



DC Power Supply TopCon Series

Model TC.P

Operating Manual V4.20

Rev. 02

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Technical changes reserved

Dear customer

The installation and commissioning of TopCon power supplies has to be done by trained, expert personnel. Please take enough time to read this operating manual carefully. The following chapters contain important information about commissioning and should therefore be read first:

- 1 General and safety-relevant information
- 3 Tips on mounting, installing and commissioning
- 4 Description of the electrical connections

We nevertheless suggest that you also read the information in the following chapters on the control software of the power supply before proceeding with commissioning, as further adjustments might be necessary at that time.

By observing all the hints you will save a considerable amount of time and possibly avoid the need to call for questions during commissioning. The knowledge of this manual is also important in order to avoid damage to the unit itself and/or the loads connected to it and other parts of the plant that could derive from incorrect operation. The high operational voltages of the device and possible arcs in the respective applications further cause danger to persons and animals!

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Note

Putting a plant or machine with built-in TopCon power supply units into operation in countries of the European Union (EU) requires the plant or machine to comply with the following directives:

LVD 73/23/EEC Low voltage directive
EMC 89/336/EEC EMC norm

TopCon power supply units are fixed-mount appliances intended for permanent connection to the mains supply line. They must be mounted and installed exclusively by trained, expert personnel. The installation must comply with the norms and directives valid for the specific case.

TopCon power supply units are designed to be mounted, cabled and trouble-shooted according to the applicable directives with minimum effort. For this reason it is important to follow the norms and directives and to consider all the installation and cabling hints in this operating manual.

Annotation

The validity range of the machine directives (MDs) does not cover electrical power supplies, as these fall under the low voltage directives (LVDs), which cover the relevant basic requirements of the machine directives (see article 1, paragraphs 4 and 5).

As far as the MDs are concerned, power supplies are not machines, but electrical components to be built into machines. Their commissioning as part of a machine is therefore prohibited until the requirements of the MDs are met by or after the integration in the end product.

1. General	1
1.1 TopCon power supply	1
1.2 Document conventions	1
1.3 Safety notes	2
1.4 Regulations and prescriptions	2
2. Technical data	3
2.1 Construction	3
2.2 Mains connection	4
2.3 Output	4
2.4 Control	5
2.5 Protection functions	6
2.6 Environmental conditions	6
2.7 Analog and digital inputs and outputs	7
2.8 Serial interface	7
2.9 Mechanical properties	8
3. Installation and commissioning	9
3.1 Mounting instructions	9
3.1.1 General	9
3.1.2 Cabinet mounting	9
3.1.3 Shipment with cabinet	10
3.1.4 Cooling	10
3.1.5 Openings and minimal clearances	10
3.2 Electrical installation	11
3.2.1 General installation notes	11
3.2.2 Electromagnetic compatibility	12
3.2.3 Interference suppression	12
3.2.4 Radio interference suppression	12
3.3 Commissioning of the power supply	12
3.3.1 Before powering up for the first time	12
3.3.2 Device self test	13
3.3.3 Parameter setup	13
3.3.4 Function test	13
3.3.5 Optimization of control and monitoring functions	14
3.4 Safety notes	14
4. Electrical connections	15
4.1 System overview	15
4.1.1 Block diagram	15
4.1.2 Control connections	15
4.1.3 Isolation	16
4.2 Mains terminals	16
4.2.1 Multi-unit systems	16
4.3 Output terminals	17
4.3.1 Remote-error-sensing (X104)	17
4.3.2 Parallel or serial operation	18
4.4 Control interface (X105)	18
4.4.1 Device control	20

4.4.2	Analog programming of voltage and current	20
4.4.3	Power limiting and Ri-Simulation	21
4.4.4	Digital outputs (relais)	22
4.4.5	Interlock / Emergency shutdown	23
4.5	System communication (X101 / X102)	25
4.5.1	Cabling	25
4.5.2	Setting of the network ID's in a multi-unit system	26
4.6	Diagnosis and configuration connector RS-232 (X301)	27
4.7	Diagnosis and configuration connector RS-422 (X106)	28
4.7.1	Cabling	28
5.	Control	29
5.1	Device control	29
5.1.1	Module-Statemachine	30
5.1.2	System statemachine	31
5.1.3	States	32
5.1.4	State display	33
5.2	Error handling	34
5.2.1	Error display / error groups	34
5.2.2	Error group codes / warn codes	35
5.2.3	Detail error codes / warn codes	36
5.2.4	Warnings	40
5.3	Control	40
5.3.1	Structure of the regulator	40
5.4	Multi-unit master slave systems	41
5.4.1	Master / Slave configuration	42
5.4.2	ID-Selector	42
5.4.3	System control	42
5.4.4	Multi-unit operating modes	42
5.4.5	Configuration settings	43
6.	Servicing and diagnosis program TopControl	45
6.1	Installation	45
6.1.1	Installation of the TopControl Software	45
6.2	RS-232 connection with the TopCon power supply	46
6.3	Operation	46
7.	Control through RS-232 / RS-422	47
7.1	Control functions	47
7.1.1	Device control	47
7.1.2	State query	49
7.1.3	Error memory query	49
7.1.4	Set values	53
7.1.5	Actual values reading	54
7.1.6	Operating mode reading	54
7.2	Protocol	55
7.2.1	READ MEMORY WORD	56
7.2.2	WRITE MEMORY WORD	57
8.	Maintenance and troubleshooting	59
8.1	Periodic maintenance	59
8.1.1	General	59
8.1.2	Air filters	59
8.2	Fault diagnosis	59
8.3	Troubleshooting	60

8.3.1	Replacing a complete module	60
8.3.2	Replacing internal assemblies	60
8.3.3	Repairing internal assemblies	60
9.	<i>Human Machine Interface – optional integrated control unit HMI</i>	61
9.1	Short description of the Human Machine Interface	61
9.2	Technical Data on the Human Machine Interface	61
9.3	Operating the Human Machine Interface	61
9.3.1	Start screen	61
9.3.2	Main screen	62
9.3.3	System screen	63
9.3.4	Edit / Select mode	63
9.3.5	Main menu	64
9.3.6	Operating elements	68
9.4	Handling faults with the Human Machine Interface	70
9.4.1	Acknowledging warning and fault messages	70
9.4.2	Faults during initialization	70
9.4.3	Faults during operation	71
9.4.4	Warnings during operation	71

1. General

1.1 TopCon power supply

The full digitally controlled TopCon power supplies make it possible to design, install and commission industrial power supply systems in the 10 to several 100 kW power range in an easy, quick and reliable way.

TopCon power supply units are the heart of such modular power supply systems: they include all the necessary basic functions for standalone operation or for interconnected operation of multiple units with one or more loads.

Every TopCon unit is equipped with powerful microprocessors that take over all device control functions as well as extensive protection and monitoring functions. The fully digital control of output voltage, current and power provides high dynamics and long term stability.

The Windows-based operating and service software "TopControl" provides the user with a very easy way to configure the device and set its parameters.

1.2 Document conventions

Important notes are marked with the following symbols throughout this operating manual:



Notes and hints

Sections marked by this symbol give useful and important advice that must be followed when operating the devices.



Warnings

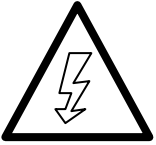
Non observance of these warnings might represent danger for health or life and can lead to damage or destruction of the devices and/or other objects.



Not allowed

Incorrect manipulation could lead to device damage.

1.3 Safety notes



Due to high operating voltages of up to 460 V and to output voltages of up to 1000 V, an industrial power supply can endanger the life of persons.

In order to avoid severe body injuries or serious damage to things, only qualified personnel accustomed to working with industrial power supplies is allowed to work with the devices. These persons must read the operating manual carefully before starting with the installation and commissioning and follow all the safety directives.

Electronic devices are basically not fail-safe. The user is therefore responsible for making sure that all loads and supplies connected are brought to a safe state in case of a failure of the device.

1.4 Regulations and prescriptions

Electrical installations must be done according to the mounting and installation directions. The following is valid in particular in the countries of the European Union:

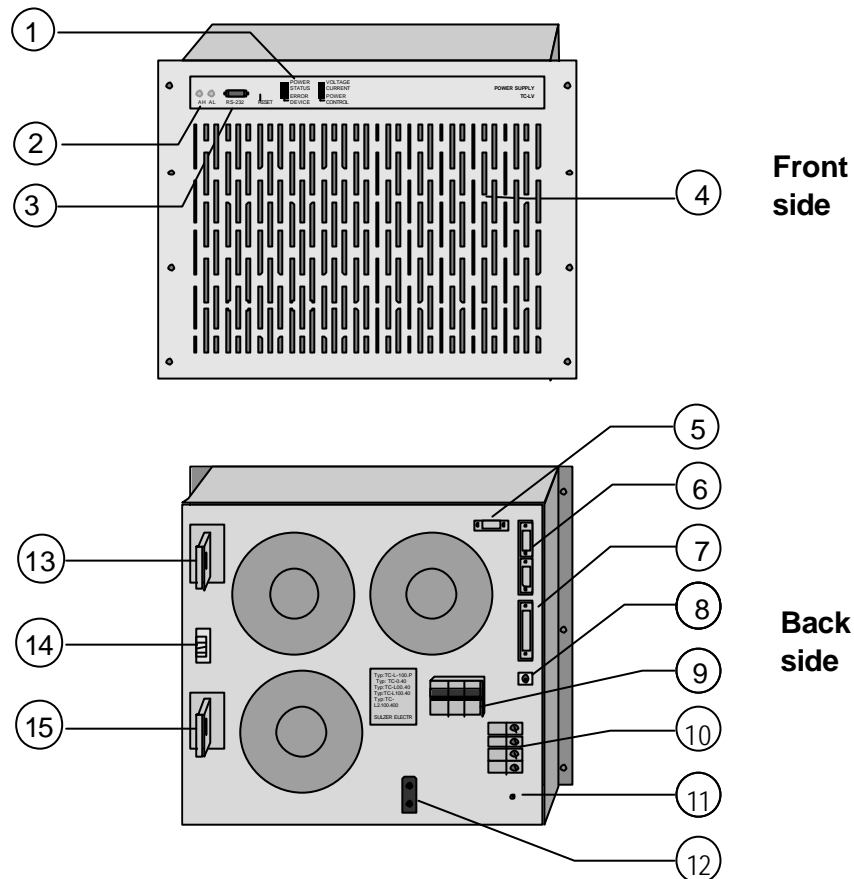
EN50178 Fitting high current systems with electronic equipment.



If the power supply is to be put into operation in a special application domain, the specific norms and accident prevention directives must be followed.

2. Technical data

2.1 Construction



Key:

- 1 Operating state display
- 2 ID-Selector for network ID setting
- 3 RS-232 interface
- 4 Cooling air intake
- 5 RS-422 interface
- 6 Interface for system internal communication
- 7 Analog and digital inputs and outputs, Interlock
- 8 Circuit breaker - control current circuits
- 9 Main breaker (now placed on front panel)
- 10 Mains line terminals (3 LPE)
- 11 Earth connection bolt
- 12 Strain-relief for cable
- 13 Output terminal (positive)
- 14 Sense terminal
- 15 Output terminal (negative)

2.2 Mains connection

Device type	TC.P.10	TC.P.16	TC.P.20	TC.P.32
Connection type	3 LPE (without neutral)			
Mains voltage (3-ph., phase-phase)	360 V _{eff} – 440 V _{eff}			
Mains frequency	48 – 62 Hz			
Maximal allowed non-symmetry	< 3%			
Power rating	14 kVA	23 kVA	28 kVA	46 kVA
Current absorption ^{1, 2} (3-phase) Model 400 VAC	20 A _{eff}	35 A _{eff}	44 A _{eff}	71 A _{eff}
Power-up transient current ²	< 15 A		< 25 A	
Nominal current main breaker ³	25 A	32 A	63 A	80 A
Breaking capacity main breaker ³	10 kA			
cos phi	> 0.97			
Harmonics content	< 0.65			
Efficiency ¹ approx.	90 %	91 %	92 %	93 %
Dissipated power ¹ approx.	1100 W	1400 W	1900 W	2200 W

¹ For nominal output voltage and nominal output current

² For nominal mains voltage

³ built-in main breaker

2.3 Output

Device type	TC.P.10	TC.P.16	TC.P.20	TC.P.32
Output power	10 kW	16 kW	20 kW	32 kW
Output voltage control range ¹	0 – 100 %			
Output current control range ¹	0 – 100 %			
Output voltage and current	see separate technical datasheet			
Output ripple and noise	see separate technical datasheet			
Isolation from mains and earth	1000 V, 10 MOhm			

¹ Referred to nominal values, with ohmic load

2.4 Control

Remote programming	
Analogue programming voltage setpoint current setpoint power limit internal resistance	input impedance 20 kOhm 0 – 10 VDC for 0 – 100% Vnom 0 – 10 VDC for 0 – 100% I _{max} 0 – 10 VDC for 100 – 0% P _{nom} 0 – 10 VDC for 0 – 1000 mOhm ⁵
Digital programming	RS-232/422, HMI, TC.RCU
Isolation from mains	2500 VAC
Accuracy	
Resolution of measured values ² analog inputs and outputs voltage actual value current actual value temperature	0.1 % (10 Bit) 0.025 % (12 Bit) 0.025 % (12 Bit) 0.2 °C
Cycle timings	
Power-up time control circuitry ³ power circuitry ⁴	5 s 0.1 s
Cycle timings power circuits voltage and current controller power controller protection and monitoring state machine system communication	25 us 50 us 50 us 50 us 1 ms 1 ms / 300 us

¹ referred to nominal values

² absolute value or referred to nominal values

³ after turning on the voltage supply

⁴ after enabling the power circuits

⁵ range optionally extendable to 0 .. 32000mOhm

2.5 Protection functions

Overvoltage protection Operation as current source In case of failure: settable threshold range ¹ settable reaction time	voltage limiting electronic block 0 – 110 % 50us – 1600 ms
Overcurrent protection Operation as voltage source In case of failure: settable threshold range ² settable reaction time	constant current electronic block 0 – 110 % 50us – 1600 ms
Internal monitoring functions mains voltage power circuits control measuring unit multi unit operation	

¹ referred to nominal voltage

² referred to maximal current

2.6 Environmental conditions

Ambient temperature storage temperature cooling air during operation	-25 – 70 °C 5 – 40 °C
Cooling type	forced cooling, temperature controlled
Relative air humidity	15 – 85 %, non condensing
Altitude operation at nominal power operation at reduced power	0 – 1000 m.a.s.l. max. 2000 m.a.s.l.
Type of protection (IEC529) basic construction with cabinet	IP 20 IP 43
Usage category protection class overvoltage category contamination level	I IV 3 (4 ¹)
Vibration (IEC 68-2-6)	2 g

¹ With air filter

2.7 Analog and digital inputs and outputs

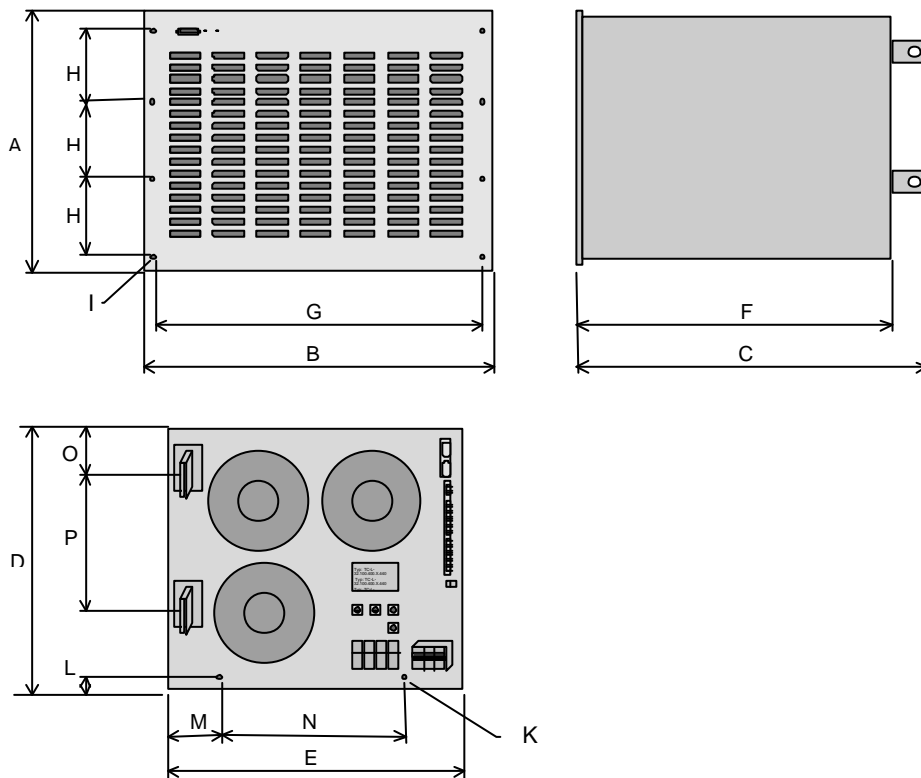
Analog inputs		4, configurable, single ended
Input voltage range	0 – 10 VDC	
Input impedance	20 kOhm	
Reference ground	common to all analog inputs	
Isolation from control and earth	125 V	
Analog outputs		2, configurable, single ended
Output voltage range	0 – 10 VDC	
External termination impedance	min. 1 kOhm	
Reference ground	common with analog inputs	
Isolation from control and earth	125 V	
Reference output		1
Output voltage	10 VDC	
Output current	max. 15 mA	
Reference ground	common with 24 VDC control voltage	
Digital inputs		3, configurable
Input voltage not active	0 – 1 V	
Input voltage active	10 – 28 V	
Input impedance	4.7 kOhm	
Isolation from control and earth	125 V	
Digital outputs		3, configurable
Relais contacts	potential free, closing	
Max. switching voltage	250 VAC, 50 VDC	
Max. current	2 A	
Isolation from control and earth	125 V	

