UNITROL® 1020 User Manual

Automatic Voltage Regulator

Compact voltage regulator for synchronous machines
up to 20 A exciter current

Product Release 6.3xx

DSP Control: 6.3xx
MCU Control: 6.3xx
CMT1000: 6.3xx

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This document has been prepared and checked with great care. If however it still contains errors, please report them to ABB.

Table of Contents

Terms and Abbreviations

AC	Alternating Current
AIO	Analog Input and Output
AUTO	Automatic Voltage Regulation (Auto Mode)
AVR	Automatic Voltage Regulator
Bat	Battery
CAN	Controller-area network
CB	Circuit Breaker
MAIN	Main Channel in double channel systems.
CT	Current Transformer
DC	Direct Current
DIO	Digital Input and Output
ESD	Electrostatic Discharge
ETH	Ethernet Terminal
EXC	Excitation
FCB	Field Circuit Breaker
GEN	Generator
GFR	Ground Fault Relay (Rotor Ground Fault Protection)
HW	Hardware
IGBT	Insulated Gate Bipolar Transistor
MANUAL	Field Current Regulation (Manual Mode)
MCU	Microcontroller unit
PC	Personal Computer
PCB	Printed Circuit Board
PDF	Portable Document Format
PE	Protective Earth (Protective Ground)
PF	Power Factor Mode
PPE	Personal Protective Equipment
PS	Power Supply
PSS	Power System Stabilizer
PT	Potential Transformer
PWM	Pulse Width Modulation
Q	Reactive Power
RDM	Rotating Diode Monitoring
SW	Software
UMAUX	UM Auxiliary Input Measurement
VAR	Reactive Power Mode
V/Hz	Volt per Hertz (-Limiter)
VDC	Voltage Droop Compensation
VM	Voltage Matching

Chapter 1 - Introduction

1.1 General

The User Manual provides detailed information on the

- safety instructions
- description of the product,
- installation,
- commissioning & operation,
- maintenance and troubleshooting

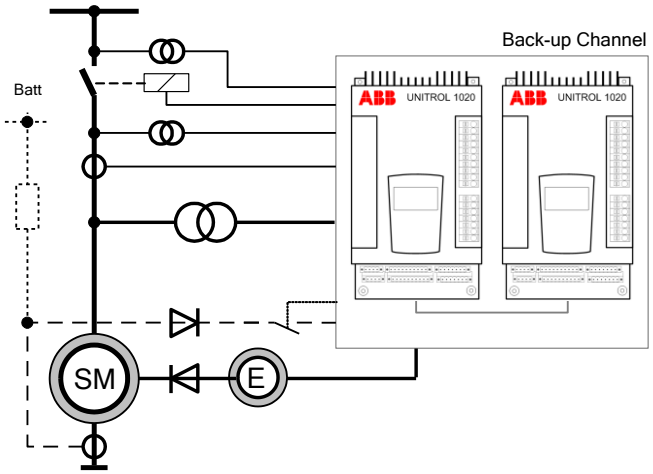
of the UNITROL 1020, including detailed descriptions of the functions and the hardware of the device. Technical data is included as well.

1.2 Field of Application

This advanced-design automatic voltage regulator is used for the excitation of indirectly excited synchronous machines and motors. The regulator can also be switched over to function as a reactive power-, power factor- or field current regulator.

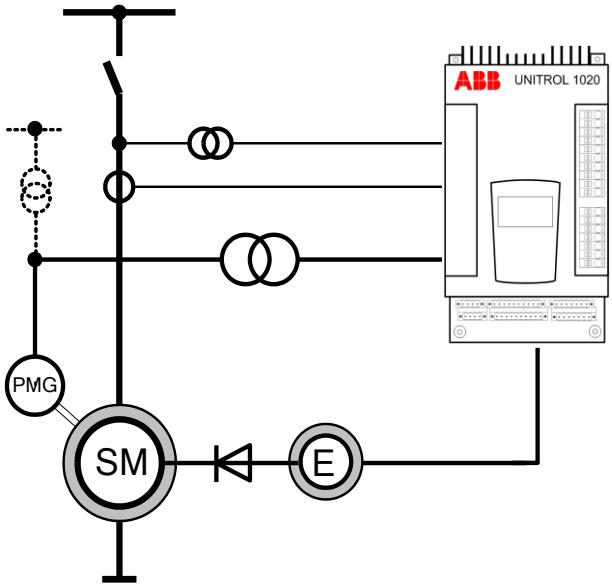
SM = Synchronous Machine
E = Exciter

Optional:
- Power System Stabilizer (PSS)
- Synchronization unit
- Data Logger
- Event Recorder



SM = Synchronous Machine
E = Exciter
PMG = Permanent Magnet Gen.

Generator or motor excitation with PMG or external supply.



1.3 Contents of this Manual

Chapter 1 - Introduction describes the contents of the User Manual and provides the manufacturer's information.

Chapter 2 - Safety Instructions explains the safety instruction levels and provides general instructions on safety, which need to be strictly observed.

Chapter 3 - Device Overview outlines the description of the device, operation modes, hardware capabilities and software features.

Chapter 4 - Installation and Storage provides information on environmental conditions to be maintained during transportation and storage, information on disposal and recycling of materials.

Chapter 5 - Commissioning provides information on preparing the device for commissioning.

Chapter 6 - Operation describes the instructions how to operate the device.

Chapter 7 - Preventive Maintenance contains the maintenance schedule and step-by-step instructions for specific maintenance tasks to be carried out by the customer.

Chapter 8 - Troubleshooting provides instructions on how to proceed when encountering problems.

Chapter 9 - Technical Data describes the technical data from the device, ordering number and parameter list.

1.4 Intended Audience

The User Manual addresses the following target groups:

- Engineering
- Installation personnel
- Operators
- Maintenance and repair personnel

1.5 Manufacturer's Address

If any questions arise, consult the local ABB representative or the manufacturer:

IMPORTANT!

When calling ABB, please leave your name, department and phone number. This will allow the responsible ABB representative to call back without delay.

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Chapter 2 - Safety Instructions

2.1 General

Chapter 2 - Safety Instructions includes the safety instructions that must be followed during installation, operation and maintenance of the excitation system. Please read all instructions carefully before operating the device and keep this manual for future reference.

2.2 Qualifications and Responsibilities

2.2.1 Qualifications and Responsibilities

Personnel involved in installation work and commissioning of the UNITROL 1020 must be familiar, specially instructed and informed about the residual danger areas according to the regulations currently in force.

Operating personnel are not permitted to work at the control system.

Specially instructed personnel must only carry out maintenance and repair work.

The maintenance personnel must be informed about the emergency shutdown measures and must be capable of turning off the system in case of emergency.

The maintenance personnel must be familiar with the accident prevention measures at their workplace and must be instructed in first aid and firefighting.

It is the owner's responsibility to ensure that each person involved in the installation and commissioning of the UNITROL 1020 has received the appropriate training or instructions and has thoroughly read and clearly understood the safety instructions in this chapter.

2.2.2 Consequences of Non-Compliance

Failure to comply with the safety instructions increases the risk of electric shock and damage to the equipment. Third parties who approach the installation are also at risk.

If the scheduled maintenance activities are performed only partially or not at all, damage may occur with associated expensive repair costs.

2.3 Safety Concept

2.3.1 General

The safety regulations in this chapter generally apply when working on the excitation system. You will find additional instructions and warnings related to particular topics or actions throughout the manual where relevant.

The following regulations must be strictly observed:

- The technical specifications and the typical application of the excitation system (see *Chapter 1 - Introduction, Field of Application)* must be strictly adhered to.
- Training of personnel: only trained personnel are allowed to install, operate, maintain or service the excitation system.
- Modifications without authorization: modifications and constructional changes of the equipment are not allowed.
- Duty of maintenance: The owner must ensure that the excitation system is used only under proper conditions and in a fully serviceable state.

2.3.2 Safety Rules

The following safety procedures according to EN 50110-1 must absolutely be followed if any (maintenance) work is carried out on the excitation system:

1 Disconnect completely.

2 Secure against re-connection.

3 Verify that the installation is dead.

4 Carry out grounding and short-circuiting.

5 Provide protection against adjacent live parts.

2.3.3 Residual Danger Areas

Danger areas that cannot be eliminated by technical measures are clearly marked with warning labels.

The operating voltage in the control cubicles is above 50 V. In the power part, voltages can reach 300 V ac and short-circuit currents can be very high. In order to warn personnel against opening the doors during operation, warning labels are affixed to all cubicle doors.

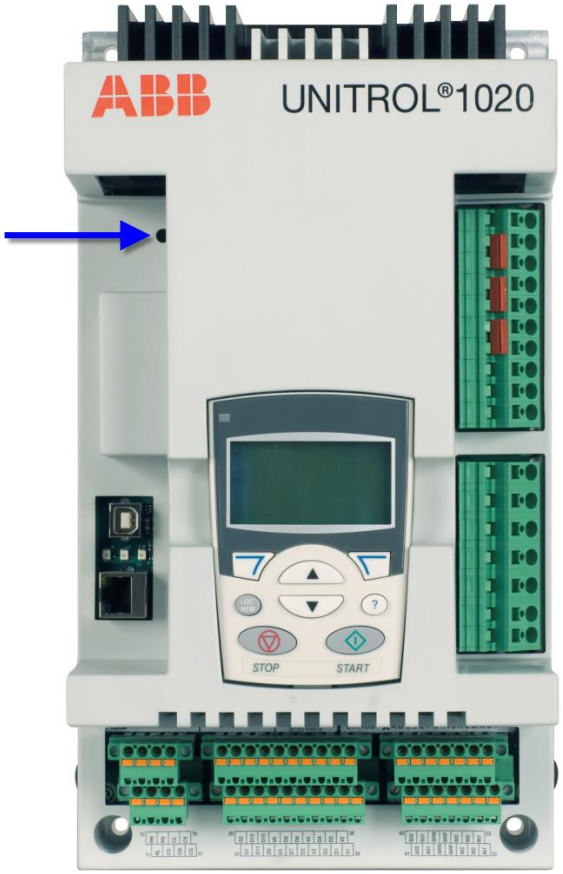
If the device is built into a whole system, other warning labels are attached to the inside of the cubicle doors and to the covers of the power converter modules.

The following residual danger areas must be taken into account when working on the excitation system:

- Danger from live equipment inside the excitation system, if the protective covers are removed.
- Hazardous voltage from the rotor field winding and the secondary side of the excitation transformer.
- Capacitors may still be charged if a power converter cubicle door is opened immediately after stopping the system.
- Danger from main and auxiliary voltages in cubicles when cubicle doors are open.

Attention must be paid when installing / replacing the UNITROL 1020. The unit has large capacitors, which might be charged even after disconnecting the unit.

An orange blinking LED warns the user in case the internal voltage exceeds 30 V dc. Depending on the size of the capacitor, discharging can take a couple of minutes. **Do not connect or disconnect the unit when the LED is still blinking. There is the risk of electric shock.**



2.4 Safety Regulations

2.4.1 Structure of Safety Instructions

	Signal Word!
Symbol	Situation - Type of Hazard Statement
	Possible consequence - Consequence Statement
	Essential safety measure - Avoidance Statement

The safety instructions always appear at the beginning of each chapter and/or precede any instruction in the context where a potentially dangerous situation may appear. The safety instructions are divided into five categories and emphasized by the use of the following layout and safety signs:

DANGER!

This symbol indicates an imminent danger resulting from mechanical forces or high voltage. Non-observance leads to life-threatening physical injury or death.

WARNING!

This symbol indicates a dangerous situation. Non-observance can result in bad or life-threatening physical injury or death.

CAUTION!

This symbol indicates a dangerous situation. Non-observance can lead to physical injury or cause damage to the installation.

NOTICE!

This symbol emphasizes important information. Non-observance can cause damage to the installation or to objects close to it.

IMPORTANT!

This symbol indicates useful information. Not to be used to indicate dangerous situations.

2.5 Instructions for Emergency Situations

2.5.1 *Firefighting*

All personnel must be familiar with the location of fire extinguishers and emergency exits and must be able to operate the fire extinguishers.

Fire extinguishers are carbon dioxide (CO_2) or foam-based.

- **CO_2 fire extinguishers** are intended for fighting fires in electrical installations and may not be directed at persons.
- **Foam extinguishers** are intended for fighting fires in non-electrical equipment. They may be directed at persons but must not be used for extinguishing fires in electrical equipment.

DANGER!

In case of fire,

Be aware of voltage, toxic gases, overheating.

See the instructions below.

1. Shut down the system.

   Operators must be familiar with the emergency shutdown sequence.
2. Put on a protection mask.
3. Use only CO_2 to extinguish the fire, no foam, no water.

2.5.2 *First Aid Measures for Electrical Installations*

In case of an emergency, follow the instructions below:

DANGER!

A person is in contact with electricity.

There is a danger of electric shock for the first aider as well.

Do not touch the person until the system is grounded.

1. Shut down the plant.

   Operators must be familiar with the emergency shutdown sequence of the system.

DANGER!

Residual voltage of the rotating machine is present immediately after shut-down of the system.

There is a danger of electric shock.

Wait until the system is grounded.

1 Switch off all power supplies and ground the system.

2 Remove the injured person from the dangerous location.

3 Provide first aid for electric shock.

4 Call for emergency assistance.

2.5.3 *Pacemaker*

DANGER!

Electrical and magnetic fields.

The system can cause malfunction of pacemakers.

Avoid being close to the excitation system.

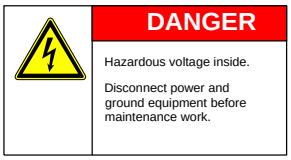
Electrical and magnetic fields can influence pacemakers. It is difficult to predict the general sensitivity of pacemakers.

2.6 Danger signs

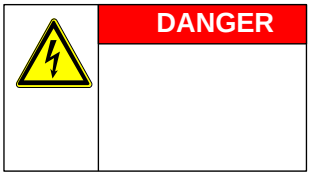
Danger signs are attached to any equipment/location with a potential danger.

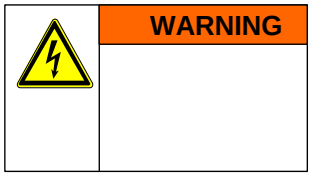
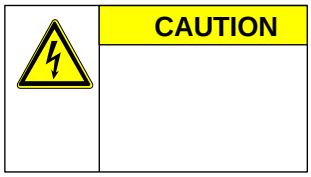
The degree and likelihood of such dangers are described by the signal words DANGER, WARNING and CAUTION. The content of the warning sign contains information about the respective situation and the preventive safety measures that must be taken.

Structure of danger signs:

Sign	Description
	Signal word Situation Essential safety measures

Meaning of signal words and consequence statement:

Sign	Description of the signal word
	DANGER, electrical This symbol indicates imminent danger that will result in life-threatening physical injury or death.

	WARNING, electrical This symbol indicates a possible dangerous situation that could result in serious physical injury or death.
	CAUTION, electrical This symbol indicates a possible dangerous situation that could result in moderate physical injury. This signal word can also be used for warnings related to equipment damage.

Chapter 3 - Device Overview

3.1 General

Chapter 3 - Device Overview provides the technical data of the device.

This chapter contains:

- Hardware description
- Operation modes and software features
- Parameter description

3.2 Description of the Excitation System

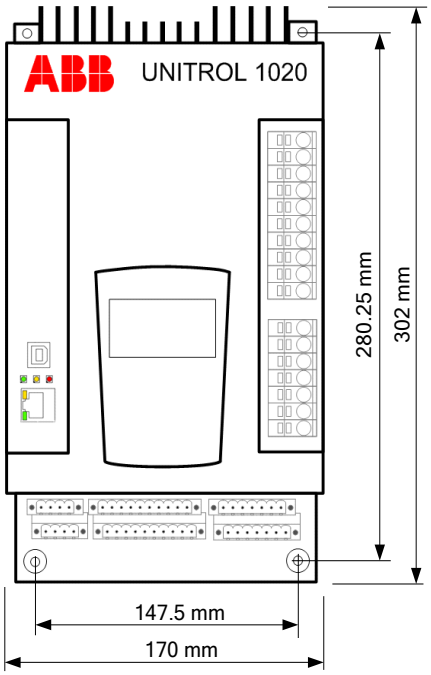
UNITROL 1020 is an automatic voltage regulator of the latest design for synchronous generators and synchronous motors. The unit contains the most advanced microprocessor technology together with IGBT semiconductor technology (Insulated Gate Bipolar Transistor).

The mechanical construction is extremely compact and robust.

UNITROL 1020 operations are effected through a practical and simple-to-operate panel on the unit. In addition, user-friendly software facilitates commissioning and allows optimization of operation.

The UNITROL 1020 unit can be connected to a 40 A Power Module called UNITROL 1000-PM40. For further information refer to the separate User Manual.

3.3 Hardware



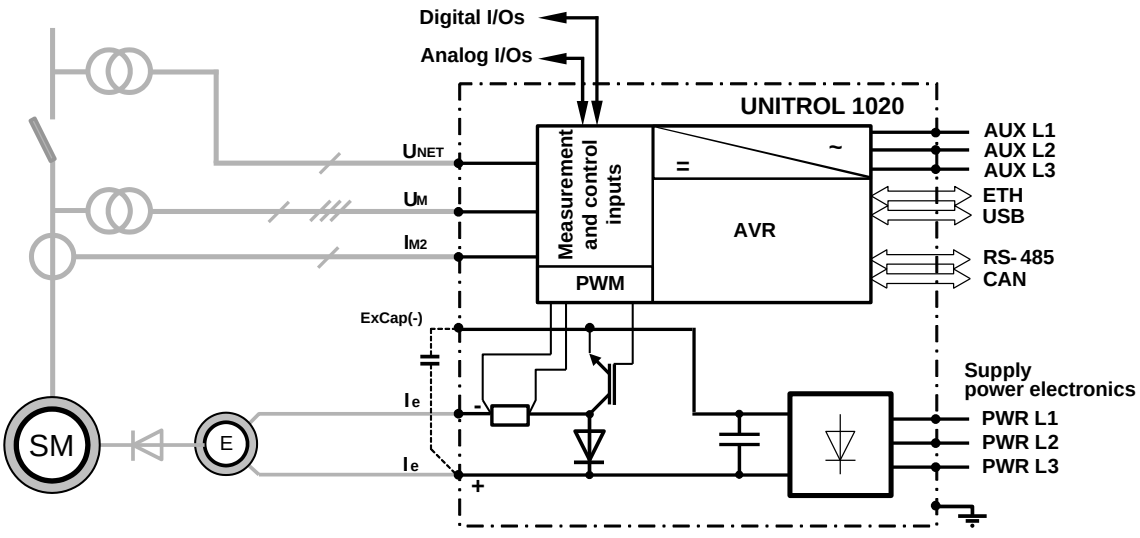
Casing
The device's base is an aluminum back plane. Cooling is done by the main heat sink on top of the device. The unit itself is covered with plastic and provides an IP20 protection.

Power electronics
The power part is fitted with an IGBT semi-conductor. The average value of the output voltage is always positive. The output is current-limited and thus short-circuit-proof.

Control elements
The display panel and connectors for the USB and Ethernet interface are located on the unit cover.

Installation
The site of installation must be dry and free of dust.

3.3.1 Connection Diagram



3.3.2 *Control Interfaces*

The UN1020 device can be operated and controlled in different ways as described in the rest of this section.

3.3.2.1 Digital and analog IO

The UN1020 can be controlled by means of digital and analog inputs and can therefore set up several configurations to fulfill most target applications. Digital and analog IO has highest priority and cannot be overridden by any other controls.

3.3.2.2 Keyboard and Panel Display

The 4-line display and the 8 keys allow full operation.

All settings can be carried out directly on the unit without additional equipment:

- Configuration of inputs and outputs
- Parameter setting
- Display of important measuring values.

The operation of the Panel is described in detail in section *6.3 Panel Operation*.

3.3.2.3 Remote Access using MODBUS protocol

The Remote Access feature allows device access and control from local or remote locations by using MODBUS as application protocol. The communication can be performed either via RS485 or Ethernet. More information about the connection possibilities can be found in Chapter *3.3.9 - Communication Ports*.

Basic features and advantage of Remote Access

- Configuration of parameters and I/O signals.
- Measurement reading.
- Setpoint adjustment and PID tuning.
- Possibility to create a custom application that uses Remote Access to fully control the device.
- Monitor only and full control possible.

The Remote Access feature is fully interoperable with the CMT1000 software; both interfaces can access and read from the device at the same moment. Control permission (write parameters) is handled automatically by the AVR microcontroller. The Remote Access feature is described in detail in *Chapter 3.4.6 - Modbus for Remote Access.*

3.3.2.4 Terminal Blocks

The terminal blocks are separated regarding their functions, see following figure.

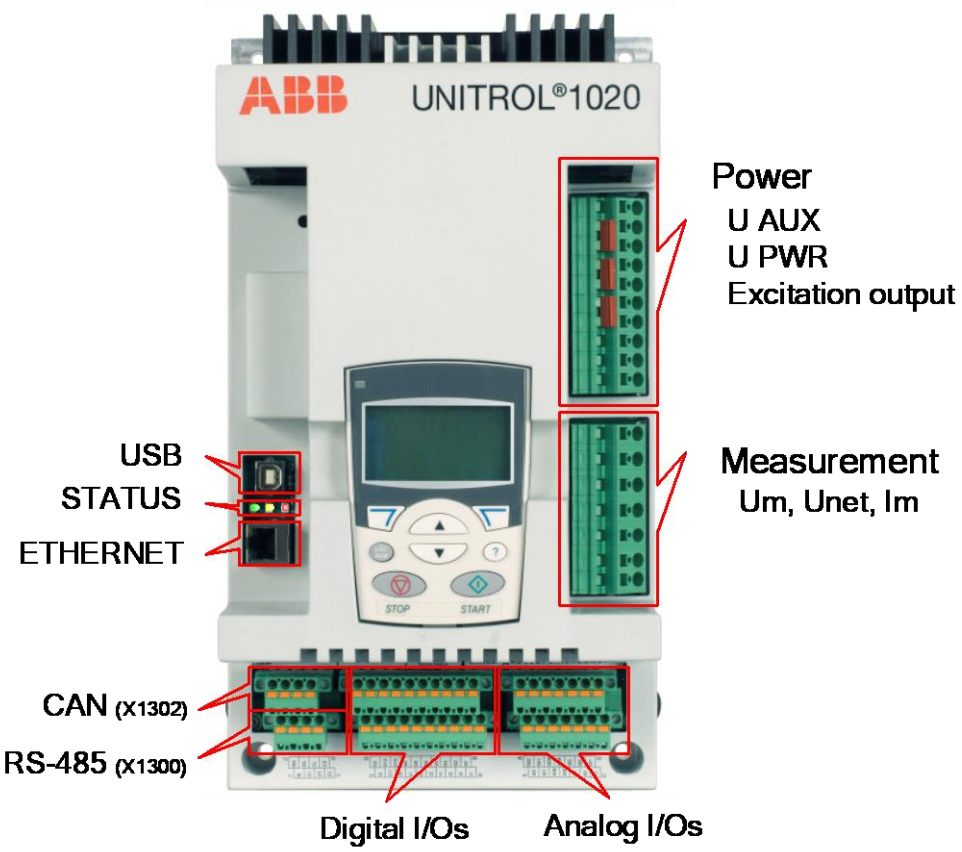
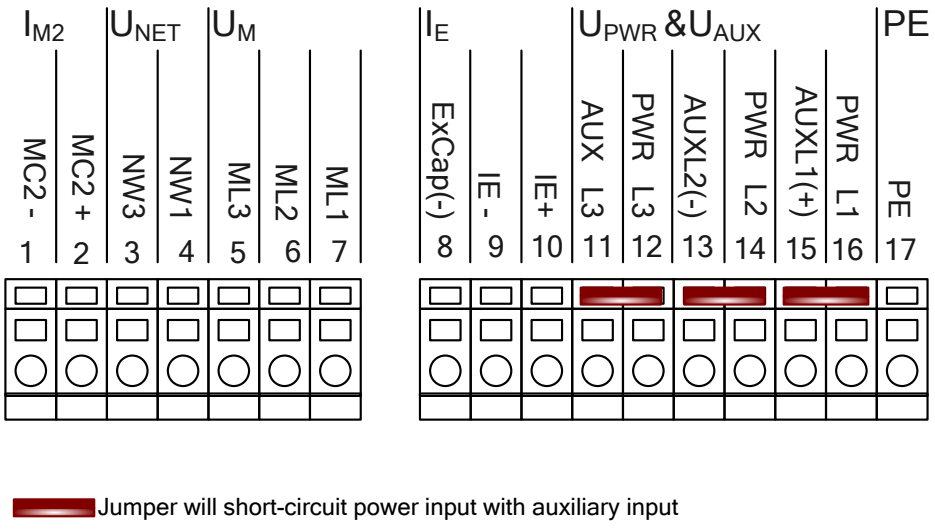
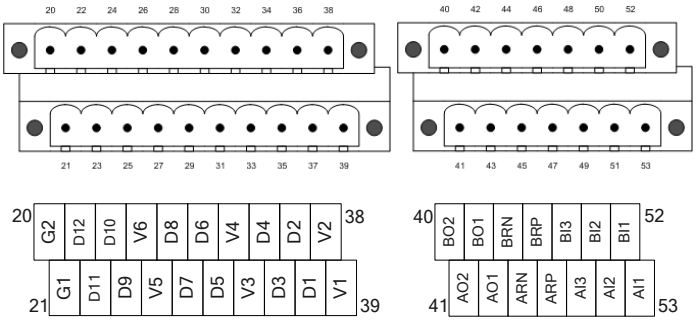


Figure 3-1Terminal Block of UN1020



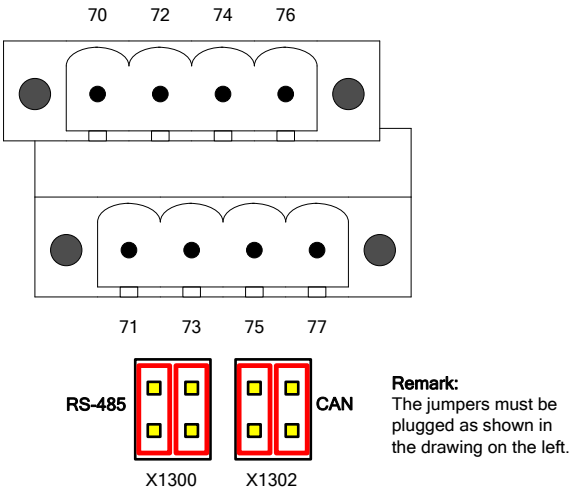
Ref.	Label	Signal Description
1	MC2-	Machine Current -
2	MC2+	Machine Current +
3	NW3	Network L3
4	NW1	Network L1
5	ML3	Machine L3
6	ML2	Machine L2
7	ML1	Machine L1
8	ExCap(-)	External Capacitor -
9	IE -	Exciter Current -
10	IE +	Exciter Current +
11*	AUX L3	Power Supply L3
12*	PWR L3	Main L3
13*	AUX L2(-)	Power Supply L2 (-)
14*	PWR L2	Main L2
15*	AUX L1(+)	Power Supply L1 (+)
16*	PWR L1	Main L1
17	PE	Protection Earth

*Jumpers can be used to shorten excitation power input with control power Uaux input in order to reduce wiring

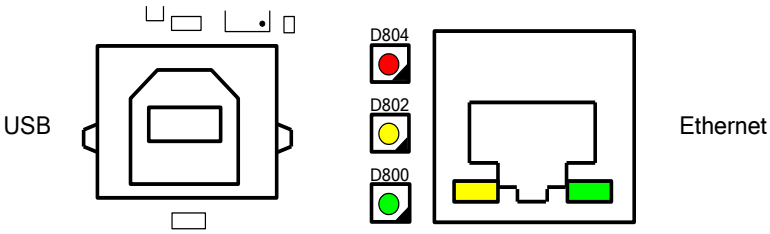


	Ref.	Label	Signal Description
Digital IO Terminal	20	G2	GND
	21	G1	GND
	22	D12	Digital Input 12
	23	D11	Digital Input 11
	24	D10	Digital Input 10
	25	D9	Digital Input 9
	26	V6	24V Power
	27	V5	24V Power
	28	D8	Digital Input / Output 8
	29	D7	Digital Input / Output 7
	30	D6	Digital Input / Output 6
	31	D5	Digital Input / Output 5
	32	V4	24V Power
	33	V3	24V Power
	34	D4	Digital Input / Output 4
	35	D3	Digital Input / Output 3
	36	D2	Digital Input / Output 2
	37	D1	Digital Input / Output 1
	38	V2	24V Power
	39	V1	24V Power
	Ref.	**Label**	**Signal Description**
Analog IO Terminal	40	BO2	GND Analog Output 2
	41	AO2	Analog Output 2
	42	BO1	GND Analog Output 1
	43	AO1	Analog Output 1
	44	BRN	GND Negative Reference
	45	ARN	-10V Negative Reference
	46	BRP	GND Positive Reference
	47	ARP	+10V Positive Reference

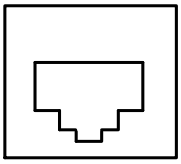
Analog IO Term.	48	BI3	Analog Input 3 –
	49	AI3	Analog Input 3 +
	50	BI2	Analog Input 2 –
	51	AI2	Analog Input 2 +
	52	BI1	Analog Input 1 –
	53	AI1	Analog Input 1 +



	Ref.	Label	Signal Description
RS-485 / CAN Terminal	70	RH	RS-485 +
	71	CH	CAN High
	72	RS	RS-485 shield
	73	CS	CAN Shield
	74	RL	RS-485 -
	75	CL	CAN Low
	76	CV	CAN Power 5V
	77	CG	CAN GND



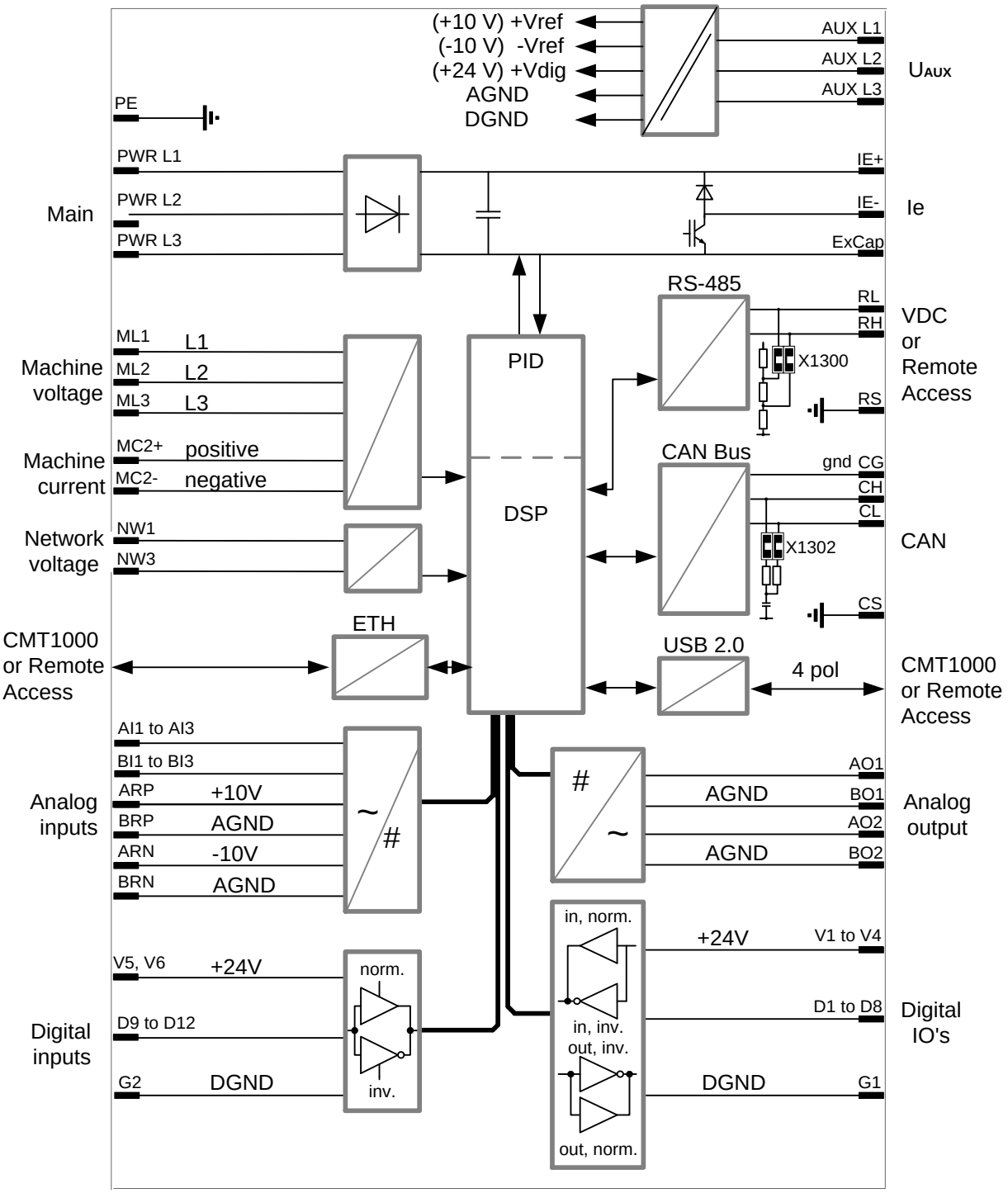
	Pin	Label	Signal Description
Ethernet	1		Transmitter +
	2		Transmitter –
	3		Receiver +
	4		Do not use [connected to magnetics]
	5		Do not use [connected to magnetics]
	6		Receiver –
	7		Do not use [connected to magnetics]
	8		Do not use [connected to magnetics]
	LED	**Green**	ETH Link OK
	LED	**Yellow**	ETH Data Traffic
	Ref.	**Label**	**Signal Description**
USB	1		USB Power 5V
	2		Data -
	3		Data +
	4		GND
	Ref.	**Color**	**Description**
Status LEDs	D800	Green	Power ON status ON: DSP and MCU is powered Blinking: Target SW is running
	D802	Yellow	Excitation ON, Blinking: Limiter active
	D804	Red	Device status ON: Alarm or trip active Blinking: Startup failure, target could not load parameters Excitation output is blocked Save parameter to EEPROM first before starting excitation



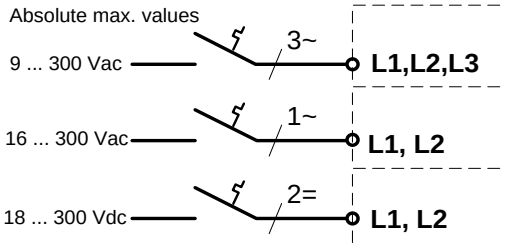
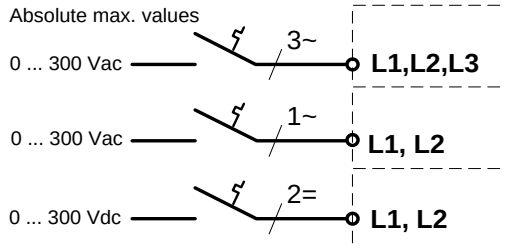
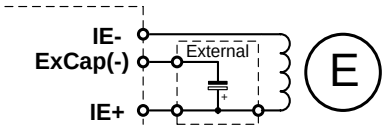
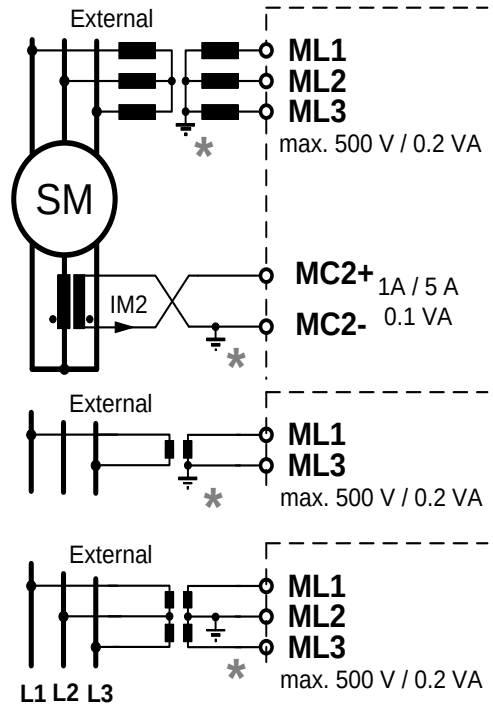
RS232
on
RJ45

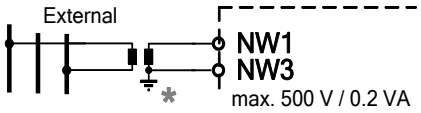
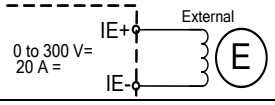
Panel connector	*Key board panel can be mounted inside front panel. Following additional equipment can be ordered:* ***Door mouning kit:*** OPMP-01-Kit: Mounting Cabinet Panel ACS 3AUA0000013086 ***RJ45 cables:*** RJ45 CAT 5e SF/UTP, gray 1,5 meter 3BHE027825R0150 RJ45 CAT 5e SF/UTP, gray 3.0 meter 3BHE027825R0300

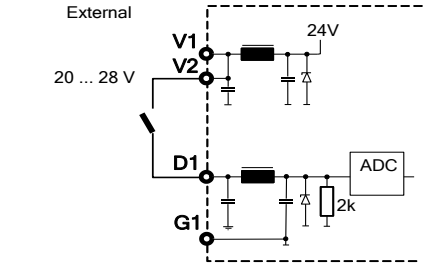
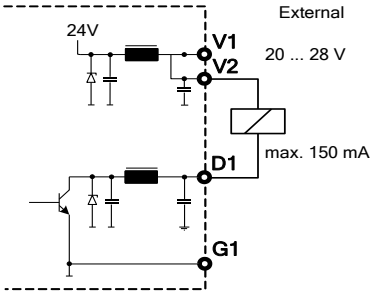
3.3.3 *Block Diagram*



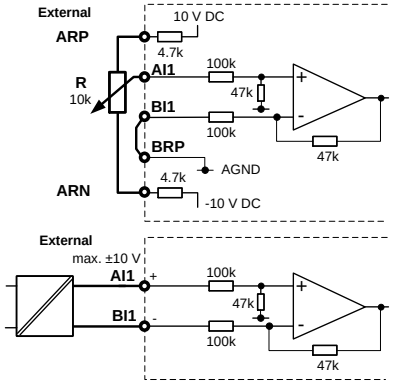
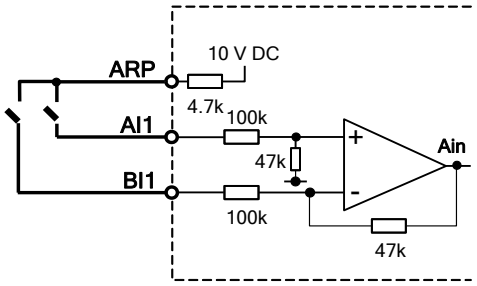
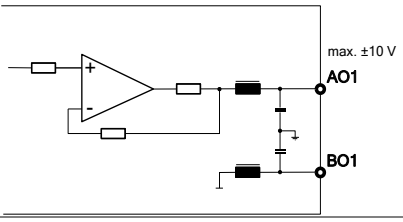
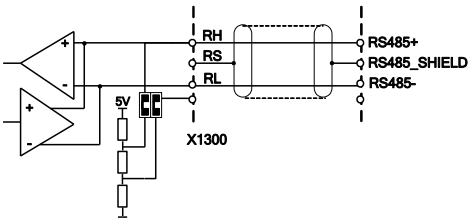
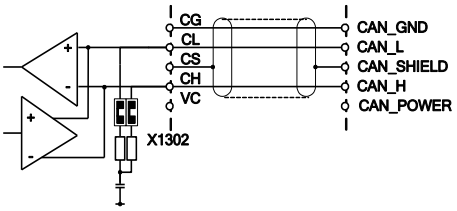
3.3.4 *Device Connectors*

Terminal designation	*Signal*	*Circuit*
15 = AUX L1 13 = AUX L2 11 = AUX L3	Auxiliary Power Supply U_{AUX} - Auxiliary Power Supply L1 (+) - Auxiliary Power Supply L2 (-) - Auxiliary Power Supply L3	
16 = PWR L1 14 = PWR L2 12 = PWR L3	Power Electronics Supply U_{PWR} - Main L1 - Main L2 - Main L3 Remark: Max inrush current (average) must not exceed 200 A within 10ms (See chapter *4.5.1*).	
8 = ExCap(-)	External Capacitor Capacitor: 1000 µF, 450 V Types: PEH200YK410TM PEH169YO4100M Requirements: min. Voltage: >=450 V Temp. Range: -40...85 °C Oper. lifetime at 85 °C: >5000 h Rip. curr. at 100 Hz at 85 °C: >5 A ESR 20 °C 100 Hz: <120 mOhm	 **Wiring must be within 0.1 Ohm and 0.5uH in series** **Warning:** ***Reverse polarity of external capacitor will damage device***
7 = ML1 6 = ML2 5 = ML3 2 = MC2+ 1 = MC2- 7 = ML1 5 = ML3 7 = ML1 6 = ML2 5 = ML3	Machine Voltage three-phase U_M - Machine L1 - Machine L2 - Machine L3 **Warning:** If Um > 250 Vac, then the starpoint must be connected to PE Machine Current single-phase I_{M2} - Machine Current + - Machine Current - Machine Voltage single-phase U_M - Main L1 - Main L3 Machine Voltage three-phase with ground U_M - Machine L1 - Machine L2 - Machine L3 *PT & CTs ***must be grounded***	
	Line Voltage measurement single-	

4 = NW1 3 = NW3	phase U_{NET} Network L1 Network L3 *PT & CTs **must be grounded***	
10 = IE + 9 = IE -	Excitation Current Output Ie - Exciter Current + - Exciter Current -	
17 = PE	Protection Earth	

Terminal Designation	Signal	Circuit
	Digital input / output	
37 = D1	Digital Input / Output 1	
36 = D2	Digital Input / Output 2	
35 = D3	Digital Input / Output 3	
34 = D4	Digital Input / Output 4	
31 = D5	Digital Input / Output 5	
30 = D6	Digital Input / Output 6	
29 = D7	Digital Input / Output 7	
28 = D8	Digital Input / Output 8	
	Caution: Configured as outputs, DIO1 … DIO8 must not be connected directly with 24 V Power (causes short circuit via internal transistor)	
	24V Power	
39 = V1	24V Power	
38 = V2	24V Power	
33 = V3	24V Power	
32 = V4		
	GND	
20 = G2	GND	
21 = G1		
	Digital input only	
25 = D9	Digital Input 9	
24 = D10	Digital Input 10	
23 = D11	Digital Input 11	
22 = D12	Digital Input 12	
27 = V5	24V Power	
26 = V6	24V Power	
20 = G2	GND	

Note: The internal 24 V supply (V1 to V6) can be loaded with **a maximum of 600 mA** by all used digital inputs and outputs.

Terminal Designation	Signal	Circuit
53 = AI1, 52 = BI1 51 = AI2, 50 = BI2 49 = AI3, 48 = BI3 47 = ARP 45 = ARN BRP = 46 BRN = 44	<u>Analog Inputs</u> AIx/BIx Signal bandwidth 100Hz +10 V pos Ref -10 V neg Ref GND Positive Reference GND Negative Reference R = 10kOhm (+-5V input range)	
53 = AI1, 52 = BI1 51 = AI2, 50 = BI2 49 = AI3, 48 = BI3	<u>Analog Inputs digitally assigned</u> AIx/BIx see Chapter *3.3.7 - Analog Inputs*	
43 = AO1 41 = AO2 42 = BO1 40 = BO2	<u>Analog Outputs</u> AOx to BOx (AGND = BO1, BO2) Max. output current: 10mA	
72 = RS 70 = RH 74 = RL	<u>Serial interface RS-485</u> RS-485_SHIELD RS-485 + RS-485 – Two jumpers X1300 for the bus terminating resistor. Jumpers must be placed at both ends of the bus	
77 = CG 75 = CL 73 = CS 71 = CH See terminals	<u>CAN Bus</u> CAN_GND CAN_L CAN_SHIELD CAN_H Two jumpers X1302 for the bus terminating resistor. Jumpers must be placed at both ends of the bus	

3.3.5 *Digital Inputs*

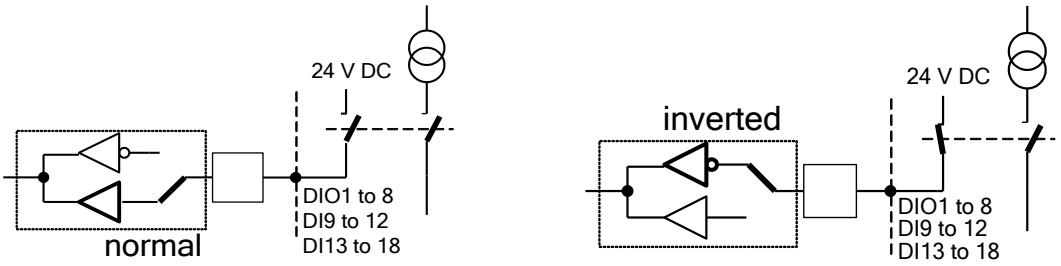
<table>
<tr><th>Input Function</th><th>Description</th></tr>
<tr><td>None</td><td>Input not assigned</td></tr>
<tr><td>Excitation ON active</td><td>Excitation ON command active:
- Field flashing begins if Off Level > 0%
- Auto mode: Soft start begins after the Off Level has been reached, and rises up to the Auto Initial Setpoint.
- Other modes: Initial Setpoint is used.</td></tr>
<tr><td>Excitation ON not active</td><td>Excitation ON command not active:
All setpoints are immediately set to their initial values and remain fixed there (see table on the right).
Auto, Manual and Open loop Initial setpoints can be changed from there
<table>
<tr><th>Mode</th><th>Initial Setpoint</th></tr>
<tr><td>Auto</td><td>100%</td></tr>
<tr><td>Manual</td><td>0%</td></tr>
<tr><td>Open Loop</td><td>0%</td></tr>
<tr><td>PF</td><td>1.0</td></tr>
<tr><td>Var</td><td>0%</td></tr>
</table></td></tr>
<tr><td>Gen CB Closed Status active</td><td>Circuit-breaker closed status active:
- Activates current measurement
- This message immediately triggers the ramp of the Soft start as if still the hold time.</td></tr>
<tr><td>Gen CB Closed Status no longer active</td><td>Circuit-breaker closed status changes from active to not active. All setpoints are immediately set to the following values:
<table>
<tr><th>Mode</th><th>Final Value</th></tr>
<tr><td>Manual</td><td>90% Ie No Load</td></tr>
<tr><td>Open Loop</td><td>90% 1/Kceil</td></tr>
<tr><td>Auto</td><td>100%</td></tr>
</table></td></tr>
<tr><td>Parallel with Grid Status</td><td>Parallel with grid status active:
- With Gen CB Closed, enables changeover to PF and Var modes.
- Disables VDC mode.
Connecting unit parallel with grid action:
Depending on Parameter “Enable PF/VAR initial SP”, SP before parallel with grid status is taken over or SP is changed to initial value.
Disconnecting unit from grid action:
Depending on the parameter “Loose grid go to initial SP”, AUTO SP is taken from the initial SP instead of keeping the same operation point.</td></tr>
<tr><td>Increase</td><td>Increase setpoint of active regulator</td></tr>
<tr><td>Decrease</td><td>Decrease setpoint of active regulator</td></tr>
<tr><td>Reset Setpoint</td><td>Status reset setpoint is active:
The setpoint of the active regulator goes to the following value at ramp speed:

Depending on parameter “Reset SP to initial value”, SP of defined final values or initial values are taken over
<table>
<tr><th>Mode</th><th>Final Value</th></tr>
<tr><td>Manual</td><td>Ie No Load</td></tr>
<tr><td>Open Loop</td><td>100% 1/Kceil</td></tr>
<tr><td>PF</td><td>1.0</td></tr>
<tr><td>Var</td><td>0%</td></tr>
<tr><td>Auto</td><td>100%</td></tr>
</table></td></tr>
<tr><td>Remote SP Enable</td><td>When active it enables the setpoint adjustment from an analog input (remote setpoints should be configured in the Analog Input section).</td></tr>
<tr><td>PF Enable</td><td>Activates Power factor regulation. (Requires the PF/VAR SW)</td></tr>
<tr><td>Var Enable</td><td>Activates Reactive power regulation. (Requires the PF/VAR SW)</td></tr>
<tr><td>Manual Enable</td><td>Activates Manual operation mode (field current regulation).</td></tr>
<tr><td>Open Loop Enable</td><td>Open loop, direct control of power transistor active</td></tr>
<tr><td>Synchronize</td><td>Activates Synchronization or Voltage Matching: If Synchronization SW (optional) is not available in the device, the input signal will activate Voltage Matching only. (Requires Synchronization SW)</td></tr>
<tr><td>VDC Enable</td><td>Activates the Voltage Droop Compensation (VDC) control mode. (Requires Voltage Droop Compensation (VDC) SW)</td></tr>
</table>

Input Function	*Description*
Secondary Net 1	Selects the Secondary Net for VDC operation. Binary coding to select 4 net IDs or left side breaker in ring structure. *(Requires Voltage Droop Compensation (VDC) SW)*
Secondary Net 2	Selects the Secondary Net for VDC operation. Binary coding to select 4 net IDs or left side breaker in ring structure. *(Requires Voltage Droop Compensation (VDC) SW)*
Reset Alarm	Clear the following alarms: *(Requires Double Channel SW)* - Supervision Alarm 1 and 2 - Supervision Trip - Switch over - Monitor Alarm 1 and 2
Standby	When the AVR is in Standby mode: - The excitation output of the AVR is turned off - Boost is disabled - Field flashing is off - Integrator is kept in 1/Kceiling - All limits are disabled - No VDC data is transmitted via RS-485. - The AVR displays Standby as Operation Mode. - DCH Follow-up[1] operates, only if DCH communication is active; otherwise the Channel Follow-up operates instead. For more information see Chapter *3.4.4.4.8 - DCH Follow-Up* and *3.4.1.5 - Channel Follow-up*. - Alarm and Trip statuses[1] output their values via digital outputs only if they are configured to behave like that. For more information see Chapter *3.4.4.4.2 - DCH Supervision*.
RC Fieldbus Block	It disables the Fieldbus communication in local operation. All control registers are reset to default, excitation is switched off if controlled over Modbus *(Requires Modbus Option)*
FCB closed Status	Field circuit breaker closed status active.
External Alarm	Input to use as External Alarm input.
EmergencyExcitationOff	Excitation OFF command, overwrites Excitation ON input and Modbus control input
PSS enable	Enables PSS. In case digital IO is selected, PSS is blocked when digital input is not activated *(Requires PSS Option)*
Gain Reduction	Reduces the gain of PID tuning (AUTO and PF/VAR) by factor 2
Sync Dead Bus Enable	Enables dead bus synchronization, Unet < 5%
Synchrocheck	Enables synchrocheck function, voltage matching is disabled
Unload VAR	Regulates VAR to 0, command must be activated until VAR reaches 0
Line Charging	Second parameter set for soft start, activated with new digital input "Line Charging"

3.3.5.1 Polarity

Polarity can be configured for all digital input/output ports separately, and each one has a separate polarity configuration when configured as input or output. Each DIO port can be configured as only input or only output at the same time.



