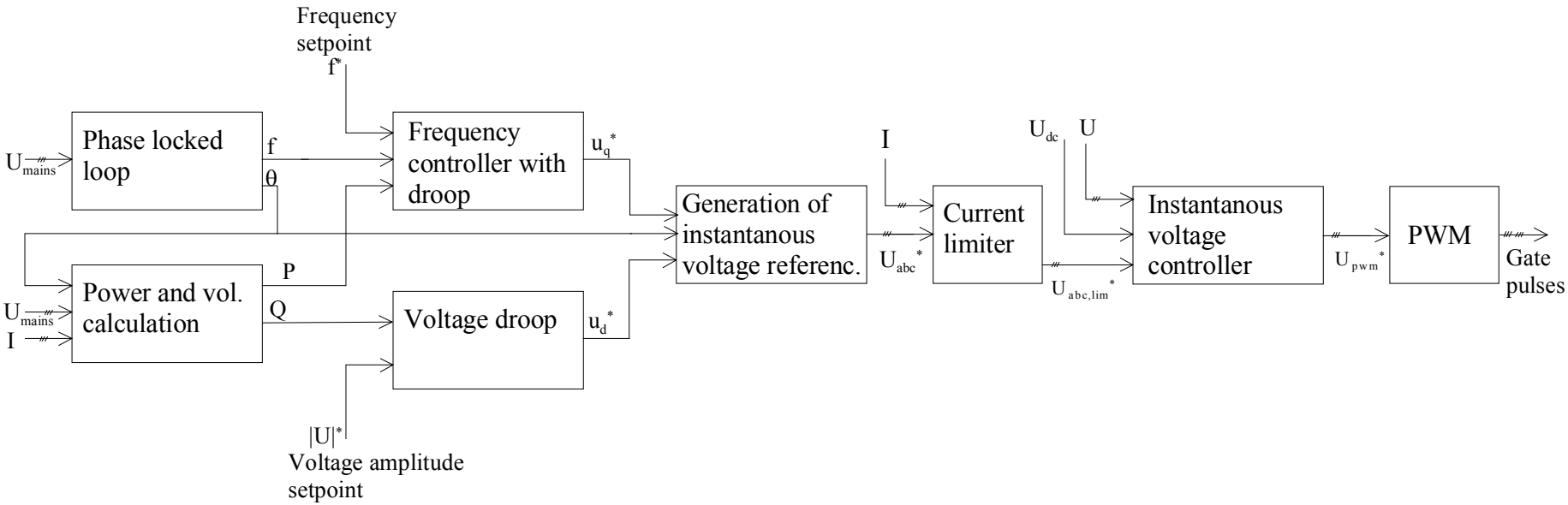
Project memo AN 02.12.24

Description of a voltage control system for an active front-end converter

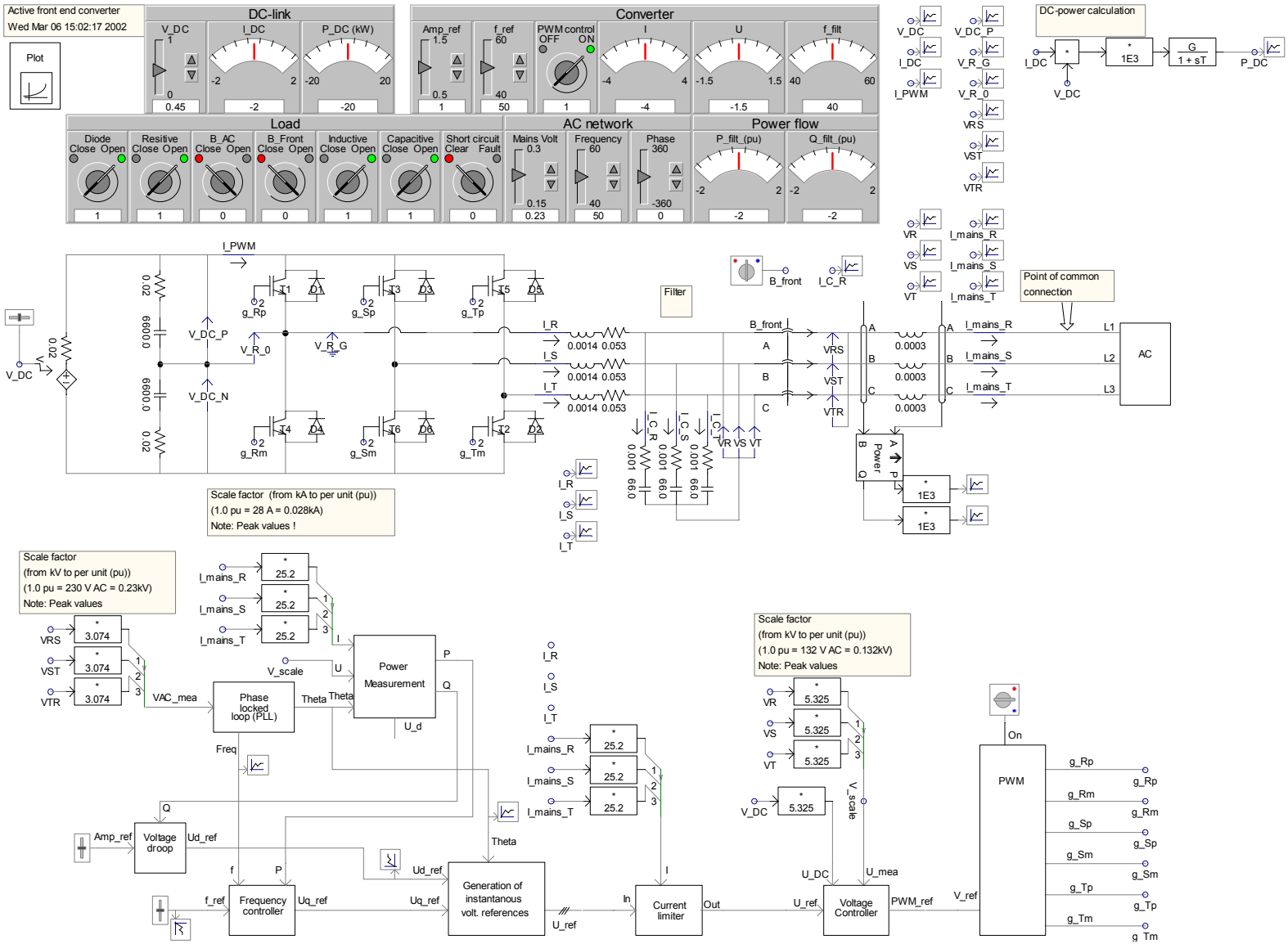
Objectives

- Modify active front-end controller from current control to voltage control suitable for stand-alone applications
- Test controller behaviour in the PSCAD/EMTDC simulation tool
- Implement and test outer control loops for active and reactive power flow control in order to allow parallel connection of sources