2.8 Serial interface

RS-232		standard
Electrical level	RS-232 / V.24	
Baud rate	9600 baud	
Stop bit	1	
Parity check	none	
Isolation from control and earth	125 V	
Connector	D-Sub, 9-pole, female, on front-side	
RS-422		optional
Electrical level	RS-422	
Baud rate	9600 baud	
Stop bit	1	
Parity check	none	
Reference ground	common with RS-232	
Isolation from control and earth	125 V	
Connector	D-Sub, 9-pole, male, on rear-side	

2.9 Mechanical properties

Device type		TC.P.10	TC.P.16	TC.P.20	TC.P.32
Weight		42 kg	44 kg	64 kg	68 kg
Dimensions					
Height	front panel	A	269	399	
	housing	D	265	394	
Width	overall	B	482	482	
	without front panel	E	440	440	
Depth	overall	C	490	580	
	without terminals	F	440	525	
Front panel fixing					
	horizontal distance	G	466.2	466.2	
	vertical distance	H	190.6	120.6	
	holes	I	7 x 10.5	7 x 10.5	
Earth connection bolt					
	outside thread	K	M5	M6	
Strain-relief for cable					
	horizontal distance	N	255	255	
Output terminals					
	distance from top	O	40	40	
	distance between	P	180	220	
	horizontal distance	M	40	40	



3. Installation and commissioning

TopCon power supply units are fixed-mount appliances intended for permanent connection to the mains supply line. They must be mounted and installed exclusively by trained, expert personnel. The installation must comply with the norms and directives valid for the specific case.

Putting a plant or machine with built-in TopCon units into operation in countries of the European Union (EU) requires the plant or machine to comply with the following directives:

LVD 73/23/EEC Low voltage directive
EMC 89/336/EEC EMC norm

TopCon power supply units are designed to be mounted, cabled and trouble-shooted according to the applicable directives with minimum effort. Nevertheless, the responsibility for the compliance of plants and machines with TopCon units built in remains with the manufacturer of the plant or machine.



If the power supply is to be put into operation in a special application domain, the specific norms and accident prevention directives must be followed.

3.1 Mounting instructions

These mounting instructions apply to standard TopCon power supply units with complete cabinet and air cooling.

3.1.1 General



The mounting location must be free from conductive and aggressive substances and humidity.

Minimal clearances must be respected in order to prevent heat build-ups. The air intakes and outlets on both the front and rear panels of the unit must never be obstructed or closed.



Caution: Care must be taken in order prevent debris such as metal chips or screws from entering the unit, as these could cause serious damage.

3.1.2 Cabinet mounting

TopCon power supply units in their standard execution are designed to be mounted in standard 19" rack housings and cabinets with external air inflow.

They are intended to be placed on rails or unit floors and fixed by means of six M6 screws to the fixing points on the front panel.

The following points must be observed when mounting the units in cabinets or housings:

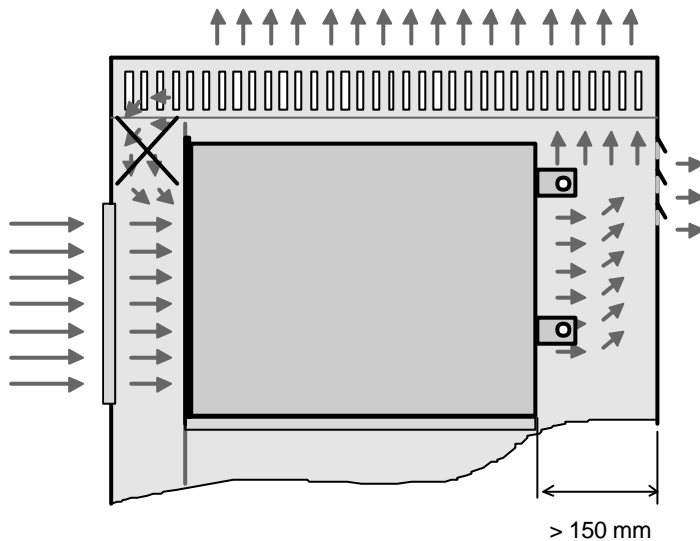
- Use only robust rails or unit floors (from housing, resp. cabinet manufacturer). The TopCon modules must lay on their full depth. A crossbrace must be provided on the back for additional fixing of the units.
- Appropriate means of transportation should be used when mounting or removing the units, e.g. a crane with transport loops. The units have to be lifted by means of the carrying handles provided on the sides as well as the handles on the front panel.

3.1.3 Shipment with cabinet

TopCon power supplies are shipped singularly or as multi unit systems and optionally pre-mounted in either standard housings or cabinets.

3.1.4 Cooling

In their basic execution TopCon units are fitted with forced air cooling. Therefore sufficient cooling air supply in accordance to the maximal allowed temperature and humidity has to be assured.



3.1.5 Openings and minimal clearances

Adequately dimensioned cabinets with air intakes and outlets must be used in order to provide sufficient cooling air circulation.

Air supply: Cooling air is sucked in through the front panel. The air flow must not be obstructed and air filters, if necessary, have to be mounted on the cabinet door or directly on the front panel of the unit. An air intake of **at least 300 mm x 300 mm** must be provided for each TopCon module in order to guarantee sufficient air flow. If necessary the intake will be fitted with an appropriate filter.





Air outflow: The cooling air is blown out of the unit through the back panel. It is therefore very important to provide enough room for the air flow: at least 150 mm depth on the whole width of the unit. The cooling air can be blown out through the back wall or the roof of the cabinet. Care must be taken in order to avoid an "air short circuit" (direct intake of output air).



Air filter: In cases where the TopCon units operate in environments with medium or high air pollution, the cooling air must be filtered either by means of external filters (e.g. on the cabinet door intake) or directly at the unit's intake on the front panel. This will prevent the accumulation of dirt inside the unit.

The air filters TC-ACC-Afx supplied as standard accessories consist of a filter mat and a snap-in frame to fix them to the front panel of the TopCon unit.

3.2 Electrical installation

The basic requirements for the electrical installation of power supplies with TopCon modules are discussed in the following section. The electrical connections for power and signals and their correct cabling are described in detail in chapter Electrical connections.

3.2.1 General installation notes



- This operating manual and any other documentation supplied with the unit must be carefully studied before installing and commissioning the unit.
- Electrical installation must be done by trained, expert personnel.
- The components supplied must be checked:
 - Does the information on the data plates correspond to the ordering and delivery information?
 - Do the nominal specifications of the unit match the application?
 - Do the supplied cables match the respective connectors?
- The following in particular must be observed during installation:
 - never connect or disconnect electrical terminals under voltage
 - specify high current conductors with sufficient section according to VDE0110
 - assure proper earthing of every module on a common PE-rail
 - cable shieldings must absolutely be earthed or connected to the unit's housing by large surface contacts either on the connector housings or to the cable clamps specially provided for that purpose
 - observe the measures for compliance to the EMC directives in the following section
 - provide an emergency shutdown device such as an emergency shutdown button or an interlock.

3.2.2 Electromagnetic compatibility

TopCon units are fitted with interference suppression and protection filters on all power lines and signal connections. Therefore a correctly installed unit will comply with the IEC and EN norms regarding interference suppression according to EN50082-2, EN61000-4-4 and interference emission according to EN50081-2, EN55011, limit A with no necessity for further measures.

3.2.3 Interference suppression

The main contribution to the device's interference suppression comes from correct earthing and shielding of all cable connections:

- shielded control cables, shield earthed at both ends
- EMC-proof Y-connection earthing of the device

The mounting frame or the cabinet in which the power supply will be mounted must be fully and EMC-proof earthed.



Particular care must be taken in earthing and shielding the control cables: all cable shields must be connected to ground potential by **large surface contacts**. The ideal solution is to make use of shielded connectors that are earthed directly through the earthed connectors on the power supply.

3.2.4 Radio interference suppression

TopCon power supplies are fitted with integrated radio interference suppression. In order for it to function properly, the unit must be earthed EMC-proof by means of large surface contacts (see above). Depending on the load and the mounting location it can be possible that shielded mains and load connections be necessary in order to comply with the radio interference suppression directives. The shields must then be earthed at both ends.

3.3 Commissioning of the power supply

TopCon power supplies can only be put into operation after correct installation and only by the hands of trained, expert personnel. We recommend the following stepwise proceeding for the first commissioning.

3.3.1 Before powering up for the first time

Check the following points before powering up the unit for the first time:

- Does the information on the data plate match the mains connection and the load?
- Is the mains supply correctly cabled?
- Is the load connected correctly (polarity)?
- Are the control signals connected correctly?
- Is the interlock or emergency shutdown circuit connected?

3.3.2 Device self test

The external control signals for the device's ON/OFF control must be inactive and the circuit breakers of the unit must be closed. Upon powering up, the digital signal processors start a self test of the unit that ends after about 5 - 10 seconds. In the case of multi-unit operation the system is further configured and the communication functions between all connected units are tested.

Self test OK: The green LED lights permanently, the device is ready for operation.

Self test failed: The red LED lights permanently. In case a second self test attempt should fail, the cause for the failure can be searched by means of the servicing and diagnosis program "TopControl" and a PC. The necessary measures should then be taken as described in the chapter Error handling.

3.3.3 Parameter setup

The factory presettings of the device should not need to be modified for operation in the specified application.

Nevertheless, if application specific changes to settings should need to be done before the function test (e.g. assigning control inputs and outputs to the corresponding signals), this is possible by means of the servicing and diagnosis program "TopControl" and a PC.

We recommend to run the function test as described in the following section before changing any setting (i.e. monitoring values, ramp functions or controller settings).

3.3.4 Function test

With the main breaker switched on and the load connected, the control signal VOLTAGE_ON as well as the specified current and/or voltage setpoint signals are activated.

VOLTAGE_ON: After activation of VOLTAGE_ON the output voltage is turned on and regulated at the specified setpoint value. The device is in the RUNNING state, one of the three LED's CV, CC, CP lights.

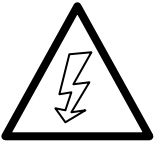
The output voltage and/or output current can now be compared to their setpoint values. Please note that depending on the configuration of the ramp functions the specified setpoint values will only be reached after completion of the respective ramp function.

3.3.5 Optimization of control and monitoring functions

Monitoring etc.: Application-specific settings of controller configurations, ramp functions and application monitoring are done easily by means of the servicing and diagnosis program “TopControl”.

Saving: Once the optimal settings are known they can be written to the non-volatile memory with TopControl.

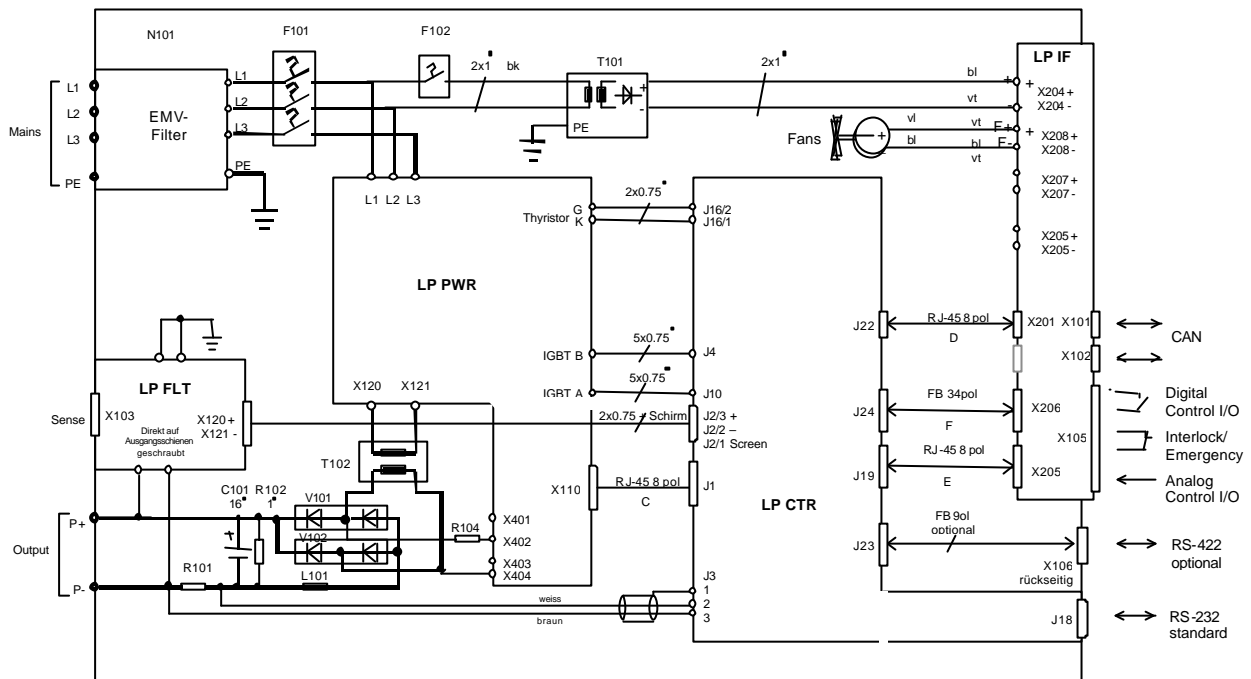
3.4 Safety notes



- Never connect or disconnect electrical lines under voltage
- Design all high current conductors with sufficient section
- The power supply units are only allowed to be used with the application and load types for which they were designed. In particular, the mains voltage and the load must comply with the indications on the data plate of the unit.
- The output current bars must be provided with sufficient protection from inadvertent touching (e.g. by mounting them inside a cabinet or housing).
- Never open the unit during operation, as it contains parts carrying high voltages.
- Dangerous voltages remain in the unit up to 3 minutes after disconnecting it from the mains.

4. Electrical connections

4.1 System overview



4.1.1 Block diagram

The mains voltage is rectified and buffered by condensers in the DC-link circuit. An IGBT-based full bridge in the power unit (printed circuit board LP PWR) generates a high frequency AC voltage that serves the phase shift modulation control of the output voltage and current.

4.1.2 Control connections

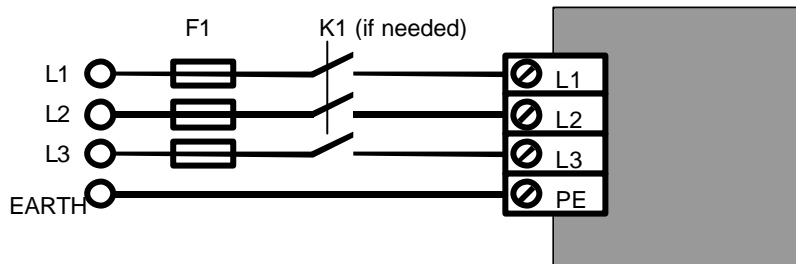
The unit in its standard execution can be turned on, off or remotely programmed through the digital and analog inputs and outputs, or digitally through the RS-232 interface. All the control and monitoring functions are taken over by a powerful digital signal processor based control unit (LP CTR).