3.3.5.2 Forcing Digital Input Signals

Each digital input signal can be set to a predefined value (i.e. active/not active) by means of configuration, without the need to make connections at the device's terminals; this process is also known as *forcing*.

Forcing a digital input terminal can be done by configuring the Polarity parameter of an input to Normal or Inverted. When Polarity is set to Normal, the digital input is set to not active, i.e. false or logical 0. When it is set to Inverted, the input is set to active, i.e. true or logical 1. The digital input which is being configured, must not be wired at the device terminals. For more information about configuration see *Chapter 6 - Operation*.

3.3.6 *Digital Outputs*

Output Function	***Description***
None	Output not assigned
Boost	Status signal boost is active Boost supports excitation in the event of line short circuit or heavy load. The boost function is blocked during field flashing and Soft start.
Field Flashing See section *3.4.2.2*	Field flashing (voltage build up) active, if Excitation ON. The next field flashing can only be started after Excitation ON or after the power has been switched off. During field flashing the output of the regulator is blocked in all operation modes.
System OK	Reserved signal, do not use
Limit Active	One of the limiters (V/Hz, Ie, PQ, UM or Im) is active or setpoint limit has been reached (min. or max. position)
V/Hz Limit Active	V/Hz limiter active
SP Limit Reached	Setpoint limit has been reached
SP Minimum Reached	Minimum setpoint has been reached
SP Maximum Reached	Maximum setpoint has been reached
Operational Limit Active	Ie, PQ, UM, Im limiter or Diode Alarm active
Min Ie Active	Ie minimum current limiter active
Max Ie Active	Ie maximum current limiter active
Min PQ Active	PQ limiter active
Min UM Active	Limit value for minimum machine voltage is under-run, voltage limiter active
Max UM Active	Limit value for maximum machine voltage is exceeded, voltage limiter active
Voltage Relay	Active = machine voltage below boost threshold Inactive = boost threshold plus hysteresis exceeded Not dependent on signal Excitation ON.
Close CB Command	The command is released:

Output Function	*Description*
(Requires Synchronization SW)	- Angle is in a value where it would take the Total CB Closing Time for the breaker to close at zero degrees with current speed and acceleration. - Sync Check demand active - The command is active as long as the command Sync Check is active
Sync Check *(Requires Synchronization SW)*	Sync Check demand to be active: - Generator circuit breaker is open - Machine voltage is higher than 50% - Synchronization is possible (unit with Sync-Option) - Synchronize is enabled - Slip is between minimum slip and maximum slip - Machine voltage is deviating from network voltage maximum Delta U - Angle is between -maximum delta angle and +maximum delta angle
Sync Speed increase	Control signal to governor to increase speed, pulses *(Requires Synchronization SW).*
Sync Speed decrease	Control signal to governor to decrease speed, pulses *(Requires Synchronization SW).*
Switch Over	Control signal to 2nd channel to take over control *(Requires Double Channel SW).*
Supervision Trip	Trip indication, depending on the activated monitor functions *(Requires Double Channel SW)*
Supervision Alarm 1	Alarm indication, depending on the activated monitor functions *(Requires Double Channel SW)*
Supervision Alarm 2	Alarm indication, depending on the activated monitor functions *(Requires Double Channel SW)*
Monitor Alarm 1	Alarm indication, depending on the activated monitor functions *(Requires Double Channel SW)*
Monitor Alarm 2	Alarm indication, depending on the activated monitor functions *(Requires Double Channel SW)*
Diode Alarm	Event of open diode *(Requires Rotating Diode Monitoring SW)*
Diode Trip	Event of a shorted diode *(Requires Rotating Diode Monitoring SW)*
PSS Active	Indication that PSS is contributing *(Requires PSS SW)*
Close FCB Command	Close command for FCB
Open FCB Command	Open command for FCB
FRT Detection	Fault ride through indication (Sudden voltage dip at network)
ExcON status	Indication that Excitation is ON
Softstart Active	Indication that Softstart is still active (ramping up of the SP)
Manual Active	Indication that Manual mode is active
PF VAR Active	Indication that PF/VAR mode is active

3.3.6.1 Polarity

Polarity can be configured for all digital input/output ports separately, and each one has a separate polarity configuration when configured as input or output. Each DIO port can be configured as only input or only output at the same time.

3.3.6.2 Forcing Digital Output Signals

Each digital output can be forced for test purposes by inverting its polarity. This will even work when no output signal is selected.

3.3.7 *Analog Inputs*

Input Function	*Description*
None	Input not assigned
Auto Remote Setpoint	External setpoint input to Auto regulator
PF Remote Setpoint *(Requires PF/VAR SW)*	External setpoint input to PF regulator
Var Remote Setpoint *(Requires PF/VAR SW)*	External setpoint input to Var regulator
Manual Remote Setpoint	External setpoint input to Manual regulator
Open Loop Remote SP	External setpoint input to open loop
UM Aux *(Requires UM AUX SW)*	Auxiliary supply to the summing point of Auto regulator
VAR Aux Measurement	Auxiliary supply to the summing point of the PF/VAR regulator
Cooling Media Temperature	Input temperature measurement for the temperature influence limiter
Ie External	Reserved for real-time simulator
PSS Power Injection *(Requires PSS SW)*	PSS power injection point, scaling see PSS test interface
PSS Frequency Injection *(Requires PSS SW)*	PSS frequency injection point, scaling see PSS test interface
PSS LeadLag Injection *(Requires PSS SW)*	PSS lead lag injection point, scaling see PSS test interface
PSS External Input *(Requires PSS SW)*	Input for external PSS signal
Digital Input 13(+) & 14(-)	Assign digital inputs
Digital Input 15(+) & 16(-)	Assign digital inputs
Digital Input 17(+) & 18(-)	Assign digital inputs

Note: When configuring an external setpoint from the analog input list shown above, the "Remote SP Enable" digital input should also be configured. For more information see Chapter *3.3.5 Digital Inputs.*

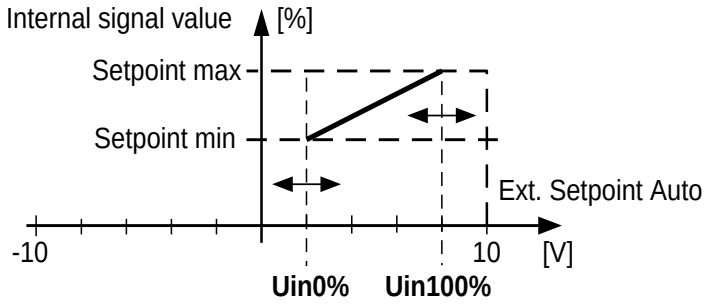
3.3.7.1 Level of the Analog Inputs

A minimum and maximum voltage level can be set for every analog input. This level represents a defined scaling, which is shown in the table below.

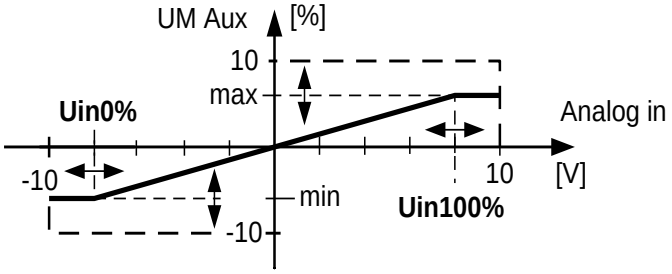
Input Function	*Uin0% Min (-10… +10 V)*	*Uin100% Max (-10…10 V)*	*Remarks*
Auto Remote Setpoint	Auto setpoint min	Auto setpoint max	See Chapter *3.4.1.1*
PF Remote Setpoint *(Requires PF/VAR SW)*	PF setpoint min	PF setpoint max	See Chapter *3.4.1.1*
Var Remote Setpoint *(Requires PF/VAR SW)*	PF setpoint min	PF setpoint max	See Chapter *3.4.1.1*
Manual Remote Setpoint	PF setpoint min	PF setpoint max	See Chapter *3.4.1.1*
Open Loop Remote SP	PF setpoint min	PF setpoint max	See Chapter *3.4.1.1*
UM aux	UM Aux min	UM Aux max	Range – 100% to +100%
VAR Aux Measurement	-10%	+10%	Fix scaling
Cooling Media Temperature	-100 °C	+100 °C	Fix scaling
Ie External	Ie Ext Range min	Ie Ext Range max	
PSS Power Injection *(Requires PSS SW)*	Neg. peak value	Pos. peak value	Scaling from 1% to 10%
PSS Frequency Injection *(Requires PSS SW)*	Neg. peak value	Pos. peak value	Scaling from 0.1% to 1.0%
PSS LeadLag Injection *(Requires PSS SW)*	Neg. peak value	Pos. peak value	Scaling from 0.1% to 1.0%
PSS External Input *(Requires PSS SW)*	-25% U_M	+25% U_M	Range symmetrically adjustable

Input Function	*Uin0% Min (-10… +10 V)*	*Uin100% Max (-10…10 V)*	*Remarks*
Digital Input 13(+) & 14(-)	Set to 2.0 V	Set to 5.0 V	See graphic below
Digital Input 15(+) & 16(-)	Set to 2.0 V	Set to 5.0 V	See graphic below
Digital Input 17(+) & 18(-)	Set to 2.0 V	Set to 5.0 V	See graphic below

External setpoint input



Input to the summing point

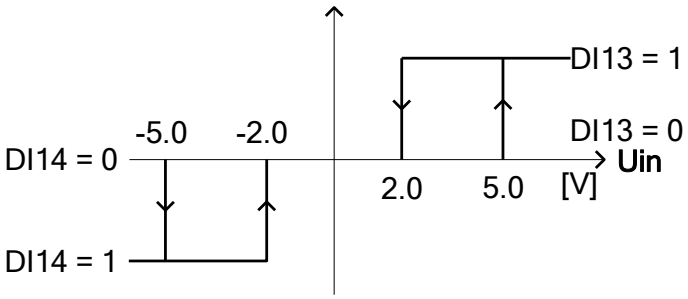


- Input voltage of the cooling media temperature

Range: Uin0% = - 10.0 V refers to - 100 °C
Uin100% = +10.0 V refers to +100 °C

Condition of the digital inputs

(DI 13 to DI18)



Status of the digital inputs

-> Din13(+) = 0
-> Din14(-) = 1

-> Din13(+) = 1
-> Din14(-) = 0

Note: AI and BI must not be active simultaneously, DI13 and DI14 will both be “0”

3.3.8 *Analog Outputs*

Output Function	*Description*
None	Output not assigned
Excitation Current	Excitation current
PWM	Pulse width modulation, control value is scaled from 0 to 100%. It represents the actual field voltage output of 0.5 to 99%
Ue Field Voltage	Excitation voltage (absolute)
Upwr DC Link Voltage	Received excitation input power voltage
Um relative	Machine terminal voltage
Active Power	Machine active power (relative)
VAR relative	Machine VAR relative
PF absolute	Machine PF absolute, negative: -Q / positive for +Q
Fbias	Analog continuous signal presenting difference between U_{NET} and U_M Fbias = $f_{NET} – f_{NOM} – (Slip_{MAX} – Slip_{MIN})/2- Slip_{MIN}$ Output signal Fbias is forced to zero: - Not in Sync mode - Synchronization function not enabled (unit without Sync-Option) - Network frequency is not between 45 to 66 Hz
Slip	Slip between Network and Machine frequencies
PSS TP output 1	PSS test point 1, select signal over PSS test interface in CMT1000
PSS TP output 2	PSS test point 2, select signal over PSS test interface in CMT1000

Note: The assignment of the analog outputs to the 2 terminals **AO1 and AO2** can be selected freely.

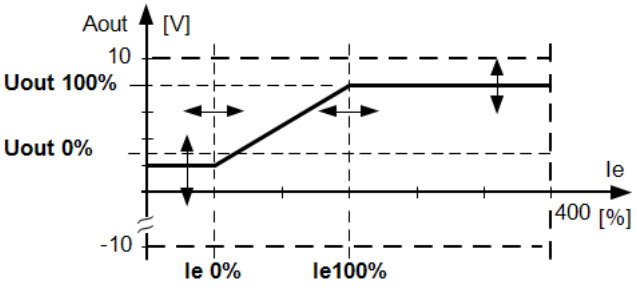
3.3.8.1 Level of the Analog Outputs

A minimum and maximum voltage level can be set for every analog output. This level represents a defined scaling, which is shown in the table below.

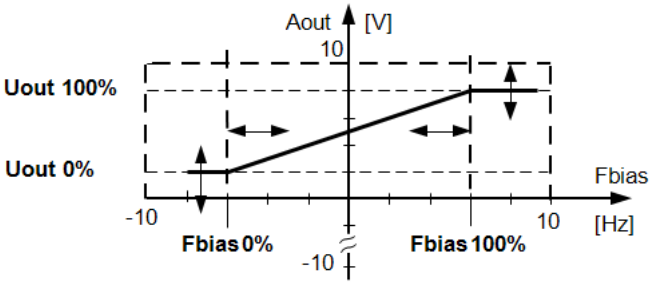
Output Function	*Uout0% Min (-10… +10 V)*	*Uout100% Max (-10…10 V)*	*Remarks*
Excitation Current	Ie Range min	Ie Range max	Scaling: 0% … 400%
PWM	0% (fix)	100% fix	
Ue Field Voltage	0V (fix)	Ue Field Voltage max	Range: 0 to 500 V
Upwr DC Link Voltage	0V (fix)	Upwr DC Link Voltage max	Range: 0 to 500 V
Um relative	0V (fix)	Um relative max	Range: 0% … 400%
Active Power	Active Power min	Active Power max	Range: -200% … +200%
VAR relative	Negative VAR max	VAR max	Range: 0% … 200%
PF absolute	Min PF setpoint	Max PF setpoint	Scaling according to min/max PF setpoint
Fbias	Fbis min	Fbias max	Range: -10 to +10 Hz
Slip	Negative Slip max	Slip max	Range: 0 to 10 Hz
PSS TP output 1	Neg. peak value	Pos.peak value	Scaling depending on PSS test interface settings
PSS TP output 2	Neg. peak value	Pos.peak value	Scaling depending on PSS test interface settings

Excitation Current

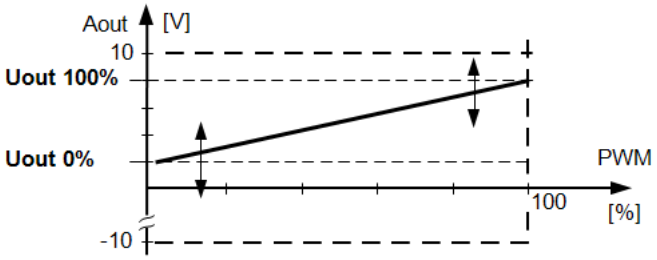
Caution:
Ie0% must be less than Ie100%



Fbias

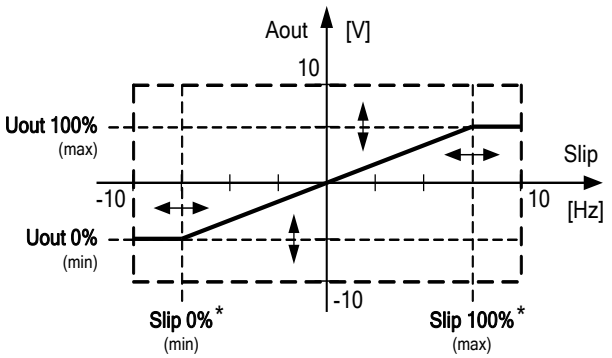


PWM Output

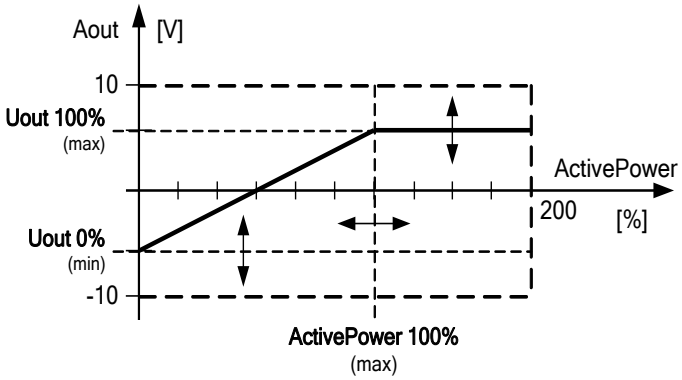


Slip

* The parameter "Slip0%" cannot be set by the user. This parameter is internally set as the negative of "Slip 100%":
"Slip0%" = (-)"Slip100%"



ActivePower



3.3.8.2 Forcing Analog Outputs

Analog outputs can be forced to a certain level by selecting the min and max voltage level to the same value.

3.3.9 *Communication Ports*

UN1020 has three main communication ports to share several features that can be used in combination to cover the requirements of an application.

- USB is a point-to-point interface that can be used to connect the UNITROL 1020 with a PC and is used by the CMT1000 software to control the device.
- The Ethernet port is used to connect the UNITROL 1020 to a multiple point Ethernet network in order to connect the CMT1000 remotely and to access the UNITROL 1020 by a plant control system in parallel.
- RS-485 is a multi-point interface that could be used for Remote Access (Modbus RTU) or VDC; only one feature can be used at the same time.
- CAN is a multi-point interface used to connect a UN1000-PM40 module and uses the Double Channel feature for setpoint follow-up of the second channel. Only one of the above features can be used at same time.

This section describes the hardware and wiring requirements for the communication interfaces. The software features that use these communication interfaces are explained in Chapter *3.4 Software.*

3.3.9.1 USB Interface

The serial USB port of UN1020 can be used to connect a PC that runs a CMT1000 software. Max. USB cable length is 3 m. The USB port will power up control devices of UNITROL 1020 in order to allow the user to download or upload files to the unit without additional power supply connection.

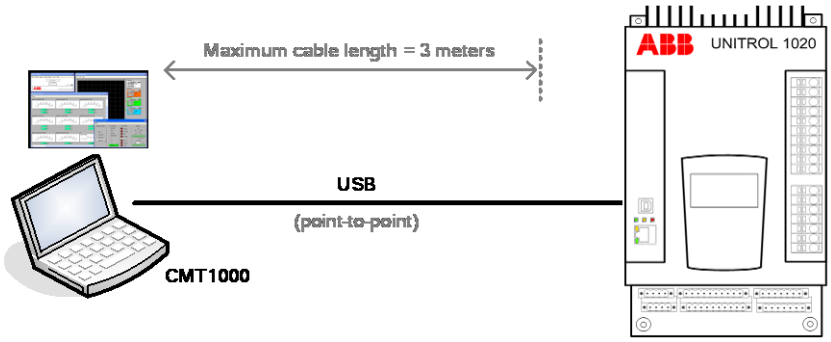


Figure 3-2 USB connection to a PC

NOTICE!

Use only the USB cable that is supplied with the device. Using another cable might cause communication failure or power over USB might not work correctly so that the device does not start.

3.3.9.2 Ethernet Interface

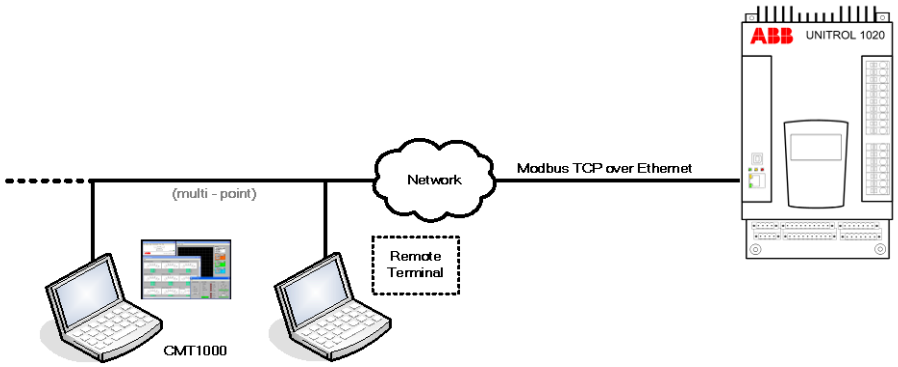


Figure 3-3 Ethernet TCP/IP connection

The Ethernet TCP/IP connection:

- Ethernet allows monitoring and control from a remote location.
- Max. one CMT1000 connection can simultaneously access the AVR
- Multiple Remote Control connections can simultaneously access the AVR
- Open TCP Ports
    1. Device detection. (Port 5002/5003)
       Ethernet scanning (CMT1000 function)
    2. Modbus TCP (Port 502)
    3. SNTP client (Port123)

More information about these software features and configuration can be found in Chapters *3.4.6 Modbus for Remote Access* and *6.4 PC Software Tool.*

3.3.9.3 RS485 Interface

UN1020 provides a RS485 interface for both VDC and Remote Access; however only one can be operated with the RS485 interface. If both features are simultaneously required, the solution is the usage of Remote Access over Modbus TCP and VDC over RS485.

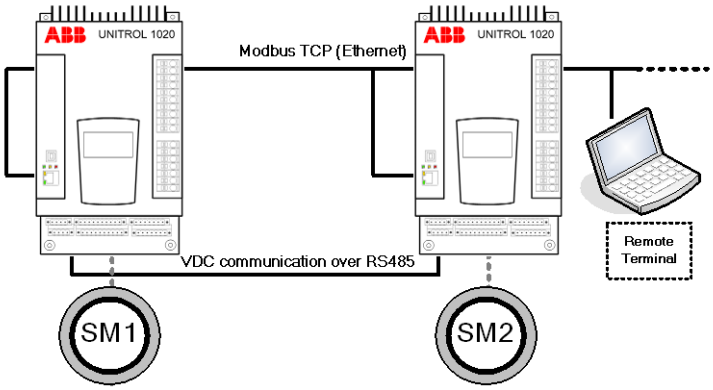


Figure 3-4 ABB solution if both Remote Access and VDC features are required.

The electrical connections of the RS485 bus should be performed according to EIA485 standard specification. The 120 Ohm resistor that is normally used to terminate a RS485 bus is already included in UN1020 and should be used by placing a jumper bridge over the X1300 terminals. The X1300 location is shown in Chapter *3.3.2.4 Terminal Block*.

Cable type requirements

- Cable cross-section: 2 x 0.25 mm^2
- Cable impedance: 100 to 120 Ohm
- Shielded twisted pair.
- 500 m max cable length
  (in case of UNITROL 1000-15 the bus is only 250 m)

Bus topology

- 31 devices maximum for single channel and 62 for dual channel configuration.
- 57.6 kBaud

The cable shielding shall be grounded as closely as possible to the device's terminals as shown in the figure below.

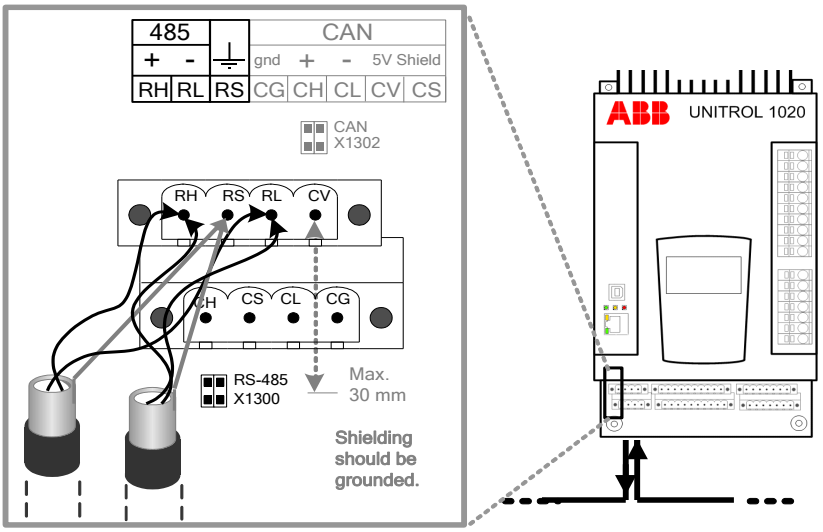


Figure 3-5 Shielding and wiring recommendation when using the RS-485 interface.

The signal line shield must be connected only at one location to PE, typically at the end of the line.

RS485 for VDC and remote access

When configuring the RS485 interface for VDC or remote access, a jumper bridge must be placed over the X1300 terminals of each AVR located at the end of the bus; and it should be removed from those not located at the end (see *Figure 3-6*). No resistor should be placed externally, i.e. on the device's terminals, when the jumper bridge of the UN1020 is already being used.

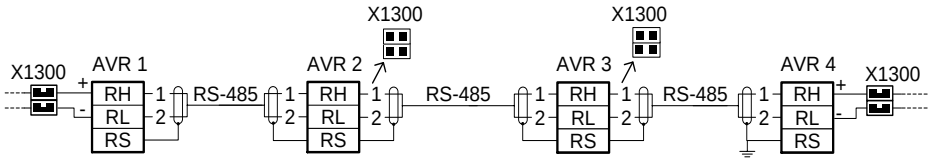


Figure 3-6 RS-485 wiring and jumper settings to use VDC on a set of four AVRs.

As shown in *Figure 3-6* the topology of the bus should be as "one line" with two endings, and not as a "star". The recommendations described in Chapter *3.3.9.3 RS485 Interface* should be strictly followed. The VDC feature operates only over RS485 and could not work properly if there is any other device incompatibly connected to the same bus.
The VDC software should be configured in each device prior to use. The configuration is described in Chapter *3.4.3.1 Voltage Droop Compensation (VDC)*.

3.3.9.4 CAN Interface

A CAN interface is provided for both Double Channel (connection with a second channel) and UN1000-PM; however both cannot use the bus simultaneously. As will be explained in *Chapter 3.4.4.4 - Double Channel (DCH)*, the DCH Supervision can be used together with a UN1000-PM connected to the AVR since the CAN communication is not needed for the operation of the monitoring functions. However, the remaining functions from Double Channel are not compatible with the UN1000-PM. For more information see Chapter *3.4.4.4.9 - DCH Communication: Configuration and Compatibility*.

The electrical connections should be performed according to CAN standard guidelines. A 120 ohm resistor normally used to terminate the bus, is already included in the device and can be used by placing a jumper bridge over the X1302 terminals. The location of the X1302 terminals can be identified by referring to Chapter *3.3.2.4 Terminal Block.*

The CAN interface cannot be used for remote access and for any other purpose not explicitly indicated in this user manual.

CAN for UN1000-PM40

For more information see the UN1000-PM40 User Manual.

CAN for Double Channel

When using Double Channel, the CAN connections should be performed as shown in the figure below (CAN connection for Double Channel SW). The cable used for the CAN communication has to be connected between the two channels, i.e. Main and Redundant, and not to any other device. To properly terminate the bus, place one jumper bridge over the X1302 terminals of each device.

Cable type requirements

- Cable cross-section: 2 x 2 x 0.34 mm^2
- Cable impedance: 120 Ohm
- Maximum cable length: 30 meters.
- Shielded twisted pair. The cable shielding must be grounded.

The Double Channel is an optional feature that should be previously activated in the device (by password or product rubric), configured and the communication activated. For more information refer to *Chapter 3.4.4.4- Double Channel (DCH)*.

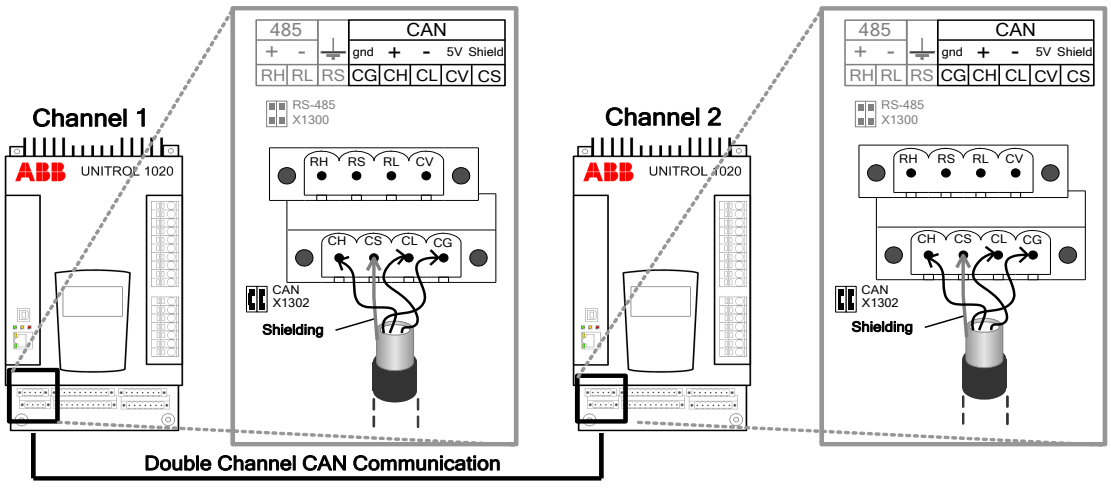


Figure 3-7 CAN connection for Double Channel SW

3.4 Software

The UN1020 device supports several operating modes and software features, such as machine voltage regulator (Auto), field regulator (Manual), measurements monitoring and others which are described in detail in this section.

There are three different SW function packages defined as BASIC and FULL packages (and PSS as option only). The table below shows the configurations.

A set of basic software features is enabled by default in each UN1020 product and is referred to as *basic software package*. There are optional software features which extend the UN1020 capabilities and which can be enabled by password.

No.	*SW-Option Name (Figure 6-16)*	*Descriptions*	*BASIC / FULL/ Option*	*See chapter*
1	AVR/FCR/PF/VAR	PF / Var Regulator	*BASIC*	*3.4.1.3*
2	Limiters	Limiters	*BASIC*	*3.4.4*
3	Soft Start	Soft Start	*BASIC*	*3.4.2.1*
4	Voltage Matching	Voltage Matching	*BASIC*	*3.4.2.6*
5	VDC	Voltage Droop Compensation	*BASIC*	*3.4.3.1*
6	UMAUX	Auxiliary Supply to Summing Point	*BASIC*	*3.3.7*
7	Modbus	Modbus TCP for remote access	*BASIC*	*3.4.6*
8	RDM	Rotating Diode Monitoring	*BASIC*	*3.4.4.5*
9	Double Channel	Double Channel and supervision functions	*BASIC*	*3.4.4.4*
10	Synchronization	Synchronization	*BASIC*	*3.4.2.7*
11	Extended Data Logger	Non-volatile Data logger	*FULL*	*3.4.4.6*
12	Event Recorder	Non-volatile Event Recorder	*FULL*	*3.4.4.7*
13	External Ie Meas.	External current measurement ➔ Must only be used with real time simulator	*Option*	*3.3.7* or *3.3.9*
14	PSS	Power System Stabilizer	*Option*	*3.4.5.4*

Once a password code has been acquired from ABB, an optional software feature can be enabled using the CMT1000 software. A pre-configured device with selected optional features can also be ordered by means of the product rubric number, and in this case there is no need for software activation by password. More information regarding the activation procedure can be found in Chapter *6.4.5 Menu Structure of CMT1000.*

The following sections explain the complete UN1020 software including optional features. It is clearly mentioned at the beginning of the description if a software feature is optional or not. The Panel and CMT1000 software are explained in *Chapter 6 - Operation*.

After the configuration of the device, the parameters should be stored in the non-volatile EEPROM memory; otherwise the changes are lost after restarting the device. The command *Save to the EEPROM* is used to store parameters in the non-volatile memory and is explained in *Chapter 6 - Operation.*

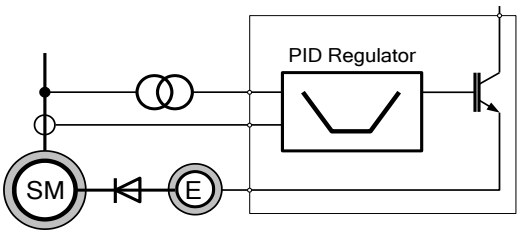
3.4.1 *Operating Modes*

There is a bumpless changeover between all modes performed by the *Channel Follow-up* function. For more information see Chapter *3.4.1.5 - Channel Follow-up*. Tuning and other parameters are described in Chapter *3.4.1.6 - Description of Parameters.*

3.4.1.1 Automatic Voltage Regulation (Auto)

Regulates the terminal voltage of the synchronous machine.

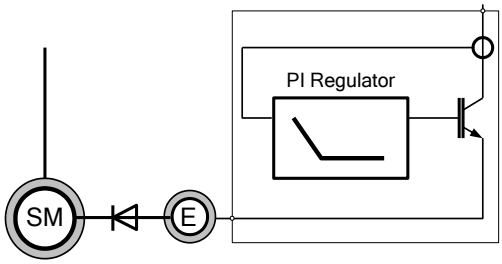
Note:
Current measurement for compensation / droop



3.4.1.2 Manual Control

Regulates the field current of the excitation machine.

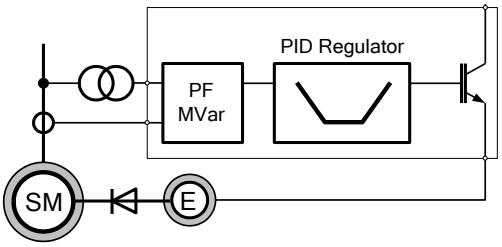
Note:
No limiters are active as long as this mode is active.



3.4.1.3 PF or Var Regulation

Regulates the power factor or reactive power of the synchronous machine.

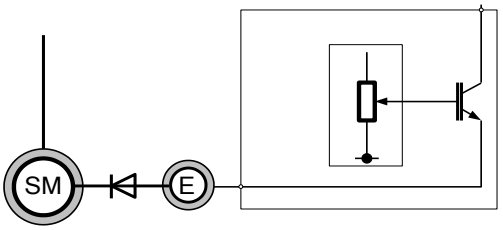
Remark:
Var setpoint is normalized at 1pu terminal voltage of the generator



3.4.1.4 Open Loop

Control with a fixed output signal.

Note:
No limiters are active as long as this mode is active.



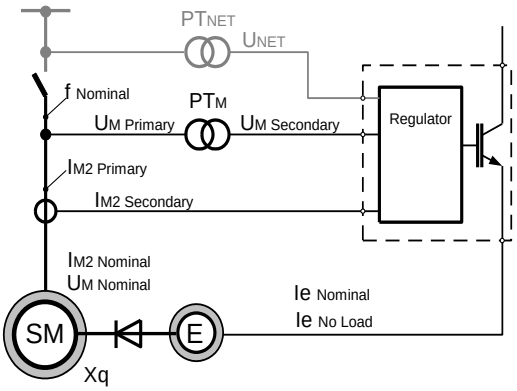
3.4.1.5 Channel Follow-up

While the UN1020 device is operating at an operating mode, the setpoint from the other modes are *following* the actual one in order to provide a *soft transition,* with no bumps (e.g. from Auto to Manual). This feature is called *Channel Follow-up.*

3.4.1.6 Description of Parameters

3.4.1.6.1 *System Data*

Nominal excitation current:	Ie Nominal	[A]
Measuring voltage three- or single-phase:	PT [Single_Phase] [Three_Phase] [Three_ph_gnd]	
Nominal voltage of the Machine:	UM Nominal	[kV]
Potent. transformer, prim. voltage:	UM Primary	[kV]
Potent. transformer, sec. voltage:	UM Secondary	[V]
Nominal voltage of the Network:	U_{NET} Nominal	[kV]
Potent. transformer, prim. voltage:	U_{NET} Primary	[kV]
Potent. transformer, sec. voltage:	U_{NET} Secondary	[V]
Nominal machine current	IM2 Nominal	[A]
Current transformer primary:	IM2 Primary	[A]
Current transformer secondary:	IM2 Secondary	[A]
No load excitation current:	Ie No Load	[%]
Ceiling factor:	Kceil	[V/V]
Machine reactance:	Xq	[p.u.]
Frequency nominal:	f Nominal	[Hz]
Single phase machine	Checkbox	



IMPORTANT!

If there is a block transformer with any circuit configuration between PT_M and PT_{NET}, the phase shift must be compensated. The phase can be compensated as described in Chapter *3.4.2.7 Synchronization* (SYNC).

3.4.1.6.2 *Setpoint Setting for the Regulator*

- Auto — to voltage regulator
- PF, Var — to power factor, reactive power regulator
- Manual — to manual regulator
- Open Loop — to open loop regulation circuit

All setpoints have the following parameters

- Minimum
- Maximum
- Ramp Rate

Auto, Manual and Open Loop also have the following parameters

- Initial Setpoint

Default Level of the setpoint if the digital input Excitation ON is not active.

Auto, Manual and Open Loop initial setpoints can be configured.

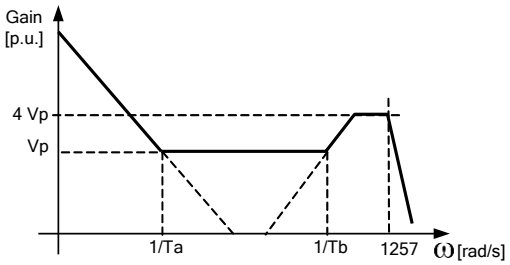
Mode	Initial Setpoints
Auto	100% (configurable)
Manual	0% (configurable)
Open Loop	0% (configurable)
PF	1.0
Var	0%

The limits and ramp rate can be set separately for each operating mode.
The setpoints of the non-active regulators follow the relevant operating point. For example, for reactive power regulation (Var) the setpoint of the auto regulator follows the current machine voltage. This allows surge-free switching between operating modes if the new setpoint is within the setpoint limit.

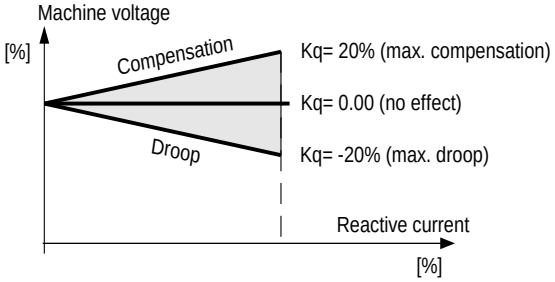
3.4.1.6.3 *Regulator Tuning*

Auto (voltage control)

- Proportional gain — Proportional Gain Vp
- Derivative time constant — Derivation Time Tb [s]
- Integral time constant — Integration Time Ta [s]



Compensation or droop — Droop Kq [%]

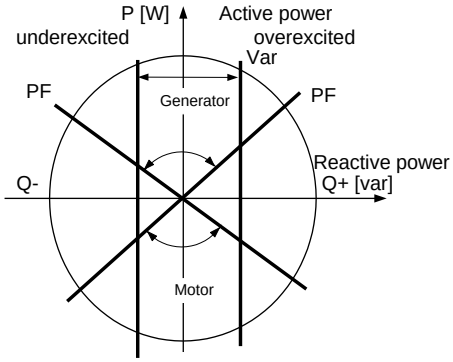


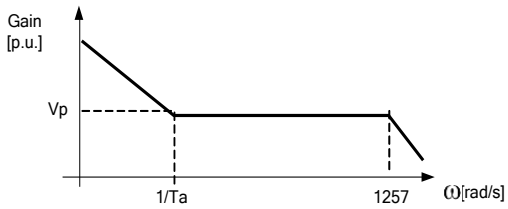
The second droop setting can be selected by digital input or over Modbus. Droop setting can be selected on active power as well.

PF or Var Control and PQ Limiter

Proportional Gain Vp
Derivation Time Tb[s]*)
Integration Time Ta [s]

*) Only one parameter, see voltage control



Indirect PF or VAR control	Indirect PF/VAR enable ☑		PF or VAR controller can be configured for direct or indirect control In case of indirect control the PF/VAR is regulated by increasing and decreasing the voltage setpoint with a defined ramp rate for AUTO mode.
	Dead band of Q reg	[%]	Voltage SP is only changed when an error of the VAR/PF regulator is higher than the defined dead band. Note: In PF mode the PF SP is calculated to VAR SP.
	On Delay	[sec]	*On Delay* will define the reaction time of the indirect regulator. If the network voltage changes, the voltage SP is changed after a defined delay time. If SP is changed no delay is given.
	AUTO Ramp rate PF indirect	[%/s]	*AUTO Ramp rate PF indirect* will define ramp rate just in case indirect PF regulator is active
Manual Field current control and Ie Limiter	Proportional Gain Vp Integration Time Ta	[s]	

All parameters should be stored in the EEPROM non-volatile memory after they are configured. Store to EEPROM can be done via CMT1000, Panel or Remote Access. For more information refer to the appropriate sections.

3.4.1.6.4 *Expert Tuning*

Derivator gain *Kb*:

By default Kb is set to 3. This gives a derivator gain of 4 x Vp. The parameter can be set between 1 and 50 which will give a derivator gain between 2 x and 51 x Vp.

Variable kceiling, *Upower @ Noload*:

In case of variable input voltage, UNITROL 1020 will adjust the kceiling factor automatically by setting the parameter *Upower @ Noload.* The kceiling factor will be adjusted depending on the Upower input. By default the Upower @ NoLoad is set to 0 V, which will lead to fix kceiling.

Variable kceiling, *Kc Freq Dep*

In case of variable machine frequency, UNITROL 1020 will adjust the kceiling factor automatically by checking the check box. The kceiling will be adjusted linear to the measured frequency, where the nominal frequency is taken as base.

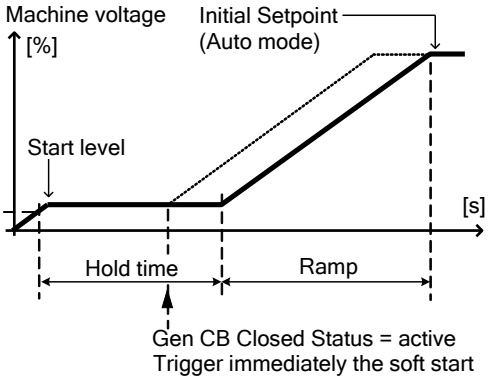
Max PWM when boosting

When this function is enabled, the AVR will apply 100% PWM during undervoltage. Thresholds are defined by the boosting setting.

3.4.2 *Startup Functions*

3.4.2.1 Soft Start and Line Charging

- Starting voltage : Start Level [%] from Initial Setpoint
- Delay until ramp : Hold Time [s]
- Ramp time : Ramp Time [s]
- Start Frequency Machine Freq. [Hz]



The final value of Soft Start ramp is the Initial Setpoint for Auto mode. For more information refer to Chapter *3.4.1.6.2 Setpoint Setting for the Regulator*.

A second set for Line Charging parameters is also available. Line Charging is enabled by Digital Input

Blocking excitation until UM frequency reaches a predefined level (parameter name: Start Frequency)

Excitation is switched on (Command via digital input or remote control) when the machine frequency is higher than the start frequency threshold. The Soft Start time starts after the internal Excitation ON command. When the machine frequency goes below 10Hz for longer than 10 sec, excitation is blocked. Excitation is started with Soft Start when the generator frequency goes above the start frequency again.

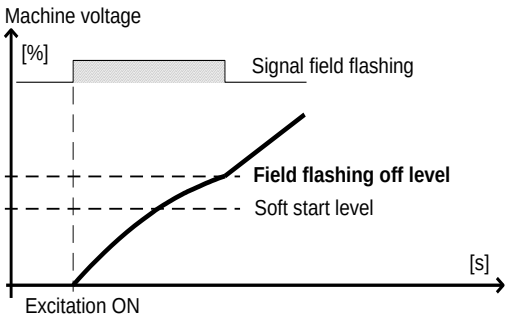
Note: Soft Start is available only in Auto mode.
There is no indication if Excitation ON is blocked or not.

In order to measure the correct frequency, the machine voltage must be above 2%

3.4.2.2 Field Flashing

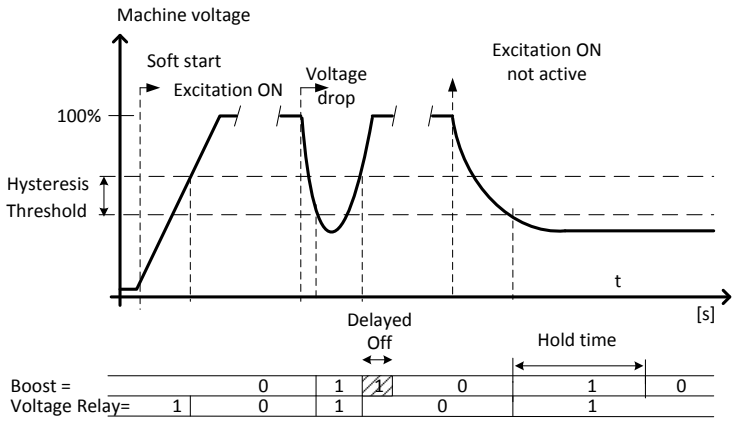
- Off Level Off Level [%]

Setting the Off Level to 0% disables field flashing.



3.4.2.3 Boost / Voltage Relay

- Pick-up volt. to *Threshold [%]* generate boost command
- Time boost *Hold Time [s]* output is active
- Hysteresis for *Hysteresis [%]* the reset of boost output
- Delayed OFF *Delay time [s]*
- Boost on grid *Check box* only
- Block boosting *Check box* in case of PT alarm



Hold Time = Maximum active Boost Time

Boosting is disabled if “Block boosting in case of PT alarm” parameter is selected and any of the following failures is detected.

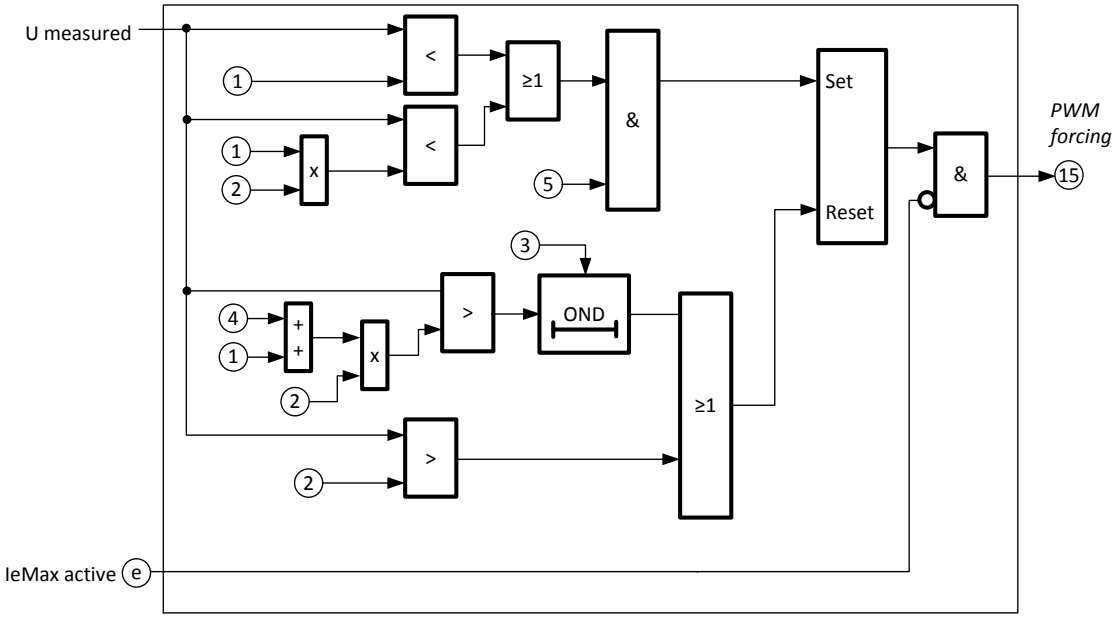
Failures: a) Partial Loss of UM
b) Loss of UM

Current boost operation is canceled when either failure is detected

Detection of PT failures relies on Supervision functions (status, not latched), PT failures will only be detected when the DCH SW option is enabled
Note that Voltage Relay operates independently of the status of Excitation ON.

3.4.2.4 Forcing PWM to maximum

In order to make boosting independent of PID settings, PWM output can be driven to the maximum value in case of undervoltage detection. This function is enabled by the parameter “Maximum PMW when Boosting”.
The function is parametrized by the normal boost setting and on off timing is also considering actual SP.



1. Boost - Threshold
2. Voltage setpoint: if AUTO, setpoint itself; if PF or VAR, followup used to generate AUTO setpoint (1.3s delayed voltage measurement)
3. Boost - Delayed OFF
4. Boost - Hysteresis
5. Boost - Checkbox «Enable PWM forcing»

Boosting is disabled if the “Block boosting in case of of PT alarm” parameter is selected and any of the following failures is detected.

Failures: a) Partial Loss of UM
b) Loss of UM

Current boost operation is canceled when either failure is detected

Detection of PT failures relies on Supervision functions (status, not latched), PT failures will only be detected when the DCH SW option is enabled

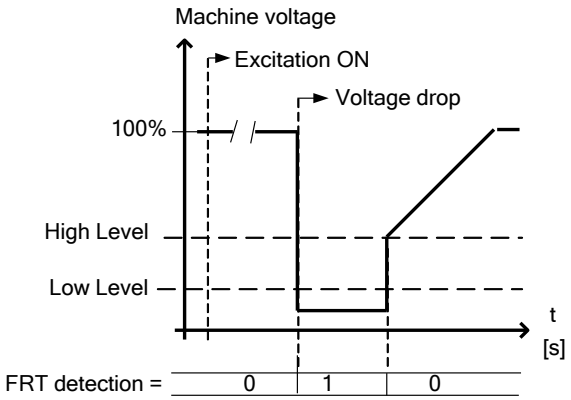
3.4.2.5 FRT Detection (Fault Ride Through)

FRT detection is a very fast detection of voltage dips as it is defined by grid code requirements. The output is used to give a fast indication to the governor control in order to remove active power. This will prevent the generator to trip because of speeding up. The output is only activated in case the active Power is over the configurable power threshold.

The reaction time depends on the configured voltage measurement

- 3-phase measurement 20ms
- 1-phase measurement 50ms

- Voltage level to generate FRT detection *Low Level [%]*
- Voltage release level to reset FRT detection *High Level [%]*
- Power Threshold to enable FRT detection *Power Thr. [%]*



Remark:
If *FRT_HighThreshold* **<** *FRT_LowThreshold*, then the output signal is switched off when UM **>** (Low Threshold + 2%)
Therefore, High Level cannot be set below low level

3.4.2.6 Voltage Matching (VM)

Voltage Matching is a function from the Synchronization software (Chapter *3.4.2.7*) but included in the *AVR basic software package*. When Voltage Matching is activated, the generator voltage setpoint is adjusted to match U_M with U_{NET}, also during Synchronization; however there is no Fbias output. More information about Voltage Matching can be found in Chapter *3.4.2.7 - Synchronization (SYNC).*

3.4.2.7 Synchronization (SYNC)

The automatic synchronization of a synchronous machine with the Line is achieved using the optional integrated synchronizing function. By setting a few simple parameters, UNITROL 1020 supplies the corresponding control signals for the speed governor and closes the circuit breaker.

