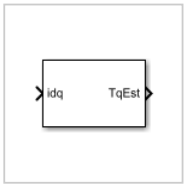
PMSM Torque Estimator

Estimate permanent magnet synchronous machine torque

Library: Simscape / Electrical / Control / PMSM Control



Description

The PMSM Torque Estimator block implements a torque estimator for permanent magnet synchronous machines (PMSM).

Use this block to estimate the mechanical torque of a motor when it is not directly measurable. The block estimates torque using known machine parameters and the measured phase current vector in the $dq0$ reference frame.

Use the Park Transform block to convert the measured phase current vector in the abc reference frame to the $dq0$ reference frame.

Equations

The block estimates the mechanical torque T_e of the PMSM using the torque equation in the d-q rotor reference frame:

$$T_e = \frac{3p}{2}\left(\psi_m i_q + (L_d - L_q) i_d i_q\right),$$

where

- p is the number of pole pairs of the PMSM.
- ψ_m is the flux linkage of the permanent magnet.
- L_d and L_q are the d- and q-axis inductances of the PMSM.
- i_d and i_q are the d- and q-axis currents of the PMSM.

In practice, the machine parameters are not constants and depend on some physical phenomena. You can choose to define these parameters simply as constants or, more realistically, as functions of currents by using lookup tables.

Assumptions

The machine parameters are known.

Ports

Input

collapse all

`idq` — Stator currents
vector

Stator direct and quadrature currents of the PMSM, in A.

Data Types: `single` | `double`

Output

collapse all

`TqEst` — Torque estimate
scalar

Estimated mechanical torque value of the PMSM, in N*m.

Data Types: `single` | `double`

Parameters

collapse all

`Machine parameters` — Parameter selection strategy
`Constant parameters` (default) | `Lookup table based parameters`

Specify the type of machine parameters, which can be in the form of constant values or tabulated data.

`Number of pole pairs` — Pole pairs
`8` (default) | positive integer

Number of permanent magnet pole pairs on the rotor.

`D-axis current vector, id (A)` — D-axis current breakpoint vector
`[-200,0,200]A` (default) | monotonically increasing vector

Direct-axis current vector used in the lookup tables for parameters determination.

`Q-axis current vector, iq (A)` — Q-axis current breakpoint vector
`[-200,0,200]A` (default) | monotonically increasing vector

Quadrature-axis current vector used in the lookup tables for parameters determination.

`Ld matrix, Ld(id,iq) (H)` — D-axis inductance lookup data
`0.0002 * ones(3, 3)H` (default) | positive matrix

L_d matrix used as lookup table data.

`Lq matrix, Lq(id,iq) (H)` — Q-axis inductance lookup data
`0.0002 * ones(3, 3)H` (default) | positive matrix

L_q matrix used as lookup table data.

`Permanent magnet flux linkage matrix, PM(id,iq) (Wb)` — Flux linkage lookup data
`0.04 * ones(3, 3)Wb` (default) | real matrix

Permanent magnet flux linkage matrix used in the lookup table.

`D-axis inductance (H)` — Inductance of d-axis
`0.0002` (default) | positive scalar

Direct-axis inductance.

`Q-axis inductance (H)` — Inductance of q-axis
`0.0002` (default) | positive scalar

Quadrature-axis inductance.

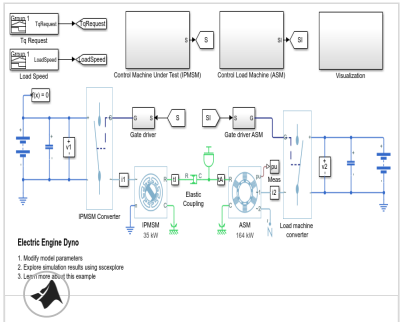
`Permanent magnet flux linkage (Wb)` — PM Flux Linkage
`0.04Wb` (default) | positive scalar

Peak permanent magnet flux linkage.