4.1.3 Isolation

All control interfaces are isolated from mains, earth and output. The analog inputs and outputs are isolated from mains, earth, output and from the digital interfaces. The RS-232/422-Interface is isolated from mains, earth, output and controller.

4.2 Mains terminals

The mains connection of the TopCon units is realised through the terminals L1, L2, L3 and PE. Though not necessary for the operation of the unit, a shielded mains cable is needed in order to comply with the EMC directives.



Mains fuse

TopCon modules are fitted with an internal protection breaker on the mains lines. Nevertheless, the external conductors must have a sufficient section, and line fuses are necessary for lengths of more than 3 meters, as prescribed by VDE636 and shown in the following table.

Mains connection	TC.P.10	TC.P.16	TC.P.20	TC.P.32
Line fuse				
Mains voltage 400 VAC	25 A	35 A	50 A	80 A
Mains voltage 480 VAC ¹⁾	20 A	32 A	40 A	63 A
Section				
Mains voltage 400 VAC	6 mm ²	10 mm ²	16 mm ²	25 mm ²
Mains voltage 480 VAC ¹⁾	4 mm ²	10 mm ²	10 mm ²	16 mm ²

1) An AC line input of 480 VAC requires a superposed auto transformer.

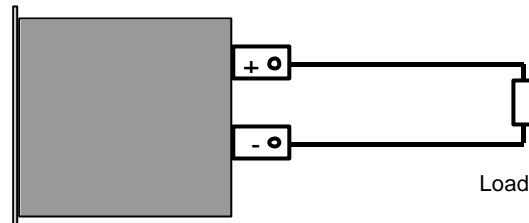
4.2.1 Multi-unit systems

All the units in a multi-unit system can be supplied by a common mains line. In this case the cables must be designed for the total resulting nominal current and fused externally according to the specifications.

As the TopCon units are provided with an internal protection breaker on the mains connection, it is possible to realize the distribution in Y-form from a common mains connection point (e.g. one of the main terminals in a cabinet) with reduced section. The conductor section for each unit shall be taken from the table above.

4.3 Output terminals

The output terminals are realised as current bars on the back of the unit.



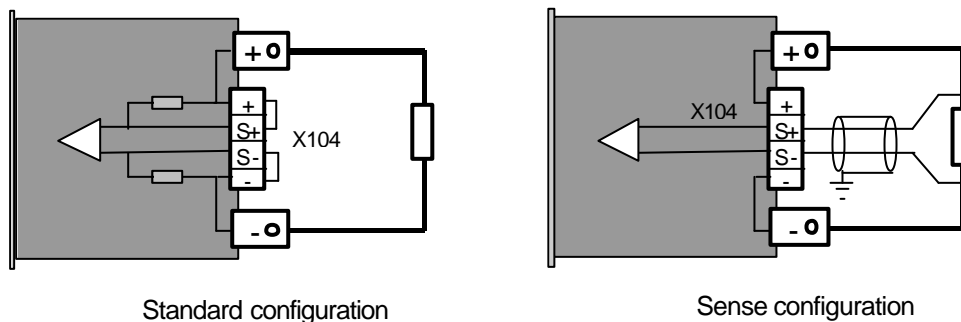
The load cables can be connected and screwed by means of cable clamps directly to the current bars. The conductor sections have to be chosen according to the following table, depending on the unit's nominal power and nominal voltage. The values are given as a recommendation, specifically valid standards have to be taken into account.

Load connection	TC.P.10	TC.P.16	TC.P.20	TC.P.32
Output voltage / section				
Nominal voltage 50 V	50 mm ²	70 mm ²	95 mm ²	150 mm ²
Nominal voltage 100 V	35 mm ²	50 mm ²	70 mm ²	70 mm ²
Nominal voltage 200 V	16 mm ²	25 mm ²	35 mm ²	50 mm ²
Nominal voltage 500 V	4 mm ²	10 mm ²	16 mm ²	25 mm ²
Nominal voltage 1000 V	2.5 mm ²	4 mm ²	6 mm ²	10 mm ²

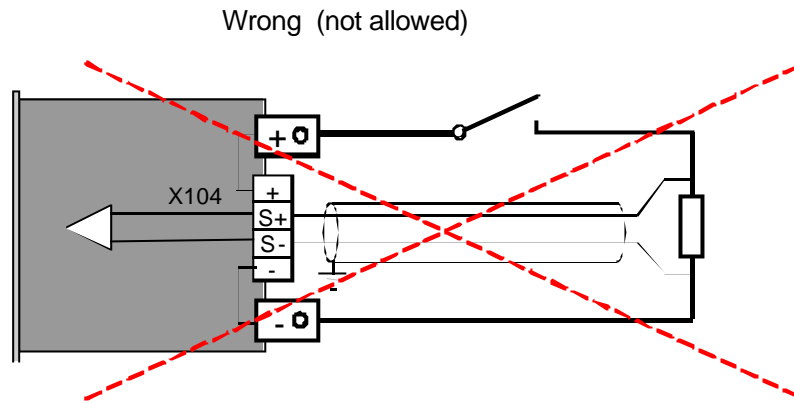
For cable lengths of more than 5 m the next higher section in the table should be chosen. This way the voltage drop across the line is kept within reasonable limits.

4.3.1 Remote-error-sensing (X104)

TopCon units are fitted with remote error sensing for an accurate voltage regulation also in case of long load cables and/or high currents.



In case of usage of remote error sensing, the load connection between the TopCon unit and the sensing point must not be interrupted. In case of interruption, the TopCon unit and the load may be damaged because the output voltage may rise to the maximum output voltage of the power supply.



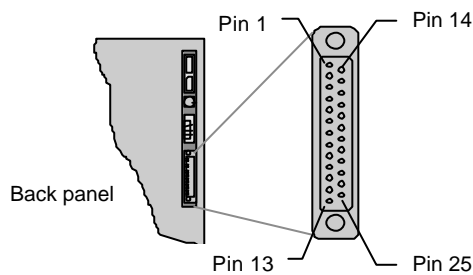
4.3.2 Parallel or serial operation

The outputs of the TopCon units can be directly connected in parallel or in series. This can either be done by means of multiple load cables connected together at the load or by means of current busbars at the back of the units. Mixed configurations are not allowed. The system must be configured for multi-unit-operation by means of the servicing and diagnosis program TopControl.

4.4 Control interface (X105)

All the signals that serve the power supply's control and setpoint values setting are fed through a female 25 pole D-Sub connector on the back of the unit. The electrical characteristics are described in the chapter "Technical data".

Control signals X105



The following table shows the pin connections of connector X105 with the signal meanings according to the factory default allocation.

Pin	Signal	I/O	Description
1	AGND	I	Analog ground for Pins 2–4, 14–16
2	VREF	I	Voltage setpoint input 0–10 V
3	IREF	I	Current setpoint input 0–10 V
4	IACT	O	Current feedback output 0–10 V
5	0VDC	O	0VDC I/O Ground for Pin 25
6	+10VDC	O	Analog reference voltage
7	COM	I	0VDC DigIn; Common ground for Pins 8–9, 18–20, 24
8	APP_DIGITALIN_4; CLEAR_ERROR	I	Digital input 0/24V AC/DC
9	VOLTAGE_ON	I	Digital input 0/24V AC/DC
10	OK/ALARM_b	O	Relais output 1 normally open
11	OK/ALARM_a	O	Relais output 1 Common
12	RUN_b	O	Relais output 2 normally open
13	RUN_a	O	Relais output 2 Common
14	PREF	I	Power limit analog input 0–10 V
15	RREF	I	Ri-simulation analog input 0–10 V
16	VACT	O	Voltage feedback output 0–10 V
17	COM	I	Common ground to Pins 8–9, 18–20
18	APP_DIGITALIN_1	I	Digital input 0 / 4–24V AC/DC
19	APP_DIGITALIN_2	I	Digital input 0 / 4–24V AC/DC
20	APP_DIGITALIN_3; ANALOG_REFERENCE_SELECT	I	Digital input 0 / 4–24V AC/DC Analog reference select
21	WARN_a	O	Relais output 3 normally open
22	WARN_b	O	Relais output 3 normally closed
23	WARN_c	O	Relais output 3 Common
24	INTERLOCK_IN_+	I	Input Interlock +
25	+24VDC	O	24VDC I/O Aux power output 24VDC, max. 0.2 A

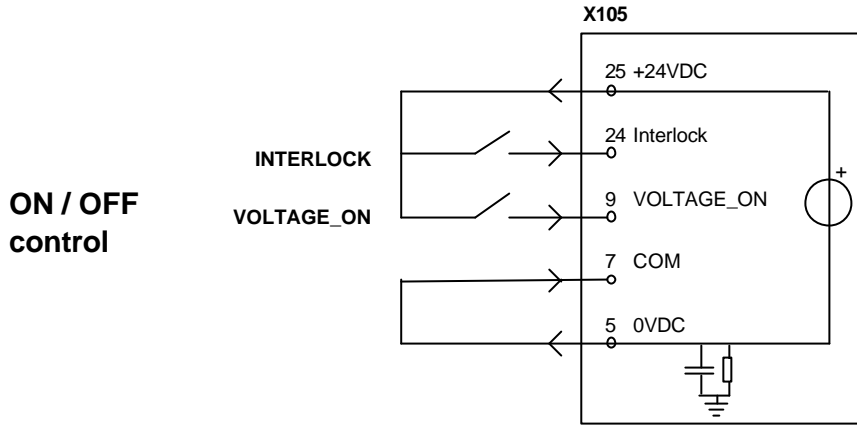
Pin 5 (0VDC I/O Ground for Pin 25) is internally connected through a 1kOhm resistor to earth.



Do not connect pin 25 (aux power output 24VDC) to earth.

4.4.1 Device control

The isolated digital inputs can be driven by the auxiliary 24 VDC supply available on connector X105 or by an external signal source (e.g. PLC). Driving digital inputs as shown in the example below can be applied to the other digital inputs as well.

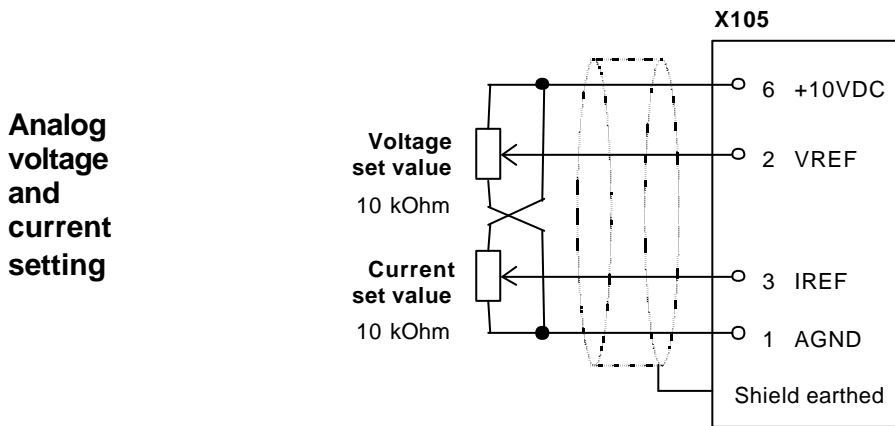


ON-/OFF control via digital inputs and internal auxiliary power supply

The control signal VOLTAGE_ON drives the power circuits of the power supply and is directly linked to the state machine of the device's system control. The interlock signal serves as a safety loop.

4.4.2 Analog programming of voltage and current

As a factory default the setting of voltage and current setpoint values is assigned to the pins 2 and 3 (X105). In case another interface (e.g. RS-232) is set active, by means of a raising edge (0->24V) on pin 20 / X105, the control interface X105 becomes again the active interface for the set value setting.



Analog reference values for current and voltage

The scaling of the voltage and current setpoint and actual values is given in the following table.

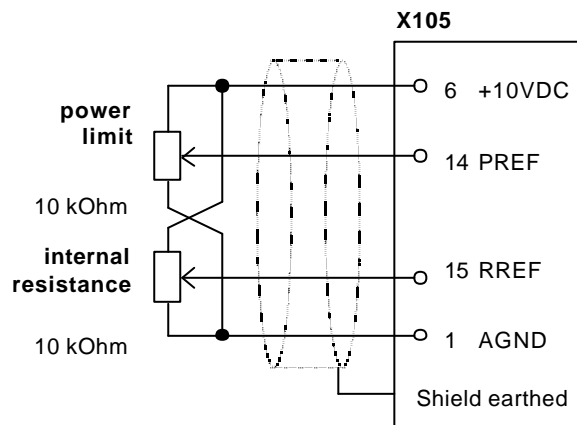
Scaling

Voltage set and actual value	TC.P.10	TC.P.16	TC.P.20	TC.P.32
Device type:	Output voltage for set value 0 - 10 V:			
Nominal voltage 50 V	0 - 50 V			
Nominal voltage 100 V	0 - 100 V			
Nominal voltage 200 V	0 - 200 V			
Nominal voltage 500 V	0 - 500 V			
Nominal voltage 1000 V	0 - 1000 V			

Current set and actual value	TC.P.10	TC.P.16	TC.P.20	TC.P.32
Device type:	Output current for set value 0 - 10 V:			
Nominal voltage 50 V	0 – 100% of I _{max}			
Nominal voltage 100 V				
Nominal voltage 200 V				
Nominal voltage 500 V				
Nominal voltage 1000 V				

4.4.3 Power limiting and Ri-Simulation

In addition to the analog setpoint inputs for current and voltage two further analog inputs are available. They can be used for power limiting and the simulation of the internal resistance of the power supply (Ri-simulation). If these functions are not used, the corresponding inputs can stay unwired or they can be connected to the analog ground.



Analog settings for power limiting and internal resistance

Power limiter

Power limiter	TC.P.10	TC.P.16	TC.P.20	TC.P.32
Device type	Output power for setpoint values 0 – 10 V:			
Nominal voltages 50 – 1000 V	10 – 0 kW	16 – 0 kW	20 – 0 kW	32 – 0 kW

Please note that the signal for power setting is inverted: 0 V = full power!

Internal resistance

Ri-Simulation	TC.P.10	TC.P.16	TC.P.20	TC.P.32
Device type	Internal resistance for setpoint values 0 – 10 V:			
Nominal voltages 50 – 1000 V	0 – 1000 mOhm			

Instead of with analog signals, the set values for voltage, current, power and internal resistance can be given directly in digital form from a PC with TopControl or from some other device through the RS-232 interface.

Analog reference ground

All four analog inputs are fully isolated. Therefore external isolation amplifiers can be spared. Please note, though, that the reference ground is common for all four inputs and must be connected to the reference potential of the supplying source.

4.4.4 Digital outputs (relais)

The three digital outputs are available externally as closing relais contacts. The factory default configuration assigns them the following meanings:

DIGOUT_1:	OK/ALARM	closed = OK
DIGOUT_2:	RUN	closed = RUN
DIGOUT_3:	WARN	change-over contact = warning state

When the controller is powered off, all relais contacts are open.

4.4.5 Interlock / Emergency shutdown

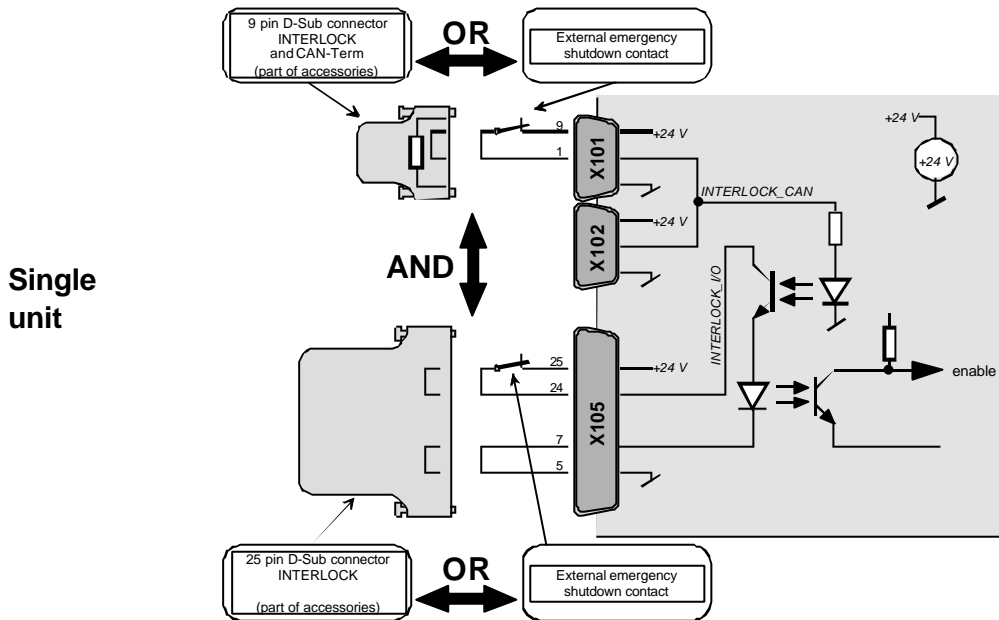


TopCon units provide the means for a safe and quick emergency shutdown.