Analog speed correction Fbias is given out from the UNITROL 1020 analog output to the speed governor control summing point (not as pulse). This signal represents the difference of network NOMINAL and network ACTUAL frequency. The reference (setpoint) value for the speed governor must be nominal (50 or 60 Hz) and the Fbias given by UNITROL 1020 will drive the speed close to actual network frequency.

As an alternative, UNITROL 1020 supports digital increase / decrease signals towards the governor control.

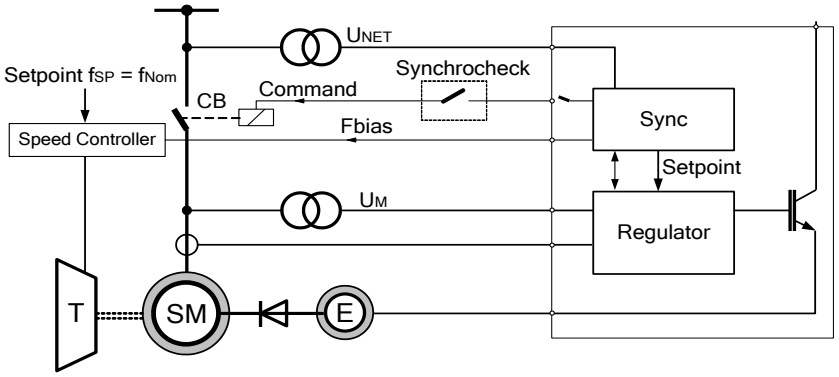


Figure 3-8 Typical application for Synchronization.

CAUTION!

Synchronization should never be performed by calculation only. All measurements shall be confirmed on site before synchronization takes place.

The power circuit breaker (CB) must not be closed unless both voltages are at least approximately synchronous (coincident).

Otherwise, this may result in faulty line operation, loading of the synchronous machine and, in extreme cases, damage to the synchronous machine.

A separate synchrocheck relay might be used to secure the right operation. For further information please contact ABB.

Measuring and Matching

The values are obtained by the two measurement signals UNET and UM

- Voltage difference (amplitude)
- Slip (frequency difference)
- Phase-angle difference

The voltage matching function gives the adjusting value to the internal voltage regulator and the frequency matching function sends the analog signal Fbias to the turbine regulator.

Monitoring and command generation

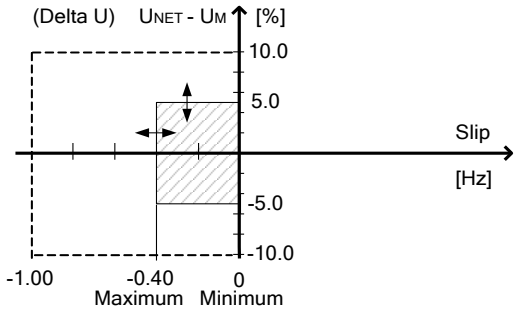
The command to close the breaker (CB) is released if all conditions are fulfilled.

Description of parameters:

Min Slip [Hz] :
Max Slip [Hz] :
Max DeltaU[%] :

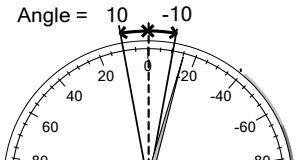
Minimum Slip
Maximum Slip
Max. voltage difference

Note: $f_M > f_{NET}$
Slip always negative



Max Delta Angle [deg]

Max Delta Angle [deg]



Tot CB CloseTime [ms]

Time between closing command and closed breaker (see data sheet of the breaker).

Voltage Offset [%]

Voltage correction factor between U_M and U_{NET}.

$U_{NET\ USED} = U_{MEASURED\ FROM\ NET}$ + Voltage Offset

Voltage Offset is provided in the current software release for backwards compatibility with earlier versions.

Note 1: Voltage correction can be achieved by modifying the Network PT parameters.
Note 2: Because *Voltage Offset* functions independently of other functions, it's recommended to leave Voltage Offset = 0 when correcting voltage using the Network PT settings.

Angle Offset [deg]

Phase correction factor between U_M and U_{NET}. Delta angle is calculated as follows:

Delta Angle = $Phase_{NET}$ – $Phase_M$ + Angle Offset

Example
Situation: Due to a step-up transformer between machine and grid, U_{NET} is delayed 30º with respect to U_M.
Correction needed: Angle Offset = + 30º (positive).

SYNC DisableCBCheck [True / False]

When set to False (default), this enables the monitoring of *Gen CB Closed Status* input during Synchronization (only): if *Gen CB Closed Status* is active, Voltage Matching is not performed.

When set to True, this disables the monitoring of *Gen CB Closed Status* during Synchronization (only): Voltage Matching is performed disregarding the *Gen CB Closed Status* input (not recommended in most applications).

Important: This parameter must be configured to False for backwards compatibility with releases 4.401 or earlier.

IMPORTANT!

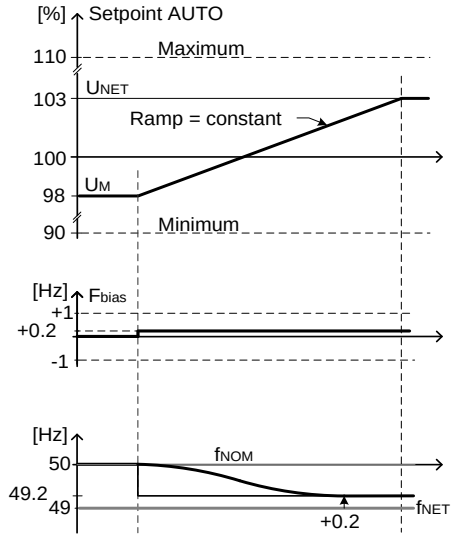
After the power circuit breaker has been closed, the Synchronize command **must be** deactivated.

The setpoint of the speed controller must have the nominal value of 50 resp. 60 Hz for the synchronization.

Examples

Voltage matcher
The machine voltage is raised to the level of the line voltage.

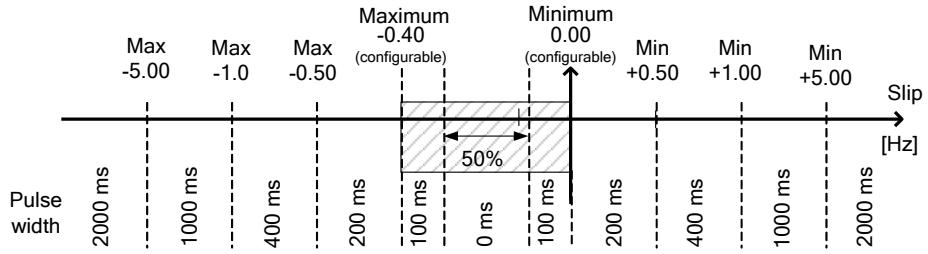
Ramp Rate has to be adjusted in the menu Setpoint AUTO



Frequency matcher
fNOM = 50 Hz (45 Hz < fNET ≤ 54 Hz, **50 Hz**)
(54 Hz < fNET < 66 Hz, **60 Hz**)
fNET = 49 Hz
fM = 50 Hz
fSP = 50 Hz (Setpoint speed governor)
Slipmax = -0.4 Hz
Slipmin = 0 Hz
Fbias =
$f_{NET} – f_{NOM} – (Slip_{MAX} – Slip_{MIN})/2 - Slip_{MIN}$ = -0.8 Hz
fSP+Fbias = 49.2 Hz

Using digital output signals to adjust the speed:

As an alternative to the fbias signal, UNITROL 1020 also supports increase and decrease signals as digital outputs in order to adjust the speed. The digital outputs are pulse width modulated with 4000 ms base time. The more the machine frequency matches the network frequency, the shorter the pulses are.



Dead Bus Synchronization

UNITROL 1020 supports synchronization to a dead bus (Unet < 10%). To enable dead bus synchronization, the digital input “Sync Dead Bus enable” must be configured and applied.
The digital input should be wired over the MCB of the Unet PT protection in order to ensure that Unet is < 10%.

WARNING!

In case of broken or open Unet PT measurement, the machine might be seriously damaged when applying dead bus synchronization

Preconditions for Synchronization

Unet	*Sync dead bus enable*	*Output behavior*
<10%	1	CB close command and Synchrocheck output is applied after the network voltage is below 10% for 2 sec. Voltage matching and control signal to the governor are disabled
10% …50%	any	Synchronization and Synchrocheck is **blocked** Voltage matching and control signal to the governor are disabled
>50%	any	CB close command and Synchrocheck output is applied. Control signals to the governor are applied

Activation:

The Synchronization can be activated via digital input or Remote Access. For more information refer to Chapter *3.3.5 Digital Inputs*, Chapter *3.4.6 Modbus for Remote Access* and *6.4.5 Menu Structure of CMT1000*.

The Synchronization and Voltage Matching are features that are activated using the same activation signal, called Synchronize. When the Synchronization SW is not available in the AVR (i.e. LED off in SW-options window of CMT1000), only Voltage Matching will be activated when Synchronize digital input is set to high. On the other hand, when Synchronization SW is available (i.e. LED on in the SW-options window of CMT1000), Synchronize input will fully activate the Synchronization feature, which also includes the capability of voltage matching and the Fbias output. For more information about Voltage Matching see Chapter *3.4.2.6 Voltage Matching (VM)*.

3.4.2.8 Start sequence with dead bus synchronization

With regard to support dead bus synchronisation and line charging in combination, UNITROL 1020 provides a special start sequence.

In case digital input *Sync Dead Bus Enable* is active, *Excitation On* and *Line Charging* are enabled, the soft start ramp (Internal Excitation ON status) is started after the generator breaker is closed. Generating the close command of the generator breaker is only applied if SYNC is enabled.

3.4.3 *On-line Operation Functions*

3.4.3.1 Voltage Droop Compensation (VDC)

For island operation only

UNITROL 1020 offers a special feature called Voltage Droop Compensation or VDC. This feature equally shares the amount of reactive power between generators connected in parallel to the same bus by using the RS485 bus for communication between AVRs.

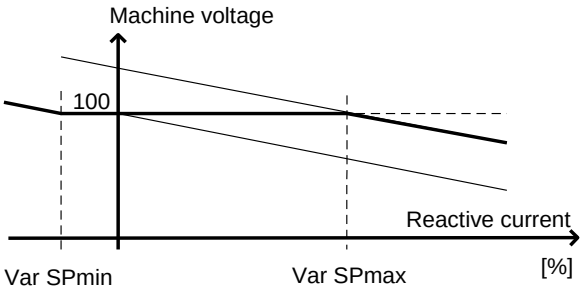
During VDC mode all AVRs operate in Auto mode with a voltage droop control. Each AVR sends the value of its own amount of reactive power over the RS-485 bus, while the other AVRs take this information to calculate a common average MVAR setpoint and compensate the effect of the voltage droop. The setpoints are calculated to maintain the voltage level on the busbar at 100% (not adjustable).

The AVRs that are considered to calculate the common average MVAR can be selected:

A) All units which are connected to the busbar, only dependent on the GCB status

B) All units working in VDC mode

In order to get a smooth transition between any mode and VDC mode the load sharing is activated over a ramp time. The ramp time defines the time after switching on VDC mode until VAR on all machines is equalized.



Important:
The Compensation Droop Kq shall be set at -5% (negative value) if VDC mode is used. The voltage is kept at 100% Um inside the VAR SP min/max. If VAR is outside this range the voltage will be adjusted according to the set droop (Kq).
VDC Mode will keep the bus voltage at 100% within the Var Setpoint min and max limits.

NOTICE!

Load sharing will only be accurate in case of matched PTs. Voltage must be matched to a single reference with 0.1% accuracy

Voltage droop compensation can be used for two different bus configurations.

a) Busbar configuration with 2 breakers

b) Ring structure with up to 8 segments

The load sharing takes place only in machines that are connected directly and automatically controlled by digital inputs that give information about the breaker.

Common parameters for VDC:

Network Connection Type	Busbar or Ring
RS485 error forces to AUTO mode	False / True
VDC Ramp Time	0.1 – 60.0 sec
Baud Rate	59.7k / 57.6k
Calc ref from AVRs in VDC mode only	False / True

Communication over RS485 between the parallel units:

Each AVR has to be configured with a unique AVR-ID number which identifies itself among the others on the bus.

The VDC communication refers to the data transmitted over the RS485 bus whereas the VDC operating mode refers to whether this data is used for compensation of the reactive power or not. The AVR enables the VDC communication (i.e. transmit data over the bus) as soon as the "Gen CB Closed status" input is active (logical one) in case bus bar configuration is selected and VDC software is available in the device except during Standby or when Remote Access via the RS485 is active. When Ring structure is selected all AVRs will transmit their information on the bus. As long as the AVR is in Standby or as long as Remote Access via RS485 is active, the VDC communication is disabled and will not be transmitted over the bus. Once the VDC communication is enabled, the data available on the bus is taken and used for the regulation. This is only possible when the AVR is switched to VDC operating mode (i.e. by *VDC Enable* digital input).

The availability of the VDC communication disregarding the operation mode (even during Excitation Off) allows the cabling connections and communication quality to be easily tested. The testing is performed by forcing the "Gen CB Closed status" input signal and by monitoring the status of the communication using the VDC Monitor tool included in the CMT1000. For more information about VDC Monitor refer to Chapter *6.4.7 Communication Menu*.
The wiring connections of the RS485 bus are explained in Chapter *3.3.9.3 RS485 Interface*.

3.4.3.2 Voltage Droop Compensation for busbar configuration

The VDC software allows the network to be divided into smaller entities. Each AVR can operate in one of three pre-determined island grids called Primary and Secondary Nets. The Primary Net (open breaker) is selected by default if the Secondary is not configured.

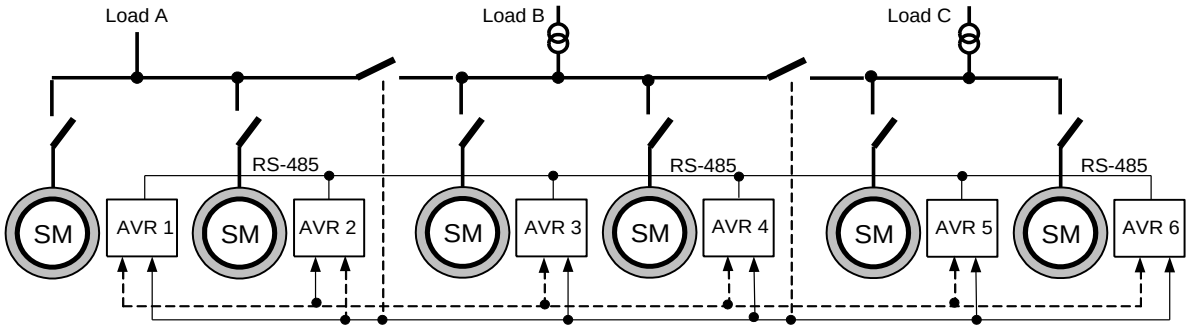


Figure 3-9 VDC application example of six machines and two nets.

When the Secondary Net is required, it should be configured using a digital input. This input determines whether the AVR uses data for VDC calculation from the devices configured in the Primary **or** Secondary Net. The user can select 4 different net IDs depending on two digital inputs. The load sharing takes place between AVRs with the same net IDs. The list below shows an example of how to set the net IDs for each AVR in relation to the digital input.

Net type	***Net ID default***	***Digital input Secondary Net 1 Secondary Net 2***		***AVR 1+2 Net ID***	***AVR 3+4 Net ID***	***AVR 5+6 Net ID***
		Net 2	Net 1			
Primary Net	1	0	0	11	12	13
Secondary Net	2	0	1	2	2	13
Secondary Net	3	1	0	11	3	3
Secondary Net	4	1	1	4	4	4

Note that the net IDs are chosen in a way to represent the possible load sharings:

- Net ID1: Load sharing only in the same bus segment
- Net ID 2: Load sharing between Load A and B
- Net ID 3: Load sharing between Load B and C
- Net ID 4: Load sharing between all machines

The Primary and Secondary Net ID numbers should be different from each other and unique for each load sharing group.

When no digital input is configured for Secondary Net 1 nor Net 2, the VDC net ID is set to the primary net ID.

3.4.3.3 Voltage Droop Compensation for Ring Configuration

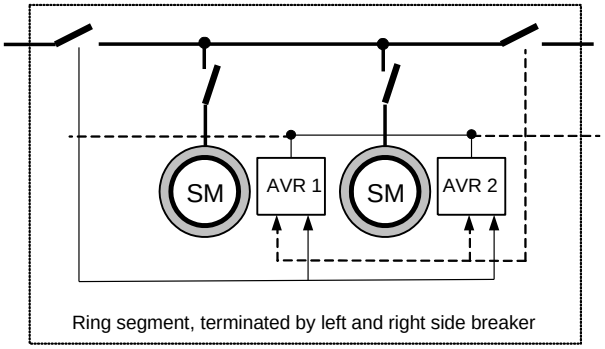
VDC mode can also be used in a ring structure, where the ring can be split up and the AVR automatically shares load with the connected machines.

A ring is based on segments with a left (decreasing) and right (increasing) breaker. The

number of machines inside a segment is not limited. Only the maximum number of total machines is limited to 31.

The status of the breakers must be wired to digital input (Secondary Net 1 and Secondary Net 2) of the AVR.

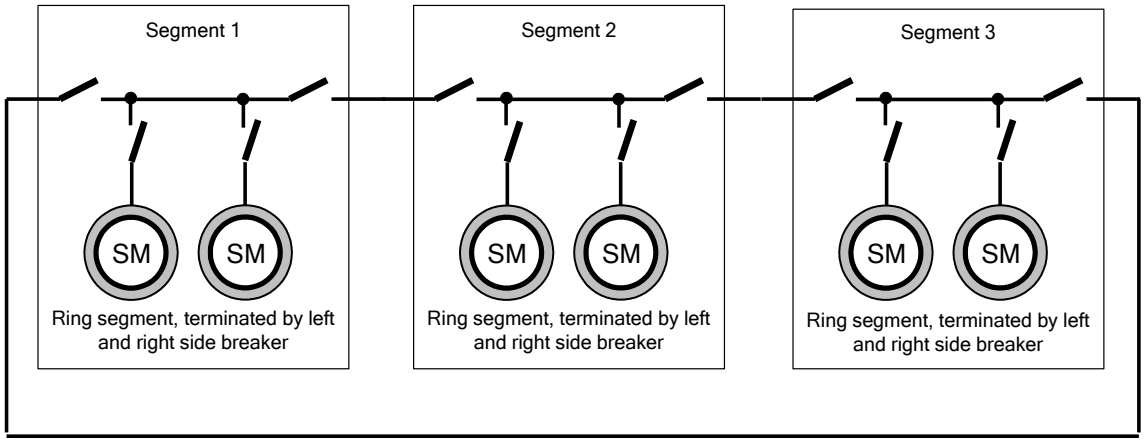
Where Secondary Net 2 is used for the left side (decreasing) breaker and Secondary Net 1 is used for the right side (increasing) breaker.



Note that the net IDs are equal to the bus segment where the AVR is connected to. The AVR status gives an indication of two different island operations.

- Primary Net One of the section breakers is open
- Secondary Net Both section breakers are closed

A ring structure is built with up to 8 segments; see the example for 3 segments below.



The auxiliary contact of the breaker must be wired only inside the segment. In order to select the correct machines regarding the load sharing, all AVRs give the information of the segment breaker and their own position (segment number) over the RS485 bus to all other AVRs. This enables the system to detect wrong configuration which is indicated as “VDC Ring Error”.

In addition the user can select the common section breaker, where a combination of two breakers in series is routed to neighboring sections. This will ensure correct load sharing even if one segment is completely powered off.

If there is neither left nor right side breaker, the corresponding digital input (Secondary Net1 / 2) must be forced to logical 1.

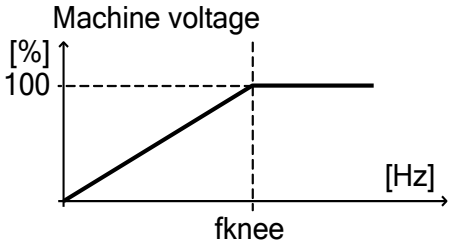
Each AVR is collecting all status information of the ring tie breakers over the RS485 bus in order to select the correct load sharing group. In case of a separated segment the load sharing takes place on the remaining ones and separately on the isolated segment.

3.4.4 *Limiters and Monitor Functions*

3.4.4.1 Limiters

V/Hz Limiter

- V/Hz knee point frequency fknee [Hz]
- Slope Slope [%/fk]
  (diff between fknee and 0Hz)

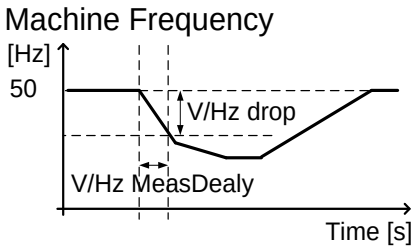


In case of a short circuit at the machine terminals, the frequency is calculated out of the machine current. This guarantees a correct functioning of the V/Hz limiter in any condition.

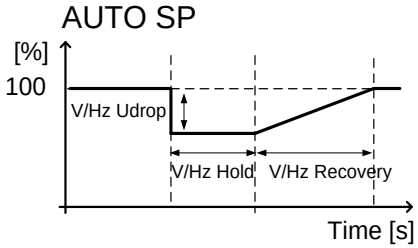
During soft start the V/Hz limiter minimum output is limited to 5%

Sudden AUTO SP drop at frequency drop

- Freq. drop threshold V/Hz Fdrop [Hz]
- Freq. drop time span V/Hz MeasDe [ms]



- AUTO SP drop V/Hz Udrop [%]
- SP hold time V/Hz Hold [sec]
- SP recovery time V/Hz Recov. [sec]



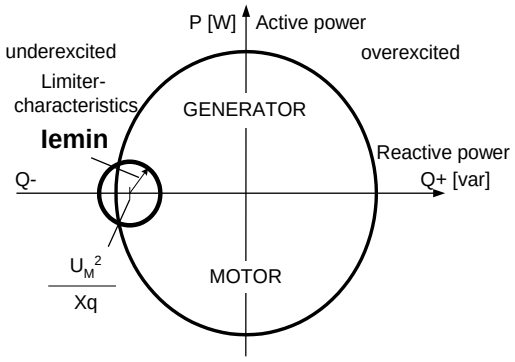
The function is blocked:

- During Soft Start
- When PQ Limiter is active
- When Voltage Relay is active
- When Generator state is “no load” or “Parallel with grid”

Used for heavy load applications in island operation to unload the engine in order to recover faster to nominal speed.

Ie Minimum current limiter

- Minimum limit — Minimum [%]
- Limiter active — Active = True/False

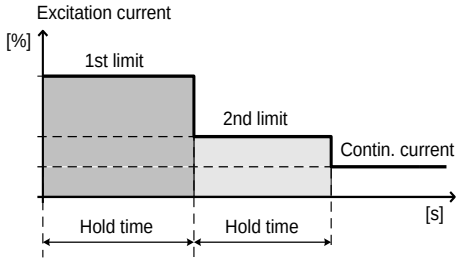


Ie Maximum current limiter

- 1st limit — Maximum [%]
- Hold time — Maximum Hold Time [s]

- 2nd limit delay — Delayed [%]
- Hold time — Delayed Hold Time [s]

Continuous current Limiter active — Continuous [%] Active = True/False

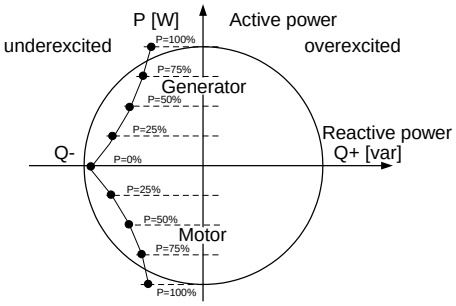


Cool-down behavior
In case Ie Limiter is hit short after Ie Limiter was released, the 1st limit hold time will be reduced in order not to overheat the winding, where the reduction of Limiter times is depending on the time Ie actual was running below 100%.

PQ Limiter
The characteristic is determined by 5 points

- Q limit at P = 0% — Minimum Q(P @ 0%) [%]
- Q limit at P = 25% — Minimum Q(P @ 25%) [%]
- Q limit at P = 50% — Minimum Q(P @ 50%) [%]
- Q limit at P = 75% — Minimum Q(P @ 75%) [%]
- Q limit at P = 100% — Minimum Q(P @ 100%) [%]

Voltage dependency active — Volt.Dependency:True/False
- Limiter active — Active = True/False



UM Limiter (only in PF / Var mode)

- Limiting value of the minimum machine voltage — Minimum [%]
- Limiting value of the maximum machine voltage — Maximum [%]
- Limiter active — Minimum Active = True/False
- Limiter active — Maximum Active = True/False
- With active limiter, AUTO SP is taken from the operation point prior to fault condition — FRT AUTO SP Hold enable = True/False

IM Limiter

- Limiting value of the maximum machine current — Maximum [%]
- Time Multiplier according to IEC 60255-3, Table 1, Col. B, very inversed characteristic — Time Multiplier K
- Limiter active — Maximum Active = True/False

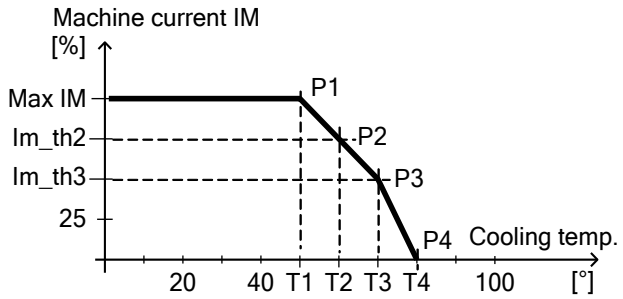
Limiter becomes active after time set by „very inverse characteristic“

$$t = \frac{13.5}{\frac{Im}{I_{LIM}} - 1} * K$$

3.4.4.2 Limiters Temperature Influence

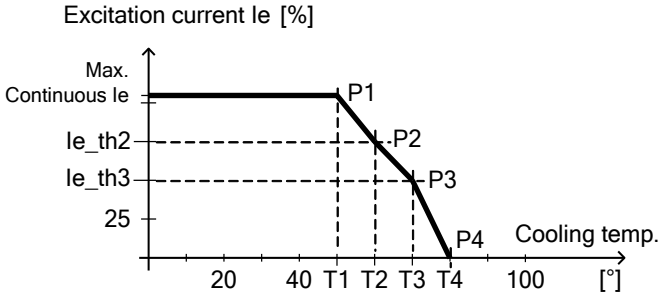
IM Limiter

T1 at Max IM	T1 [°]
T2 at IM th2	T2 [°]
T3 at IM th3	T3 [°]
T4 at IM th4	T4 [°]
Machine current level	IM th2[%]
Machine current level	IM th3[%]



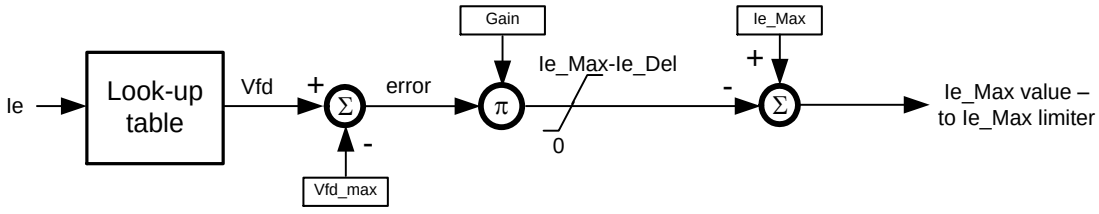
Ie Limiter

T1 at Max continuous Ie	T1 [°]
T2 at Ie th2	T2 [°]
T3 at Ie th3	T3 [°]
T4 at Ie th4	T4 [°]
Excitation current level	Ie th2[%]
Excitation current level	Ie th3[%]



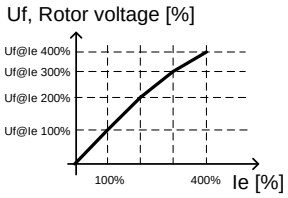
3.4.4.3 Field Voltage Limiter

The measured excitation current is used to estimate the field voltage through a look-up table, in which the values are linearly interpolated. If the estimated field voltage is larger than the defined maximum field voltage (Ufmax), the difference is multiplied with the gain UfLimGain. The resulting value subtracts the maximum excitation current limit Max Ie, thus reducing the field voltage.
If the gain UfLimGain is set to zero, this limiter is disabled.



Look-up table

Uf@Ie100%	Vf [%]
Uf@Ie200%	Vf [%]
Uf@Ie300%	Vf [%]
Uf@Ie400%	Vf [%]
Ufmax	Vf [%]
UfLimGain	[n]



To set this parameter, refer to *6.4.8 Tune Menu.*

3.4.4.4 Double Channel (DCH)

Double Channel (DCH) is an optional feature that integrates supervision or monitor functions and redundant channel support to build robust and flexible double channel systems.
The SW-feature is also used for single channel systems in order to force the system into Manual mode or trip excitation.

3.4.4.4.1 *Overview*

The Double Channel feature has the following main components (*Figure 3-10*):

1. **DCH Supervision / Monitor**

   The Double Channel Supervision is a feature with 23 supervision functions that can be used to trigger two Alarms and/or a Trip output from the AVR. The configuration is performed using a so-called Configuration Matrix.

   In addition, 10 monitor functions can be configured in order to control 2 Monitor Alarm outputs. The monitor Alarm outputs can also be routed to the Supervision alarm and trip outputs.

   With the configuration matrix the customer can define up to 5 independent digital output signals.

2. **Redundant Channel support**

   Channel changeover, DCH Follow-up and *DCH communication*

   The Channel Changeover is a feature used to transfer the control to the other channel; normally used when the active channel trips or under special circumstances (i.e. monitoring alarms) that can be configured in the AVR.

   The DCH Follow-Up is a function which is active as long as the AVR is in Standby mode (i.e. not active), monitoring the setpoint used on the other channel in order to be ready to takeover in case of changeover. The DCH Follow-up is different from the Follow-up used to change between operation modes within the same AVR. For more information see *Chapter 3.4.4.4.8 - DCH Follow-Up*.

   The communication with the *second channel* is made using the CAN interface and is called *DCH Communication*. Throughout the CAN bus, measurements, statuses and setpoints are transmitted and received from both channels. The data information can be read from Panel, CMT1000, using Remote Access and is used

for the channel changeover functionality.

The features included in the Redundant Channel support (channel changeover, follow-up and communication) are in operation and active as long as the DCH CAN communication is enabled and error-free. However, DCH Supervision can be used independently of the existence of a second channel, and is therefore also suitable for single channel applications. DCH Supervision does not depend on the DCH CAN communication.

The Double Channel software must be available in the AVR (i.e. unblocked) before the use of DCH Supervision and/or functions from Redundant Channel support. Otherwise the configuration is not possible and Alarm, Trip and Changeover digital output are unconditionally set to logical zero (i.e. not active). The schema in *Figure 3-10* shows the relationship between the main functions described.

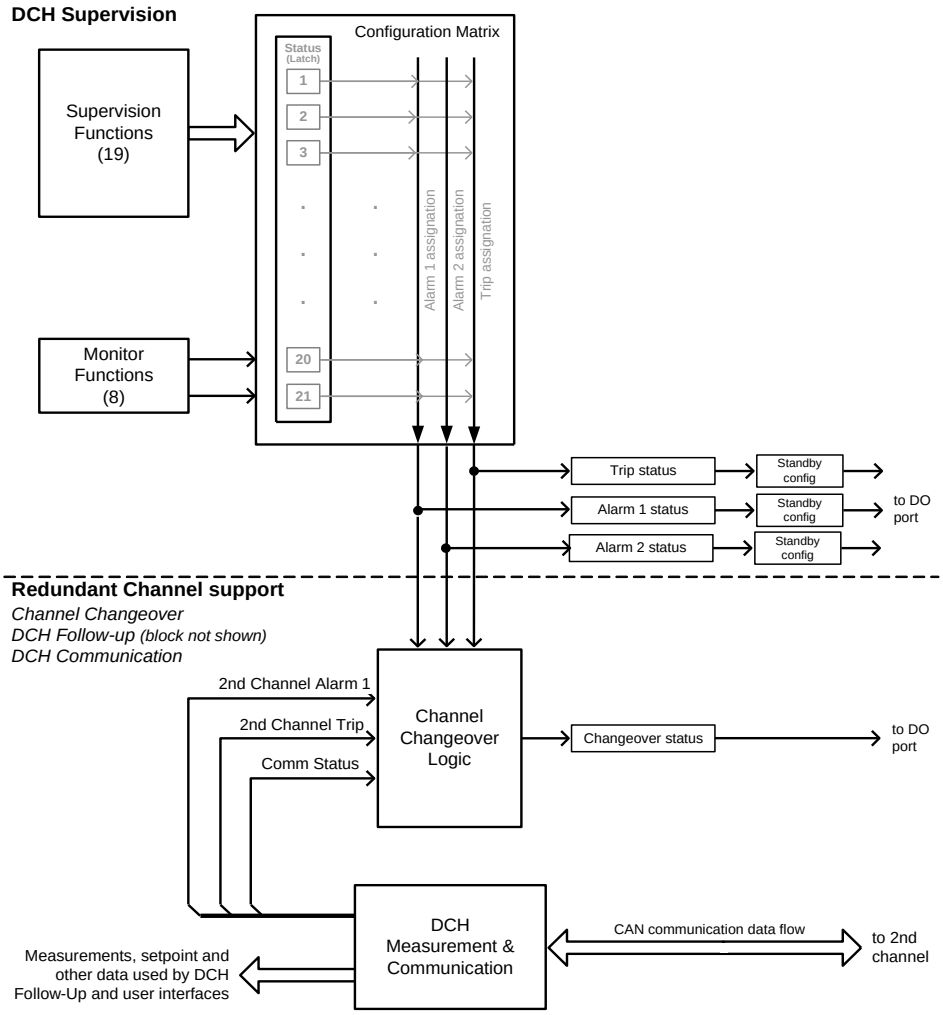


Figure 3-10 Schema of main Double Channel functions.

3.4.4.4.2 *DCH Supervision Functions*

The DCH Supervision has a total of 23 status signals from different supervision functions. It also has two Monitor Alarm outputs that can be configured to generate a (global) Alarm and/or a (global) Trip. As shown in *Figure 3-11*, Alarm and Trip status signals are configured by a so called Configuration Matrix. Alarm and Trip are independent of each other and they can be configured differently.

The Configuration Matrix allows the user to select which monitoring function will produce an Alarm and/or a Trip at the output of the Supervision function. For instance, as soon as a monitoring function, which is configured to produce an Alarm, reports a failure, the Alarm status at the output of the Configuration Matrix will be set to active (logical true). The same could happen to the Trip status if the monitoring function is configured to produce a Trip. The configuration of Alarm and Trip is handled independently of each other and therefore it provides great flexibility when engineering a project-specific system.

Each monitoring function that can be configured in the Configuration Matrix has a *status* which is used to detect the failure and triggers Alarm and/or Trip according to the configuration. The *status* from each monitoring function is implemented with a latch memory which makes the value remain active (logical true) even after the failure has been diminished and the monitoring function no longer reports a failure. Therefore, it is possible to determine which monitoring function causes an Alarm or Trip even after de-exciting the machine. The latch memory of all monitoring function statuses can be cleared by the digital input "Reset Alarm" (only if the failure has already been diminished) or by powering off the device (*Figure 3-11*).

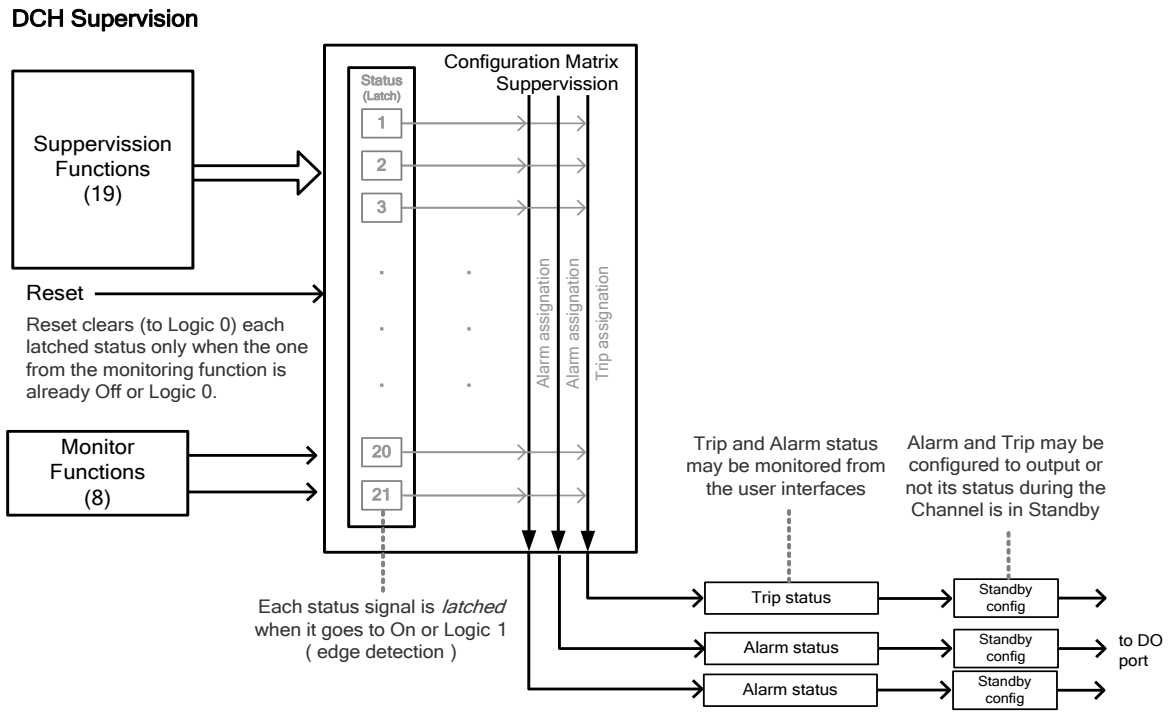


Figure 3-11 Double Channel Supervision.

Both Alarm and Trip statuses are the outputs from the Configuration Matrix and they can be monitored using the CMT1000 and Remote Access. Alarm and Trip Status can be configured as digital outputs (DO), however as shown in *Figure 3-11,* they are not directly connected to the output. Instead they are connected to the Standby Configuration boxes. The Standby Configuration boxes, shown in *Figure 3-11*, prevent Alarm and Trip to output their status values to the DO port during Standby mode; and this function can be used to prevent undesired alarms as long as the Channel is in Standby. When the Standby Configuration blocks the status of Alarm and/or Trip, the value transferred to the DO port is logical zero.

A list with all the DCH monitoring functions (12) is shown in *Table 3-1.* Following, *Table 3-2* shows the 5 status signals from other UN1020 functions which can also be configured with the Configuration Matrix.

Table 3-1 Double Channel Supervision functions.

Supervision Function	***Description***	***Detection Time***
SW real time error On CMT1000: "*Watchdog*"	The SW is not running within time frames or the real-time system **Failure condition:** Controller overload	200ms
MODBUS Comm. Alarm On CMT1000: "*Loss of Remote Control*".	Supervision of MODBUS keep alive Remote Access feature. Active independent of “remote access” is granted. Supervision function is only reset in case new communication is established by toggling the keep-alive bit.	1 sec.
Machine Voltage *One or Two phases lost* On CMT1000: "*Partial Loss of UM*"	Machine PT monitoring function for 3-phase system only. **Failure condition:** Error is detected if U0 sum is over 70% of Unom.	30 msec.
Machine Voltage *Loss of all phases* On CMT1000: *"Loss of UM"*	Machine PT monitoring function. The function is activated only after the Soft start is finished. **Failure condition:** Excitation current is higher than 80% of No-Load and Machine Voltage falls below 10%. Monitor function is triggered only when no short-circuit condition is detected. Short circuit is detected when voltage falls below 10% and machine current jumps up more than 100% within 50ms. The monitor functions can only be reset in case UM>15% and Ie>50% of No Load	60 msec.
Machine current monitor On CMT100: *“Loss of CT”*	Machine CT monitoring function **Failure condition**: Machine current is below 2% and machine voltage is between 90% and 110% and excitation current is out of the range of 50% to 150% of noload excitation current. The supervision function is blocked in Standby mode.	60 msec.
Machine Voltage Freeze monitoring Phase L1 Phase L2 Phase L3 On CMT100: *“UMLx Freeze”*	Monitoring of the electronics for the Machine voltage measurement components on the PCB (this is not a PT monitoring function). **Failure condition:** The voltage measurement is more than 10%, constant and not alternating.	60 msec.

Supervision Function	***Description***	***Detection Time***
Network Freeze monitoring On CMT100: *"Unet Freeze"*	Monitoring of the electronics for the Network voltage measurement components on the PCB (this is not a PT monitoring function). **Failure condition:** The voltage measurement is more than 10%, constant and not alternating.	60 msec.
Machine Current Freeze monitoring On CMT1000: "*IM2 Freeze*"	Monitoring of the electronics for the Machine current measurement components on the PCB (this is not a CT monitoring function). **Failure condition:** The current measurement is more than 10%, constant and not alternating.	60 msec.
Loss of control On CMT1000: "*Loss of control*"	Supervision of PWM control **Failure condition:** Excitation is On, PWM stays below 12.5% of 1/Kceiling and excitation current is above 250% compared to No Load condition. Function is blocked when "Voltage Relay" is active	500 msec.
Loss of Excitation On CMT1000: "*Loss of Excitation*"	Supervision of Excitation current **Failure condition:** Excitation current is less than 50% of the specified value of No-Load condition or Upwr is less than 10V and PWM is above 2/Kceiling. (Ie < 50% OR Upwr < 10V) AND PWM > 2/Kceiling This function is disabled in standby mode. Function is blocked when "Voltage Relay" is active or at switchover (standby channel becomes active) for 5 sec. The time blocking can be disabled in the expert window.	500 msec.
Temperature Level 1 On CMT1000: "*Temperature Limit 70°C*"	Supervision of controller temperature **Failure condition:** Temperature is equal to or above 70 ºC.	2 sec.
Temperature Level 2 On CMT1000: "*Temperature Limit 85°C*"	Supervision of controller temperature **Failure condition:** Temperature is equal to or above 85 ºC.	2 sec.
External Alarm On CMT1000: *"External Alarm"*	Supervision of external digital input signal (must be assigned in the digital input section). **Failure condition:** The digital input value is copied to the status of this function.	100 msec.
RS 485 communication monitor On CMT1000: *"RS485 Bad Frames"*	Communication supervision based on bad frames rates **Failure condition:** Modbus: 10 bad frames in 10 sec VDC: 10 bad frames in 2 sec	10 / 2 sec
VDC breaker error On CMT1000: *"VDC Breaker Status Error "*	Mismatch of breaker detection for busbar configuration or in the same section for VDC ring configuration **Failure condition:** The same breaker will show up with a different status	1 sec

Supervision Function	***Description***	***Detection Time***
Internal Power supply monitor On CMT1000: *"Internal Power Fail"*	Supervision of all internal power supply **Failure conditions**: According to HW design	10 msec
Digital output supervision on CMT1000: *"Digital Output Fail"*	Digital output and 24 V power supply supervision **Failure condition**: Digital output current per pin exceeded 500 mA or 24 V output voltage goes below 12 V dc	10 msec
CAN communication supervision on CMT1000: *"CAN Monitor"*	Supervision of communication in case a double channel setup is used. The following conditions must be fulfilled in order that supervision is active: - Double channel communication must be enabled (checkbox in monitor and protection window) - SWO Startup Hold time must be >0 The supervision becomes active after the startup hold time is expired and no data can be sent / received any more.	1 sec
Monitor Alarm 1	Configured monitor Alarm 1	
Monitor Alarm 2	Configured monitor Alarm 2	
Monitor Alarm 3	Configured monitor Alarm 3	

3.4.4.4.3 *DCH Monitor Functions*

Table 3-2 Monitor function statuses that can be configured with the Configuration Matrix.

Monitor Functions	***Description***	***Detection Time***
FCB Alarm	Supervision of Field Circuit Breaker.	1 sec.
Diode Alarm	Rotating diode monitoring alarm. Requires RDM software (optional).	configurable
Diode Trip	Supervision of diode monitoring trip status. Requires RDM software (optional).	configurable
Generator Overvoltage	Configurable overvoltage monitor	configurable
Generator Undervoltage	Configurable undervoltage monitor Will be activated after soft start is finished	configurable
Excitation Overcurrent	Configurable overcurrent monitor	configurable
Excitation Overvoltage	Configurable overvoltage monitor	configurable
Upwr Overvoltage	Configurable overvoltage monitor of excitation power	configurable
External Alarm	Supervision of external digital input signal (must be assigned in the digital input section).	100 msec.
Emergency Exc. OFF	Emergency Exc. Off Command latch	5 msec.
Reverse Power	Supervision of relative power (Prel) Negative threshold is used for generator mode Positive threshold is used for motor operation	Configurable
GCB Alarm	Alarm is triggered in case GCB cannot be closed by the close command within 2 sec or machine current exceeds 20% with open GCB status	2 sec
AVR output SC	AVR output short-circuit detection	10 ms
Limiter Monitor 1	Sum of configurable Limiter status (Configurable in 'Limiter Monitor' Window)	na
Limiter Monitor 2	Sum of configurable Limiter status (Configurable in 'Limiter Monitor' Window)	na

3.4.4.4.4 *Alarm output toggling*

Supervision and monitor alarms can be assigned for digital outputs as a summary alarm. If a single monitor function is triggered, the output becomes active and the status is latched.

The user can activate the toggling function by means of a parameter if the monitor function detects a new alarm again. In this case the digital output linked to the alarm will be deactivated for 1 sec (toggled off) and reactivated again (toggled on).

3.4.4.4.5 *Channel Changeover Logic*

As shown in *Figure 3-12,* the Changeover status is the output of the AND-gate which depends on the Alarm and Trip Status from the current channel, Alarm and Trip Status from the Second Channel and the DCH Communication Status which is an indication of the communication quality between both channels.

The DCH Communication refers to the data transmitted over CAN between both channels, and it contains setpoint information, measurements, status signals (including Alarm and Trip) and others. The status of this communication is logical one (good) if data coming from the Double Channel feature is received well and free of errors (CRC check). On the other hand, the Communication Status is logical zero (bad) if the received data contained errors, the communication was not enabled (no data received) and/or the configuration was not set properly. Alarm and Trip from the Second Channel should be configured using the DCH Supervision in the other channel.

To increase the flexibility, the Changeover dependency on Alarm and Trip status is configurable; i.e. checkboxes allowing to configure whether these signals are part of the AND and OR gate inputs of the logic decision (*Figure 3-12*). Each checkbox output is determined according to the rules shown in *Figure 3-13*. An important setting is the checkbox connected to the DCH Communication Status, which additionally lets the signal pass through until the input of the AND gate. It also enables the DCH Communication over CAN. The DCH Communication should be enabled to use the Changeover functionality; otherwise the Changeover Status will be zero all the time (see *Figure 3-12* and *Figure 3-13*).

The decision logic from *Figure 3-12* shows that once the DCH Communication is enabled, the dependency of Changeover Status is defined according to the checkbox configuration and the Alarm and Trip status from both channels. When, for instance, the checkboxes are configured according to *Figure 3-12,* the Changeover Status will be logical one when: the Trip Status from the current channel is equal to one, the Trip Status from the Second Channel is equal to zero (i.e. no trip in the Second Channel and it is ready to takeover) and the Communication Status is equal to one (data from the Second Channel is being received correctly).

The Changeover status value is latched (retains the value) when the AND gate output changes from zero-to-one. The latched value may be cleared (to zero) using the Reset command only if the output of the AND gate is already zero as well.

The Changeover status can be assigned to a digital output signal from the AVR. When compared with Alarm and Trip DO signals, the DO assigned for Changeover always outputs the Changeover Status disregarding whether the channel is Standby or Active; for Changeover DO, this cannot be configured as it is for Alarm and Trip.

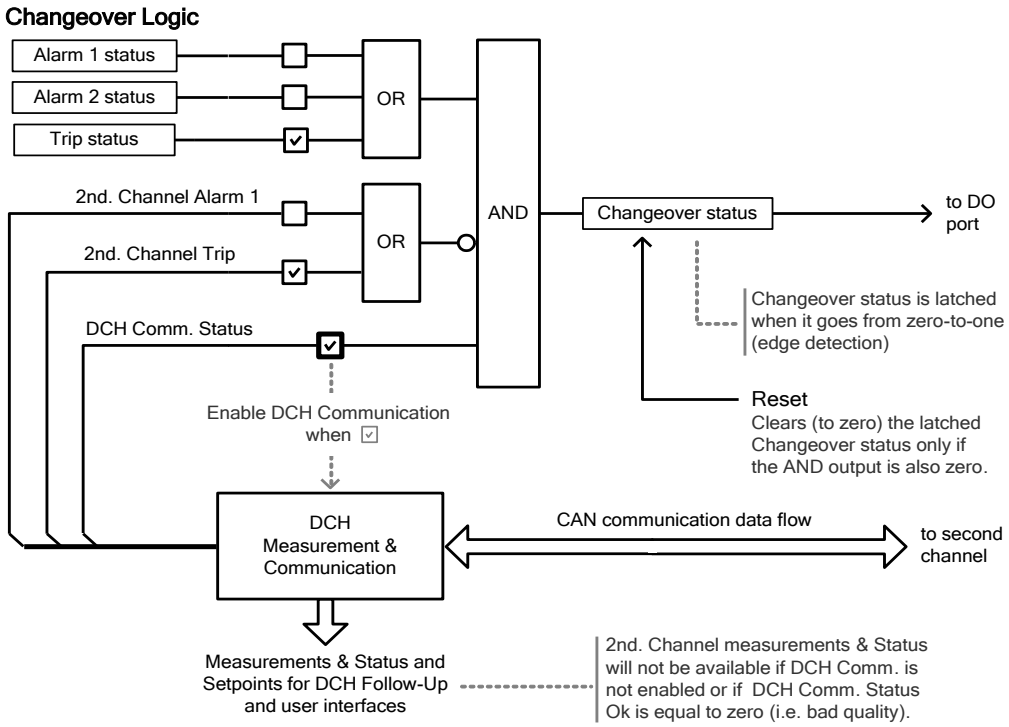


Figure 3-12 Channel Changeover logic and configuration.

