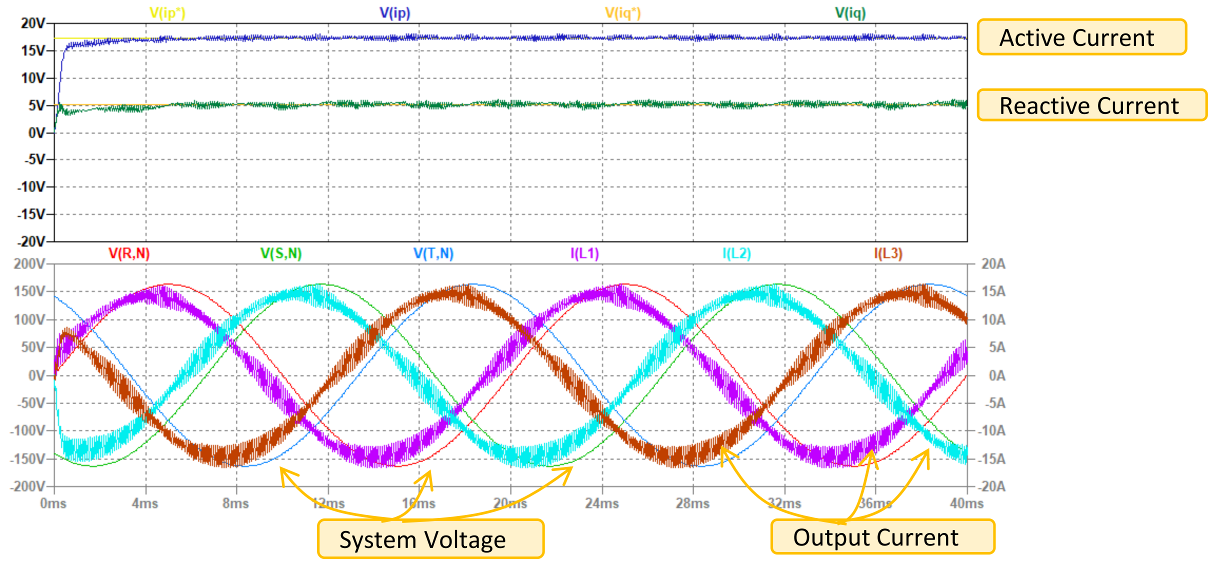
PSpice



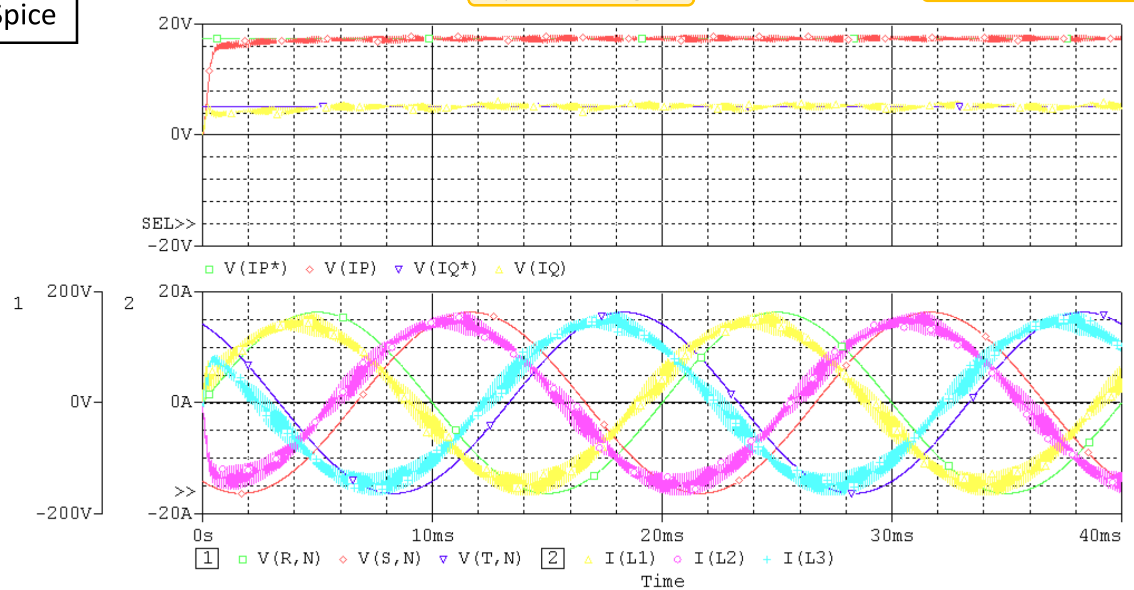
Example 5. 3-Phase Inverter Control

This is an example of 3-phase inverter which controls active current to 10√3 A and reactive current to 3√3 A.

