Project memo AN 01.12.40

Modelling of generator trains in PSCAD/EMTDC

Objectives

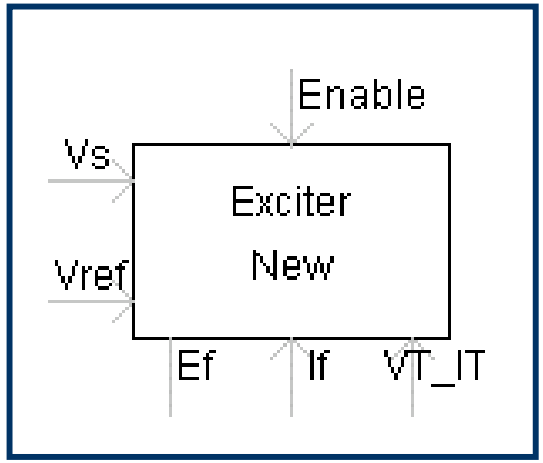
- Test and describe models of generator trains such that these are easily available for future studies in the project
- Study of generator train modelling in general
- Study and test of PSCAD / EMTDC simulation software models in particular
- Focus on models suitable for studies of:
  - weak, possible autonomous, power systems
  - Diesel or gas-turbine generator trains connected to large power electronic converter loads or connected to other converters connected power sources.

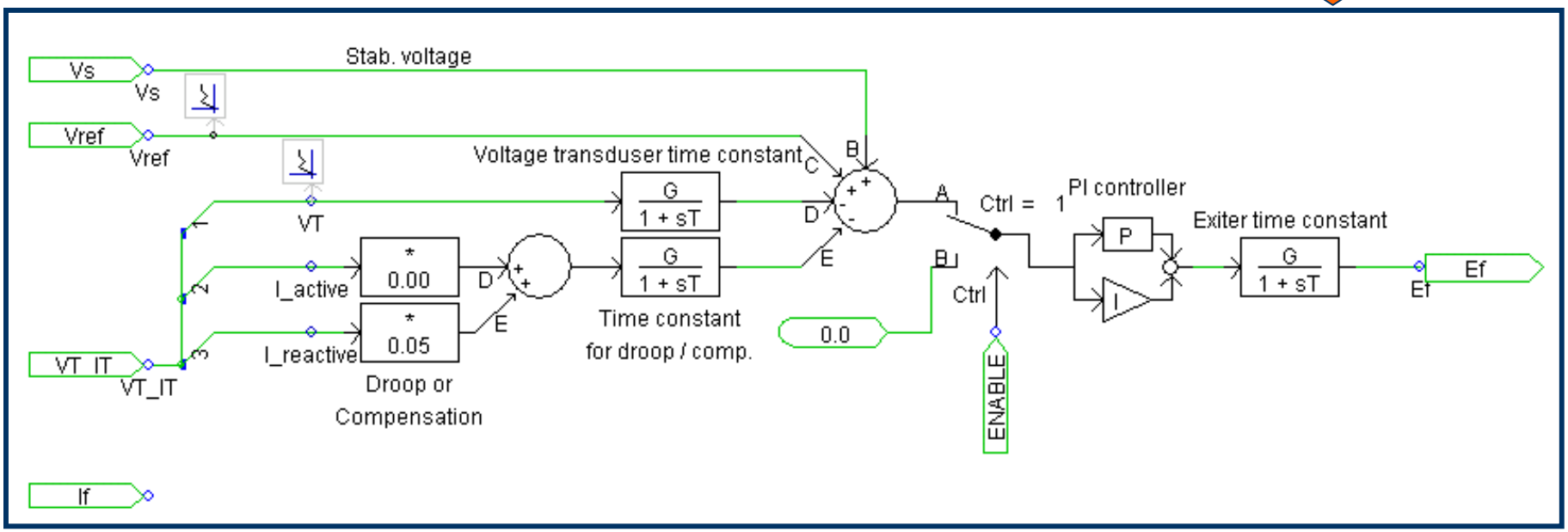
Models described in memo

- Generator models
- Exciter models
- Diesel engine models
- Gas turbine models
- Speed governor models
- Dynamic shaft models