One or several external emergency shutdown contacts must close the Interlock / emergency shutdown circuit in order for normal operation to be possible: the corresponding contacts on X105 and X101/102 must be closed.

If this circuit is interrupted, the integrated semiconductors (IGBT's) disconnect the power circuits from mains, while the controller remains active and (in case of an interruption during operation) the power supply changes to the error state.

The following shows the standard cabling for the emergency shutdown circuit.

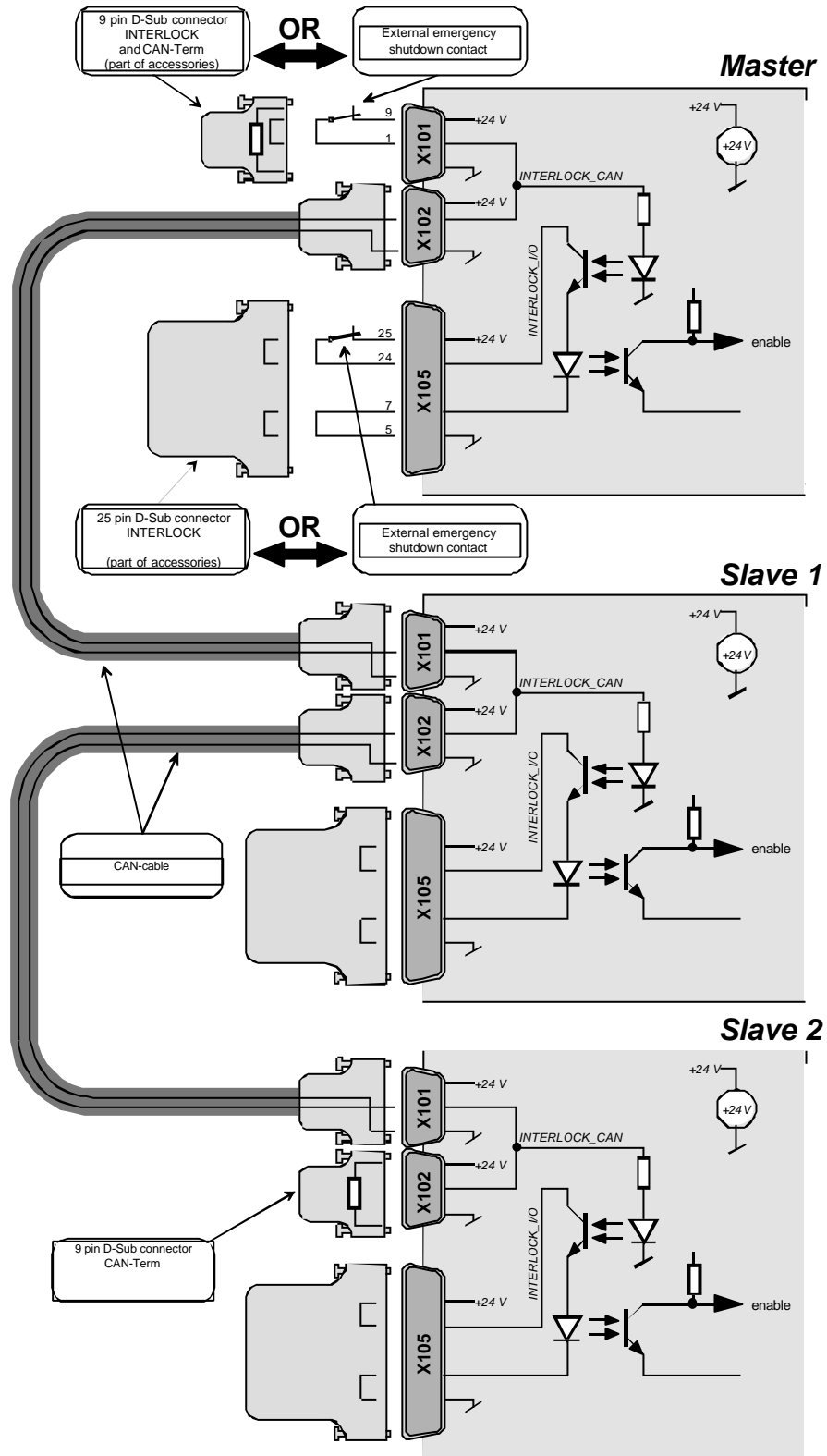


Emergency shutdown circuit for a single TopCon unit

Multi-unit systems

In order to run a multi-unit system with a single emergency shutdown contact, the shutdown circuit must be supplied by a 24 V supply (from any module). The corresponding cabling is shown in the following diagram.

Emergency shutdown circuit for a multi-module system



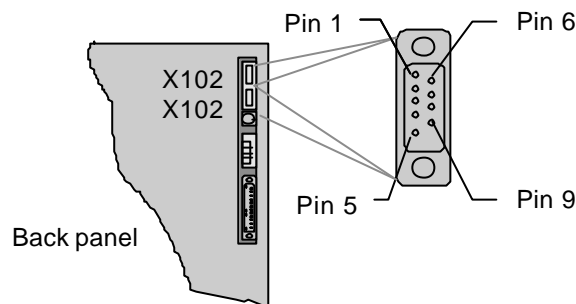
Emergency shutdown circuit in a multi-unit system

4.5 System communication (X101 / X102)

In multi-unit configurations, the system communication assures the digital data exchange (CAN). Electrically the signals are realised on the base of differential transmission according to the definitions of CAN 2.0 B. The cabling is realised with point-to-point connections between the units and terminator resistors at both physical ends of the bus structure.

4.5.1 Cabling

For the cabling, it is preferable to use the cables supplied for multi-unit systems. At both ends of the bus configuration a terminator resistor CANTERM has to be inserted.



Pin configuration X101/X102 (D-Sub 9 pole, female)

The following tables give an overview of the pin connections, as well as the electrical characteristics of the CAN connections.

Pin	Signal	I/O	Description
1	INTERLOCK_CAN	I	Interlock CAN
2	CAN_L	I/O	CAN Low
3	GND_CAN	O	CAN Common
4			
5			
6	GND_CAN	O	CAN Common
7	CAN_H	I/O	CAN High
8	0 VDC I/O	O	Auxiliary supply common
9	+24 VDC I/O	O	Auxiliary supply + 24 VDC
	Shield		connected to earth

Pin connections X101/X102

Recommended cables

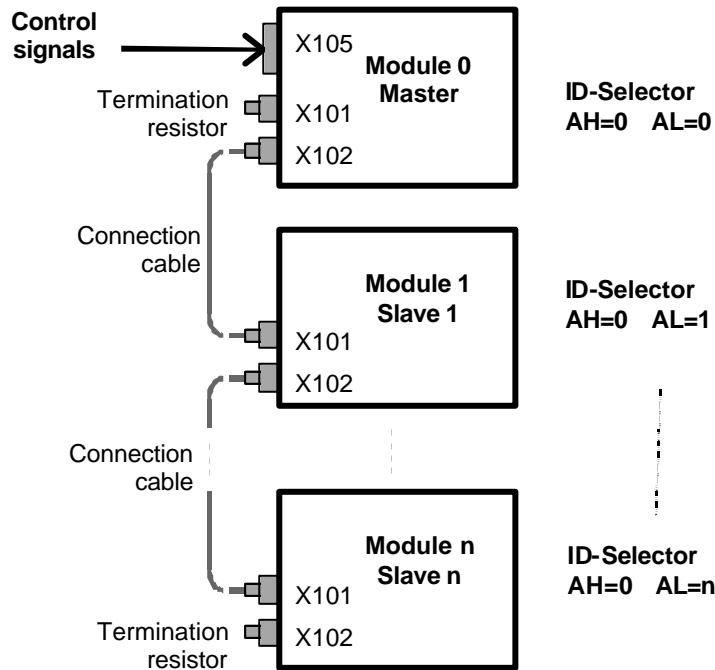
System communication	
Wave impedance	120 +- 20 Ohm
Cable section	4 x 2 x 0.14 mm ² + shield
Twisting	pairwise 1+8 / 2+7 / 3+6 / 4+5
Recommended cables	Dätwyler Uninet –4P, Dätwyler Uninet –4P flex

4.5.2 Setting of the network ID's in a multi-unit system

In a multi-unit system the ID-selector on the front panel of the unit must be set in the following way:

	Master	Slave 1	Slave 2	Slave n
Series operation	AH=0, AL=0	AH=0, AL=1	AH=0, AL=2	AH=0, AL=n
Parallel operation	AH=0, AL=0	AH=1, AL=0	AH=2, AL=0	AH=n, AL=0

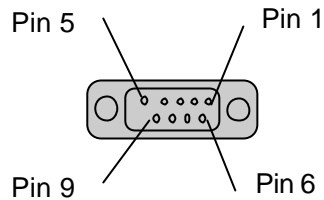
Please note: Continuous incrementation from 1 to n for the slave units.



Cabling and ID-setting for a series multi-unit system

4.6 Diagnosis and configuration connector RS-232 (X301)

An RS-232 / V.24 interface with a 9-pole, female, D-sub connector is located on the front panel of the unit.



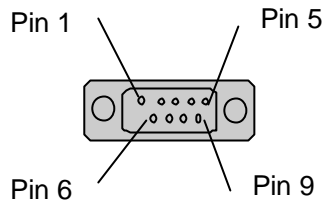
X301: RS-232 (D-Sub 9 pole, female)

**Pin
connec-
tions
X301**

Pin	Signal	I/O	Description
1			not connected
2	TXD	O	Transmit data
3	RXD	I	Receive data
4			not connected
5	GND		Common ground
7	RTS, internally connected to CTS only => not used	O	Request to send (output) not used
8	CTS, internally connected to RTS only => not used	I	Clear to send (input) not used
9			not connected
	Shield		connected to earth

4.7 Diagnosis and configuration connector RS-422 (X106)

The diagnosis and configuration interface RS-422 is optionally available. The RS-422 interface with a 9-pole, male, D-sub connector, is located on the rear side of the unit.

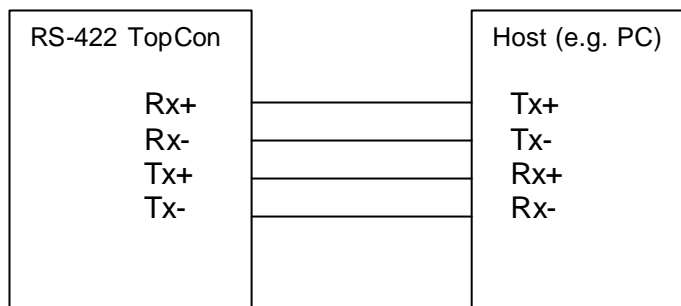


X106: RS-422 (D-Sub 9 pole, male)

Pin connections X106

Pin	Signal	I/O	Description
1	GND		Common ground
2	Rx+	I	Receive data +
3	Tx-	O	Transmit data -
4			not connected
5	GND		Common ground
6			not connected
7	Rx-	I	Receive data -
8	Tx+	O	Transmit data +
9			not connected
	Shield		connected to earth

4.7.1 Cabling

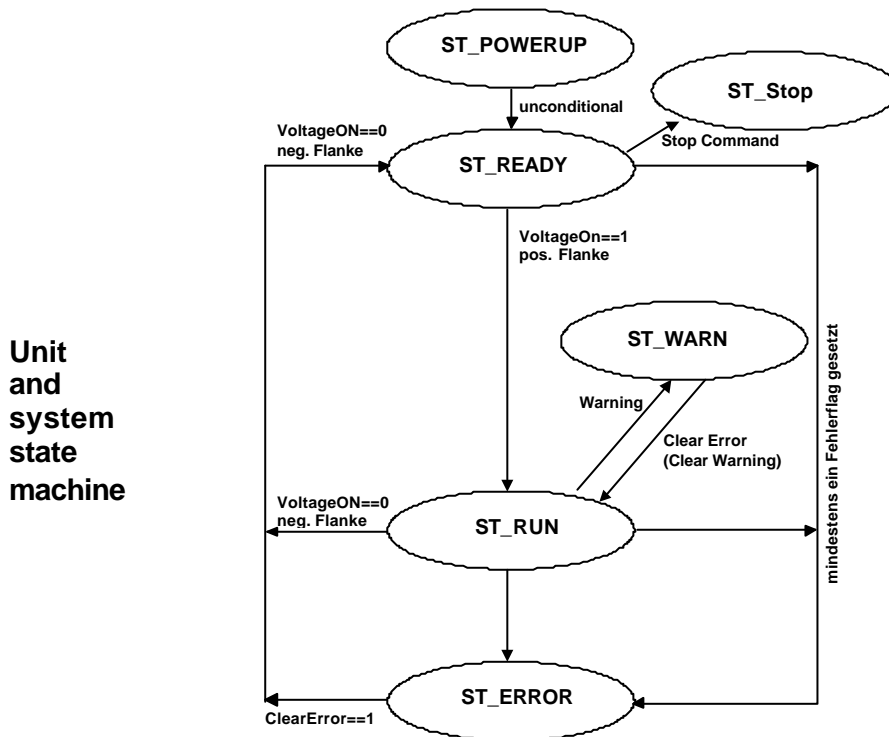


5. Control

All the regulation and control tasks are carried out full digitally by a DSP system. A very powerful DSP overtakes the regulation functions. It is coupled with a DSP for peripheric tasks (I/O tasks like RS232, CAN, analog I/O, etc.) and a modulator DSP (control of the power stage).

5.1 Device control

The control of TopCon power supply units is controlled by a central state machine. This state machine is responsible for the following tasks: correct start-up of the power supply by starting the unit's self test, initializing the charge of the DC-link by driving the power breakers after a clearance signal, respond to user commands, test warning and error flags and operate the corresponding state transitions. The following diagram shows the different states.



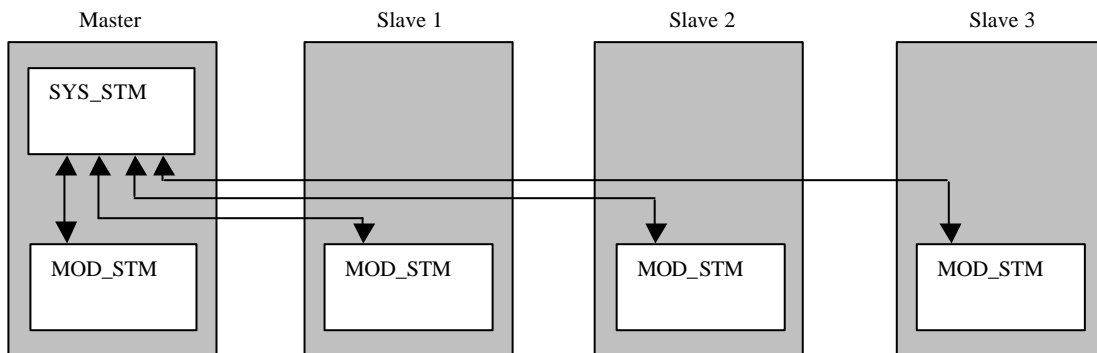
The state machine is divided into to two parts:

- Module statemachine (MOD_STM)
- System statemachine (SYS_STM)

The system statemachine is only active in the master unit and takes instructions from the user.

The module statemachine is active in all units (also in the master unit). It takes the instructions not from the user but from the superposed system statemachine. A stand-alone unit contains a system statemachine and a module statemachine.