LTspice



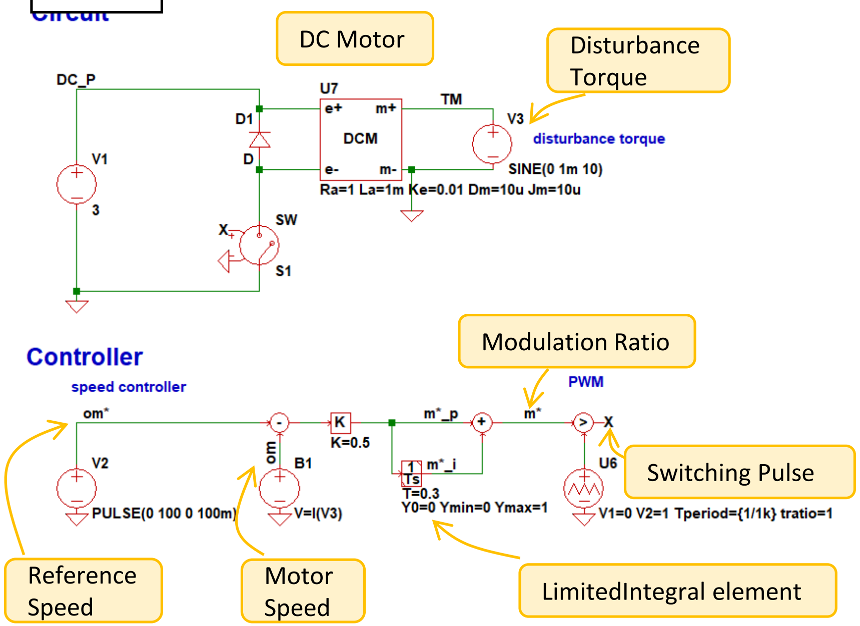
PSpice

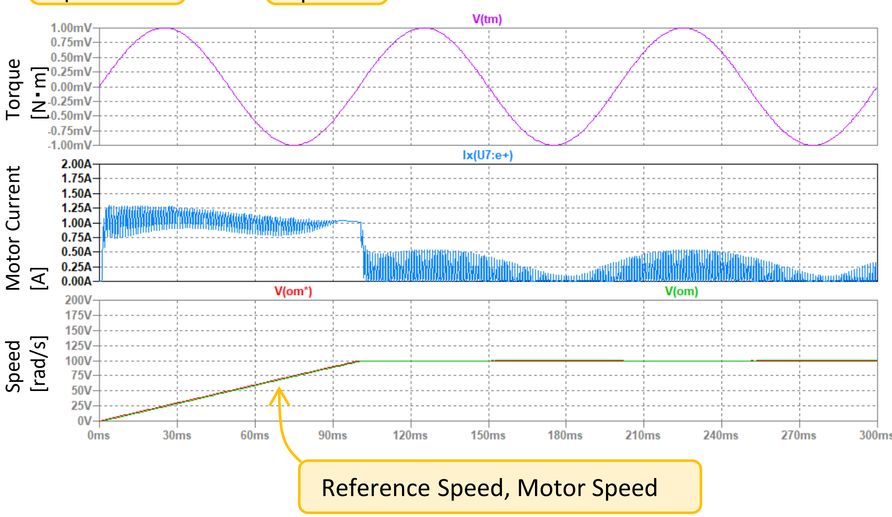


Example 6. DC Motor Speed Control

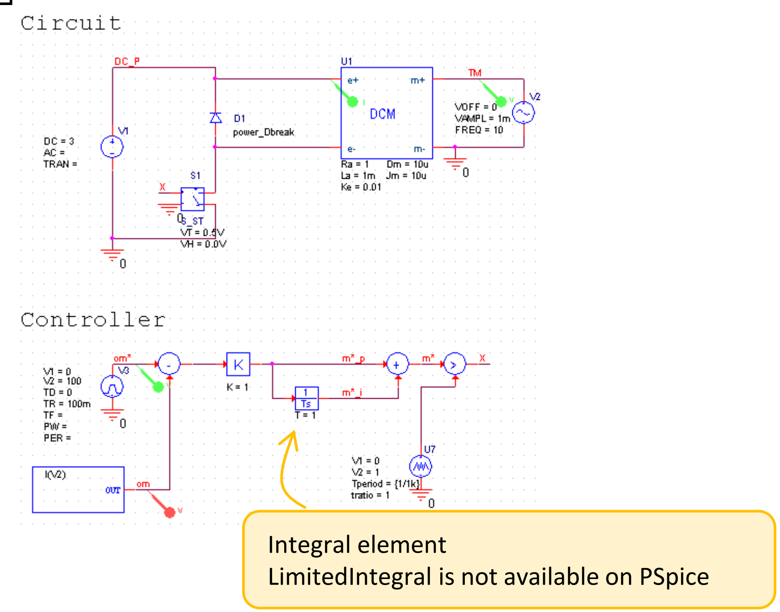
This is an example of DC motor drive which controls motor speed to 100 rad/s.

