Documentation of an implemented control system for an active front-end converter

Objectives

- Establish a guide for the use of the laboratory converter
- Establish the documentation needed in order to be able to modify or model the converter controller.

- NOTE: The memo is no stand alone complete documentation of hardware and software of laboratory set-up.
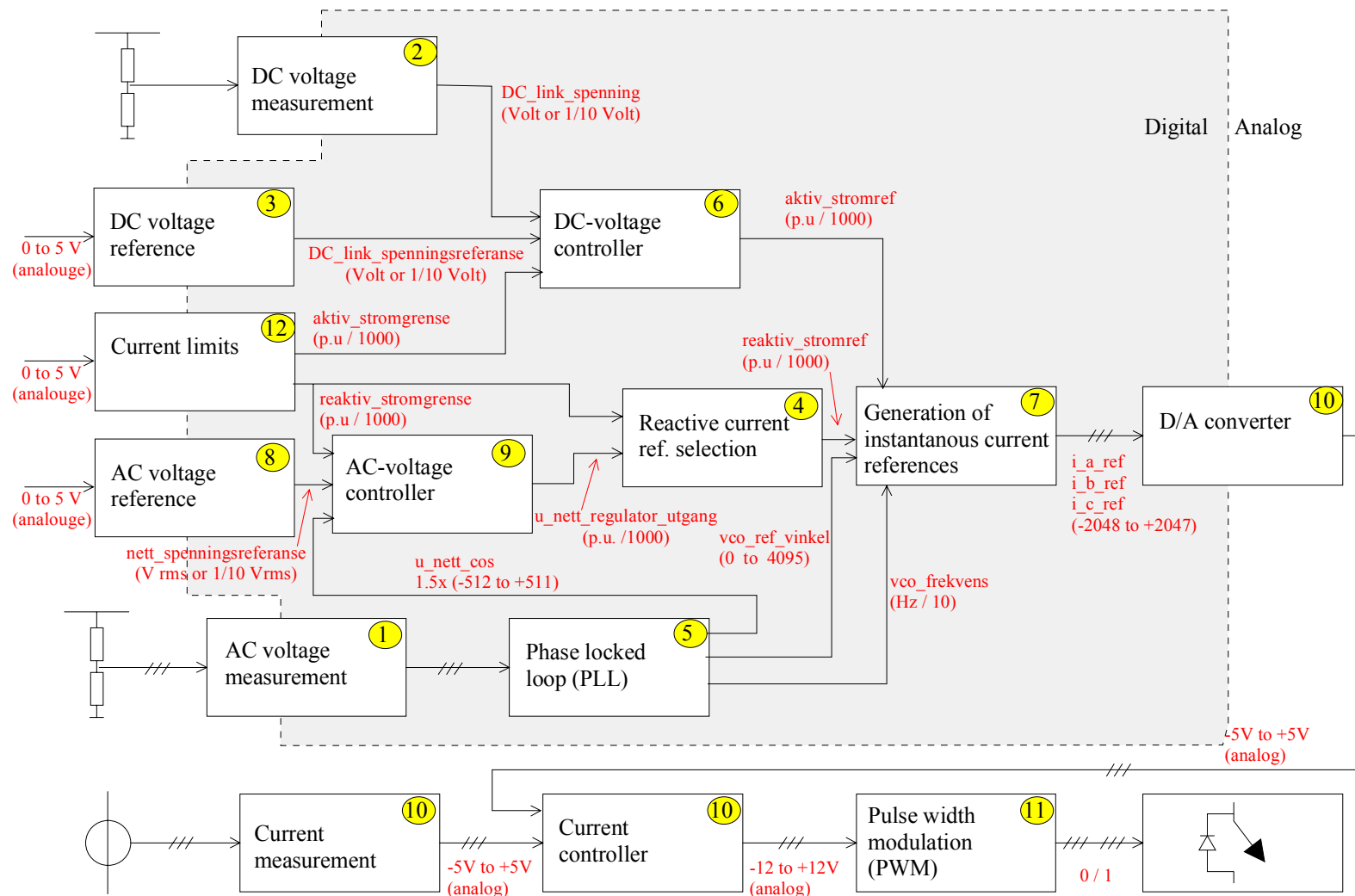
Documentation presented in memo