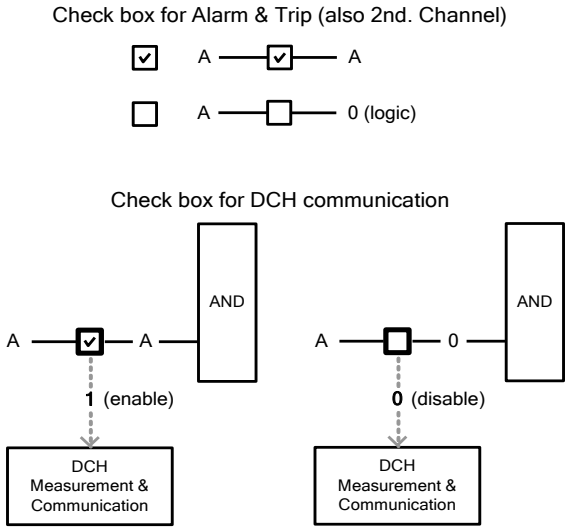


Figure 3-13 Configuration checkboxes rules.

The Changeover output is intended to be used together with the *Standby* input, in order to activate the Redundant channel and deactivate the Main one. The Standby status can be set via Remote Access or via a digital input (common case). *Figure 3-14* shows a typical example of Changeover output to set the Redundant Channel to Standby or Active mode. The *ResetAlarm* input is normally used to clear the latch memory of Changeover

output and bring the Main Channel back to Active (and the Redundant back to Standby) once the failure has been diminished or fixed.

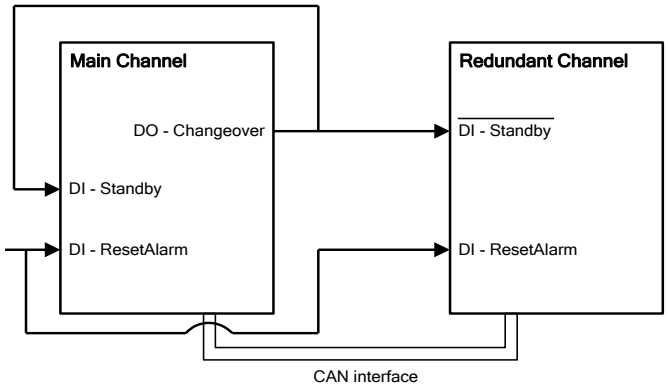


Figure 3-14 Typical configuration of Changeover output

3.4.4.4.6 *Delay on Switch Over output after Power Cycle*

Switching back to channel 1 can be done by applying reset Alarm signal to Channel 1 AVR or by power cycling Channel 1.

In order to enable the correct setpoint follow up on Channel 1, the switch over output is kept active for a defined delay time, configurable by the parameter ***SWO Startup Hold Time,*** which allows Channel 1 to initialize all filters and statuses before taking over control again.
Switchover hold time is normally only active in case of a power cycle. In terms of Modbus communication setup, the hold time can also be enabled for regular switch back by setting the checkbox “SWO Hold Time always active”.

3.4.4.4.7 *Automatic Logic*

Within the DCH SW a configurable logic for forcing the AVR into Manual or automatically switching off excitation logic is provided.

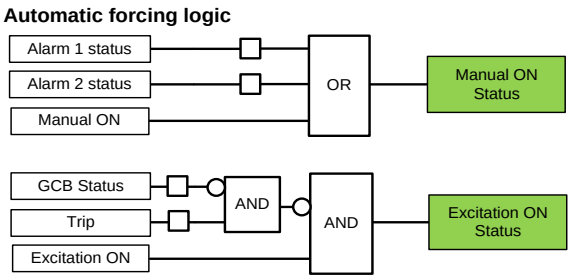


Figure 3-15 Automatic forcing logic

3.4.4.4.8 *DCH Follow-Up*

The DCH Follow-up is an automatic function that runs in the Standby channel, *following* the actual setpoint used by the Active channel, in order to perform a bumpless transfer during changeover. The *DCH Follow-up* is different from *Channel Follow-up*, which is used to have bumpless changeover between operating modes within the same Channel and could also be used on systems without Double Channel software support. For more information about Channel Follow-up see Chapter 3.4.1.5 - *Channel Follow-up*.

The DCH Follow-up uses the setpoint information from the Active channel over the CAN

interface. During DCH software operation, the Active channel sends the setpoints of the current operation mode and the one for Manual mode through the CAN interface. These two values are setpoints *delayed* and calculated out of the measurements of the Active channel; the delaying method minimizes the influence of failures on the setpoint calculation (e.g. wrong measurement due to PT failure) and improves the bumpless characteristic at the moment of changeover.

At the moment of changeover, the Standby channel decides whether to take the setpoint from the Active channel (over the CAN interface) or from its current measurements, before it goes Active. The decision depends on the operation mode of both channels according to the following:

- If operation modes on both channels are the same (except for OpenLoop), the setpoint is taken from the Active channel, i.e. delayed setpoint over CAN.
- If the Standby channel has Manual mode enabled, the setpoint is taken from the Active channel, i.e. delayed setpoint over CAN.
- If the Standby channel has Open Loop mode enabled, the setpoint after changeover is set to zero.
- For all other possibilities not described above, the setpoint will be calculated from the current measurements of the Standby channel; i.e. not from CAN. Under these conditions, the setpoint is calculated based on delayed measurements from the own channel; the delaying method minimizes the influence of failures on the setpoint calculation and improves the bumpless characteristic.

A summary of the described cases is shown in *Table 3-1*

Table 3-3 Setpoint follow-up logic **Note:** SP = Setpoint.

		Mode	**Standby**	**AVR**		
		Auto Sync VDC	Manual	PF	VAR	Openloop
Mode	Auto Sync VDC	**Auto SP of Active AVR**	**Manual SP of Active AVR**	Calculated from Standby AVR Measurements	Calculated from Standby AVR Measurements	SP = 0%
Active	Manual	Calculated from Standby AVR Measurements	**Manual SP of Active AVR**	Calculated from Standby AVR Measurements	Calculated from Standby AVR Measurements	SP = 0%
AVR	PF	Calculated from Standby AVR Measurements	**Manual SP of Active AVR**	**PF SP of Active AVR**	Calculated from Standby AVR Measurements	SP = 0%
	VAR	Calculated from Standby AVR Measurements	**Manual SP of Active AVR**	Calculated from Standby AVR Measurements	**VAR SP of Active AVR**	SP = 0%
	Openloop	Calculated from Standby AVR Measurements	**Manual SP of Active AVR**	Calculated from Standby AVR Measurements	Calculated from Standby AVR Measurements	SP = 0%

The dark-gray cells show the setpoint follow-up taken from the CAN Interface (more reliable)
In order that the channel take over the previous operation point as fast as possible, the PWM of the standby channel starts regulating with the same PWM value of the main channel.

3.4.4.4.9 *DCH Communication: Configuration and Compatibility*

As explained in Chapter 3.4.4.4.3 DCH Monitor Functions

DCH communication must be enabled to use the Changeover feature. When the DCH communication is enabled, measurement, setpoints and status indications from the Second Channel are read and valid as long as the DCH Communication Status is logic one; i.e. correctly configured, enabled and free of communication errors.

The Double Channel software is only partially compatible with the UN1000-PM40 module. The DCH Supervision can be used together with UN1000-PM40, because it does not depend on the CAN communication status and activation. However, a PM40 module cannot be used in the same device, where Changeover and/or DCH Follow-up features are also required. Even whenever DCH Communication can be enabled, the operation of the UN1000-PM40 has a higher priority and the DCH data transmission will be stopped as soon as the AVR detects a UN1000-PM40 on the CAN bus. This priority order is fixed in the AVR and not configurable.

Even without functions from Redundant Channel support, a double channel system with UN1000-PM40 can be built using analog and digital inputs and outputs as communication interface between the AVRs. Furthermore, Alarm and Trip output signals from DCH Supervision could be used to extend the functionality to some extent.

The AVR-ID should be configured with the same number in both channels. One channel should be configured as Main and the other as Redundant. The channel identification can be configured using the CMT1000 or Remote Access. Only one channel should be Active while the other is in Standby. The use of interlocked contacts (connected externally) is a recommended practice to assure this situation. The Standby/Active status of both channels can be monitored using the CMT1000. For more information refer to Chapter *6.4 PC Software Tool*.

3.4.4.5 Rotating Diode Monitoring (RDM)

The aim of the Diode Monitoring is to detect the following failures:

- Break of a diode
- Short circuit of a diode

It is needed in brushless excitation systems and can only be done indirectly, because the diodes are part of the rotor. See the principle circuit for the excitation in *Figure 3-16.*

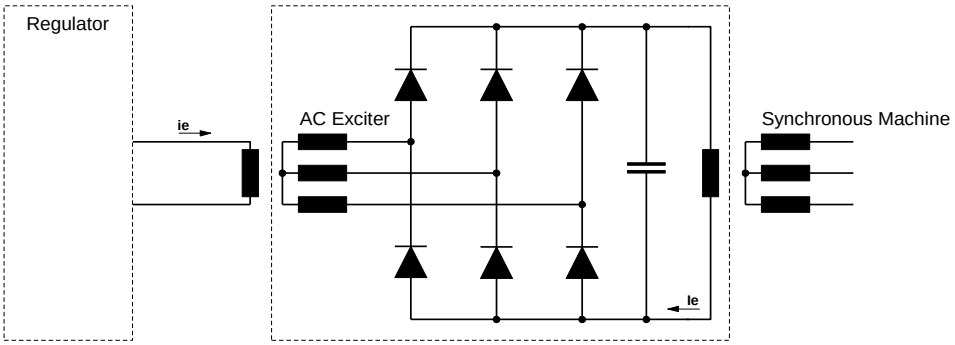


Figure 3-16 Rotating Diode Monitoring application

RDM parameters

Nominal exciter frequency (Machine) :	f Exc Nominal	[Hz]
Exciter time constant :	Tconst Exc	[s]
Diode monitoring active :	Active =	TRUE/FALSE
Diode alarm level:	Alarm Level	[%]
Diode alarm delay :	Alarm Delay	[s]
Diode trip level :	Trip Level	[%]
Diode trip delay :	Trip Delay	[s]

The device evaluates the alternating current induced in the field circuit of the exciter in the event of a fault in the rotating rectifier.
The ALARM is triggered in the event of a broken branch in the rotating exciter.
The TRIP is triggered in the event of a branch short-circuit in the rotating exciter.
The machine frequency must be configured prior to using RDM (in the System Data) in addition to the above-mentioned RDM parameters.

Detecting an alarm or trip is based on the level of ripple current on the exciter frequency, where the filter is tracked by the measured machine frequency. So in order that RDM is working correctly the machine voltage must stay above 10% nominal voltage.

3.4.4.6 Data Logger

The Data Logger is a SW-Option. If this SW-Option is not enabled there is only a reduced functionality available.

It can record max. 12 signals, 7 of which are fixed and 5 of which can be programmed individually.

Fix predefined signals

- Generator Voltage
- Generator Current
- Reactive Power
- Excitation Current
- PWM
- Generator Status
- Generator Operation Mode

The number of samples is limited to 2000 samples/signal. If the SW-Option is disabled the recording will be limited to 200 samples/signal.

3.4.4.7 Event Monitor

Events are stored on non-volatile flash and can be read out by MODBUS requests. Event triggering signals are grouped as follows:

- Generator state changes
- Active Mode changes
- Limiters ON and OFF
- Alarms
- Trips
- Excitation ON (operation mode)
- Parameter change

3.4.5 *Miscellaneous Functions*

3.4.5.1 History Logger

The History Logger records the last two hours of operation. A measurement sample of 12 defined signals is stored in the non-volatile flash every minute. Each time the excitation is started the default values are stored in the log to identify restart conditions.

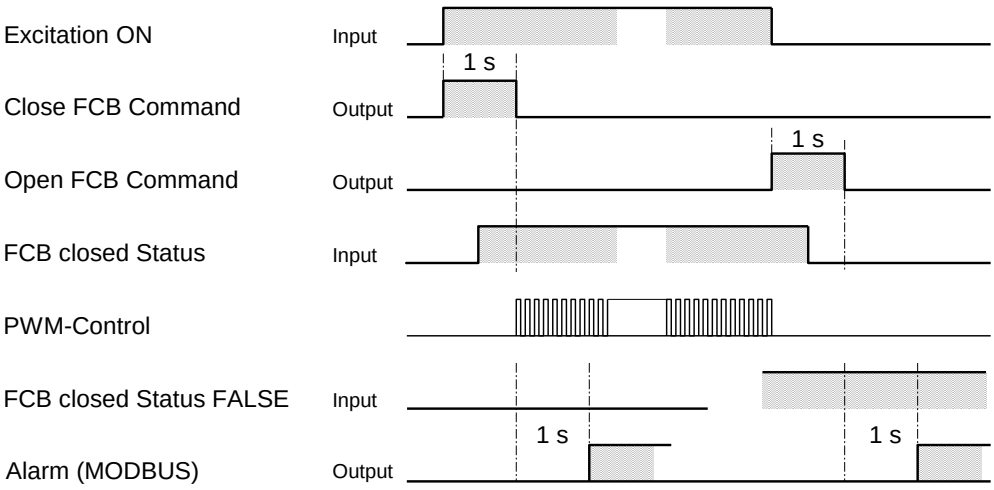
Table 3-4 Recorded signal of History logger

Signal	***Signal identification***	***Value of start Exc.***
Machine voltage	Umrel	0%
Machine current	IM2rel	0%
Reactive power	Qrel	0%
AVR output PWM	PWM	50%
Generator state	GenState	0
AVR Control mode	Generator control mode	0
Machine frequency	fMachine	0Hz
Limiter status	Combined Limit	0
Active Power	Prel	0%
AVR input voltage (rectified)	Upwr	0V
Temperature of controller	Temperature DSP	0°C

3.4.5.2 FCB Control

Field circuit breaker control

FCB Control is an alternative way to control the field circuit breaker. The control is active, when the FCB command signals are configured.



In redundant channel operation the FCB closing works as follows:

- Main channel: FCB close command is given when Ex. ON command is received as described above
- Redundant channel: FCB close command is given as soon as the redundant channel becomes active (Standby not active)

Open FCB command is given only in case of received Exc OFF command regardless whether the AVR is active or in standby operation.

3.4.5.3 Miscellaneous expert functions

Details on expert functions are described in a separate document.

Functions	***Description***	***Required SW Option***
Kc Freq Dep (2)	Adjust PID output by multiplying the frequency gain correction. a) Kc Freq Dep Linear b) Kc Freq Dep 2 Both selected: square	PWM Inversion
Hold ExcOn when GCB closed	Safety feature for marine applications. Excitation OFF can only be achieved after GCB was closed in case GCB status is open again.	None
Um Filter ena BS 50Hz to 200Hz	Add filter on calculated RMS value	None
Um Filter ena LP 25Hz	Add filter on calculated RMS value	None
UnSym. Anti Windup	PID integrator anti windup logic disabled in case of negative error until integrator is set to 0.	None
Compounding AVR	Inverts the PWM output signal	PWM Inversion
Switch OFF Loss of Exc. Delay	Monitor function “Loss of Excitation” is disabled in standby mode. When changing from standby to active mode, a delay of 5 sec of switching on monitor function is implemented. Options will activate monitor function at once when AVR becomes active	
Field Voltage Limiter	See separate chapter	None

Kp	Setting of derivator gain	None
Upwer@Nolad	Adjustment of kceiling depending on input voltage	None
HIR Controller	High initial Response controller: Fast proportional exciter current regulator, processing the output AUTO PID regulator as an input to fast exciter current regulator. Improves stability for very high ceiling factors	None
Ve Limiter	Limits PWM output Improves stability for very high ceiling factors	None
Non-linear error of AUTO PID	Non-linear error amplification depending on configurable threshold	None
FRT Testing	Manipulating voltage measurement signal by multiplication of time profile **Attention**: The machine will boost and deliver extensive Q to the network	None

3.4.5.4 Power System Stabilizer (PSS)

The PSS is used to improve the damping of possible oscillations in large transmission networks by adding a signal to the voltage regulator of the existing excitation system. It is also used to attenuate local rotor oscillations in synchronous generators through additional influencing of the excitation. The main application is in excitation systems in single or multi-machine power plants.

Electromechanical oscillations can be classified into four main categories:

- **Local oscillations** between a unit and the rest of the generating station and between the latter and the rest of the power system. Their frequencies typically range from 0.8 to 2.0 Hz.
- **Inter-plant oscillations** between two electrically close generation plants. Frequencies may vary from 1 to 2 Hz.
- **Inter-area oscillations** between two major groups of generation plants. Frequencies are in a typical range of 0.2 to 0.8 Hz.
- **Global oscillation** characterized by a common in-phase oscillation of all generators as found on an isolated system. The frequency of such a global mode is typically under 0.2 Hz.

The IEEE Std. 421.5-1995 PSS 2A/2B/2C type model functionally represents the PSS. This model is shown in the figure below.

The object of the power system stabilizing (PSS) equipment is to increase the generator exciter‘s contribution in order to improve the stability of the highest possible operating range of the generator. The PSS derives additional signals from the generator internal frequency, which considerably improves the stability of the power transmission.

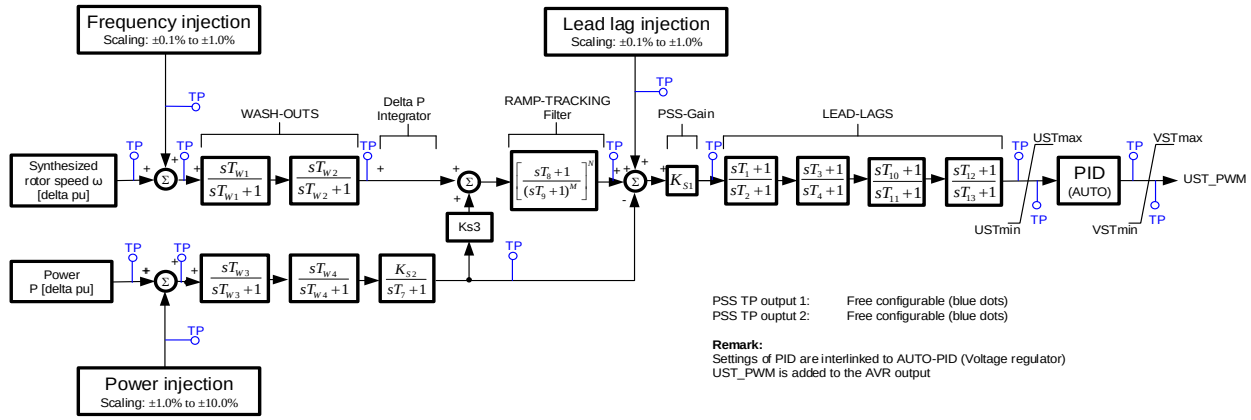


Figure 3-17 PSS model.

Figure 3-18 shows a simplified diagram of the PSS and related functions

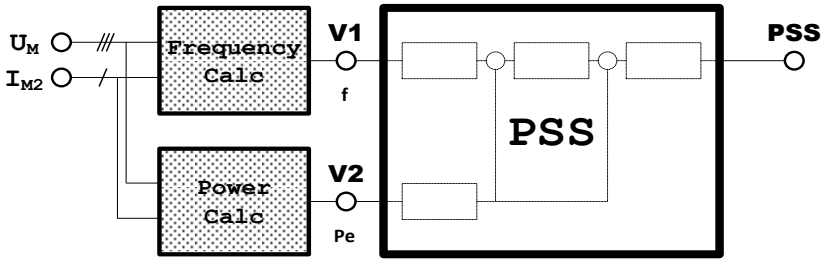


Figure 3-18. Simplified diagram of PSS.

The frequency input is based on synthesized frequency measurement taking into account terminal voltage as well as machine current.

Due to the PSS function implementation and structure of UNITROL 1020 AVR, there are some points to be noticed when using this PSS. The following elements limit the maximum performance of the PSS:

- Brushless excitation system,
- Positive field voltage (only) can be supplied.

PSS Parameters

The PSS function can be activated by the PSS_SELECT configuration and by digital input or over Modbus.

If digital input “PSS Enable” is activated, PSS activation only depends on the status of the digital input. Otherwise PSS activation is defined by the parameter PSS-Select or the Modbus control bit.

PSS is blocked in case the machine voltage is below 0.8 p.u., above 1.2 p.u. or active power is below the defined threshold. In addition, the PSS can be blocked by configurable frequency gradients.

The PSS feature is only functional if the PSS SW Option is released on the unit.
The PSS signal comes either from the internal PSS or from the analog input ‘External PSS’. The switch is controlled by a checkbox in the PSS setup.

When the switch is set to external PSS, the internal PSS calculation can be skipped.

The parameters are not explained here. For more information refer to the following documents:

- UNITROL 1020 Power System Stabilizer (PSS) Engineering Notes
  Doc. No. 3BHS351450 E01
- Simplified Computer Representation for Power System Stability Studies
  UNITROL 1020 and UNITROL 1010
  Doc. No. 3BHS354059 E01

3.4.6 *Modbus for Remote Access*

Remote Access is a feature that allows monitoring and control of the AVR using the MODBUS protocol. It can be suitable for applications where the control from remote locations is preferred (i.e. offshore) and/or a custom user interface is required.

The following sections explain the Remote Access software and configuration. The electrical connections are described in Chapter *3.3.9 Communication Ports*. It is recommended to read Chapter *3.4.7 Access Levels* prior to this section, in order to fully understand the software capabilities.

3.4.6.1 Overview

A remote terminal configured as MODBUS master can access the device through RS485 or Ethernet TCP/IP using Remote Access. The communication choice is up to the application requirements but since VDC needs a dedicated RS485 connection, Ethernet TCP/IP is the only choice when VDC is used. When VDC is not needed, Remote Access can be performed using the RS485 interface. More information about the communication interfaces can be found in *3.3.9 Communication Ports*.

The Remote Access feature allows the user to read and write registers (measurements, setpoints and other information) from the AVR. The document that describes the MODBUS Registers Table is normally included in the CD-ROM that comes with new devices. It can also be ordered from ABB. The manufacturer details and contact information can be found in Chapter *1.5 - Manufacturer's Address*.

The feature supports up to one MODBUS remote terminal and it must be assured that requests are sent from only one remote terminal using the same communication interface (RS485 or Ethernet TCP/IP). If more than one request comes from different interfaces, they might be answered via the same interface from where they come. This method is however not recommended and should not be used.

In order to communicate with the device, the remote terminal should gain a determined *access level* in the AVR according to the operation desired: Monitor Access for reading only and Control Access for reading and writing to registers. More information about Access Levels can be found in Chapter *3.4.7 - Access Levels*.

3.4.6.2 Compatibility

The Remote Access feature over RS485 cannot be used together with VDC. If both Remote Access and VDC are required, Remote Access should be used via TCP/IP using an external gateway. When VDC mode is not required, Remote Access can be used via either RS485 or Ethernet. For more information see Chapter *3.3.9 - Communication Ports*.

3.4.6.3 Configuration

Remote Access over RS485 has a number of parameters that should be configured: Protocol (Modbus RTU or TCP), Activation (of the feature over RS485), Baud Rate, Answer delay and others shown in Chapter *6.4.7 Communication Menu*.

The Modbus Slave ID value is used for both Remote Access over RS485 and Ethernet TCP/IP; there is no differentiation of the physical interface. This number can be

configured between 1 and 247; the latter being the default value. A restriction applies when the number is configured between 1 and 63 (except 32) and matches with the AVR ID number for main channels or AVR ID number +32 for the redundant channel.

In these situations, the AVR will change the Remote Access Slave ID to 247 upon restart. The Modbus Slave-ID for Remote Access can be configured between 64 and 247 without restrictions. This is the range which is recommended for most applications.

The Modbus slave ID used for CMT1000 access is a number between 1 and 63, which depends on the AVR-ID and the Channel Identification (Main or Redundant), even if the Double Channel feature is not being used. When the parameterization is done using the CMT1000, the Modbus ID used for CMT1000 is shown in the MODBUS Supervision window. This number should not be used as Modbus Slave ID for Remote Access. For further information refer to Chapter *6.4.7 Communication Menu*.

3.4.7 *Access Levels*

Generally, digital inputs have the highest priority when controlling the AVR. Remote access for control signals, e.g. Excitation ON, is only possible if the digital input is not assigned.
The UN1020 device can be accessed from three different operators: Front Panel, CMT1000 or Remote Access. While all operators can read data simultaneously, only one of them can have *control access* and is allowed to write or change parameters in the AVR. This concurrence is managed in the AVR main controller by assigning, to each operator, a determined *Access Level* or privilege:

- **Local control mode (default)**
  The UN1020 device is by default in local control.
- **Front panel control (highest priority)**
  The customer can take over control to change parameters, the UN1020 device will automatically switch back to local control mode
  Customers who are taking control by the panel will block out other operators
- **CMT1000 control (medium priority)**
  CMT1000 can be connected to the target, where three different access levels are defined: Offline, Monitor and Control.
  If front panel control is granted, then CMT1000 cannot be set to control mode in order to change parameters.
  CMT1000 will block out other CMT1000 applications or remote access of plant control system if CMT1000 control mode is used.
  In case CMT1000 is disconnected from the target the UN1020 device will go back to local control mode.
- **Remote access (lowest priority)**
  Remote access is granted only if the UN1020 device is in local control mode.

The Access Level status of each operator is stored in the AVR main controller and is used to grant and deny access requests. An operator can request the change of its Access level to the AVR main controller, i.e. from Monitor to Control. Access changes to Monitor are normally granted without restrictions since all sources can read simultaneously from the AVR.

An Access Level changing request can be denied when more than one CMT1000 and/or more than one Remote Access device are trying to establish a connection to the same AVR. The UN1020 supports a simultaneous connection of one CMT1000 and up to ten

independent Remote Access connections per device (maximum). If those limitations are surpassed, one or all connected operators can lose their access and go Offline. This practice is not recommended by ABB. The method to change Access Levels from Panel, CMT1000 and Remote Access is explained in the following sections. For more details about UN1020 user interfaces, refer to *Chapter 6 - Operation*.

3.4.7.1 Panel

The Panel is normally in Monitor mode. By clicking the LOC button, the access right is given to the panel. All other operators are blocked out.

3.4.7.2 CMT1000

The CMT1000 manages the Access changing requests (Offline, Monitor and Control) by using a graphic slide-bar displayed in the software main window. The slide-bar shows the CMT1000 current access status from the AVR and allows the user to simply change it by sliding up and down. For more information about the user interfaces see *Chapter 6 - Operation.*
Changing to Control mode is not granted if the panel is in local mode. If the Plant control system is in Control mode over remote access, the CMT1000 forces it into Monitor mode. This means the plant control system has only read access.

- **Offline or disconnected (no access)**

  If the status of an operator is Offline, the AVR microcontroller considers the operator as not connected to the UN1020 and, therefore, there is mainly no data exchange with the AVR. Only when using the CMT1000 as operator and the presence of a compatible AVR is detected, a small quantity of data is exchanged to provide and display the AVR-ID information on the main window of the software.

- **Monitor (read access)**

  If an operator has Monitor Access, it is only possible to *read* data from the device (i.e. measurements, parameters, etc.). Data cannot be changed or modified in the AVR during this access mode. All the operators, i.e. Panel, CMT1000 and Remote Access, can have Monitor access to the AVR at the same time; all of them can read simultaneously from the same AVR.

- **Control (read and write, full access)**

  If an operator has Control Access, he has full control of the device (write and read data). All operators can request Control Access, but the access will be granted to only one operator at the same time, based on the operator's priority.

3.4.7.3 Remote Access

Changing of Access Levels from Remote Access is performed by requests via Modbus protocol. Control access level is only granted if no other operator is in control mode. For more information, refer to the *UN1020 Modbus Reference* document: Doc. No 3BHS358281 E80.

Chapter 4 - Installation and Storage

4.1 General

Chapter 4 – Installation and Storage provides all instructions for installation and storage of the excitation system. It also contains information on how to dispose of and recycle materials.

4.2 Safety Regulations

NOTICE!

First read and understand the general safety instructions in *Chapter 2 - Safety Instructions* before starting to work with the excitation system.

NOTICE!

Converter components can be damaged while transporting the excitation system.

4.3 Unpacking

The unit should be unpacked with the maximum care, without the use of force and using suitable tools.

The unit should be inspected visually to check for any damage caused during transport. Complaints regarding defects resulting from inappropriate transport are to be addressed immediately to the receiving station or the last carrier.

NOTICE!

The unit is visibly damaged:

- Safe operation is not possible.
- The unit must not be installed and taken into operation.

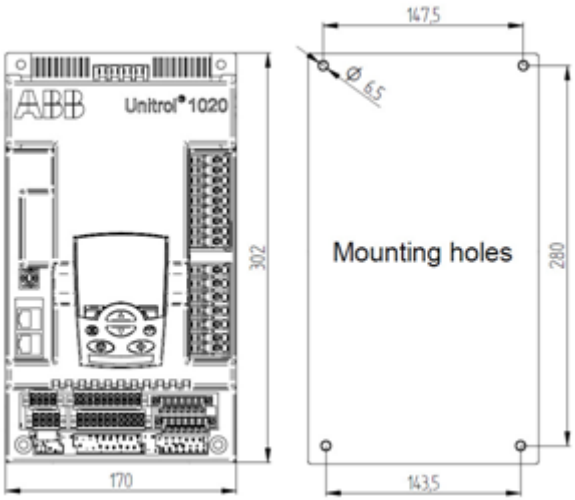
4.4 Mechanical Installation

The unit is mounted by means of four screws.

See dimensional diagram for fixing holes and spacing.

Mounting instructions see Chapter *3.3 - Hardware*

The unit should only be installed in indoor areas which are dry and dust-free and which do not contain any gases, acid fumes or similar.

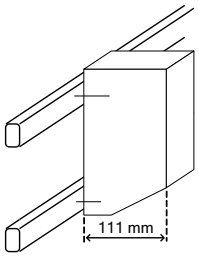


Mounting

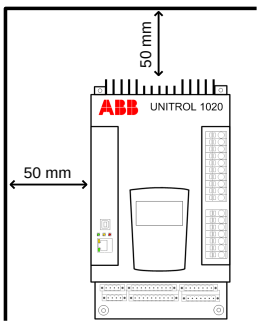
The UNITROL 1020 is designed for rack or wall mounting in upright position.

A distance of approx. 50 mm around the unit shall be kept free for optimal cooling.

Rack mounting



Wall mounting



NOTICE!

Electrostatic discharge (ESD) can damage electronic boards and components!

- Do not touch printed circuit boards or other sensitive components without taking static-sensitive handling precautions.
- Do not touch the components without wearing a wrist grounding strap.
- Put the board or component on a grounded working surface which is protected against electrostatic discharges.
- Hold a board only at the edge.
- Handle a faulty board with care.

4.5 Electrical Installation

The emission limits in accordance with standard EN 61000-6-4 will only be complied with if the connections for the power electronics supply and the field output are made using shielded cables grounded at each end. We also recommend that shielded cables be used for the analog and digital connections.

The connection terminals are fitted on the front side of the unit, on three levels:

Cross sections	- Power electronics, terminal numbers 1 to 17	0.2 to 4 mm^2	(AWG 24 to 10)
	- Electronic sections, terminal numbers 20 to 77	0.2 to 2.5 mm^2	(AWG 24 to 12)

The casing must be grounded at terminal 17 with 4 mm^2. Additional earth terminals are provided for the shielded cables. The ground connection should be kept as short as possible.

NOTICE!

Excitation cables longer than 3 m should be shielded. If not, there is a risk of severe EMI-distortion.

4.5.1 *Digital and analog IO cabling 1020*

Digital and analog IOs are referenced to PE, meaning analog and digital ground (Dx / BOx) is connected directly to PE.

Therefore the maximum cable length is limited to 30m.

In addition the following recommendations shall be followed:

- <3m: none
- 3-10m: Twisted pair cable
- 10-30m: Shielded cable with one PE connection close to the UNITROL 1000 device.
- >30m: not allowed

Digital and analog IO cables must be separated from any power or measurement cable

4.5.2 *Inrush current of UNITROL 1020*

Due to the large internal DC capacitor the inrush current might become very high especially with a strong voltage source.

Following instructions must be followed in order not to damage UNITROL 1020

Shunt supply	Excitation power is taken from the generator output over a shunt transformer ➔ Always use excitation supply transformer ➔ Excitation transformer must not exceed 10 kVA
PMG supply	Excitation power is taken form PMG ➔ PMG output power must not exceed 10 kVA
Auxiliary Windings	Excitation power is taken from additional stator winding of the generator ➔ No measures must be taken
Auxiliary supply	Excitation power is taken directly from an auxiliary power source ➔ Use always excitation supply transformer ➔ Excitation transformer must not exceed 10 kVA
DC battery	Excitation is taken from a battery ➔ Inrush current must be limited by a resistor

Inrush can be easily calculated assuming that the capacitor voltage is 0V at startup. The external resistor for 200Vac input is typically 1.5Ω.

NOTICE!

This inrush current must be limited to 200 A average for 10 ms, otherwise the unit might be damaged

4.5.3 *Extended operation lifetime with external capacitor*

Operation lifetime is limited by the internal capacitor used to filter the excitation input power. The operation lifetime is influenced by:

a) Ambient temperature, +10 °C decreases lifetime by factor 2

b) Nominal excitation output current

c) Source of input voltage, DC, 3-phase or single-phase

The following table defines when an external capacitor is needed in order to have a suitable operation lifetime.

Table 4-1 Operational Lifetime Chart for UNITROL 1020

Operational Lifetime Chart for UNITROL 1020

Light Grey: No external capacitor needed
Dark Grey: External capacitor needed
Black: No operation possible

Excitation Current Supply	<5A	5A to 8A	8A to 10A	10A to 15A	15A to 20A	Ambient Temperature
1 phase input						<30°C
						30° to 40°C
						40° to 55°C
						55° to 70°C
3 phase or DC input						<30°C
						30° to 40°C
						40° to 55°C
						55° to 70°C

4.6 Storage

The storage procedures described below must be followed in order to avoid damage or a degradation of quality due to corrosion, dirt or mechanical damage. The corresponding precautions must be observed from the time the equipment is put into storage until the time it is taken out of storage and installed.

4.6.1 *Storage Conditions*

The equipment must be stored in the original packing.

Make sure that the following environmental conditions are fulfilled during the entire period of storage. ABB recommends keeping the air temperature and the relative air humidity constant:

Air temperature: 0 °C to +55 °C

4.6.2 *Disposal*

Used materials can serve as raw materials for recycling or other purposes. For an ecological separation of materials and waste handling contact your community or the local waste disposal company.

The printed circuit boards are simple to remove. The boards must be removed and should be disposed of by a licensed disposal company. Environmentally hazardous elements such as capacitors must be separated from the boards.

Dispose of the following components according to local regulations:

1. Capacitors
2. Printed circuit boards
3. Electronic components
4. Batteries

4.7 Recycling Instructions

The inappropriate disposal of electrical equipment can lead to an environmental hazard. It is therefore important that electrical equipment be disposed of by qualified personnel.

The metallic casing, cover and front frame do not present any environmental risk and can be recycled.

The circuit boards must be removed and should be disposed of by a licensed disposal company. Environmentally harmful elements such as capacitors must be separated from the circuit boards.

The Unitrol 1000 devices are environmentally friendly designed. The circuit boards are easy to remove.

Product disposal can be made in two alternative ways. The product can be disassembled manually or crushed in a shredding machine.

4.7.1 *Manual Disassembly*

The product is disassembled manually and parts are sorted according to their material contents as follows:

• Aluminum (cabinets, heat sinks etc.)

• Plastics

• Printed circuit boards

Metal parts (iron, copper and aluminum) can easily be recycled, other materials according to local arrangements.

4.7.2 Mechanical Shredding

In this method, a whole product is mechanically shredded into small pieces. Materials are sorted using dedicated sorting processes. Components containing harmful materials must however be removed before shredding.

Chapter 5 - Commissioning

5.1 General

The commissioning should be carried out by certified commissioning personnel.

5.2 Safety Regulations

The safety regulations according to *Chapter 2 - Safety Instructions* must be followed.

WARNING!

UNITROL 1020 units operate with dangerous voltages of up to 300 V ac or 300 V dc.

Manipulation of live parts can lead to death or injury to the persons involved or damage to the surroundings.

Possible risks are largely excluded if the unit is handled properly in accordance with these instructions.

WARNING!

The secondary voltage of the excitation transformer and the voltage of the excitation field are fed into the excitation cabinet.

These components present a great danger of electric shocks.

The control elements and the PC interface on the front plate of the UNITROL 1020 unit are to be touched and/or attached only with caution.

After the unit has been switched off, it must be ensured by measurement that no measuring voltages or control voltages >50 V are present at the terminals. At an interrupted field circuit the input capacitor is slowly discharged through internal circuits.

In order to prevent unintentional closing of open voltage circuits by third parties, the circuits in question should be identified at the point of interruption (e.g. by means of a warning sign).

Before switching on, check whether the connection terminals are wired up according to the plant schematic.

5.3 Setting Aids

All parameters have to be controlled at the first commissioning.

See the description of the parameters in Chapter 3.4.1.6 *Description of Parameters* and settings recorded in Chapter *7.3 - Standard Procedures for Maintenance*.

Parameter Settings, Default Values

Overview of parameter blocks	
Setup	System Data Soft Start Field Flashing Limiters Setpoints Voltage Droop Compensation Digital I/Os Analog Inputs Analog Outputs Synchronization Diode Monitoring PSS Double Channel AVR Time and Date Data Logger
Communication	ID Definition Port Configuration AVR Ethernet Settings MODBUS Supervision VDC Monitor
Tune	Setpoint Adjust Auto PF/Var/PQ Limiter Manual/Ie Limiter

5.3.1 *Setting Aids*

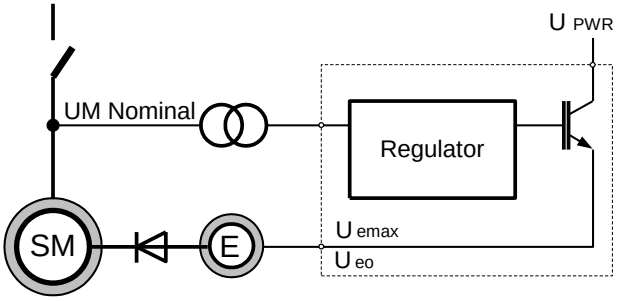
5.3.1.1 Setup \ System Data, Ceiling Factor Kceil

The following section describes how to determine the Ceiling Factor in two different ways. We recommend the measuring method. Measuring method:

$$K_{ceil} = \frac{Ue\max}{Ueo} = \frac{100}{PWMnoload}$$

Uemax: Maximum output voltage

Ueo: Output voltage at nominal voltage of the machine (machine in no-load operation)



PWM no load: Regulator output at no load (PWM)

Definition: The ceiling factor Kceil determines the relationship between the maximum output voltage of the regulator and the exciter voltage, which is required for no-load excitation and is thus a measure for the possible overexcitation of the machine.

Example: Regulator output signal (PWM) at no load shows 20% at nominal voltage

$$K_{ceil} = \frac{100}{20} = 5$$

Calculating method		
Power electronics supply	Three-phase	Uemax = 1.35 ***** UPWR - 8 V
	Single-phase	Uemax = 1.25 ***** UPWR - 8 V
	DC	Uemax = 0.98 ***** UPWR - 8 V

Example	
Specifications	Power electronics supply U_{PWR} = 240 V, single-phase
	No-load exciter voltage Ueo = 50 V
Calculation	Uemax = 1.25 * 240 V - 8 V = 292 V
	Kceil = 292 V/50 V = 5.8 p.u.

NOTICE!

The Kceiling value **must** be in the range of 5 to 15 in order to achieve optimal and stable regulation. If not, the input voltage value may have to be reduced.

NOTICE!

The ceiling value must be calculated for a machine working at nominal load, therefore ceiling factor measurement with PWM can only be considered after the machine reaches nominal operational temperature.

5.3.1.2 Setup \ System Data, Machine Reactance Xq (non-saturated)

- Salient pole machine: Xq ≈ 0.7 to 0.5 Xd
- Cylindrical-rotor machine (Turbo): Xq ≈ Xd

5.3.1.3 Setup \ Soft Start

Soft start must match the start-up time of the machine. Soft start ramp should reach 100% nominal voltage after the machine reaches nominal frequency.

5.3.1.4 Setup \ Field Flashing

Field flashing must start to build up voltage, but on the other hand must not over-excite the machine. Designing a proper field flashing is a demanding engineering task. Maximum excitation current of field flashing circuits must be between 10% and 15% of I_e no load.

5.3.1.5 Setup \ Limiters, in Manual and Open Loop Mode

No limiters are active in Manual and Open loop mode.

5.3.1.6 Setup \ Limiters \ Operational Limits \ UM Limiter

The limiting values of the UM limiter are, as a rule, set equally, like the setpoint range of the voltage regulator (Auto mode).

Setpoint Auto	***UM Limiter***	***Example***
Minimum	= Minimum	90%
Maximum	= Maximum	110%

5.3.1.7 Setup \ Limiters \ Operational Limits \ Ie Limiter

Depending on the machine data and recommendations of the machine supplier.

5.3.1.8 Setup \ Limiters \ Operational Limits \ IM Limiter

Depending on the machine data and recommendations of the machine supplier.

5.3.1.9 Setup \ Limiters \ Operational Limits \ Q Limiter

Depending on the machine data and recommendations of the machine supplier.

5.3.1.10 Setup \ Digital I/Os, Configuration

Software configuration of the digital I/Os

- Define terminal as input or output
- Assign terminal to desired signal
- Select polarity

Note:

Digital IO can be configured at the same time as input and output

5.3.1.11 Setup \ Analog Inputs / Outputs, Configuration

Software configuration of the analog inputs

- Assign terminal to desired signal.
- Define signal level of the input signal [Uin 0% to Uin 100%].
- If the input is used as a digital input, the desired signal name is to be assigned in the menu.

Software configuration of the analog outputs

- Assign terminal to desired signal.
- Define signal level of the output signal [Uout 0% to Uout 100%].
- Define signal level of the field current [Ie 0% to Ie 100%].

5.3.1.12 Setup \ Digital I/Os, Selection of Operating Mode

The operating mode is selected via the digital inputs. For this purpose, a maximum of 10 inputs have to be occupied by the following signals:

Mode	***Digital inputs to be assigned***								
	Stand by	SYN	Gen CB Closed Status	Parallel with Grid Status	Manual Enable	Open Loop Enable	VDC Enable	PF Enable	Var Enable
Standby	1	X	X	X	X	X	X	X	X
Sync	0	1	X	X	X	X	X	X	X
Manual	0	0	X	X	1	X	X	X	X
Open Loop	0	0	X	X	0	1	X	X	X
VDC	0	0	1	0	0	0	1	X	X
PF	0	0	1	1	0	0	0	1	X
Var	0	0	1	1	0	0	0	0	1
Auto	0	0	0	X	0	0	X	X	X
with *)	0	0	1	X	0	0	0	0	0

*) with droop or compensation
0 = logical 0 or open 1 = logical 1, X = not relevant

Note: If an input is to be continuously logical 1, then it can also be inverted by software means. The input then naturally counts as being occupied.

The inputs DI13 to DI18 can be used as virtual digital inputs even if they are not defined in Analog Inputs as Digital Inputs.

5.3.1.13 Setup \ Synchronization

The machine frequency must always be higher than the network frequency and cannot be synchronized by a positive slip.

5.3.1.14 Setup \ Diode Monitoring

The Nominal Exciter Frequency has to be adjusted. For the others, the default value has to be kept.

$f_{exc} = P_{exc} \times f_{gen} / P_{gen}$

f_{exc}	Nominal Exciter frequency
P_{exc}	Number of pole pairs in exciter machine
f_{gen}	Nominal Generator frequency
P_{gen}	Number of pole pairs in generator

5.3.1.15 Setup \ PSS

ABB offers PSS parameter calculation and stability studies, contact us for further questions.
For more information refer to following documents:

- UNITROL 1020 Power System Stabilizer (PSS) Engineering Notes
  Doc. No. 3BHS351450 E01
- Simplified Computer Representation for Power System Stability Studies
  UNITROL 1020 and UNITROL 1010
  Doc. No. 3BHS354059 E01

See manufacturer's details, Chapter *1.5 - Manufacturer's Address.*

5.3.1.16 Setup \ Double Channel

The configuration of Double Channel depends on the application and connections. For detailed information about configuration, refer to *3.4.4.4 Double Channel (DCH)*.

5.3.1.17 Tune \ Setpoint Adjust, Step

Mode	*Maximum adjustable setpoint jump during 10 s*
Manual	±50%
Open Loop	±20%
PF	±0.2
Var	±50%
Auto	±20%

5.3.1.18 Tune, Order of Priorities

If several operating modes are selected simultaneously by the digital inputs, the following order of priority applies:

Priority	*Mode*	*Remark*
1. resp. top	Standby	
2.	Sync	
3.	Manual	
4.	Open Loop	
5.	VDC	Only active, if Gen CB Closed status is active and

Priority	*Mode*	*Remark*
		Parallel with Grid status is not active
6.	PF	Only active, if parallel with Grid status is active
7.	Var	Only active, if parallel with Grid status is active
8. resp. lowest	Auto	Active, if no other operation mode is active

5.3.1.19 Tune, Auto

The PID tuning tool is on the CMT1000 CD. The following settings can be preset on the basis of the machine data.

Integral time constant Ta

This lies within the range of Td‘ of the main machine.
Setting: Ta = 1.0 to 1.5 x Td‘ (Typical value 2 to 5 s).
(Optimized for load conditions)

Derivative time constant Tb

This approximately compensates the load time constant TE of the exciter machine.
Setting: Tb = 0.7 to 1.0 * TE (Typical value 0.1 to 0.3 s).

Proportional gain Vp

This most important setting value depends primarily on the controlled system.
If the ceiling factor Kceil has been set correctly, values between 10 and 40 should result in stable regulation of the machine.

A default value of 20 is set for the first excitation.

Note: Since the Kceiling affects Vp from all the operating modes, be sure to calculate this value before tuning the AVR. If Kceiling has changed after tuning, the AVR shall be re-tuned again.

Reactive power influence Kq

In case of machines which, without step-up transformers, are connected to the fixed grid or, via a busbar, to other synchronous machines, it is essential that the droop Kq is set to a **negative value** of -5 to -20%. A higher negative value makes the machine more independent of voltage fluctuations in the grid. This stabilizes the reactive power output or consumption in those configurations. At low negative values, the machine will support the grid or busbar voltage.
In the case of machines with step-up transformers, the voltage drop of the transformer can be partly compensated with positive values of Kq.

Example	
Step-up transformer	Reactance = 12%
Compensation	Kq = +7% = 12% - 5% ➔ After step up transformer Drop of 5%

5.3.1.20 Communication \ MODBUS (Remote Access)

The RS485 port is shared between VDC mode and MODBUS. With factory settings, MODBUS is disabled.

To use MODBUS, the parameter MB_Enable must be set to true, then the parameters have to be written to the EEPROM. Afterwards, the UNITROL 1020 must be restarted. This procedure has to be followed for any change to MODBUS related parameters to take effect. It serves as a protection against inadvertently overwriting the setup by MODBUS itself and therefore losing connection to the UNITROL 1020.

Standard Configuration	Answer Delay: 10 ms
	Bit Rate = 19200
	Character Framing = even
	RTU: Protocol of the RS485

Slave ID

Zero and values higher than 247 are reserved, so the valid range for the slave ID is 1 to 247. The default value is 247. Recommended range is 64 to 247 due to the possible influence with the Modbus ID used for CMT1000 access. For more information refer to *Chapter 3.4.6 – Modbus for Remote Access*

Keep-alive time

The parameter “MB_KeepAliveTime” defines in what time-period the “Keep Alive Bit” in control word 1 must be changed. Valid settings are 1 to 120 seconds and 0 to disable the connection monitoring.

Keep-alive action

If the timer reaches the supervision time, a “Modbus Communication Alarm” will appear and one of the events can be selected with the “MB_KeepAliveAction”.

Priority of input signals
All signal assigned to a physical input (digital or analog) cannot be overwritten by modbus remote acces, and data are ignored

Configurable modbus signals
UNITROL 1020 provides a free configurable signal list to read out required signal with one access.

Access Levels
Modbus Remote Access shares the control of the AVR with the CMT1000 and the SCP Panel. The control access has to be granted as explained in Chapter *3.4.7.*

For more information, refer to the *UN1020 Modbus Reference* document, document number 3BHS348611 E80

5.4 Work carried out while Machine is at Standstill

Preliminary Checks

- Wiring check, compare connections with schematics.

CAUTION!

Check the insulation strength of the plant with the insulation tester

During the test, the equipment could be damaged by the testing voltage.

Disconnect cables to the UNITROL 1020

- Switch on auxiliary voltage U_{AUX}
- Adjust parameters
- Check measuring voltage and current transformer circuits
- Measure field resistance
- Checking input and output signals
- Low-load test: External power electronics supply (3x <300 V ac)
  - Open loop mode
  - Optimize regulator Ie
- Adjust limiter settings based on the customer's power chart

5.5 Work carried out while Machine is running

5.5.1 *No-load Tests (nominal speed, not synchronized)*

- Field flashing and discharge in Auto and Manual mode
- Soft start in Auto mode
- Adapt setpoint range, optimize voltage regulator
- V/Hz limiter: The actuation point fknee is set to 48 Hz by default

  For 60 Hz machines the fknee should be set at approximately 58 Hz.

5.5.2 *Tests under Load*

- Stator current measurement, internal P- and Q-measurement, droop/compensation.

  The droop/compensation is set to 0% by default. If the machine is paralleled directly with the rigid grid or, via a busbar, with other synchronous machines, it is essential that the droop Kq is set to a value of approx. -10% before the first synchronization. The reactive current must be monitored carefully during the first paralleling. If it increases uncontrollably following the first synchronization, then the current polarity of the I_{M2} measurement is incorrect or the CT phase position is wrong.

- Load rejection overexcited and underexcited

- Optimize Iemin / Iemax Limiter
- Optimize PQ Limiter

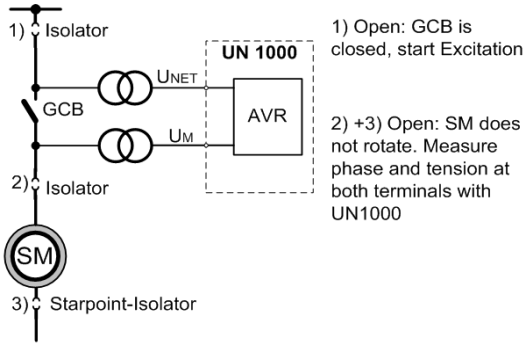
  The setting of the PQ limiter must be coordinated with the settings of the generator protection. As a rule, the limiter should be set at least 5% lower.
- PF and Var regulator, stability, setpoint range.

  To enable correct operation of PQ Limiter, the PF / Var regulator must be tuned, even if these modes are not used.

5.5.3 *Synchronization*

It is a prerequisite for the correct functioning of the synchronization that there is no error in phase or magnitude between UNET and UM, caused by wrong connection or ratio of PTs on the grid side and generator side.