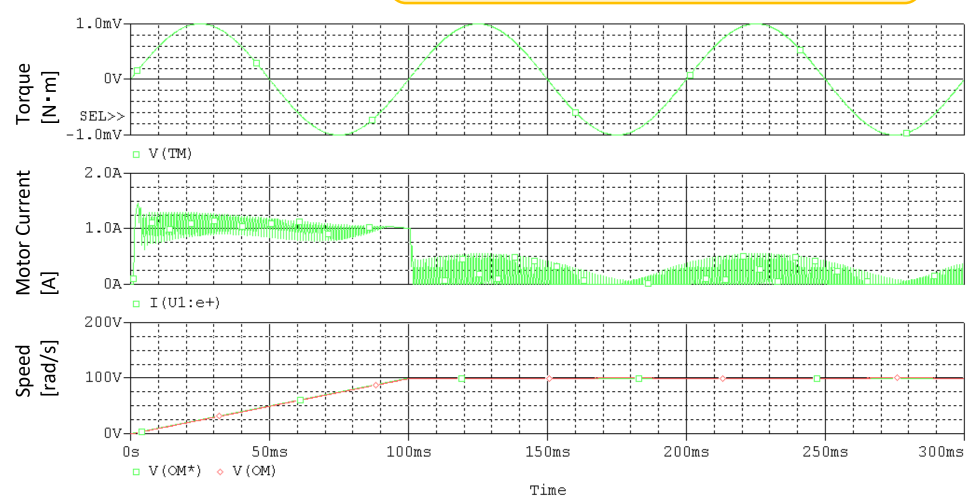
LTspice





PSpice

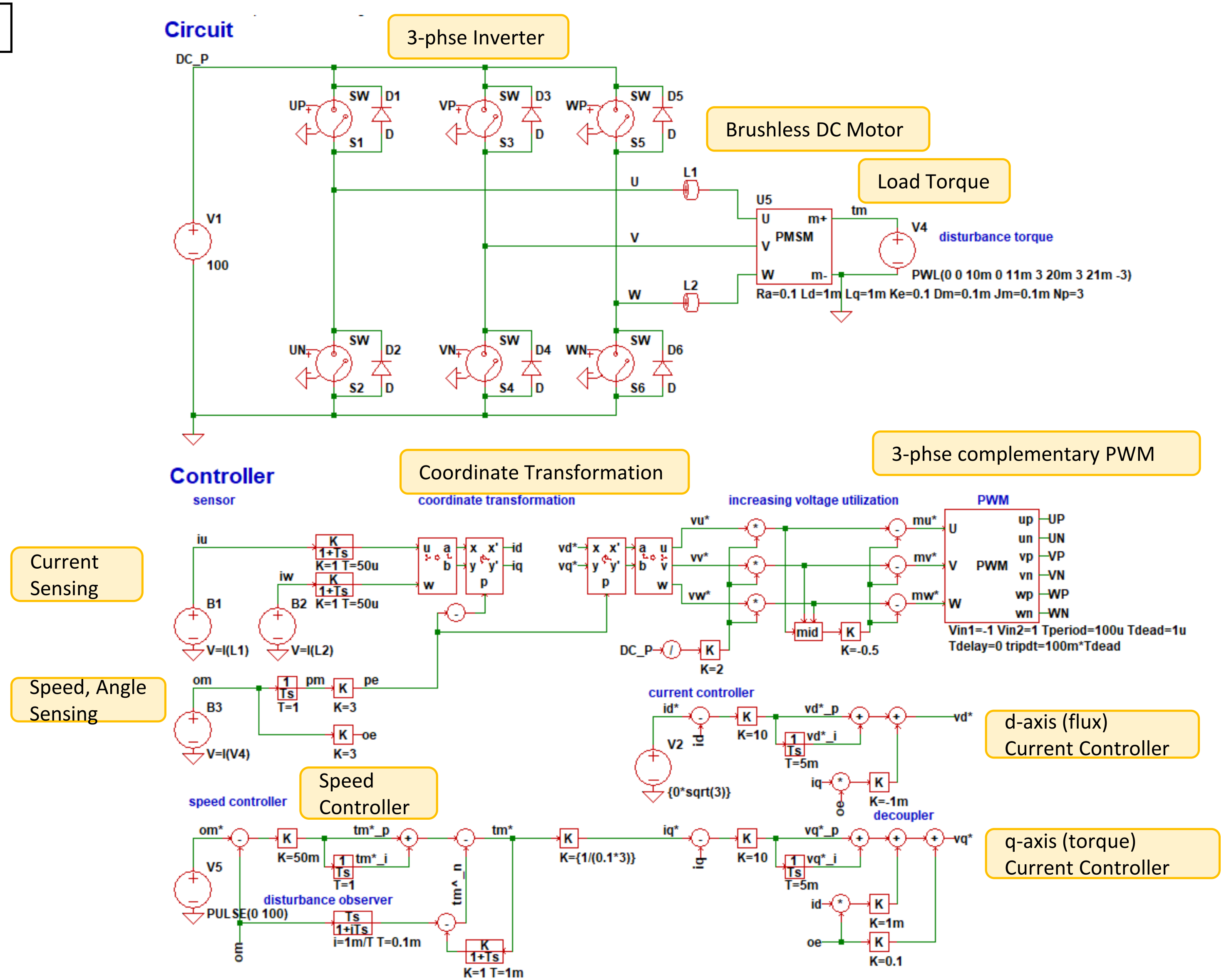




Example 7. Brushless DC Motor Vector Control

This is an example of brushless DC motor vector control which controls motor speed to 100 rad/s.

