UNITROL® 1010 User Manual

Automatic Voltage Regulator

Compact voltage regulator for synchronous machines
up to 5 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)
PELV	Protective extra low voltage
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

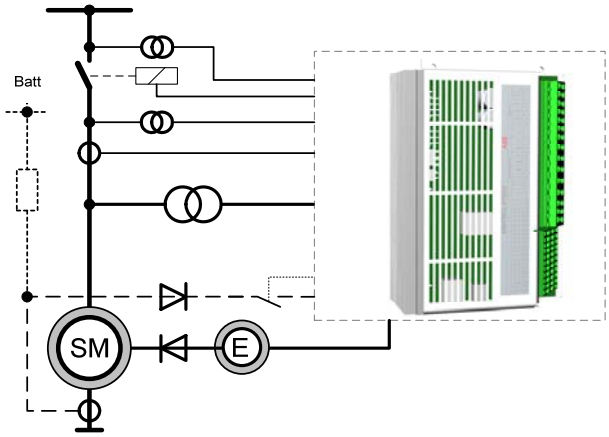
of the UNITROL 1005, including detailed descriptions of the functions and the hardware of the device. Technical data is included as well.

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.

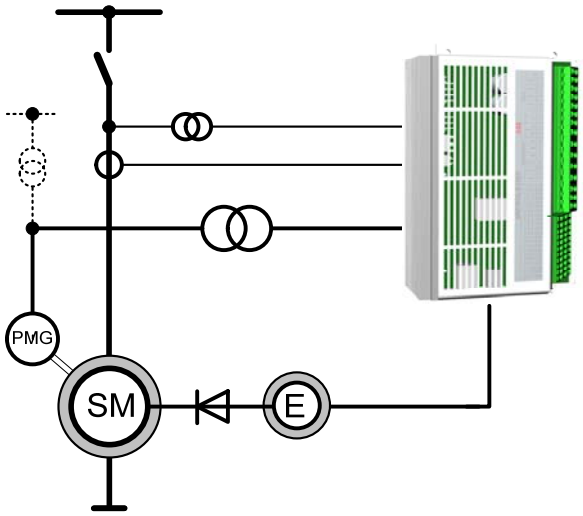
SM = Synchronous Machine
E = Exciter

Optional:
- Modbus TCP
- Rotating diode monitoring
- History logger



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

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 1005 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 1005 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 1005. The unit has large capacitors, which might be charged even after disconnecting the unit.

2.4 Safety Regulations

2.4.1 Structure of Safety Instructions

Symbol

Signal Word!

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.

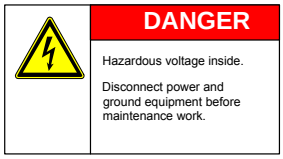
Electrical and magnetic fields can influence pacemakers. It is difficult to predict the general sensitivity of pacemakers.

2.6 Danger signs

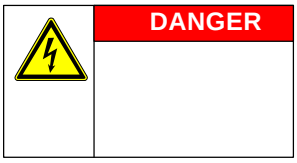
Danger signs are attached to any equipment/location with a potential danger.

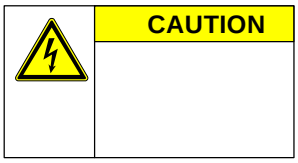
The degree and likelihood of such dangers are described by the signal words DANGER, WARNING and CAUTION. The content of the warning sign contains information about the respective situation and the preventive safety measures that must be taken.

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

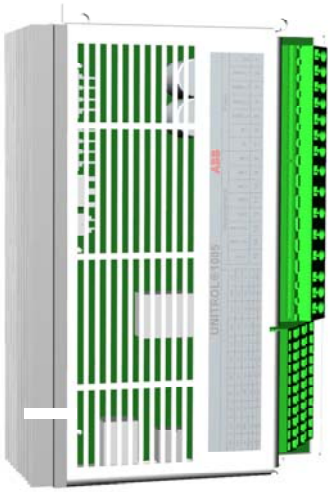
3.2 Description of the Excitation System

UNITROL 1005 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).

All operations are effected through a user-friendly software, which facilitates commissioning and allows optimization of operation.

The mechanical construction is compact and robust.

3.3 Hardware



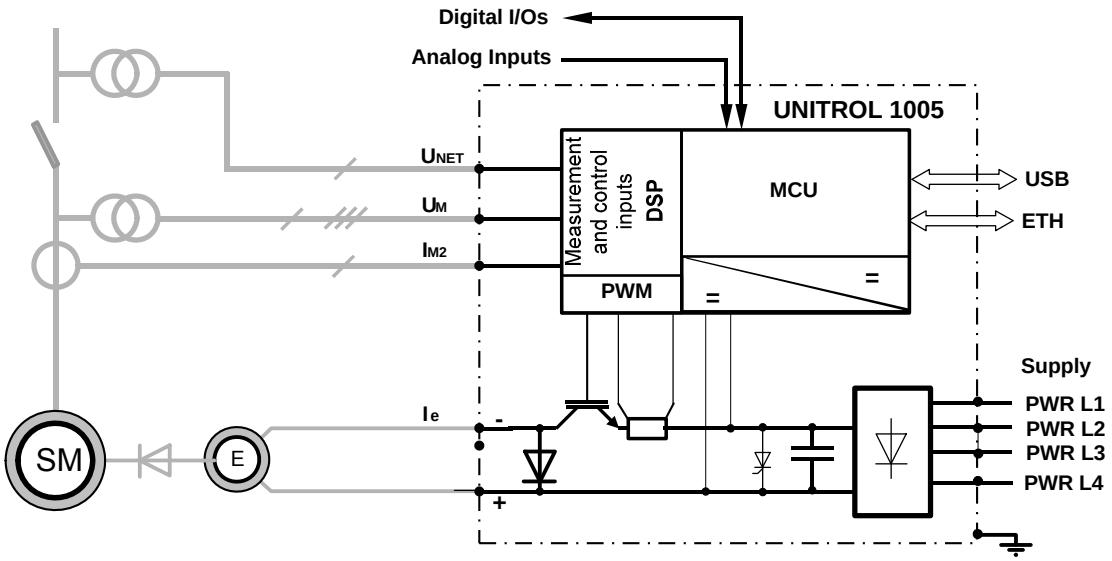
Casing
The device's base is an aluminum back plane including side heat sink. The unit itself is covered with metal sheet and provides an IP20 protection.

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 connectors for the USB and Ethernet interface are located on the side wall of the cover.

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

3.3.1 Connection Diagram



3.3.2 *Control Interfaces*

The UNITROL 1005 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 UNITROL 1005 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 Remote Access using MODBUS/TCP protocol

The Remote Access feature allows device access and control from local or remote locations by using MODBUS/TCP as application protocol. The communication can be performed via Ethernet. More information about the connection possibilities can be found in Chapter *3.3.8 - Communication Ports*.

Basic features and advantage of Remote Access

- Extending and read/write of digital and analog IO
- Measurement reading.
- Setpoint adjustment.

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 (control inputs and adjust set points) is handled automatically by the AVR microcontroller. The Remote Access feature is described in detail in *Chapter 3.4.5 - Modbus for Remote Access.*

3.3.2.3 Terminal Blocks

The terminal blocks are separated according their functions.

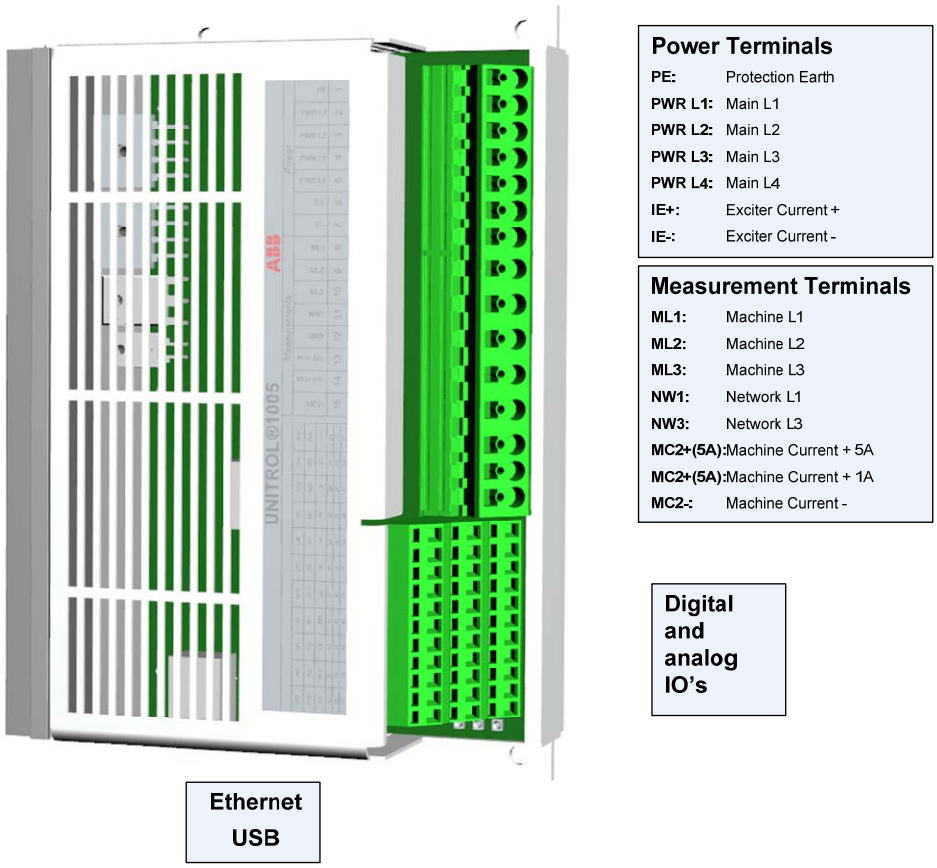
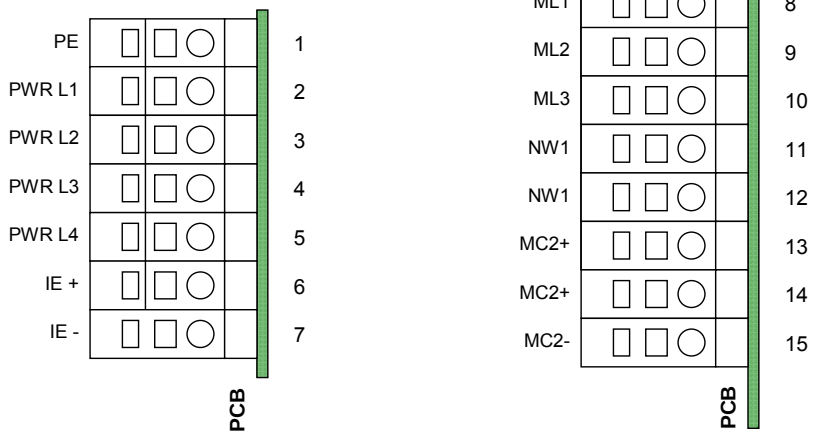
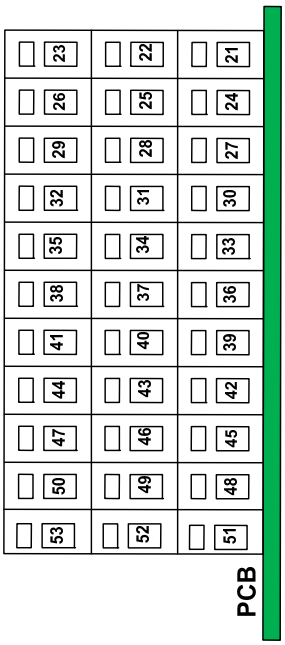


Figure 3-1 Terminal Block of UNITROL 1005



	Ref.	Label	Signal Description
Power Terminals	1	PE	Protection Earth
	2	PWR L1	Main L1
	3	PWR L2	Main L2
	4	PWR L3	Main L3
	5	PWR L4	Main L4
	6	IE +	Excitation Current +
	7	IE -	Ecitation Current -
Measurements Terminals	8	ML1	Machine L1
	9	ML2	Machine L2
	10	ML3	Machine L3
	11	NW1	Network L1
	12	NW3	Network L3
	13	MC2+ (5A)	Machine Current 5A +
	14	MC2+ (1A)	Machine Current 1A+
	15	MC2-	Machine Current -



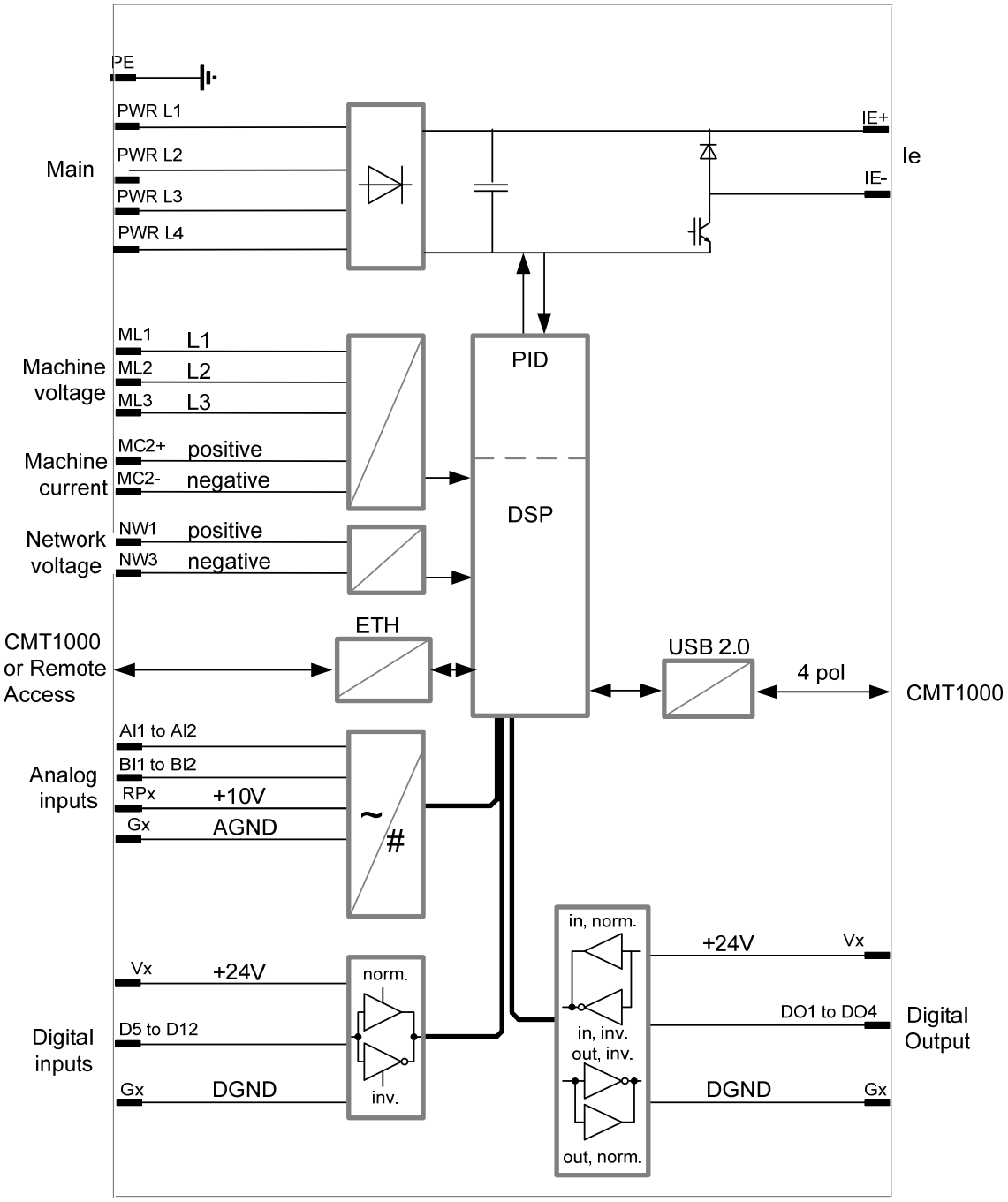
	Ref.	Label	Signal Description
Digtial IO Terminal	21	G1	GND, connected to PE *(PELV)*
	22	O1A	Digital output 1, potentail free, positive
	23	O1B	Digital output 1, potentail free, negative
	24	G2	GND, connected to PE *(PELV)*
	25	O2A	Digital output 2, potentail free, positive
	26	O2B	Digital output 2, potentail free, negative
	27	V2	24V output, connected to other Vx *(PELV)*
	28	DO3	Digital output 3 *(PELV)*
	29	DO4	Digital output 4 *(PELV)*
	30	V3	24V output, connected to other Vx *(PELV)*
	31	DI5	Digital input 5 *(PELV)*
	32	DI6	Digital input 6 *(PELV)*
	33	V4	24V output, connected to other Vx *(PELV)*
	34	DI7	Digital input 7 *(PELV)*
	35	DI8	Digital input 8 *(PELV)*
	36	V5	24V output, connected to other Vx *(PELV)*
	37	DI9	Digital input 9 *(PELV)*
	38	DI10	Digital input 10 *(PELV)*
	39	V6	24V output, connected to other Vx *(PELV)*
	40	DI11	Digital input 11 *(PELV)*
	41	DI12	Digital input 12 *(PELV)*

	Ref.	Label	Signal Description
Analog IO Term	42	RP1	Positive reference 1, +10V *(PELV)*
	43	BI1	Analog input 1, negative *(PELV)*
	44	AI1	Analog input 1, positive *(PELV)*
	45	G3	Analog Ground, connected to PE *(PELV)*
	46	CN1	Config terminal for 20mA input *(PELV)*
	47	CP1	Config terminal for 20mA input *(PELV)*
	48	RP2	Positive refernce 1, +10V *(PELV)*
	49	BI2	Analog input 1, negative *(PELV) (PELV)*
	50	AI2	Analog input 1, positive *(PELV)*
	51	G4	Analog Ground, connected to PE
	52	CN2	Config terminal for 20mA input *(PELV)*
	53	CP2	Config terminal for 20mA input *(PELV)*

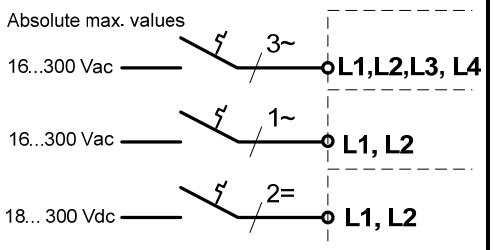
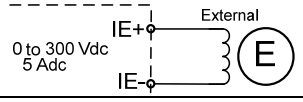
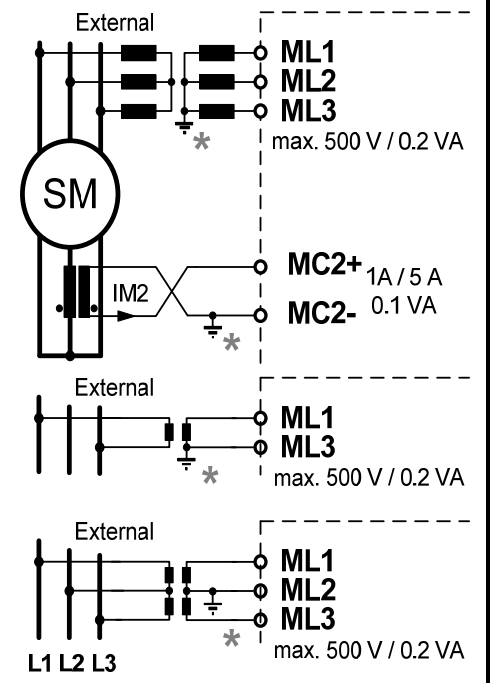
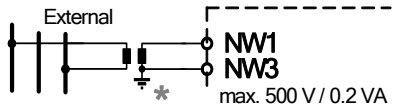
	Pin	Label	Signal Description
Ethernet	1		Transmitter +
	2		Transmitter –
	3		Receiver +
	4		Do not use [connected to magnetics]
	5		Do not use [connected to magnetics]
	6		Receiver –
	7		Do not use [connected to magnetics]
	8		Do not use [connected to magnetics]
	LED	**Green**	ETH Link OK
	LED	**Yellow**	ETH Data Traffic
	Ref.	**Label**	**Signal Description**
USB	1		USB Power 5V *(PELV)*
	2		Data - *(PELV)*
	3		Data + *(PELV)*
	4		GND *(PELV)*