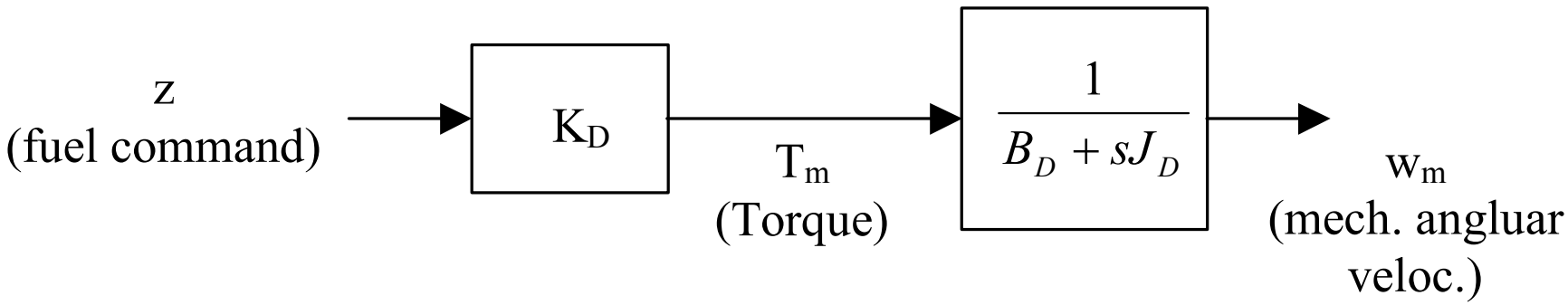
Simple exciter model

- Alternative to the standard IEEE based models in PSCAD/EMTDC
- Transparent (no hidden details)