The states of the system and module statemachines are identical.
Example of a multi-unit system with three slave units:



5.1.1 Module-Statemachine

The module statemachine is active in every unit (master as well as slave units) and changes its state only upon request of the system statemachine. Exceptions are:

- The module statemachine changes to the state `ST_STOP`, if the user pushes the STOP-button in the PC program TopControl (this step is necessary for firmware updates). This is only possible if the module statemachine before was in the state `ST_READY`. The module statemachine remains in the state `ST_STOP` until the user pushes the START-button in the PC program TopControl.
- The module statemachine can independently change from the state `ST_RUN` to `ST_WARN` if warnings are detected. As soon as there are no more warnings (the user selected "Clear Errors", the module statemachines change from `ST_WARN` back to `ST_RUN`.
- In the error case the module statemachine independently changes to the state `ST_ERROR`. As long as errors persist the module statemachine remain in the error state independently from the system statemachine.

5.1.2 System statemachine

The system statemachine is only active in the master unit and exclusively reacts upon user instructions (VoltageOn and ClearError). The state of the system statemachine depends on the states of all module statemachines. The following table shows how the states of system and module statemachines are interconnected. The higher the position of a state in the table, the higher is the priority of the state. If for instance one module statemachine changes to ST_STOP and another one to ST_ERROR, then the system statemachine changes to ST_STOP.

State of module state-machine	Number of module state-machines in this state	Resulting state of system statemachine
ST_POWERUP	at least 1	ST_POWERUP
ST_STOP	at least 1	ST_STOP
ST_ERROR	at least 1	ST_ERROR
ST_WARN	at least 1	ST_WARN
ST_RUN	at least 1	ST_RUN
ST_READY	all	ST_READY



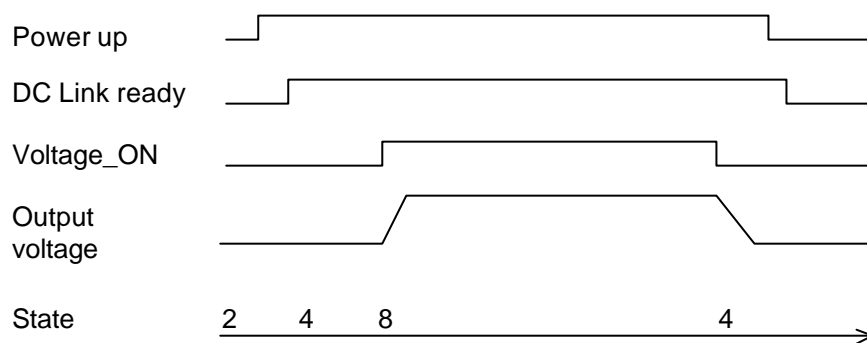
The front panel control unit HMI, the remote control unit RCU and the PC program TopControl show the state of the system statemachine, not of the module statemachine. In TopControl it is possible to show the states of all the module statemachines.

5.1.3 States

State	Number	Description
ST_POWERUP	2	Initialisation, CAN-Login, all units asynchronous
ST_READY	4	All units ready, output free of voltage, fans off ¹⁾
ST_RUN	8	Output voltage on, output controlled, fans on
ST_WARN	10	Like ST_RUN, at least 1 warning flag set
ST_ERROR	12	Error in at least 1 unit, output free of voltage, fans off ¹⁾
ST_STOP	14	Stop state for software-update

¹⁾ fans on if device temperature high

The control signal VOLTAGE_ON can be activated through the corresponding control parameters, either through the assigned digital input or directly digitally. The following diagram illustrates the time sequence of the On/Off control.



On / off control in normal operation

5.1.4 State display

State display with LEDs on the front panel as well as through the digital outputs (Relais) on the rear panel:

State display with LED's and Relais outputs

State	LED READY GREEN	LED STATUS YELLOW	LED ERROR RED	LED CV,CC,CP	RELAIS 1 OK/ALM	RELAIS 2 RUN	RELAIS 3 WARN
POWER UP	OFF	ON	OFF	OFF	OPEN	OPEN	OPEN
STOP	ON	ON	OFF	OFF	OPEN	OPEN	OPEN
READY	ON	OFF	OFF	OFF	CLOSED	OPEN	OPEN/ CLOSED ³⁾
RUN	ON ⁴⁾	OFF	OFF	ON ¹⁾	CLOSED	CLOSED	OPEN
WARN	ON ⁴⁾	BLINK ²⁾	OFF	ON ¹⁾	CLOSED	CLOSED	CLOSED
ERROR	ON	OFF ⁵⁾	BLINK ²⁾	ON	OPEN	OPEN	OPEN/ CLOSED ³⁾
FATAL ERROR ⁶⁾	BLINK	BLINK	BLINK	OFF	OPEN	OPEN	CLOSED

¹⁾ one of the three LEDs, according to the actual controller mode

²⁾ Blinkcode according to error table respectively warn table (see chapter Error handling)

³⁾ Closed, if there is a warning, otherwise open

⁴⁾ Blinking, if downprogramming unit (discharge) active

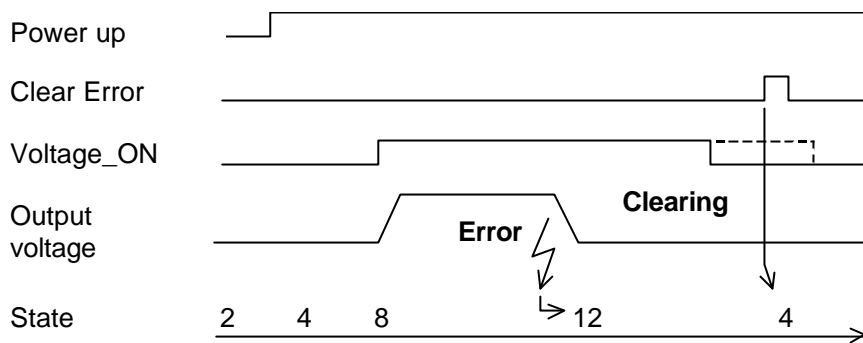
⁵⁾ Blinkng, if there is a warning at the same time

⁶⁾ The three LEDs are blinking together: internal communication failed

5.2 Error handling

If an error occurs, the unit changes to the state ERROR. This state is signalled by the digital outputs (relays) and the LED's on the front panel. The positive edge of the signal Clear Error is used to clear errors. Error clearing is done by the corresponding digital input or the corresponding control parameter (RS232).

Control signals in the error case

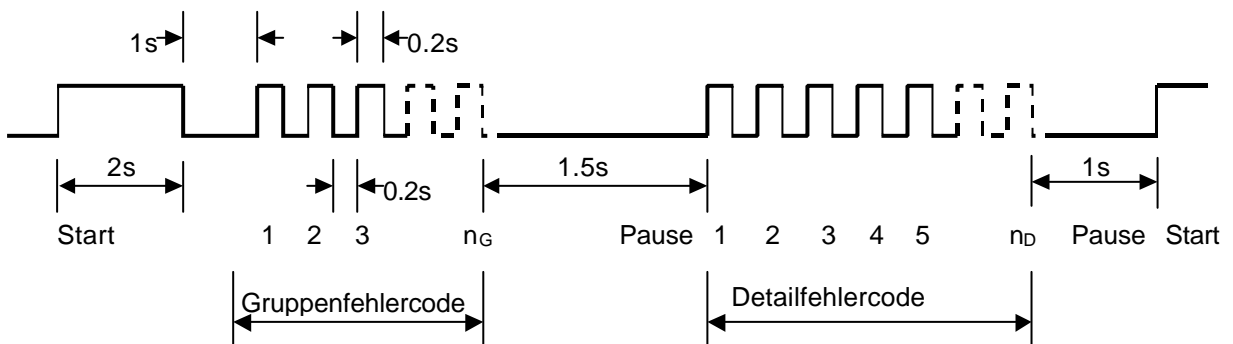


Errors and clearing

Warnings are also saved until they are cleared. The positive edge of the signal Clear Error is used to clear warnings.

5.2.1 Error display / error groups

In order to make a quick and precise error diagnosis, the possible errors are subdivided into 16 error groups. Each group is again subdivided into 16 detail errors. The error groups and detail errors are displayed on the front panel control unit HMI, on the remote control unit RCU and in the PC program TopControl. The error groups and detail errors are additionally displayed with a blinking code (red LED ERROR) sequentially on the front panel. The number of blinking signals describes the error (group and detail error). The following picture shows one period of the display cycle.



For warnings the same mechanism is applied. Warnings are displayed with a blinking code on the yellow LED STATUS. Error and warn codes are identical. All errors and warnings are sequentially displayed according to the above picture. Then the blinking sequence starts over again with the first warning resp. error.

5.2.2 Error group codes / warn codes

**Display of
the error
cause**

Blink Code	Error Group	Display TopControl	Group Code
1	Internal errors	Internal	0x0001
2	PDSP error	Internal (PDSP)	0x0002
3	Error due to output current	Output current	0x0004
4	Error due to output voltage	Output voltage	0x0008
5	Error in power supply	Supply	0x0010
6	Temperature error	Temperature	0x0020
7	Communications error	Communication	0x0040
8	Modulator error	Internal (Modulator)	0x0080
9	AD_Ovrrange_1-error	Internal (AD overrange 1)	0x0100
10	AD_Ovrrange_2-error	Internal (AD overrange 2)	0x0200
11	AD_Underrange_1-error	Internal (AD underrange 1)	0x0400
12	AD_Underrange_2-error	Internal (AD underrange 2)	0x0800
13	Login-error	Login	0x1000
14	Configuration-error	Configuration	0x2000
15	-- (not used)	Not def.(group 14)	0x4000
16	Interlock open, Miscellaneous	Interlock open, Miscellaneous	0x8000

5.2.3 Detail error codes / warn codes

Blink Code	Internal errors (0x0001) – Details	Internal	Detail Code
1-1	Invalid systemstate	Invalid systemstate	0x0001
1-2	Invalid modulestate	Invalid modulestate	0x0002
1-5	EEPROM table write	EEPROM table write	0x0010
1-6	Flash timeout	Flash timeout	0x0020
1-7	ADC sequence	ADC sequence	0x0040
1-8	Invalid EEPROM table	Invalid EEPROM table	0x0080
1-9	Requested state not available	Requested state not available	0x0100
1-10	Tyristor not switched on	Tyristor not switched on	0x0200
1-11	No active controller defined	No active controller defined	0x0400
1-12	ADC timeout	ADC timeout	0x0800
1-13	ADC DMA interrupt missing	ADC DMA interrupt missing	0x1000
1-14	Division by 0 for powercoeff.	Division by 0 for powercoeff.	0x2000
1-15	Invalid interrupt routine called	Invalid interrupt routine called	0x4000

2	PDSP error (0x0002) – Details	Internal (PDSP)	Detail Code
2-1	PDSP package checksum	PDSP package checksum	0x0001
2-2	Wrong PDSP SW version	Wrong PDSP SW version	0x0002
2-3	PDSP fault	PDSP fault	0x0004
2-4	Write queue overrun	Write queue overrun	0x0008
2-5	Too many PDSP packages	Too many PDSP packages	0x0010
2-6	SCI checksum	SCI checksum	0x0020
2-7	SCI parity	SCI parity	0x0040
2-8	SCI overrun	SCI overrun	0x0080
2-9	SCI framing	SCI framing	0x0100
2-10	SCI break	SCI break	0x0200
2-11	Unknown SCI state bit	Unknown SCI state bit	0x0400
2-12	Unknown CAN state bit	Unknown CAN state bit	0x0800
2-13	Unknown PDSP package	Unknown PDSP package	0x1000
2-14	Package from not initialized mailbox	Package from not initialized mailbox	0X2000

3	Error due to output current (0x0004) – Details	Output current	Detail Code
3-1	i2t	i2t	0x0001
3-2	Overcurrent Isek	Overcurrent Isek	0x0002
3-3	Overcurrent Iprim	Overcurrent Iprim	0x0004
3-4	Gatedrive A fault	Gatedrive A fault	0x0008
3-5	Gatedrive B fault	Gatedrive B fault	0x0010
3-6	Overcurrent Isek (Level derated by Temperature)	Overcurrent Isek (Level derated by Temperature)	0x0020

4	Error due to output voltage (0x0008) – Details	Output voltage	Detail Code
4-1	Overvoltage	Overvoltage	0x0001

5	Error in power supply (0x0010) – Details	Supply	Detail Code
5-4	+5V too low	+5V too low	0x0008
5-5	+5V too high	+5V too high	0x0010
5-6	+15V too low	+15V too low	0x0020
5-7	+15V too high	+15V too high	0x0040
5-8	-15V too low (absolute value)	-15V too low	0x0080
5-9	-15V too high (absolute value)	-15V too high	0x0100
5-10	DC link voltage too low	DC link voltage too low	0x0200
5-11	DC link voltage too high	DC link voltage too high	0x0400
5-12	+24V too low	+24V too low	0x0800
5-13	+24V too high	+24V too high	0x1000
5-14	Fast voltage drop on DC link	Fast voltage drop on DC link	0x2000

6	Temperature error (0x0020) – Details	Temperature	Detail Code
6-1	Rectifier temp. too high	Rectifier temp. too high	0x0001
6-2	IGBT temp. too high	IGBT temp. too high	0x0002

7	Communications error (0x0040) – Details	Communication	Detail Code
7-1	CAN bus off	CAN bus off	0x0001
7-2	CAN error passive	CAN error passive	0x0002
7-3	CAN write to mailbox denied	CAN write to mailbox denied	0x0004
7-4	CAN transmission aborted	CAN transmission aborted	0x0008
7-5	CAN receive message lost	CAN receive message lost	0x0010
7-6	HMI/RCU does not respond	HMI/RCU does not respond	0x0020
7-7	CAN transmit queue overrun	CAN transmit queue overrun	0x0040
7-8	Slave does not respond	Slave does not respond	0x0080

8	Modulator error (0x0080) – Details	Internal (Modulator)	Detail Code
8-1	Invalid checksum (Modulator)	Invalid checksum (Modulator)	0x0001
8-2	Invalid checksum (Main)	Invalid checksum (Main)	0x0002
8-3	Modulator queue overrun	Modulator queue overrun	0x0004
8-4	Transmit register full	Transmit register full	0x0008
8-5	Receive register full	Receive register full	0x0010
8-6	Transmit not called	Transmit not called	0x0020
8-7	Undefined ID (Modulator)	Undefined ID (Modulator)	0x0040
8-8	Undefined ID (Main)	Undefined ID (Main)	0x0080
8-9	VZ gain too low	VZ gain too low	0x0100
8-10	lprim gain too low	lprim gain too low	0x0200
8-11	Still in fault condition	Still in fault condition	0x0400
8-12	Fault on reading scope buffer	Fault on reading scope buffer	0x0800
8-16	Unknown modulator error bit	Unknown modulator error bit	0x8000

9	AD_Ovrrange_1-error (0x0100) – Details	Internal (AD overrange 1)	Detail Code
9-1	Voltage reference overrange	Voltage reference overrange	0x0001
9-2	Current reference overrange	Current reference overrange	0x0002
9-3	Power reference overrange	Power reference overrange	0x0004
9-4	Resistance reference overrange	Resistance reference overrange	0x0008
9-5	Output voltage overrange	Output voltage overrange	0x0010
9-6	Output current overrange	Output current overrange	0x0020
9-7	Sense voltage overrange	Sense voltage overrange	0x0040
9-8	System voltage overrange	System voltage overrange	0x0080
9-9	System current overrange	System current overrange	0x0100
9-10	DC link voltage (DC) overrange	DC link voltage (DC) overrange	0x0200
9-11	Primary current overrange	Primary current overrange	0x0400
9-12	DC link voltage (AC) overrange	DC link voltage (AC) overrange	0x0800

10	AD_Ovrrange_2-error (0x0200) – Details	Internal (AD overrange 2)	Detail Code
10-1	+5V overrange	+5V overrange	0x0001
10-2	+15V overrange	+15V overrange	0x0002
10-3	-15V overrange	-15V overrange	0x0004
10-4	+24V overrange	+24V overrange	0x0008
10-5	IGBT temperature overrange	IGBT temperature overrange	0x0010
10-6	Rectifier temperature overrange	Rectifier temperature overrange	0x0020
10-7	Reserved temperature overrange	Reserved temperature overrange	0x0040
10-8	Reserved 1 overrange	Reserved 1 overrange	0x0080
10-9	Reserved 2 overrange	Reserved 2 overrange	0x0100