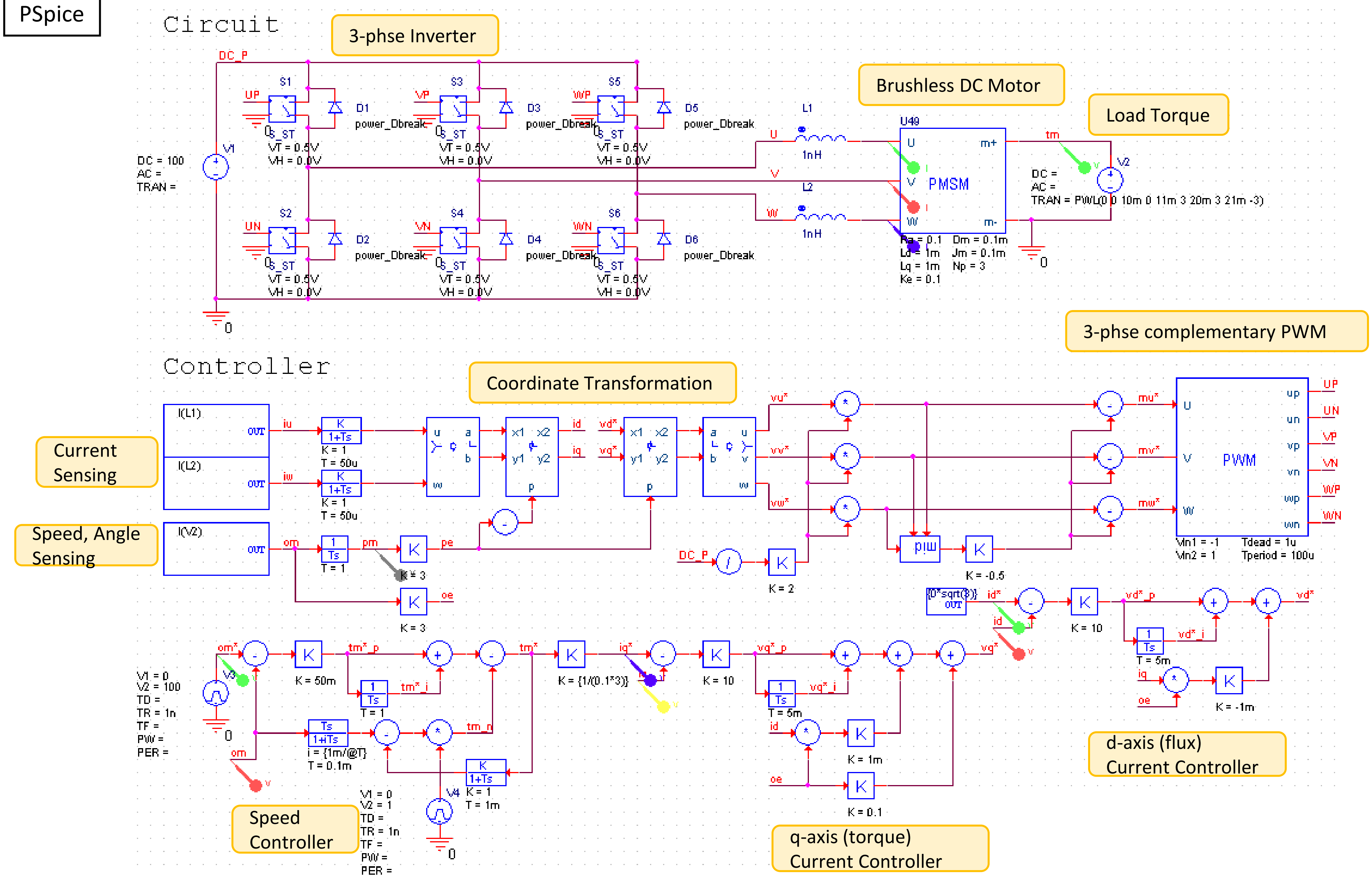
LTspice



Example 7. Brushless DC Motor Vector Control

This is an example of brushless DC motor vector control which controls