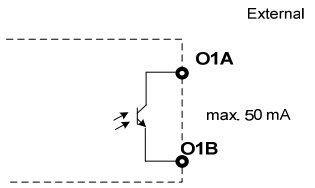
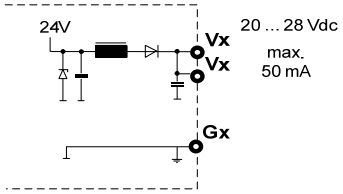
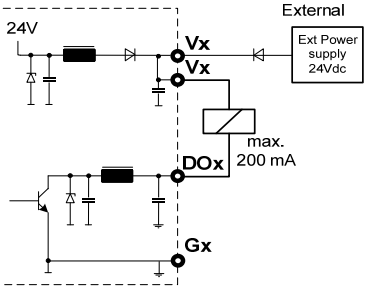
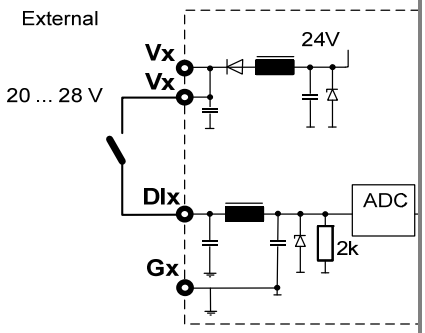
	Ref.	Color	Description
Status LEDs	D800	Green	Power ON status *(PELV)* ON: DSP and MCU is powered Blinking: Target SW is running
	D802	Yellow	Excitation ON, Blinking: Limiter active *(PELV)*
	D804	Red	Device status *(PELV)* ON: Alarm or trip active Blinking: Startup failure, target could not load parameters Excitation output is blocked Save parameter to EEPROM first before starting excitation

3.3.3 *Block Diagram*

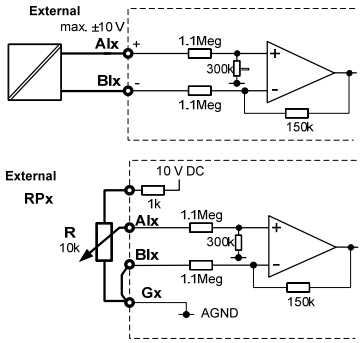
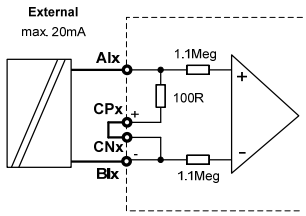
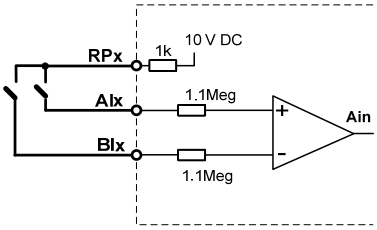


3.3.4 *Device Connectors*

Terminal designation	*Signal*	*Circuit*
1 = PE	Protection Earth	
2 = PWR L1 3 = PWR L2 4 = PWR L3 5 = PWR L4	Power Electronics and Control Supply U_{PWR} - Main L1 - Main L2 - Main L3 - Main L4 **Remark:** 6V ac start level can only be achieved when using L1, L2	
6 = IE + 7 = IE -	Excitation Current Output Ie - Exciter Current + - Exciter Current -	
8 = ML1 9 = ML2 10 = ML3 13,14 = MC2+ 15 = MC2- 8 = ML1 10 = ML3 8 = ML1 9 = ML2 10 = ML3	Machine Voltage three-phase U_M - Machine L1 - Machine L2 - Machine L3 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***	
11 = NW1 12 = NW3	Line Voltage measurement single-phase U_{NET} Network L1 Network L3 *PT & CTs **must be grounded***	

Terminal Designation	Signal	Circuit
	Digital output, potential free	
22 = OA1 23 = OB1 25 = OA2 26 = OB2	Digital output 1, collector Digital output 1, emitter Digital output 2, collector Digital output 2, emitter	
	24V supply for external contacts	
27, 30, 33, 36, 39 = Vn	24Vdc output	
21, 24, 42, 45, 48 = Gn	Digital ground, connected to PE	
	Digital output	
28 = DO3 29 = DO4	Digital Output 3 Digital Output 4	
27 = V2	24V output	
21 = G1 24 = G2	Digital ground, connected to PE Digital ground, connected to PE	
	The open collector transistor can switch up to 500 mA peak and 200mA continuously	
	Digital input	
31 = DI5 32 = DI6 34 = DI7 35 = DI8 37 = DI9 38 = DI10 40 = DI11 41 = DI12	Digital Input 5 Digital Input 6 Digital Input 7 Digital Input 8 Digital Input 9 Digital Input 10 Digital Input 11 Digital Input 12	
30 = V3 33 = V4 36 = V5 39 = V6	24V Power 24V Power 24V Power 24V Power	

Note: The internal 24 V supply (V1 to V6) can be loaded with **a maximum of 50 mA** by all used digital inputs and outputs. In case of higher power consumption external power supply shall be used.

Terminal Designation	Signal	Circuit
44 = AI1, 43 = BI1 50 = AI2, 49 = BI2 42 = RP1, 48 = RP2 45 = G3, 51 = G4	<u>Analog Inputs ±10Vdc</u> AIx/BIx +10 V pos Ref GND Positive Reference R = 10kOhm Input range 0V to 9.1V	
44 = AI1, 43 = BI1 50 = AI2, 49 = BI2 47 = CP1, 46 = CN1 53 = CP2, 52 = CN1	<u>Analog Inputs 20mA</u> AIx/BIx ; CPn/CNn Add bridge between CPx and CNx to enable 20mA input	
44 = AI1, 43 = BI1 50 = AI2, 49 = BI2 42 = RP1, 48 = RP2	<u>Analog Inputs digitally assigned</u> AIx/BIx see Chapter *3.3.7 - Analog Inputs* **Note**: In case both switched are active at same time, none of the digital inputs are activated	

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).
<table>
<tr><th>Mode</th><th>Initial SP default</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:
- Changing to active immediately triggers the ramp of the Soft start even when the hold time is not completed.</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:
Machine current measurement is forced to 0% in case IM2 < 5%
<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.

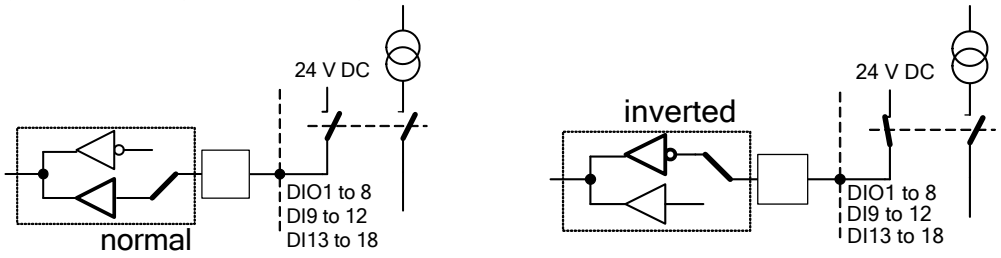
Depending on Parameter “Enable PF/VAR initial SP”, SP before parallel with grid status is taken over or SP is changed to initial value.</td></tr>
<tr><td>Increase</td><td>Increase setpoint of active regulator</td></tr>
<tr><td>Decrease</td><td>Decrease setpoint of active regulator</td></tr>
<tr><td>Reset 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; enables the setpoint adjustment from an analog input. (Analog remote setpoints must be configured in the Analog Input section).</td></tr>
<tr><td>PF Enable</td><td>Activates Power factor regulation.</td></tr>
<tr><td>Var Enable</td><td>Activates Reactive power regulation.</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 Voltage Matching</td></tr>
</table>

Input Function	*Description*
Reset Alarm	Clear the following alarms: - Supervision Alarm 1 and 2 - Supervision Trip - Monitor Alarm 1, 2 and 3
Standby	Reserved
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)*
External Alarm	External Alarm input, used to detect axillary contacts of MCB's
EmergencyExcitationOff	Excitation OFF command, overwrites Excitation ON input and Modbus control input
Droop 2 select	Selects 2nd droop setting
Unload VAR	Regulates VAR to 0, command must be activated until VAR reaches 0

3.3.5.1 Polarity

Polarity can be configured for all digital input/output ports.



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.
Limiter Active1	One of the selected limiter in the limiter matrix gets active
Limiter Active2	One of the selected limiter in the limiter matrix gets active
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 OFF or after the power has been switched off. During field flashing the output of the regulator is blocked in all operation modes (PWM forced to 0%).
Voltage Relay	Active = machine voltage below boost threshold Inactive = boost threshold plus hysteresis exceeded Not dependent on signal Excitation ON.
Supervision Trip	Trip status according to fault matrix configuration
Supervision Alarm 1	Alarm status according to fault matrix configuration
Supervision Alarm 2	Alarm status according to fault matrix configuration
Monitor Alarm 1	Monitor status according to monitor matrix configuration
Monitor Alarm 2	Monitor status according to monitor matrix configuration
Monitor Alarm 3	Monitor status according to monitor matrix configuration
Diode Alarm	Event of open diode *(Requires Rotating Diode Monitoring SW)*
Diode Trip	Event of a shorted diode *(Requires Rotating Diode Monitoring SW)*
FRT Detection	Fault ride through indication (Sudden voltage dip at network)
ExcON status	Excitation On status, not active if excitation is blocked internally
Softstart Active	Softstart not completed

3.3.7 *Analog Inputs*

Input Function	*Description*
None	Input not assigned
Auto Remote Setpoint Auto Remote SP 20mA	External setpoint input to Auto regulator
PF Remote Setpoint PF Remote SP 20mA	External setpoint input to PF regulator
Var Remote Setpoint Var Remote SP 20mA	External setpoint input to Var regulator
Manual Remote Setpoint Manual Remote SP 20mA	External setpoint input to Manual regulator
Open Loop Remote Setpoint Open Loop Remote SP mA	External setpoint input to open loop
UM Aux UM Aux 20mA	Auxiliary supply to the summing point of Auto regulator
VAR Aux Measurement VAR Aux Measurement 20mA	Auxiliary supply to the summing point of the PF/VAR regulator
Ie External	Reserved
Digital Input 13(+) & 14(-)	Assign digital inputs
Digital Input 15(+) & 16(-)	Assign digital inputs
Digital Input 17(+) & 18(-)	Assign digital inputs as constant signals (No analog input available)

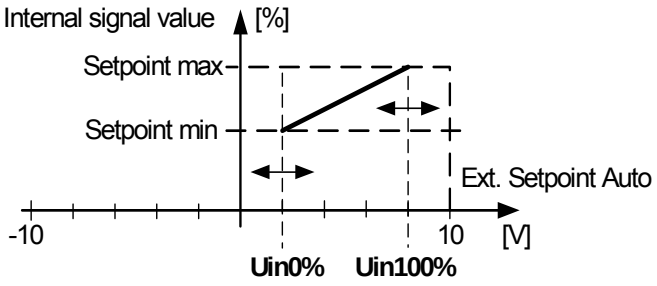
Note:
When configuring an external setpoint from the analog input list shown above, the "Remote SP Enable" digital input should also be configured. For more information see Chapter *3.3.5 Digital Inputs.*

3.3.7.1 Level of the Analog Inputs

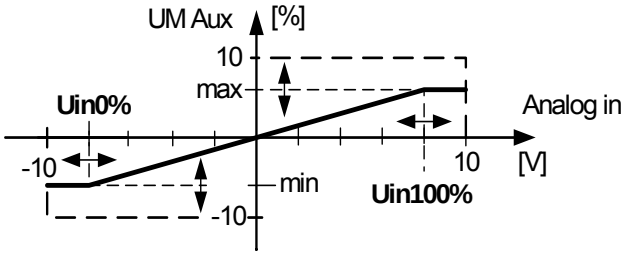
A minimum and maximum voltage level can be set for every analog input. This level represents a defined scaling, which is shown in the table below.

Input Function	*Uin0% Min (-10… +10 V) (0 … 20 mA)*	*Uin100% Max (-10…10 V) (0 … 20 mA)*	*Remarks*
Auto Remote Setpoint	Auto setpoint min	Auto setpoint max	See Chapter *3.4.1.1*
PF Remote Setpoint	PF setpoint min	PF setpoint max	See Chapter *3.4.1.1*
Var Remote Setpoint	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
Ie external	na	na	reserved
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

External setpoint input



Input to the summing point

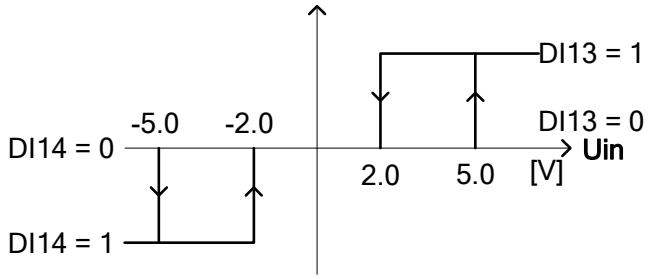


- Input voltage of the cooling media temperature

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

3.3.8 *Communication Ports*

UNITROL 1005 has two 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 1005 with a PC and is used by the CMT1000 software to control the device.
- The Ethernet port is used to connect the UNITROL 1005 to a multiple point Ethernet network in order to connect the CMT1000 remotely and to access the UNITROL 1005 by a plant control system in parallel.

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.*

3.3.8.1 USB Interface

The USB port of UNITROL 1005 can be used to connect a PC that runs the CMT1000 software. Max. USB cable length is 3 m. The USB port will power up control devices of UNITROL 1005 in order to allow the user to download or upload files to the unit without additional power supply connection.

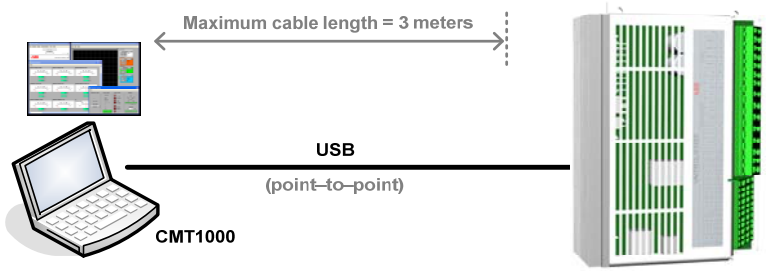


Figure 3-2 USB connection to a PC

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.

NOTICE!

When units is powered only by the USB following restrictions will be valid:

- IGBT power stage is disabled, no regulations possible unless AVR input voltage is above 6Vac
- SW upgrades are enabling of SW Options are not possible

Status will be indicated at the CMT main window by a **yellow** error on the section bar of *Offline / Monitor / Control.*

3.3.8.2 Ethernet Interface

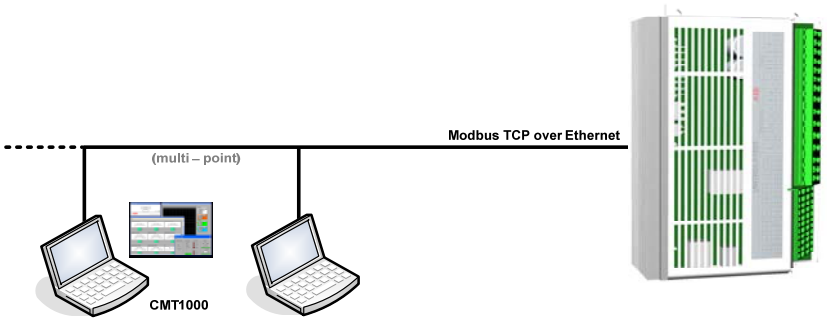


Figure 3-3 Ethernet TCP/IP connection

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)

More information about these software features and configuration can be found in Chapters *3.4.5 Modbus for Remote Access* and *6.3 PC Software Tool.*

3.4 Software

The UNITROL 1005 device supports several operating modes and software features, such as machine voltage regulator (Auto), field current regulator (Manual), measurements, monitoring and others which are described in detail in this section.

There are two different SW function packages defined as ECO and LIGHT. The table below shows the configurations.

A set of software features is enabled by default in each UNITROL 1005 product and is referred to as *E or Light software package*. There are optional software features which extend the UNITROL 1005 capabilities and which can be enabled by password.

No.	***SW-Option Name (Figure 6-14)***	***Descriptions***	***LIGHT / BASIC/ Option***	***See chapter***
1	AVR/FCR/PF/VAR	PF/Var Regulator	*ECO*	*3.4.1.3*
2	Limiters	Limiters	*ECO*	*3.4.3*
3	Soft Start	Soft Start	*ECO*	*3.4.2.1*
4	Voltage Matching	Voltage Matching	*ECO*	*3.4.2.5*
5	History Logger	Records last hour of operation	*LIGHT*	*3.4.4.1*
6	Modbus	Modbus TCP for remote access	*LIGHT*	*3.4.5*
7	Rotating Diode Monitoring	Monitoring of rotating diodes on the exciter machine	*LIGHT*	*3.4.3.3*

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 *6.3.5 Menu Structure of CMT1000.*

The following sections explain the complete UNITROL 1005 software including optional features. It is clearly mentioned at the beginning of the description if a software feature is optional or not. The 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.*

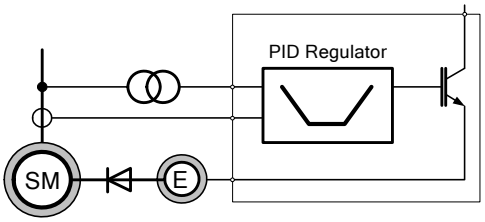
3.4.1 *Operating Modes*

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.

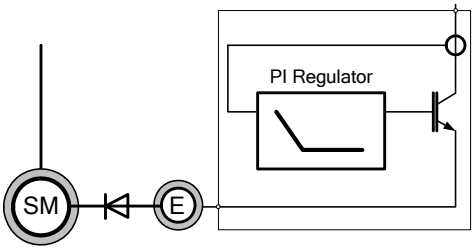
Note:
Current measurement for compensation / droop



3.4.1.2 Manual Control

Regulates the field current of the excitation machine.

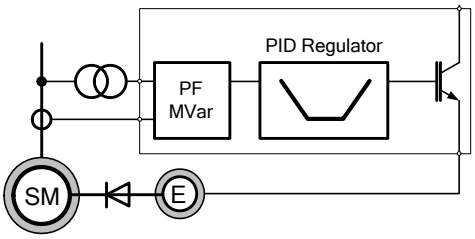
Note:
No limiters are active as long as this mode is active.



3.4.1.3 PF or Var Regulation

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

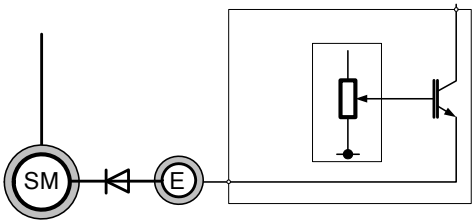
Remark:
Var setpoint is normalized at 1pu terminal voltage of the generator



3.4.1.4 Open Loop

Control with a fixed output signal.