11	AD_Underrange_1-error (0x0400) – Details	Internal (AD underrange 1)	Detail Code
11-1	Voltage reference underrange	Voltage reference underrange	0x0001
11-2	Current reference underrange	Current reference underrange	0x0002
11-3	Power reference underrange	Power reference underrange	0x0004
11-4	Resistance reference underrange	Resistance reference underrange	0x0008
11-5	Output voltage underrange	Output voltage underrange	0x0010
11-6	Output current underrange	Output current underrange	0x0020
11-7	Sense voltage underrange	Sense voltage underrange	0x0040
11-8	System voltage underrange	System voltage underrange	0x0080
11-9	System current underrange	System current underrange	0x0100
11-10	DC link voltage underrange	DC link voltage underrange	0x0200
11-11	Primary current underrange	Primary current underrange	0x0400
11-12	DC link voltage (AC) underrange	DC link voltage (AC) underrange	0x0800

12	AD_Underrange_2-error (0x0800) – Details	Internal (AD underrange 2)	Detail Code
12-1	+5V underrange	+5V underrange	0x0001
12-2	+15V underrange	+15V underrange	0x0002
12-3	-15V underrange	-15V underrange	0x0004
12-4	+24V underrange	+24V underrange	0x0008
12-5	IGBT temperature underrange	IGBT temperature underrange	0x0010
12-6	Rectifier temperature underrange	Rectifier temperature underrange	0x0020
12-7	Reserved temperature underrange	Reserved temperature underrange	0x0040
12-8	Reserved 1 underrange	Reserved 1 underrange	0x0080
12-9	Reserved 2 underrange	Reserved 2 underrange	0x0100

13	Login-error (0x1000) – Details	Login	Detail Code
13-1	Slave did not receive CFL	Slave did not receive CFL	0x0001
13-2	Slave received invalid CFL	Slave received invalid CFL	0x0002
13-3	Slave did not receive EOL	Slave did not receive EOL	0x0004
13-4	Slave received incomplete EOL	Slave received incomplete EOL	0x0008
13-5	Master did not receive RFL subframes from slaves	Master did not receive RFL subframes from slaves	0x0010
13-6	Master did not receive all RFL subframes from slaves	Master did not receive all RFL subframes from slaves	0x0020
13-7	Master did not receive RFL subframes from HMI/RCU	Master did not receive RFL subframes from HMI/RCU	0x0040
13-8	Master did not receive all RFL subframes from HMI/RCU	Master did not receive all RFL subframes from HMI/RCU	0x0080
13-9	CAN protocol version is not identical	CAN protocol version is not identical	0x0100
13-10	Software version is not identical	Software version is not identical	0x0200
13-11	Not def. (Login) 10)	Not def. (Login) 10)	0x0400
13-12	Not def. (Login) 11)	Not def. (Login) 11)	0x0800
13-13	HMI/RCU did not receive CFL	HMI/RCU did not receive CFL	0x1000
13-14	HMI/RCU received invalid CFL	HMI/RCU received invalid CFL	0x2000
13-15	HMI/RCU did not receive EOL	HMI/RCU did not receive EOL	0x4000
13-16	HMI/RCU received incomplete EOL	HMI/RCU received incomplete EOL	0x8000

14	Configuration-error (0x2000) – Details	Configuration	Detail Code
14-1	Slave ID not unique	Slave ID not unique	0x0001
14-2	HMI/RCU ID not unique	HMI/RCU ID not unique	0x0002
14-3	More than one master in system	More than one master in system	0x0004
14-4	Not def. (Configuration) 3	Not def. (Configuration) 3	0x0008
14-5	Not def. (Configuration) 4	Not def. (Configuration) 4	0x0010
14-6	Not def. (Configuration) 5	Not def. (Configuration) 5	0x0020
14-7	Not def. (Configuration) 6	Not def. (Configuration) 6	0x0040
14-8	Not def. (Configuration) 7	Not def. (Configuration) 7	0x0080
14-9	All slave ID's have to be	All slave ID's have to be	0x0100
14-10	All HMI/RCU ID's have to be	All HMI/RCU ID's have to be	0x0200
14-11	More slaves in system than allowed	More slaves in system than allowed	0x0400
14-12	More HMI/RCU in system than allowed	More HMI/RCU in system than allowed	0x0800
14-13	Invalid slave ID (out of range)	Invalid slave ID (out of range)	0x1000
14-14	Invalid HMI/RCU ID (out of range)	Invalid HMI/RCU ID (out of range)	0x2000
14-15	Not def. (Configuration) 14	Not def. (Configuration) 14	
14-16	Not def. (Configuration) 15	Not def. (Configuration) 15	

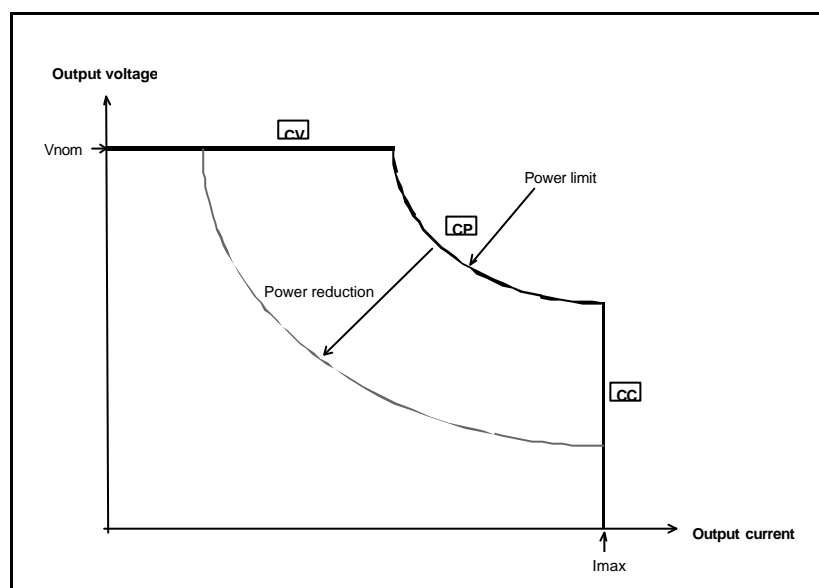
16	Interlock open, Miscellaneous (0x8000) – Details	Interlock, Miscellaneous	Detail Code
16-1	Not def. (Miscellaneous) 1	Not def. (Miscellaneous) 1	0x0001
16-2	Not def. (Miscellaneous) 2	Not def. (Miscellaneous) 2	0x0002
16-3	Interlock	Interlock	0x0004
16-4	External PWM shutdown	External PWM shutdown	0x0008

5.2.4 Warnings

The warnings are also subdivided into 16 groups of maximum 16 detail warnings. The same codes are used as for the errors.

5.3 Control

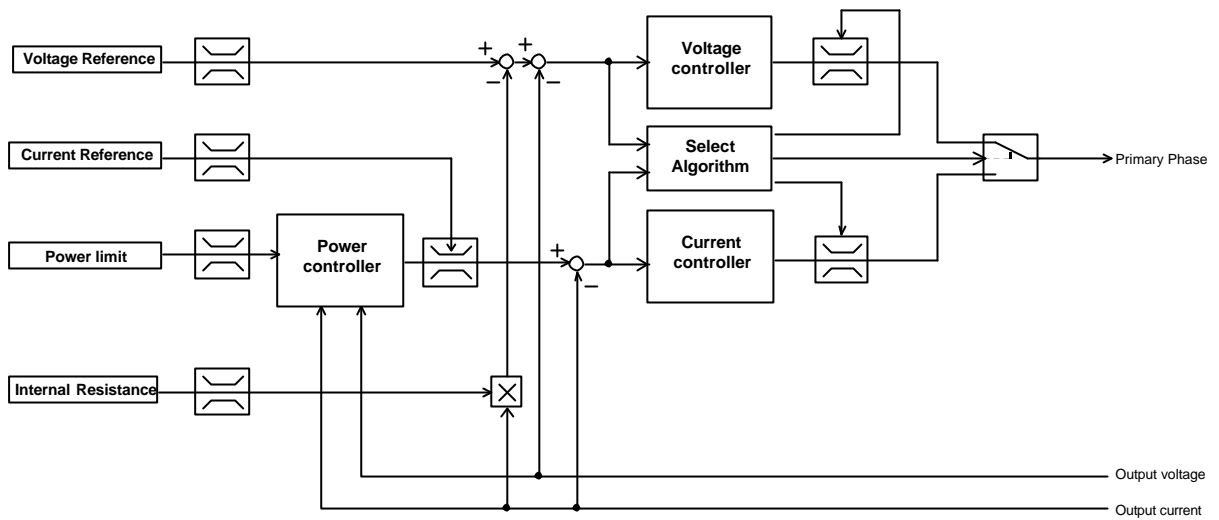
The basic version of the TopCon units provides not only unipolar current and voltage regulation but also active output power limitation and internal resistance simulation. The internal resistance can be set to a value between 0 and 1000 mOhm.



If the power supply unit has the optional user interface HMI integrated, the unit is preset to receive the control signals through the HMI. However the control can be assigned to another interface (RS-232, analog/digital inputs) through the corresponding user menu in the integrated user interface HMI.

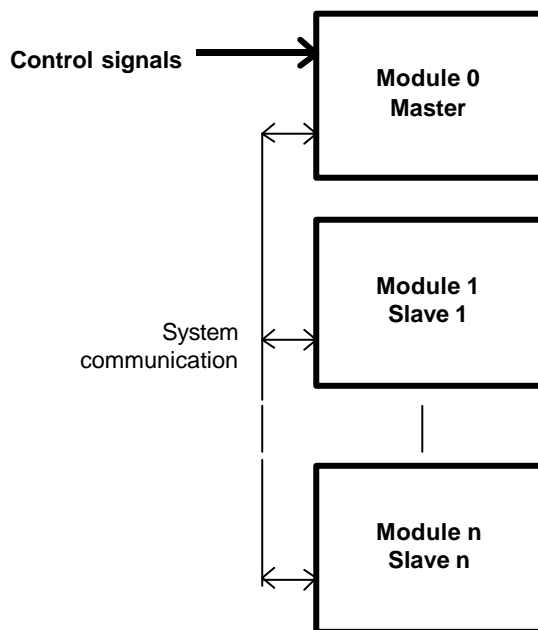
5.3.1 Structure of the regulator

The following picture shows the voltage, current and power controller structure.



5.4 Multi-unit master slave systems

One of the advantages of the TopCon units is the full digital communication in multi-unit systems. Therefore the control signals only have to be fed to one device in the network, the so called "master". The safe distribution of the necessary signals and values is done via internal communication.



Master/Slave configuration in a multi-unit system

5.4.1 Master / Slave configuration

In a multi-unit system the different units communicate over a communication bus. The control signals to and from a superposed control system (PC, PLC, HMI, RCU) are only connected to the master unit.

Upon switching-on of the main breakers (for all units approximately at the same time), the system configures itself automatically and the master unit checks the system integrity according to the preset values for the number and type of connected units.

5.4.2 ID-Selector

Two ID-selectors are situated on the front panel of each unit. These selectors must be set to the right position before powering up the multi-unit system:

	Master	Slave 1	Slave 2	Slave n
Series operation	AH=0, AL=0	AH=0, AL=1	AH=0, AL=2	AH=0, AL=n
Parallel operation	AH=0, AL=0	AH=1, AL=0	AH=2, AL=0	AH=n, AL=0

Please note: Continuous incrementation from 1 to n for the slave units.

5.4.3 System control

The system control functions according to the same principles as for single units, with the following extensions:

- Slave units follow the master state
- Every unit can enter the WARN or FAULT state independently and cause the entire system to enter that state
- Error clearing at the master unit is effective on the entire system

Slave units continuously send operational key-values to the master unit. These can be displayed with TopControl.

5.4.4 Multi-unit operating modes

Different system configurations must be considered when operating in a multi-unit system.

Operating mode	Description
Parallel operation	All unit outputs are connected in parallel.
Serial operation	All unit outputs are connected serially.
Multi-load system	Each unit supplies a load and no terminal or only one terminal connects it to an other unit.

5.4.5 Configuration settings

In order to configure a multi-unit system the following parameters must be correctly set through the servicing program TopControl:

- Master slave operating mode
- Total number of units in master slave system



Mixed configurations (parallel *and* serial operation) are not allowed.

After each modification of the configuration settings, the system must be powered up again.

6. Servicing and diagnosis program TopControl

TopControl is a PC program that supports the user commissioning and configuring TopCon power supplies. The software features a graphical user interface through which all tasks related to the operation of TopCon power supplies are accomplished.

6.1 Installation

The following is a list of the requirements for a successful installation of the TopControl software:

Installation requirements

Resource	Minimal requirement	Recommended
Computer	Personal Computer with 80386 processor	Personal Computer with Pentium processor
free memory	RAM: 8MB Harddisk: 4MB	RAM: 16MB Harddisk: 8MB
Graphic card Monitor	VGA graphic card 15" Monitor	SVGA graphic card 17" Monitor
Operating system	Windows 3.11 Windows 95 with Internet Explorer 4 or higher Windows 98 and 98 SE Windows 2000, service pack 2 recommended Windows NT 3.51 Windows NT 4, from service pack 5	
Pointing device	Windows compatible mouse	
Free interfaces	serial RS-232 interface COM 1	
Diskette drive	3½" Disk drive	

6.1.1 Installation of the TopControl Software

- Start Windows and insert the installation diskette in drive A
- Create a new directory e.g. C:\Programs\TopControl
- Copy the files tcio.dll and TopControl.exe into this directory
- Connect PC and power supply unit via RS-232 cable
- Start TopControl by doubleclicking onto the file TopControl.exe

6.2 RS-232 connection with the TopCon power supply

A commercial 1:1 RS232 cable should be used for the communication between the PC and the power supply. The data lines Rx and Tx are not crossed. A RS232 cable is shipped with each TopCon power supply unit.

6.3 Operation

In order to be able to work correctly with TopControl, the PC must be connected to the TopCon power supply by means of a RS-232 cable on COM1, COM2, COM3 or COM4. The mains voltage must be connected to the power supply and be turned on.

After successful installation, TopControl can be started. The integrated TopControl operating environment appears. This operating environment is your central working desktop that integrates all the services necessary for a quick and simple parameter setup, control and monitoring of the TopCon power supply.

7. Control through RS-232 / RS-422

7.1 Control functions

Abbreviations:

R/W: The value can be read (R) and / or written (W.) Reading of a W-value can deliver undefined values. It is not permitted to write on a R-value.

7.1.1 Device control

Definition of active Interface

RemoteControlInput		
Addr. RAM	R/W	Condition
005087h	R/W	Only settable on the master unit
<i>Possible values / meaning:</i>		
0:	Analog/digital inputs	
1:	HMI	
2:	RS232	
32767:	Inactive (no interface has the control)	

RemoteControlInput defines which interface is active. Values which can only be set if the RS232 is active have a corresponding remark (condition).

On/Off control

VoltageOn		
Addr. RAM	R/W	Condition
005089h	W	RemoteControlInput must be set to RS232. Switching-on only possible, if the system is in the state READY. Only settable on the master unit.
<i>Possible values / meaning:</i>		
0:	output voltage OFF	
1:	output voltage ON	

Alternatively to the On/Off control through the analog / digital interface, the power supply unit can be directly switched on and off with the control parameter VoltageOn.

Clear errors and warnings

ClearErrors		
Addr. RAM	R/W	Condition
00508bh	W	RemoteControllInput must be set to RS232. Only settable on the master unit.
<i>Possible values / meaning:</i>		
1: Clear errors and / or warnings		

With this instruction all errors and warnings can be cleared. In a multi-unit system the errors and warnings of all slave units will be cleared as well. Exception: Errors from the Login and Configuration group cannot be cleared with this instruction: the power supply has to be switched off and on again with the main circuit breaker.