motor speed to 100 rad/s.

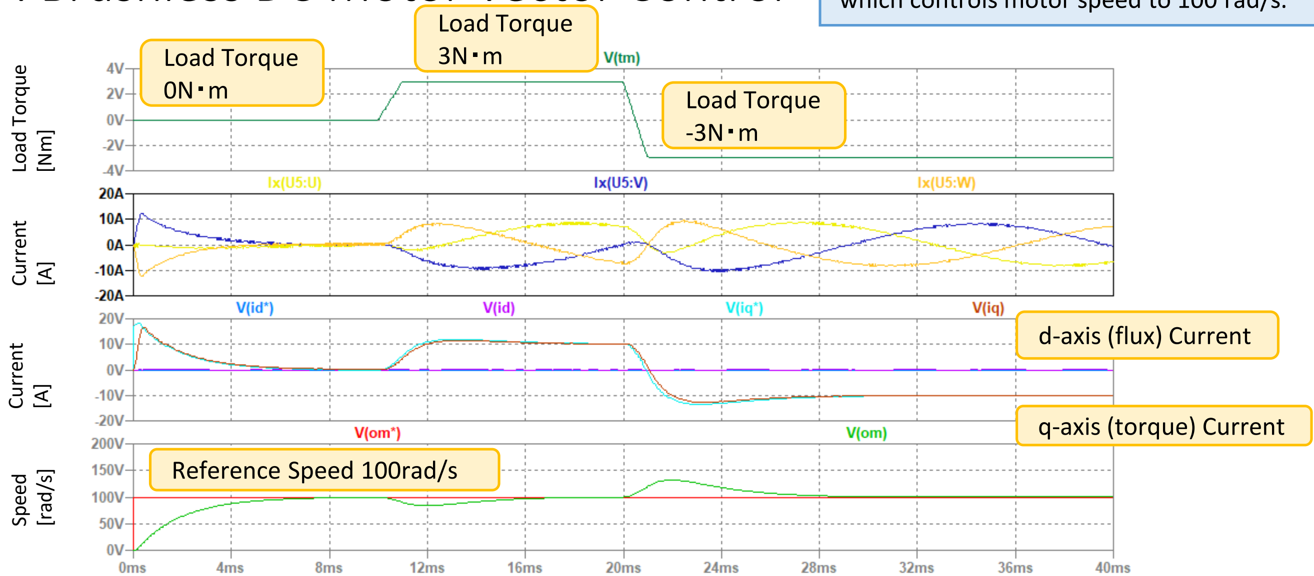
PSpice



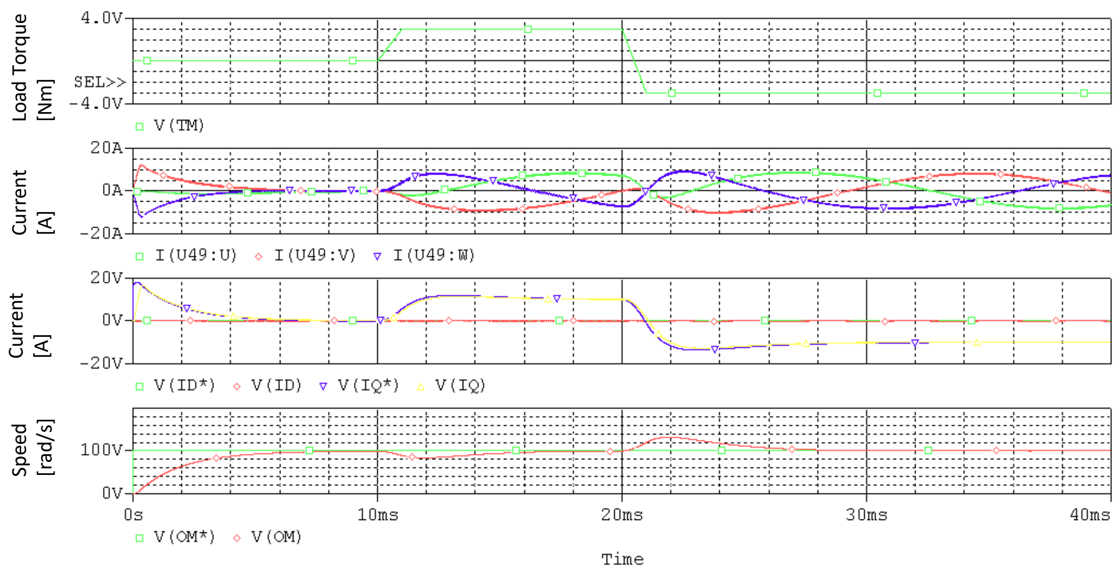
Example 7. Brushless DC Motor Vector Control