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



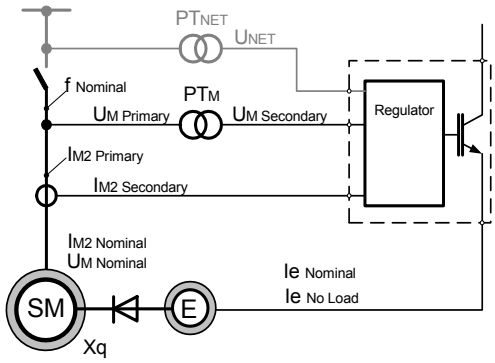
3.4.1.5 Channel Follow-up

While the UNITROL 1005 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	



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
- Initial Setpoint

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

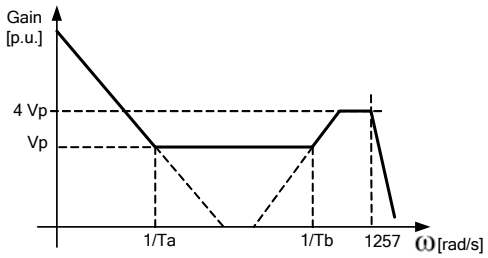
Mode	Initial Setpoints
Auto	100% (configurable)
Manual	0% (configurable)
Open Loop	0% (configurable)
PF	1.0 (configurable)
Var	0% (configurable)

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 bumpless switching between operating modes if the new setpoint is within the setpoint limit.

3.4.1.6.3 *Regulator Tuning*

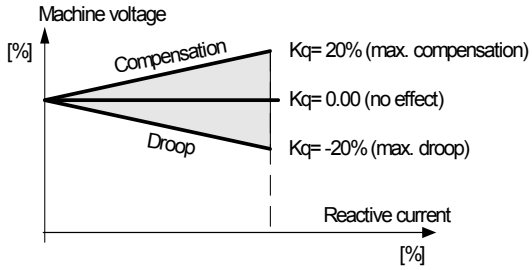
Auto (voltage control)

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



Compensation or droop

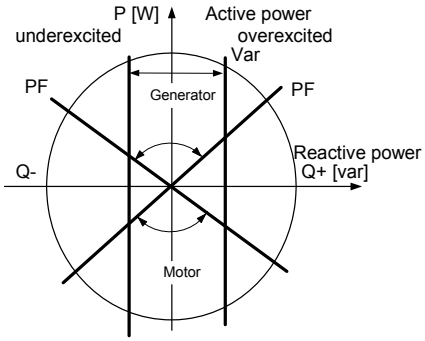
Droop Kq	[%]	
Droop Kq2	[%]	
Kq2 acts on P	☑	
Kq2 active when on grid	☑	



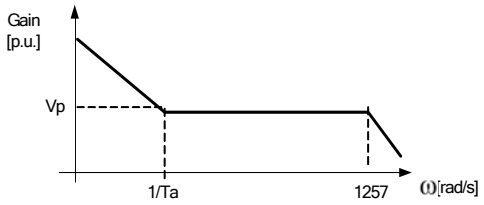
PF or Var Control and PQ Limiter

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 en	☑	PF or VAR controller can be configured for direct or indirect control In case of indirect control the PF/VAR are regulated by increasing and decreasing the voltage setpoint with defined ramp rate for AUTO mode.
	Dead band of Q reg	[%]	Voltage SP is only changed in case 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 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 1005 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 1005 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

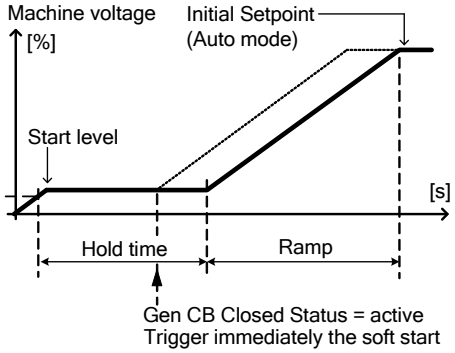
When this function is enabled, the AVR will apply 100% PWM during undervoltage. Thresholds are defined by the boosting setting.

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*.



Starting excitation after UM frequency reaches a predefined level (parameter name: Start Frequency)

Excitation is switched on when the machine frequency is higher than the start frequency threshold. *ExcitationOn* input (also from remote control) is set to OFF until the machine frequency is higher than *FreqUM*. 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 generator frequency goes above the start frequency.

Note: Soft Start is available only in Auto mode.
Status of internal excitation can be indicated by digital output.

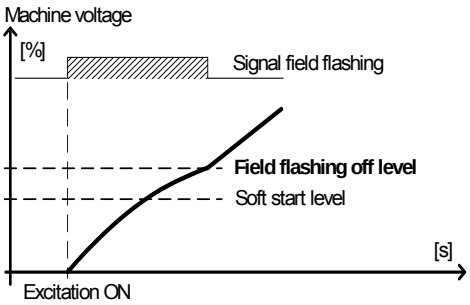
In order to measure the correct frequency, the machine voltage must be above 2%

3.4.2.2 External Field Flashing

- Off Level Off Level [%]

External Field Flashing is controlled by digital output of the UNITROL 1000.

Setting the Off Level to 0% disables Field Flashing.



3.4.2.1 Internal Field Flashing

- Enable Checkbox
- PWM value PWM [%]
- Upwr OFF voltage Upwr OFF voltage [V]

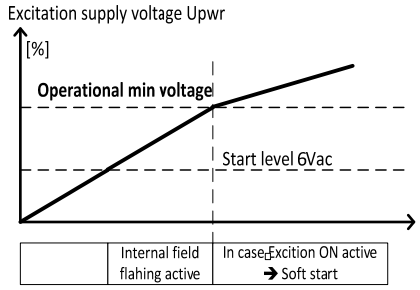
The UNITROL 1005 will fully operate with a minimum control supply of 16Vac or 18Vdc. The AVR output can be forced by internal Field Flashing to enable starting even at 6Vac or 10Vdc.
When Internal Field Flashing is enabled the AVR applies the defined PWM at the output until
a) MCU is powered and working
b) Defined Upwr level is reached

After Upwr was established over a defined working area and excitation start did not work properly, indicated by a drop of Upwr under 18Vdc, the AVR output is blocked. The user must stop the machine and power cycle the UNITROL 1005 in order to start again.

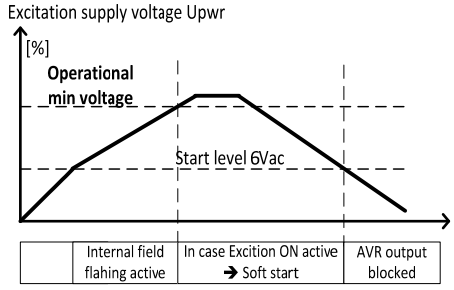
The UNITROL 1005 will indicate such a status with Emergency Exc. OFF.

Note:
Parameter for internal field flashing become active only in case Upwr goes above 16V ac or 18V dc.

Start sequence

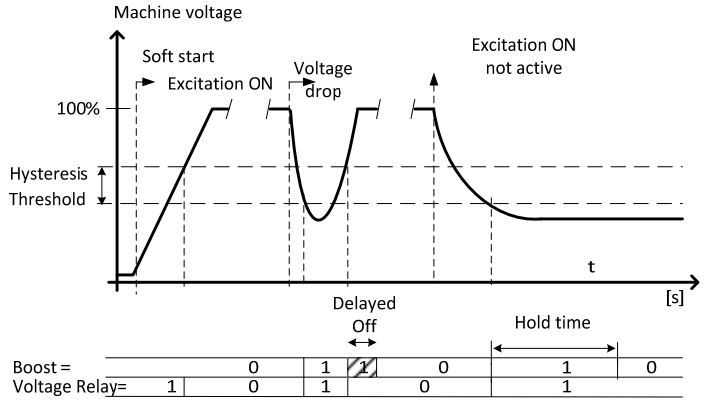


Start sequence aborted



3.4.2.2 Boost / Voltage Relay

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



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

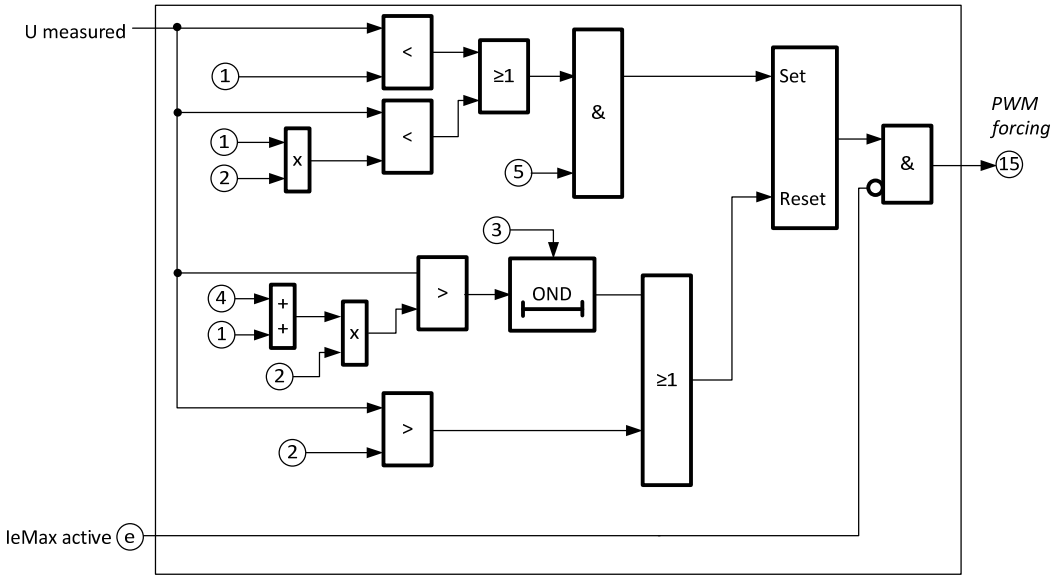
Current boost operation is canceled when either failure is detected

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.

3.4.2.3 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

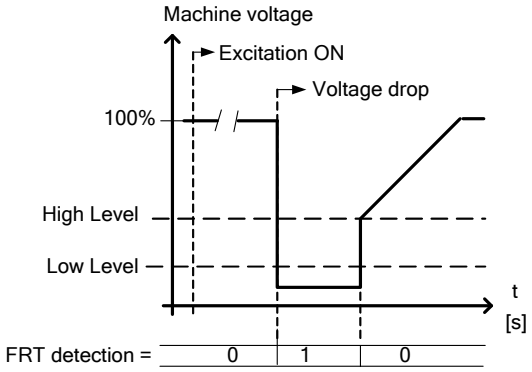
Detection of PT failures relies on Supervision functions (status, not latched), PT failures will only be detected when the DCH SW option is enabled

3.4.2.4 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.
Reaction time depends on configured voltage measurement

- 3 phase measurement 20ms
- 1 phase measurment 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

3.4.2.5 Voltage Matching (VM)

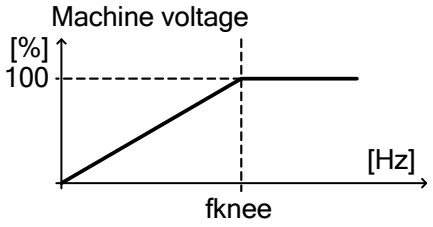
When Voltage Matching is activated (digital input *Synchronize*), the generator voltage setpoint is adjusted to match U_M with U_{NET}.

3.4.3 *Limiters and Monitor Functions*

3.4.3.1 Limiters

V/Hz Limiter

- V/Hz knee point frequency fknee [Hz]
- Slope Slope [%]

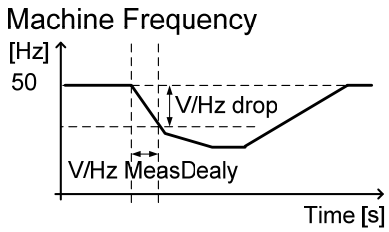


In case of a short circuit at the machine terminals, the frequency is calculated out of the machine current. This guarantees a correct functioning of the V/Hz limiter in any condition.

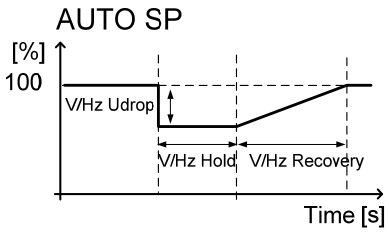
During soft start the V/Hz limiter minimum output is limited to 5%

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]



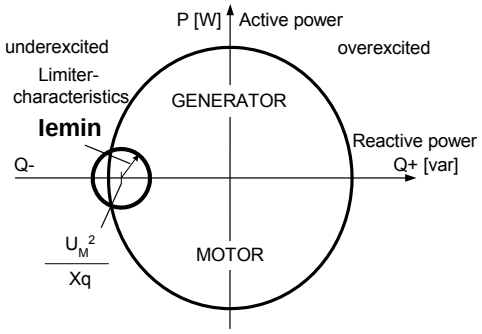
The function is blocked:

- 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 application in island operation to unload the engine in order to recover faster to nominal speed.

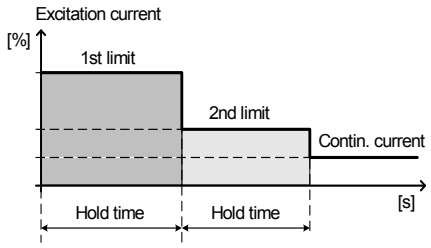
Ie Minimum current limiter

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



Ie Maximum current limiter

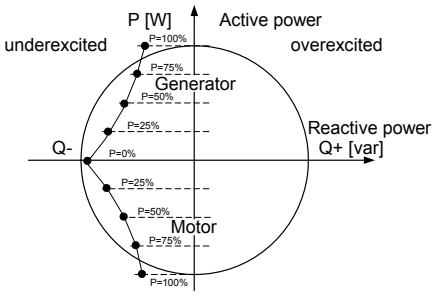
- 1st limit	Maximum [%]
- Hold time	Maximum Hold Time [s]
- 2nd limit delay	Delayed [%]
- Hold time	Delayed Hold Time [s]
Continuous current Limiter active	Continuous [%] Active = True/False



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

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“

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

3.4.3.2 Monitor and protection functions

UNITROL 1005 provides limited monitor and protection functions.

3.4.3.2.1 *Overview*

UNITROL 1005 does provide a freely configurable fault matrix to configure digital outputs.

In the supervision matrix user can configure three digital outputs (two alarms and one trip), where several supervision functions of AVR internal status and summing status of Monitor functions can be configured.

Monitor functions can be setup in order to configure three independent digital outputs, where summing status of Limiters can be added.

Limiters monitor matrix can be set up to configure digital ouputs.

3.4.3.2.2 *Supervision Functions*

The Supervision has several 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 3-4*, 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.

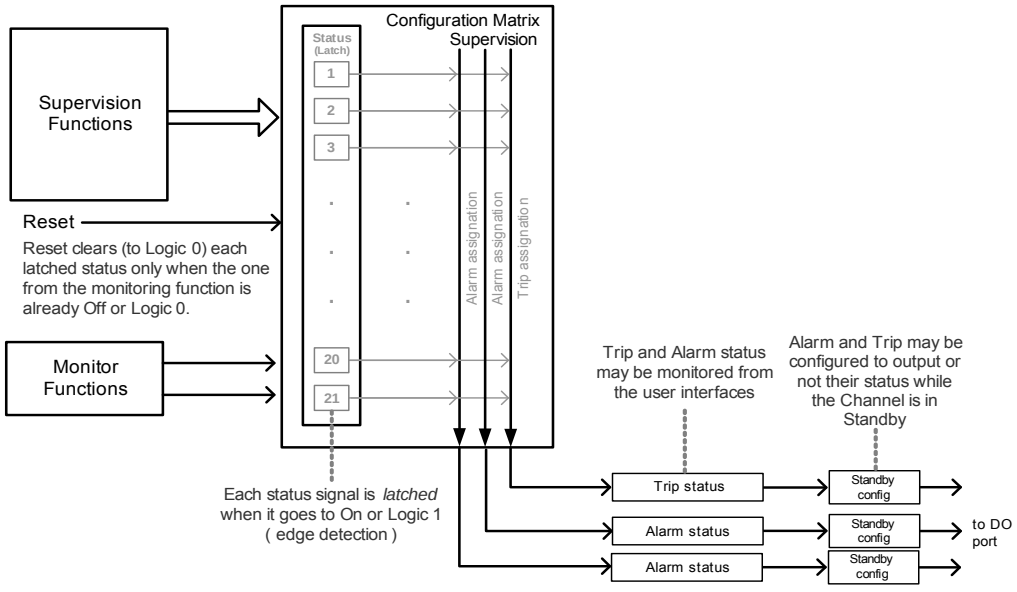


Figure 3-4 Supervision function logic

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 3-4,* they are not directly connected to the output. Instead they are connected to the Standby Configuration boxes. The Standby Configuration boxes, shown in *Figure 3-4*, 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 Supervision functions is shown in *Table 3-1.* Following,

Table 3-1 Supervision functions.

Supervision Function	***Description***	***Detection Time***
SW real time error On CMT1000: "*Watchdog*"	SW is not running **Failure condition:** 1ms Task is not finished within 1ms	2 msec
MODBUS Comm. Alarm On CMT1000: "*Loss of Remote Control*".	Supervision of MODBUS keep alive Remote Access feature. Active independent of “remote access” is granted.	1 sec.
Machine Voltage *One or Two phases lost* On CMT1000: "*Partial Loss of UM*"	Machine PT monitoring only for 3 phase PT configuration **Failure condition:** Error is detected if two phase to phase voltages are in the range of 45% to70% of the biggest measured phase-to-phase voltage **Note:** Correct function is only provided in case of 3 phase PT is used. Secondary side of PT must be connected to PE	80ms
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 Ie 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 60ms. In this case, the monitor function is blocked.	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	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.

Supervision Function	***Description***	***Detection Time***
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 Function is blocked when "Voltage Relay" is active	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.
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 Monitor function blocked in case Upwr < 22Vdc	10 msec
Monitor Alarm 1	Configured monitor Alarm 1	
Monitor Alarm 2	Configured monitor Alarm 2	
Monitor Alarm 3	Configured monitor Alarm 3	

3.4.3.2.3 *Monitor Functions*

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

Monitor Functions	***Description***	***Detection Time for testing***
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 Over Voltage *	Configurable overvoltage monitor	configurable
Generator Under Voltage *	Configurable undervoltage monitor Will be activated after soft start is finished	configurable
Excitation Over Current *	Configurable overcurrent monitor	configurable
Excitation Over Voltage *	Configurable overvoltage monitor	configurable
Upwr Over Voltage *	Configurable overvoltage monitor	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 Block excitation until monitor function is reset by “Reset Alarm”	5 msec.
Reverse Power Indication	Supervision of relative power (Prel) Negative threshold is used for generator mode Positive threshold is used for motor operation	Configurable
GCB Alarm	Machine current exceeds 20% with open GCB status (Machine current is forced to 0% when Im < 5%)	2 sec
AVR output SC *	Detection of short circuit at AVR output	10 ms
Limiter Monitor 1	Summing status of Limiter matrix	10 ms
Limiter Monitor 2	Summing status of Limiter matrix	10 ms

* Monitor functions can be configured to fire the AVR internal crowbar thyristor. This will trip the external MCB or fuse in order to safely trip the machine and limit the overvoltage on the machine.

3.4.3.2.4 *Limiter Monitor*

Table 3-3 Limiter Monitor matrix

Limiter Monitor	***Description***	***Detection Time for testing***
Min. Excitation Current Limiter (Min Ie)	Min. Ie Limiter	10ms
Min. Machine Voltage (min UM)	Min. machine voltage limiter, only active in direct PF/VAR mode	10ms
Min. Reactive Current (Min Iq)	P/Q limiter active	10ms
Max. Excitation Current (Max Ie)	Max. Ie Limiter active	10ms
Max. Machine Voltage (Max UM)	Max. machine voltage limiter, only active in direct PF/VAR mode	10ms
Max.Machine Current (Max IM)	Max. IM limiter active	10ms
V/Hz Limiter	V/Hz limiter active	10ms
Min. Setpoint reached	Setpoint set to minimum	10ms
Max. Setpoint reached	Setpoint set to maximum	10ms

3.4.3.2.5 *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).

