

PLECS

*DEMO MODEL*

## DC Motor Drive with Armature Chopper

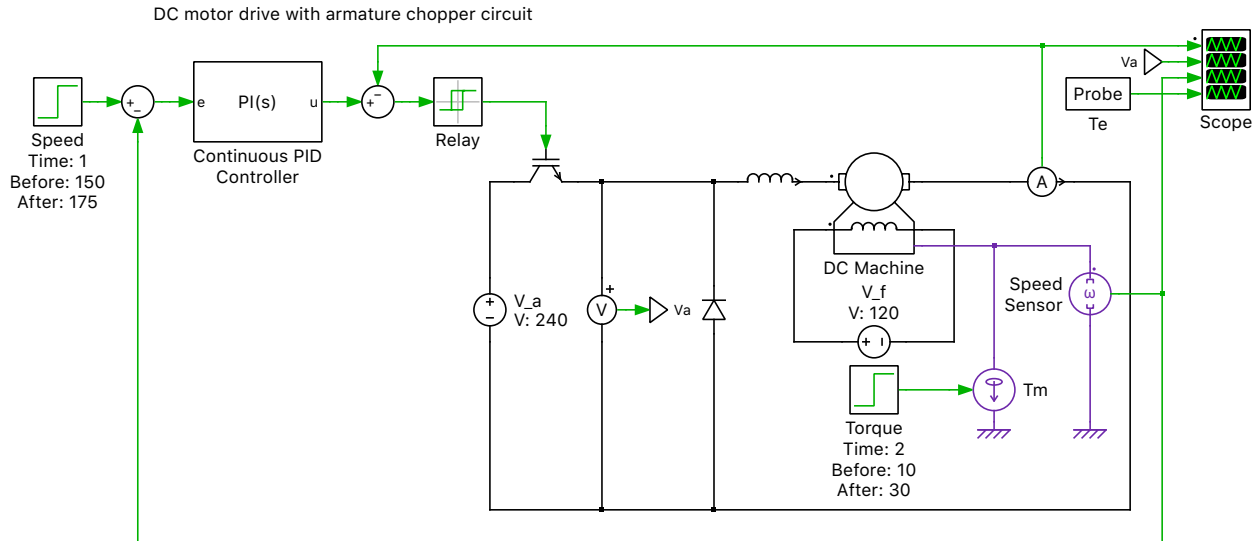
Last updated in PLECS 4.4.2

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# 1 Overview

This example shows the start up of a brushed DC machine drive with speed control using a chopper circuit connected to the armature winding. Step changes in speed set point and load torque are applied during the simulation.



**Fig. 1: DC motor drive with speed control using a chopper circuit**

## 2 Model

### 2.1 Electrical and machine model

A DC machine is started up from standstill. A fixed voltage of 240 VDC is applied to the armature winding and a fixed voltage of 120 VDC is applied to the field winding. The machine initially experiences a constant load torque of 10 Nm. The armature current is chopped by the controller turning on and off an IGBT. The measured armature current and machine speed values are fed into the control circuit.