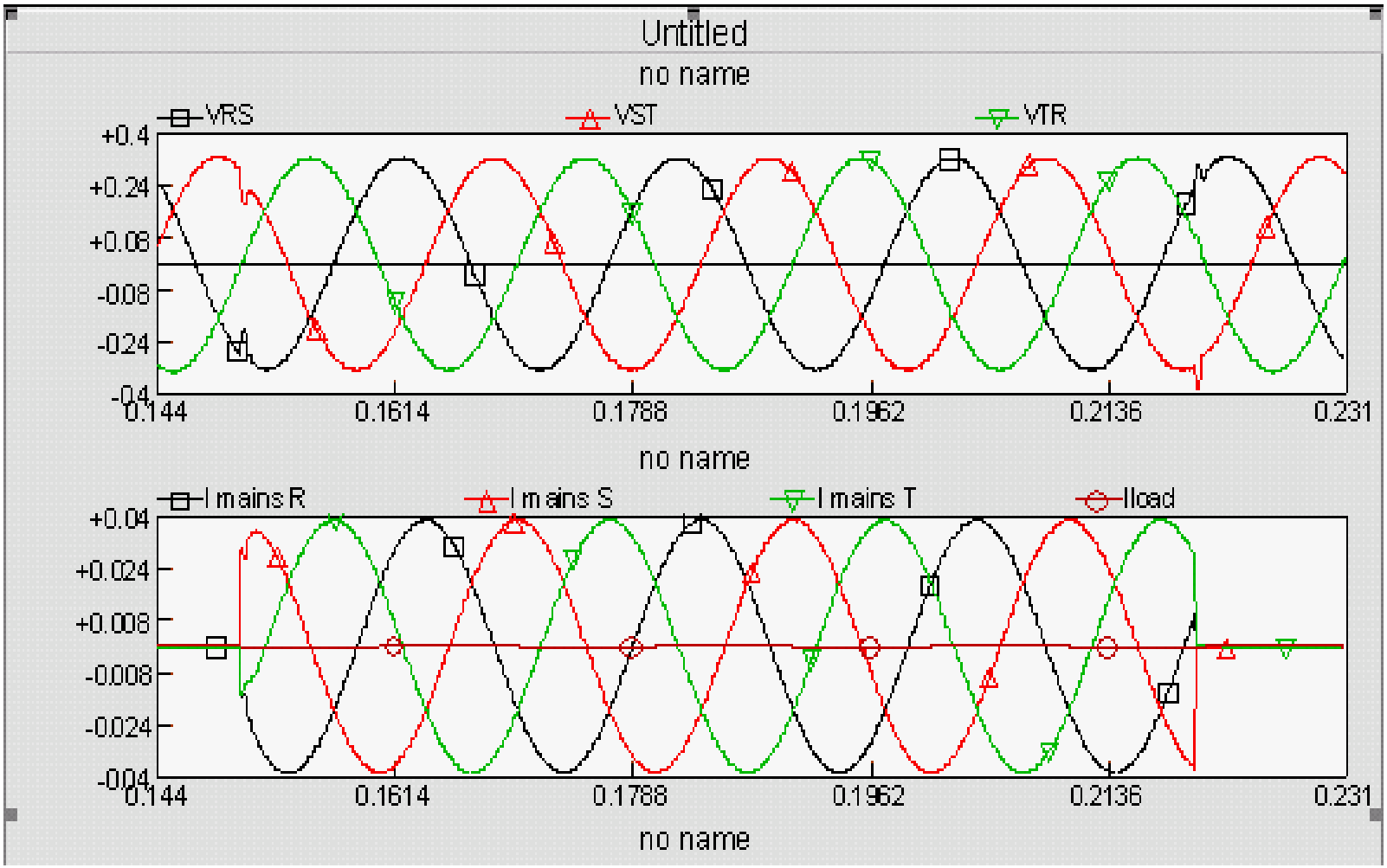
Controller block diagram



Simulation model (top level)