3.4.3.2.6 *Automatic Logic*

Configurable logic to force the AVR into Manual or to automatically switch off excitation logic is provided.

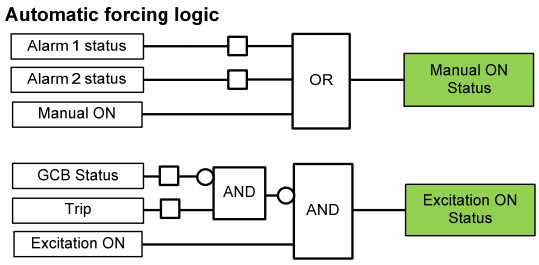


Figure 3-5 Automatic forcing logic

3.4.3.3 Rotating Diode Monitoring (RDM)

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

- A diode is broken
- Short circuit of a diode

RDM 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 3-6.*

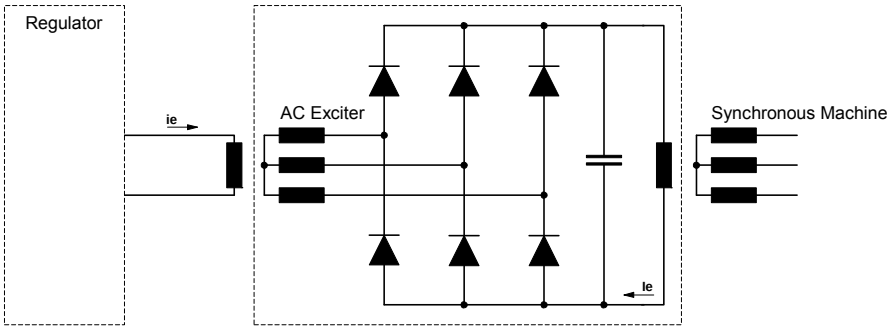


Figure 3-6 Rotating Diode Monitoring application

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 when there is a fault in the rotating rectifier.

The ALARM is triggered in case 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.

3.4.4 *Miscellaneous Functions*

3.4.4.1 History Logger

History Logger records the last 2 hours of operation. A measurement sample of 12 defined signals are stored every min in the non-volatile flash. Everytime excitation is started default values are stored in the log to identify restart conditions.

Table 3-4 Recorded signal of History logger

Signal	***Signal identification***	***Value for start Exc.***
Machine voltage	Umrel	
Machine current	IM2rel	
Reactive power	Qrel	
AVR ouput PWM	PWM	
Generator state	GenState	
AVR control mode	Generator control mode	
Machine frequency	fMachine	
Limiter status	Combined Limit	
Active Power	Prel	
AVR input voltage (rectivied)	Upwr	
Temperature of controler	Temperature DSP	

3.4.5 *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 *3.3.8 Communication Ports*. It is recommended to read Chapter *3.4.6 Access Levels* prior to this section, in order to fully understand the software capabilities.

3.4.5.1 Overview

A remote terminal configured as MODBUS master can access the device through Ethernet TCP/IP using Remote Access.

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. 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 *3.4.6 - Access Levels*.

3.4.5.2 Configuration

The Modbus Slave ID value is used for both Remote Access over Ethernet TCP/IP. 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 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 *6.3.6 Communication Menu*.

3.4.6 *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 UNITROL 1005 device can be accessed from two different operators: 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 UNITROL 1005 device is by default in local control.
- **CMT1000 control (medium priority)**
  CMT1000 can be connected to the target, where three different access levels are defined: Offline, Monitor and Control.
  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 UNITROL 1005 device will go back to local control mode.
- **Remote access (lowest priority)**
  Remote access is granted only if the UNITROL 1005 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 UNITROL 1005 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 CMT1000 and Remote Access is explained in the following sections. For more details about UNITROL 1005 user interfaces, refer to *Chapter 6 - Operation*.

3.4.6.1 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 in any case. 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 UNITROL 1005 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. 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.

3.4.6.2 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 UNITROL 1005 *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*

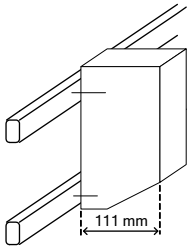
The unit should only be installed in indoor areas which are dry and dust-free and which do not contain any gases, acid fumes or similar.

Mounting

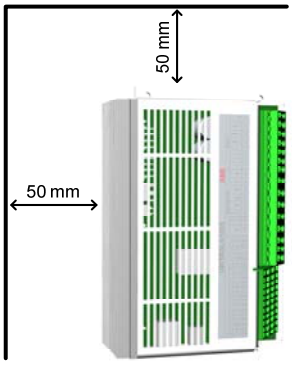
The UNITROL 1005 is designed for rack or wall mounting in upright position.

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 15	0.2 to 4 mm^2	(AWG 10 to 30)
	- Electronic sections, terminal numbers 21 to 53	0.2 to 2.5 mm^2	(AWG 12 to 30)

Grounding (PE)

The casing must be grounded at terminal 1. Additional earth connection are provided by the mechanical mounting holes. The ground connection should be kept as short as possible.

External fuses for machine and network measurements

Proper fuses or cable dimension, which withstand short circuit currents, shall be used to prevent consequent damages.

NOTICE!

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

4.5.1 *Fuse for excitation power*

UNITROL 1005 is equipped with a crowbar firing thyristor. The firing is triggered by a configurable monitor function in order to safely switch off the excitation by tripping the external fuse device. The UNITROL 1005 device can withstand short overcurrent of 100Ap for 10ms.

Following fuses shall be taken:

6A nominal with MCB type C characteristic

If bigger fuses with higher short-circuit currents are selected, the fuses are still safety blown out, however the UNITROL 1005 might be damaged.

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

4.7 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 1005 units operate with dangerous voltages of up to 300 V ac or 300 V dc as power input and up to 500 V ac for machine and network voltage measurement.

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 1005 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 Digital I/Os Analog Inputs Monitor and Protection
Communication	ID Definition Port Configuration AVR Ethernet Settings MODBUS Supervision
Tune	Setpoint Adjust Auto PF/Var/PQ Limiter Manual/Ie Limiter

5.3.1 *Setting Aids*

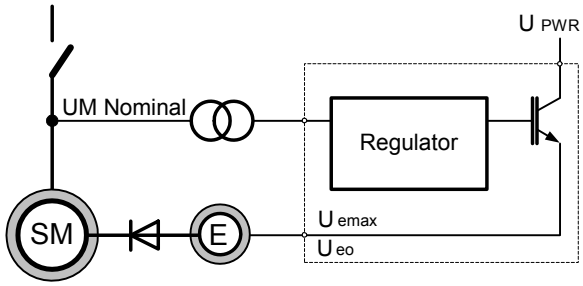
5.3.1.1 Setup \ System Data, Ceiling Factor Kceil

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 \ Internal Field Flashing

Internal field flashing release configurable PWM as fix value at Upwr voltage of 6Vac. PWM is stopped at either UNITRL 1005 is fully power up and conrol circuits are operational or Upwr exceed the configurable threshorld.

PWM shall be configured below kceiling factor in order to avoid generator overvoltage.

NOTICE!

In order parameters for internal field flashing becomes active at a input voltage of 6Vac, the parameters must be saved to EEPROM and the device must be powered up to Upwr of minimum 16Vac or 18Vdc

5.3.1.6 Setup \ Limiters, in Manual and Open Loop Mode

No limiters are active in Manual and Open loop mode.

5.3.1.7 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%

5.3.1.8 Setup \ Limiters \ Operational Limits \ Ie Limiter

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

5.3.1.9 Setup \ Limiters \ Operational Limits \ IM Limiter

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

5.3.1.10 Setup \ Limiters \ Operational Limits \ Q Limiter

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

5.3.1.11 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

5.3.1.12 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%].

5.3.1.13 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	PF Enable	Var Enable
Standby	1	X	X	X	X	X	X	X
Sync	0	1	X	X	X	X	X	X
Manual	0	0	X	X	1	X	X	X
Open Loop	0	0	X	X	0	1	X	X
PF	0	0	1	1	0	0	1	X
Var	0	0	1	1	0	0	0	1
Auto	0	0	0	X	0	0	X	X
with *)	0	0	1	X	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.

5.3.1.14 Tune \ Setpoint Adjust, Step

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

5.3.1.15 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 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

5.3.1.16 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%

5.3.1.1 Selection of drop

Two independent drop factors Kq and Kq2 can be selected either by digital input or depending on several checkboxes. The table below shows the priority of different control sources.

Selection source for Kq2	***Priority***	***Drop functions***
Digital input or Modbus	Highest	Selects between Kq and Kq2
Checkbox “Select Kq2 when parallel to grid” enabled	Overwrites digital input or Modbus register when parallel to grid	Enables automatically KQ2, drop on active power is blocked
Checkbox “Kq2 acts on active Power”	Only in case of no-load or island operation. Kq2 must be selected over	Activates drop on active power.

	digital input or Modbus	

5.3.1.2 Tune, PF/VAR

PF/VAR regulator shall be tuned in same way as the AUTO mode. The tuning is required for optimized operation of the regulation mode as well as for the performance of the PQ-Limiter.

Using the indirect PF mode requires further more setting of dedicated AUTO ramp rate. In case of low net reactance (Xn < 5%), the AUTO ramp rate shall be selected very small as well to avoid unstable regulation.

5.3.1.3 Communication \ MODBUS (Remote Access)

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 1005 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 1005.

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 3.4.5 – 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 1005 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. The control access has to be granted as explained in Chapter *3.4.6.*

For more information, refer to the *UNITROL 1000 Modbus Reference* document, document number 3BHS358381 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 1005

- 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.

5.6 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 PC Software Tool

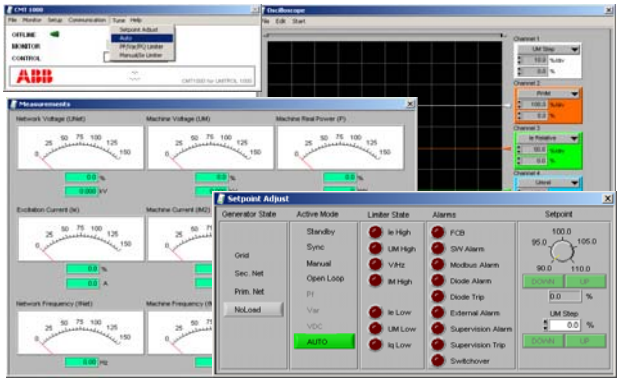
The PC software tool used with UNITROL 1005 is called CMT1000**.** Release 6.300 is compatible with all previous 6.xxx releases but not with releases older than 6.000.

6.3.1 *General*

Parameter configuration and optimization can be done with the user-friendly software *CMT1000* for Microsoft Windows. CMT1000 accesses the UNITROL 1005 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 *3.3.8 – 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.



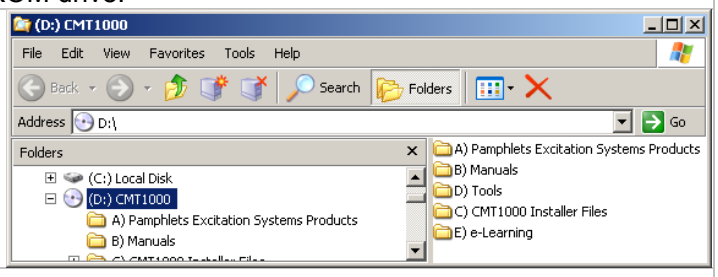
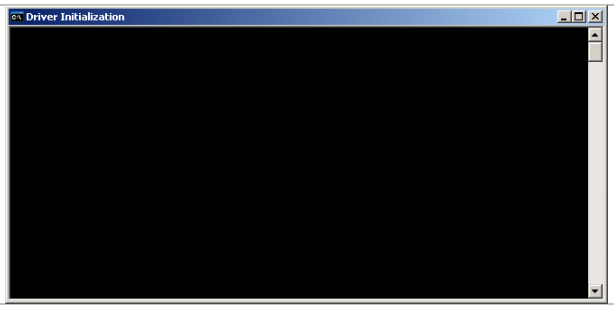
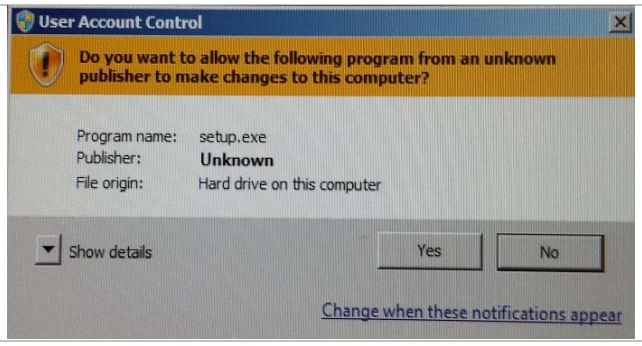
The CMT1000 software operation is described in Chapter *6.3 – PC Software Tool*.

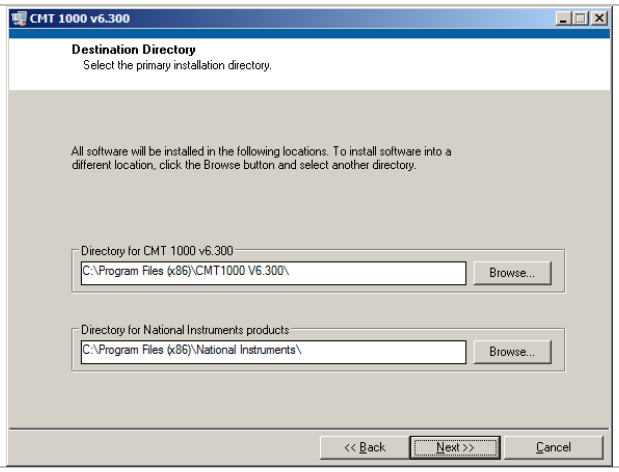
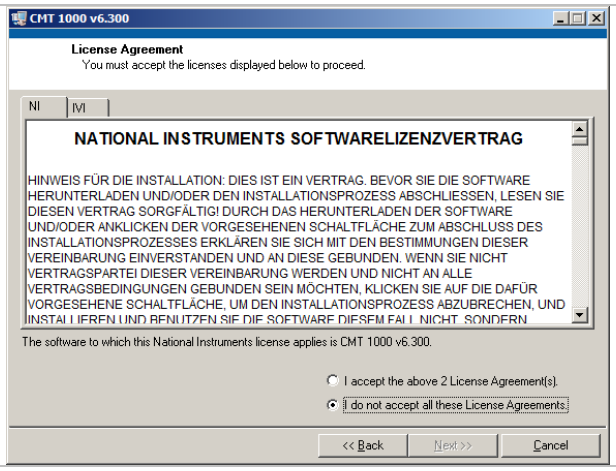
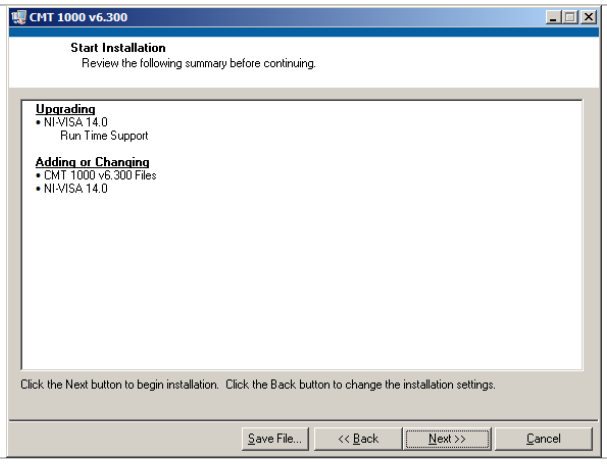
6.3.2 *System Requirements for CMT1000 Release 6.200*

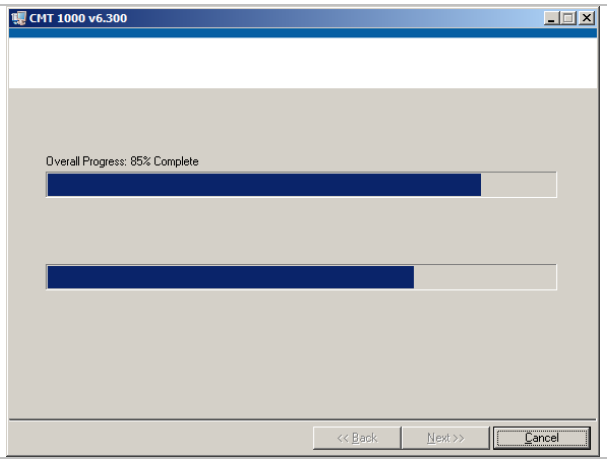
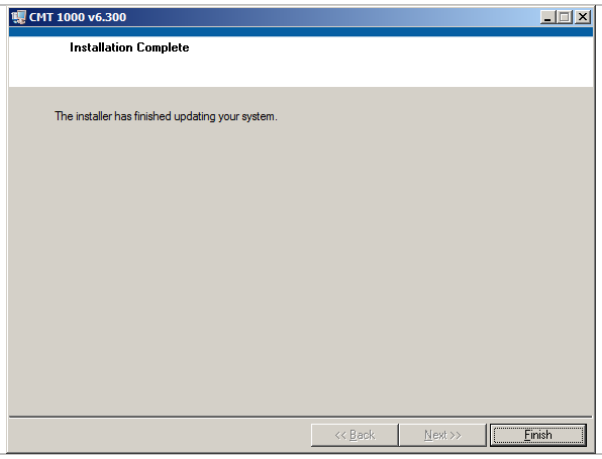
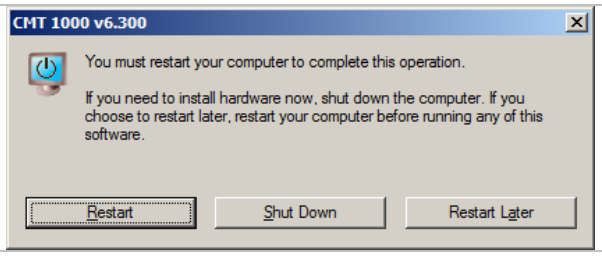
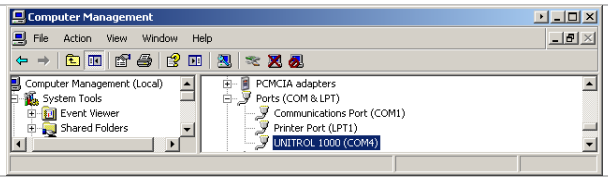
- Minimum Pentium 1 GHz or equivalent processor. Recommended: Pentium III or Celeron 1 GHz or equivalent processor or higher.
- Minimum 512 MB RAM.
- Minimum screen resolution of 800x600 pixels. Recommended: 1024x768 pixels or higher.
- CD-ROM drive.
- Microsoft® Windows ™ Vista, Win 7 and Win 8.
- Minimum 10 GB of free hard disk space.