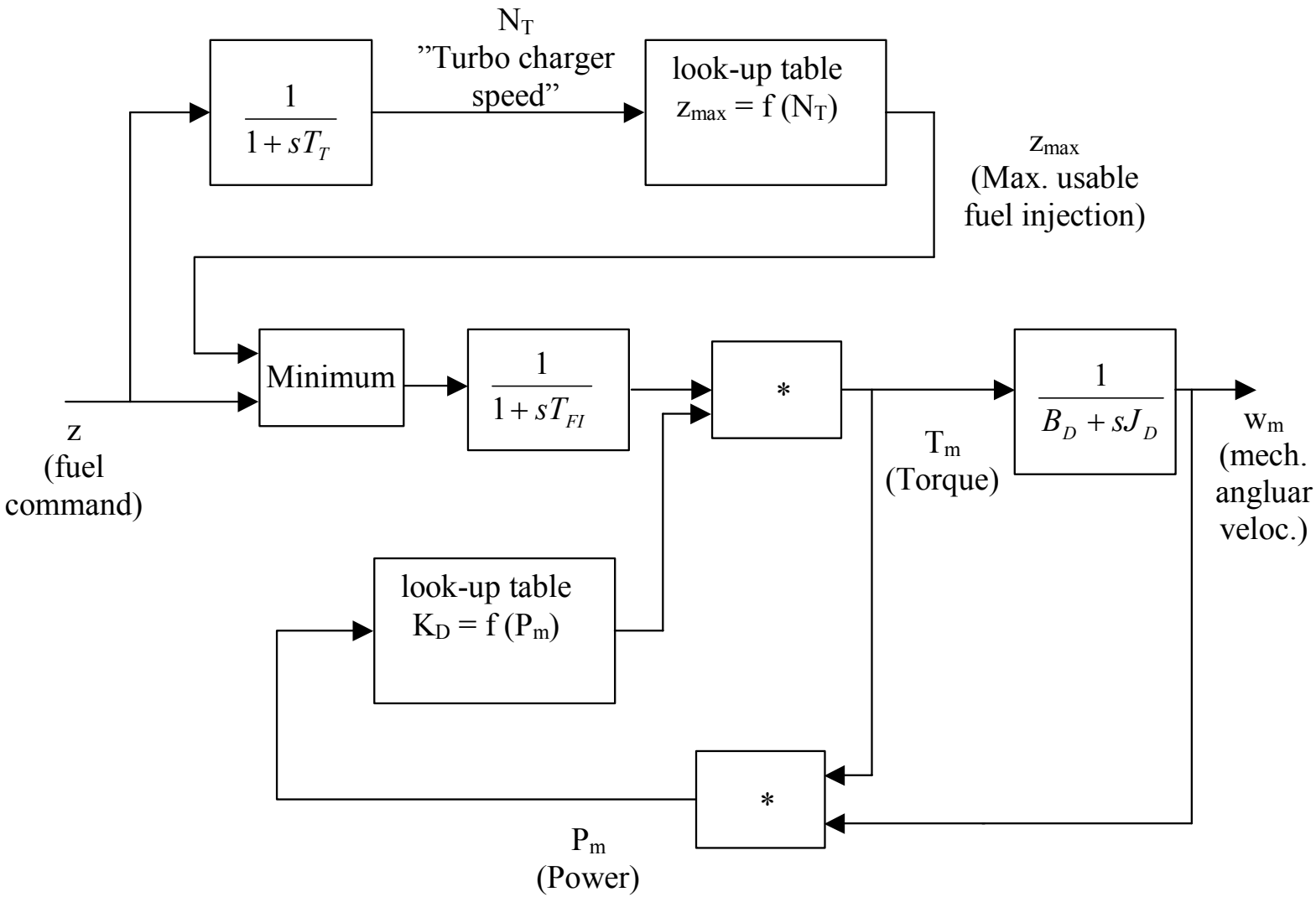




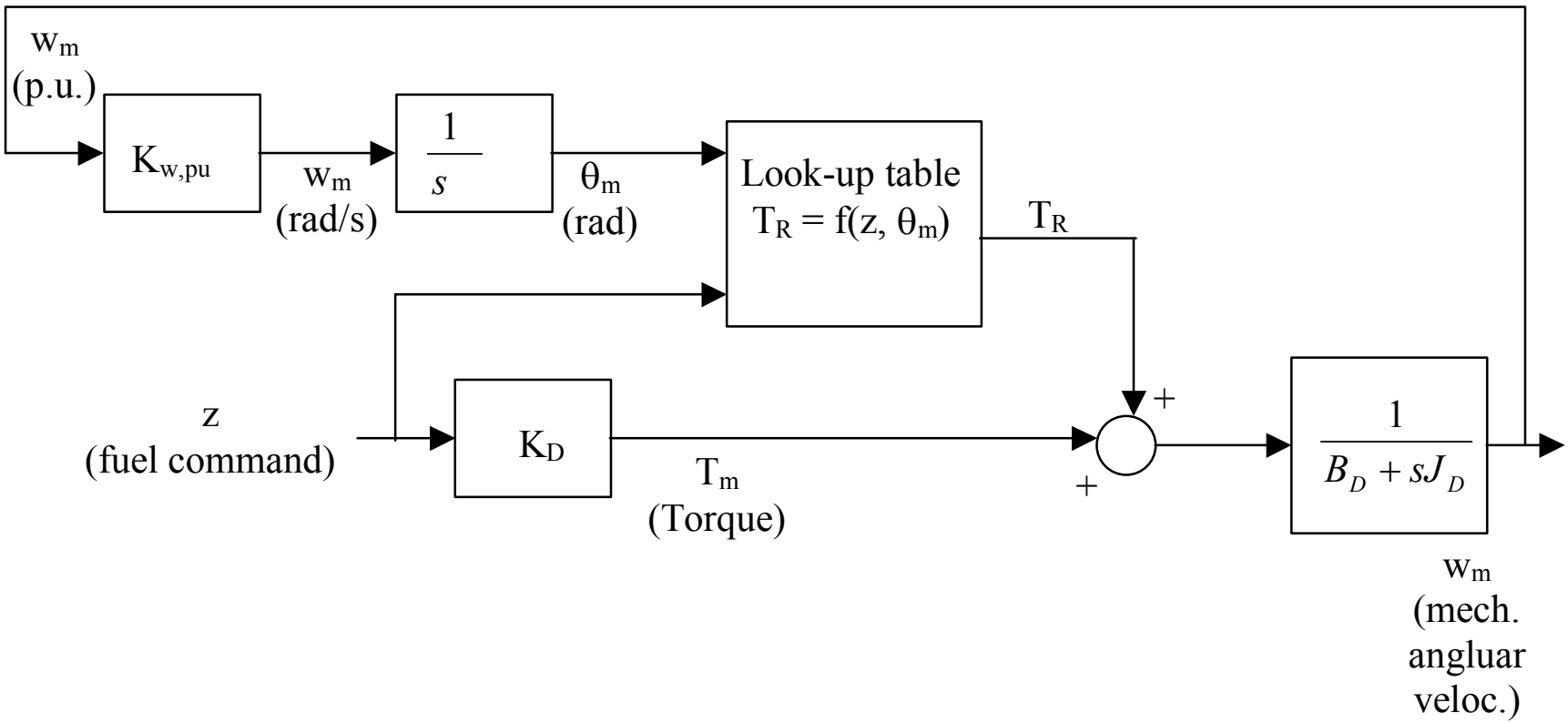
Diesel engine (Level 1 model)