This is an example of brushless DC motor vector control which controls motor speed to 100 rad/s.

LTspice

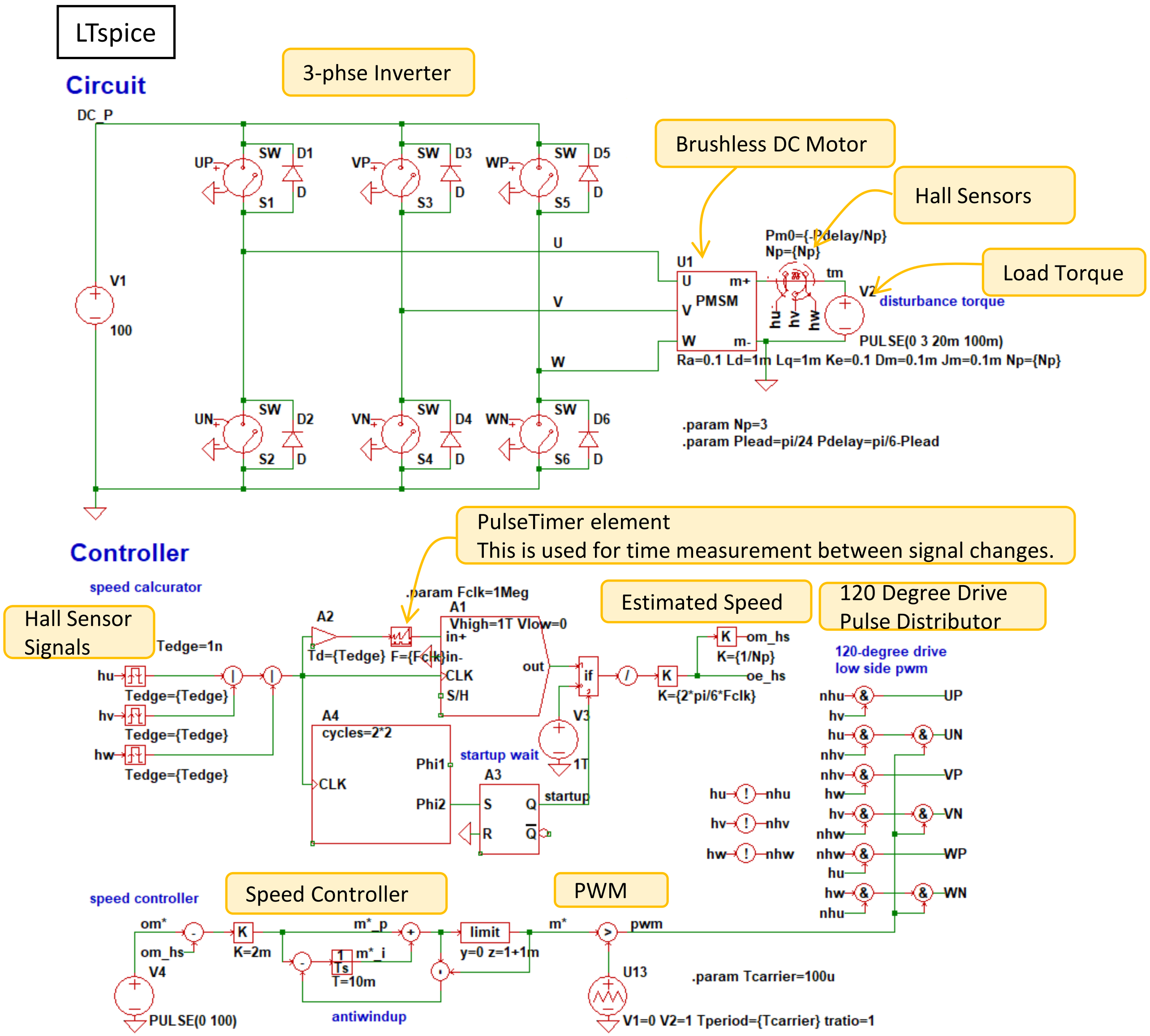


PSpice



Example 8. Brushless DC Motor 120 