Project memo AN 03.12.14

Active front-end converter configured for reactive power support

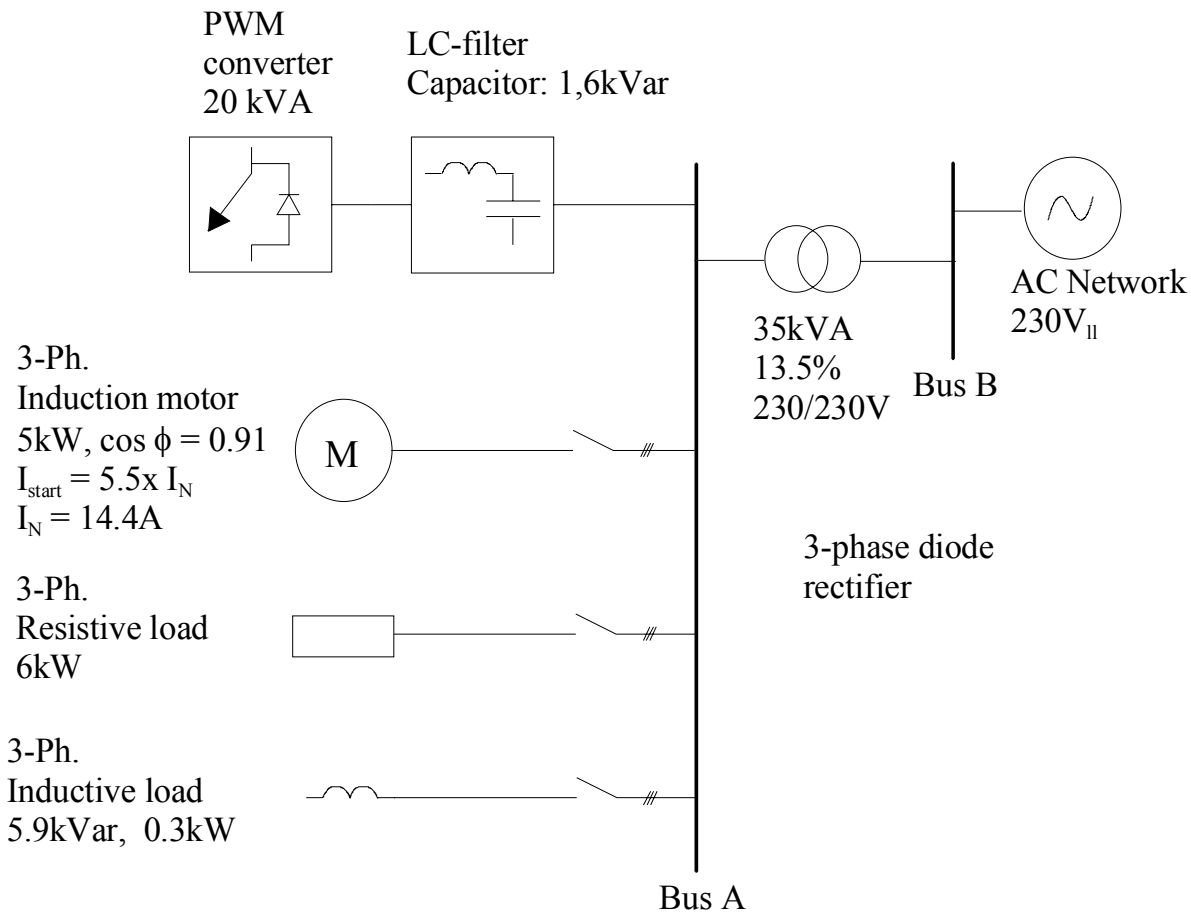
Objective

To use simulation to illustrate the principal performance of an implemented AC-voltage control loop in the controller of a grid connected PWM converter