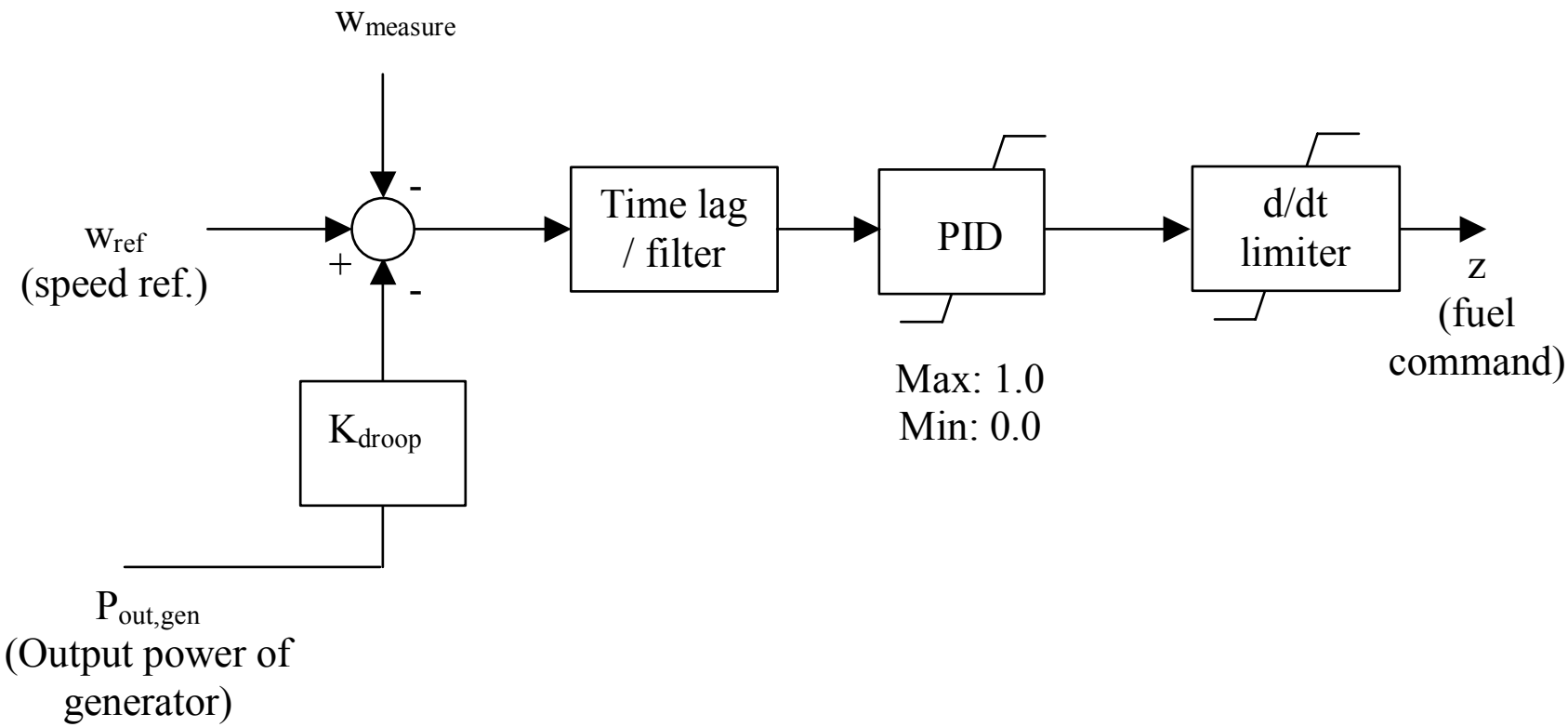
Diesel engine (Level 4 model)



Inclusion of torque ripple in diesel engine model (level 1 model)