- Block diagrams of control system
- Illustration of the sequence / state control of the converter
- List of parameters to be specified
- List of available monitoring signals
- List of status messages with explanations
- Description of LED indicators
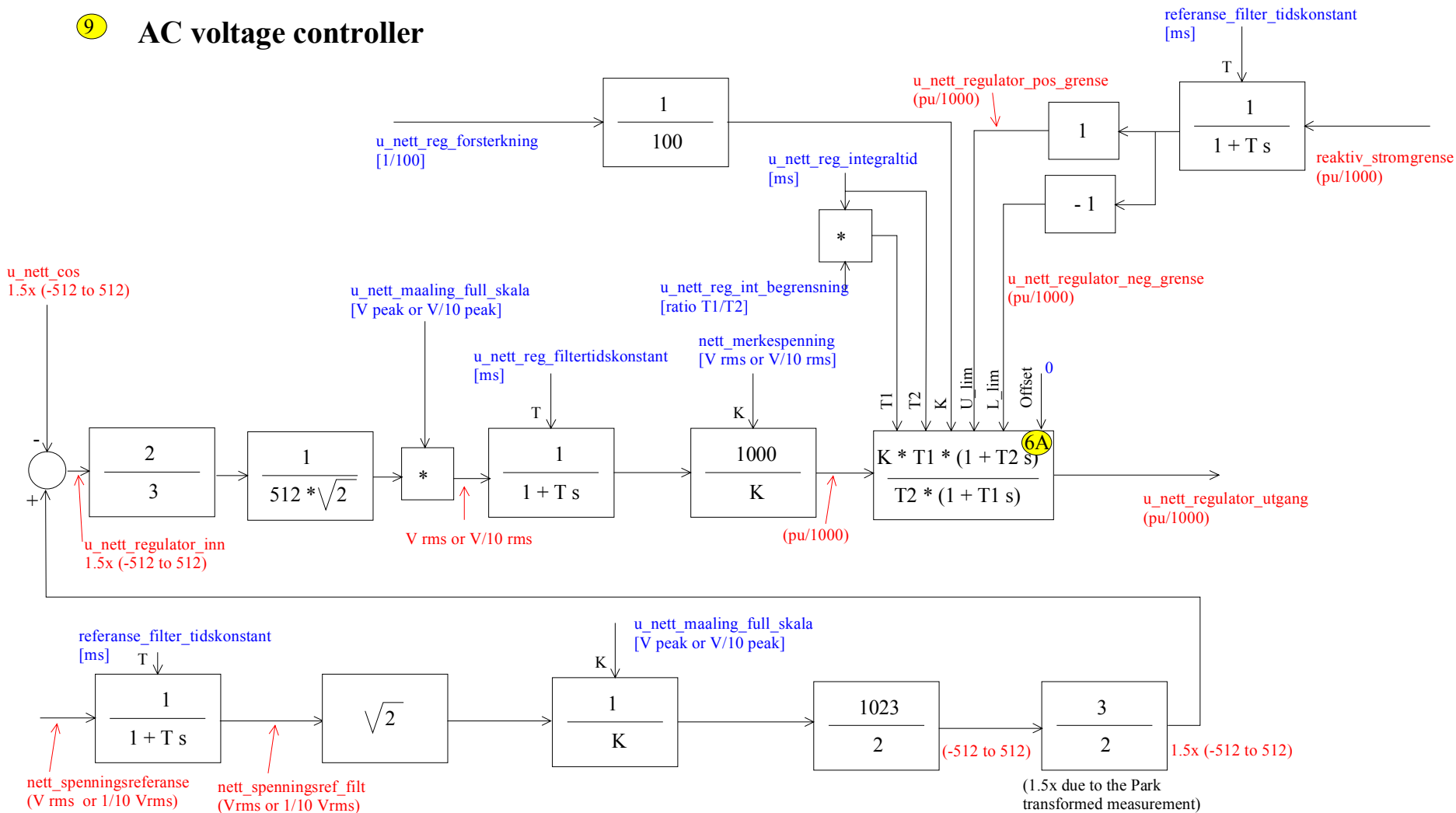
Implemented control tasks