`Sample time (-1 for inherited)` — Block sample time
`-1` (default) | `-1` or positive number

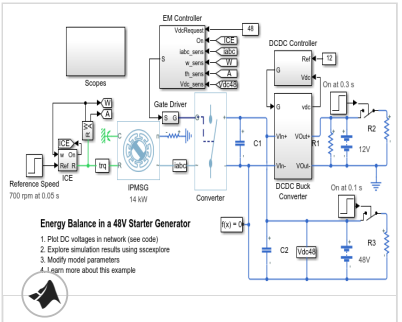
Sample time for the block (-1 for inherited). If you use this block inside a triggered subsystem, set the sample time to `-1`. If you use this block in a continuous variable-step model, set the sample time explicitly.

Model Examples



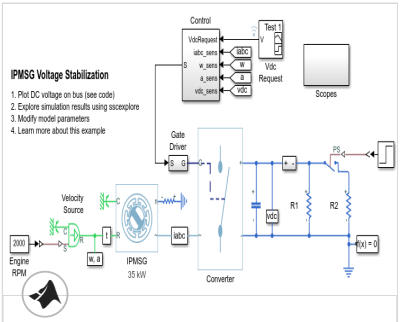
Electric Engine Dyno

Model an electric vehicle dynamometer test. The test environment contains an asynchronous machine (ASM) and



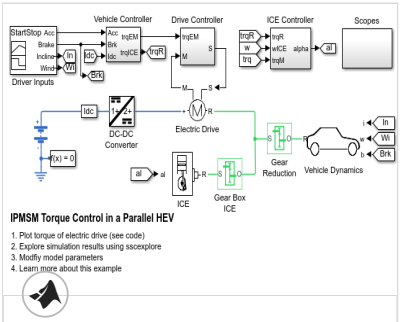
Energy Balance in a 48V Starter Generator

An interior permanent magnet synchronous machine (IPMSM) used as a starter/generator in a simplified 48V automotive system.



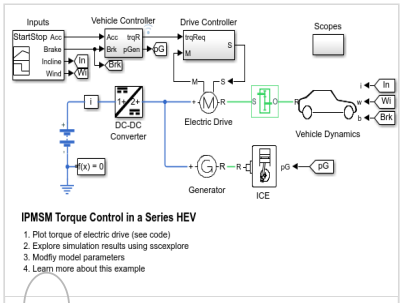
IPMSG Voltage Stabilization

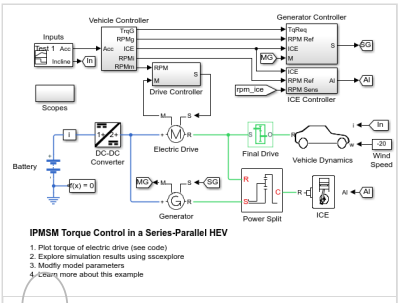
Control an Interior Permanent Magnet Synchronous Generator (IPMSG) based low voltage generator system for a hybrid

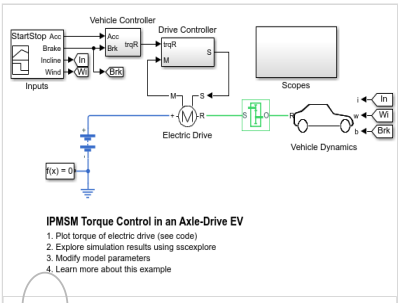


IPMSM Torque Control in a Parallel HEV

A simplified parallel hybrid electric vehicle (HEV). An interior permanent magnet synchronous machine (IPMSM) and an internal combustion







IPMSM Torque Control in a Series HEV

An interior permanent magnet synchronous machine (IPMSM) propelling a simplified series hybrid electric vehicle (HEV). An ideal

IPMSM Torque Control in a Series-Parallel HEV

A simplified series-parallel hybrid electric vehicle (HEV). An interior permanent magnet synchronous machine (IPMSM) and an internal

IPMSM Torque Control in an Axle-Drive HEV

An interior permanent magnet synchronous machine (IPMSM) propelling a simplified axle-drive electric vehicle. A high-voltage

Extended Capabilities

C/C++ Code Generation
Generate C and C++ code using Simulink® Coder™.

See Also

Blocks

PMSM Current Controller | PMSM Current Controller with Pre-Control | PMSM Current Reference Generator

Introduced in R2017b