Background

- A grid connected PWM converter (active-front-end converter) may be configured to supply reactive power to the AC-network
- The reactive power can be controlled such that the AC-voltage amplitude is kept close to a desired level (STATCOM operation).
- This feature can be included in converters used as interface for power consumption as well as power production (add-on feature)
- The principle and performance of this feature are illustrated in the memo

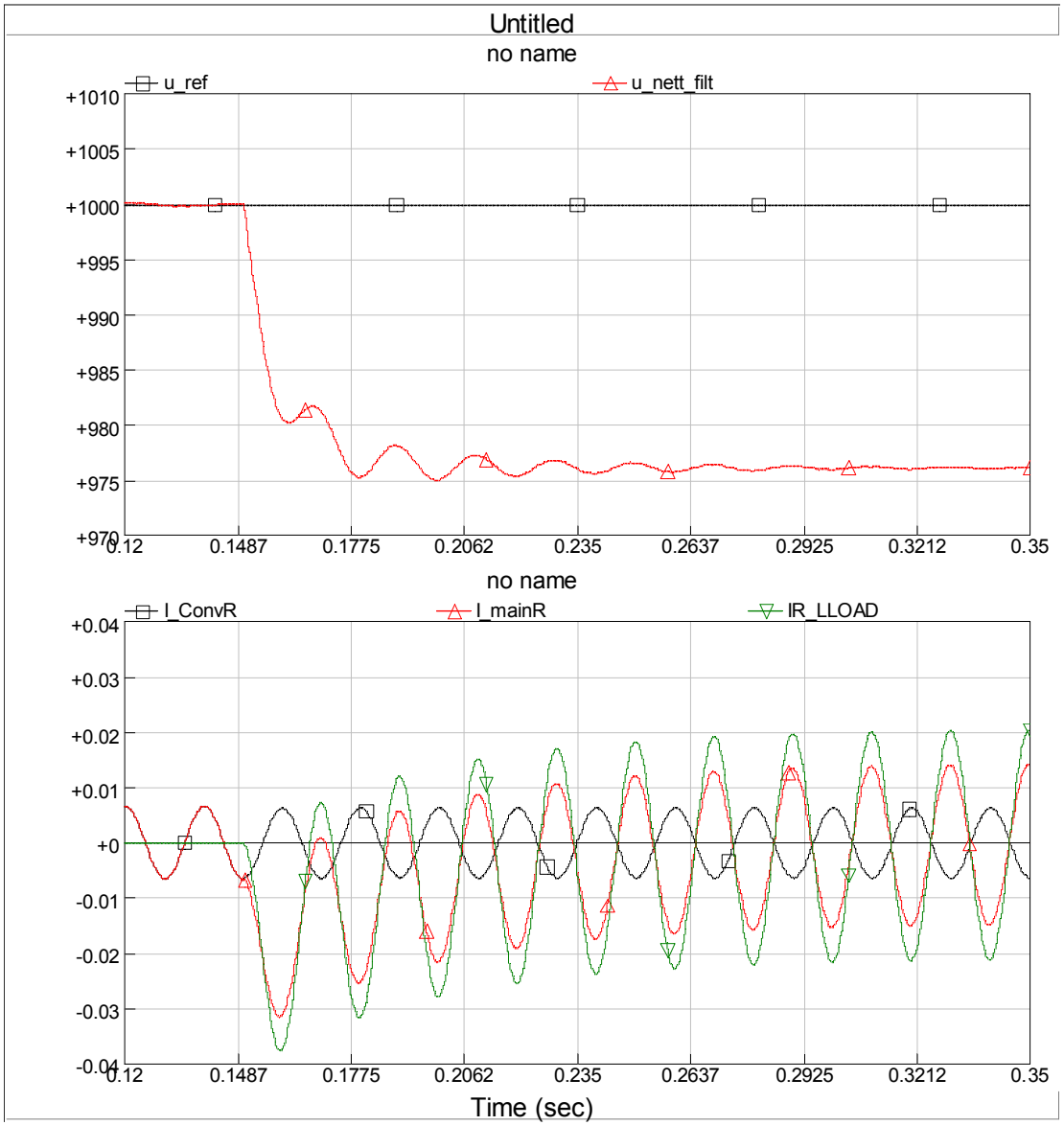
System used for the illustration



Presented case

- PWM-converter:
  - 5500 Hz switching frequency