Another prerequisite is the correct rotating direction of the three phases on the machine and line side.



- Measurement of the phase angle of the voltages UNET and UM

  Open the isolator, close the circuit breaker (CB). Due to safety reasons the measurements have to be obtained not only from the *Monitor\Oscilloscope* or *Monitor\Sync Diagram* but also from an external oscilloscope.
- “Blind” synchronization

  Monitor the Synchronoscope (*Monitor\Sync Diagram*) by disabling the closing mechanism of the circuit breaker.
- “Live” synchronization

  Record the event with a Synchronoscope.

CAUTION!

The synchronoscope must stand at “twelve o’clock”. If the synchronoscope stands at “six o’clock”, one voltage is incorrectly connected. In other positions, either measuring is being carried out on incorrect phases or a phase shift caused by the connection group of a step-up transformer has not been compensated.

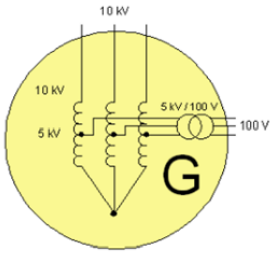
CAUTION!

In this status, the phase-angle difference must be 0 deg. Otherwise the measuring cable is incorrectly connected. Incorrect polarity cannot be detected by the UNITROL 1020. Paralleling with incorrect polarity can lead to serious damage.

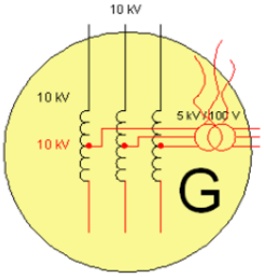
A phase shift caused by one of both measuring transformers or by the connection group of a step-up transformer must never take place.

CAUTION!

Be careful when the opening the star point of the primary voltage range of the PT



Generator transformers do not always measure the full primary voltage



When the neutral point is opened, the transformer receives the full primary voltage and burns

5.6 Concluding Work after Commissioning

Write the currently adjusted parameters to EEPROM so that they are saved in the device. Save the corresponding settings into an INI file or print the INI file (see Chapter *9.3 – Parameter Settings, Default Values*).
The INI file can be opened using an editor (Word, Note- or WordPad) and printed.

Chapter 6 - Operation

6.1 General

NOTICE!

ABB recommends periodical training for operating personnel

6.2 Safety Regulations

DANGER!

Dangerous voltage.

There is a danger of electric shock.

NOTICE!

Before operating the excitation system the general safety instructions in *Chapter 2 - Safety Instructions* must be read and understood.

CAUTION!

Parameters are set during commissioning of the device and must not be changed afterwards without taking into consideration the consequences they can produce.

Running the excitation system with incorrect data can result in improper operation, reduction in control accuracy and damage to the equipment.

Only qualified and certified personnel are allowed to operate the device, i.e. personnel who are familiar with the excitation system and the hazards involved.

6.3 Panel Operation

The panel is operated using the buttons from the keypad installed in the front. The Panel can even be used to read measurements and/or change parameters in local operation.

6.3.1 *Panel Start-up*

After powering up the device (UAUX power) the panel performs an initialization stage to establish the communication with the AVR main controller.

1. During power up the panel tries to establish communication with the AVR main controller. During this process the panel displays the information shown in *Figure 6-1*

Figure 6-1 Panel screen just after connecting Uaux power.

2. Few seconds after the SW revisions have been shown, the panel shows the main menu as in *Figure 6-2*. The panel can now be operated using the Keypad.

Figure 6-2 Main menu. The panel can now be operated.

6.3.1.1 Connection Problems

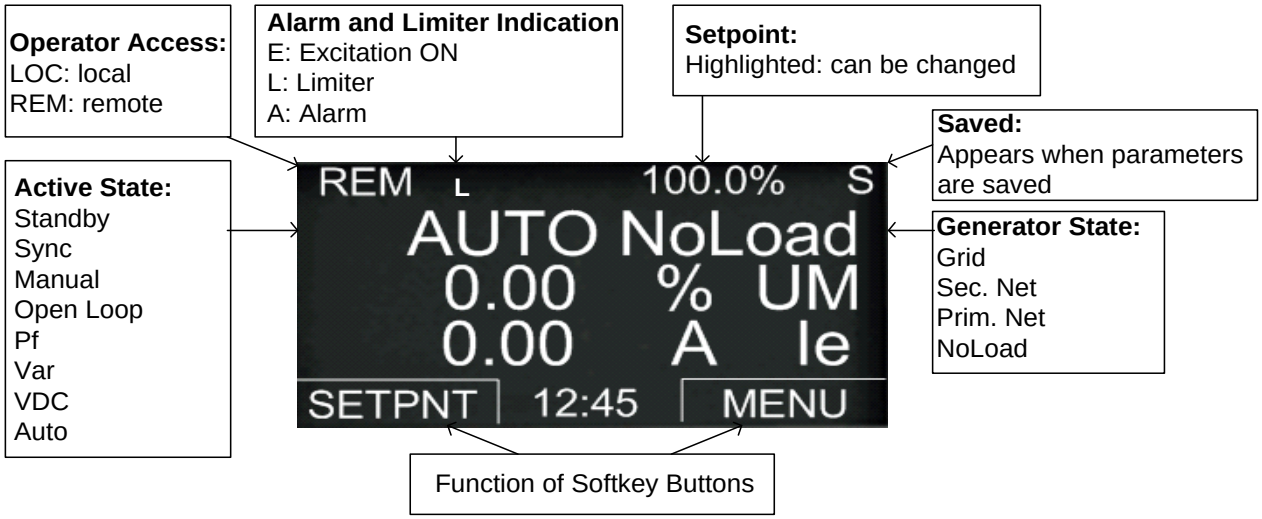
When the panel is unable to communicate with the AVR main controller due to hardware problems, the screen might show the message displayed in *Figure 6-3*. This message can also appear when the panel and AVR main controller (DSP) firmware are incompatible each other; which might occur after a firmware upgrade.

However, regulation and protection functions are normally still in operation, without being influenced by communication problems with the panel.

AVR Not Responding

Figure 6-3 Message shown when communication problems occur between panel and AVR controller.

6.3.2 *Display elements*



6.3.3 *Keypad Operation*

Key		***Command***
Up, Down		Select mode: Moves the highlighted line up or down Settings: Decrements or increments the highlighted value of a selected parameter and the value of the setpoint
Soft key Left		Select SETPNT: Highlights the setpoint value for changing the value Select EXIT: Returns to the last state Continue to click EXIT until the main display appears.
Soft key Right		Select MENU: Selects main menu Select ENTER: Selects submenu of the highlighted line Select SEL: Selects the highlighted Parameter or Clock Set group Select EDIT: Edits parameters (mostly write-protected) Select ENTER: Confirms the form of date or the new value Select CANCEL: Returns to the last menu without change Select OK: Confirms the time and date of the new value Select EXIT: Returns to the last state
REM/LOC		Select remote or local operation, click twice for local operation in case CMT or fieldbus remote access is active. The panel switches back to remote mode after 1 min without user interaction. Remote: Panel has no write access rights, only indications Local: Panel has full write access and blocks CMT and field bus remote access

?		Not used
STOP		Not used
START		Not used

6.3.4 *Emergency Excitation OFF*

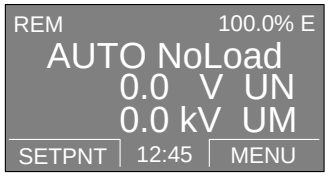
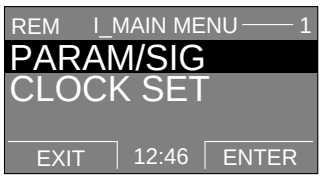
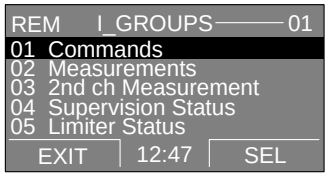
Activate or deactivate Emergeny Excitation OFF
Panel must be in local mode to enable the START/STOP buttons.
Signal from panel is overwritten by emergency excitation signal from digital IO, when configured.

- STOP sets the Emergency Excitation signal to 1 (= excitation disabled)
- START sets the Emergency Excitation signal to 0. (= excitation enabled)

6.3.5 *Setpoint Adjustment*

The panel uses INCREASE and DECREASE commands to change setpoint within DSP.
Thus setpoint changes according to ramp rate settings of DSP settings.
Setpoint mode must be left by user, it is not left automatically after a certain time with no user interaction.

6.3.6 *Menu Structure*

Main screenshots	*Menu items*
	MENU
	ENTER
	SEL

PARAM/SIG

01 Commands	0101	RESET ALARM
	0102	Save to EEPROM
	0103	AUTO Step
	0104	PF Step
	0105	VAR Step
	0106	MANUAL Step
	0107	OpenLoop Step

02 Measurements	0201	Mode
	0202	Machine Voltage
	0203	Machine Vol rel
	0204	Exc. Current
	0205	Exc Current rel
	0206	Net Voltag rel
	0207	Machine Current
	0208	Machine Cur rel
	0209	Reactive Power
	0210	React Power rel
	0211	Active Power
	0212	Act Power rel
	0213	Net Frequency
	0214	Machine Freq
	0215	Power Factor
	0216	DI Emergency OFF

03 2nd ch Measurement	0301	AVR2_Mode
	0302	AVR2_ActiveSP

	0303	AVR2_ManualSP
	0304	AVR2_Umrel
	0305	AVR2_UnetRel
	0306	AVR2_IM2rel
	0307	AVR2_Iqrel
	0308	AVR2_IeAbs
	0309	AVR2_CntrlSWVer

04 Supervision Status	0401	Watchdog
	0402	Loss of RC
	0403	Part Loss UM
	0404	Loss UM
	0405	Loss CT
	0406	UML1 Freeze
	0407	UML2 Freeze
	0408	UML3 Freeze
	0409	Unet Freeze
	0410	IM2 Freeze
	0411	Loss of Control
	0412	Loss of Exc
	0413	Temp Limit 1
	0414	Temp Limit 2
	0415	External Alarm
	0416	RS485 Bad Frames
	0417	VDC Ring Error
	0418	Int Power Fail
	0419	Dig Output Fail
	0420	Monitor Alarm 1
	0421	Monitor Alarm 2
	0422	Supervision Alrm
	0423	Supervision Trip
	0424	2nd CH Alarm
	0425	2nd CH Trip
	0426	Switch Over

05 Monitor Fnc Status	0501	FCB Alarm
	0502	Diode Alarm
	0503	Diode Trip
	0504	Gen Over Volt
	0505	Gen Under Volt
	0506	Exc Over Curr
	0507	External Alarm

06 Limiter Status	0601	Active Oper Lim
	0602	V/Hz Limiter
	0603	SP Min Reached
	0604	SP Max Reached

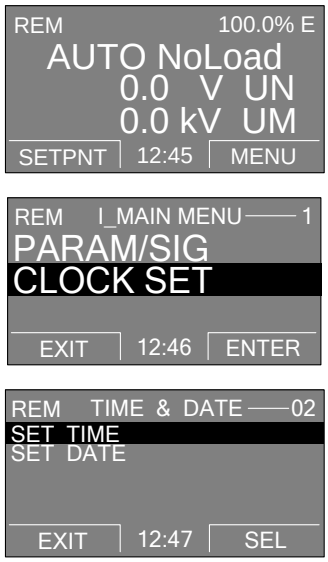
07 Alarms Status	0701	Software Alarm
	0702	FCB Alarm

	0703	External Alarm
	0704	Modbus Alarm
	0705	Diode Alarm
	0706	Diode Trip
	0707	Supervision Alrm
	0708	Supervision Trip
	0709	Switch Over

08 Comm Status	0801	RS485 Good Frams
	0802	RS485 Bad Frames
	0803	RS485 Rcv Frames
	0804	RS485 Tx Frames
	0805	RS485 Bit Errors

Parameters are listed in the same order as in the CMT1000 menu for Setup, Communication and Tune. For parameter setup refer to Chapter *9.3*

CLOCK SET

	MENU ▼ ENTER SEL, Oks

CLOCK SET

SET TIME SET DATE		Change time and date settings with the panel - Time format is always 24 hours - Date format is always dd.mm.yy Can be adjusted in remote and local operation

6.3.7 *Setpoint Step*

Apply a step to any setpoint. panel is in local mode.
It is the user's responsibility to choose the right step type according to the actual generator mode. If the wrong step is chosen, the value will also keep its value for 10 sec, but there is no influence on the operation of the AVR.

PARAM/SIG 01 Commands	0103 0104 0105 0106 0107	AUTO Step PF Step VAR Step MANUAL Step OpenLoop Step

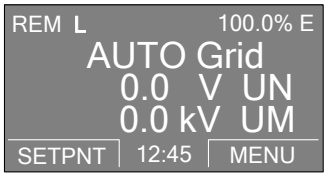
6.3.8 *Save to EEPROM*

PARAM/SIG 01 Commands	 0101 0102	 RESET ALARM Save to EEPROM

Setting new parameters over the panel or over CMT changes the parameters in the volatile memory only. To make the modification permanent, the entire parameter set must be saved.

6.3.9 *Limiters*

A limiter triggers the SCP's limiter response, which causes the panel's green LED to flash and a limiter message will be displayed on the screen every few seconds.

Operating	***Resulting Display***
LIMITERS in REMOTE mode The display periodically switches from the indication view to the limiter view and back to the indication view. It is still possible to navigate in the SETPNT or MENU, but the limiter is always displayed for a short time. The blinking display can be disabled by changing the panel to local control. Active limiters can be seen in the parameter/signal group "Limiter status" (Group 05). Example: Limiter 12 = 4 + 8 (see the table below) The limiters "Max Ie" and "V/Hz" are blinking	 

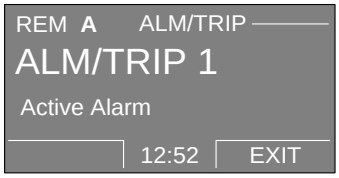
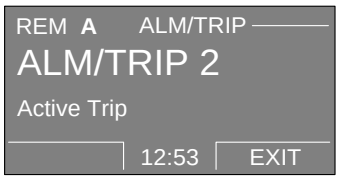
The V/Hz and setpoint limiters are added to the other limiter.
E.g. Limiter 12 display means that Max Ie and the V/Hz limiter are active.

The following limiter numbers can be monitored from the panel:

Limiter No.	***Description***	***Short Term***
0	None	
1	Minimum Excitation Current Limiter active	Min Ie
2	Minimum Machine Voltage Limiter active	Min UM
3	Minimum Iq Limiter active (PQ-Limiter)	Min Iq
4	Maximum Excitation Current Limiter active	Max Ie
5	Maximum Machine Voltage Limiter active	Max UM
6	Reserved	
7	Maximum Machine Current Limiter active	Max IM
+8	V/Hz Limiter active	
+16	Minimum Setpoint reached	
+32	Maximum Setpoint reached	

6.3.10 *Alarms and Fault Messages*

An event triggers the Alarm/Trip state of the SCP. The Alarm/Trip state is indicated with a red LED. An event message appears on the screen every few seconds.

Operating	***Resulting Display***
ALARM/TRIP in REMOTE mode The fault display periodically switches from the indication view to the alarm/trip view and back to normal view. It is still possible to navigate in the MENU (click the EXIT button) but the Alarm/Trip state will resume after 10 seconds. The blinking display can be disabled by changing the panel to local control. Alarms/trip can be cleared in the parameter/signal group commands. Alarm has higher priority than Limiter, meaning that there is a moving “A” letter in the running symbol even if there is an active limiter. Example: “ALM/TRIP 12” = 0 +4 +8 (see table below) Syntax meaning: Both External Alarm and Modbus Communication Alarms active.	 

The following Alarm/Trip numbers can be monitored from the panel:

Alarm or Trip Nr.	*Description*
0	None
+1	SW Alarm active
+2	FCB Alarm active
+4	External Alarm active
+8	Modbus Communication Alarm active
+16	Diode Alarm active (requires RDM SW)
+32	Diode Trip active (requires RDM SW)
+64	Supervision Alarm active (requires Double Channel SW)
+128	Supervision Trip active (requires Double Channel SW)
+256	DCH SwitchOver active (requires Double Channel SW)

A defective unit should be first reported to ABB in order to send back the unit after authorization. For contact information, refer to Chapter *1.5 Manufacturer’s Address*.

6.4 PC Software Tool

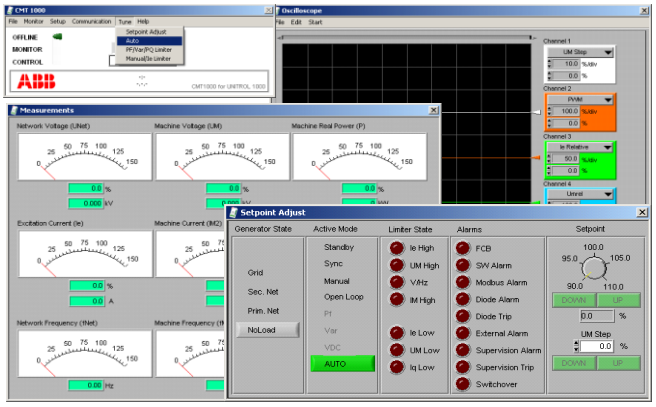
The PC software tool used with UNITROL 1020 is called CMT1000**.** Release 6.300 is compatible with all previous 6.xxx releases but not with releases older than 6.000.

6.4.1 *General*

Parameter configuration and optimization can be done with the user-friendly software *CMT1000* for Microsoft Windows. CMT1000 accesses the UN1020 device through a serial connection point-to-point via the USB or the Ethernet port, allowing access from remote locations. The connection options to use CMT1000 are described in Chapter *3.3.9 – Communication Ports*.

Basic features of CMT1000

- Configuration of parameters and I/O signals.
- Measurement reading
- Trending function for controller optimization (Oscilloscope, Power chart).
- Parameter File upload or download.
- PID tuning, Setpoint step and other powerful commissioning tools.



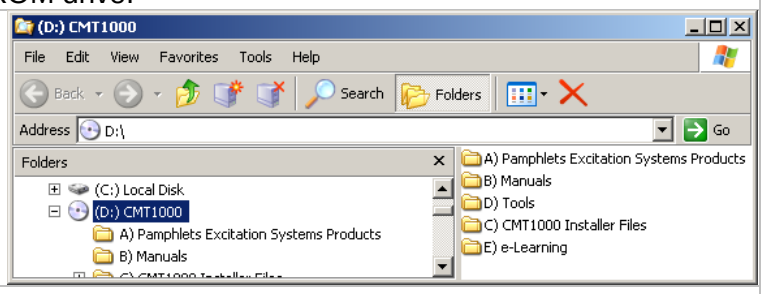
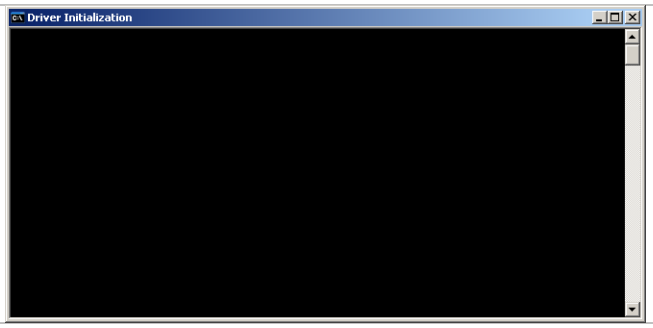
The CMT1000 software operation is described in Chapter *6.4 – PC Software Tool*.

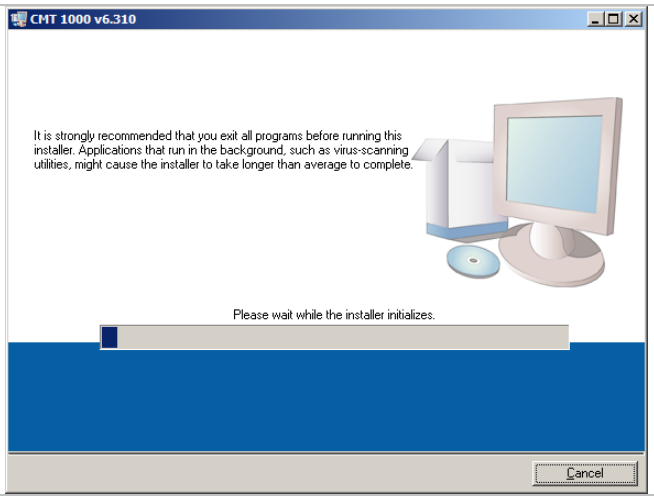
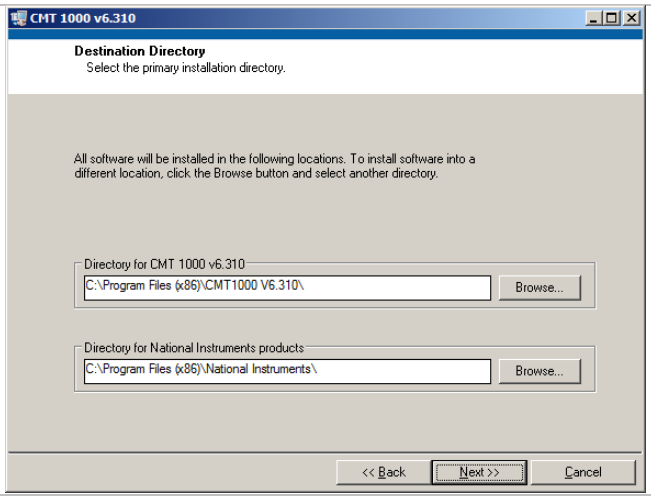
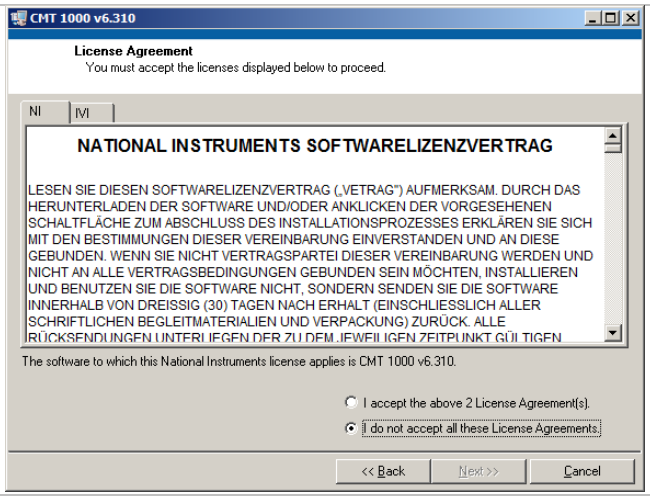
6.4.2 *System Requirements for CMT1000 Release 6.300*

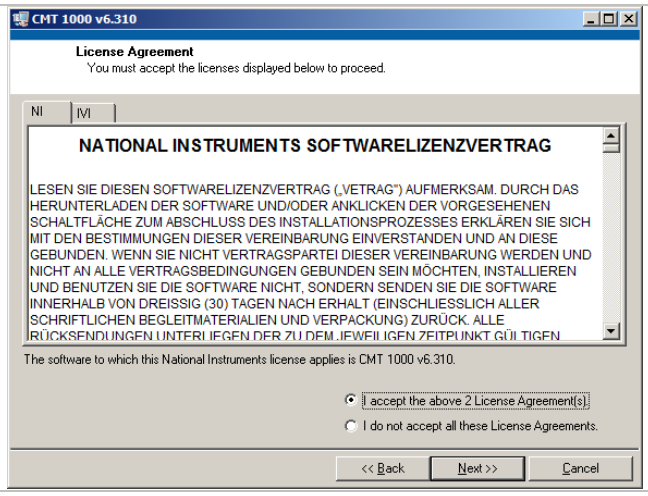
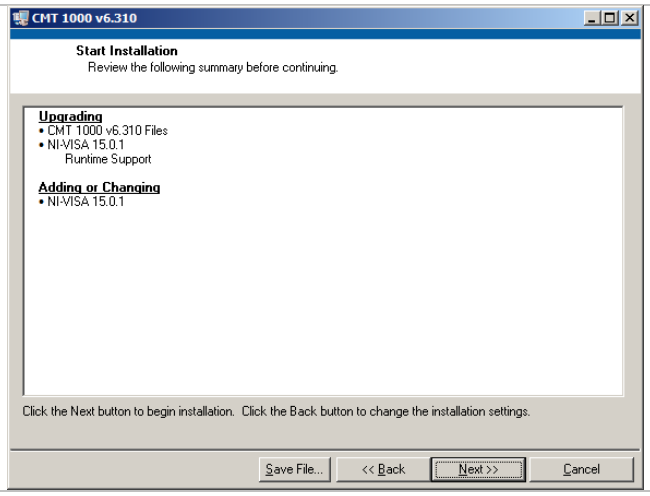
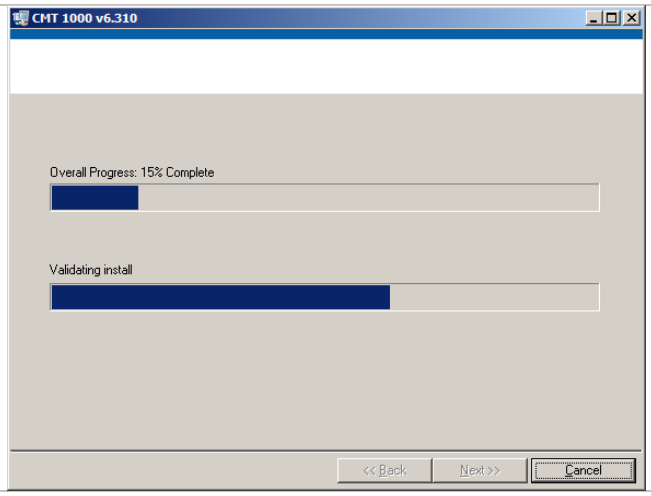
- Minimum Pentium 1 GHz or equivalent processor. Recommended: Pentium III or Celeron 1 GHz or equivalent processor or higher.
- Minimum 512 MB RAM.
- Minimum screen resolution of 800x600 pixels. Recommended: 1024x768 pixels or higher.
- CD-ROM drive.
- Microsoft® Windows ™ XP, Vista or Win 7.
- Minimum 10 GB of free hard disk space.

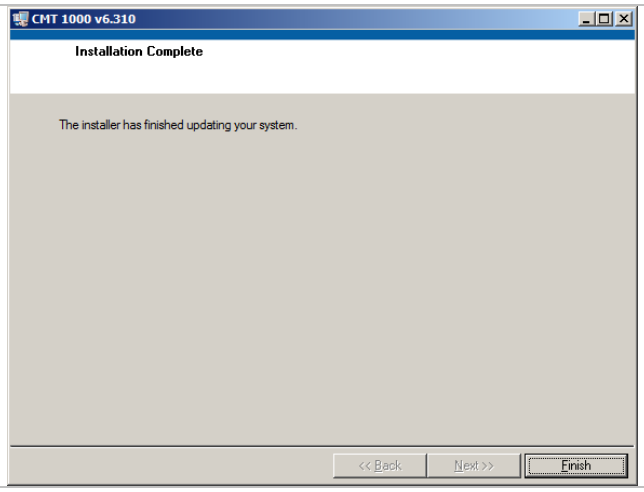
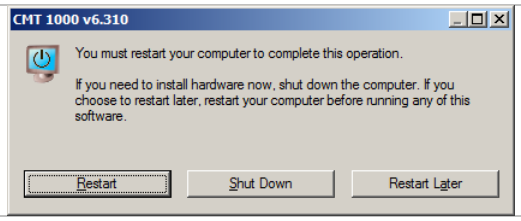
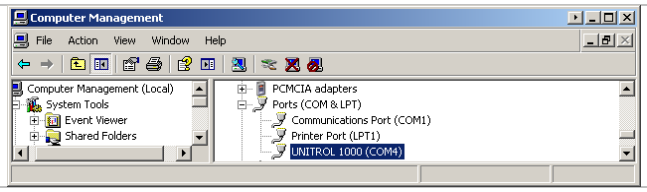
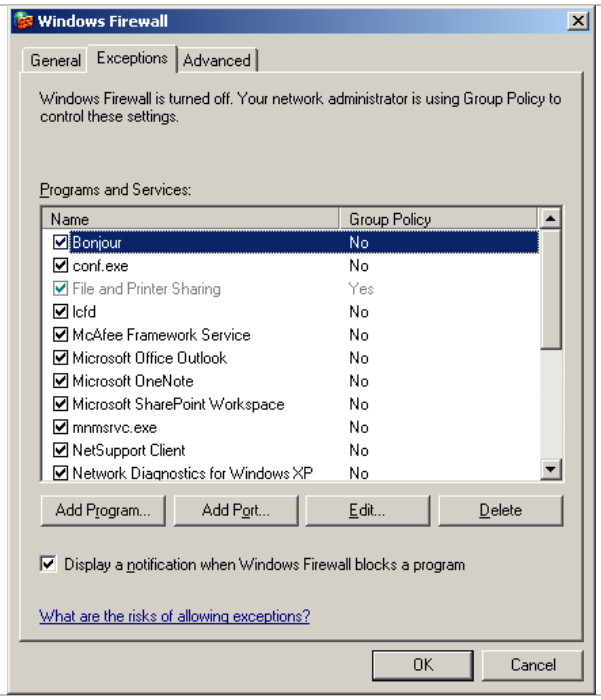
6.4.3 *Installing CMT1000 Software*

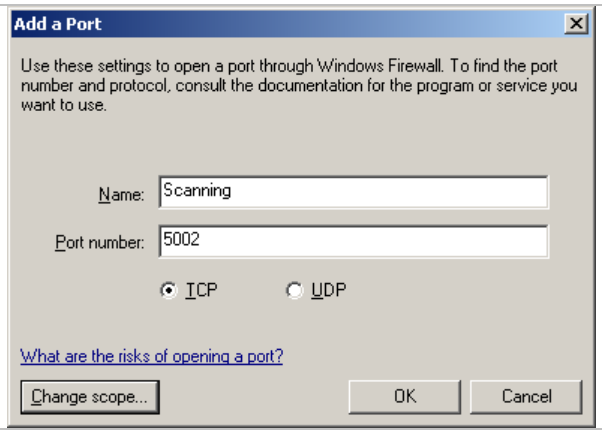
Distribution rights:
CMT1000 was developed with the Lab VIEW software and is distributed free of license charges and costs. The copyright to Lab VIEW is owned by the company National Instruments International Distribution (NIID).

Put the CMT1000 CD in the CD-ROM drive.	
Open the CD root directory	
1 Driver Installation	
Open CMT1000 Installer Files\USB Driver. Double-click InstallUSBdriver.exe The following Window appears and disappears after a few seconds.	
Connect the device with the delivered USB cable to your PC. The window "New Hardware Found" appears. Click Next until the device is installed.	
2 CMT1000 Installation	
Open *C) CMT1000 Installer Files* and double-click *Setup.exe*	

	
Click *Next*	
Select *I accept the License Agreement* Click *Next*	

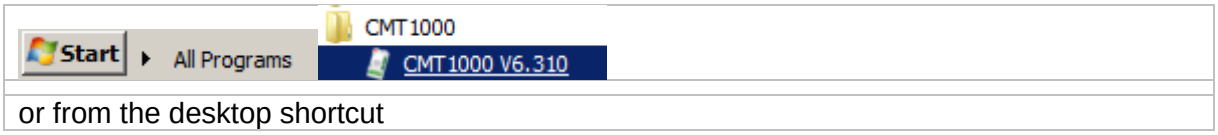
Select *I accept the License Agreement* Click *Next*	
Click *Next*	
	

Click *Finish*	
Click *Restart*	
Connect the USB cable. and check in the Device Manager if *UNITROL 1000* is listed under *Ports*	
3 PC Firewall Configuration	
Click *Start – Settings – Network Connections – Change Windows Firewall Settings* Click the tab *Exceptions* and *Add Port*	

Fill out Name: *Scanning* and Port: *5002* Do the same for Port *5003*	

6.4.4 *Starting with CMT1000*

The CMT1000 communicates with the AVR via USB or Ethernet. .For more information about the hardware connections refer to Chapter *3.3.9 Communication Ports.* Start the CMT1000 V6.310 application from Start-Programs



or from the desktop shortcut

6.4.4.1 Configuring the Port Interface (CMT1000 configuration)

Before the communication with the AVR can be established, the connection type should be set in the CMT1000. The connection type is specified using the Port Configuration window, which can be accessed from the main window of the CMT1000 (*Figure 6-4*).

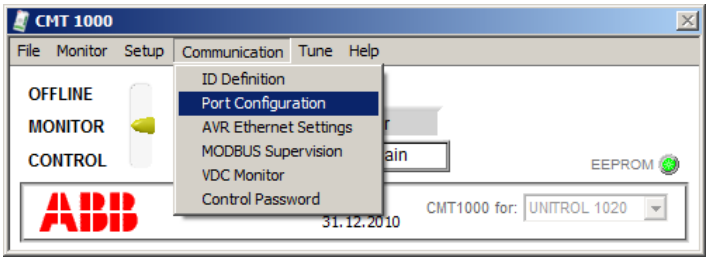


Figure 6-4 Port Configuration.

Connection over a USB port from the PC (no Ethernet)

1. Connect via the USB port from the PC. Select the "Serial" tab (1) first. See *Figure 6-5*
2. Click the Ok button (2) to save the changes or Cancel to abort the configuration.

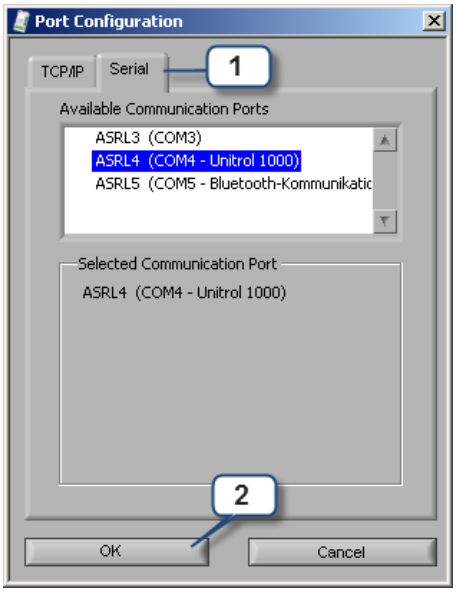


Figure 6-5 USB COM Port Configuration.

If the respective COM port is not found, check whether the required COMx is correctly configured in the operating system or is being used by another application.

Port settings normally used for COM:

Base I/O Port address: 3f8

Interrupt Request Line (IRQ): 4

Connection over an Ethernet port from the PC (TCP / IP)

1. To connect to the AVR using a TCP/IP connection, select the "TCP/IP" tab first. See *Figure 6-6*.
2. Fill out the IP Address of the remote terminal in the Remote IP Address field and click Enter on the keyboard. A pinging process should be automatically started to check whether the remote terminal can be reached using MODBUS TCP.

   After a couple of seconds the pinging process should be finished and a message is displayed whether the remote terminal could be reached or not.

   The message "Connection Ok" indicates that the remote terminal could be reached and that the connection is Ok. In case the message "Not accessible" shows up, check whether the Ethernet, gateway, firewall and/or cabling are correctly configured and installed. For configuration refer to Chapter *3.3.9 Communication Ports.*

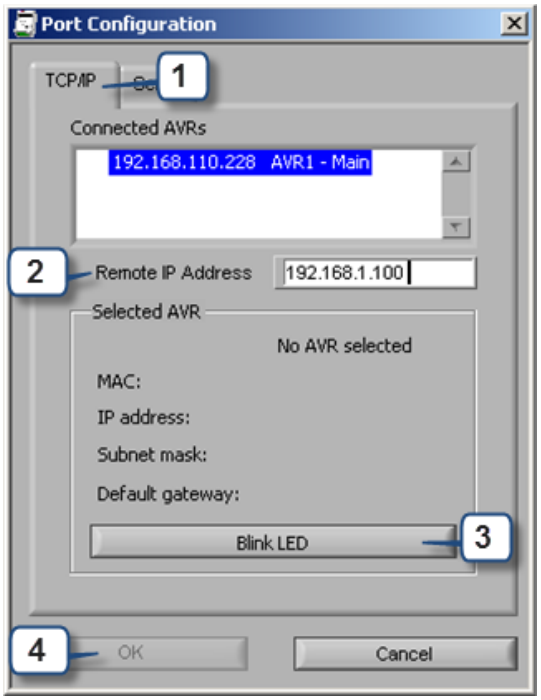


Figure 6-6 Remote IP Address Configuration.

3. The pinging process is repeated periodically and it should start a couple of seconds after displaying the last message. The message "Connection Ok" indicates that the remote terminal could be reached and that the connection is Ok. In case the message "Not accessible" shows up, check whether the Ethernet, gateway, firewall and/or cabling are correctly configured and installed. For configuration refer to Chapter *3.3.9 Communication Ports.*
   The pinging process is repeated periodically and it should start a couple of seconds after displaying the last message.
4. Click the Ok button to save the configuration or Cancel to abort the changes.

   Note: The message "In use" can appear when the IP address is already being used by CMT1000. This message can be ignored.

6.4.4.2 Communicating with the AVR

Once the port connection is configured, the CMT1000 performs a scanning process to detect the AVR over the interface selected (USB or Ethernet). During the scanning time (few seconds) the access levels (Control and Monitor) cannot be changed.

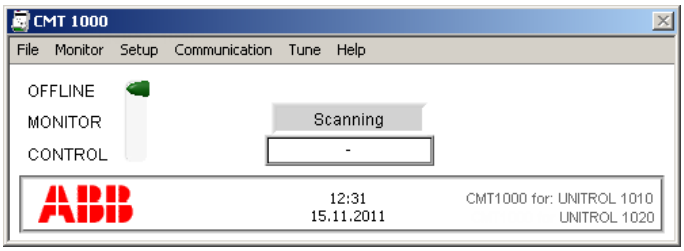


Figure 6-7 CMT1000 during AVR Scanning Process

As soon as an AVR is detected, the CMT1000 displays the AVR-ID and channel identification (Main or Redundant). The access level/type is controlled by the green slide bar and can now be used to change to Monitor or Control Access. When the CMT1000 is in Offline, most parameters are read from the computer memory, only the information shown in the main window is read from the device.

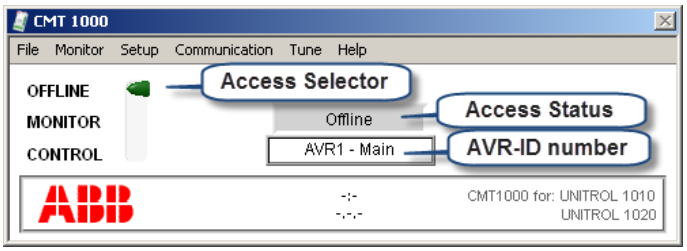


Figure 6-8 CMT1000 during Offline

As long as the CMT1000 has Monitor or Control Access, the main window looks as in *Figure 6-9* and *Figure 6-10*. In this case all parameters accessed through the menus are read from the device.

A green LED (“EEPROM”) on the right side of the window indicates whether all parameters in the RAM are stored in the non-volatile memory of the device or not. The LED is lit (green) when all parameter values match the ones stored in the EEPROM memory.

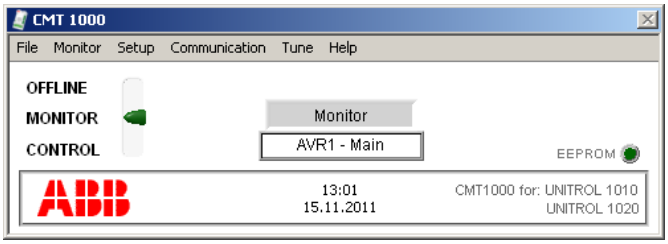


Figure 6-9 CMT1000 during Monitor Access

If the LED is dark, at least one parameter has been modified and its value will be lost after restarting the device.

To store all parameters in the EEPROM using CMT1000, click "Write parameters to EEPROM" from the File menu.

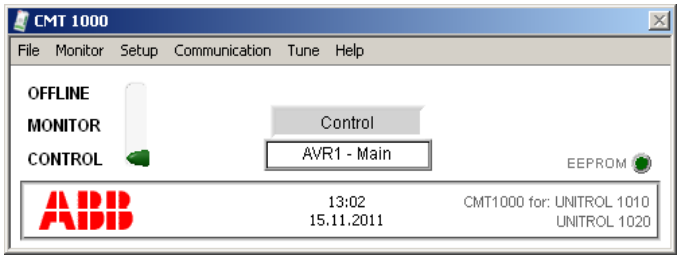


Figure 6-10 CMT1000 during Control Access

AVR scanning process failure: "Link Not Found"

The CMT1000 scanning process can last up to one minute before the AVR is detected; especially if connection type is Ethernet. If no AVR is detected by that time, the message "Link Not Found" will be shown in the main window (*Figure 6-11*). Check if the AVR is truly connected by verifying the configuration and/or the hardware.

Even after the message "Link Not Found" has been displayed, the CMT1000 continues the scanning process in the background until the AVR is found.

For details about the configuration refer to *3.3.9.1 USB Interface*.

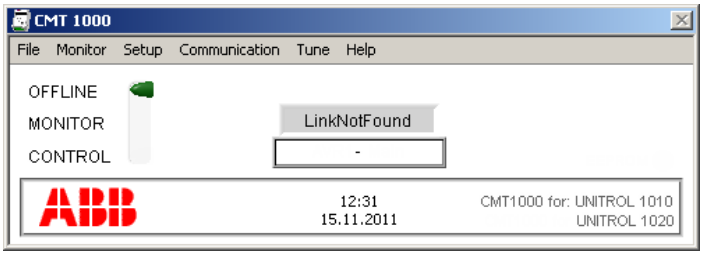


Figure 6-11 LinkNotFound message when the AVR cannot be found or the communication port cannot be accessed by the CMT1000

6.4.5 *Menu Structure of CMT1000*

The main window of the CMT1000 is shown in *Figure 6-12* and is the starting point to access all software features. The software features are accessed from the menu and each menu item is grouped according to functionality.

- File: Load/save parameters and enable optional SW.
- Monitor: Online measuring
- Setup: Set parameters
- Communication: Set IDs / Ports / MODBUS
- Tune: Tune regulator
- Help: Software information

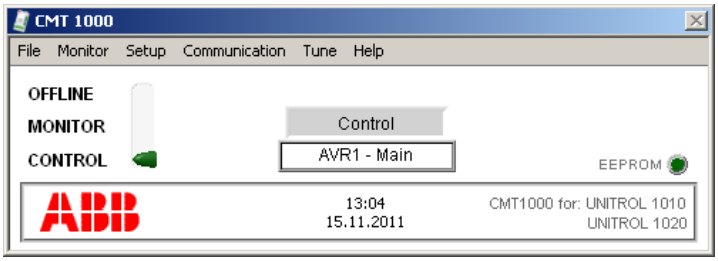


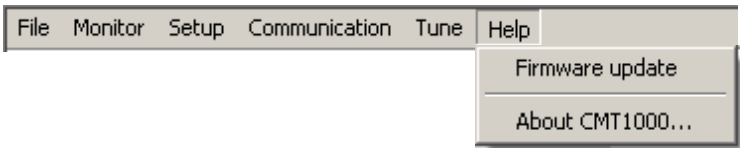
Figure 6-12 Main Window of CMT1000

The following sections describe the CMT1000 menu organization and window contents.

IMPORTANT!

All software windows shown in this User Manual were taken with standard style of Microsoft Windows (R) XP and most of them can be closed by using the mouse and clicking on the cross in the upper right corner. If the cross button is not available, the information in the window explains how to close it. This is the case for “About CMT1000” which can be opened using the menu “Help”.

6.4.5.1 Help Menu



SW Update

Software and AVR Information

About CMT1000

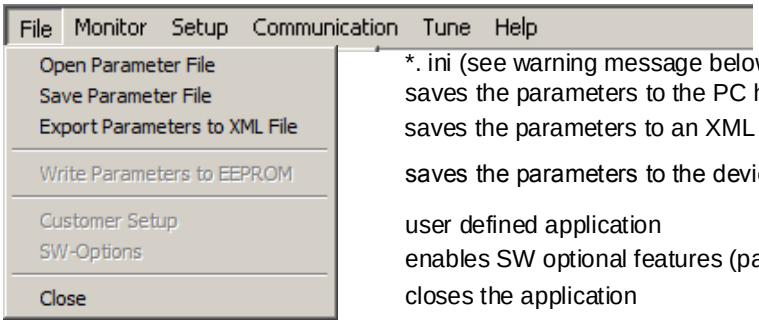
AVR S/N:	Unit's serial number
Control:	DSP software version
MCU:	Panel software version
SW Revision:	CMT1000 version
Configuration:	ABB or Custom

Click on the window to close it.

Note: the serial number of the AVR is shown in the window of and it should be provided when an optional software is requested from ABB.

Figure 6-13 About CMT Window

6.4.5.2 File Menu



*. ini (see warning message below)

saves the parameters to the PC hard disk

saves the parameters to an XML File

saves the parameters to the device's EEPROM

user defined application

enables SW optional features (password required)

closes the application

Open Parameter File

A set of parameters values, previously stored in a so-called *Configuration INI* file, can be downloaded to the AVR by using the option *Open Parameter File* from the CMT1000 menu. In order to download parameters to the AVR, make sure that the CMT1000 has Control Access before trying to use the *Open Parameter File* option. The Configuration INI file can also be opened when OFFLINE, in order to verify the values of the parameters, prior to downloading them to the AVR.

The Configuration INI file should be compatible and previously created with CMT1000 release 5.xxx, otherwise a warning message may show up. Additionally, a message indicating writing failure can appear after continuing the download of the incompatible configuration INI file, when it contains at least one parameter value out of the permitted range of selection.

The download of an incompatible configuration INI file is not recommended and it is up to the user to verify if all parameters are set correctly before going into Operation with the AVR.

While the parameters are downloading, a warning message may appear if at least one optional SW is marked as activated in the INI file but is not available in the AVR (*Figure 6-14*).

The warning window (*Figure 6-14*) also shows a list of all optional SW which is activated according to the INI file but which is not available in the AVR. These will only be activated in the AVR, when they have been enabled (available) using the SW Options tool from the CMT1000.

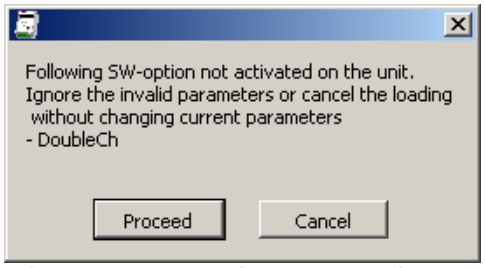


Figure 6-14 A warning message is shown when one or more optional SW is set as active in the INI file but not available in the AVR.

Save Parameter File

The parameter values can be stored in a configuration INI file to the PC hard disk, for further download to one or more AVRs (i.e. during commissioning) or for use as a reference parameter file. A configuration INI file can be downloaded to a UN1020 AVR by using the command "Open Parameter File".

When "Save Parameter File" is executed during Offline, it allows the user to create a preconfigured file for further download to one or more AVRs. Once the CMT1000 is started, all parameters are normally set to default values and they can be modified when Offline. After they have been modified and the command "Save Parameter File" is selected, all parameter values are stored in an INI file whose name is specified by the user during the file creation process. The resulting INI file can be downloaded to an AVR using the command "Open Parameter File".

When "Save Parameter File" is executed during Monitor or Control mode, all parameter values written in the configuration INI file are read directly from the connected AVR; i.e. the created INI file reflects the actual configuration of the AVR. During Monitor or Control mode, this command can be used when a device must be replaced by a spare unit.

IMPORTANT!

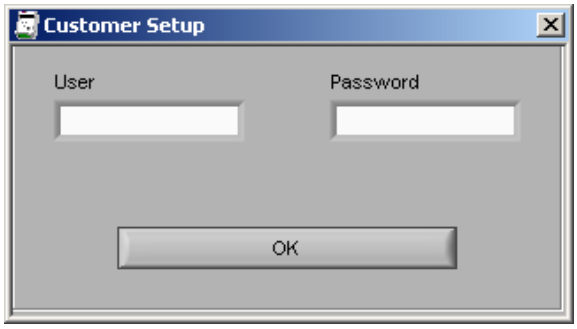
A parameter *.INI file can be opened and read with a common text editor and without the CMT1000 tool.

However, modifying a *.INI file by directly writing-in with a text editor may lead to the complete inoperability of the parameters file. The CMT1000 may not be able to correctly read the file any longer and **serious damage** may be caused to the equipment due to the incorrect parameter settings.

Please open an *.INI file using the CMT1000 all the time, when a parameter value has to be changed.

Customer Setup

Option for user-defined application and OEM customers (password protected).



SW-Options

It allows the user to enable (unblock) optional software in the AVR. A password code is required for each specific function (SW-option) and it shall be ordered with ABB.

The following steps should be followed in order to enable optional software in the UN1020:

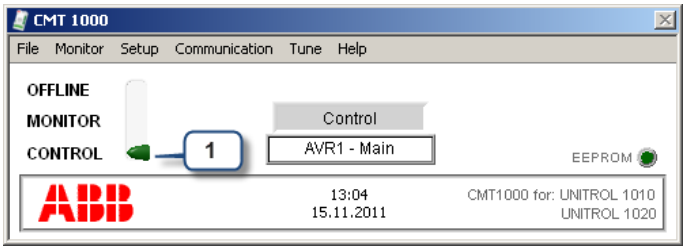


Figure 6-15 CMT1000 must have Control Access before enabling optional SW.

1. Make sure the CMT1000 has Control Access (*Figure 6-15*).

2. Type the password provided by ABB (case sensitive) in the white box located beside the SW-option intended to enable (*Figure 6-16*). Click the Enter key on the keyboard in order to validate the password.

   A couple of seconds after clicking Enter, the oval button at the right side of the white box should not be shaded anymore. Check the password spelling if this is not the case.

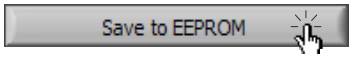
   The behavior rules for the SW activation buttons are shown in *Figure 6-17*.

3. Once the oval button becomes clear, click the button once.

   After a few seconds the LED on the button should be bright, indicating the optional SW is

now enabled.

4. After the oval button is lit click the button “Save to EEPROM“, to make the change permanent even after restarting the device.



5. In the CMT1000 main window, click in File and then, in "Write Parameters to EEPROM".

6. Restart the device.

7. After the unit is powered up, check if the SW-Option remains enabled. If not, repeat the procedure starting by Step 1.