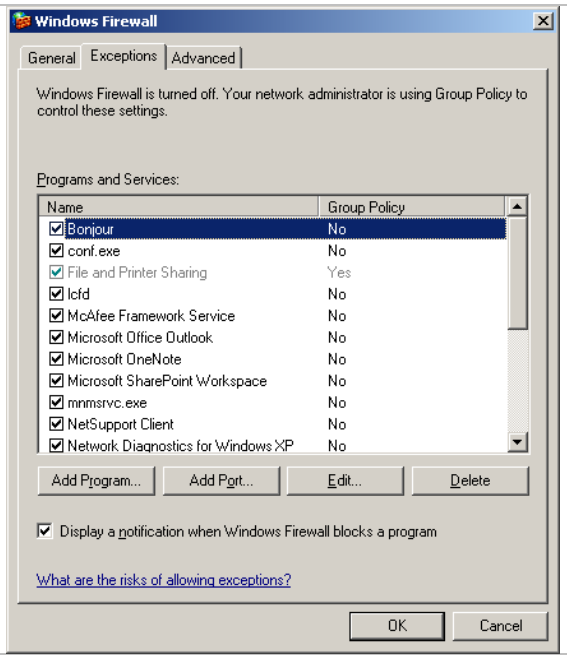
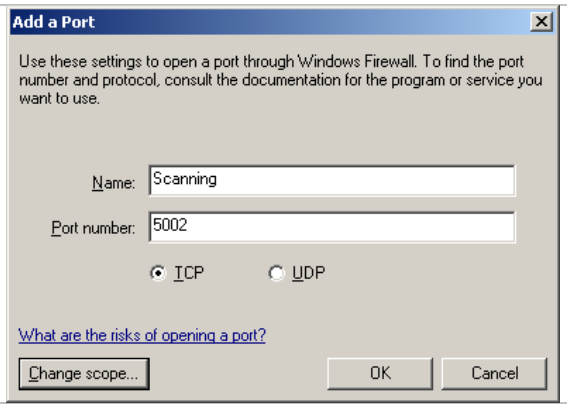
6.3.3 *Installing CMT1000 Software*

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 *Yes*	

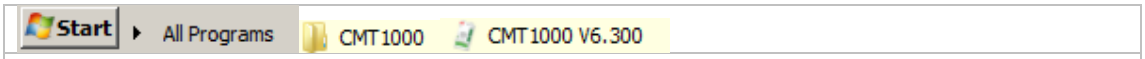
Click *Next*	
Select *I accept the above 2 License Agreement(s).* Click *Next*	
Click *Next*	

	
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*	

6.3.4 *Starting with CMT1000*

The CMT1000 communicates with the AVR via USB or Ethernet. . For more information about the hardware connections refer to Chapter *3.3.8 Communication Ports.* Start the CMT1000 V6.200 application from Start-Programs



or from the desktop shortcut

6.3.4.1 Configuring the Port Interface (CMT1000 configuration)

Before the communication with the AVR can be established, the connection type should be specified 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 6-1*).

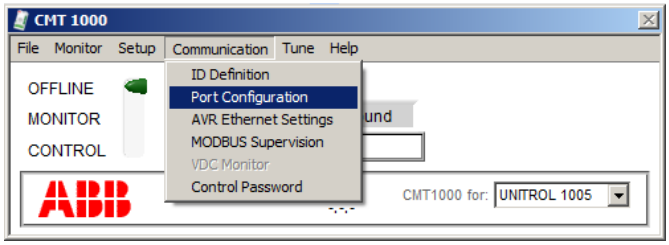


Figure 6-1 Port Configuration.

After starting the CMT 1000 application, choose UNITROL 1005 from the drop down menu.

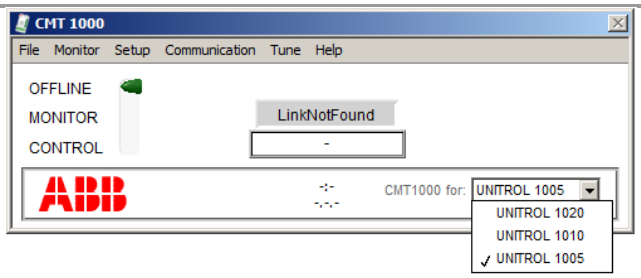


Figure 6-2 Choose Unitrol 1005

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 6-3*
2. Click the Ok button (2) to save the changes, or Cancel to abort the configuration.

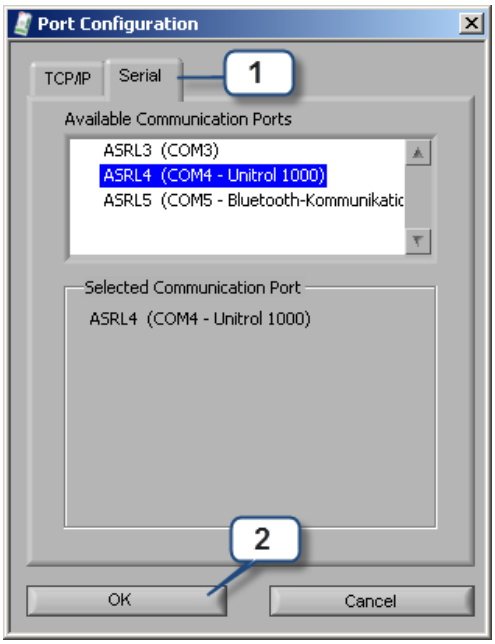


Figure 6-3 USB COM Port Configuration.

If the respective COM port is not found, check whether the required COMx is correctly configured in the operating system or 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 6-4*.
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 *3.3.8 Communication Ports.*

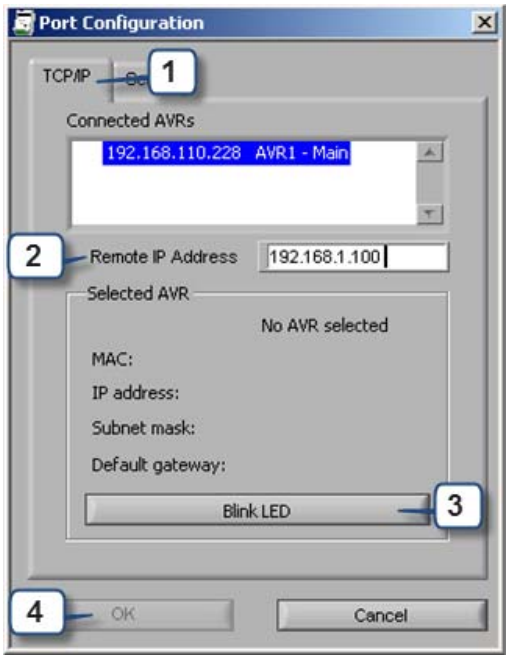


Figure 6-4 Remote IP Address Configuration.

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 *3.3.8 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.

6.3.4.2 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.

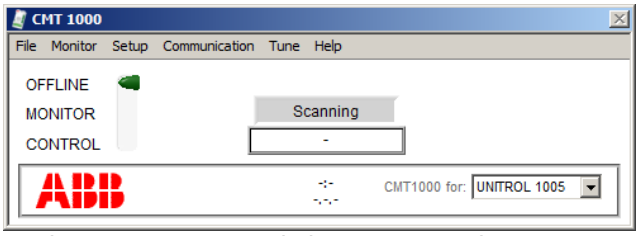


Figure 6-5 CMT1000 during AVR Scanning Process

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 Offline, most parameters are read from the computer memory, only the information shown in the main window is read from the device.

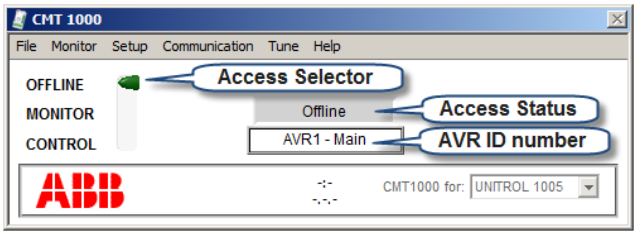


Figure 6-6 CMT1000 during Offline

As long as the CMT1000 has Monitor or Control Access, the main window looks as in *Figure 6-7* and *Figure 6-8*. 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.

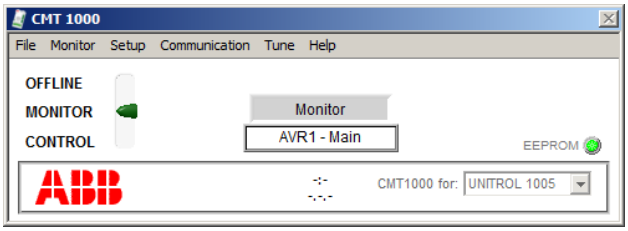


Figure 6-7 CMT1000 during Monitor Access

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.

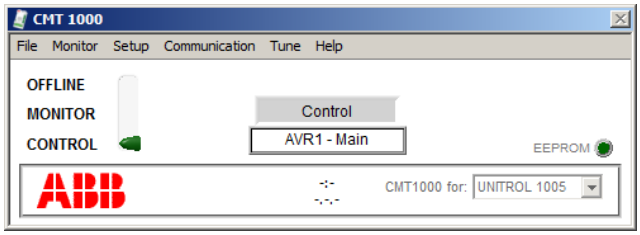


Figure 6-8 CMT1000 during Control Access

AVR scanning process failure: "Link Not Found"

The CMT1000 scanning process can last up to one minute before the AVR is detected; especially if the 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 6-9*). Check if the AVR is truly connected by verifying the configuration and/or the hardware.

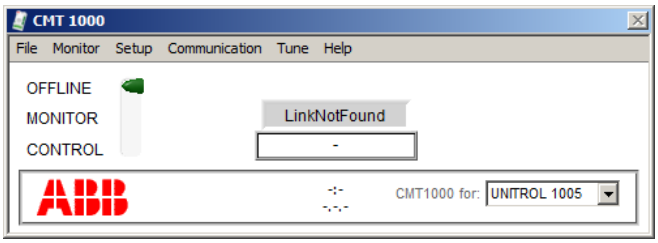


Figure 6-9 LinkNotFound message when the AVR cannot be found or the communication port cannot be accessed by the CMT1000

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 *3.3.8.1 USB Interface*.

6.3.5 *Menu Structure of CMT1000*

The main window of the CMT1000 is shown in *Figure 6-10* 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

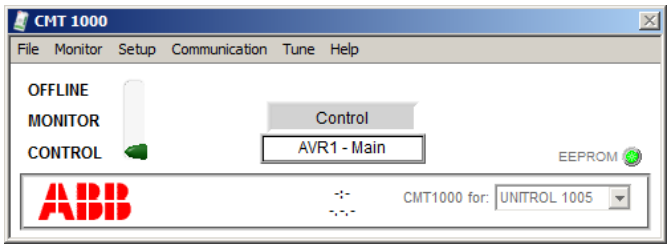


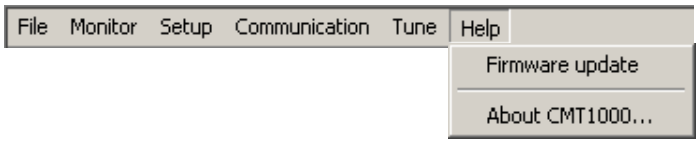
Figure 6-10 Main Window of CMT1000

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”.

6.3.5.1 Help Menu



SW Update

Software and AVR Information

About CMT1000

AVR S/N: Unit's serial number
Control: DSP software version
MCU: MCU 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.

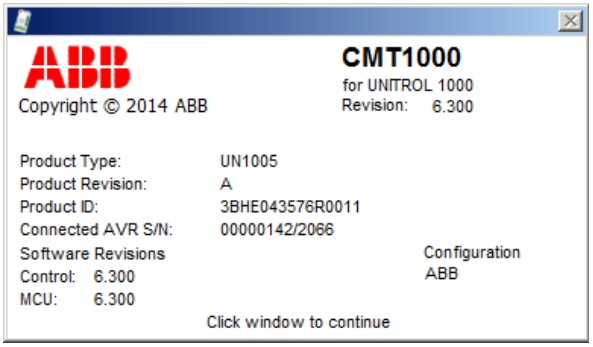
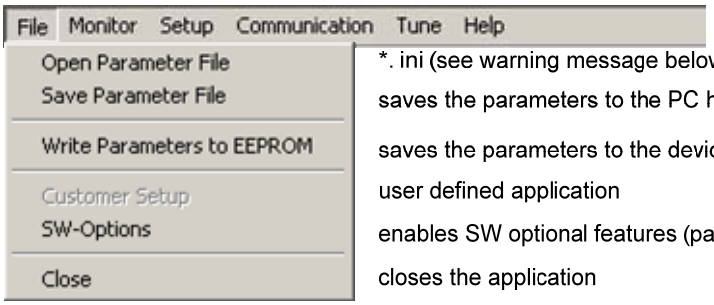


Figure 6-11 About CMT Window

6.3.5.2 File Menu



*. ini (see warning message below)

saves the parameters to the PC hard disk

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 6-12*).

The warning window (*Figure 6-12*) 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.

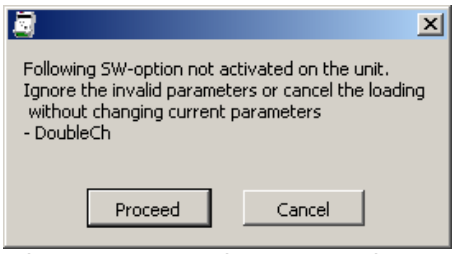


Figure 6-12 A warning message is shown when one or more optional SW is set as active in the INI file but not available in the AVR.

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 UNITROL 1005 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 must be ordered with ABB.

The following steps should be followed in order to enable optional software in the UNITROL 1005:

1. Make sure the CMT1000 has Control Access (*Figure 6-13*).

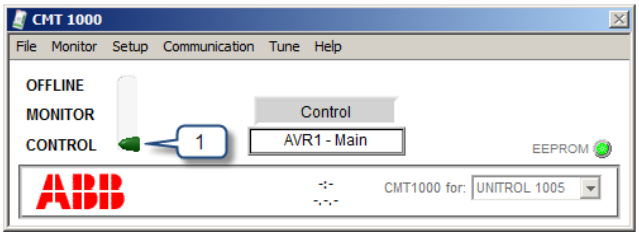


Figure 6-13 CMT1000 must have Control Access before

2. Type the password provided by ABB (case sensitive) in the white box located beside the SW-option intended to enable (*Figure 6-14*). 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.

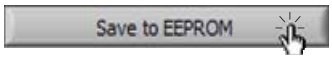
   The behavior rules for the SW activation buttons are shown in *Figure 6-15*.

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 changes 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.

enabling optional SW.

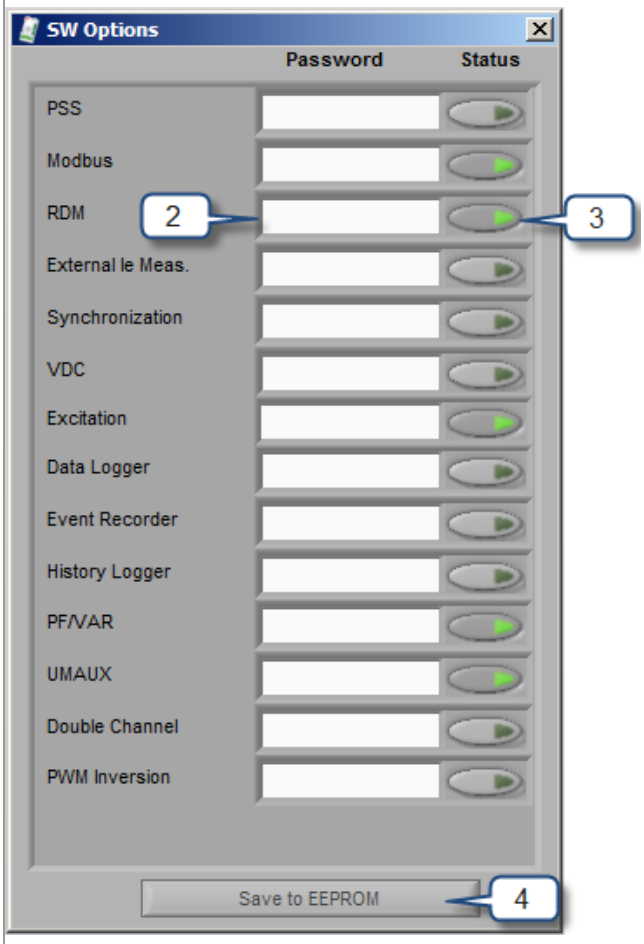


Figure 6-14.The SW Options window allows the user to enable optional software in the AVR.

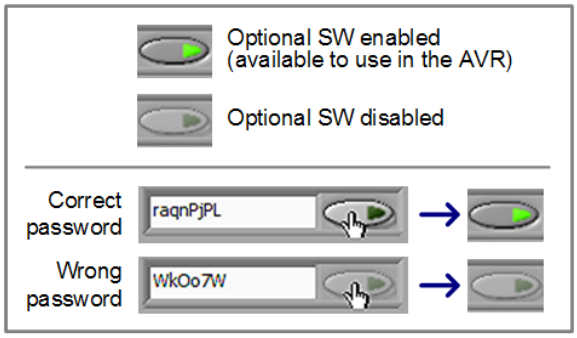
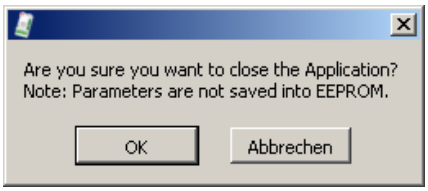


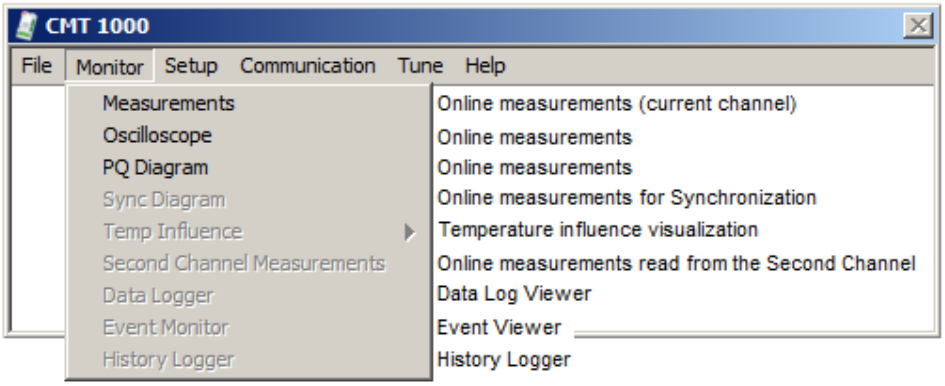
Figure 6-15 Upper: LED is bright when the optional SW is enabled in the AVR. Lower: A wrong password does not enable the SW.

Close
Exit the CMT1000 software.



Online measurements
Online measurements
Online measurements for Synchronisation
Temperature influence visualization
Online measurements read from the Second Channel
Data Log Viewer
Event Viewer
History Logger

6.3.5.3 Monitor Menu



6.3.5.3.1 *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) --

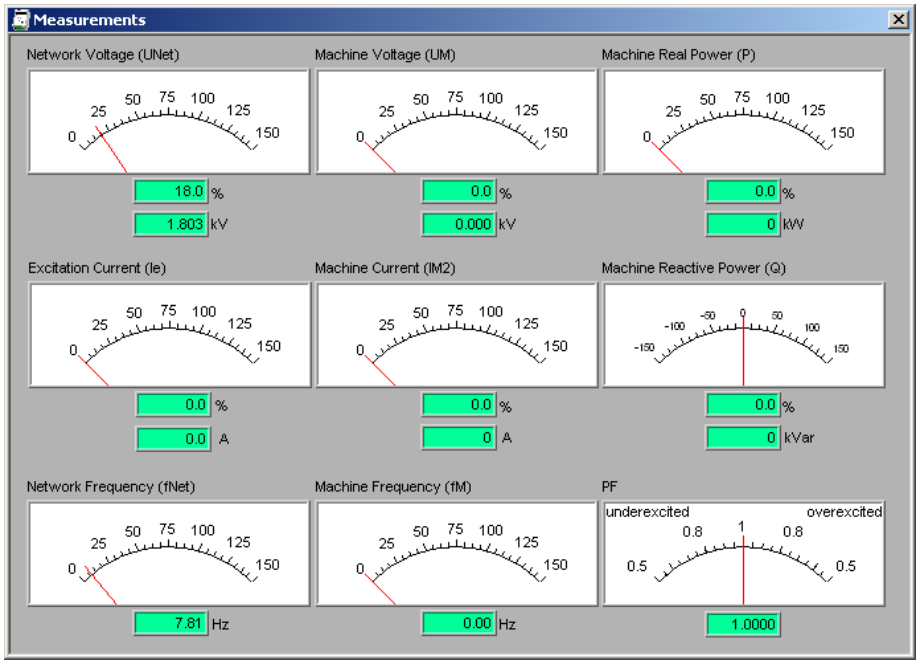


Figure 6-16 Measurements window

6.3.5.3.2 *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 6-17*). The signal or measurement to be displayed is configured on the right end side of the Oscilloscope window with the options shown in *Figure 6-17*.