Save settings permanently

StoreSettings		
Addr. RAM	R/W	Condition
00508ah	W	Only settable on the master unit.
<i>Possible values / meaning:</i>		
1: Permanently save all settings in the non-volatile memory		

Define query range

ModuleSelectIndex		
Addr. RAM	R/W	Condition
0050d0h	R/W	Only settable on the master unit.
<i>Possible values / meaning:</i>		
0: Query master values		
1-63: Query slave values		
64: Query system values		

Based on the ModuleSelectIndex setting the query through the master unit delivers the values of the master unit, of the corresponding slave unit or of the whole system:

- State query
- Error memory query
- Actual value query
- Operating mode query

On the slave unit and in case of single-unit operation the setting of the ModuleSelectIndex is of no importance. A query through a slave unit always delivers the value of this slave unit. After POWERUP the ModuleSelectIndex is on 64

The slave number (1 ... 63) required for the ModuleSelectIndex depends on the multi-unit operating mode and can be calculated with the values of the multi-unit ID selectors on the front panel according to the following formula:

Multi-unit operating mode	ModuleSelectIndex
Parallel or series operation	$(8 * AH) + AL$
Multi-load operation	$(16 * AH) + AL$

7.1.2 State query

State query

ActualState		
Addr. RAM	R/W	Condition
00508ch	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
0:	POWERUP	
4:	READY	
8:	RUN	
10:	WARN	
12:	ERROR	
14:	STOP	

Depending on the setting of the ModuleSelectIndex this query delivers the state of the master unit, of a slave unit or of the system.

7.1.3 Error memory query

All possible errors are defined by an ErrorGroupCode and an ErrorDetailCode. In order to define the error cause the ErrorGroupCode as well as the ErrorDetailCode have to be read. "Clear Error" deletes the error memory.

Depending on the ModuleSelectIndex this query delivers the errors of the master unit, of a slave unit or of the whole system.

Error cause query

ErrorGroupCode		
Addr. RAM	R/W	Condition
00508dh	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all error groups (0000h ... FFFFh)		
Meaning of the codes see chapter Error handling.		

A value of 0060h e.g. means that errors occurred in the error groups 0020h and 0040h. In order to know the precise error cause, the ErrorDetailCodes of these two error groups have to be queried.

ErrorDetailCode – Internal (ErrorGroupCode 0001h)		
Addr. RAM	R/W	Condition
005093h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "Internal" (0000h ... FFFFh)		
Meaning of the codes see chapter Error handling.		

ErrorDetailCode – PDSP (ErrorGroupCode 0002h)		
Addr. RAM	R/W	Condition
005094h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "PDSP" (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Current (ErrorGroupCode 0004h)		
Addr. RAM	R/W	Condition
005095h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "Current" (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Voltage (ErrorGroupCode 0008h)		
Addr. RAM	R/W	Condition
005096h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "Voltage" (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Supply (ErrorGroupCode 0010h)		
Addr. RAM	R/W	Condition
005097h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "Supply" (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Temperature (ErrorGroupCode 0020h)		
Addr. RAM	R/W	Condition
005098h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "Temperature" (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Communication (ErrorGroupCode 0040h)		
Addr. RAM	R/W	Condition
005099h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "Communication" (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Modulator (ErrorGroupCode 0080h)		
Addr. RAM	R/W	Condition
0050a8h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group “Modulator” (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – AD-Overrange1 (ErrorGroupCode 0100h)		
Addr. RAM	R/W	Condition
0050a9h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group “AD-Overrange1” (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – AD-Overrange2 (ErrorGroupCode 0200h)		
Addr. RAM	R/W	Condition
0050aah	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group “AD-Overrange2” (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – AD-Underrange1 (ErrorGroupCode 0400h)		
Addr. RAM	R/W	Condition
0050abh	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group “AD-Underrange1” (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – AD-Underrange2 (ErrorGroupCode 0800h)		
Addr. RAM	R/W	Condition
0050ach	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group “AD-Underrange2” (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Login (ErrorGroupCode 1000h)		
Addr. RAM	R/W	Condition
0050adh	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group “Login” (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Configuration (ErrorGroupCode 2000h)		
Addr. RAM	R/W	Condition
0050aeh	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "Configuration" (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

ErrorDetailCode – Miscellaneous (ErrorGroupCode 8000h)		
Addr. RAM	R/W	Condition
00509ah	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
Sum of all detail errors of the error group "Miscellaneous" (0000h ... FFFFh) Meaning of the codes see chapter Error handling.		

7.1.4 Set values

The following values set the set values for voltage, current, power and internal resistance.

VoltageSetPoint		
Addr. RAM	R/W	Condition
005080h	R/W	Write (W) possible only on the master unit. RemoteControllInput set to RS232.
<i>Possible values / meaning:</i>		
0 ... 4000 decimal (4000 corresponds to system nominal output voltage)		

CurrentSetPoint		
Addr. RAM	R/W	Condition
005081h	R/W	Write (W) possible only on the master unit. RemoteControllInput set to RS232.
<i>Possible values / meaning:</i>		
0 ... 4000 decimal (4000 corresponds to system maximum output current)		

PowerSetPoint		
Addr. RAM	R/W	Condition
005082h	R/W	Write (W) possible only on the master unit. RemoteControllInput set to RS232.
<i>Possible values / meaning:</i>		
0 ... 4000 decimal (4000 corresponds to system nominal output power)		

ResistanceSetPoint		
Addr. RAM	R/W	Condition
005083h	R/W	Write (W) possible only on the master unit. RemoteControllInput set to RS232.
<i>Possible values / meaning:</i>		
0 ... 4000 decimal (4000 corresponds to nominal internal resistance)		

7.1.5 Actual values reading

The actual values are scaled to match the corresponding setpoint values and can only be read.

Depending on the ModuleSelectIndex this query delivers the actual values of the master unit, one of the slave units or the whole system.

ActualOutputVoltage		
Addr. RAM	R/W	Condition
005084h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
0 ... 4000 decimal (4000 corresponds to system nominal output voltage)		

ActualOutputCurrent		
Addr. RAM	R/W	Condition
005085h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
0 ... 4000 decimal (4000 corresponds to system maximum output current)		

ActualOutputPower		
Addr. RAM	R/W	Condition
005086h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
0 ... 4000 decimal (4000 corresponds to system nominal output power)		

7.1.6 Operating mode reading

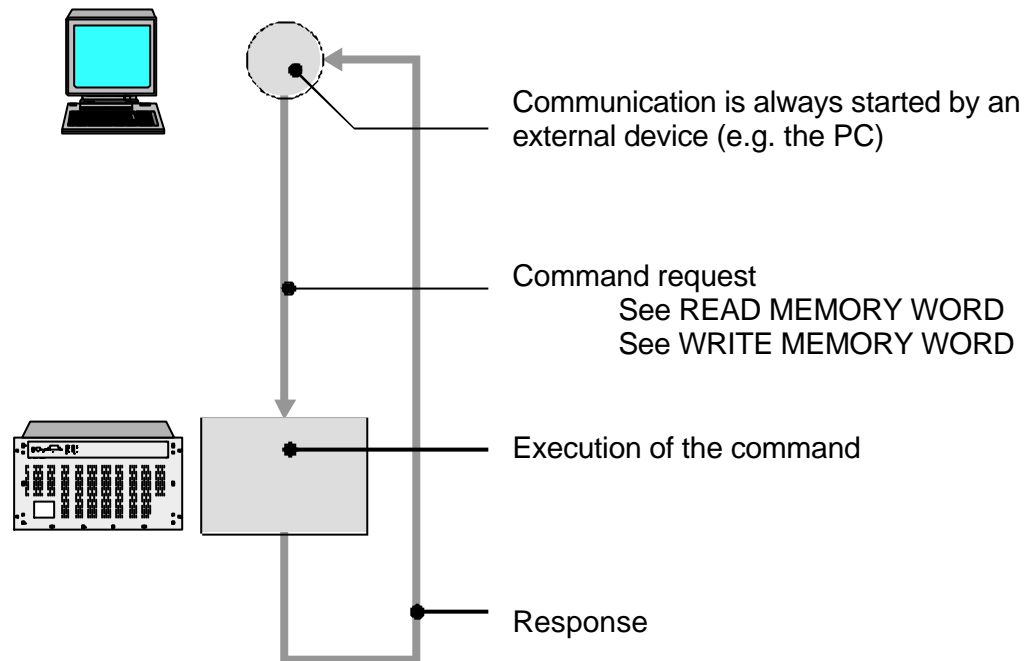
Depending on the ModuleSelectIndex this query delivers the actual values of the master unit, one of the slave units or the whole system.

ActualControlMode		
Addr. RAM	R/W	Condition
0050b8h	R	ModuleSelectIndex correctly set.
<i>Possible values / meaning:</i>		
0:	Operating mode undefined (e.g. system value in multi-load operation)	
1:	Constant voltage (CV)	
2:	Constant current (CC)	
4:	Constant power (CP)	

7.2 Protocol

The communication over the RS-232 runs on a proprietary protocol with the following proprieties:

- length and checksum coding for every frame
- address length 3 byte (24 bit)



Each transmission packet consists of:

- Talk-Header, fix length, 3 Byte
- Talk-Frame, variable length

Whether a retry takes place or not in case of an error (checksum fail, or "not ok" response) depends on the external device (e.g. the PC), or respectively from its control program.

7.2.1 READ MEMORY WORD

In this example the actual current value should be read through RS232. The TopCon power supply unit has the following output values:

Unom = 100 V
 Imax = 125 A

Actual output current reading:

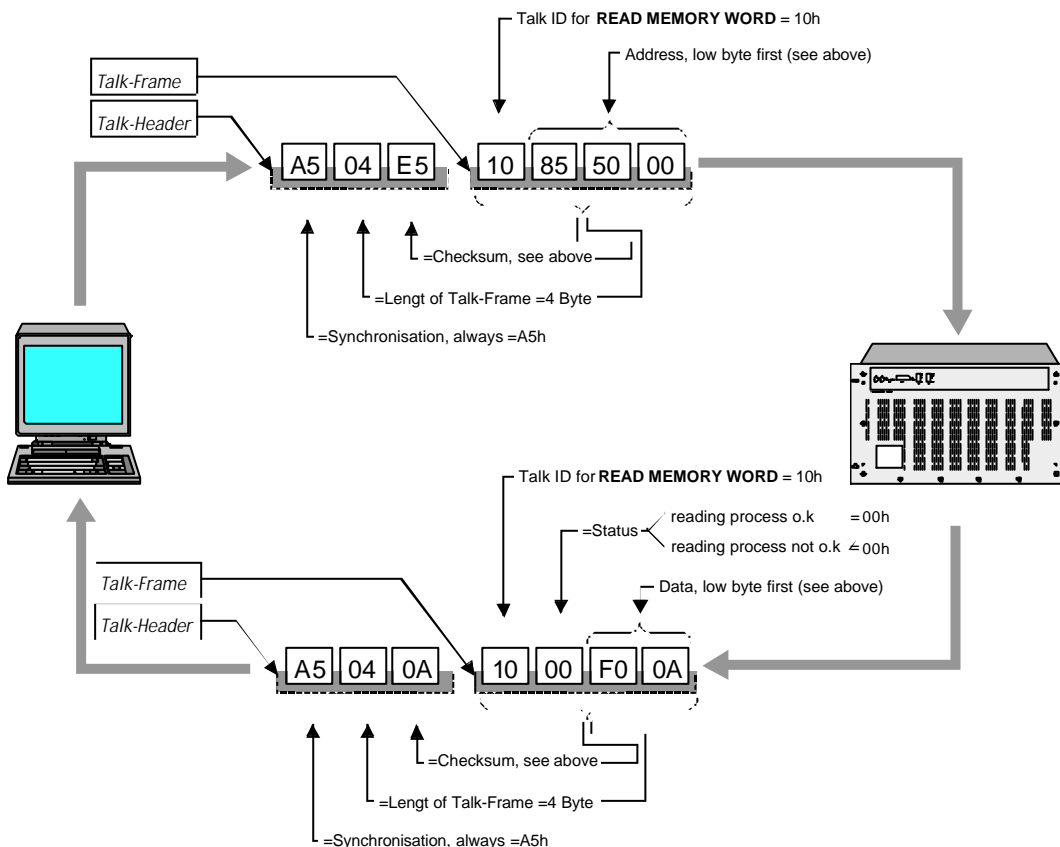
- Address: 005085h
- Value range 0 ... 4000 decimal

Remarks:

- For the instruction READ MEMORY WORD the talk ID must be set 10h.
- The checksum corresponds to the sum of all the bytes in the talk frame, modulo 100h

Example: = (10h+85h+50h+00h) Modulo 100h
 = E5 Modulo 100h
 = E5

Communication sequence over the RS-232 interface:



The TopCon answers to the actual current reading request with the value 0AF0h = 2800 decimal. In this example 2800 corresponds to a current of 87.5A (4000=125A).

7.2.2 WRITE MEMORY WORD

In this example the voltage set value should be set through RS232 to 10V. The TopCon power supply unit has the following output values:

Unom = 100 V

Imax = 125 A

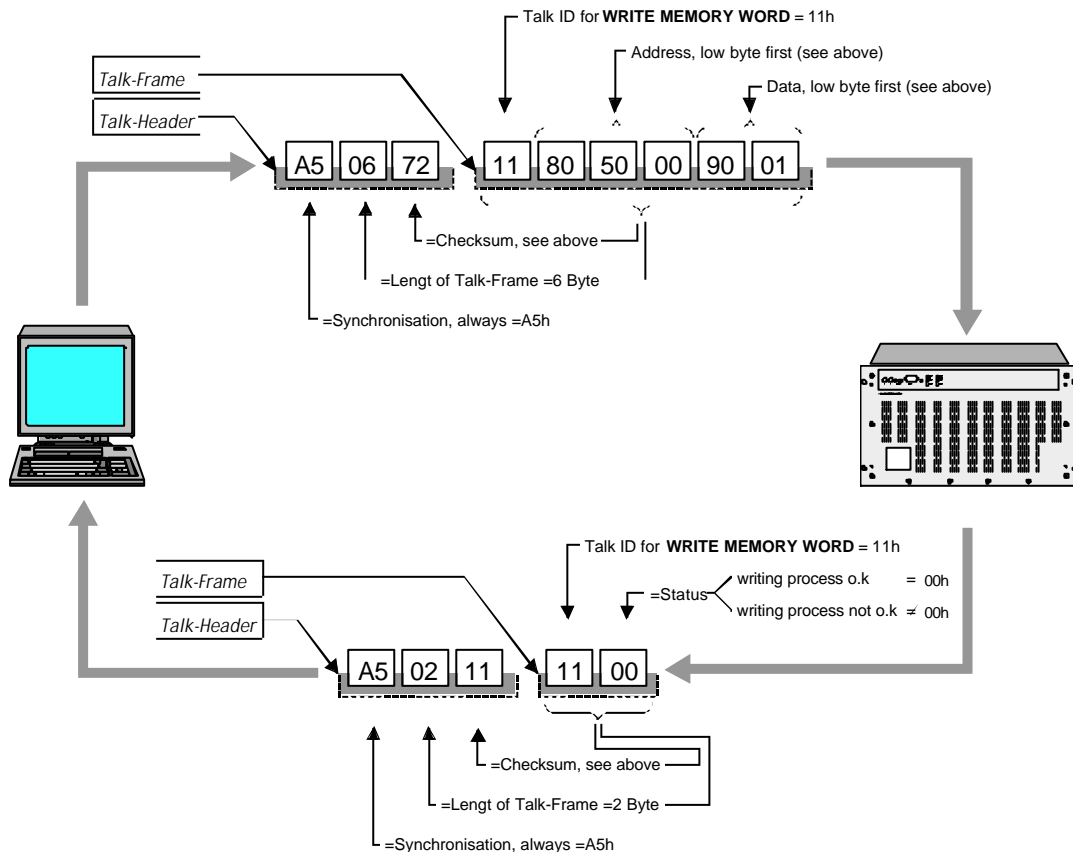
Voltage set value setting:

- Address: 005080h
- Value range 0 ... 4000 decimal
A set value of 10V corresponds to 10% Unom = 10% x 4000 = 400 = **0190h**

Remarks:

- For the instruction WRITE MEMORY WORD the talk ID must be set 11h.
- The checksum corresponds to the sum of all the bytes in the talk frame, modulo 100h
Example: = (11h+80h+50h+00h+90h+01h) Modulo 100h
= 172 Modulo 100h
= 72

Communication sequence over the RS-232 interface:



8. Maintenance and troubleshooting

8.1 Periodic maintenance

8.1.1 General

The electronics in the TopCon units operate basically maintenance-free.

8.1.2 Air filters

In case dust filters are being used to filter the cooling air, regular cleaning and/or replacing of the filters is necessary. As the operating time between filter cleanings strongly depends on the degree of air pollution, no generally applicable care intervals can be specified.