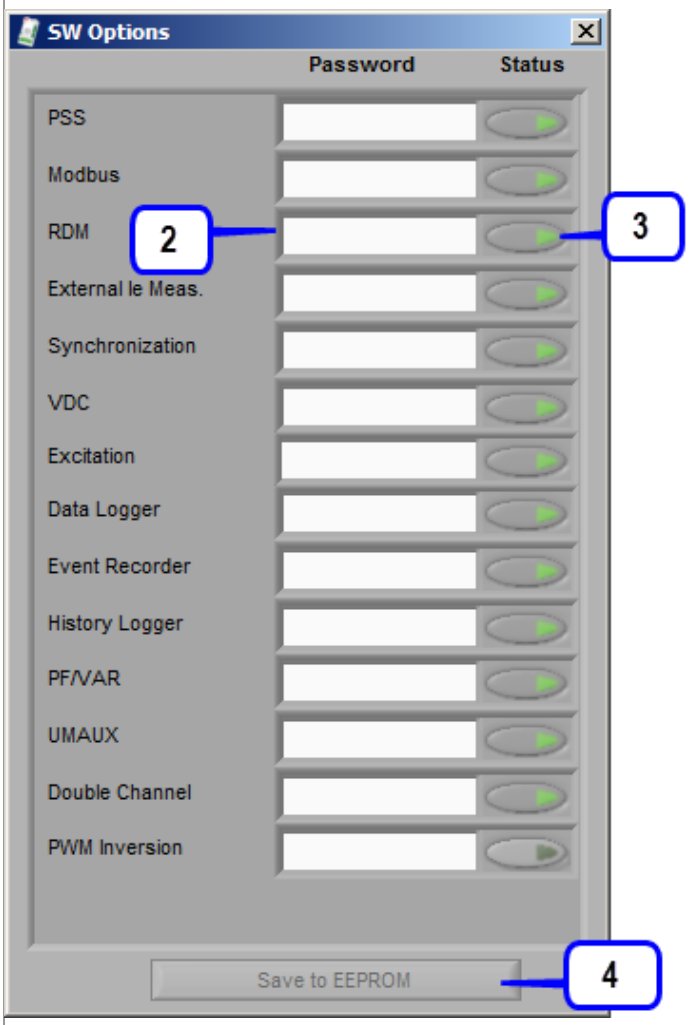


Figure 6-16.The SW Options window allows the user to enable optional software in the AVR.

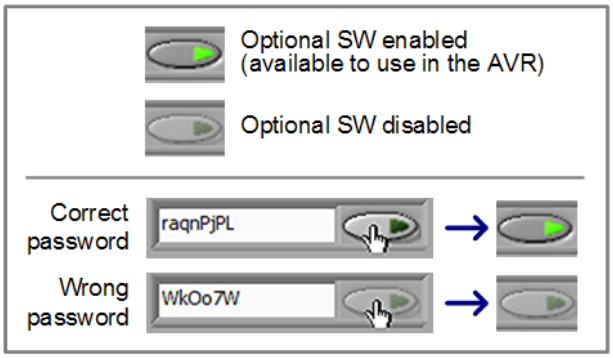
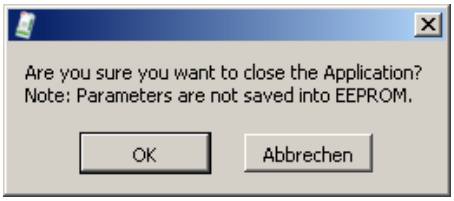
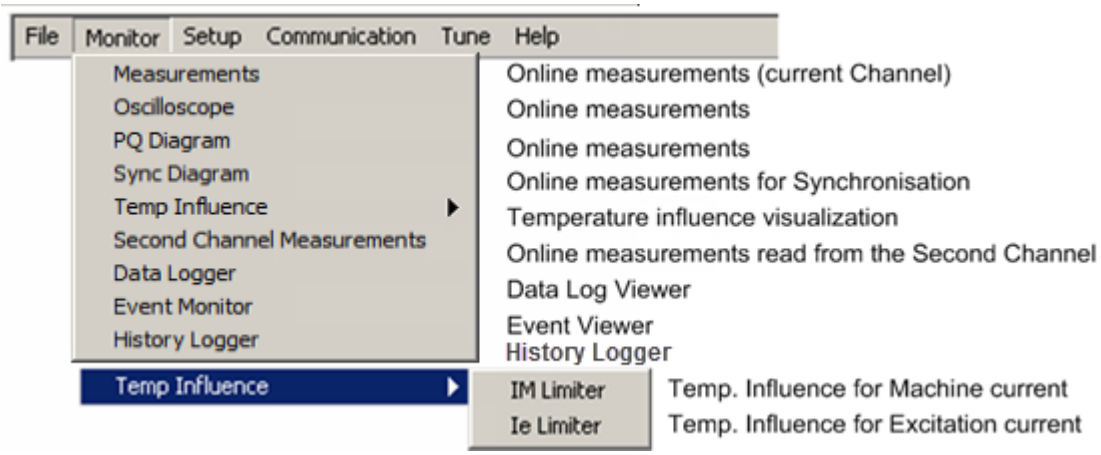


Figure 6-17 Upper: LED is bright when the optional SW is enabled in the AVR. Lower: A wrong password does not enable the SW.

Close
Exit the CMT1000 software.



6.4.5.3 Monitor Menu



6.4.5.3.1 *Measurements*

Monitor \ Measurements

- Network Voltage (UNet) [% and kV]
- Machine Voltage (UM) [% and kV]
- Machine Real Power (P) [% and kW]
- Excitation Current (Ie) [A]
- Machine Current (IM2) [% and A]
- Machine Reactive Power (Q) [% and kVar]
- Network Frequency (fNet) [Hz]
- Machine Frequency (fM) [Hz]
- Power Factor (PF) --

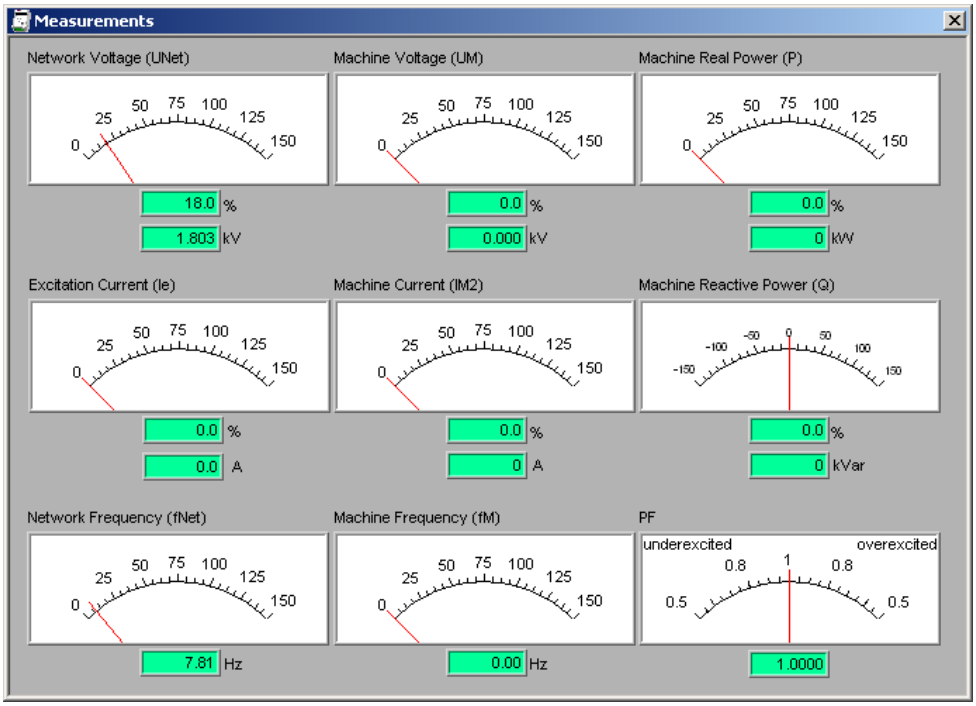


Figure 6-18 Measurements window

6.4.5.3.2 *Oscilloscope*

Monitor \ Oscilloscope

Measurements and transients can be visualized, analyzed and stored to the hard disk using the Oscilloscope tool of CMT1000. Up to 6 different measurement channels can be visualized simultaneously on the black box of the Oscilloscope window (see *Figure 6-19*). The signal or measurement to be displayed is configured on the right end side of the Oscilloscope window with the options shown in *Figure 6-19*.

The Buffer Length defines the length of the buffer size used to record the transient data and displays them on the black box of the Oscilloscope. The selection can be performed at predefined values: 1, 2, 5, 10, 20, 50, 100 and higher up to 500 seconds. Each time the Buffer Length value is changed by the user, the black box is resized in order to match with the new value selected. The transient shown on the black box can be stored to the hard disk afterwards; the transient data that could already pass-through the black box and is not shown anymore, is lost (there is no additional memory or buffer).

When a set of consecutive data measurements is received with errors (i.e. due to cabling or communication problems), the Out of Frame LED indication lights up. Under these circumstances it is recommended to check the cabling and configuration between CMT1000 and UN1020, in order to solve the problem. During the Out of Frame indication, the Oscilloscope freezes and displays the last correct (error-free) measurement for each channel, until the failure is resolved.

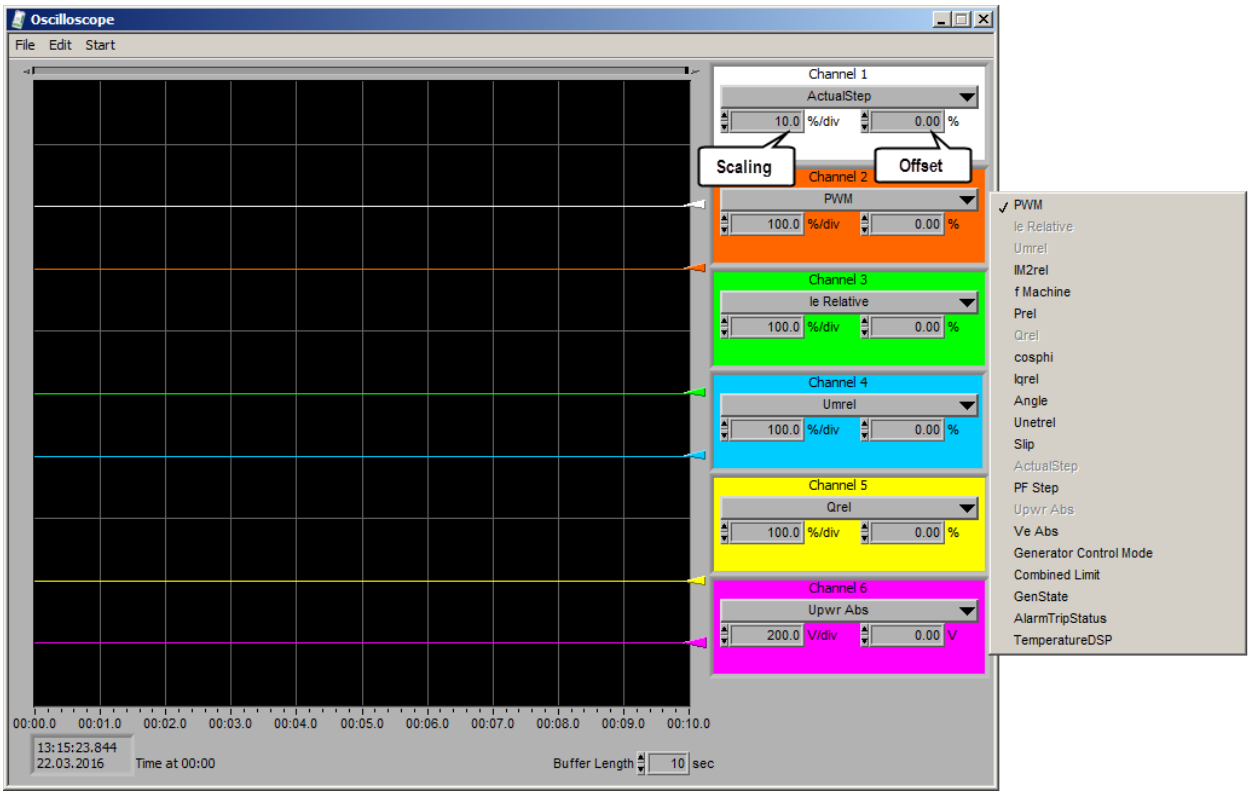


Figure 6-19 Oscilloscope window.

The Oscilloscope window menu and the function description of each item are explained in *Figure 6-20*. The Oscilloscope can be started and stopped as explained in *Figure 6-21*.

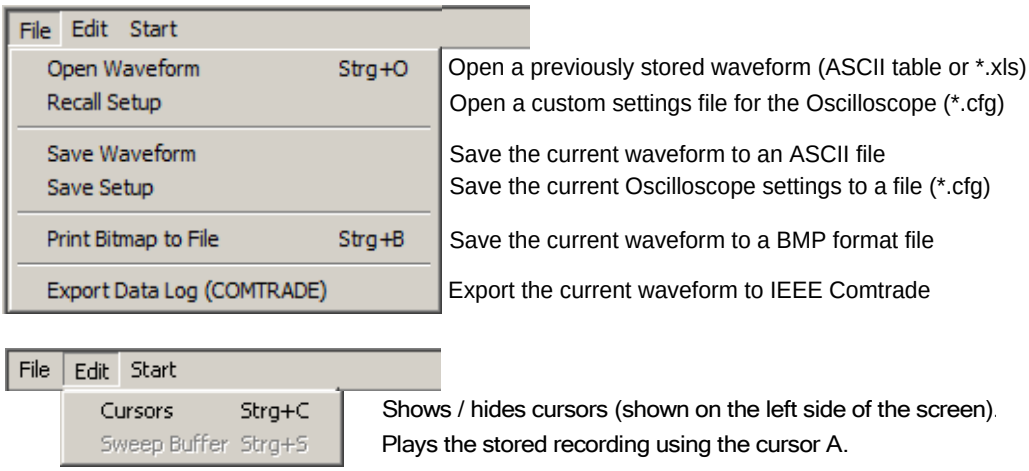


Figure 6-20 Menu structure of the Oscilloscope tool window and function of each item.

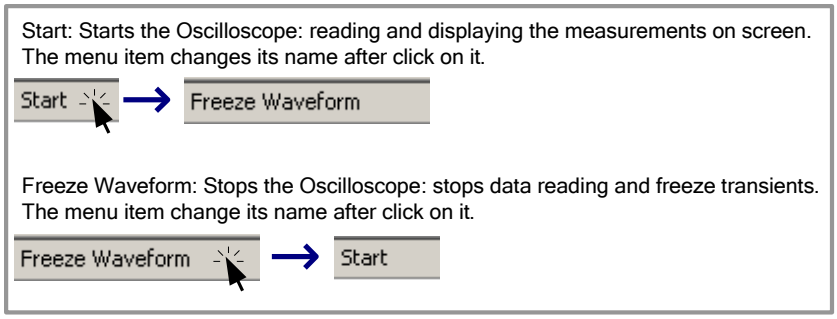


Figure 6-21 The Oscilloscope is started and stopped using the "Start" / "Freeze Waveform" button located in the menu of the window.

IMPORTANT!

Previous waveform files saved with CMT1000 releases 3.xxx or 5.xxx are not compatible with CMT1000 release 6.xxx.

Use the appropriate version of CMT1000 to open waveform files older than release 5.xxx

Evaluation of the Waveform

Instantaneous values from transients can be observed using the cursors feature of the Oscilloscope (menu Edit > Cursors).

As long as the cursors are enabled (Edit > Cursors), the two pointers or cursors A and B are shown in the black box of the Oscilloscope with their standard configuration options, as shown in *Figure 6-22*. The *cursors* can be moved with the mouse (click + hold + drag) along the curve of the transient from the Channel they are configured. When the cursors are moved, the user can see the instantaneous value of the curve at the time (dt) where they are placed (*Figure 6-22*). If the instantaneous value from another Channel is object of interest, the channel selection for the cursors A and/or B can be changed on the Oscilloscope window itself (see *Figure 6-22*).

The temporal buffer of the UN1020 can be used for troubleshooting by allowing retrieval of data history recorded during the AVR operation time. As long as the CMT1000 is **Offline**, the cursor *A* can be used to observe measurements and data stored on the temporary buffer but on the Instrument windows. When instruments such as Measurements, Setpoint Adjust, PQ Monitor and/or others are open when the cursor A is displaced along a curve in the Oscilloscope window, the Instruments will show measurements reading from the AVR at the time the temporal buffer was recorded (*Figure 6-22*). This additional information is also stored in the temporary buffer but (some of them) are not shown in the Oscilloscope window.

Notice that the *cursors* moved along the temporary buffer will show historical data on the Instrument only if the CMT1000 is Offline; otherwise the Instruments show actual measurements and reading from the AVR (and the system).

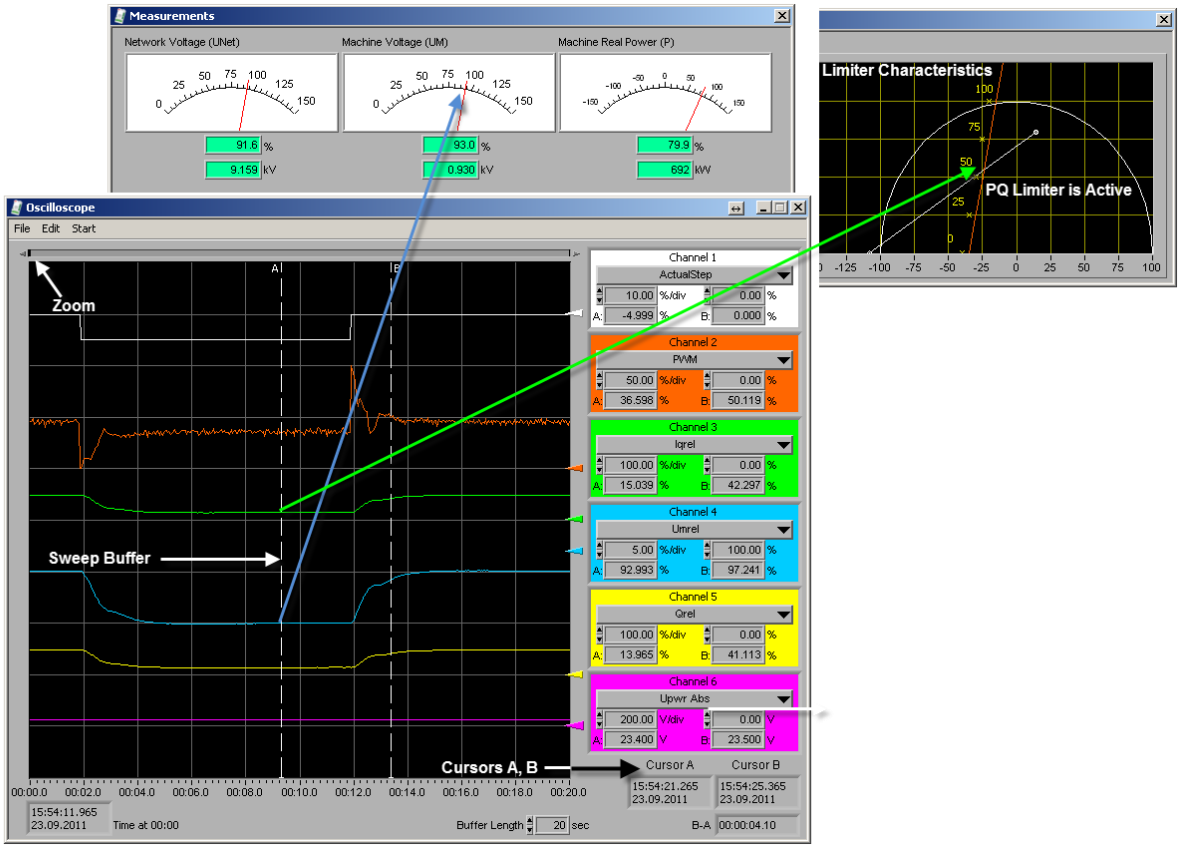


Figure 6-22 Evaluation of a waveform

A feature called Sweep Buffer can be used to displace the cursor A along the transient curve at real time speed, and so, to observe the variations of measurements and data as they might have been gathered during operation of the AVR.

When Sweep Buffer is enabled from the menu, a vertical line replaces the pointer A and runs along the transient curve starting from the cursor A until the end of the transient at real time speed (i.e. one second of cursor movement is equal to one second of operation with the AVR). During the time the vertical line runs, the instantaneous value of the curve is displayed on the Oscilloscope window, under the cursor A information. If an Instrument window is opened during this process, the instantaneous data is also updated and shown

in the window. The Sweep Buffer should be used together with the Instruments windows, and therefore, it is only available when the CMT1000 is Offline. It can only be activated from the menu when the cursors were already enabled as well.

Examples

a) During **OFF LINE**: previously stored waveform files

File \ Open Waveform:	Open stored waveform file. Adjust the Buffer Length if necessary to see the full transient on the Oscilloscope.
Edit \ Cursors:	Assign channel with buttons A and B, use left mouse button to drag cursor A to the desired point on the signal curve. The measured values can be measured on the oscilloscope, instruments or PQ diagram.
Edit \ Sweep Buffer:	The curves are run through from cursor point A using the scanning bar.

b) During **MONITOR** or **CONTROL**: Real time data

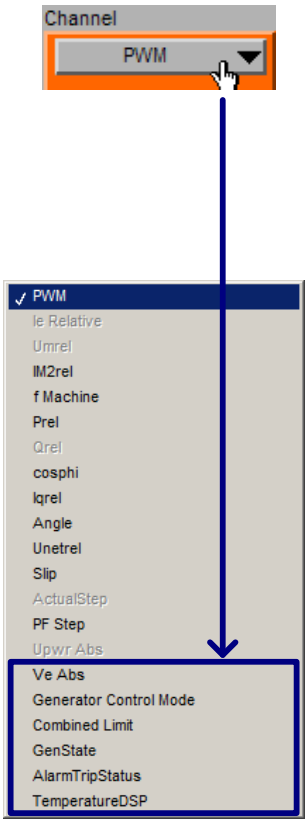
Start:	The recording of the waveform is started.
Freeze Waveform:	The recording is stopped.
File \ Save Waveform:	Save waveform.
File \ Save Setup:	Save oscilloscope settings.

Notes

- The window in "Tune" can also be opened to set the regulators.
- The setpoint step is simulated in “Tune Setpoint Adjust“.
- The buffer length can be adjusted from 1, 2, 5, 10, 20, 50, 100 and higher values up to 500 seconds.
- The time scale can be adjusted in the bar above the waveform (Zoom).

Monitor \ Oscilloscope, Status Display

There are 4 analog signals that represent status changes on the oscilloscope. The decoding of those signals is explained as follows:



Generator Control Mode:

0 = Auto
1 = Var
2 = PF
3 = Manual
4 = Open Loop
5 = VDC
6 = Sync
7 = Standby

Combined Limit:

0 = None
1 = Minimum Excitation Current Limiter active (Min Ie)
2 = Minimum Machine Voltage Limiter active (Min UM
3 = Minimum Iq Limiter active (Min Iq)
4 = Maximum Excitation Current Limiter active (Max Ie)
5 = Maximum Machine Voltage Limiter active (Max UM)
6 = Reserved
7 = Maximum Machine Current Limiter active (Max IM)
+8 = V/Hz Limiter active
+16 = Minimum Setpoint reached
+32 = Maximum Setpoint reached

Excitation ON active: Combined Limit = See values above
Excitation ON not active: Combined Limit = -1.0

GenState (Generator State):

0 = Idle (NoLoad)
1 = Change NoLoad -> Primary Net
2 = Primary Net
3 = Change Primary Net <-> Secondary Net
4 = Secondary Net
5 = Change Secondary Net -> NoLoad
6 = Primary Net or Secondary Net -> Grid ON
7 = Grid ON
8 = Grid ON -> Primary Net or Secondary Net

AlarmTripStatus:

0 = None
+ 1 = SW Alarm active
+ 2 = FCB Alarm active
+ 4 = External Alarm active
+ 8 = Modbus Communication Alarm active
+ 16 = Diode Alarm active (requires RDM SW)
+ 32 = Diode Trip active (requires RDM SW)
+ 64 = Supervision Alarm active (requires Double Channel SW)
+128 = Supervision Trip active (requires Double Channel SW)
+256 = DCH SwitchOver active (requires Double Channel SW)

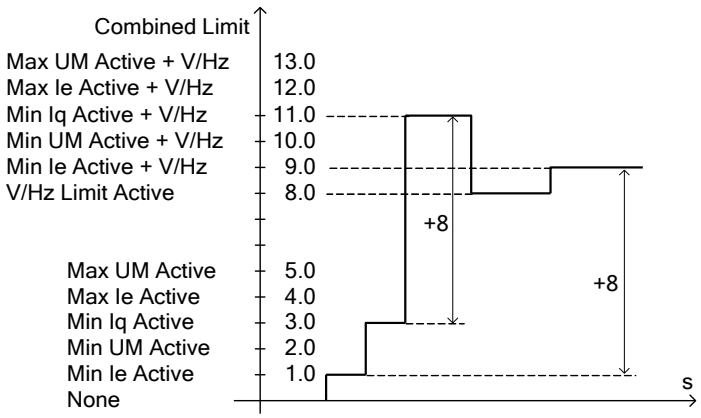
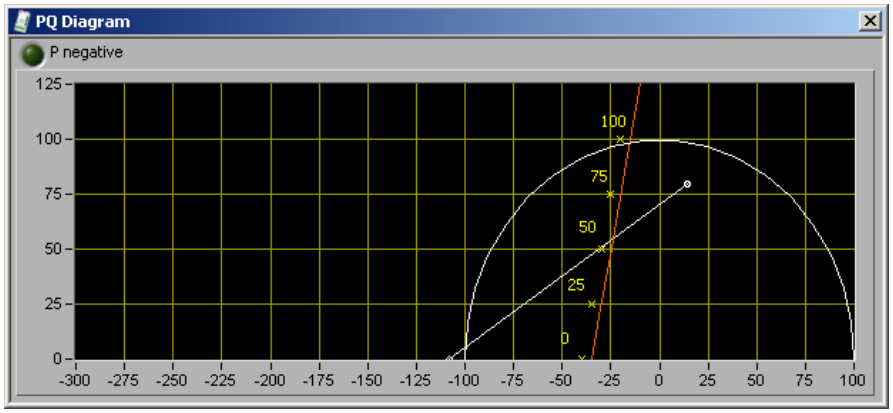


Figure 6-23 Example of Combined Limit Status

6.4.5.3.3 *PQ Diagram (Power Chart)*

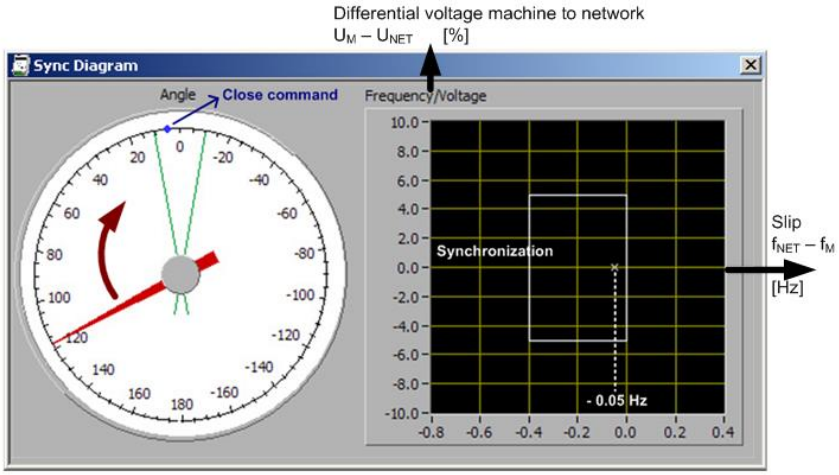
Monitor \ PQ Diagram



Note: The Limiter points can be moved with the cursor.

6.4.5.3.4 *Synchronization Diagram, Synchroscope*

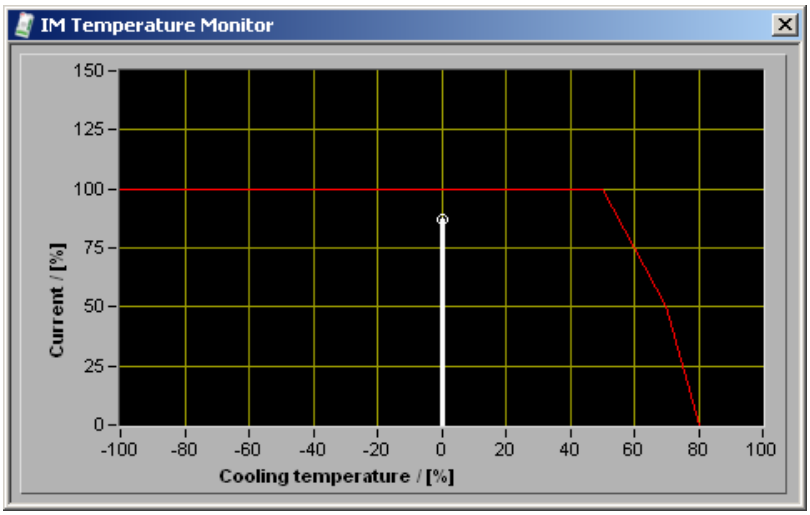
Monitor \ Sync Diagram



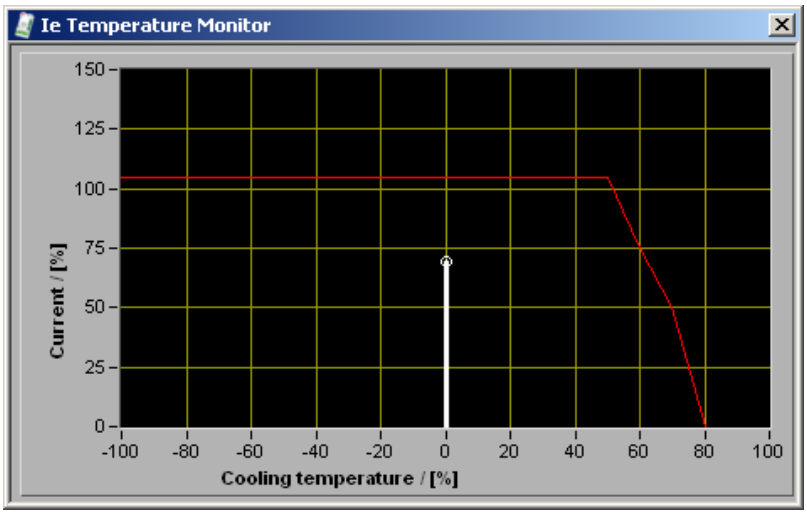
6.4.5.3.5 *IM or Ie Temperature Monitor*

Monitor \ Temp Influence

IM Limiter



Ie Limiter



6.4.5.3.6 *Second Channel Measurements*

Displays status and measurements from the Second Channel. Double Channel SW is required to show this window; otherwise it is not accessible from the CMT1000 menu.

1. Displays the current measurements of U_{NET}, U_M, Excitation Current and Machine Current from the second channel.

2. Displays the current status (Active or Standby) and the current operating mode (Auto, Standby, etc.) of the second channel.

   Example

3. Displays *Alarm* and *Trip* statuses of the second channel. The LED(s) are lit (light red) when the signal is active (logical 1).

4. Indicates the communication quality of the CAN communication for DCH software. The LED is lit (light green as the picture shows) during the time the CAN communication is enabled, established between both channels and the data free of errors (i.e. no CRC errors on data packets).

   The complete *Second Channel Measurements* window becomes shaded if the *Double Channel Comm. Ok* LED is dark (*Figure 6-25*) This means that no valid data is transmitted between both channels and that data is irrelevant to be displayed.

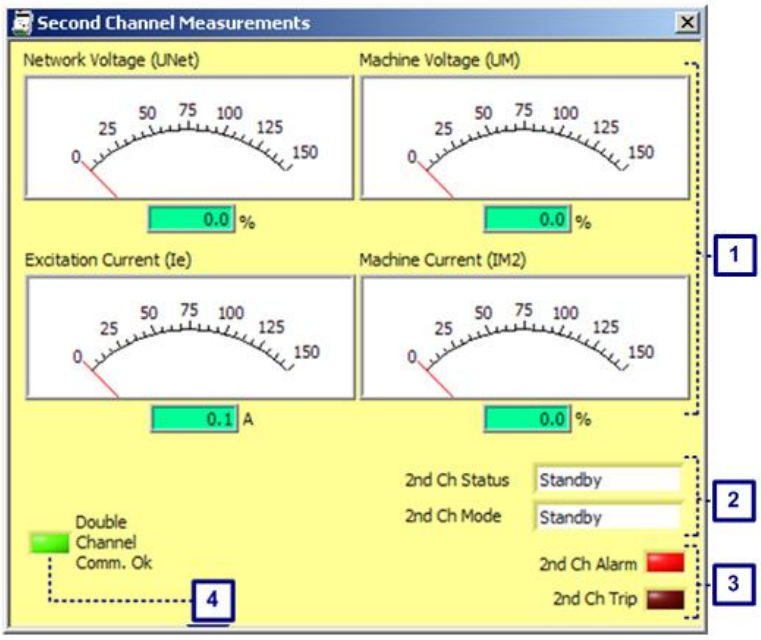


Figure 6-24 Second Channel Measurements window, when Double Channel communication over CAN is OK (data is being received correctly)

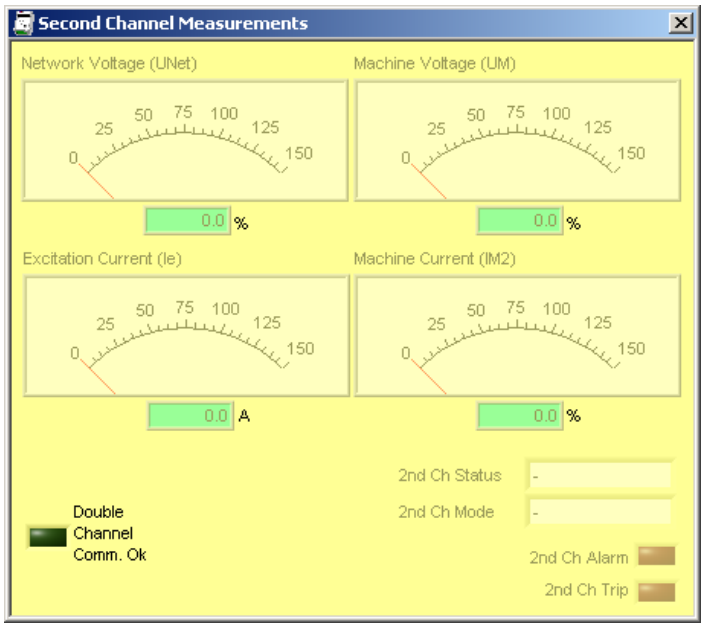
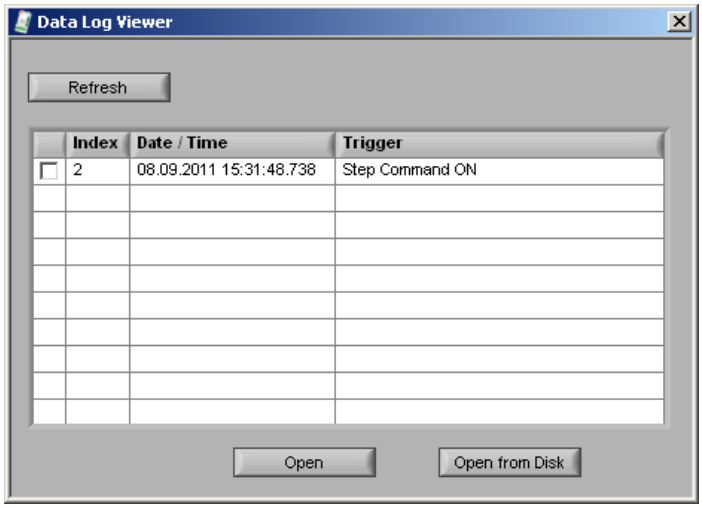


Figure 6-25 Second Channel Measurements, when Double Channel communication failed or is disabled.

6.4.5.3.7 *Data Logger*

Max 10 data logs are stored on non-volatile memory on the target triggered by configured events. All available data logs are listed.

Opening a log file goes faster when in Monitor Mode



6.4.5.3.8 *Event Monitor*

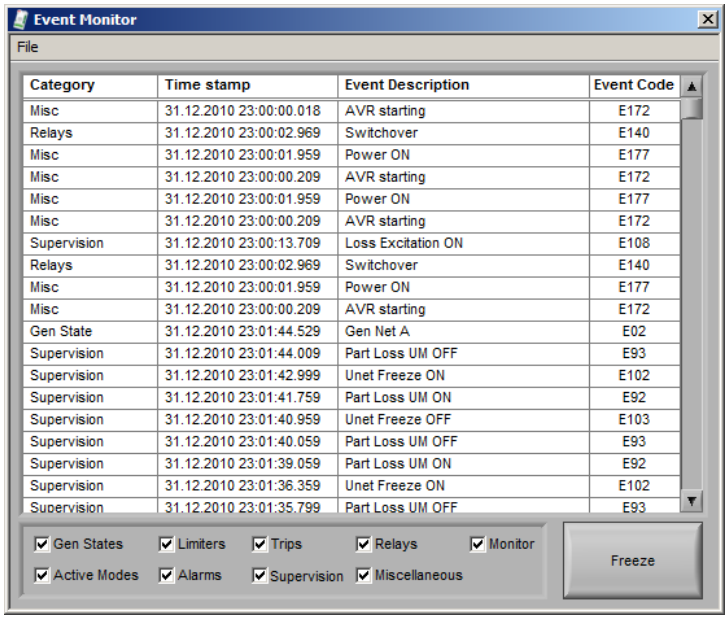
Events are stored to the target and periodically listed.

Complete list can be stored on PC as a text file

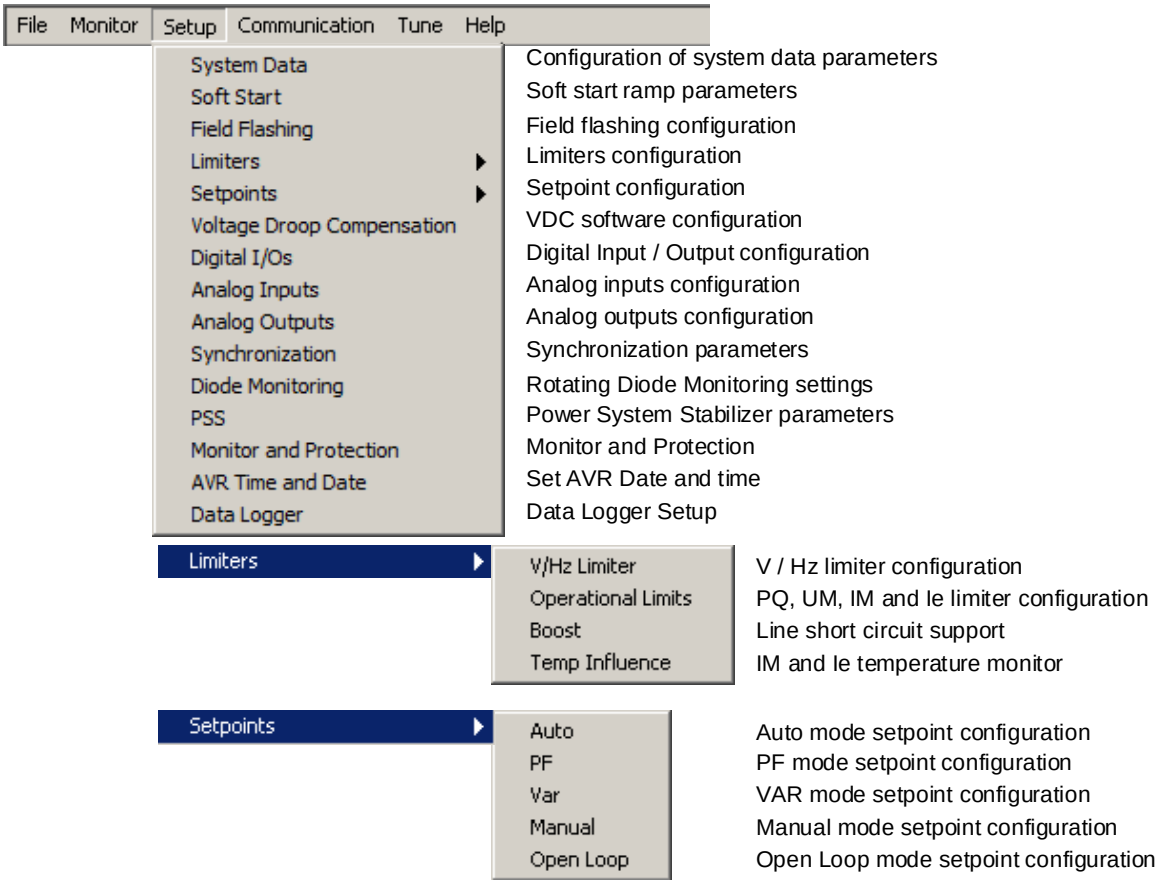
Filters can be set to give a better view on certain events

Freeze button stops periodical update in order to evaluate the received events.

The UNITROL device can store max 500 events. CMT1000 can store up to 1000 events, when connected to the UNITROL device.



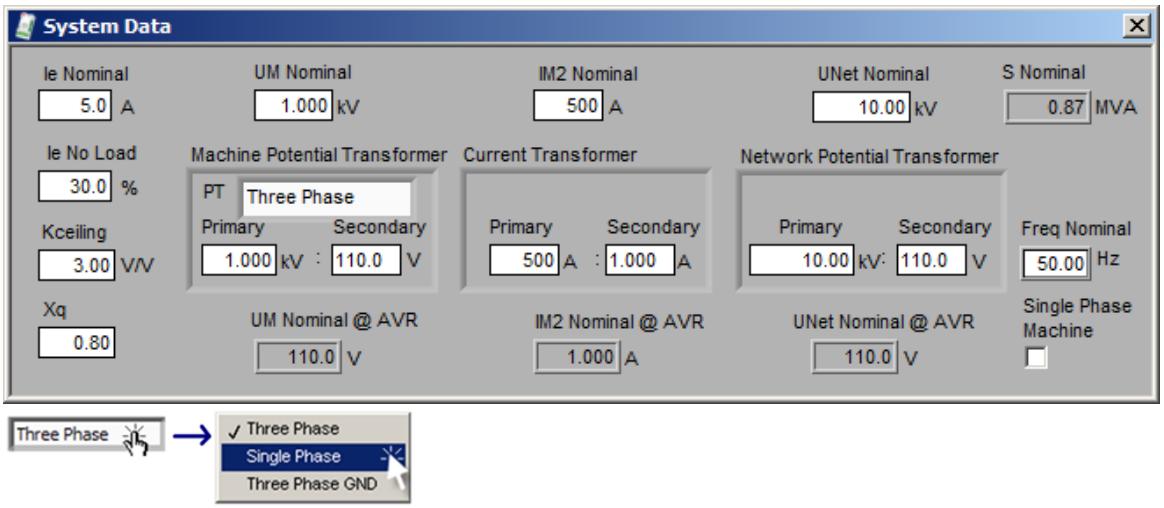
6.4.6 *Setup Menu*



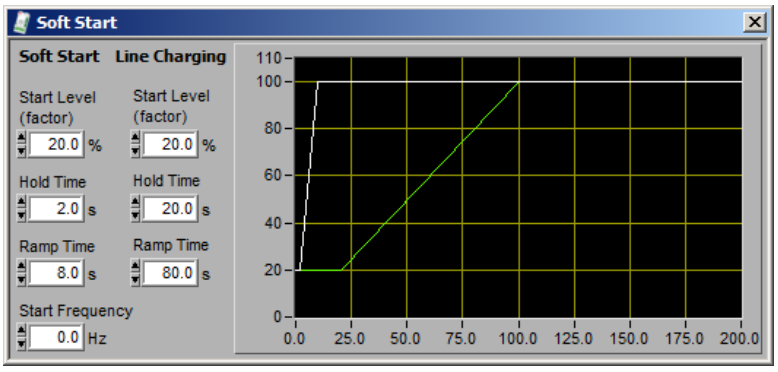
Note: Some menu items may not be accessible when the CMT1000 has Monitor or Control Access and/or the AVR has optional software which is not available. All menu items are accessible when the CMT is Offline.

6.4.6.1 Operational parameters

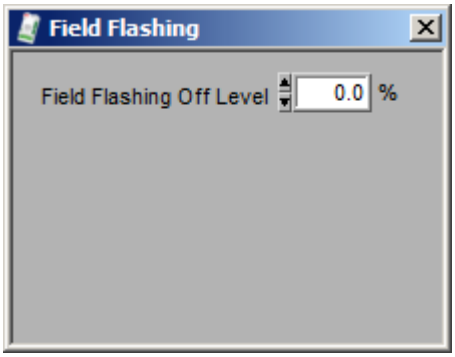
Adjust System Data
Setup \ System Data



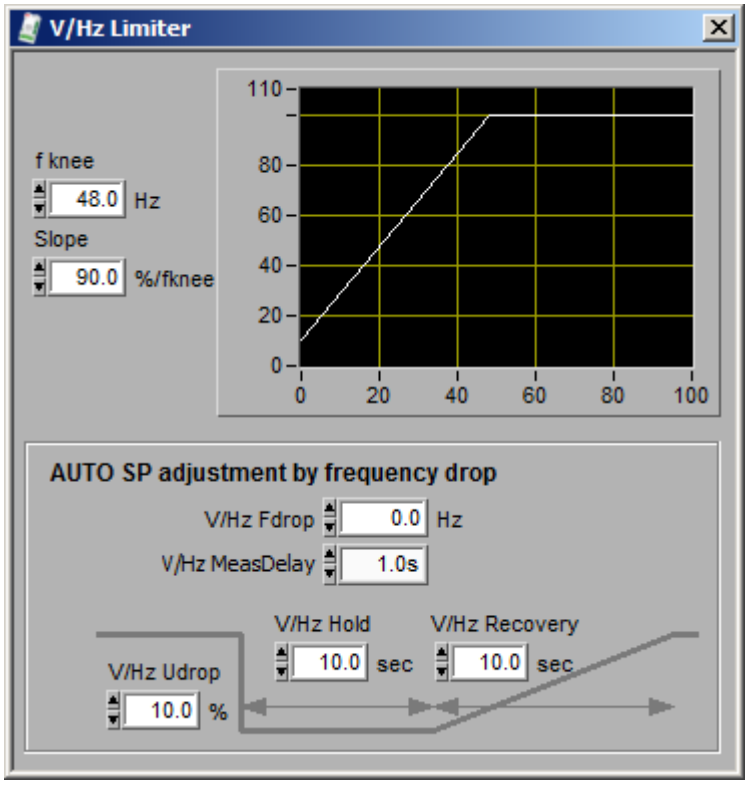
Configure Soft Start
Setup \ Soft Start



Adjust Field Flashing
Setup \ Field Flashing

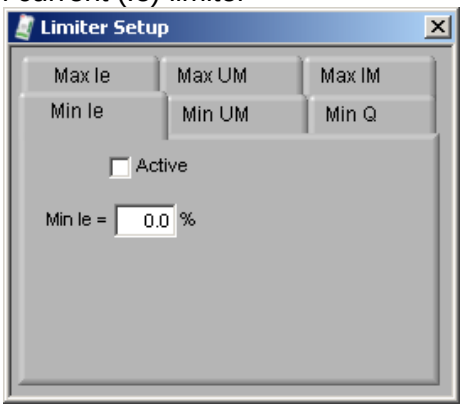


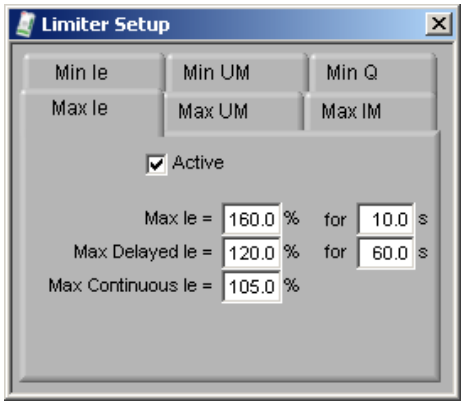
Adjust V/Hz Limiter
Setup \ Limiters \ V/Hz Limiter



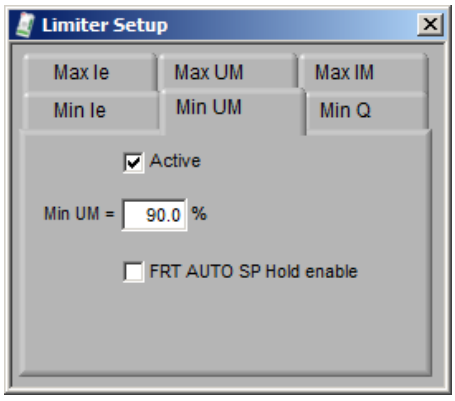
Operational Limits. Adjust Ie, UM, PQ and IM Limiter
Setup \ Limiters \ Operational Limits

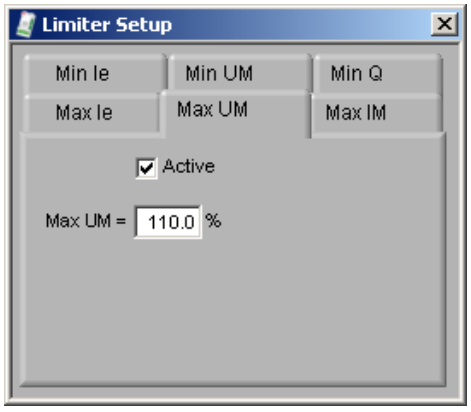
Excitation current (Ie) limiter



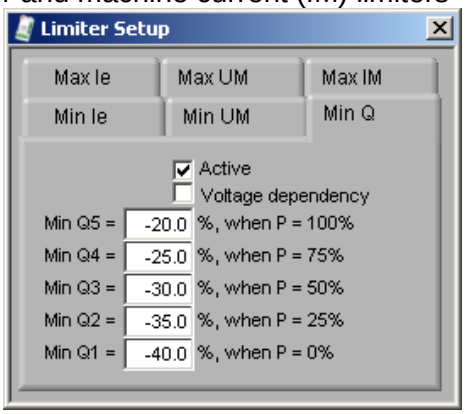


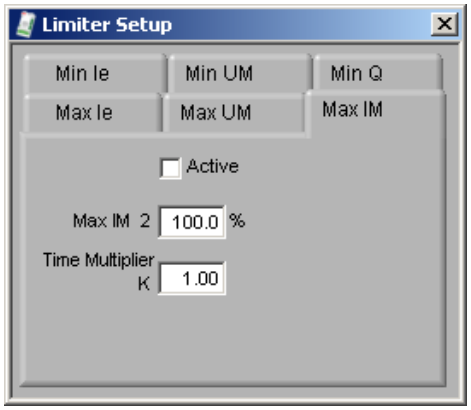
Machine voltage (UM) limiter





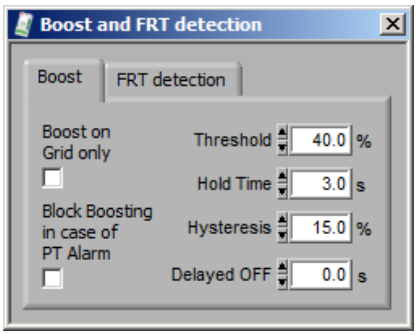
PQ limiter and machine current (IM) limiters



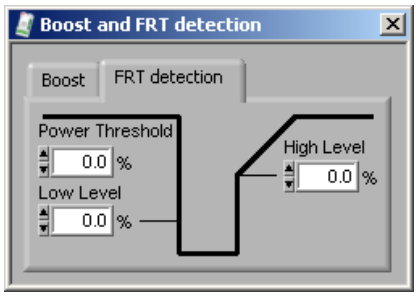


Adjust Short Circuit Support
Setup \ Limiters \ Boost

Boost
Threshold % applies for both Boost and Voltage Relay features. Boost and Voltage Relay cannot be configured with different threshold values.