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 UNITROL 1005, 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.

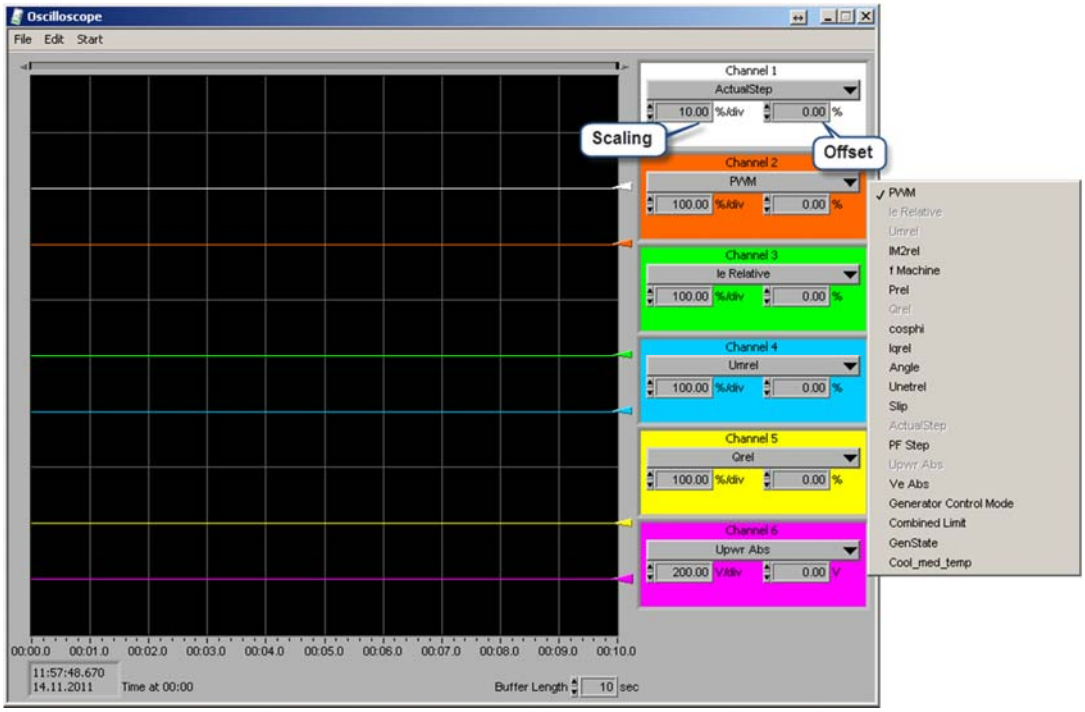


Figure 6-17 Oscilloscope window.

The Oscilloscope window menu and the function description of each item are explained in *Figure 6-18*. The Oscilloscope can be started and stopped as explained in *Figure 6-19*.

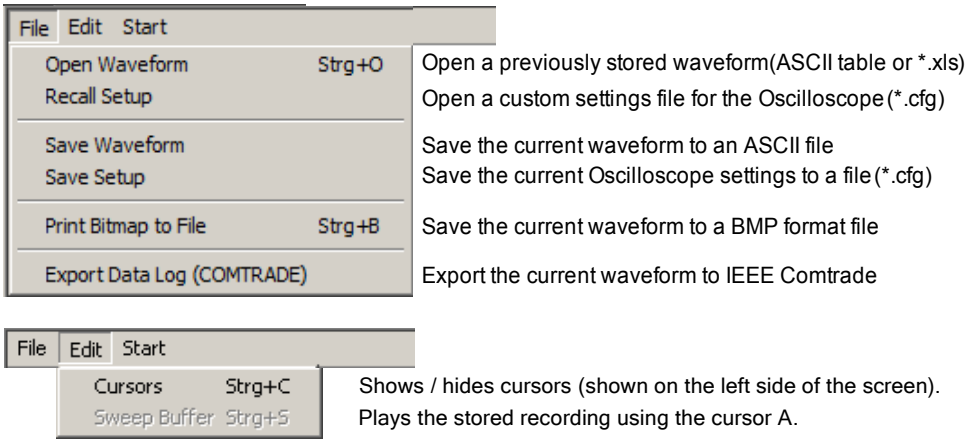


Figure 6-18 Menu structure of the Oscilloscope tool window and function of each item.

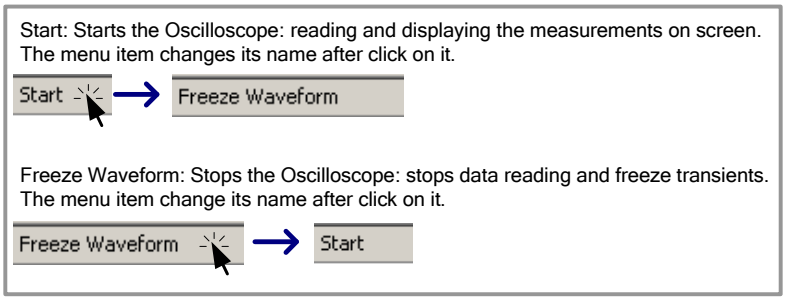


Figure 6-19 The Oscilloscope is started and stopped using the "Start" / "Freeze Waveform" button located in the menu of the window.

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 6-20*. 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 6-20*). 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 6-20*).

The temporal buffer of the UNITROL 1005 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 6-20*). 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).

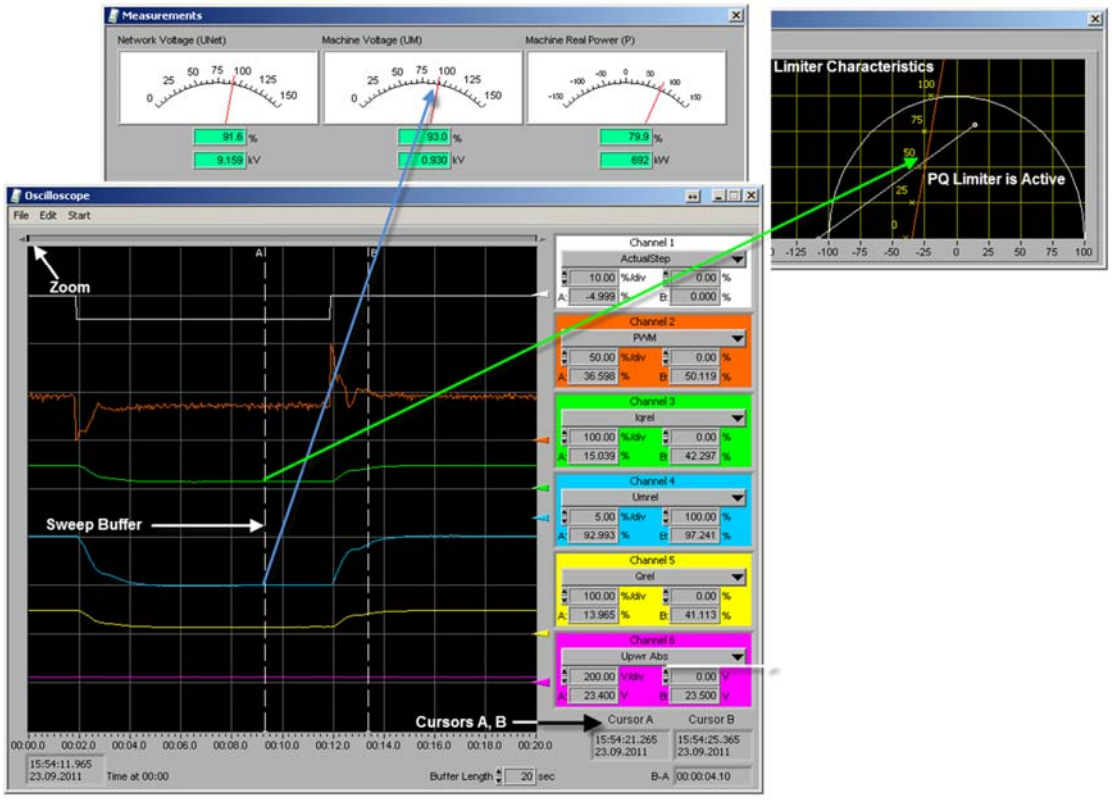


Figure 6-20 Evaluation of a waveform

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

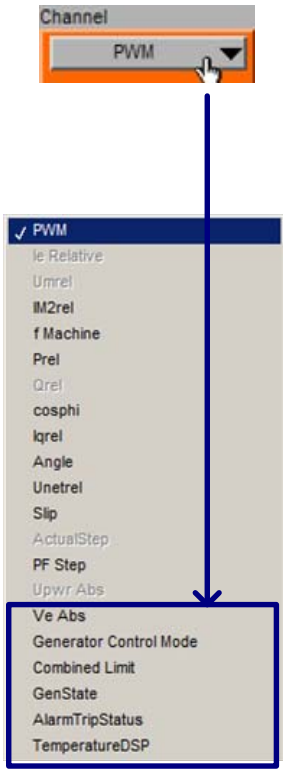
Start:	The recording of the waveform is started.
Freeze Waveform:	The recording is stopped.
File \ Save Waveform:	Save waveform.
File \ Save Setup:	Save oscilloscope settings.

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)

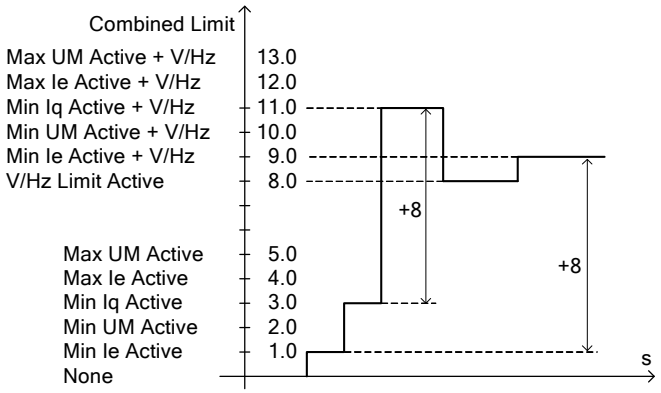
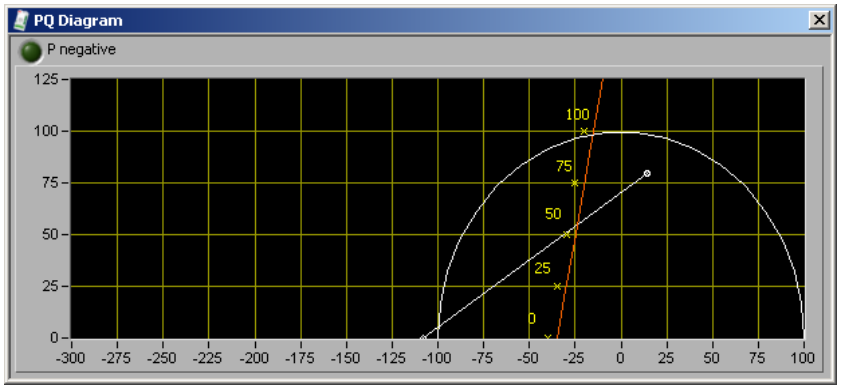


Figure 6-21 Example of Combined Limit Status

6.3.5.3.3 *PQ Diagram (Power Chart)*

Monitor \ PQ Diagram

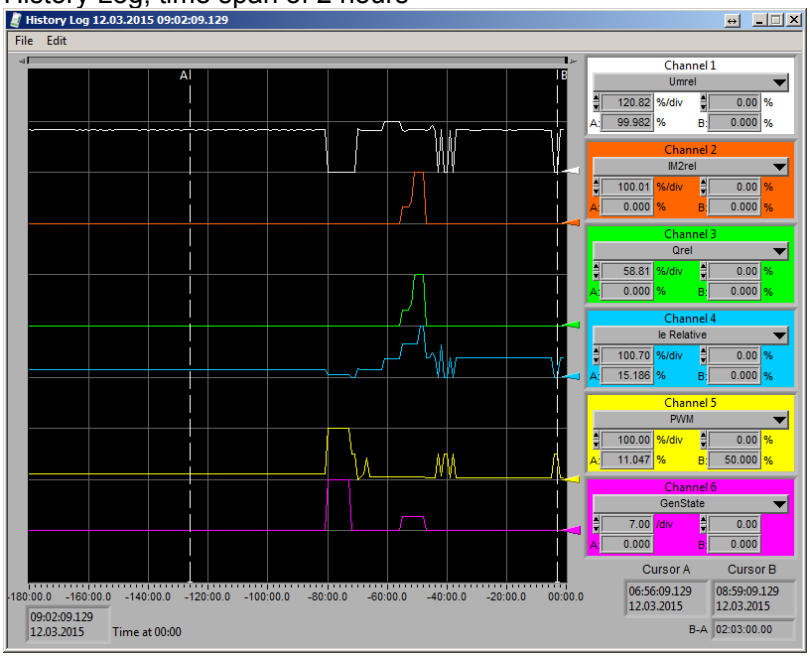


Note: The Limiter points can be moved with the cursor.

6.3.5.3.4 *History Logger*

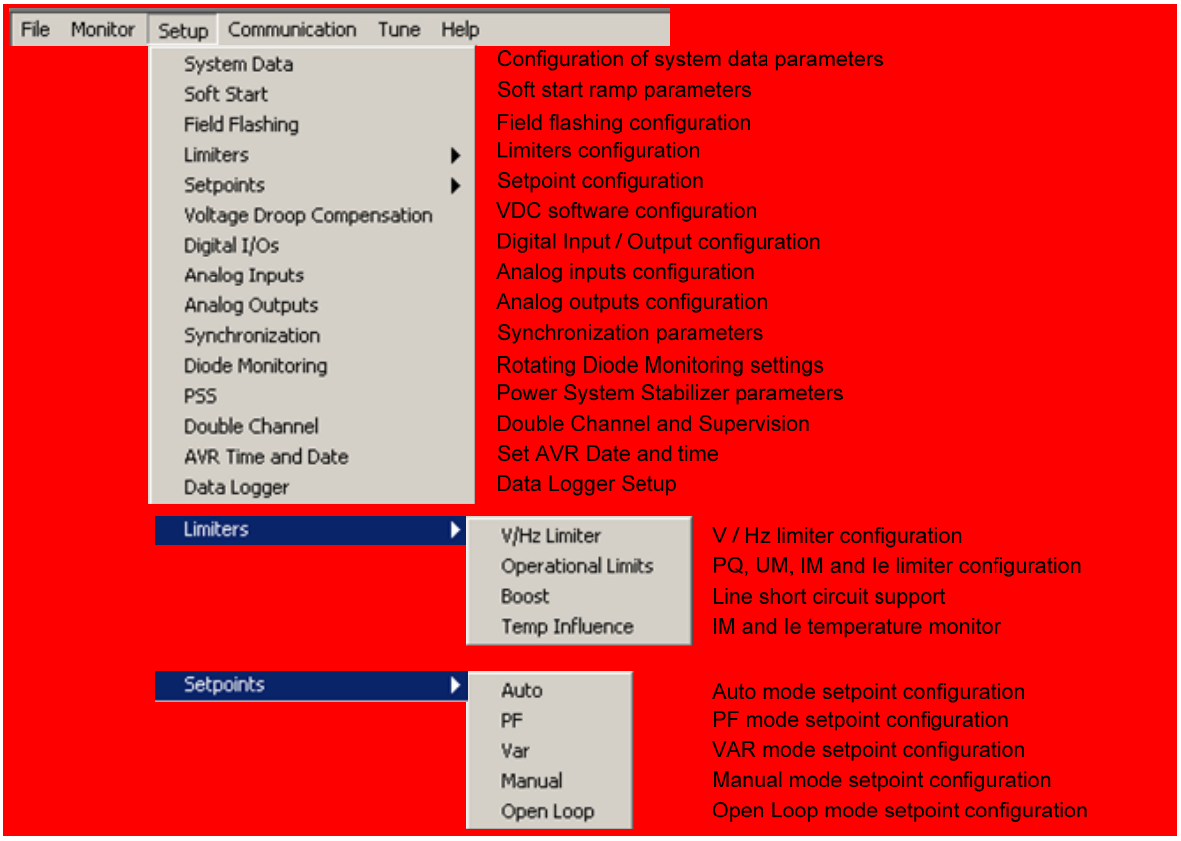
Will be displayed with similar window as a data log. For opening a saved history log on the PC, disconnect the UNITROL 1005 and select CMT1000 for UNITROL1020. No saved history log can be opened by selecting Menu Monitor/Datalog and pressing Open from disc.

History Log, time span of 2 hours



Note:
Cursor B shows Excitation OFF status. All measurement forced to 0 expect PWM which is forced ot 50%

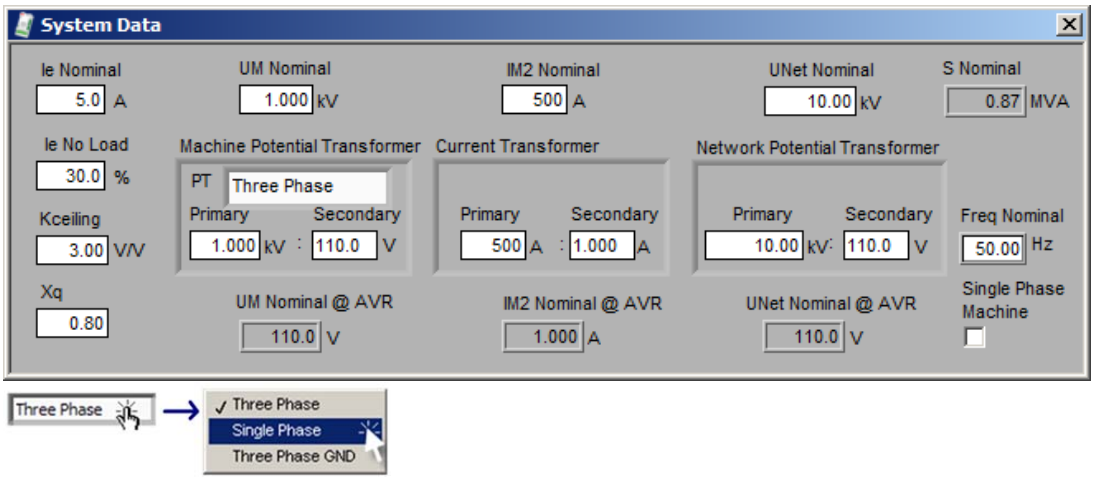
6.3.5.4 Setup Menu



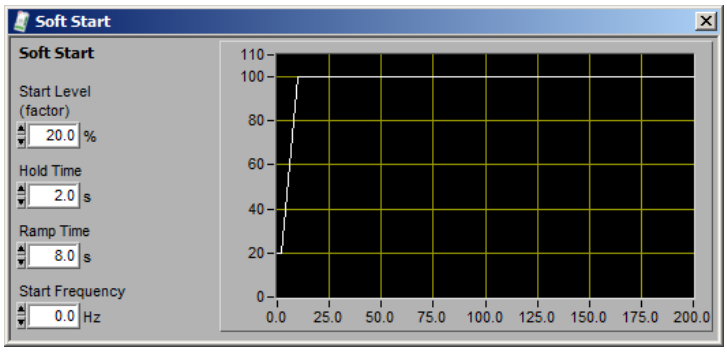
Note: Some menu items may not be accessible when the CMT1000 has Monitor or Control Access and/or the AVR has optional software which is not available. All menu items are accessible when the CMT is Offline.