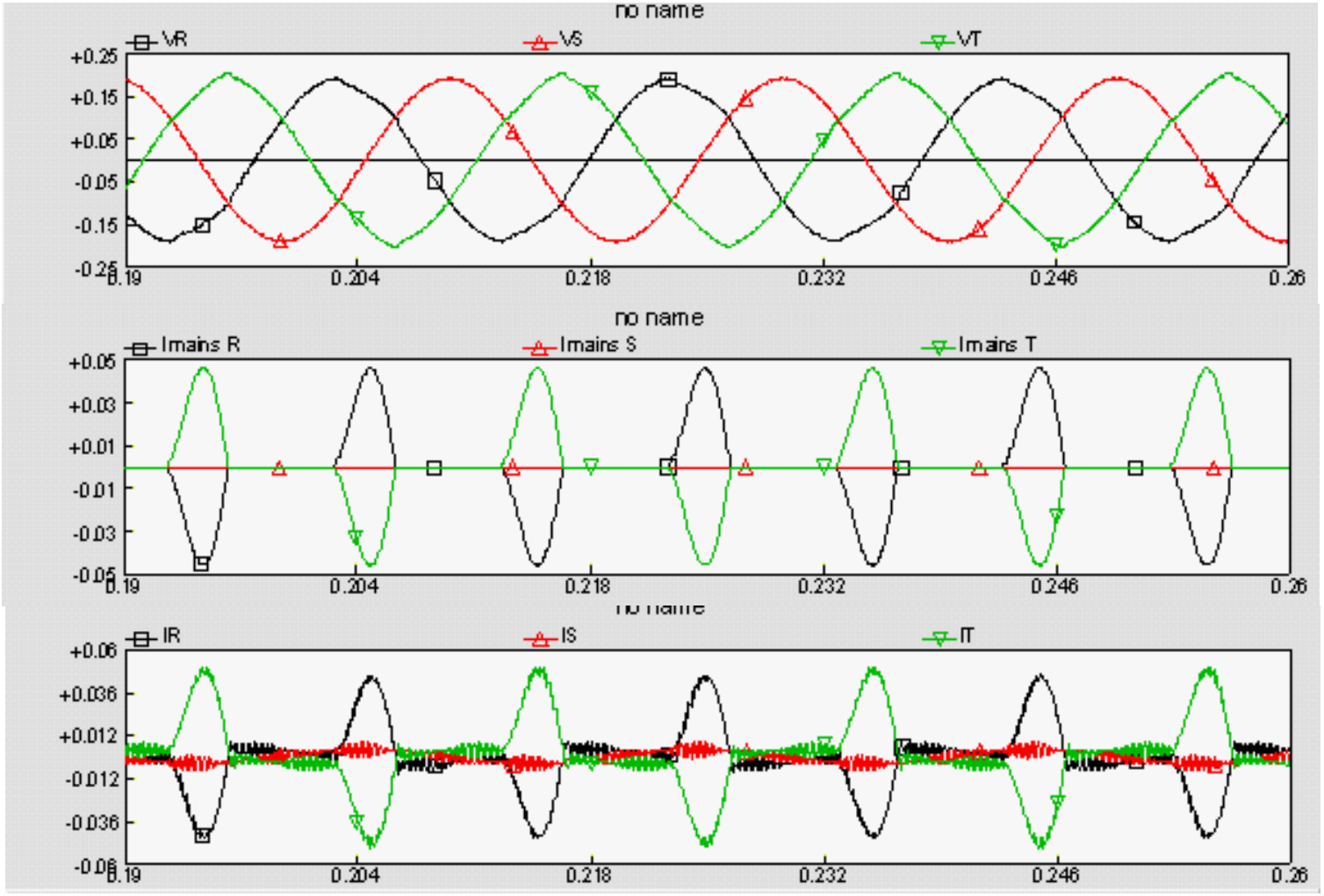
Stand alone operation: Connection/ disconnection of rated resistive load



Convert. output voltage (kV)

Load current (kA)