  - zero active power (consumes power for internal losses only)
- No other loads connected to bus A
- Connects 5.9kVar / 0.3kW inductive load at time 0.15
- Reference value for AC-voltage controller: 1000 [pu/1000] (corresponds to 230V rms line to line)
- Voltage at Bus B is set such that the AC-voltage at bus A is 230V rms line to line when only the PWM filter capacitor is connected.

AC voltage control disabled



Amplitude of fundamental, positive sequence voltage at bus A (red/triangles, [pu/1000])

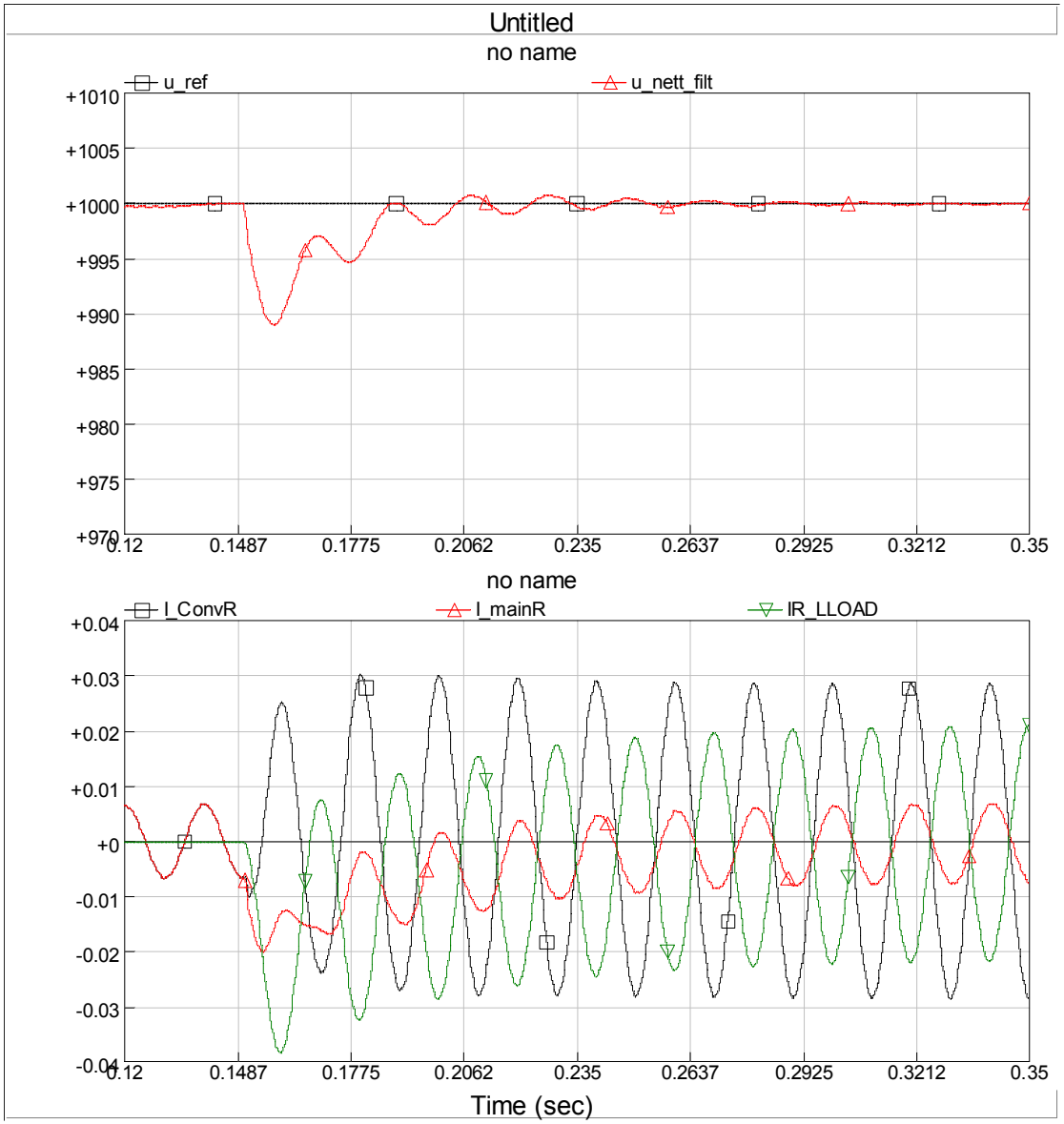
Reference for AC-voltage controller (black/square, [pu/1000])