- DC-link voltage controller that keeps the DC-link voltage equal to its reference (the output is the set-point for active current)

- AC-voltage controller that keeps the AC-voltage equal to its reference (the output is the set-point for reactive current)

- AC voltage controller can be disabled. An external reactive current reference then controls the reactive power flow.
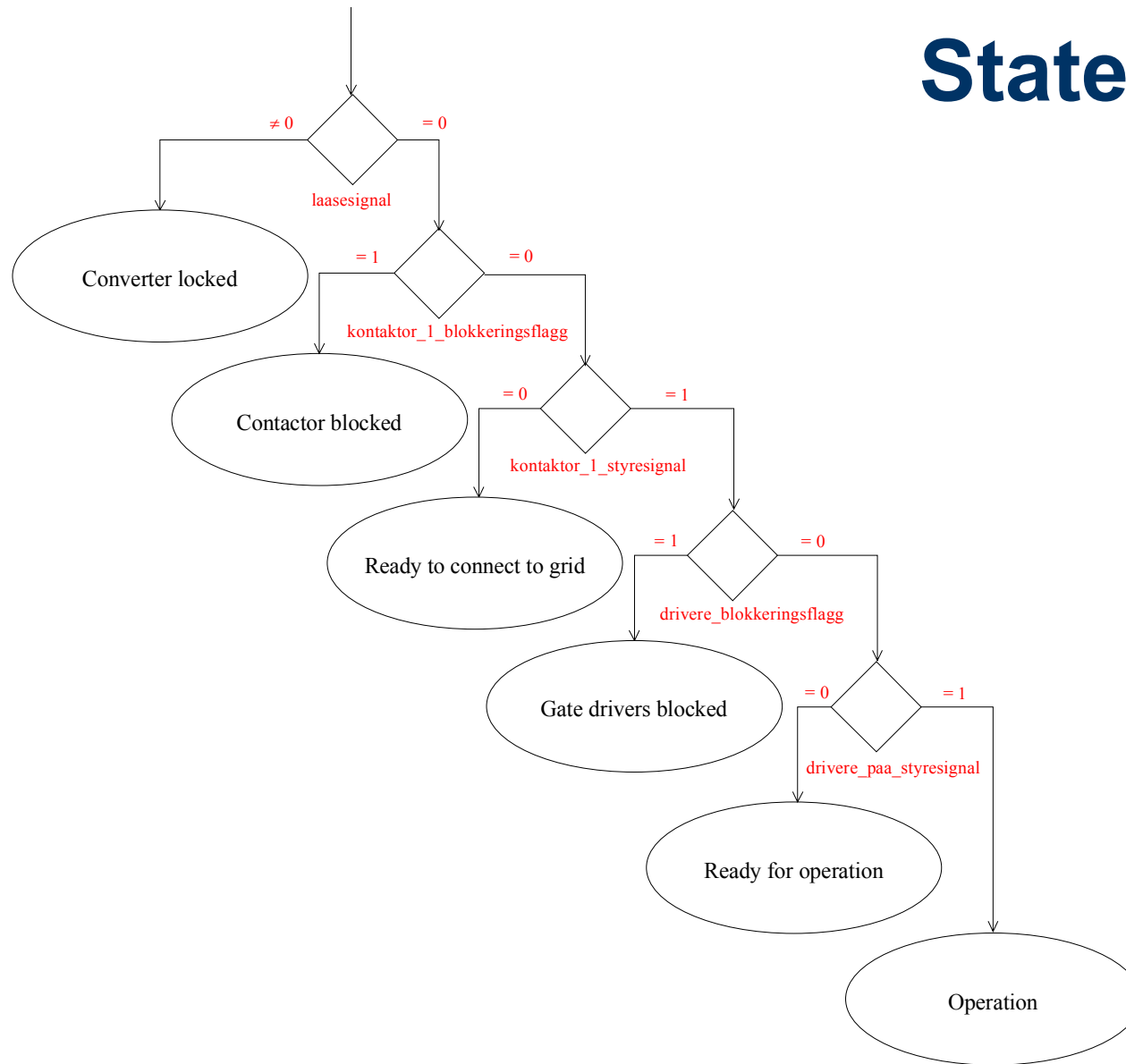
Controller top level block diagram