Stand alone operation: Non-linear, non-symetrical load

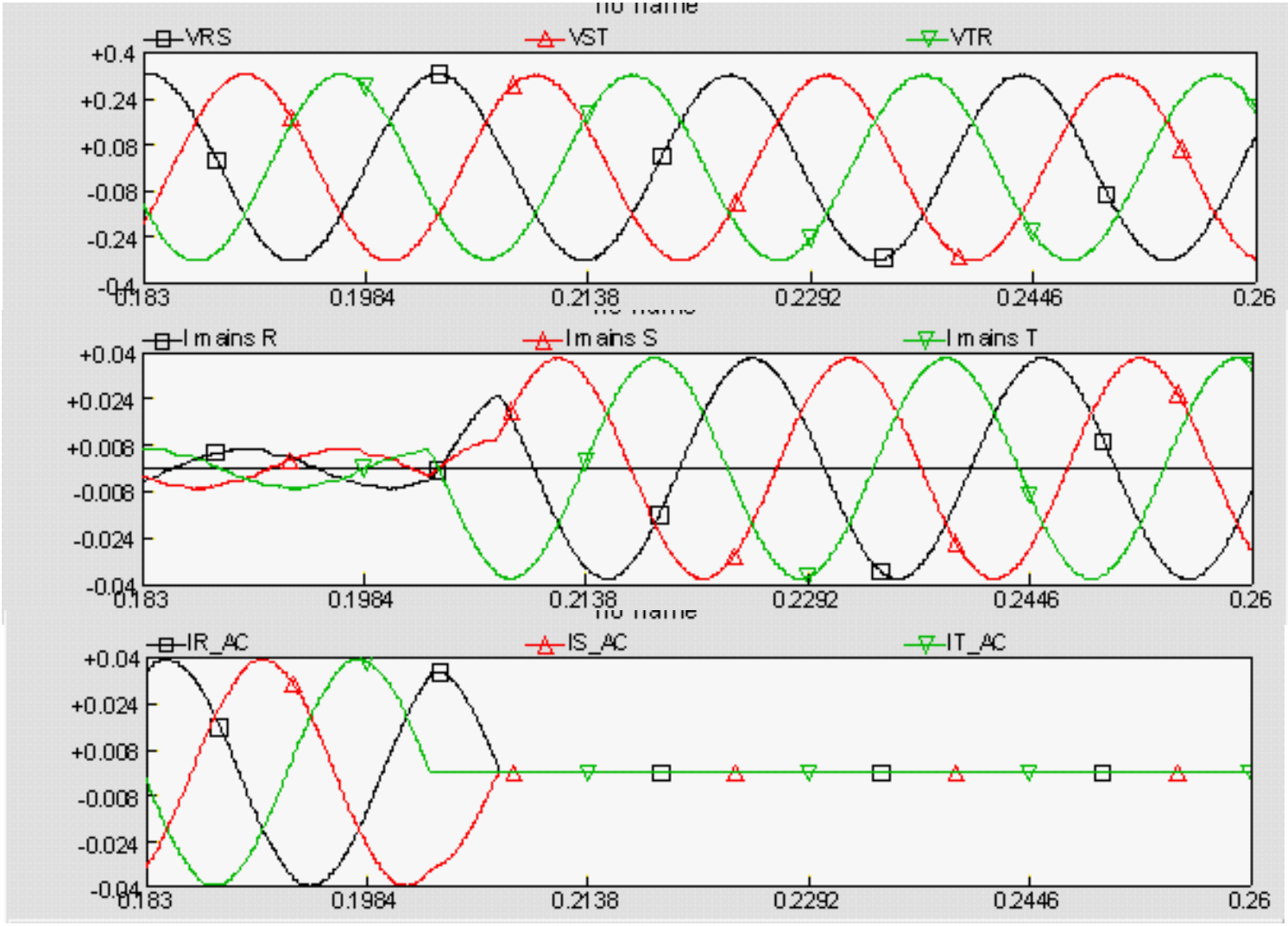


Convert. output voltage (kV)

Load current (kA)

Convert. current (kA)

From grid connected to stand-alone (loss of AC network, resistive load)

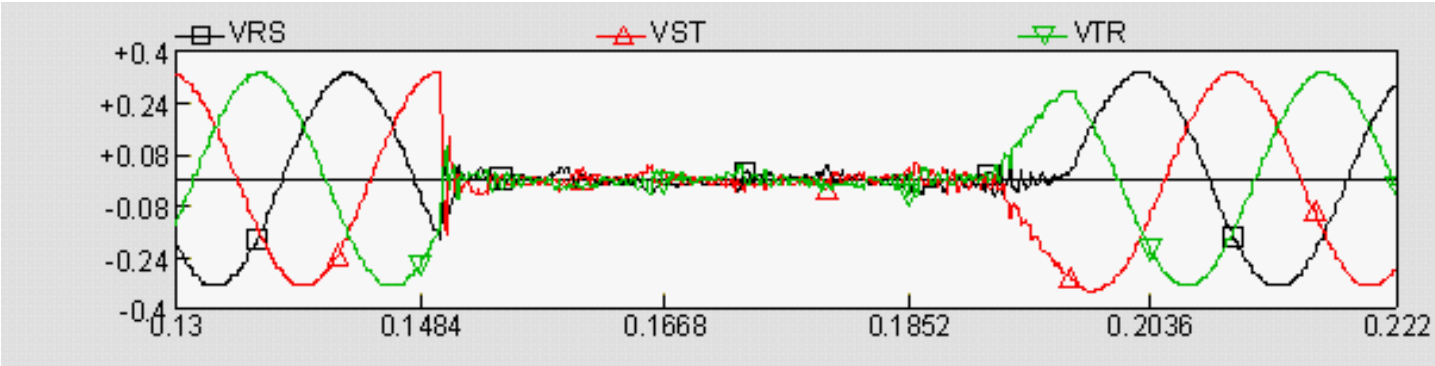


Converter output voltage (kV)