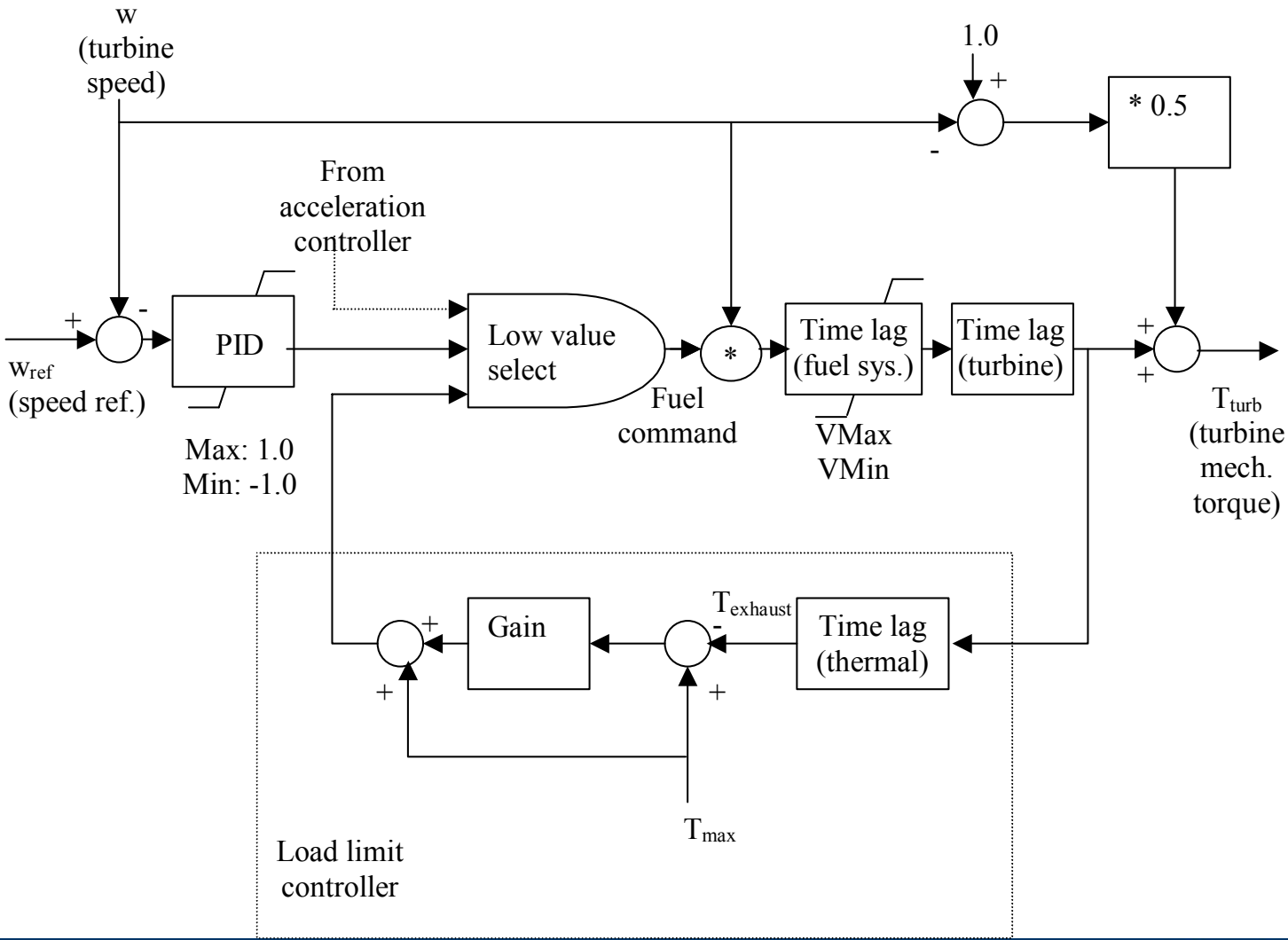
Speed governor model with droop



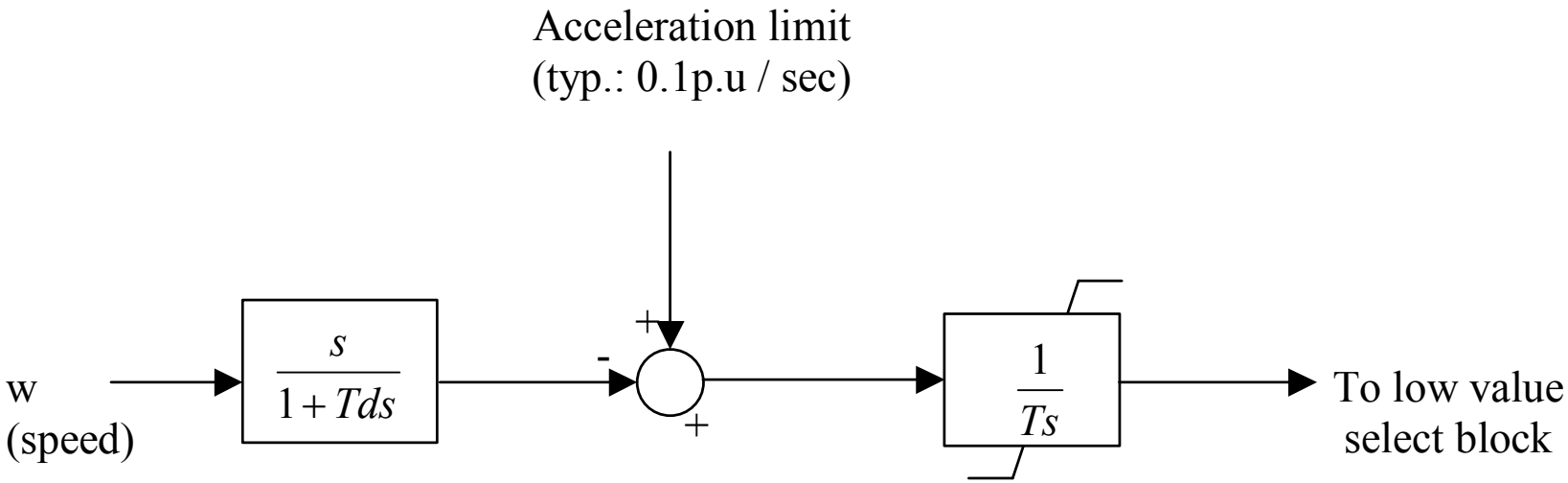
Gas turbine models

- Focused only on generators without cogeneration (i.e. exhaust is not used for electric power generation)
- Sub-systems included in model:
  - Speed governor
  - Temperature limit controller
  - Fuel injection system and turbine time constants
  - Mechanical system (inertia and mechanical damping)
  - Acceleration control