Degree Drive With Hall Sensors

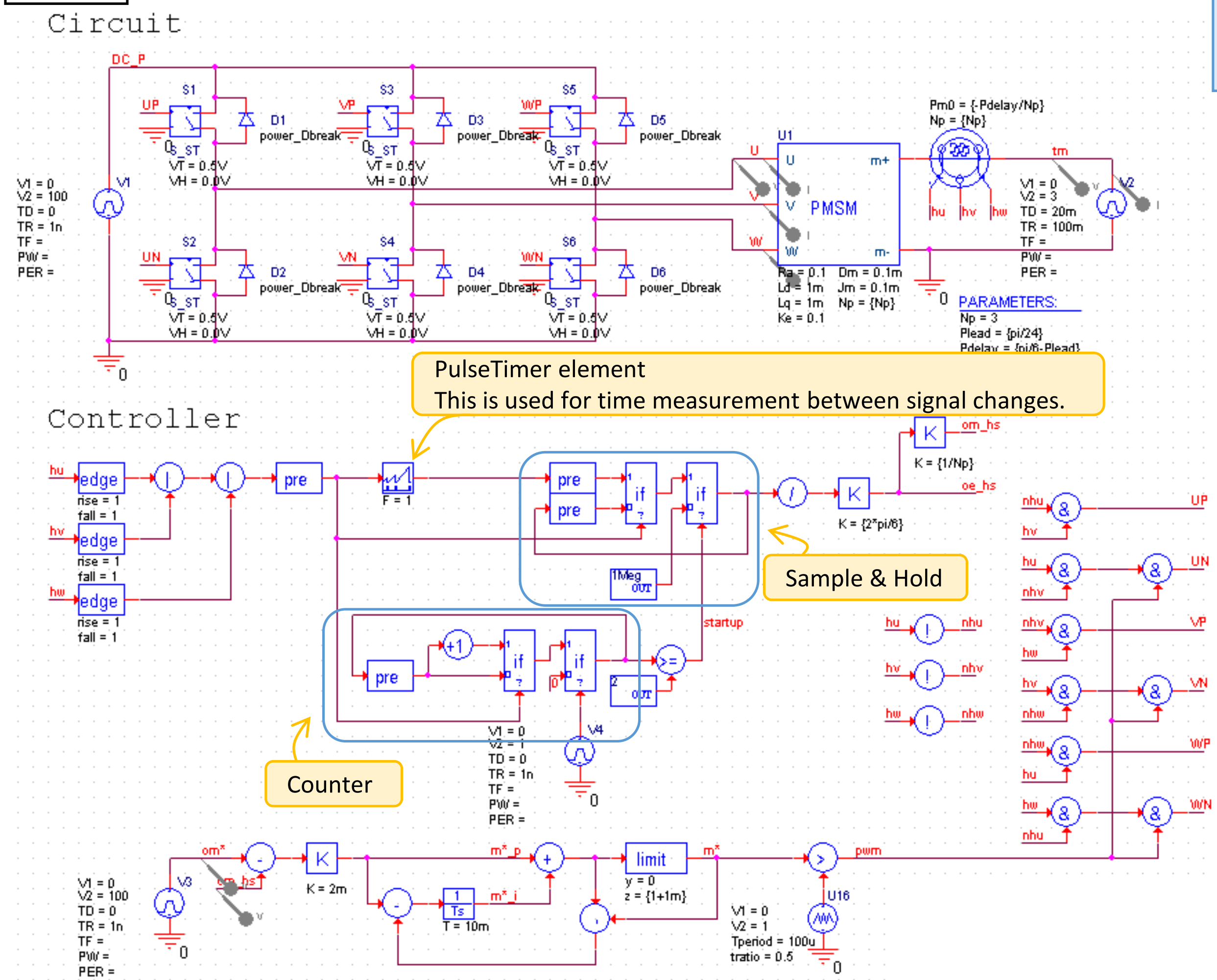
This is an example of brushless DC motor 120 degree drive with hall sensors which controls motor speed to 100 rad/s.