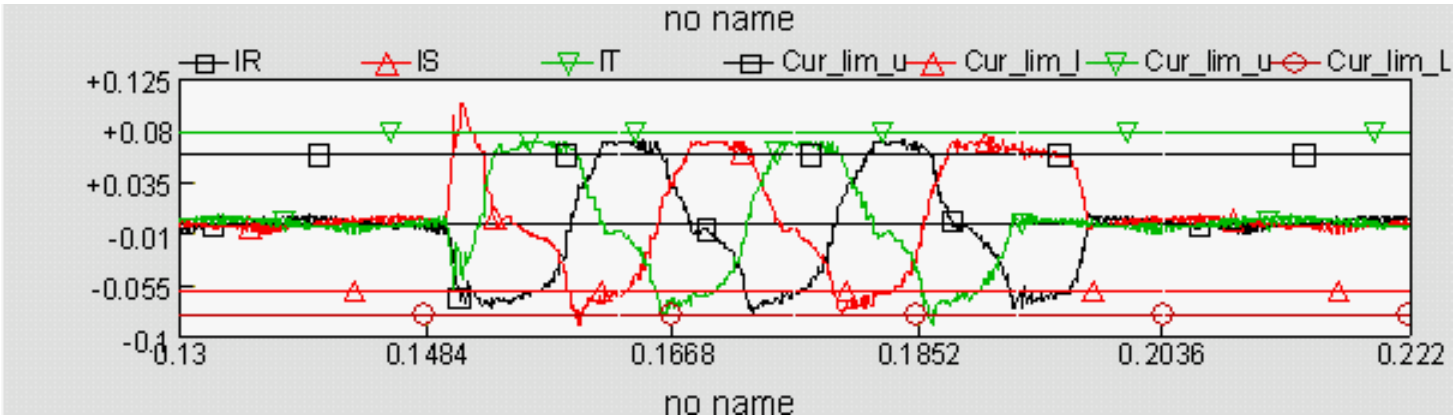
Current supplied from converter to load (kA)

Current supplied from AC-grid to load (kA)

Three phase terminal short circuit (Illustartion of current limiter)