Gas turbine model (excl. mechanical inertia and mechanical damping)



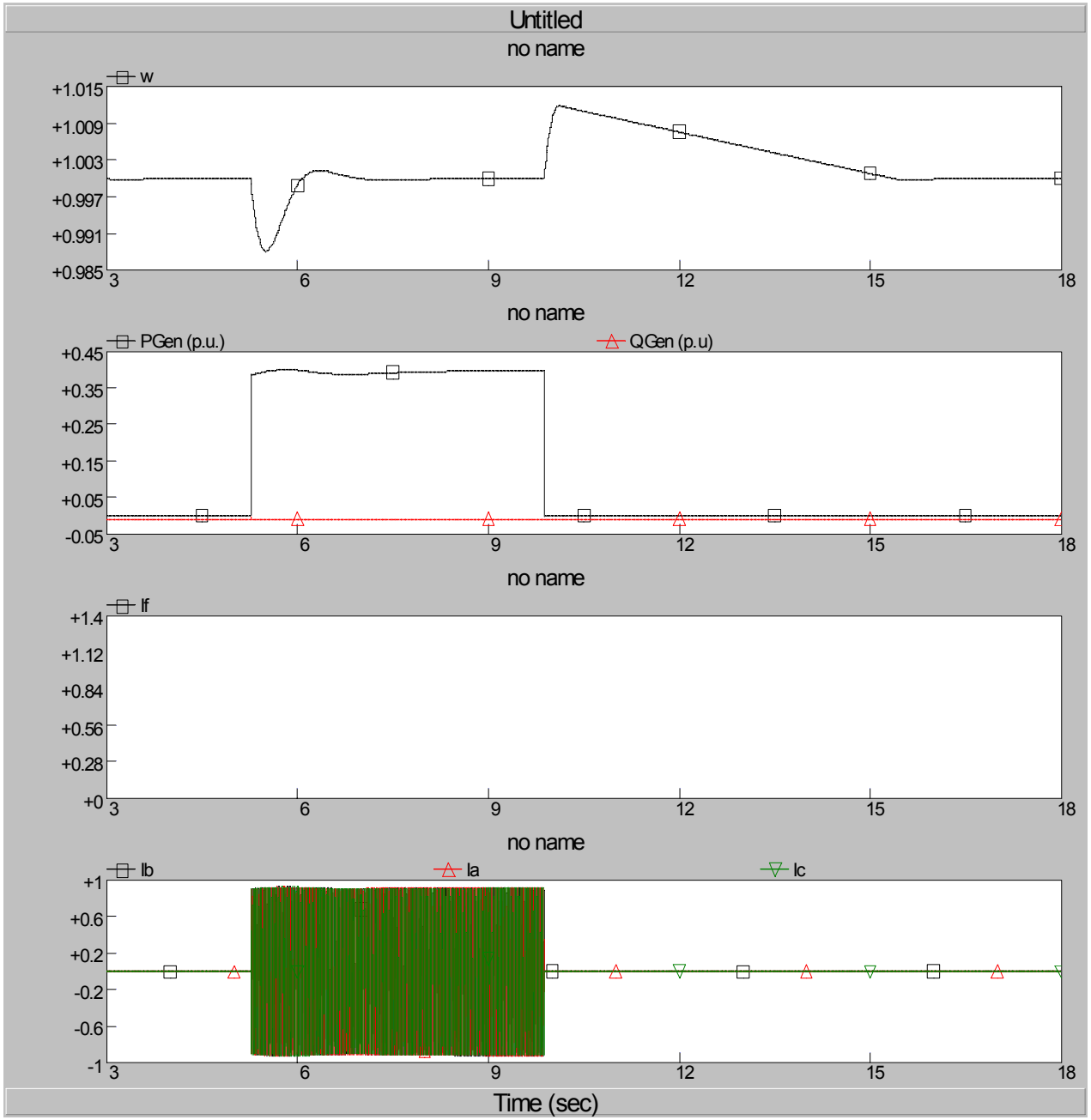
Possible realisation and modelling of acceleration controller



Example:

Diesel-generator train

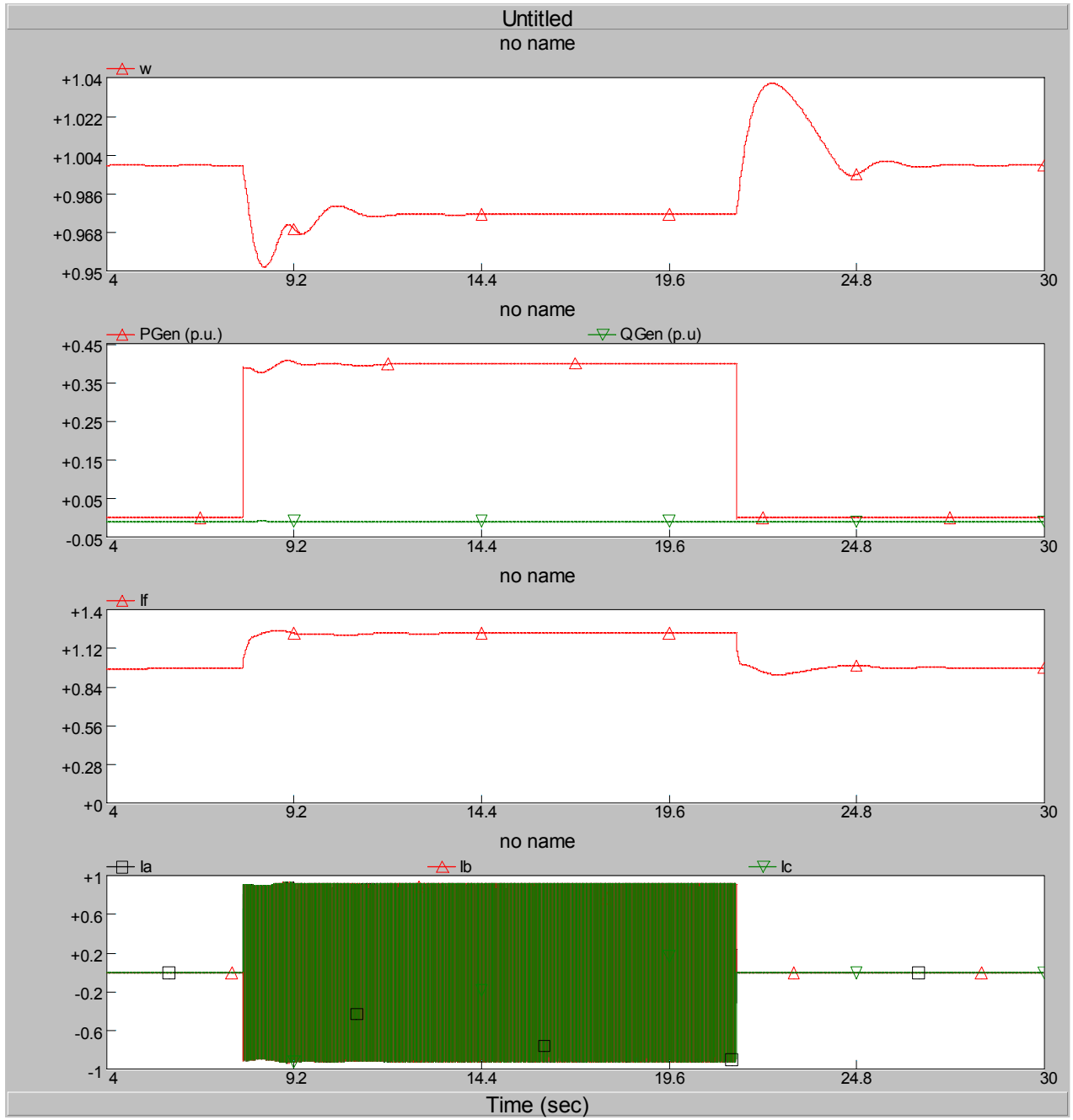
- Speed
- Power (P , Q)
- Field current
- Load current