Example 8. Brushless DC Motor 120 Degree Drive With Hall Sensors

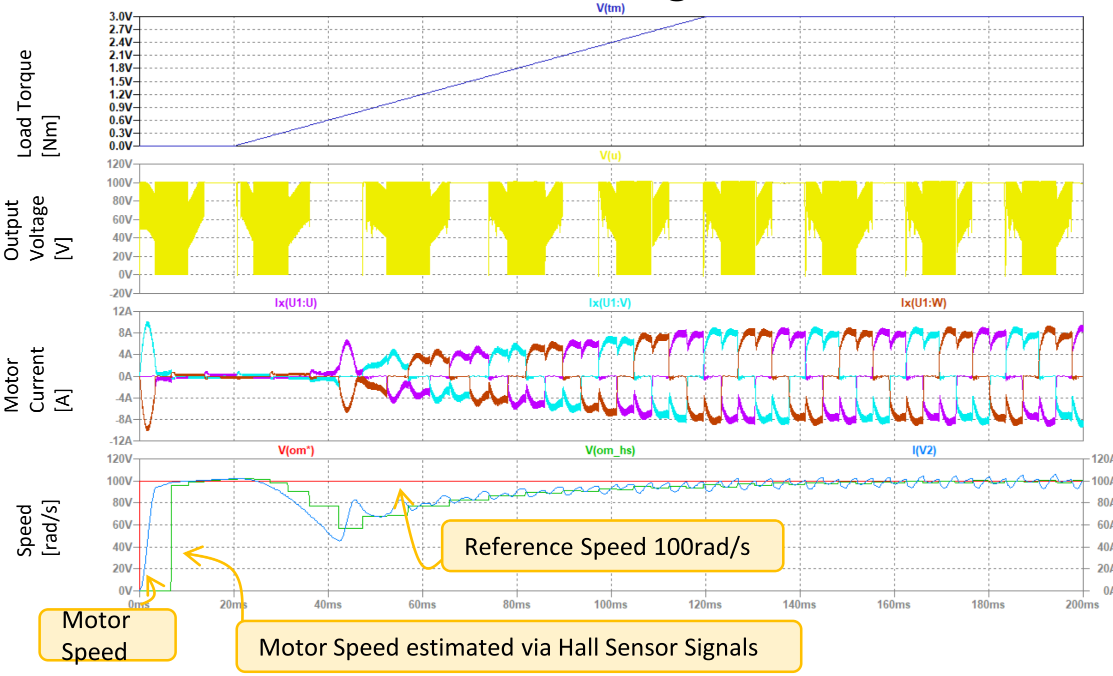
PSpice

This is an example of brushless DC motor 120 degree drive with hall sensors which controls motor speed to 100 rad/s.



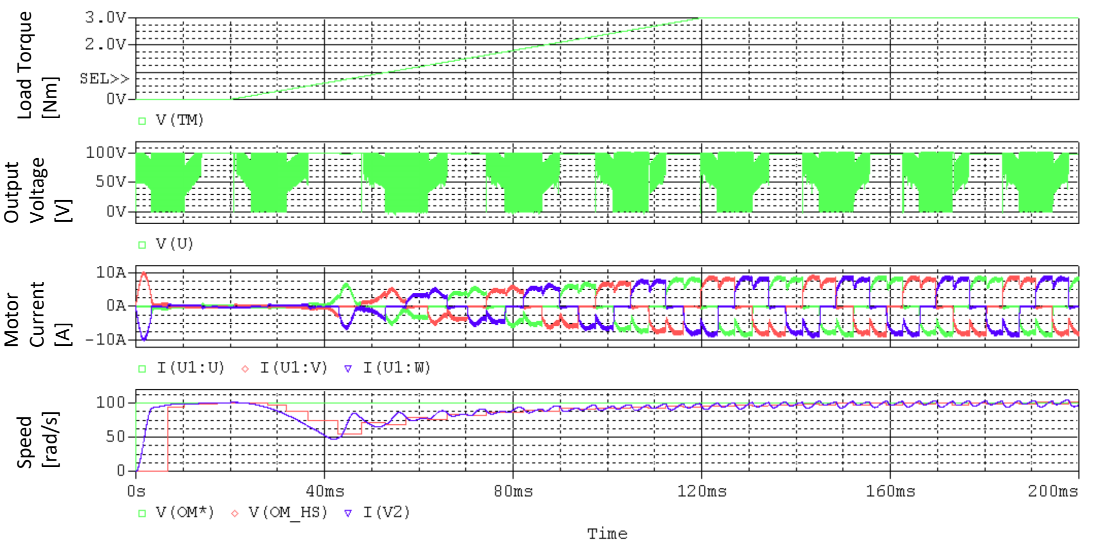
Example 8. Brushless DC Motor 120 Degree Drive With Hall Sensors

LTspice



This is an example of brushless DC motor 120 degree drive with hall sensors which controls motor speed to 100 rad/s.

PSpice



Example 9. Solar Cell MPPT Using Perturb & Observe Method

This is an example of maximum power point tracking of solar cells using perturb & observe method under conditions where the irradiance changes from 1000W/m² ⇔ 200W/m².