6.3.5.4.1 *Operational parameters*

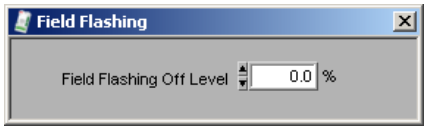
Adjust System Data
Setup \ System Data



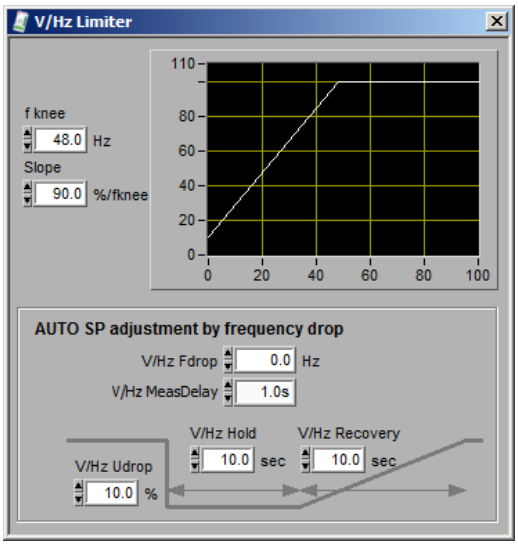
Configure Soft Start
Setup \ Soft Start



Adjust Field Flashing
Setup \ Field Flashing

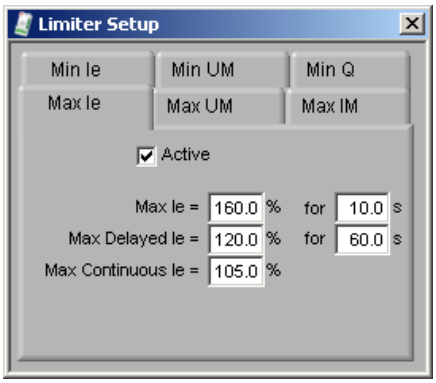


Adjust V/Hz Limiter
Setup \ Limiters \ V/Hz Limiter

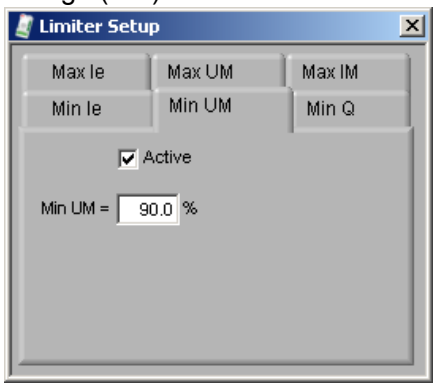


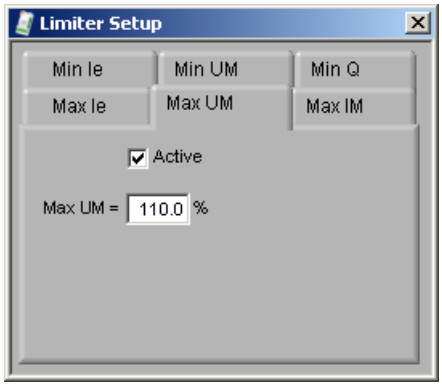
Operational Limits. Adjust Ie, UM, PQ and IM Limiter
Setup \ Limiters \ Operational Limits

Excitation current (Ie) limiter

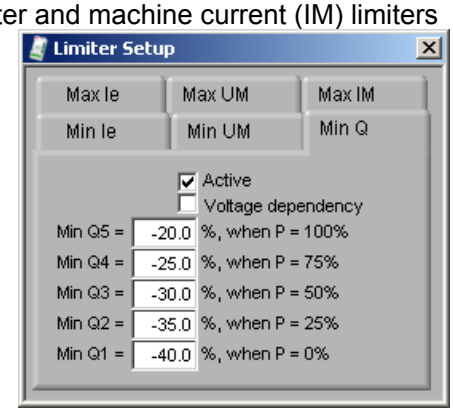


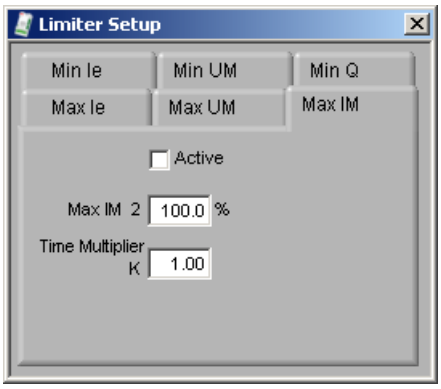
Machine voltage (UM) limiter





PQ limiter and machine current (IM) limiters



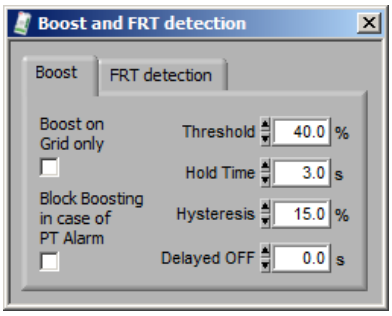


Adjust Short Circuit Support

Setup \ Limiters \ Boost

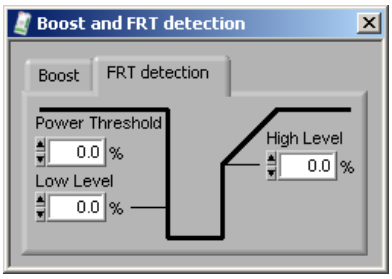
Boost

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

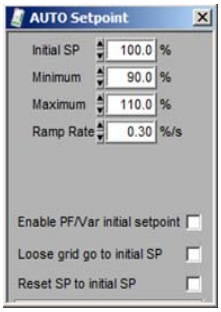


Adjust Setpoint Range

Initial SP refers to the Initial setpoint of the operation mode.

Setup \ Setpoints \ Auto

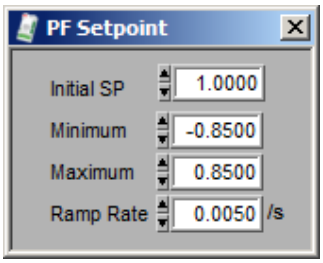
The Initial Setpoint (SP) of Auto mode is the final value of the Soft Start ramp. For more information refer to Chapter *3.4.2.1 Soft Start*.

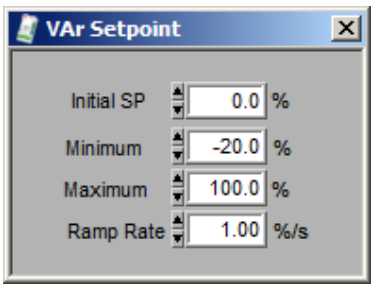


False (default)
True

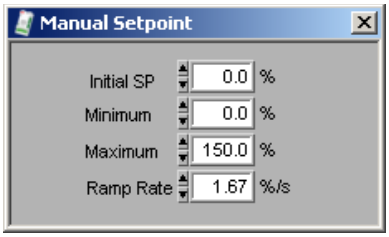
Setup \ Setpoints \ PF

Setup \ Setpoints \ Var

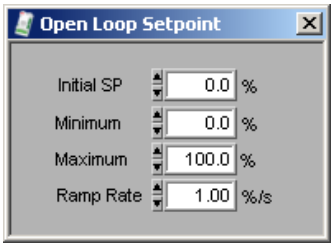




Setup \ Setpoints \ Manual



Setup \ Setpoints \ Open Loop



6.3.5.4.2 ***IO configuration***

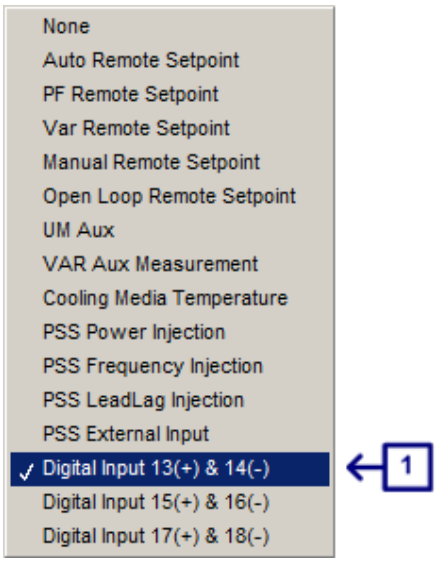
Configure Digital I/O
Setup \ Digital I/Os

Remark : DIO1 to DIO4 can only be configured as outputs
DIO5 to DIO8 can only be configured as inputs
DI17 to DI18, can be used as constants only

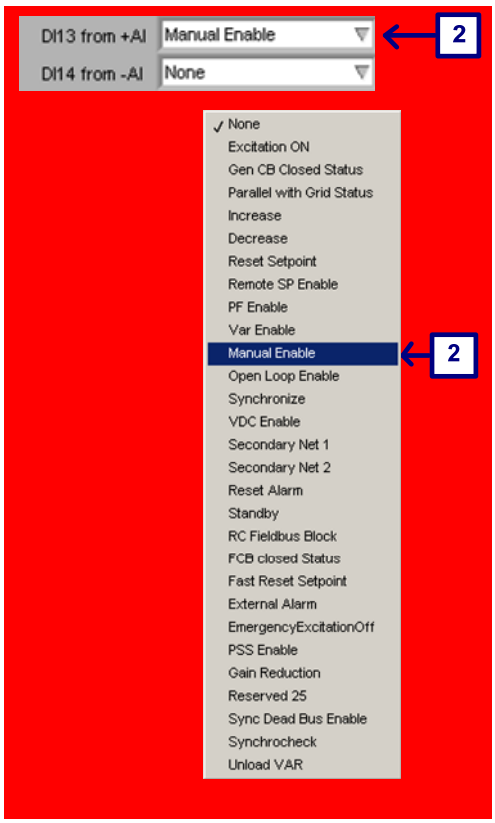
Example of configuration of the input signals with the CMT1000 software tool

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

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



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



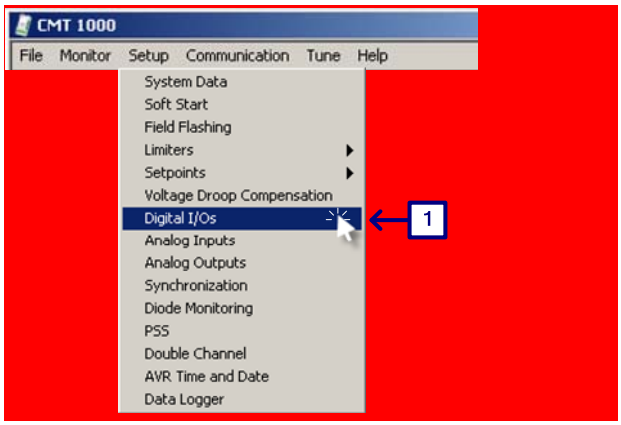
When using AI pins for DI signals, both inputs should not simultaneously be active.

Example of parameter setting using CMT1000

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

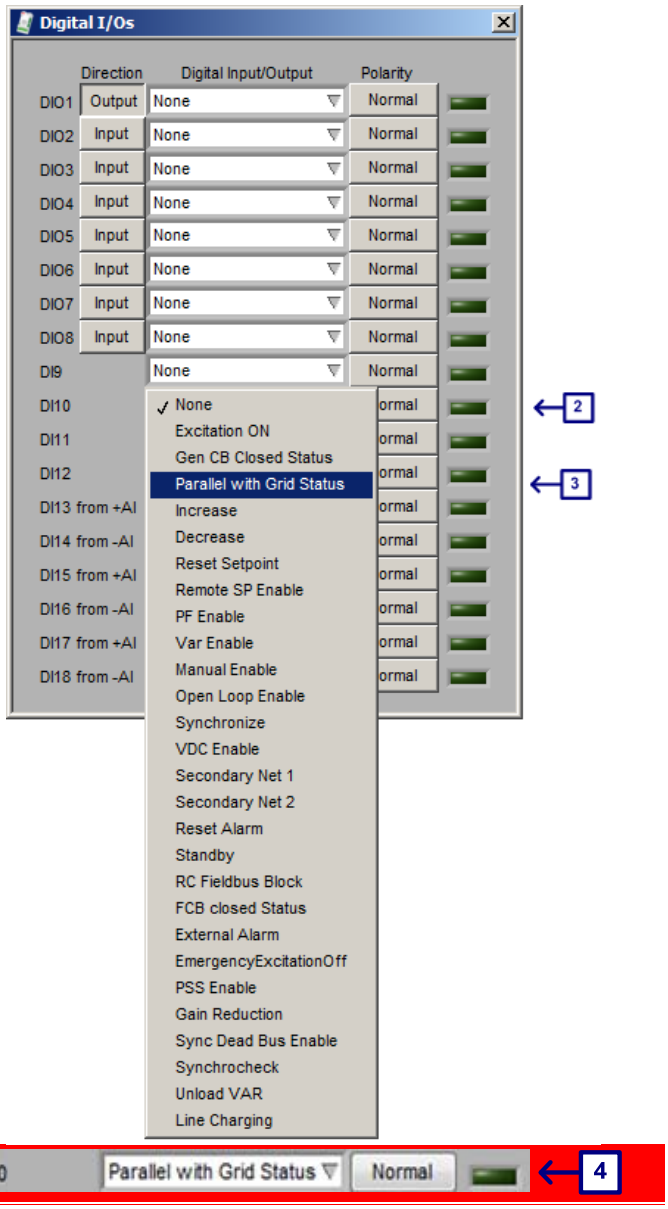
Menu bar CMT1000, start menu

1. Select setup and then Digital I/Os



2. Open input DI10 by clicking in the white field.

3. Select input *Parallel with Grid Status*

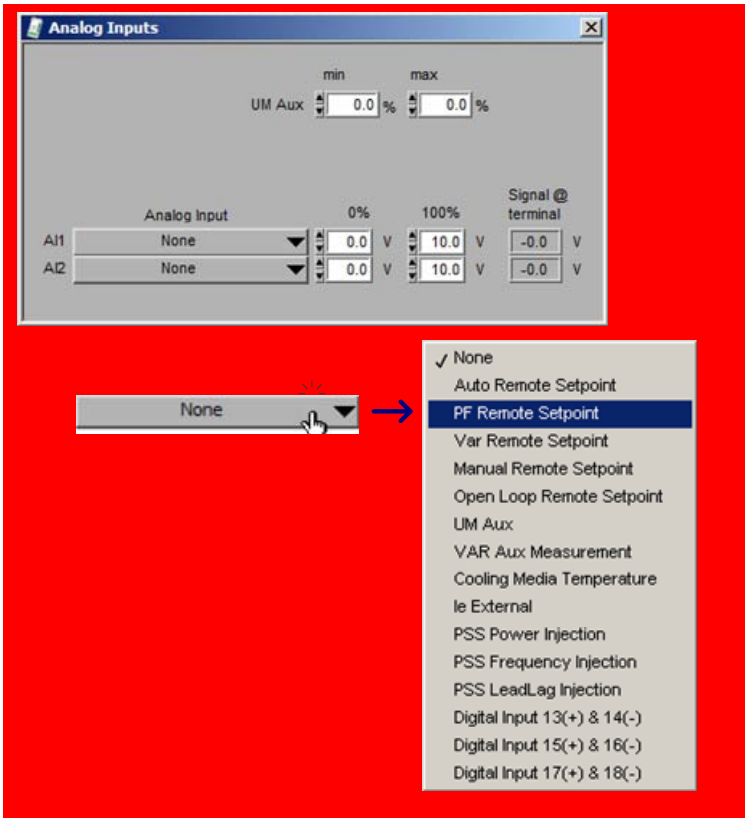


4. Result: DI10 configured

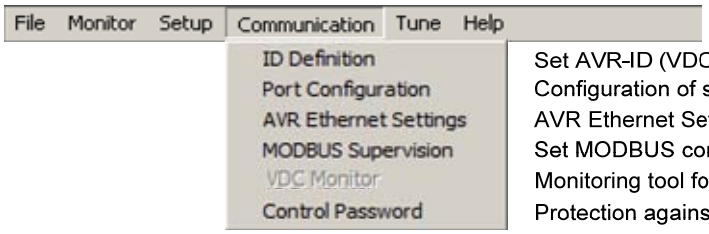
The procedure above only changes the parameters in the volatile memory.
To make the modification permanent (even after restarting the AVR), all the parameters have to be stored in the non-volatile EEPROM.

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

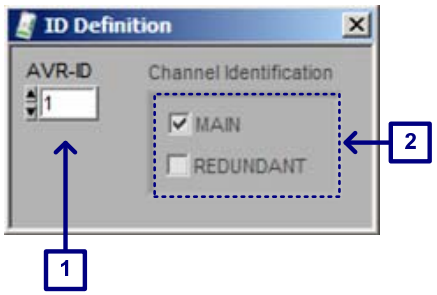


6.3.6 *Communication Menu*



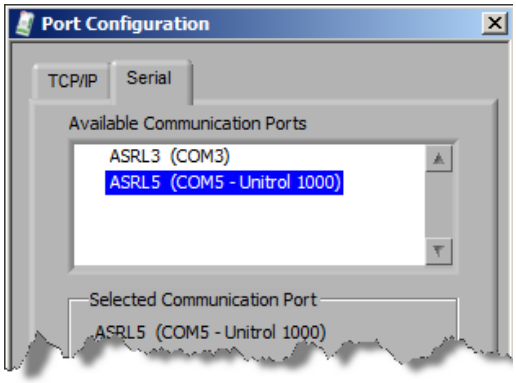
Set AVR-ID (VDC) and the Channel Identification (DCH
Configuration of serial COM port or TCP/IP address
AVR Ethernet Settings
Set MODBUS configuration for Remote Access
Monitoring tool for VDC
Protection against changing parameters

ID Definition
For easy identification, the ID number is shown in the CMT 1000 main window

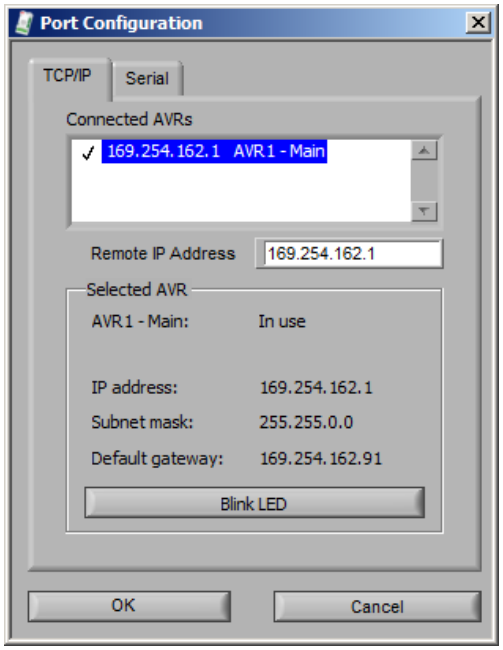


Port configuration
Communication \ Port configuration \ Serial

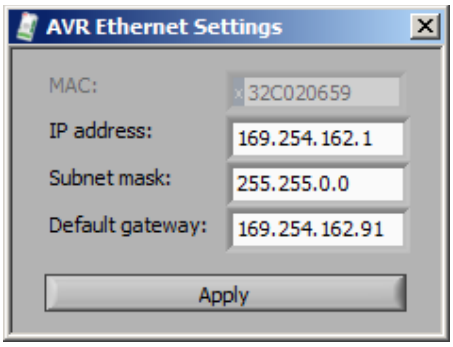
Configures the connection interface with the AVR. For more information refer to Chapter *6.3.4.1 Configuring the Port Interface.*



Communication \ Port configuration\TCP/IP



AVR Ethernet Settings

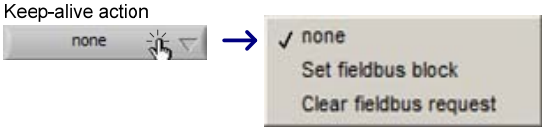


MODBUS configuration

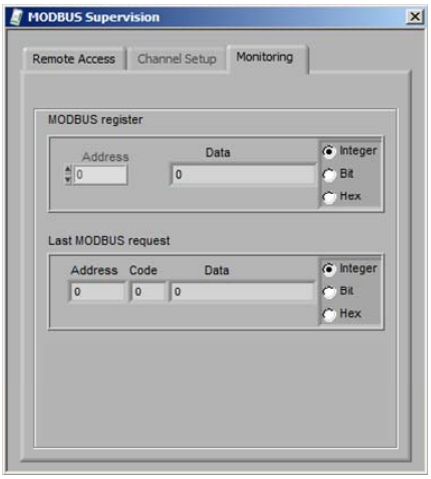
Communication \ MODBUS Supervision \ Remote Access

For configuration refer to Chapter *3.4.5 Modbus for Remote Access.*

Keep-alive action



Communication \ MODBUS Supervision \ Monitoring



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

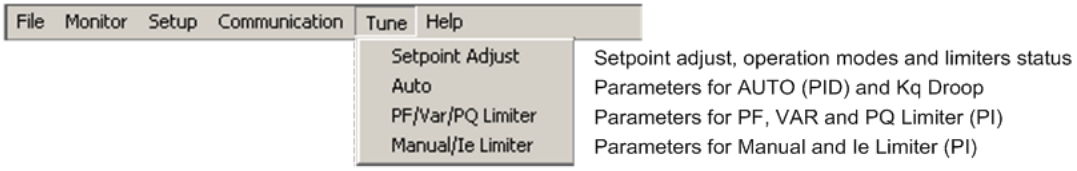
0000	No password is active / default
4783	Default password, will work independently of any setting

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.