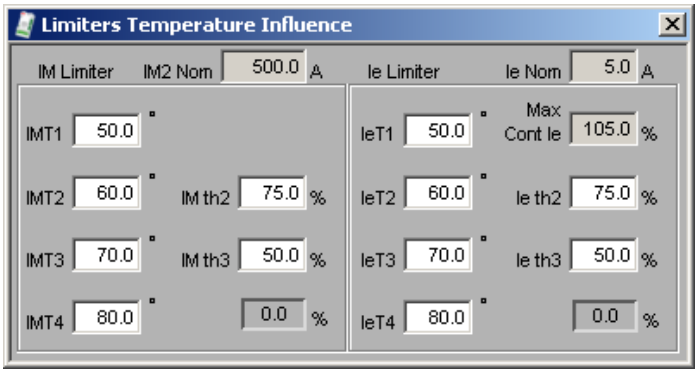


FRT detection (Fault ride through)
Setup for FRT detection output



Adjust Limiters Temperature Influence
Setup \ Limiters \ Temp Influence

IM and Ie nominal values can be changed in System Data window.



Adjust Setpoint Range new window
Initial SP refers to the Initial setpoint of the operation mode.

Setup \ Setpoints \ Auto

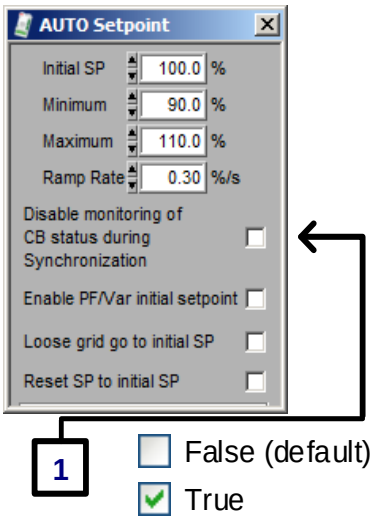
The Initial Setpoint (SP) of Auto mode is the final value of the Soft Start ramp. For more information refer to Chapter *3.4.2.1 Soft Start*.

1. Parameter configuration: "SYNC DisableCBCheck".
For more information see Chapter *3.4.2.7 Synchronization (SYNC)*

2. Parameter configuration: "Enable PF/VAR initial setpoint" will set SP to initial value in case PF/VAR is preselected when changing to grid parallel operation.

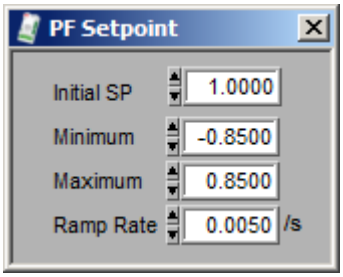
3. Parameter configuration: "Loose grid go to initial SP" will set SP to initial value when going to island operation.

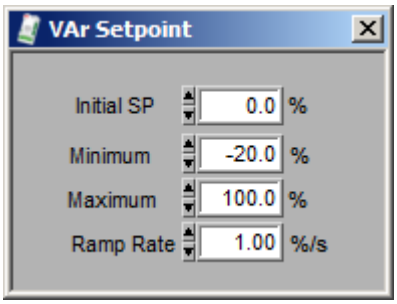
4. Parameter configuration: "Reset SP to initial SP" will set SP to initial value in case "Reset Setpoint" is activated.



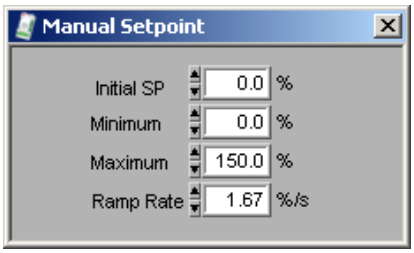
Setup \ Setpoints \ PF

Setup \ Setpoints \ Var

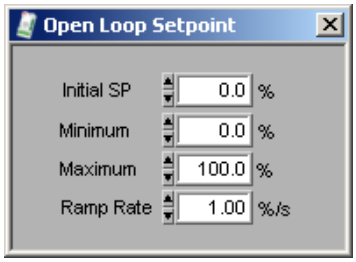




Setup \ Setpoints \ Manual



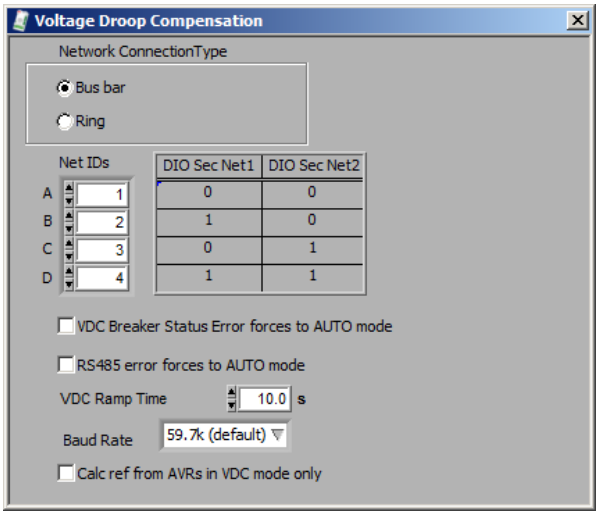
Setup \ Setpoints \ Open Loop

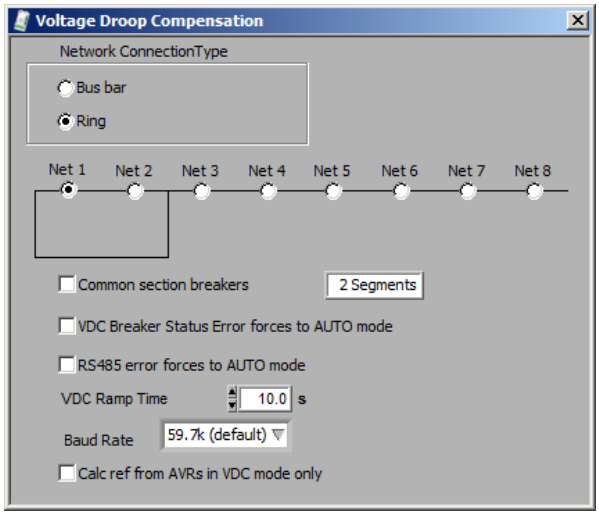


Adjust Voltage Droop Compensation Control Range
Setup \ Voltage Droop Compensation

Setup Window for busbar configuration
Setup Window for ring configuration

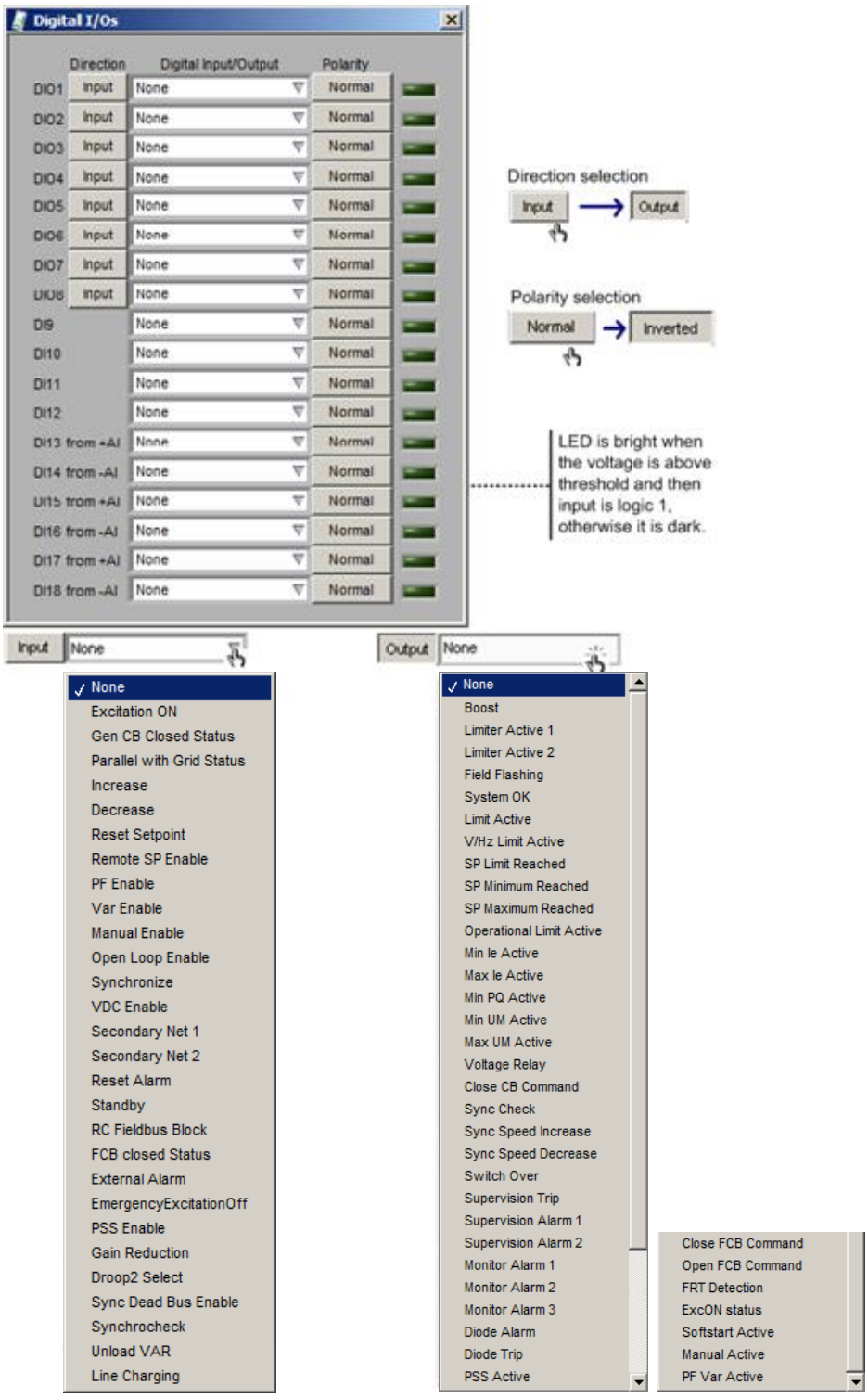
For configuration refer to Chapter *3.4.3.1 Voltage Droop Compensation (VDC)*.




Voltage Droop Compensation
Network ConnectionType
Bus bar
Ring
Net 1
Net 2
Net 3
Net 4
Net 5
Net 6
Net 7
Net 8
Common section breakers
2 Segments
VDC Breaker Status Error forces to AUTO mode
RS485 error forces to AUTO mode
VDC Ramp Time
10.0
s
Baud Rate
59.7k (default)
Calc ref from AVRs in VDC mode only

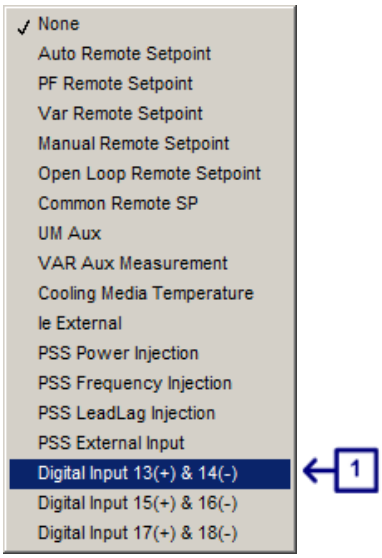
6.4.6.2 IO configuration

Configure Digital I/O
Setup \ Digital I/Os



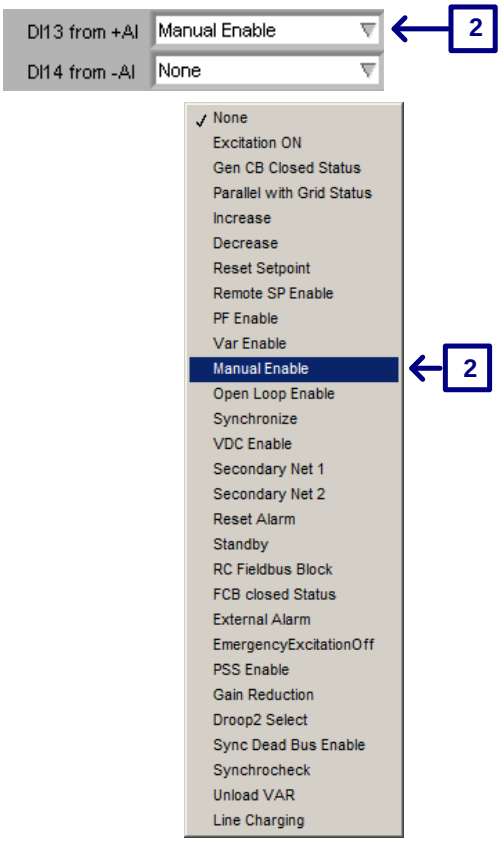
Example of configuration of the input signals with the CMT1000 software tool

1. Select the analog input AI1 (or AI2 or AI3) and adjust the input range [Setup \ Analog Inputs]



Range : Uin0% = 2.0 V
Uin100% = 5.0 V

2. Select one or two digital signals
DI13 from +AI
DI114 from –AI
[Setup \ Digital I/Os]



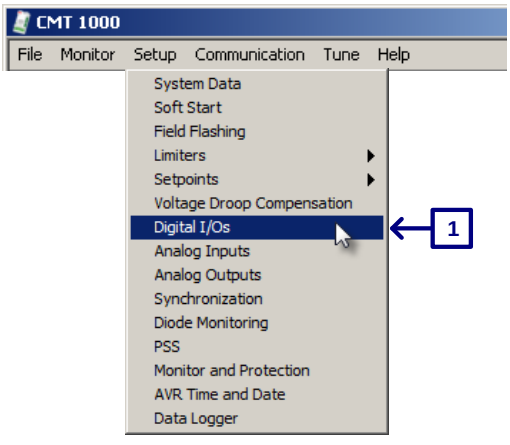
When using AI pins for DI signals, both inputs should not simultaneously be active.

Example of parameter setting using CMT1000

Example: Assigning Parallel with Grid Status to input DI10
Make Control-connection to the unit

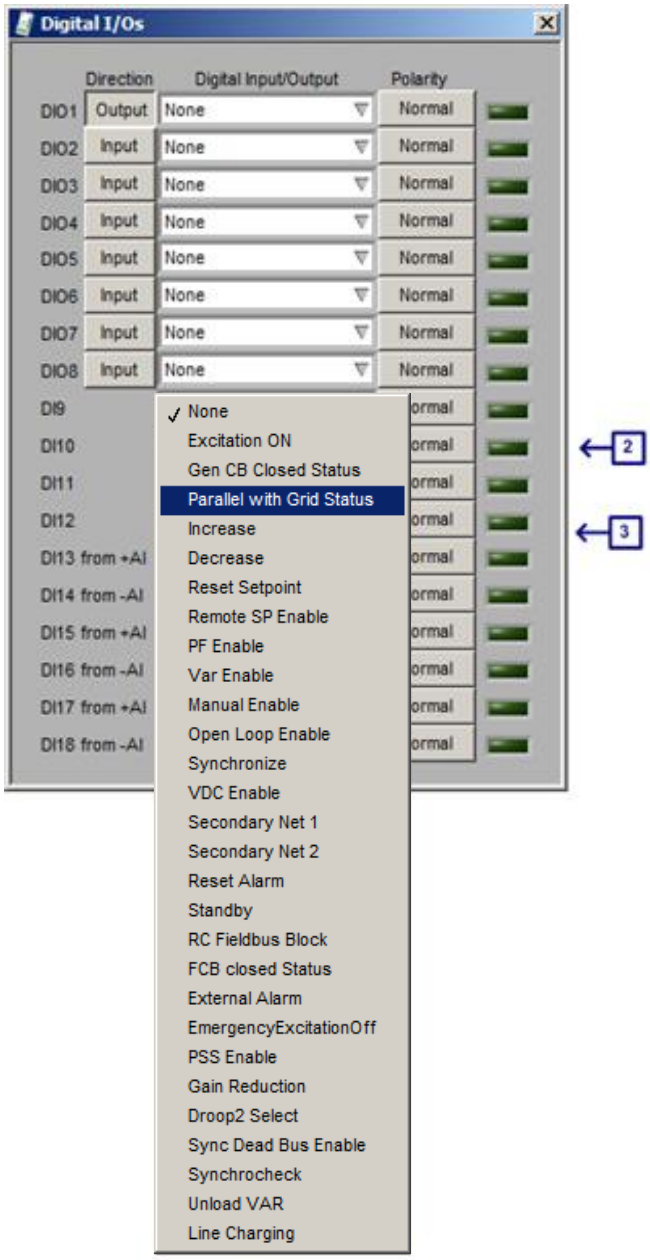
Menu bar CMT1000, start menu

1. Select setup and then Digital I/Os



2. Open input DI10 by clicking on the white box.

3. Select input: "Parallel with Grid Status"



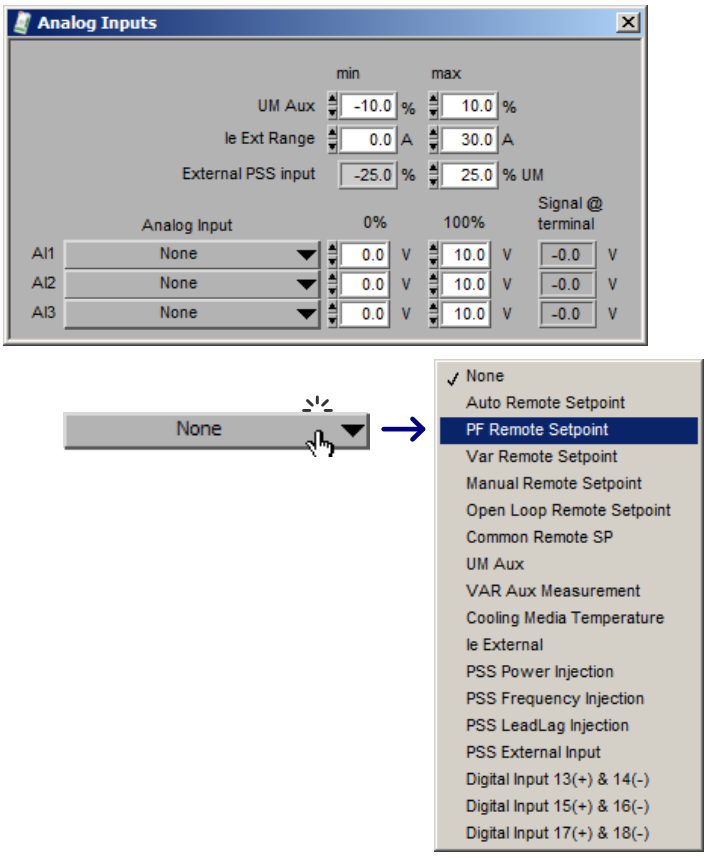
4. Result: DI10 configured

The procedure above only changes the parameters in the volatile memory.
To make the modification permanent (even after restarting the AVR), all the parameters have to be stored in the non-volatile EEPROM.

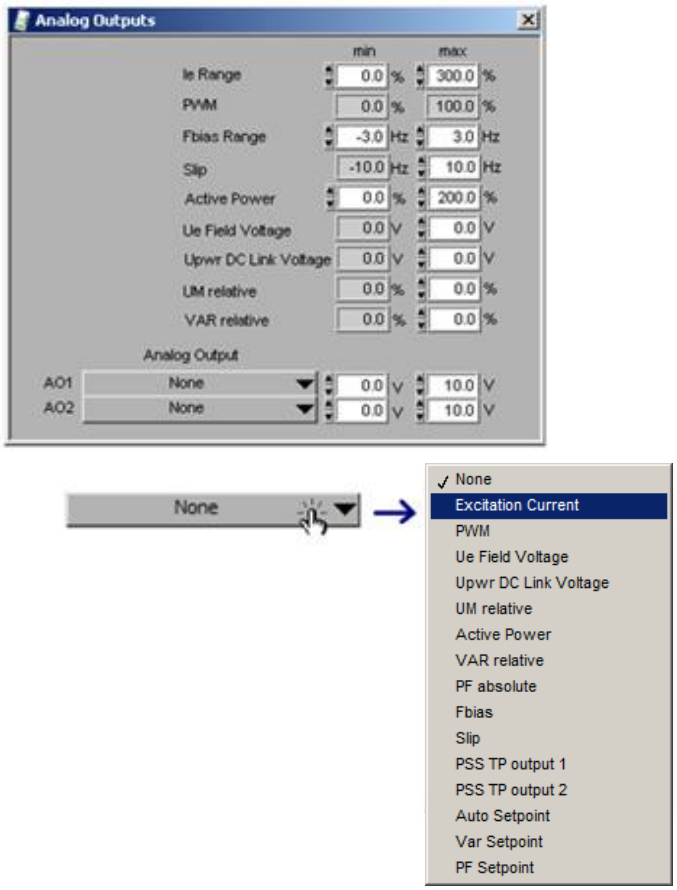
Save parameters during CONTROL Access:
- Unit: **Menu bar CMT1000 \ File \ Write Parameters to EEPROM**
- Hard disk: **Menu bar CMT1000 \ File \ Save Parameter File**

Configure Analog Inputs

Setup \ Analog Inputs



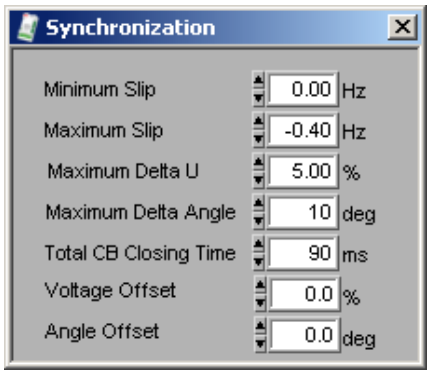
Configure Analog Outputs
Setup \ Analog Outputs



6.4.6.3 Miscellaneous Functions

Adjust Synchronization
Setup \ Synchronization

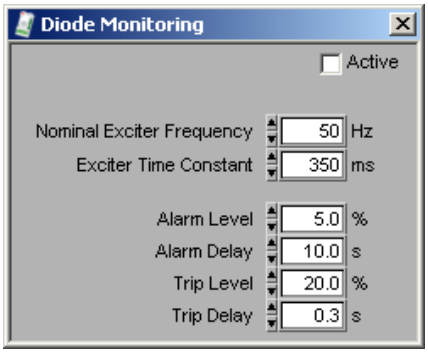
The window is shown if CMT1000 is OFFLINE and/or Synchronization SW (optional) is available in the device.



Adjust Diode Monitoring

Setup \ Diode Monitoring

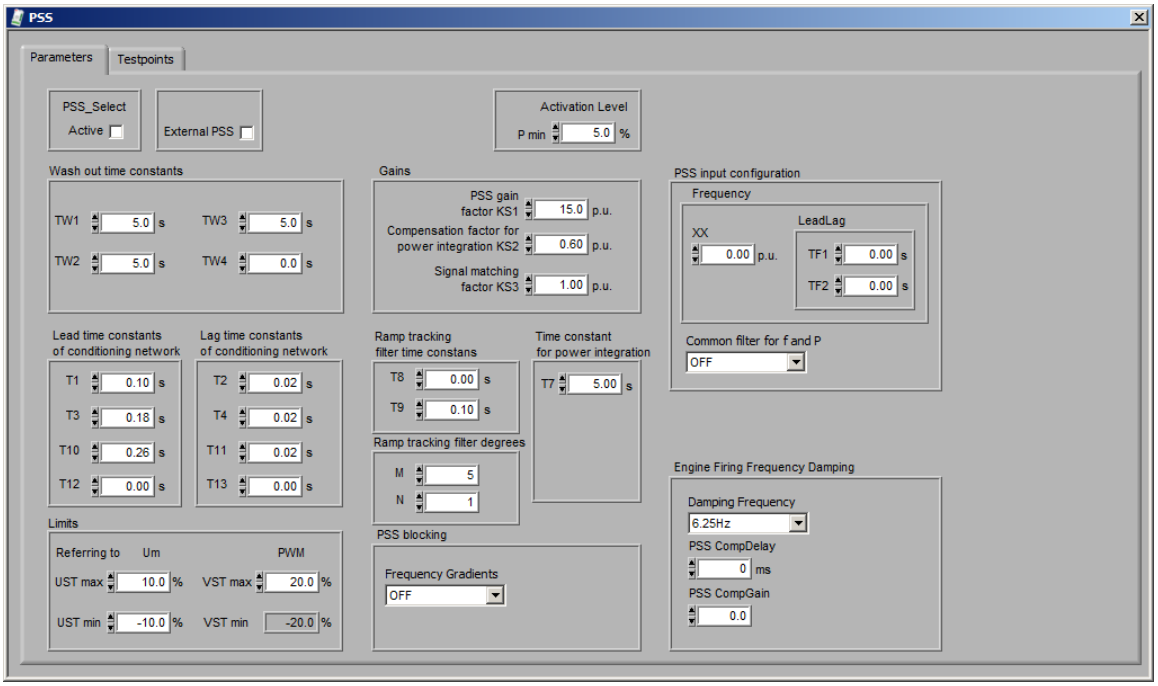
The window is shown when the CMT1000 is OFFLINE and/or the Rotating Diode Monitor SW (optional) is available in the device.



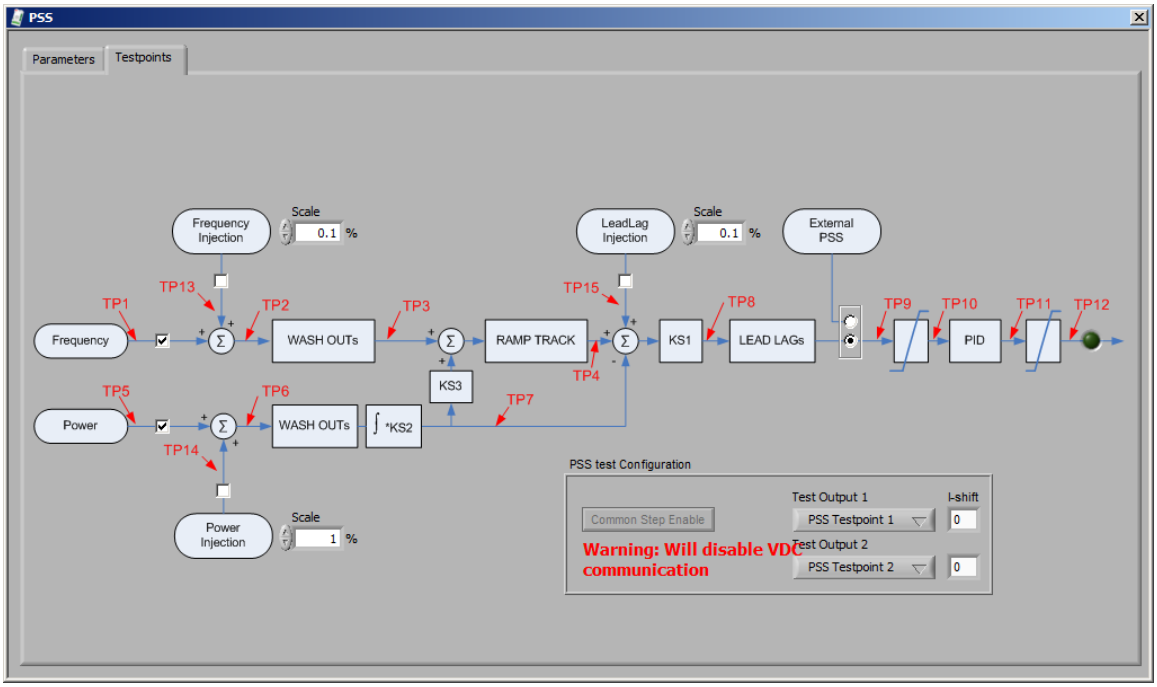
Adjust PSS

Setup \ PSS

The window is shown when the CMT1000 is OFFLINE and/or the Power System Stabilizer SW (optional) is available in the device.



This window below can only be opened when the device is online and connected. Only then both configurable test points can be monitored in the CMT oscilloscope.



PSS Test Interface

a. The operator switches on/off PSS input signals and injections points

b. The operator selects two test points from the range TP1 … TP16
Both selected signals are shown in the CMT1000 Oscilloscope and are routed to the analog output

c. The operator adjusts the analog output amplitude
I-shift (0 to 7) is equal to a factor of 2 $^{(I\text{-}sift)}$
Eg. If I-shift equals 2, the analog output is multiplied by factor 4
Scaling of TP can be seen in the table below.

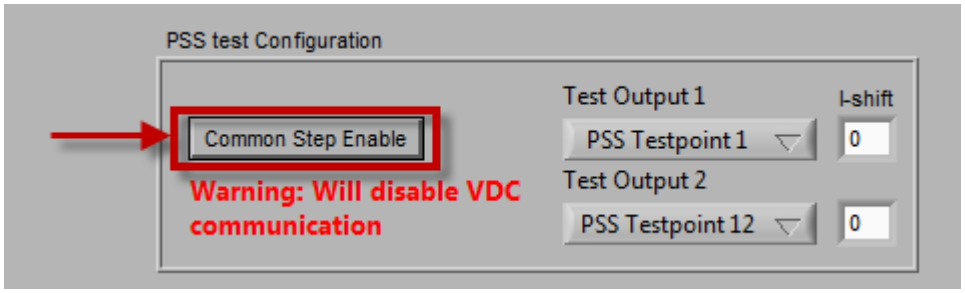
The analog output range can be configured with min (-10V to +10V) and max (-10V to +10V) values which represent the scaling. All values represent peak values.

TP	*Signal Name*	*Scaling*	*I-shift*
1	Frequency meausurement input	±12.5%	0
2	Frequency washout input	±12.5%	0
3	Frequency washout output	±12.5%	0
4	Ramp Track filter output	±25.0%	1
5	Power Input	±200%	4
6	Power washout input	±200%	4
7	Delta Power integrator output	±25.0%	1
8	Lead lag input	±25.0%	1
9	Lead lag output	±25.0%	1
10	Lead lag output limited	±25.0%	1
11	PID output	±100.0%	3
12	PID output limited	±50.0%	2

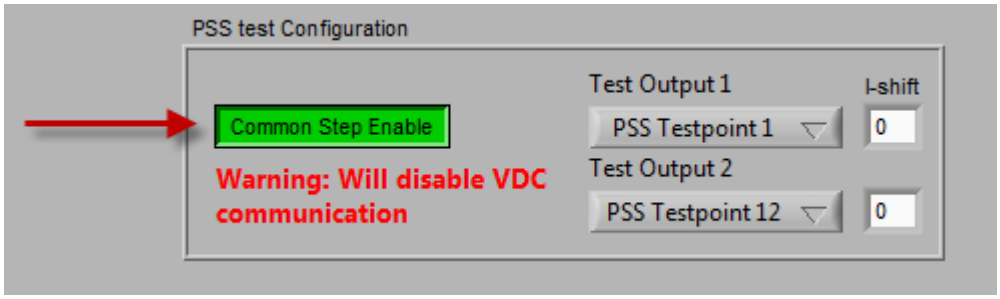
TP	Signal Name	Scaling	I-shift
13	Frequency injection point	±12.5%	0
14	Power injection point	±200%	4
15	LeadLag injection point	±12.5%	1
16	PSS Status Bit 0: PSS selected Bit 1: PSS active (contributing) Bit 2: PSS blocked by Power Bit 3: PSS blocked by Voltage lever Bit 4: PSS blocked by frequency gradient	bits	0

In order to get normalized gain for the measuring transfer function using analog outputs, the I-shift parameter must be used. The table above shows a possible setup of the I-shift parameter in order to get normalized gains.

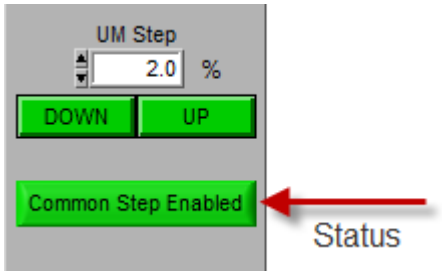
If multiple machines are connected to the same step-up transformer, the user can apply a common step command to all AVRs simultaneously. This allows testing the PSS and measuring more clearly the increased damping with a step response.
The user has to enable the common step at all AVRs. The command is given only at one AVR and is distributed over RS-485 lines to all other AVRs. A common step on all machines is applied within 1ms.
Below extract shows how the common step can be enabled.



During the time this is enabled, the VDC communication will be disabled



If the *Common Step Enable* button is selected, this status is shown in the setpoint adjust window (indication turns green).

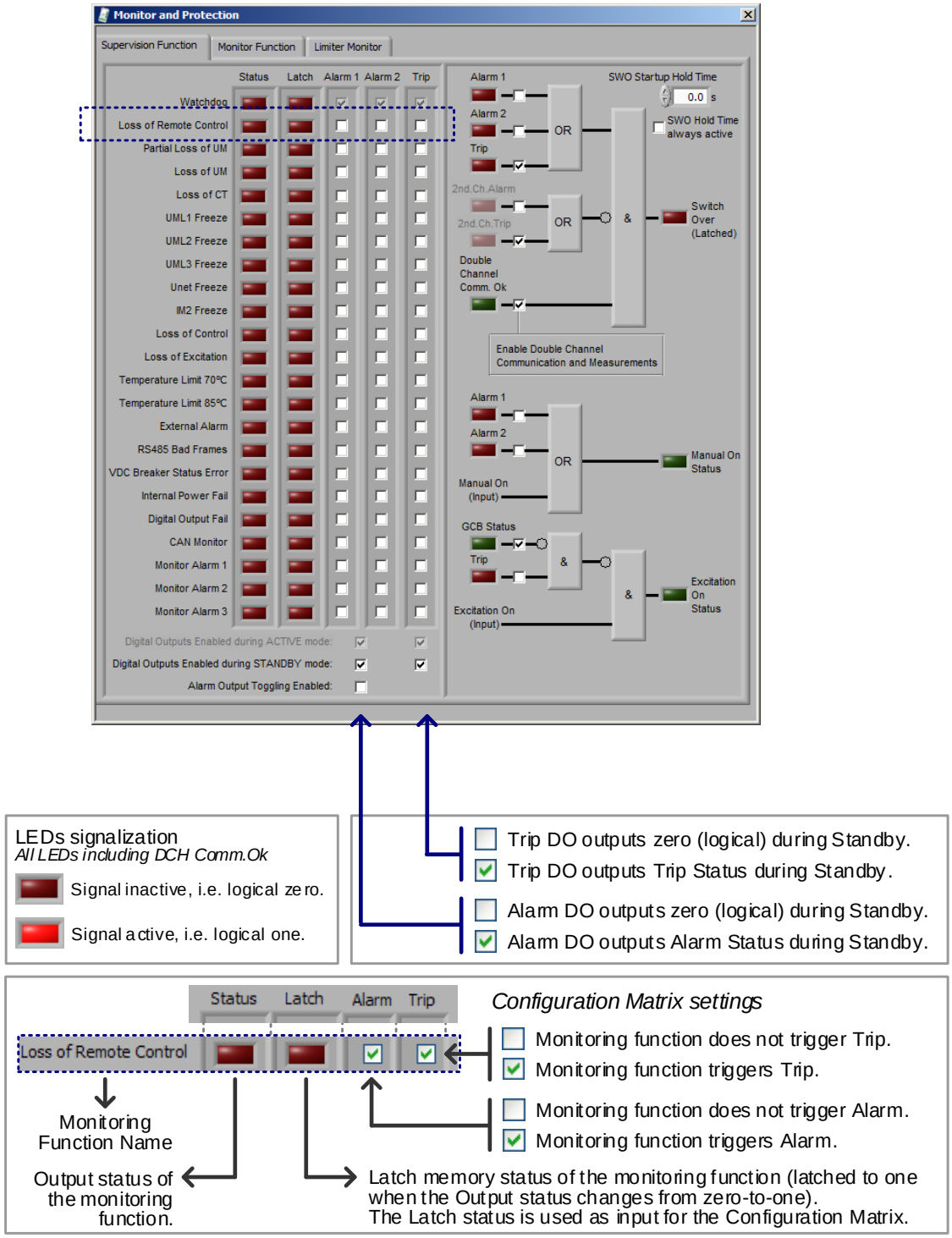


The common step function is disabled as soon as the mode is changed or the excitation is switched off.

Monitor and Protection Configuration

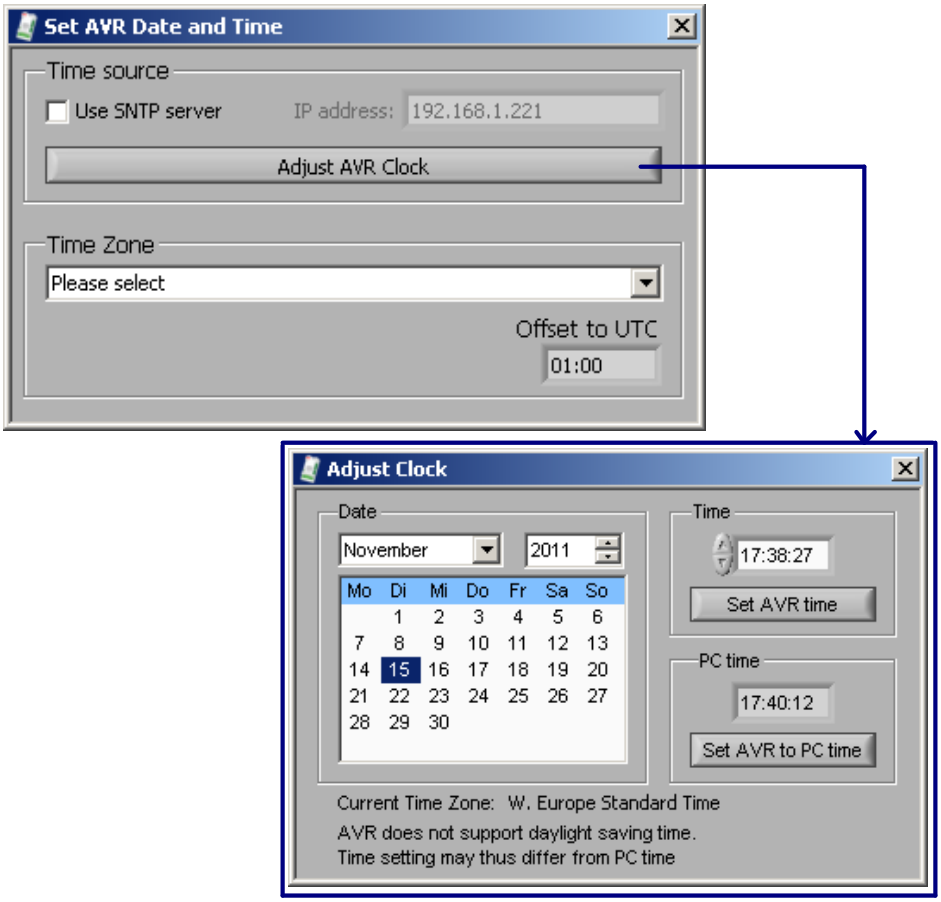
Setup \ Monitor and Protection

The window can only be accessed when Offline or when Double Channel (optional) software is available in the AVR. For more information about the configuration refer to Chapter *3.4.4.4 Double Channel (DCH)*.



AVR Date and Time

Setup \ AVR Time and Date



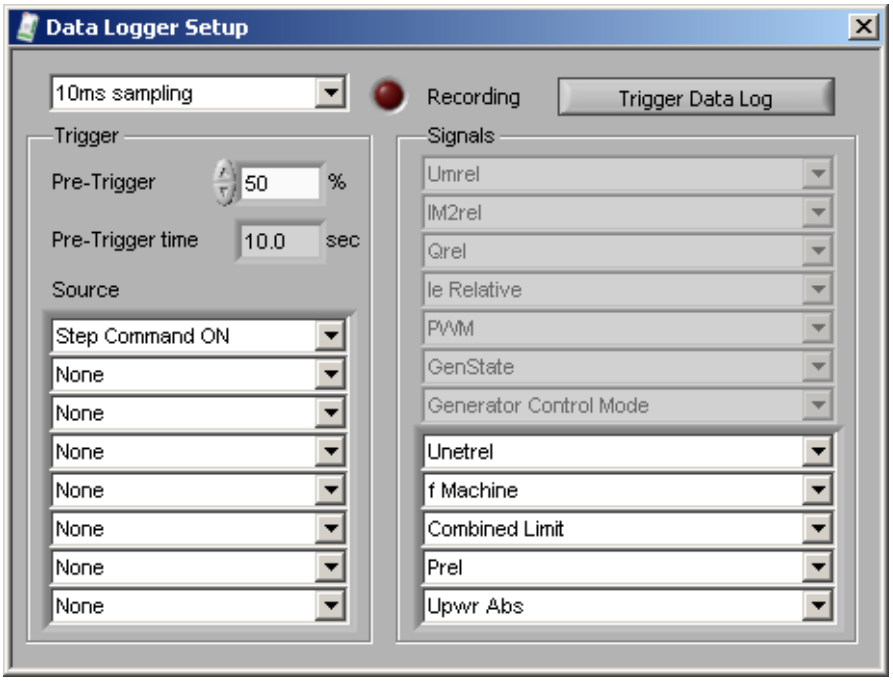
Adjust the time by means of the lower and raise buttons, then click Set AVR time
Set AVR to PC time: Click this button and the AVR will show the same time as in Windows.

Data Logger

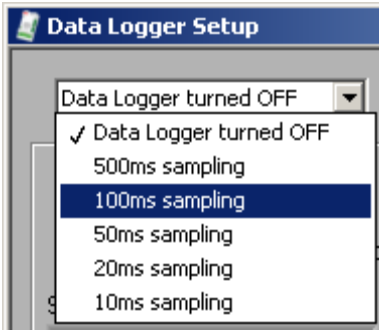
The Data Logger Setup can adjust
1 Sampling rate
2 Pre-Trigger value
3 Source
3 Extended Signal

The 7 basic signals are not listed, they are always active

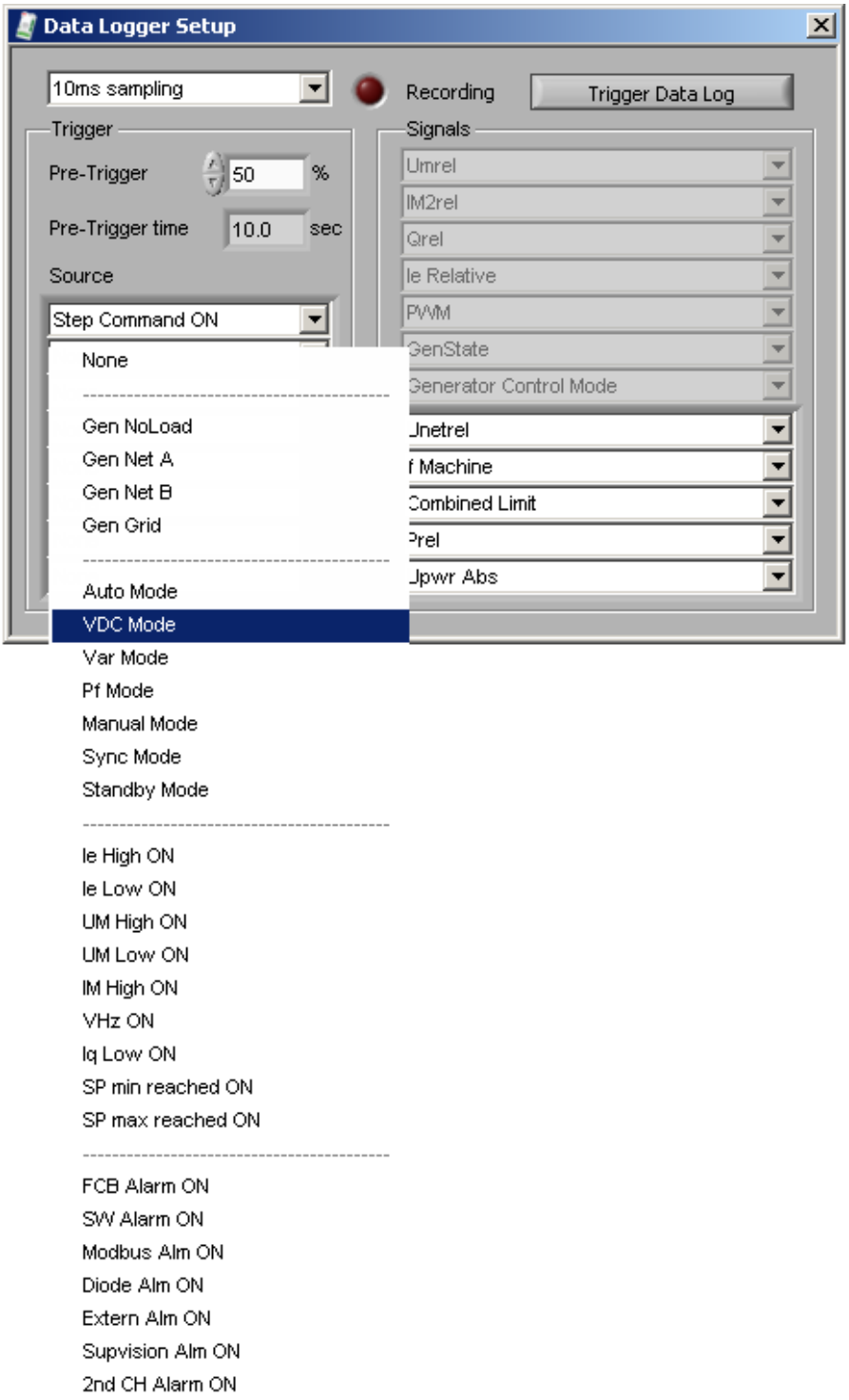
- Generator Voltage
- Generator Current
- Reactive Power
- Excitation Current
- PWM
- Generator Status
- Generator Operation Mode



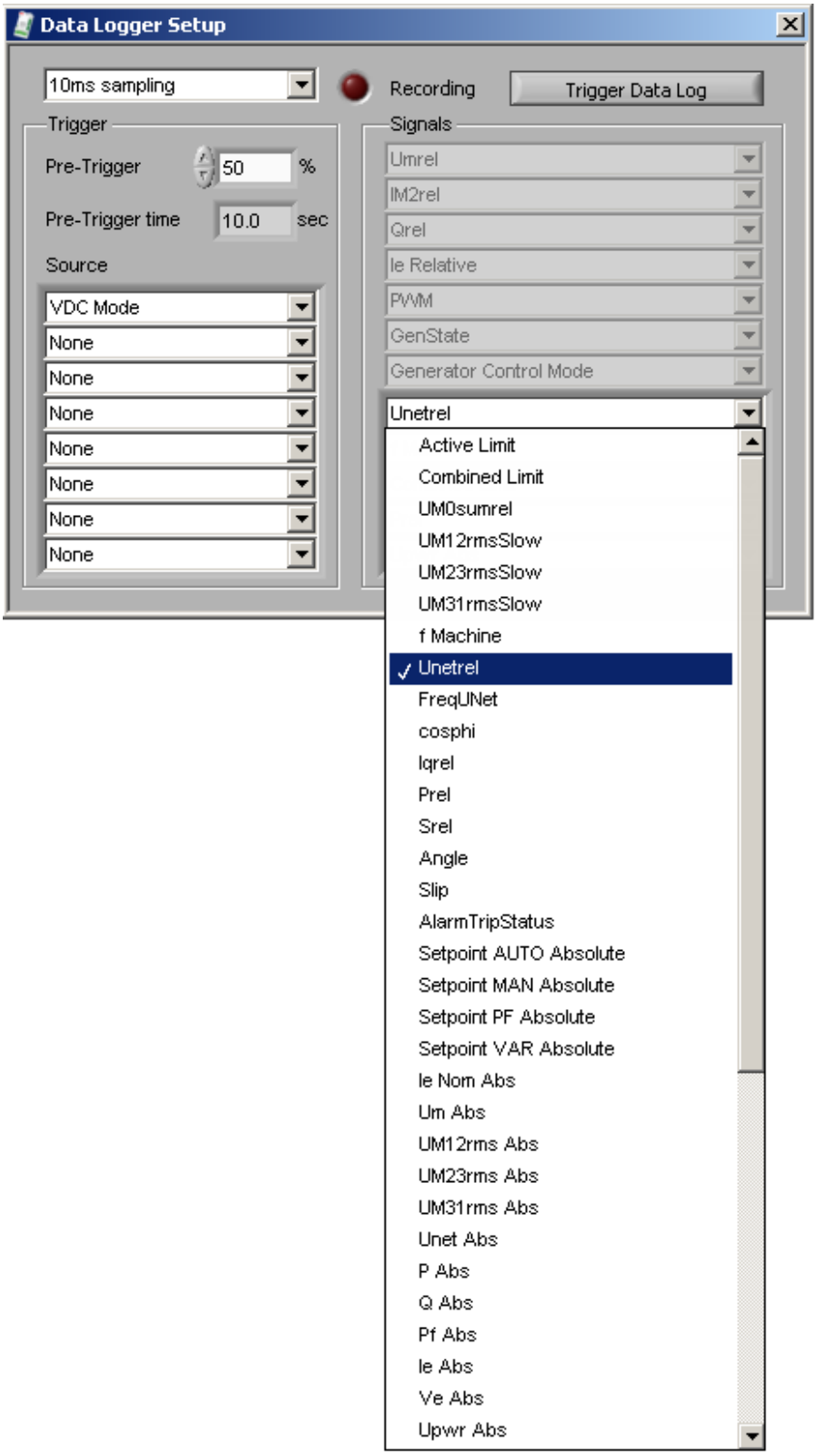
1 Sampling Rate



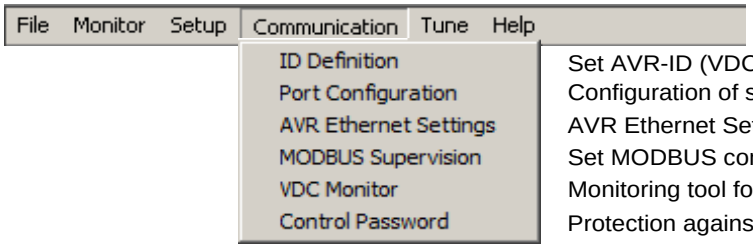
2 Source


Data Logger Setup
10ms sampling
Recording
Trigger Data Log
Trigger
Pre-Trigger
50
%
Pre-Trigger time
10.0
sec
Source
Step Command ON
Signals
Umrel
IM2rel
Qrel
Ie Relative
PWM
GenState
Generator Control Mode
Unetrel
f Machine
Combined Limit
Prel
Upwr Abs
None
Gen NoLoad
Gen Net A
Gen Net B
Gen Grid
Auto Mode
VDC Mode
Var Mode
Pf Mode
Manual Mode
Sync Mode
Standby Mode
Ie High ON
Ie Low ON
UM High ON
UM Low ON
IM High ON
VHz ON
Iq Low ON
SP min reached ON
SP max reached ON
FCB Alarm ON
SW Alarm ON
Modbus Alm ON
Diode Alm ON
Extern Alm ON
Supvision Alm ON
2nd CH Alarm ON

3 Extended Signals

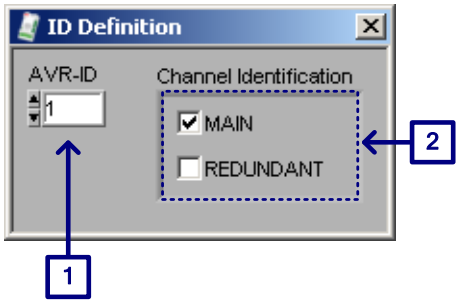


6.4.7 *Communication Menu*



Set AVR-ID (VDC) and the Channel Identification (DCH)
Configuration of serial COM port or TCP/IP address
AVR Ethernet Settings
Set MODBUS configuration for Remote Access
Monitoring tool for VDC
Protection against changing parameters

ID Definition (AVR-ID & DCH)
Communication \ ID Definition
Configuration window for AVR-ID (VDC) and Channel Identification (Double Channel).