### 2.2 Control

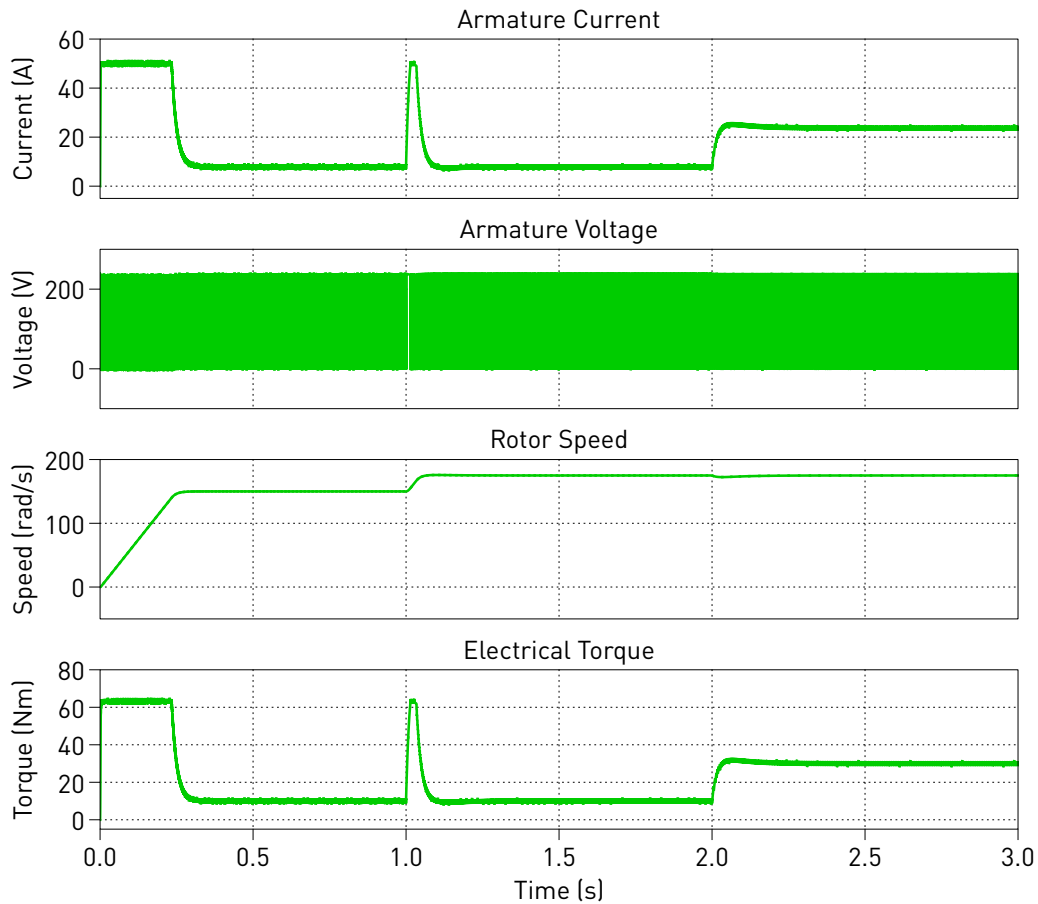
The speed of the DC machine is regulated by an outer speed loop using a PI controller with an anti-windup mechanism. The speed set point is compared to the measured speed and the output of the PI controller determines the reference current value for the armature winding. The measured armature current is compared to the corresponding reference current and the error is then fed into a hysteresis current controller to generate the switching signal for the IGBT. A hysteresis controller is employed using a Relay block that has an error band of  $\pm 1$  A.

## 3 Simulation

Run the simulation with the model as provided to view the behavior at start-up followed by two scheduled changes to the system. The control circuit will provide the armature 50 A of current when the machine is first excited from standstill. During the acceleration, the PI controller output is saturated and the maximum machine torque is applied. The machine quickly reaches the commanded speed of 150 rad/s and the armature current decreases significantly at this time. At steady-state, the average torque generated by the machine is equal to the load torque.

A step in the speed set point from 150 rad/s to 175 rad/s is then applied after one third of the duration of the simulation, and a step in the applied mechanical torque from 10 Nm to 30 Nm is applied to the shaft

after two thirds into the simulation. During each step change the outer speed regulator increases the current set point resulting in a larger armature current. Once the desired speed is attained the current and torque again settle. The magnitude of the torque ripple remains unchanged due to the fixed hysteresis band of the current controller. Changes to the set point values and times can be made to observe how the closed-loop control regulates changes to the system. The waveforms are depicted in Fig. 2.



**Fig. 2: Simulation result of the DC motor with speed control at start-up, speed reference step at 1 s, and load torque step at 2 s**

## Revision History:

PLECS 4.3.1	First release
PLECS 4.4.2	Update PI controller component

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## *PLECS Demo Model*

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