Phase R current, bus B to bus A (red/triangles, [kA])

Phase R current, bus A into LC filter (black/square, [kA])

Phase R current into the inductive load (green/triangle, [kA])

AC voltage control enabled



Amplitude of fundamental, positive sequence voltage at bus A (red/triangles, [pu/1000])

Reference for AC-voltage controller (black/square, [pu/1000])

Phase R current, bus B to bus A (red/triangles, [kA])

Phase R current, bus A into LC filter (black/square, [kA])

Phase R current into the inductive load (green/triangle, [kA])

Other cases shown in the memo

- Connection and disconnection of resistive load
- Direct on-line start of induction machine

SINTEF

SINTEF Energy Research

Address: NO-7465 Trondheim, NORWAY
Reception: Sem Sælands vei 11
Telephone: +47 73 59 72 00
Telefax: +47 73 59 72 50

www.energy.sintef.no

Enterprise No.:
NO 939 350 675 MVA

PROJECT MEMO

MEMO CONCERNS

Active front-end converter configured for reactive power support

DISTRIBUTION

SEfAS:

Magnar Hernes
Kjell Ljøkelsøy
Nils Arild Ringheim
Olve Mo

AN NO.	CLASSIFICATION	REVIEWED BY
AN031214	Unrestricted	Kjell Ljøkelsøy

ELECTRONIC FILE CODE	AUTHOR(S)	DATE
030221MO101619	Olve Mo	2003-02-21
PROJECT NO.		NO. OF PAGES
12X127	olve.mo@sintef.no	27

DIVISION	LOCATION	LOCAL FAX
Energy Systems	Sem Sælands v. 11	+47 73597250

This memo present results of the Strategic Institute Programme (SIP) “Power electronics and energy storage technologies for cost- and energy efficient power systems” funded by The Research Council of Norway.

The intention of this memo is to use simulation to illustrate the principal performance of an implemented AC-voltage control loop in the controller of a grid connected PWM converter.

A grid connected PWM converter (active-front-end converter) may be configured to supply reactive power to the AC-network in order to keep the AC-voltage amplitude at a desired level (STATCOM). This feature can be included in converters used as interface for power consumption as well as power production.

A control loop for AC-voltage control has been implemented in the laboratory PWM converter at SINTEF Energy Research. The principle and performance of this feature are in this memo illustrated by three simulated cases where the grid-connected converter is connected to a weak AC- bus. The three simulated cases are:

- Connection and disconnected of resistive load.
- Connection of an inductive load.
- Direct on-line start of induction motor.

It should be noted that this memo only presents simple illustrations. The AC-voltage controller has not been optimised for any special purpose. In a real application one would need to consider the type of error amplifier (P or PI) inclusion of droop etc. Such fast AC-voltage controllers as presented in this memo may also not be desired or acceptable in all applications.

TABLE OF CONTENTS