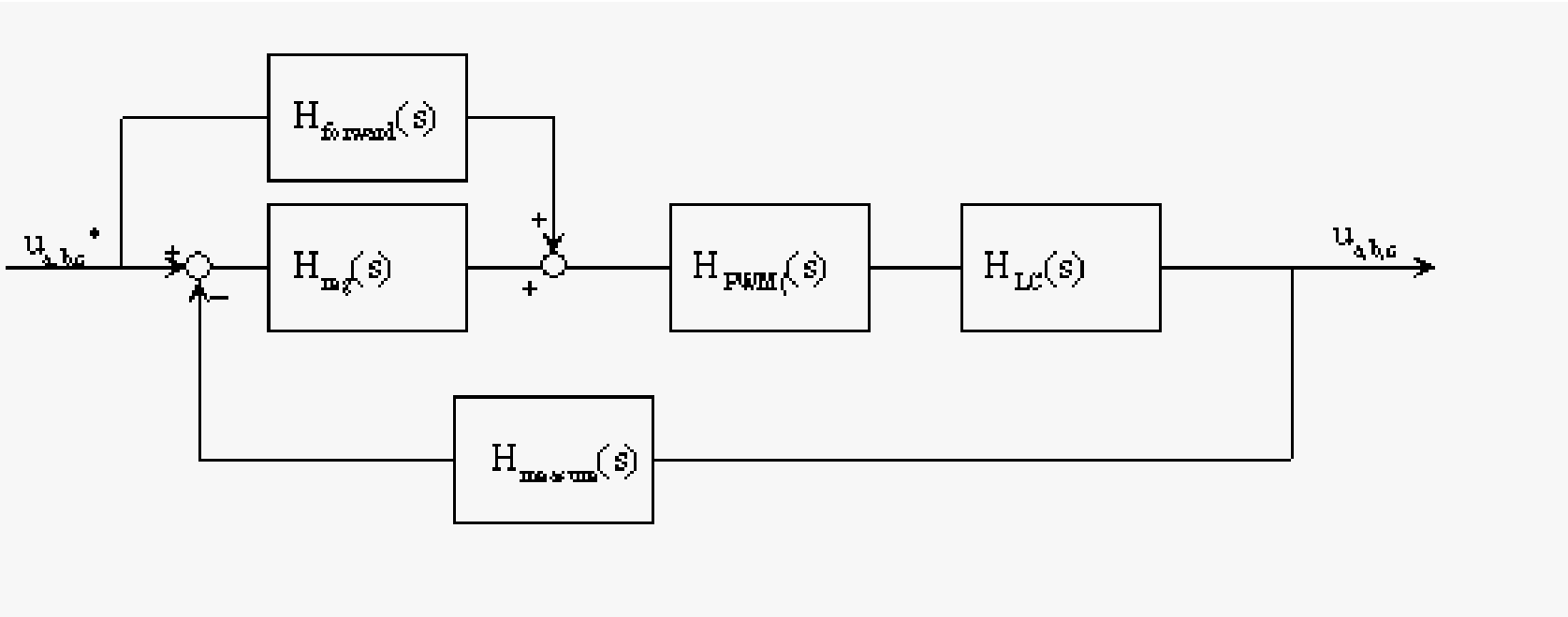


Converter output voltage (kV)



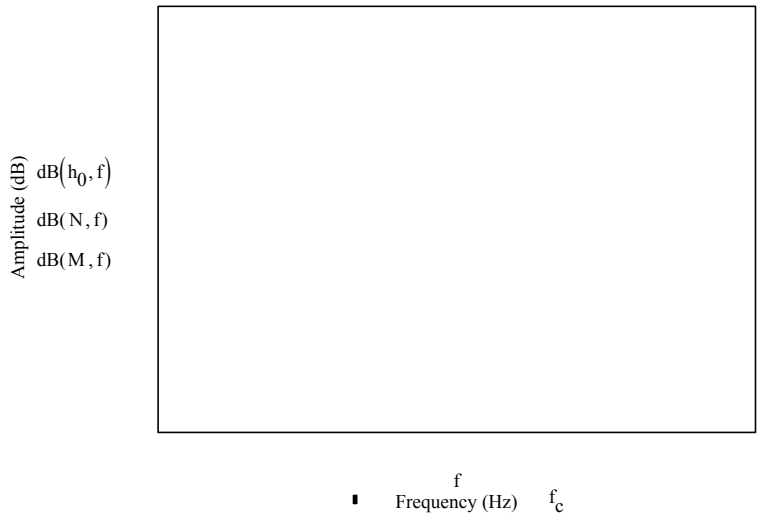
Converter output current (before filtering) (kA)

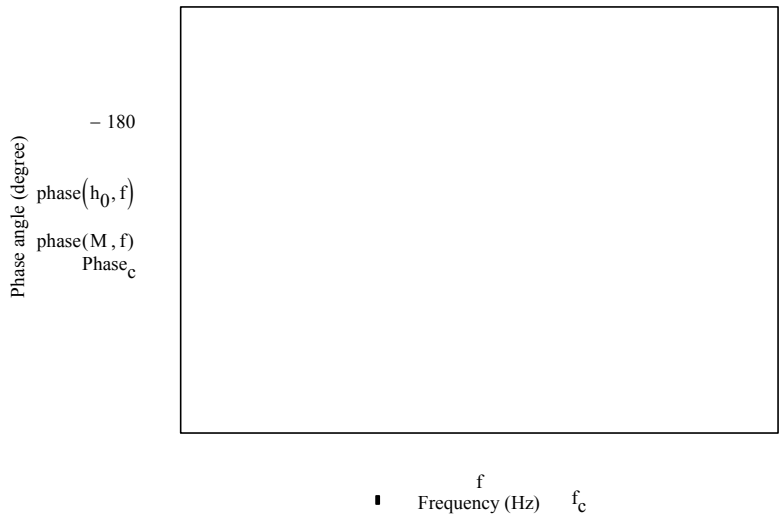
Stability analysis of inner voltage control loop