Example of details inside one of the top level block diagrams

⑨ **AC voltage controller**

State control

HEX Display status meassages

HEX	Operational state	Explanation
00	-	Error in status code detection system
01	Operation	Normal operation (no limiters active)
20	Operation	Reference for reactive output current has reached its limit
21	Operation	Reference for reactive input current has reached its limit
24	Operation	Reference for active output current has reached its limit
25	Operation	Reference for active input current has reached its limit
30	Operation	Output of AC voltage controller reached lower limit
31	Operation	Output of AC voltage controller reached upper limit
34	Operation	DC controller reached lower output limit
35	Operation	DC controller reached upper output limit
40	Operation	Phase locked loop controller reached lower frequency output limit
41	Operation	Phase locked loop controller reached upper frequency output limit
60	Ready for operation	Gate driver on-signal is 0 (unspecified reason)
61	Ready for operation	Gate driver on-signal is 0

NOTE: See memo for complete list

Controller parameters

Name of parameter	Typical value	Unit	Description
u_dc_link_maaling_full_skala	600	V or V/10	Defines which DC-link voltage that corresponds to 5 Volt input to A/D converter used for DC-link voltage measurement
dc_link_merkespenning	400	V or V/10	Base value for per unit system
u_dc_link_referanse_pot_top	500	V or V/10	Defines which DC-link voltage that corresponds to 5 Volt input to A/D converter used to input DC-link voltage reference
u_dc_link_reg_filtertidskonst	5	ms	Time constant of low pass filter applied to the input error signal of the DC-link controller
u_dc_link_reg_integraltid	30	ms	Integration time for the PI- error amplifier
u_dc_link_reg_forsterkning	200	1/100	Gain of PI-error amplifier

NOTE: See memo for complete list

Signal monitoring possibilities on DA-converter output

Variable names in Alphabetical order	DA_D_velger	Description
	-1	Minimum output of DA converter (-5.0V)
	0	Zero output to DA converter (0 V)
	1	Maximum output of DA converter (+5V)
aktiv_stromgrense	33	Active current limit
aktiv_stromgrense_filt	35	Active current limit filtered
aktiv_stromref	37	Active current reference
cos_stromref	31	Cosine input to inverse Park transform

NOTE: See memo for complete list

LED Signals

Colour of LED		Signal	Description
Green	🟢	kontaktor_1_styresignal = 1	Contactor 1 is on
Yellow	🟡	pll_grep = 1	Phase locked loop is in lock
Red	🔵	laasesignal ≠ 0	Converter locked
Blue-Green	🔵	er_i_gang_signal = 1	Converter is operating

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This memo describes the implemented control system for an active front-end converter. The control tasks are:

- A DC-link voltage controller that keeps the DC-link voltage equal to its reference (controls indirectly the active power flow)
- An AC-voltage controller that keeps the AC-voltage equal to its reference (controls indirectly the reactive power flow)
- The AC voltage controller can be disabled. An external reactive current reference then controls the reactive power flow.

Included in this memo are:
- Block diagrams of control system
- Illustration of the sequence / state control of the converter
- List of parameters to be specified
- List of available monitoring signals
- List of status messages with explanations
- Description of LED indicators

The documentation in this memo is intended to be used as a guide for the use of the converter and also as a needed documentation in order to be able to modify or model the converter controller.

This memo is no complete documentation of hardware and software.

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