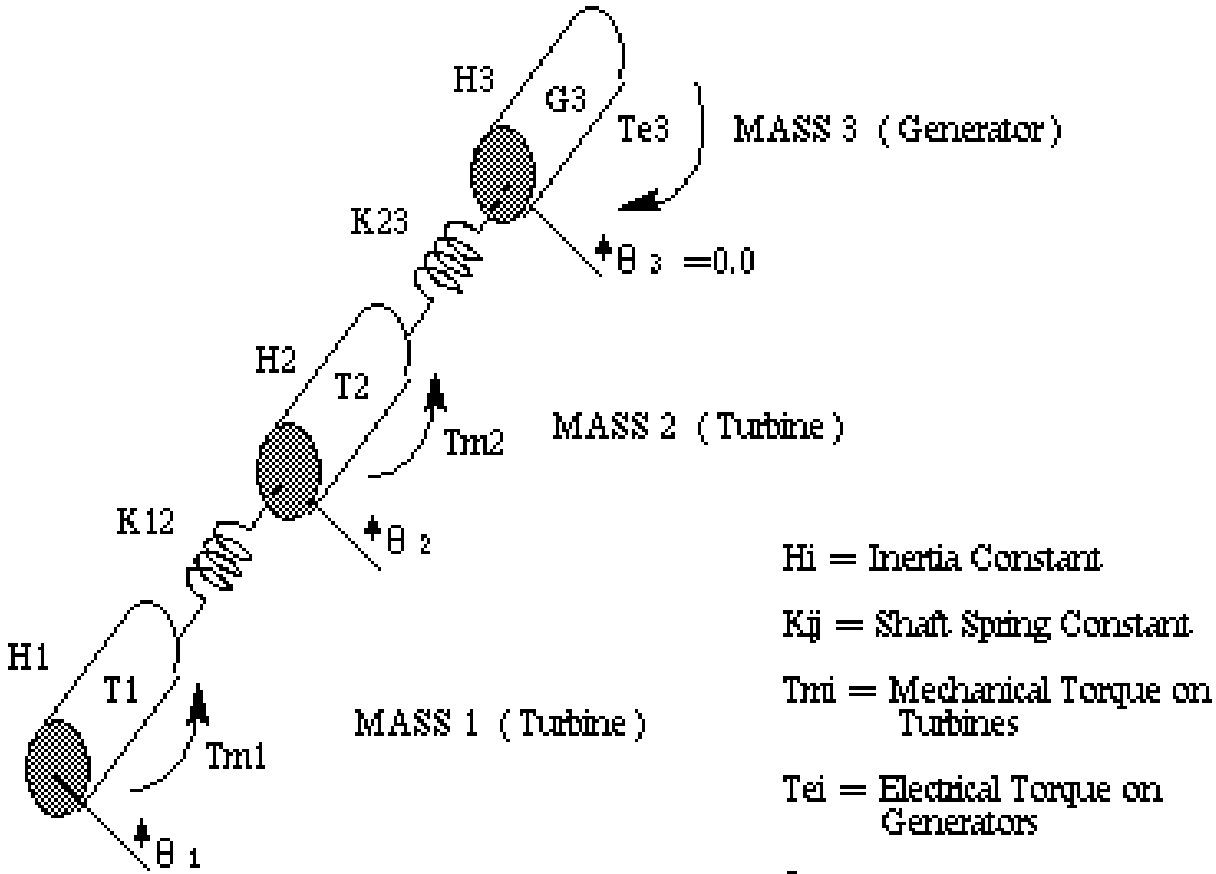
Example:

Gas turbine generator train

- Speed
- Power (P, Q)
- Field current
- Load current



Shaft dynamics can be included



Hi = Inertia Constant

Kij = Shaft Spring Constant

Tmi = Mechanical Torque on Turbines

Tei = Electrical Torque on Generators

θ i = Mass Angle

Reference angle is Generator

Conclusions

- The presented models and the simulation software PSCAD/EMTDC are suited for studies of interaction phenomena between generator trains and converters
- The generator train models are also considered suited in simulation analysis for optimal design of power converter control.
- The conclusion is however (as usual): More problems to obtain relevant data (parameters) for the system, than to implement these data in accurate models.

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PROJECT MEMO

MEMO CONCERNS

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AN NO.	CLASSIFICATION	REVIEWED BY	
AN 01.12.40	Åpen	Magnar Hernes	
ELECTRONIC FILE CODE		AUTHOR(S)	DATE
010808Mo143726		Olve Mo	2001-08-08
PROJECT NO.			NO. OF PAGES
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SUMMARY

This memo presents the results of a study of generator train modelling in general and particularly implementation of generator train models in the PSCAD/EMTDC simulation software.

The scope is generator train models suitable for studies of weak, possible autonomous, power systems, where typically a diesel or gas-turbine generator trains is connected to large power electronic converter loads or to other power sources connected to the power system via converters.

The models will be especially suited in studies of interaction phenomena between generator trains and converters, and also as a tool for optimal design of power converter control.

Presented in this memo are:

- Generator models
- Exciter models
- Diesel engine models
- Gas turbine models
- Speed governor models
- Dynamic shaft models

The intention has not been to establish new models of these system components, but rather to collect and test models presented in literature and in the PSCAD/EMTDC manuals, making them easily available for further investigation of studies like the one outlined above.

This study has shown that generally the problem is more to obtain relevant data for the system, than to implement these data in accurate models in PSCAD/EMTDC.

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