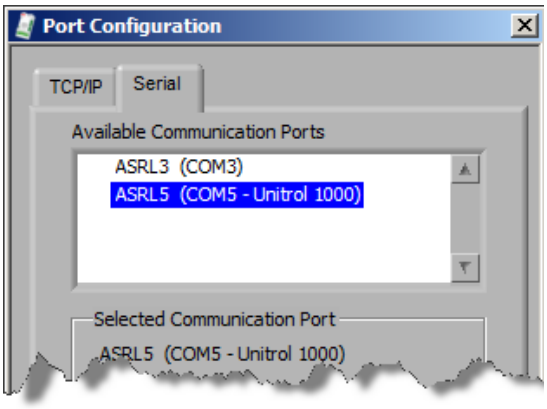
1. AVR-ID should be configured before the use of VDC. For more information refer to Chapter *3.4.3.1 Voltage Droop Compensation (VDC)*.

2. Channel Identification should be configured before using Changeover and Follow-up from the Double Channel feature. The chosen selection, Main or Redundant, is displayed in the main window of the CMT1000 (and panel) even if the Double Channel feature is not available in the AVR.

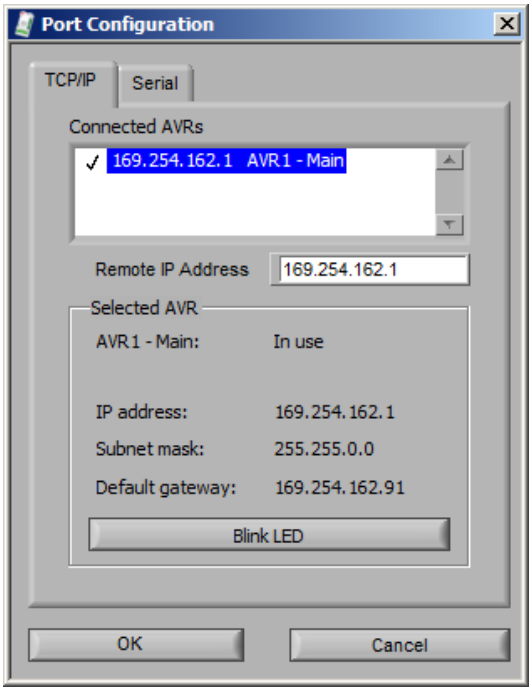
   If the Double Channel feature is not used, the channel identification can be changed without affecting other UN1020 functions with the exception of the Modbus ID, which is used for CMT1000 access. That allows changing the name displayed in the CMT1000 and panel. For more information refer to Chapter *3.4.6 Modbus for Remote Access*

Port configuration
Communication \ Port configuration \ Serial

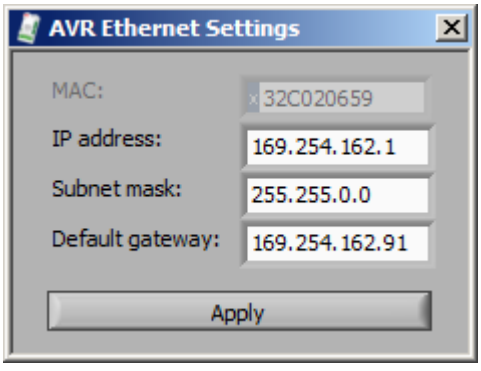
Configures the connection interface with the AVR. For more information refer to Chapter *6.4.4.1 Configuring the Port Interface.*



Communication \ Port configuration\TCP/IP

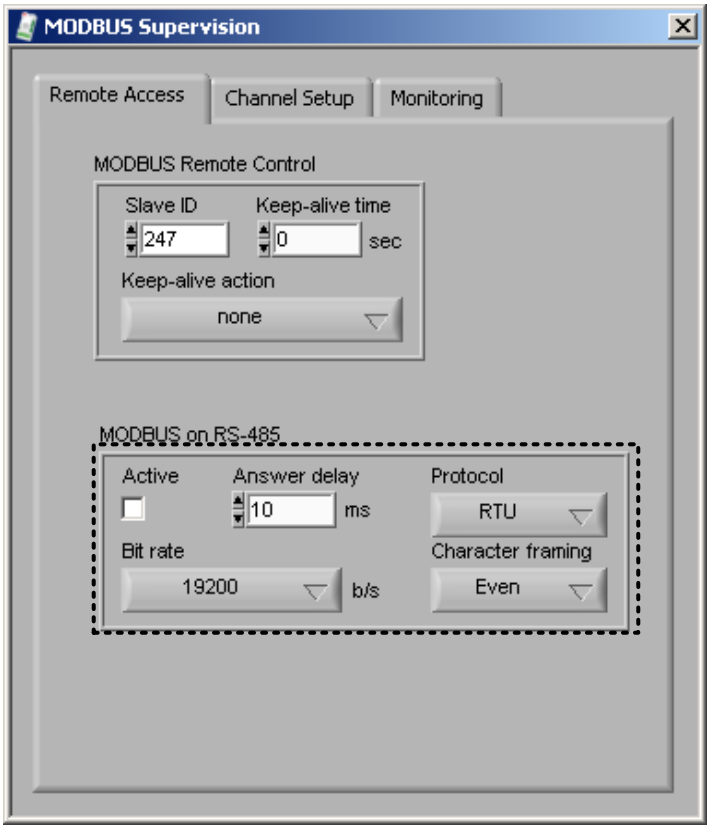


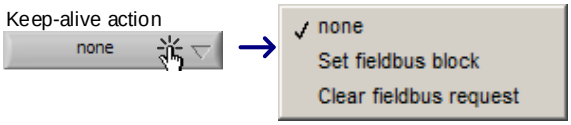
AVR Ethernet Settings

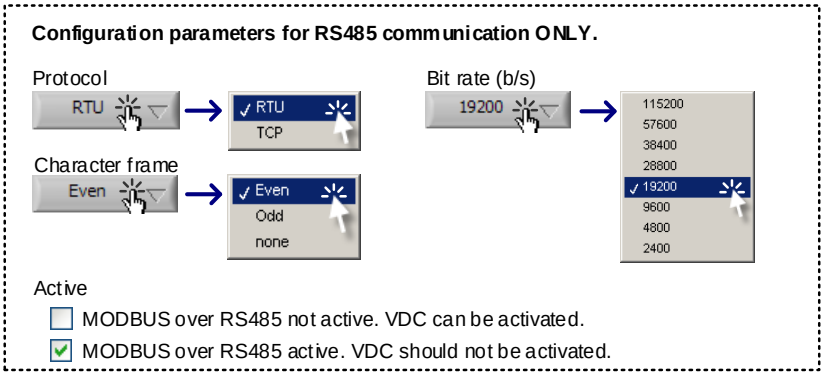


MODBUS configuration (RS485)
Communication \ MODBUS Supervision \ Remote Access

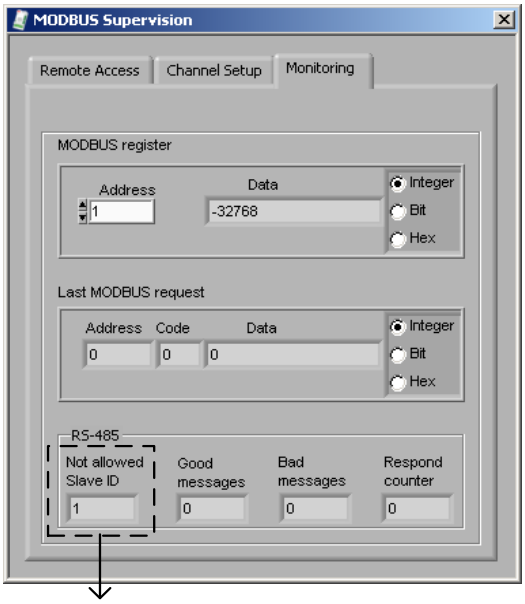
The MODBUS Slave-ID is the same used for MODBUS RS485. For configuration refer to Chapter *3.4.6 Modbus for Remote Access.*





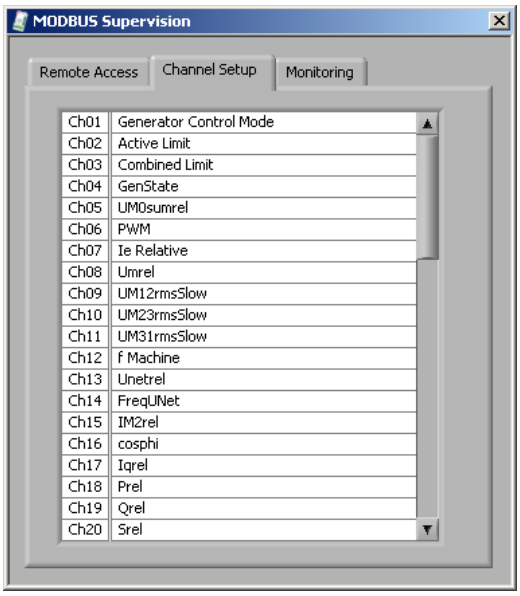


Communication \ MODBUS Supervision \ Monitoring



Do not use the ID displayed here
Please be aware that this number will be automatically adjusted according the AVR-ID number and the Channel Indentification (Main / Redundant)

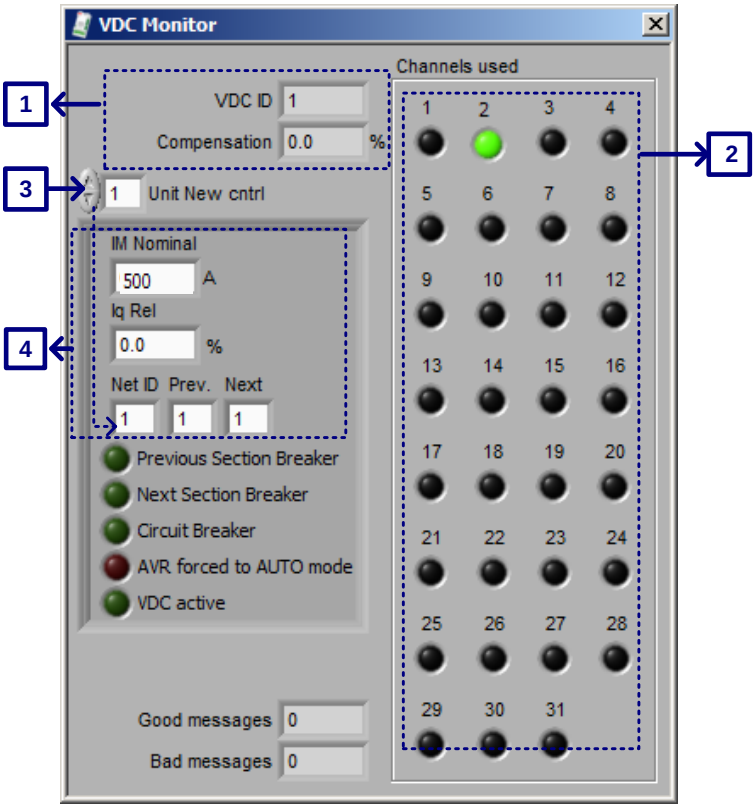
Communication \ MODBUS Supervision \ Channel Setup



VDC Monitor

Communication \ VDC Monitor

VDC Monitor is a tool to analyze the VDC communication between the AVRs connected to the same RS485 bus. The VDC communication should be enabled before using this tool.



1. Displays the AVR-ID number and the actual compensation used for regulation. The compensation value will only be used when the AVR is operating in VDC mode.
2. Each LED number = the AVR-ID 1 to 31 for each AVR connected to the RS-485 bus. A LED is lit when valid (error free) VDC data packets are being received from the AVR whose AVR-ID matches the LED number.

   The LEDs indication is useful for troubleshooting problems when using VDC.
   Green:
   Q sharing on same bus
   Yellow:
   Q sharing on different bus
   Red:
   AVR is forced to AUTO
3. It selects the AVR-ID (or LED) of the AVR from which specific (Net ID, IM Nominal and Iq rel) has to be displayed.

4. This is the information displayed after the user selects an AVR-ID using the selector explained in Item 3 (above).

   All data displayed is real-time data. The Net ID shows Primary or Secondary Net numbers according to the current status of the AVR. A special case applies if Net ID is equal to zero, which means that the VDC data packets had communication errors or the data packets from this particular AVR-ID are not being received at all. During the time Net ID = 0, the LED for this AVR-ID is shown dark.

   IM Nominal refers to the Nominal Machine Current and Iq Rel to the Reactive Current in p.u. units.

Control Password

In order to protect parameter changes by unauthorized persons, the customer can define passwords to enter CONTROL mode to change parameters.

When hash is 1...9999, CMT will ask for a password before going to CONTROL mode. 0 means no password.

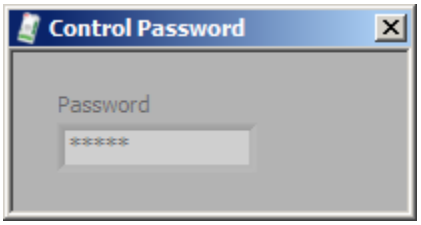
Setting for password, range 0 to 9999

0000	No password is active / default
4783	Default password, will work independently of any setting

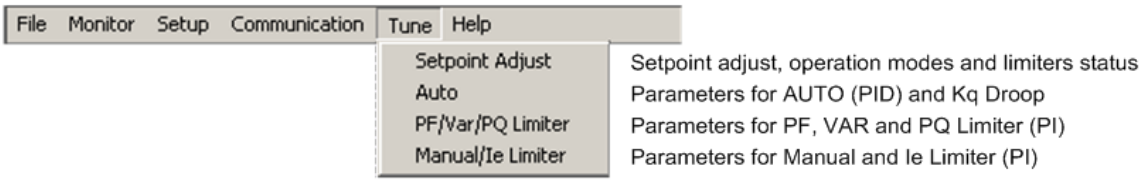
Password will be asked when changing CMT from MONITOR to CONTROL mode. The password is active for 10min

When CMT runs in MONITOR mode, the password setting field is grayed out.

When CMT runs in CONTROL mode password can be set

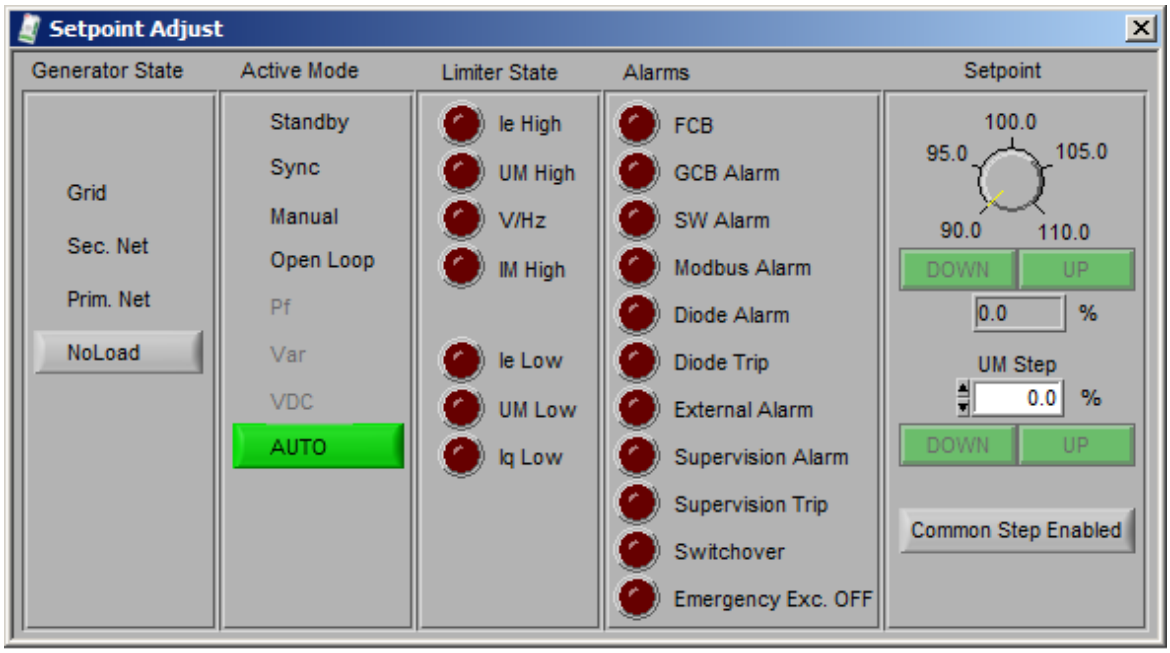


6.4.8 *Tune Menu*



Adjust Setpoint, Trigger Setpoint, Status Displays
Tune \ Setpoint Adjust

It allows setpoint adjustment, step response tests and visualization of operating modes, generator states, limiters and alarms status.

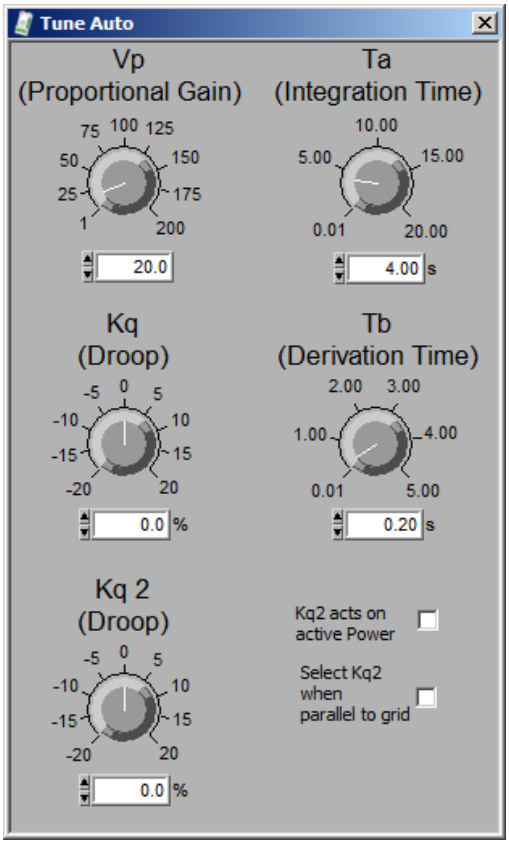


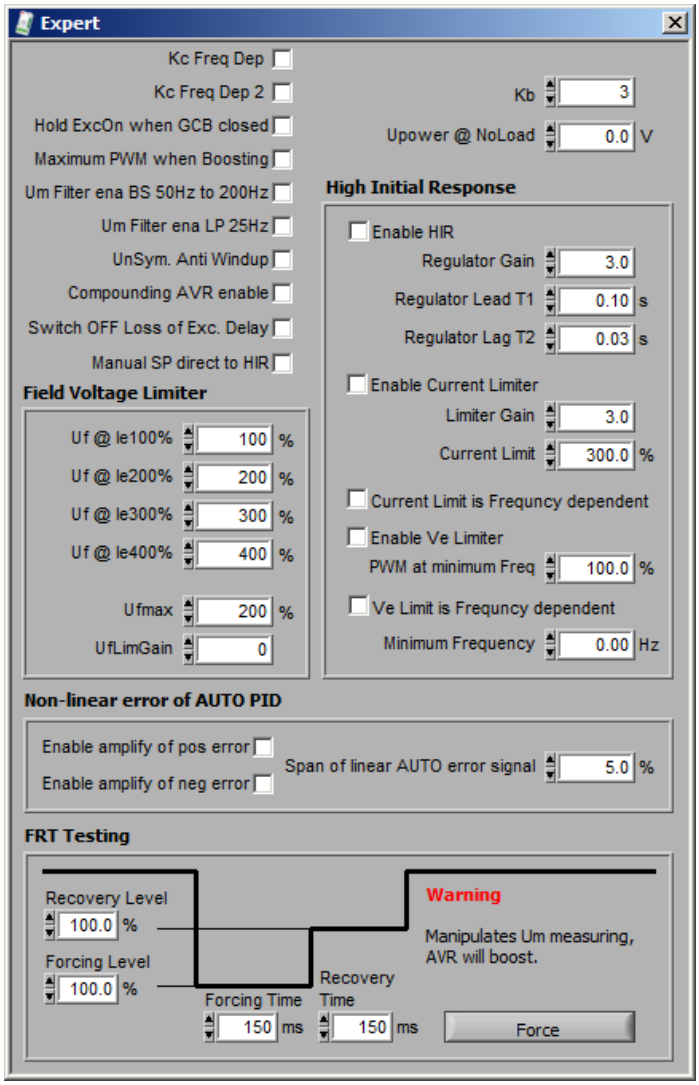
1. Displays the generator state condition, according to the Gen CB Closed and Parallel with the Grid status signals. Prim. Net and Sec. Net are used during VDC operation mode.
2. Displays the actual operating mode of the AVR. Some modes may be shaded (disabled) if an optional feature is not available or due to system conditions or configuration. For more information about the software feature and operation modes refer to Chapter *3.4 Software*.
3. Displays Limiters status.
4. Displays AVR Alarms status. Not all alarms statuses are shown when an optional feature is not available in the AVR.
5. The actual setpoint can be adjusted with the upper Up and Down buttons (if the adjustment is not performed via analog or digital inputs). A step response can be performed by specifying the Step value and then clicking the lower Up (actual setpoint + Step) and Down (actual setpoint – Step) buttons.

Regulator Parameters AUTO
Tune \ Auto

Allows the parameter configuration of the PID regulator to be used during AUTO mode and the Kq Droop.

Expert Tuning:
In order to open the window, click Control+Shift+F9 when the Tune Auto window is active

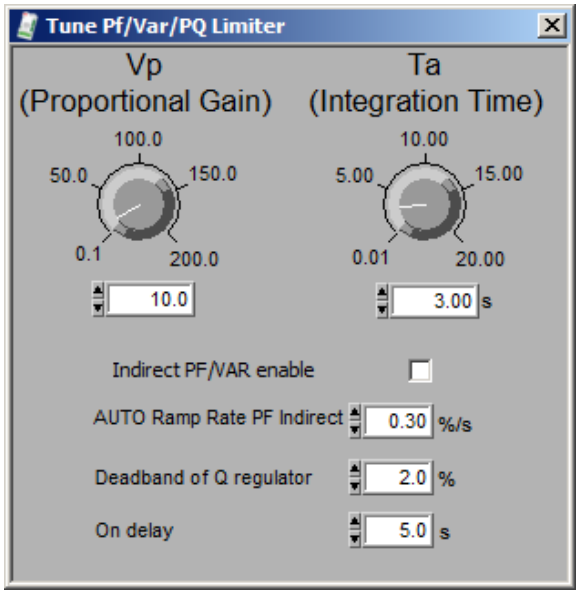




For details on the field rotor limitation, refer to *3.4.4.3 Field Voltage Limiter.*

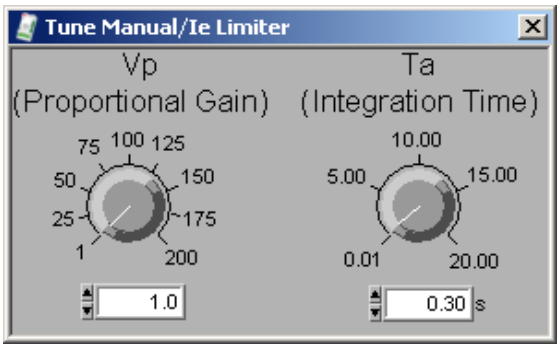
Regulator Parameters PF/VAR/PQ Limiter
Tune \ [PF/VAR/PQ Limiter]

Allows the configuration of parameters of the PI regulator used during PF/VAR modes and PQ Limiter.



Regulator Parameters Manual / Ie Limiter
Tune \ [Manual/Ie Limiter]

Allows the configuration of parameters of the PI regulator used during Manual mode and Ie Limiter.



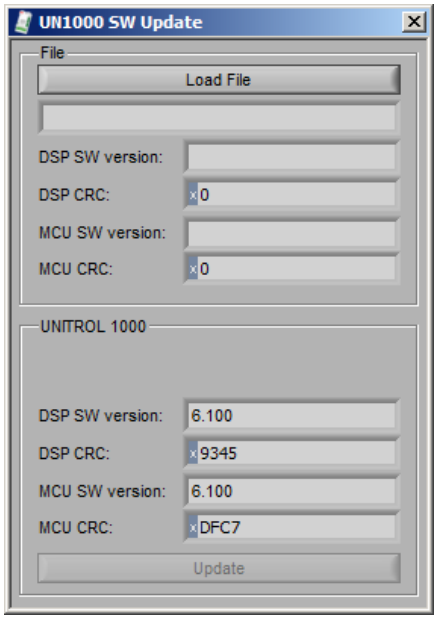
6.4.9 *Help Menu*

Help \ Firmware update

Click *Load File* and select the appropriate *.abb file.

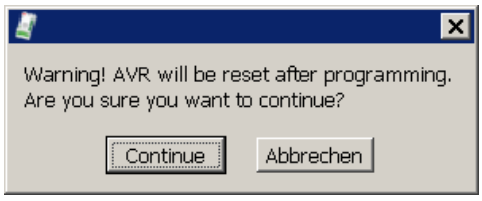
Newest version as of release date of this manual:

ZAB_Release6.100.abb



Then click *Update*. It is possible to update the Target SW from USB or Ethernet (faster).

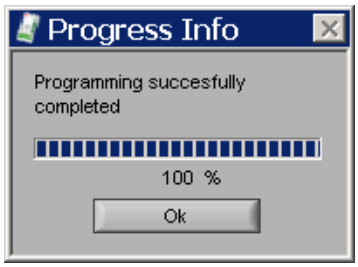
In the following pop-up click *Continue:*



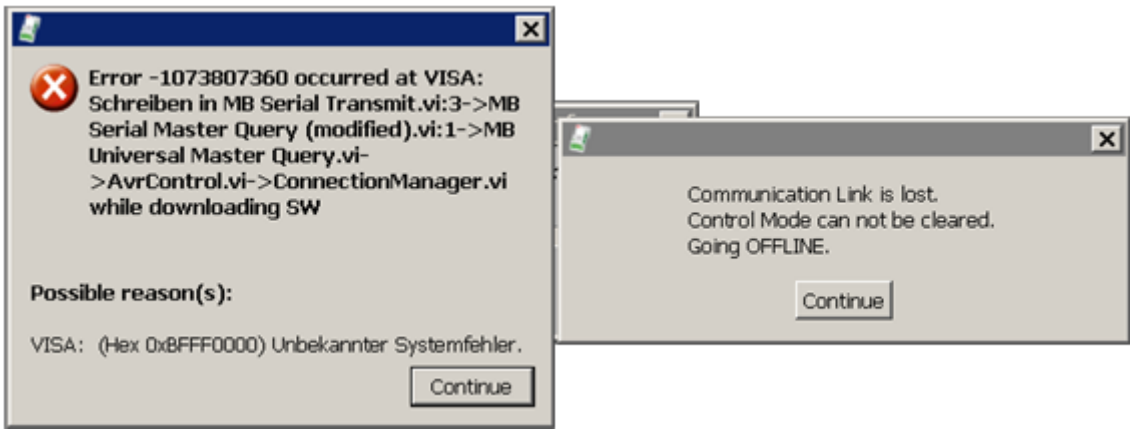
The update process is started and will take around three minutes.

Download successful
The download succeeded successfully if following pop-up appears:

Click *Ok*.



If the programming completed successfully, disconnect the USB cable and power cycle the device.
Connect the CMT1000 to the device and double-check the loaded target software version against the CMT1000.
In all other cases, the download has failed.



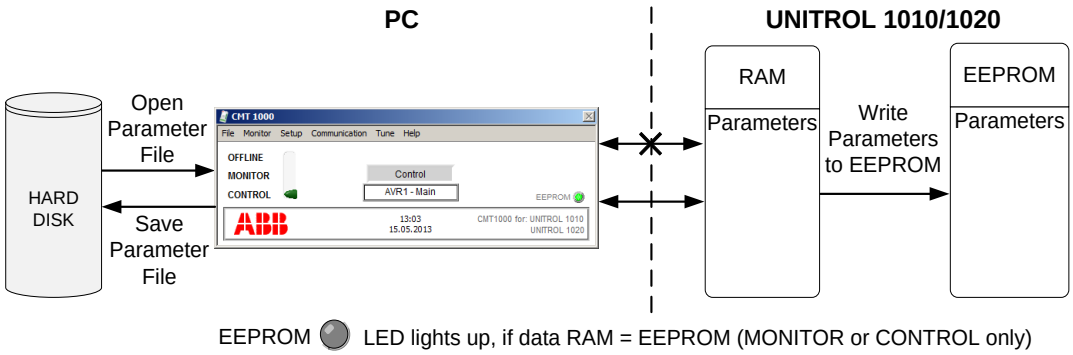
Proceed with following instructions.

1. Close all the pop-ups by clicking *Continue*
2. Disconnect the USB cable, after 5 seconds connect it again.
3. Go into CONTROL mode
4. Repeat the download

Help \ About CMT1000..

Shows SW and HW Revision and HW serial number

6.4.10 *Save Parameter File*



6.4.10.1 Status during MONITOR or CONTROL

After switching from OFF LINE to MONITOR/CONTROL, CMT1000 reads the parameters from the device‘s RAM. Now, all parameter changes carried out using CMT1000 are written directly into the device‘s RAM.

- Write Parameters to EEPROM: The parameters in the RAM are stored in the device (only possible during CONTROL Access).
- Save Parameter File: The parameters are saved to the hard disk as an INI file.
- Open Parameter File: The INI file is loaded into CMT1000 and the RAM is overwritten again (only possible during CONTROL Access).

When opening a parameter file from disk, the old parameter file is immediately overwritten in the RAM (only possible during CONTROL Access).

6.4.10.2 Status during OFF-LINE

No parameter changes carried out in CMT1000 are transferred into the device.

- Write Parameters to EEPROM: No effect, since there is no communication between CMT1000 and the device.
- Save Parameter File: The parameters are saved to the hard disk as an INI file.
- Open Parameter File: The INI file is only loaded into CMT1000.

If you now switch to MONITOR or CONTROL the CMT1000 reads data from the RAM again.

6.5 Additional Tools

In addition to the tool on the delivered CD, ABB recommends using following SW Tools, which can be downloaded free of charge from the internet:

Software Tool	*Description*	*URL*
Notepad++	compares parameter files and indicates differences	http://notepad-plus-plus.org)
TOP	enables viewing IEEE comtrade files and doing overlays	http://www.pqsoft.com/top/

Chapter 7 - Preventive Maintenance

7.1 General

NOTICE!

ABB recommends periodical training for the maintenance personnel.

7.2 Safety Regulations

WARNING!

The secondary voltage of the excitation transformer and the voltage of the excitation field are fed into the excitation cabinet.

These components present a great danger of electric shocks.

The control elements and the PC interface on the front plate of the UNITROL 1020 unit are to be touched and/or attached only with caution.

7.3 Standard Procedures for Maintenance

When the system is at a standstill, the screwed terminals, which can get loose due to vibrations, should be checked for tightness. Dusty cooling flanges should also be cleaned.

Chapter 8 - Troubleshooting

8.1 General

Chapter 8 - Troubleshooting provides instructions to assist in localizing a fault within the excitation system as a whole. However, it is not possible to deal with all eventualities in full.

8.2 Safety Regulations

Before working on the excitation system the general safety instructions in *Chapter 2 - Safety Instructions* must be read and understood.

8.3 List of Possible Faults

Possible causes	Checks, action
Machine is not excited	Check operation of AVR, green LED must be blinking and yellow LED must be on
Field circuit interrupted Field circuit-breaker does not close	Check wiring for break Check field circuit-breaker
Shunt supply: Field flashing does not work	 Check field flashing circuit
No electronic supply UAUX	Measure auxiliary supply UAUX Check for tripped protective circuit-breaker
No control element supply UPWR	Measure power electronics supply UPWR Check for tripped protective circuit-breaker
Shunt supply: Machine is only excited to the value supplied by the field flashing Machine is first excited then discharges again	 Measure auxiliary supply UAUX, Measure power electronics supply UPWR Check field flashing Off level Check operating mode. For field flashing Auto is normally used Check field flashing Off level Check setpoint Measure power electronics supply UPWR If all supplies and setpoints are correct, then change the unit
Setpoint error	Check operating mode. For field flashing normally Auto is used Check setpoint
Regulator error	Measure output voltage at terminals 8, 9 (Osc.) -> positive Measure voltage UPWM (CMT1000, Monitor) -> positive rising

Possible causes	Checks, action
Overvoltage during build-up	Check Soft start settings with the oscilloscope
Overvoltage caused by voltage regulator	Machine voltage UM present Check system data Check operating mode. For field flashing normally Auto is used Check setpoint Check thresholds of UM Limiter Check regulator settings
Field flashing current too high	Check design of the field flashing circuit. Field flashing should deliver 10 to 15% of the no load excitation current

Machine voltage not stable in no-load operation	
Regulator error	Check operating mode. For field flashing Auto is normally used Check setpoints Check parameters of Auto regulator
Setpoint error	Higher, lower inputs unstable External input setpoint unstable
Control element fault	Check wiring, loose contact UM, Ie

Parallel operation with grid unstable. Periodic oscillation of reactive and possibly active power	
Regulator settings incorrect	Were changes made to the grid configuration? Additional outputs, loads etc. installed? Yes: reset regulator No: check parameters of Auto and PF, Var regulator

Possible causes	Checks, action
Irregular instability, i.e. sporadic over- or underexcitation which is not caused by grid	
Droop influence of the voltage regulator ineffective or IM2 measurement defective	Check droop/compensation setting Check external current transformer circuit Gen CB Closed Status not active
Machine within inadmissible operating range (normally protected by limiters)	Bring machine into normal operating range by adjusting the setpoint. Check setting of limiters
Regulator fault	Measure output voltage at terminals 8, 9 (oscillos-cope) Measure voltage UPWM (CMT1000, Monitor) Signals in phase opposition: unit defective Signals in phase: disturbance possibly caused by the driving side of the machine or by disturbances from the grid

Operating point cannot be adjusted	
Setpoint error	Check operating mode. For field flashing normally Auto is used Check setpoint
Limiter active	Bring machine into normal operating range by adjusting the setpoint. Check setting of limiters
<u>Excitation with compounding and boost circuit:</u> Excitation is only supplied by the series compounding No control element voltage Regulator fault	 Measure power electronics supply UPWR Check for tripped protective circuit-breaker Check operating mode. For field flashing normally Auto is used Check setpoint Check parameters of Auto regulator

Possible causes	Checks, action
External controls faulty	
No external control voltage	Measure control voltage Check wiring
No internal control voltages Vdig, Vref	Measure internal control voltages
Configuration of the digital or analog inputs or outputs is not correct	Check configuration

8.4 Repair

It is forbidden to open the plastic cover of the unit. A defective unit has to be sent in to the return center for repair with a failure description and, if possible, trending of the failure. Contact our return center prior to sending it to the manufacturer's address. Note that the manufacturer's address may be different than the one specified by our return process.

See manufacturer's details on *Chapter 1.5 Manufacturer's Address*.

8.5 Compatibility

Target Release	*PC Tools / CMT1000*	*Panel Release*	*VDC*
6.xxx	CMT1000 Release 6.xxx	OS 2.04, Control 1.001	No restrictions

Earlier versions of CMT1000 are no longer compatible with this AVR.

9.1 General

9.1.1 Ordering Information

Material description	Order code	
UNITROL 1020-0003 BASIC	3BHE030579R0003	
UNITROL 1020-0006 FULL	3BHE030579R0006	
UNITROL 1020-0007 FULL + PSS	3BHE030579R0007	
UNITROL 1020 SCP door kit	3AUA0000013086	Order Text: OPMP-01-Kit : Mounting Cabinet Panel ACS
UNITROL 1020 Cable to Panel	3BHE027825R0150	Ethernet Patch Cable, CAT5, RJ45, Connector/connector, shielded, Length: 150 cm Color: Grey
External capacitor kit (E251846)	3BHE044230R0010	UN1020 Ext. Capacitor UR

9.1.2 Electrical Data of AVR UN1020:

Excitation Input (AC/DC)

AC Nominal voltage (sinusoidal)	0...250 V ac
AC voltage (max, sinusoidal)	300 V ac
Frequency	40…600 Hz
DC nominal voltage	0...300 V dc
Max. DC voltage	420 V dc
Max. peak voltage (non-sinusoidal)	420V peak
Test voltage for 1 min	2.8 kV dc

Auxiliary Power Supply Input (AC/DC)

3-ph AC Nominal voltage (sin.)(1	9…250 V ac
1-ph AC Nominal voltage (sin.)(1	16…250 V ac
AC voltage (max, sinusoidal)	300 V ac
Frequency	40…600 Hz
DC nominal voltage (min/max)(1	18…300 V dc
Max. DC voltage	420 V dc
Max. peak voltage (non-sinusoidal)	420V peak
Test voltage for 1 min	2.8 kV dc
Max power consumption	40 W

Excitation Output – Maximum Ratings

Continuous current at 55 °C	20 A
Continuous current at 70 °C	10 A
Maximum current for 10 sec	38 A

Recommended Excitation Current

Voltage Regulation

Accuracy @ 25 °C	0.2%
Reaction time	20 ms
PWM limitation	0.5...99%

Exciter Current Measurement

Full range	0...40 A dc
Accuracy after digital filter	< ±1 %
Resolution of sensor	808 mA
Sample rate	130 kS
Resolution after average filter	100 mA

Machine Voltage Measurement (5

Full range peak voltage against PE	±500 Vp
Full range voltage, (phase to phase)	600 V ac
Nominal voltage	3 x 450 V ac
Input impedance	6.0 MOhm
Test voltage for 1 min.	2.8 kV dc
Accuracy (4 (-40 to 70 °C / 25 °C)	±1% / 0.1%
Resolution	245 mV rms

Network Voltage Measurement

Full range voltage	600 V ac
Nominal voltage	1 x 450 V ac
Input impedance against PE	9.0 MOhm
Test voltage for 1 min	2.8 kV dc

3~ Phase Input (2

Continuous current at 40 °C	20 A
Continuous current at 55 °C	15 A / 20 A (3

Recommended Excitation Current

1~ Phase Input (2

Continuous current at 40 °C	12 A / 20 A (3
Continuous current at 55 °C	10 A / 15 A (3

Recommended Excitation Current

DC Input (2

Continuous current at 40 °C	20 A (3
Continuous current at 55 °C	15 A /20 A (3

IGBT with Free Wheeling Diode

Max. forward voltage of integrated freewheeling diode (25 °C, I_F = 30 A)	2.6 V

M.a.s.l. >1000m derating factor

$k_H = 1 - 85.7\ E^{-6}(H - 1000m)$

Accuracy (4 (-40 to 70 °C / 25 °C)	±1% / 0.1%
Resolution	440 mV rms

Machine Current Measurement

Full range current 1A / 5A	2.8 / 13.4 A ac
Nominal current	1 to 5 A ac
Shunt resistor	10 mOhm
Maximum current for 10 s	22 A rms
Maximum current for 1 s	38 A rms
Maximum current for 100 ms	54 A rms
Common mode range	±5 V p
Accuracy (4 (-40 to 70 °C / 25 °C)	±1% / 0.1%
Resolution	0.2% of In
Impedance to Pe (not galvanically insulated from Pe)	500 Ohm

Remarks

(1:Start voltage:

Load condition			**no load at Vdig**		**100 mA at Vdig**	
Ambient			**-40 °C**	**0 °C**	**-40 °C**	**0 °C**
Input						
DC	**<0.5 Ohm**	**Imax <4.0 A Pmax = 100 W**	18 V dc	18 V dc	18 V dc	18 V dc
3 ph	**<0.5 Ohm**		9 V ac	9 V ac	11 V ac	9 V ac
1ph	**<2.0 Ohm**		30 V ac	16 V ac	55 V ac	24 V ac

(2: Excitation current can be raised by choosing improved cooling or mounting of an aluminum plate. Temperature behavior is dependent on input voltage, single, three phase or DC input and its value as well as on the resistance load of the exciter winding. Max heat sink temperature of 90 °C must not be exceeded. Please contact ABB for further information.

(3: With external capacitor of 1 mF
Requirements:
Min. Voltage: >=450 V
Temp. Range: -40...85 °C
Oper. lifetime at 85: >5000h
Ripple curr. at 100Hz at 85: >5[a]
ESR 20°C 100Hz: <120mOm

Recommended type: Manufacturer Evox Rifa PEH200TO4100M, PEH200YK410TM, PEH169YO4100M

(4: Frequency bandwidth: 10...200 Hz. Define the accuracy up to 150 Hz with 3% and up to 200 Hz with 10%

(5: Voltage measurement shall always be connected over potential transformers (PT's)
In case Um > 250Vac, the star point of the secondary side must be connected to PE
PT configuration : Three phase (star point connected to PE) ➔ Max nominal value 500Vac
Single phase / Three phase GN ➔ Max nominal value 250Vac

Short time overcurrent capability for excitation output

Duration	3 sec	10 sec	20 sec	30 sec	1 min	2 min	5 min	cont.	units
Ambient Temp.									
40 °C	38	38	34	32	26	25	24	20	A
55°C	38	38	34	30	25	24	22	20	A
60°C	38	36	32	24	20	18	16	15	A
65°C	36	34	26	20	16	15	13	12	A
70°C	34	30	20	16	14	12	11	10	A

Remark: **After an overcurrent occurs, device must not be loaded again for 100 x the defined duration.**

Electrical Data of Analog and Digital Input / Output (max. cable length 30m):

Analog Input

Full range peak voltage	±10 V
Input impedance	240 kOhm
Common mode range	±5 V
Accuracy	< ±1%
Resolution	10 mV

Analog Output

Full range peak voltage	±10 V
Max output current	±10 mA
Output impedance	100 Ohm
GND reference	PE
Accuracy	< ±1%

Digital Inputs

Number of inputs	4
Input impedance to GND	2 kOhm
GND reference	PE
Input voltage range	0…28 V
Digital input thresholds (high / low)	13 V / 5 V

Digital Inputs / Outputs

No. of configurable inputs / outputs	8
Voltage range of 24 V supply	21...25 V
Maximum output current 24 V supply	600 mA
Input impedance (set as input)	1.65 kOhm
GND reference	PE
Input voltage range	0...28 V
Digital input thresholds (high / low)	13 V / 5 V
Max driver current (to GND)	150 mA

Electrical Data of Communication Interfaces:

Ethernet Interface

Data rate	10/100 MBit/s
Maximal cable length	100m
Auto-MDIX	
Auto-negotiation and parallel detection	
Isolation to PE	1 kV dc

RS-485 Interface

RX / TX signal level	±5V
RS-485 bus	Half duplex
Data rate	Configurable
Maximal cable length	500m
Termination (configurable with Jumpers)	120 Ohm
Isolation to PE	1 kV dc

CAN Interface

CAN_L / CAN_H signal level	0…5V
Data rate	500 kBit/s
Max cable length	30m
Termination (configurable with Jumpers)	2 x 68 Ohm
Isolation to PE	1 kV dc

USB Service Interface

Data rate	12 MBit/s
Max. cable length	3m
USB Version	1.0, 1.1, 2.0

Service Control Panel

Display resolution (pixel)	128 x 64
Max. cable length	3m
Connector	RJ-45

9.1.3 *Environmental data of AVR UNITROL 1020:*

Permission ambient Temperature

Storage temperature maximum	0°...55 °C
Recommended storage temperature	25 °C
Operating temperature	-40...70 °C
Maximum heat sink temperature	90 °C

Mechanical Stability

Vibration, IEC60068-2-6	DNV class B
Shock and bump, IEC 60255-21-2	Class 2
Seismic, IEC 60255-21-3	Class 2

EMC Immunity

EN 61000-6-2
(Generic immunity standard)

EMC Emission

IEC 61000-6-4
(Generic emission standard)

Isolation Coordination

IEC60664-1

cUL-Certification (CSA compliant)

UL 508, user group (ongoing)	
File number	E251846

DNV Certification

Housing

Protection class of housing	IP20
Pollution degree	3
Dimension, L x W	302 x 170 mm
Height	111.4 mm
Weight	3.8 kg

9.1.4 *UL Certification*

To use UNITROL 1020 in a UL compliant way, the following must be considered:

Max. surrounding air temperature	*70 °C*
UNITROL 1010 max output capability at 70 °C	*5 A /150 V*
UNITROL 1020 max output capability at 70 °C	*10 A /150 V*

Only 60/75 °C wires shall be used

Marking for proper connections for the power supply, control, load

For use in Pollution Degree 2 Environment

Grounding conductor terminal shall be green-colored or plainly identified with “G”, “GRD”, “GND”, “GRND”, “Ground”, “Grounding” or IEC Publication 417, Symbol 5019.

9.1.5 *Reliability UNITROL 1020*

MTBF (MIL-HDBK-217F)	GB(40°)	22.8 years
Failure rate in time	GB(40°)	5000 FIT
Operational life time of capacitors		> 100’000 h
Average ambient temperature	*40 °C*	
Input power	*3 phases*	
Exciter current (without external cap)	*15 A*	

9.1.6 *Battery life time information*

A battery is installed inside the panel. The battery keeps the clock operating in memory during power interruptions.

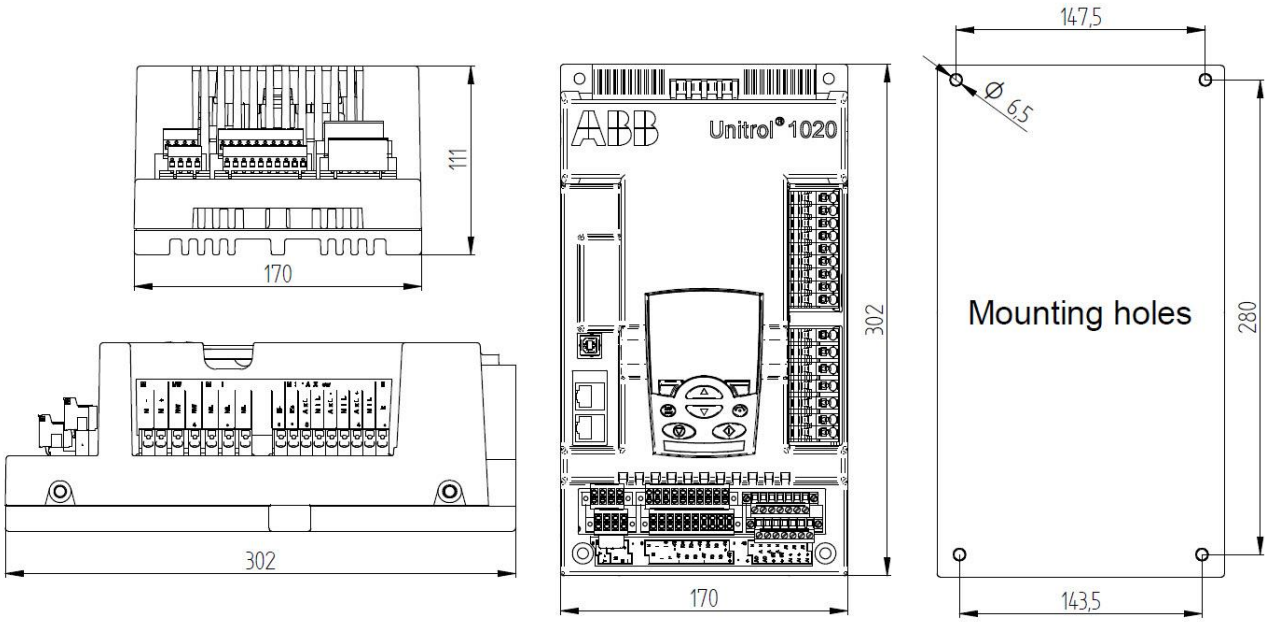
Expected lifetime of battery at 45 °C > 10 years

To remove the battery, use a coin to rotate the battery holder on the back of the control panel. Replace the battery with type CR2032.

NOTICE!

The battery is NOT required for any control functions except for the clock.

9.1.7 *Mechanical data*



9.2 Settings Record for UNITROL 1020

Name and Address of Customer:	
Plant:	
Order No.:	
Plant Schematic No.:	

Device Identification:		
Type Plate:		
Delivery Date:		
Software Revision:	Control:	
	Panel:	
	CMT1000:	

Remarks:

Place and Date of Commissioning:	
Name:	Company:

9.3 Parameter Settings, Default Values

All parameter setting sand default values are described in the Modbus address table.

Chapter 10 - Appendix

10.1 Documentation References

This User Manual is available in the following languages:

1.	UNITROL 1020 User Manual	3BHS335648 E82
2.	UNITROL 1020 Benutzerhandbuch	3BHS335648 D82
3.	UNITROL 1020 Manuel d'Utilisation	3BHS335648 F82
4.	UNITROL 1020 Manual de Usuario	3BHS335648 S82

REVISION

Rev. ind.	Page (P), Chapt. (C)	Description (or number of revision)	Date Dept./ Init.
-		First issue	2011 09 22
A		Changes new Release	2011 10 10
B		General changes and updates	2011 12 15
C		Small changes in layout, review by several people	2012 01 25
D		General changes and updates	2012 05 02
E		Release 6.1	2013-05-17
F		Release 6.2	2014-01-15
G		Release 6.2	2014-02-14
H		Release 6.3x	2016-03-24