The following care interval values are given as an indication, assuming the use of standard air filters of the type TC-ACC-AFS:

**Air filter
care
intervals**

Pollution degree of the intake cooling air	Environment example	Change the filter every
low	Labor	4000 operating hours
middle	Machine shop, free from fine metal dust	2000 operating hours
high	Construction site or Machine shop, with fine metal dust (e.g. from cutting and abrasion machinery)	1000 operating hours

8.2 Fault diagnosis

In case of a fault it is recommended to read the error log and the actual error with a PC and the "TopControl" program. The data in the error log can give useful hints regarding the cause of the fault.

8.3 Troubleshooting

8.3.1 Replacing a complete module

In case a complete TopCon unit has to be replaced in a plant or system, the following points have to be considered and checked:

- Do the device types and data plate parameters correspond?
- Are the parameters in the new device correct?
(otherways download the correct parameters with TopControl!)
- Have all power and control cables been connected correctly?

8.3.2 Replacing internal assemblies

The replacement of assemblies inside a TopCon module must be done by expert personnel and using the appropriate equipment. Only original components from the manufacturer are allowed to be used for replacement.

After the replacement of a component or assembly, the device must undergo a complete functional test as specified by the manufacturer.



Regatron AG declines all responsibility for damage to persons, devices or plants in case the replacement of a defective component or assembly was done by non-qualified and non-authorized personnel or using third party replacements!

8.3.3 Repairing internal assemblies

Internal assemblies are only allowed to be repaired by expert personnel and Regatron / TopCon authorized service staff.

In normal cases any part or assembly must be sent to Regatron AG for repair.

9. Human Machine Interface – optional integrated control unit HMI

9.1 Short description of the Human Machine Interface

Single units or entire multi-unit systems can be controlled with the control unit HMI integrated in the front panel. Text menus as well as operating status readings and measurements offer a clear control of the system.

9.2 Technical Data on the Human Machine Interface

Display	<ul style="list-style-type: none"> Graphic LC-Display, 160x80 pixels Black script on a yellow-green background LED background lighting
Input elements	<ul style="list-style-type: none"> Select button: mechanical rotating encoder with 20 stops and integrated push button 6 buttons with partially context-dependant functions
Alarm signal	<ul style="list-style-type: none"> Piezo-Summer, 1kHz
Internal interfaces	<ul style="list-style-type: none"> CAN-Bus V2.0 B (communication with power supply) RS232 (for HMI software update)
Power supply	<ul style="list-style-type: none"> 18-36V, 40-130mA @ 24V (depending on brightness)

9.3 Operating the Human Machine Interface

9.3.1 Start screen

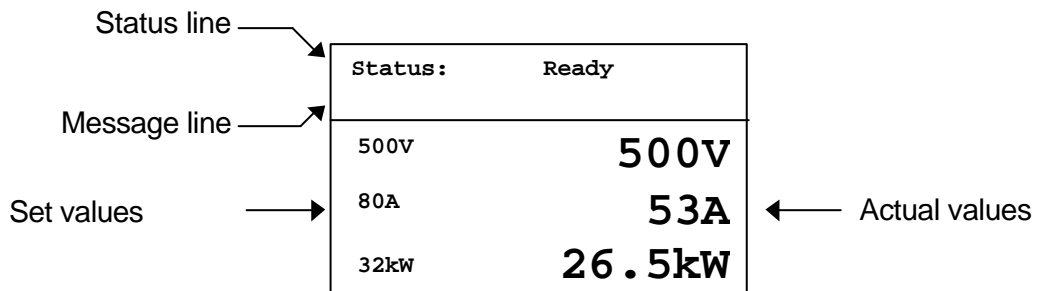
After turning on the main circuit breaker at the TopCon unit, the HMI enters the initializing phase. The start screen appears and the following system information is shown.

System Info	
U max.	500V
I max.	80A
P max.	32kW
TCbase/V2.36.00	
HMI/V1.00.01	

The start screen shows the performance data for the power supply and gives information on the software versions being used. After 5 seconds, or immediately after pressing the escape button, the start screen gives way to the main screen. The information shown on the start screen can be called up again at any time through the menu.

9.3.2 Main screen

The main screen is subdivided as follows.



Status line	Description of status (operating status)
Ready	<ul style="list-style-type: none"> The output is free of voltage (power semiconductors closed).
Running	<ul style="list-style-type: none"> Unit running
Warning	<ul style="list-style-type: none"> The warning status signals a looming fault status. A corresponding warning message is displayed in the message line. (e.g. an emerging over temperature). The unit continues to run under the warning status.
Error	<ul style="list-style-type: none"> The unit is in a fault state. The output is free of voltage (power semiconductors closed). The message line displays the cause of the fault. See chapter <i>Handling faults with the Human Machine Interface</i>.
Stop	<ul style="list-style-type: none"> This state is achieved through the corresponding user instruction in TopControl. The state Stop is needed for firmware updates. The control electronics are locked. The output is free of voltage (power semiconductors closed). The unit must be restarted by briefly switching the main circuit breaker off and then on.

Message line	Displays warning and fault messages
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Set values	Displays the set values
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Actual values	Displays the actual values in boldface
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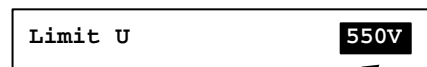
9.3.3 System screen

By pressing the display button, the screen can be switched between the main and the system screen. The system screen shows the following information.

Ref. source	HMI
Active interface	HMI
Limit U	550V
Limit I	88A
Internal resistance	0mW

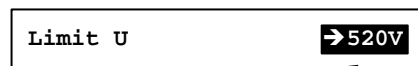
9.3.4 Edit / Select mode

The values shown on the main screen and the system screen (except for Ref. Source) can be changed directly with the select button. Turning the select button brings the individual values of the screen displayed into the select mode: the selected value is displayed in inverse color.



Select mode: inverse script

By pressing the select button, the selected value comes into the Edit mode: this mode is indicated by a blinking arrow before the selected value. In Edit mode, the selected value can be changed by turning the select button.



Edit mode: blinking arrow

The input is entered by pressing the select button. The new value is now active, but only saved in a volatile manner until the power supply is turned off. As long as the change is not finished by pressing the select button, it can be deleted by pressing the escape button. Permanently saving the change takes place through the menu entry *Save settings*.

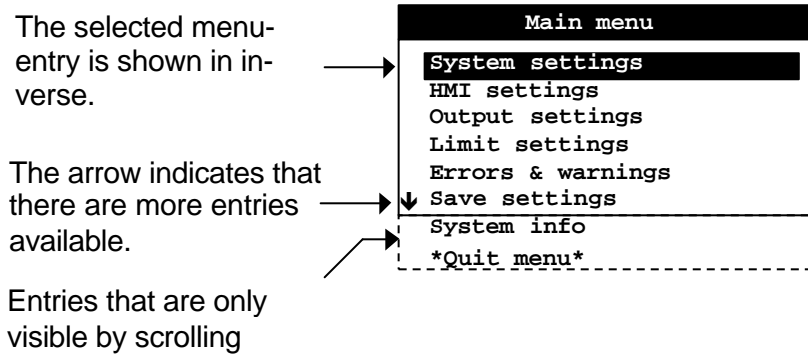
Note: The set values for voltage, current, power, and internal resistance are processed directly in the Edit mode and are already active before pressing the select button (potentiometer function).

The Edit mode can also be activated by pressing the Next button. Pressing the Next button a second time will save any change in the value (like pressing the select button) and will activate the Edit mode for the next value in the list.

Note: The Edit mode remains active until the select button, the Next button, or the escape button is pressed.

9.3.5 Main menu

Pressing the menu button will bring up the main menu, but any messages must be acknowledged first (by pressing the escape button or select button). The main menu is subdivided as follows.



If there are more menu entries than there is space on the screen, the user's attention will be drawn to the fact by an arrow before the bottom or the top entry. By turning the select button, the desired menu entry can be selected. Pressing the select button leads to the corresponding sub-menu. A menu is closed by selecting the bottommost menu entry (**Quit menu**) or by pressing the escape button.

Main menu	Sub-menu	Menu entries
System settings	• Active interface ¹⁾	• Analog • HMI • RS232 ²⁾
	• Passband ref. values	• 0.6Hz – 1kHz ³⁾
	• Passband feedb. values	• 0.6Hz – 1kHz ³⁾
	• *Quit menu*	

- 1) **Active Interface:** Defines the active control interface.
Note: The setting can also be made on the system screen.
If the HMI is not the active interface, in the message line the text “HMI is passive” appears. If more than one HMI is in the multi-unit system, only one HMI can be in control. On the HMI’s which are not in control of the system, the text “HMI is passive” appears.
- 2) **RS232:** Selecting the menu entry *RS232* activates the RS 232 as well as the optional RS422. To avoid conflicts, only one interface may be used at a time.
- 3) The filter passband for reference values and actual values of the analog interface X105 can be adjusted to 12 levels.

Main menu	Sub-menu	Menu entries
HMI settings	• Buzzer ¹⁾	• On / Off
	• Brightness ²⁾	• 0 – 100%
	• Contrast ³⁾	• 0 – 100%
	• Display format UI / UIP ⁴⁾	• UI • UIP
	• Scroll modes ⁵⁾	• Clockwise: Up • Clockwise: Down
	• Language	• German • English
	• Save HMI settings ⁶⁾	
	• *Quit menu*	

Main menu	Sub-menu	Menu entries
Output settings	• Voltage	• 0 – U maximum [Volts]
	• Current	• 0 – I maximum [Amperes]
	• Power limit	• 0 – P maximum [Kilowatts]
	• Int. resistance	• 0 – 1000mΩ
	• *Quit menu*	

Main menu	Sub-menu	Menu entries
Limit settings	• Limit U ⁷⁾	• 0 – 1.1 x U maximum [Volts]
	• Limit I ⁸⁾	• 0 – 1.1 x I maximum [Amperes]
	• *Quit menu*	

- 1) **Buzzer:** Acoustic alarm when faults occur
- 2) **Brightness:** Brightness of the LED background illumination
- 3) **Contrast:** LCD contrast settings
- 4) **Display format UI / UIP:** Displaying the output power of the power supply on the main screen. If UIP is selected, the output power will be incorporated.
- 5) **Scroll modes:** Determines whether, when turning the select button clockwise, the menu scrolls up or down.
- 6) **Save HMI settings:** Saves the values entered under HMI settings. The message *Settings saved* must be acknowledged by pressing the select button.
- 7) **Limit U:** Output voltage limit value; if it is exceeded, the power supply will pass into the *Fault* state (Over Voltage Protection).
Note: The setting can also be made on the system screen.
- 8) **Limit I:** Output current limit value; if it is exceeded, the power supply will pass into the *Fault* state (Over Current Protection).
Note: The setting can also be made on the system screen.

Main menu	Sub-menu	Menu entries
Error group	Description of the pending group errors	Description of the detail errors of the selected group error

Main menu	Sub-menu	Menu entries
Warning group	Description of the pending group warnings	Description of the detail warnings of the selected group warning

Main menu	Description
Save settings	<p>Permanently saves the changed values. The save procedure takes about 2 seconds. The message <i>Settings saved</i> must be acknowledged by pressing the select button or the escape button.</p> <p><i>Note:</i> Changes in the HMI settings are made in the sub-menu <i>HMI settings</i> and can only be saved through the appropriate sub-menu's <i>Save HMI settings</i>.</p>

Main menu	Description
System info	Calls up the screen with system information that is visible during the initializing phase (start screen). This screen can be closed by pressing the select button or the escape button.

Main menu	Description
Quit menu	<p>Closes the main menu and leads to the main or system screen, depending on which was last active.</p> <p><i>Note:</i> The main menu can also be closed by pressing the escape button.</p>

9.3.6 Operating elements

Operating element	Description
Select button	<ul style="list-style-type: none"> • Menus can be scrolled through and values changed by turning the select button. • The select button has an integrated push button, which is activated by pressing the select button against the front panel. Menu entries are selected, entries completed, and the edit mode on the main and system screen activated with the push button. • Fault messages that appear in a separate window due to their size can be acknowledged with the push button.

Operating element	Description
Display button	<ul style="list-style-type: none"> • By pressing the display button, the operator jumps from any menu location to the main or system screen, depending on which was displayed last. • When the main or system screen is displayed, the operator can switch between the two with the display button.

Operating element	Description
Next button	<ul style="list-style-type: none"> • The Next button is only active on the main and system screens. It has the following functions: <ul style="list-style-type: none"> • A value in the select mode comes into the edit mode. • The change to a value in the edit mode is finalized and the next value in the menu list comes into the edit mode. <p><i>Note:</i> The finalized change is only saved in a volatile manner until the power supply is turned off.</p>

Operating element	Description
Escape button	<ul style="list-style-type: none"> • Return to the main screen from the main menu • Return to the main menu from the sub-menu • Acknowledge fault messages • Delete settings if the change has not yet been finalized by pressing the select button or the next button • Close the info-screen

Operating element	Description
Remote button	<ul style="list-style-type: none"> When the red LED on the remote button is lit, it indicates that the HMI is inactive. Pressing the remote button brings the operating control back to the HMI, if the output is free of voltage (states ready and error). When the red LED is not lit (HMI is active), pressing the remote button sets the HMI inactive.

Operating element	Description
Menu button	<ul style="list-style-type: none"> Pressing the menu button leads to the main menu. If there is a pending message, it must first be acknowledged by pressing the select button or the escape button.

Operating element	Description
On/Off button	<p>Pressing the On/Off button causes the following change in status depending on the operating status of the system:</p> <ul style="list-style-type: none"> Ready => Running Running or Warning => Ready Error => Ready <p>For the On/Off button to work, the HMI must be the active control interface.</p> <p>Explanations of the transitions in status:</p> <ul style="list-style-type: none"> Ready => Running <ul style="list-style-type: none"> When the main screen is displayed before pressing the On/Off switch (checking the reference values!), the power supply goes directly into the <i>Running</i> status. In all other cases, the display changes to the main screen, so that the reference values can be checked. Pressing the On/Off button again changes the power supply to the <i>Running</i> status. <i>Note:</i> When there is an open interlock circuit, the system goes into the <i>Error</i> status. Running or Warning => Ready <ul style="list-style-type: none"> The output is switched free of voltage.

9.4 Handling faults with the Human Machine Interface

9.4.1 Acknowledging warning and fault messages

When faults arise, the power supply goes into *Error* status. By acknowledging the fault, the power supply comes back to the *Ready* status. Fault messages can be acknowledged by pressing the escape button.

With a one-time acknowledgement, all pending warning and fault messages are closed out. Before acknowledgement, therefore, the pending messages must be analyzed so that the cause of fault can be remedied.

9.4.2 Faults during initialization

Faults that show up during the initialization are displayed in a separate window. After acknowledging the fault message window, the main screen appears. The power supply goes into *Error* status and the message *Login error* is shown on the message line. After removing the cause of the fault, a restart is necessary:

- Briefly switch off and on the main circuit breaker at the TopCon unit!

The following initialization faults are displayed in a fault display window.

Fault	Cause/Corrective Measures
No call for login	<ul style="list-style-type: none">• The internal CAN connecting cable between the unit and the HMI is not properly connected.

9.4.3 Faults during operation

Faults appearing during operation are shown in the message line of the main screen as well as in the menu *Error groups*. A distinction is made between error groups and detail errors. The error groups contain detail errors. In the message line of the main screen only the error group appears. The detail errors can be displayed in the menu.

See chapter Error handling for a complete listing of all error groups and detail errors.

The communications errors listed in the following table are shown first in a separate window. After acknowledgement, the message *Communication error* appears in the message line of the main screen and the power supply changes to Error status.

Error description in separate window	Cause / corrective measures
CAN controller error	<ul style="list-style-type: none"> • The CAN controller is in Bus-Off state.
No data received by HMI	<ul style="list-style-type: none"> • The HMI or RCU cannot receive any data. • Please check / carry out the following points: <ul style="list-style-type: none"> • Is the connecting cable between power supply unit and RCU correctly connected? • Is a CANTERM terminal resistor connected at the end of the CAN Bus? • Push the button "Clear Errors" in the PC program TopControl • Switch the main breaker of the TopCon unit off and on again.

9.4.4 Warnings during operation

Warnings appearing during operation are shown in the message line of the main screen as well as in the menu *Warning groups*. A distinction is made between warning groups and detail warnings. The warning groups contain detail warnings. In the message line of the main screen only the warning group appears. The detail warnings can be displayed in the menu.

See chapter Error handling for a complete listing of all warning groups and detail warnings.