Stability analysis of inner voltage control loop (Mathcad)

Bodediagram





Proposals for further investigation

- Optimisation of control loops and control parameters
- Alternative methods for active and reactive power flow control
- Reduce interaction between current limiter and the other control loops
- Include virtual source impedance (virtual synchronous reactance as in generators)

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Description of a voltage control system for an active front-end converter

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The memo presents one possible way to design a control system for control of the instantaneous output voltage of an active front-end converter.

The description is based on a model that has been established in the simulation software PSCAD/EMTDC. Several simulated examples are presented. These results illustrates that the presented controller structure is working.

The inner closed control loop of the presented system is a voltage control loop. This kind of control is typical suited for converters that need to be able to feed the AC-system in stand-alone operation (for instance fuel cells, energy storage systems and other UPS-like applications). The control system is also suited for converter connected to weak power systems and for parallel operation between several converters.

The presented controller structures and their parameters are not fully optimised. Parameters are selected in order to illustrate that the presented controllers are working as intended. Optimal choices can only be decided according a specification for a specific application.

Proposal for further investigation and improvements are presented in chapter 4.

TABLE OF CONTENTS

Page

1 SYSTEM DESCRIPTION 4
1.1 Power circuit 4
1.2 Per unit system used in the controller 4
1.3 Overview of the control system 4
1.4 The pulse-width modulation 5
1.5 The inner voltage control loop 5
1.6 The current limiter 6
1.7 Generation of three phase instantaneous voltage references 6
1.8 Frequency control with droop 7
1.9 Voltage droop 8
1.10 Power calculation 8
1.11 Phase locked loop 9

2 PSCAD/EMTDC MODEL 10
2.1 The model 10
2.2 The power circuit 11
2.3 Phase locked loop 12
2.4 Power calculation 13
2.5 Voltage droop 13
2.6 Frequency controller 14
2.7 Generation of instantaneous voltage reverences 14
2.8 Current limiters 15
2.9 Voltage controller 15
2.10 Pulse width modulation 16

3 PRESENTATION OF SIMULATED RESULTS 17
3.1 Response of inner voltage loop 17
3.2 Stand-alone (autonomous) operation 18
3.2.1 Resistive load 18
3.2.2 Inductive / resistive load 20
3.2.3 Non-linear, non-symmetrical load 22
3.2.4 Overload 23
3.2.5 Three phase short circuit 25
3.2.6 Two pole short circuit 27
3.3 Converter connected to AC-network 29
3.3.1 Synchronised connection to AC-network 29
3.3.2 Manuel active power flow control by adjustment of frequency set-point 30
3.3.3 Manuel reactive power flow control by use of voltage set-point 32
3.3.4 Connection and disconnection of resistive load 33
3.3.5 Transition to stand-alone operation (loss of AC-network) 35

4 PROPOSAL FOR IMPROVEMENTS AND FURTHER INVESTIGATION 37
4.1 Optimum parameters and structures of control loops 37
4.2 Need of phase locked loop 37
4.3 Current limiting problems 37
4.4 Power control and DC-link voltage control 37

4.5 Compensation for actual DC-link voltage 37
4.6 Alternative frequency control 37
4.7 Effect of control loop digital implementation 38
4.8 Virtual source impedance 38
4.9 Improvement of voltage droop 38
4.10 Improvement of current limiter 38

5 REFERENCES 39

6 APPENDIX A : PARAMETERS USED IN THE SIMUALTION MODEL 40

7 APPENDIX B : BODEPLOT OF INNER VOLTAGE LOOP 45