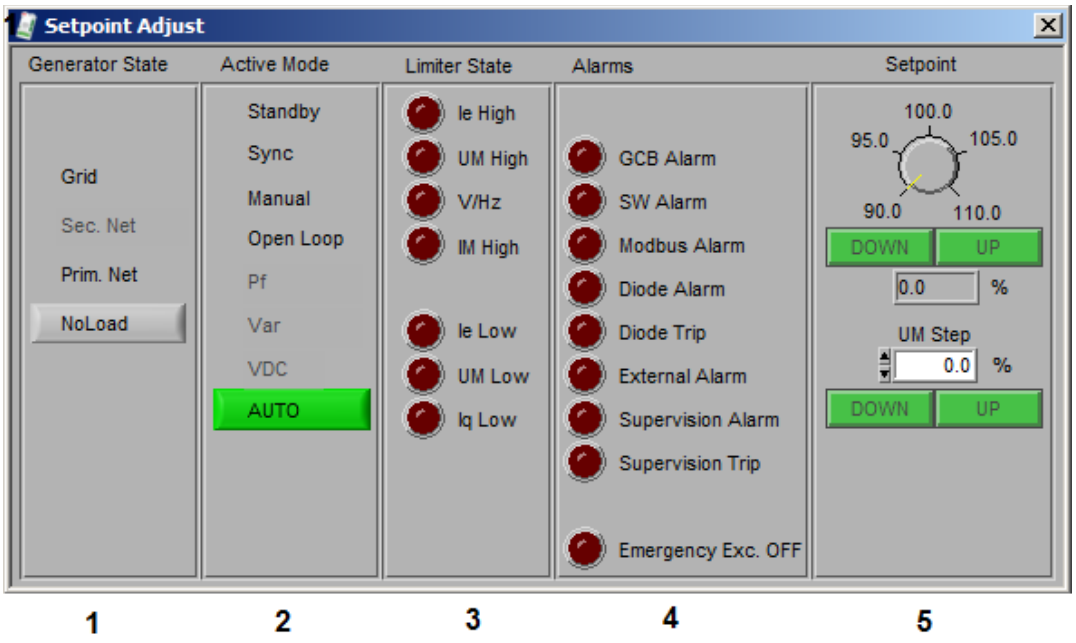
When CMT runs in CONTROL mode password can be set

6.3.7 *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 alarm statuses.

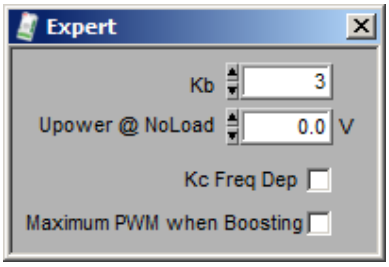


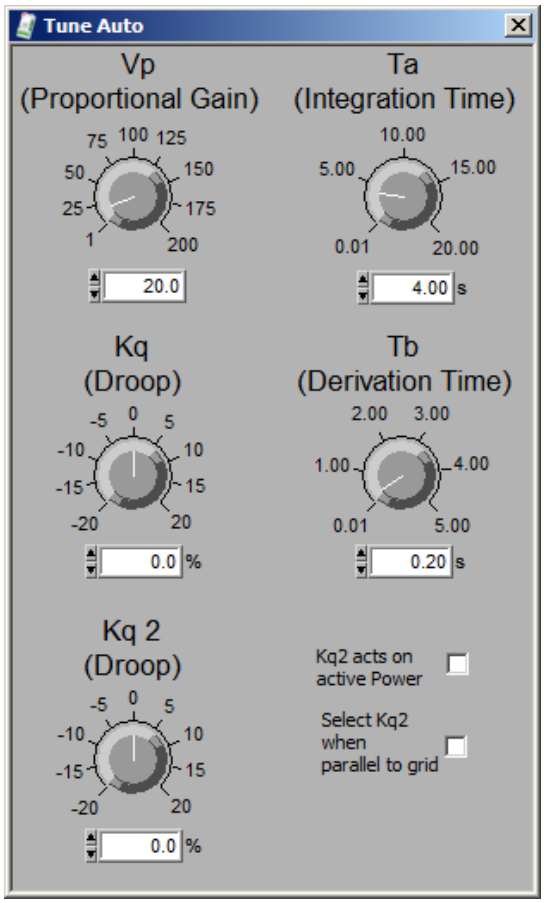
1. Displays the generator state condition, according to the Gen CB Closed and Parallel with the Grid status signals. Prim. Net and Sec. Net are used during VDC operation mode.
2. Displays the actual operating mode of the AVR. Some modes may be shaded (disabled) if an optional feature is not available 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 configuration of parameters of the PID regulator used during AUTO mode and the Kq Droop.

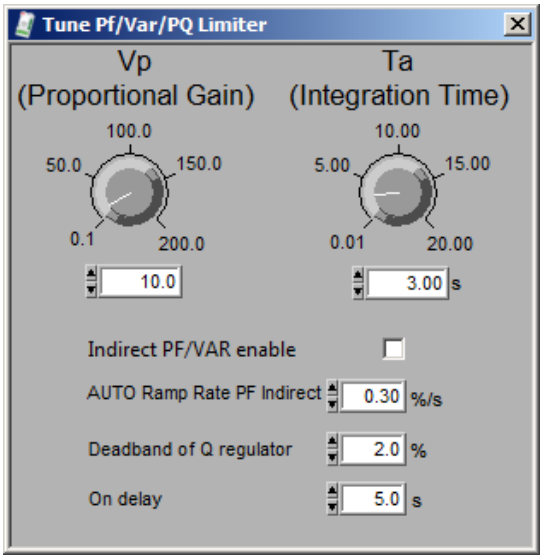
Expert Tuning:
In order to open the window, click Control+Shift+F9 when the Tune Auto window is active





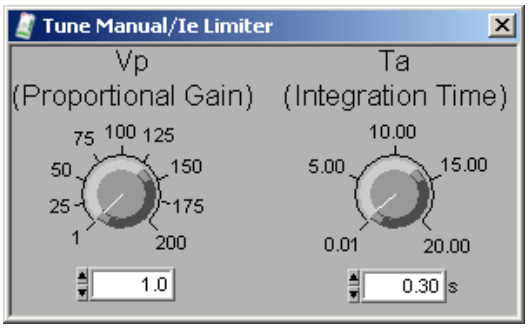
Regulator Parameters PF/VAR/PQ Limiter
Tune \ PF/VAR/PQ Limiter

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.



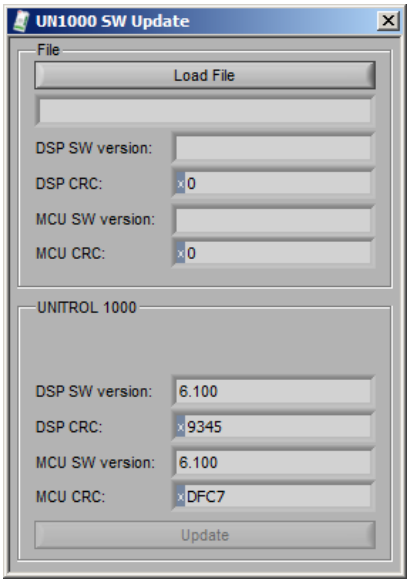
6.3.8 *Help Menu*

Help \ Firmware update

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

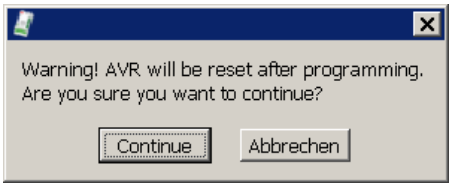
Newest version as of release date of this manual:

ZAB_Release6.100.abb

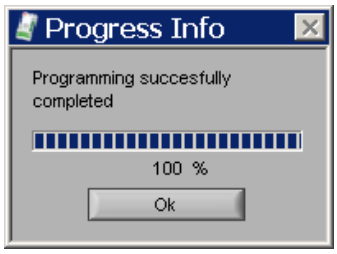


Then click *Update*. It is possible to update the Target SW from USB or Ethernet (faster).

In the following pop-up click *Continue:*



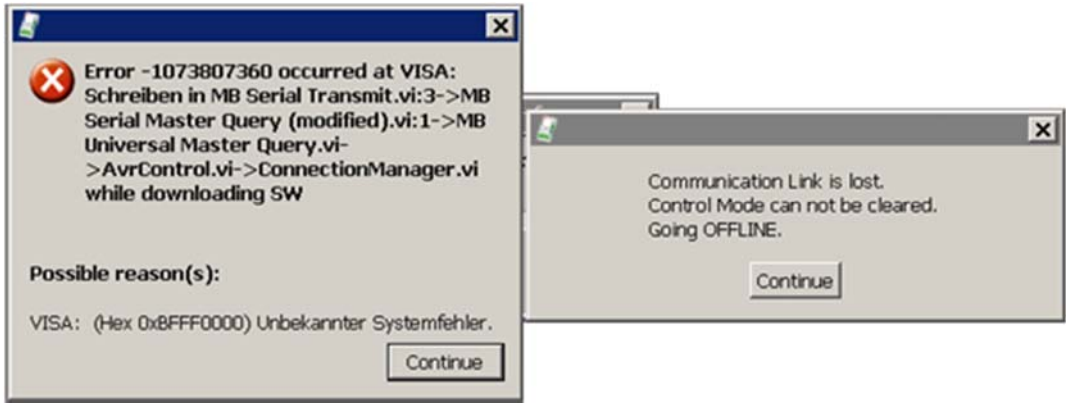
The update process is started and will take around three minutes.



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

Click *Ok*.

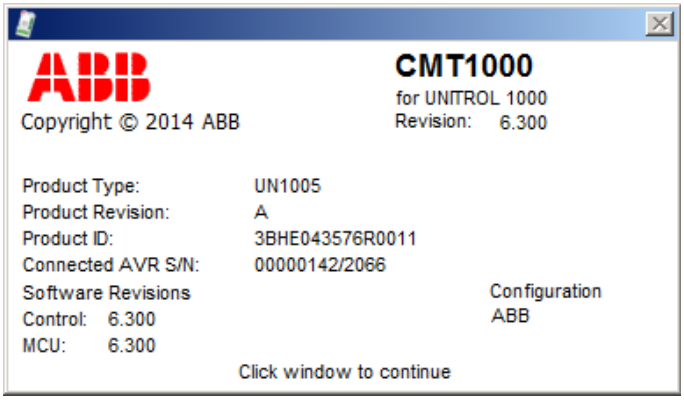
If the programming completed successfully, disconnect the USB cable and power cycle the device.
Connect the CMT1000 to the device and double-check the loaded target software version against the CMT1000.
In all other cases, the download has failed.



Proceed with following instructions.

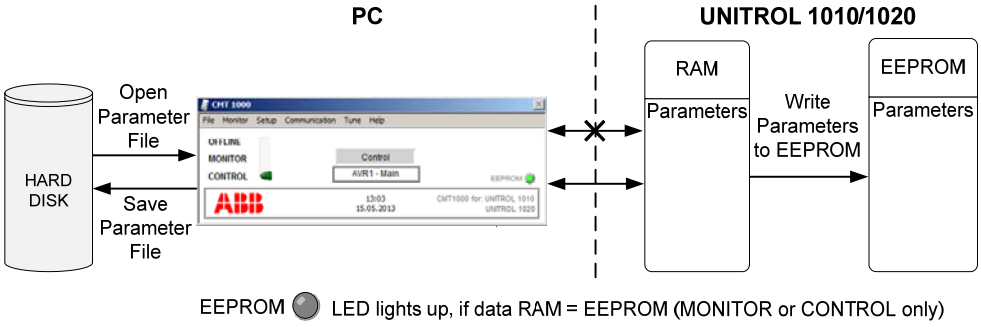
1. Close all the pop-ups by clicking *Continue*
2. Disconnect the USB cable, after 5 seconds connect it again.
3. Go into CONTROL mode
4. Repeat the download

Help \ About CMT1000...



Shows SW and HW Revision and HW serial number

6.3.9 *Save Parameter File*



6.3.9.1 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).

6.3.9.2 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.

Switch to MONITOR or CONTROL and the CMT1000 reads data from the RAM again.

6.4 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 1005 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 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
Excitation with compounding and boost circuit: 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*
6.xxx	CMT1000 Release 6.xxx

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

9.1 General

9.1.1 Ordering Information

Material description	Order code
UNITROL 1005-0011 ECO	3BHE043576R0011
UNITROL 1005-0012 LIGHT	3BHE043576R0012

9.1.2 Electrical Data of AVR UNITROL 1005:

Power Supply Input (AC/DC)	
AC Nominal voltage (sinusoidal)	16...250 V ac
AC voltage (max, sinusoidal)	300 V ac
Frequency	40…600 Hz
DC nominal voltage	18...300 V dc
Max. DC voltage	420 V dc
Max. peak voltage (none sinusoidal)	420V peak
Test voltage for 1 min	2.8 kV dc
Max power consumption (only internal electronic circuits)	7 W
Max Crowbar firing current for 10ms	100 A rms
Power Supply Input (Startup)	
Single phase voltage	6.0 V ac
DC voltage	10.0 V dc
Excitation Output	
Continuous current at 55°C	8 A
Continuous current at 70°C	5 A
Maximum current for 10 sec	16 A
IGBT & Free Wheeling Diode	
Max. forward voltage of integrated free wheeling diode (25°C, I_F = 8A)	2.6 V
Max. reverse voltage of free wheeling diode	600 V
Voltage Regulation	
Accuracy @ 25°C	0.2 %
Reaction time	2 ms
PWM limitation	0.5 ..99 %

Exciter Current Measurement	
Full range	0...25 A dc
Accuracy after digital filter	< ±1%
Resolution of sensor	20 mA
Machine Voltage Measurement	
Nominal voltage (max)	3 x 500 V ac
Full range voltage, (phase to phase)	700 V ac
Input impedance	6.0 MOhm
Test voltage for 1 min.	2.8 kV dc
Accuracy [3 (-40 to 70 °C / 25 °C)	±1% / 0.1%
Network Voltage Measurement	
Nominal voltage (max)	1 x 500 V ac
Full range voltage, (phase to phase)	700 V ac
Input impedance	6.0 MOhm
Test voltage for 1 min.	2.8 kV dc
Accuracy [3 (-40 to 70 °C / 25 °C)	±1% / 0.1%
Machine Current Measurement	
Nominal current	1 / 5 A
Full range current	2.8 / 13.4 A ac
Maximum current for 10 s (1A)	4 A rms
Maximum current for 1 s (1A)	8 A rms
Maximum current for 10 s (5A)	22 A rms
Maximum current for 1 s (5A)	38 A rms
Accuracy	< ±1 %
Resolution	< 0.1%

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.									
55°C	24	16	14	12	11	10	9	8	A
60°C	21	14	12	11	10	9	8	7	A
65°C	18	12	11	10	9	8	7	6	A
70°C	16	10	9	8	7	6	5.5	5	A

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

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

Analog Input

Full range peak voltage	±10 V
Input impedance	1100 kOhm
Common mode range	±15 V
Accuracy	< ±1%
Resolution	10 mV

Digital Inputs

Number of inputs	8
Input impedance to GND	2.2 kΩ
GND reference	PE
Input voltage range	0 ..28 V
Digital input thresholds (high / low)	13 V / 5 V

Digital Outputs, isolated

No. isolated outputs	2
Voltage range of 24V output	21 ..25 V
Maximum output current 24V output	50 mA

Digital Outputs, non-isolated

No. outputs	2
Voltage range of 24V output	21 ..25 V
Maximum output current 24V output	500 mA

24V output for contacts

Max. 24V-driver current (to GND)	50 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

USB Service Interface

Data rate	12 MBit/s
Max. cable length	3m
USB Version	1.0, 2.0, 3.0

9.1.3 *Environmental data of AVR UNITROL 1005:*

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

UL-Certification

UL 508, user group	
File number	E251846

DNV Certification

Housing

Protection class of housing	IP20
Pollution degree	3
Dimension, L x W	230 x 260 mm
Height	85 mm
Weight	1.5 kg

9.1.4 *UL Certification*

To use UNITROL 1005 in a UL compliant way, the following must be considered:

Max. surrounding air temperature	*70 °C*
UNITROL 1005 max output capability at 70 °C	*5 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 1005*

MTBF (MIL-HDBK-217F)	GB(40°)	32.4 years
Failure rate in time	GB(40°)	???? FIT
Operational life time of capacitors		> 150’000 h
Average ambient temperature		*40 °C*
Input power		*3 phases*
Exciter current (without external cap)		*8 A*

9.1.6 *Mechanical data*

9.2 Settings Record for UNITROL 1005

Name and Address of Customer:	
Plant:	
Order No.:	
Plant Schematic No.:	

Device Identification:		
Type Plate:		
Delivery Date:		
Software Revision:	Control:	
	CMT1000:	

Remarks:

Place and Date of Commissioning:	
Name:	Company:

9.3 Parameter Settings, Default Values

Parameter list with minimum, maximum and default setting are documented in Modbus Reference Manual 3BHS358281 E80

Chapter 10 - Appendix

10.1 Documentation References

This User Manual is available in the following languages:

1.	UNITROL 1005 User Manual	3BHS581681 E81
2.	UNITROL 1005 Benutzerhandbuch	3BHS581681 D81
3.	UNITROL 1005 Manuel d'Utilisation	3BHS581681 F81
4.	UNITROL 1005 Manual de Usuario	3BHS581681 S81
5.	UNITROL 1000 Modbus Reference Manual	3BHS358281 E80

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