3BHS109762 E01 Rev. D
Edition: december 2011

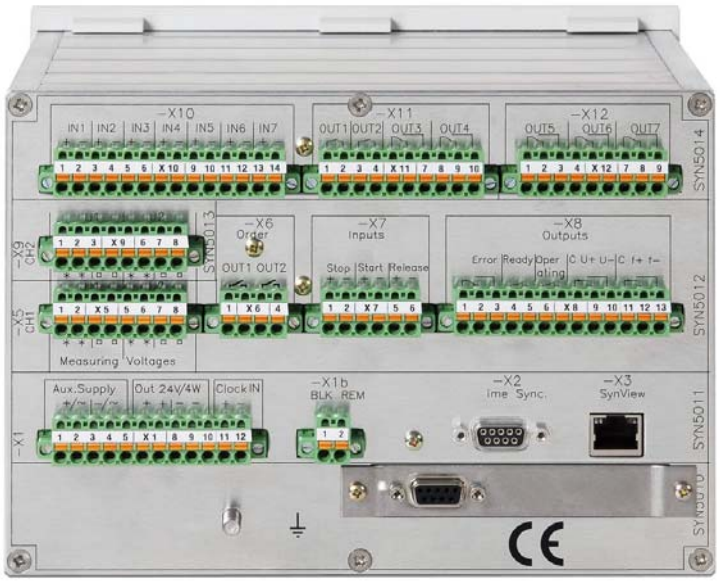
SYNCHROTACT® 5

Operating Instructions

SYN 5201
SYN 5202

Turgi

Content



1 General information

1.1 Introduction

This User Manual is aimed at persons who have a basic knowledge of working with electronic equipment, who understand electrical symbols in schematic diagrams, but who know little or nothing about working with SYNCHROTACT 5 equipment.
The User Manual provides the information required in order to install, commission and operate the SYNCHROTACT 5 device of types **SYN 5201** and **SYN 5202**.

1.2 Marking of text sections

General warning
This symbol placed before the text indicates situations or conditions which can cause a risk of death or serious injury. The text describes the procedure for preventing these risks.

Dangerous voltages
This symbol indicates that, when handling the equipment, dangerous voltages occur which can cause death or serious injury.

Caution The sections of text marked with "Caution" contain information on situations which can lead to material damage or equipment failure if the instructions are disregarded.

Note The sections of text marked with "Note" provide additional information. This must be taken into consideration in order to prevent malfunctions.

1.3 Purpose and use of the SYN 5201 and SYN 5202

The digital synchronizer can be used for the following applications:

- For automatic synchronization and paralleling of generators
- For automatic paralleling of synchronous and asynchronous lines, transmission lines and busbars (incl. tap-changer matching).
- As a paralleling monitoring device (synchrocheck) for monitoring automatic or manual paralleling sequences including dead bus.

1.4 Manufacturer's address

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Synchronizing devices and voltage regulators
CH-5300 Turgi/Switzerland

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2 Functional principle

2.1 Brief description

The SYNCHROTACT 5 digital synchronizer is used for automatic synchronizing and paralleling of generators with lines and for the paralleling of already synchronous lines. The device is designed for system frequencies of either 50/60 Hz or 16 $^{2}/_{3}$ Hz.

SYN 5201 is a single-channel synchronizing device whose component choice and software design provides the highest security against incorrect paralleling.

SYN 5202 consists of two independent channels with different hardware and software. This dual-channel property maximizes security against incorrect paralleling.

All parameters required for paralleling are stored in a parameter set. The paralleling conditions and the characteristics of the voltage and frequency matchers are defined in this set. With the option providing seven parameter sets, paralleling can be carried out under different conditions or with different matcher characteristics using the same device. Seven configurable digital inputs and outputs are available for the selection and back indication of a parameter set.

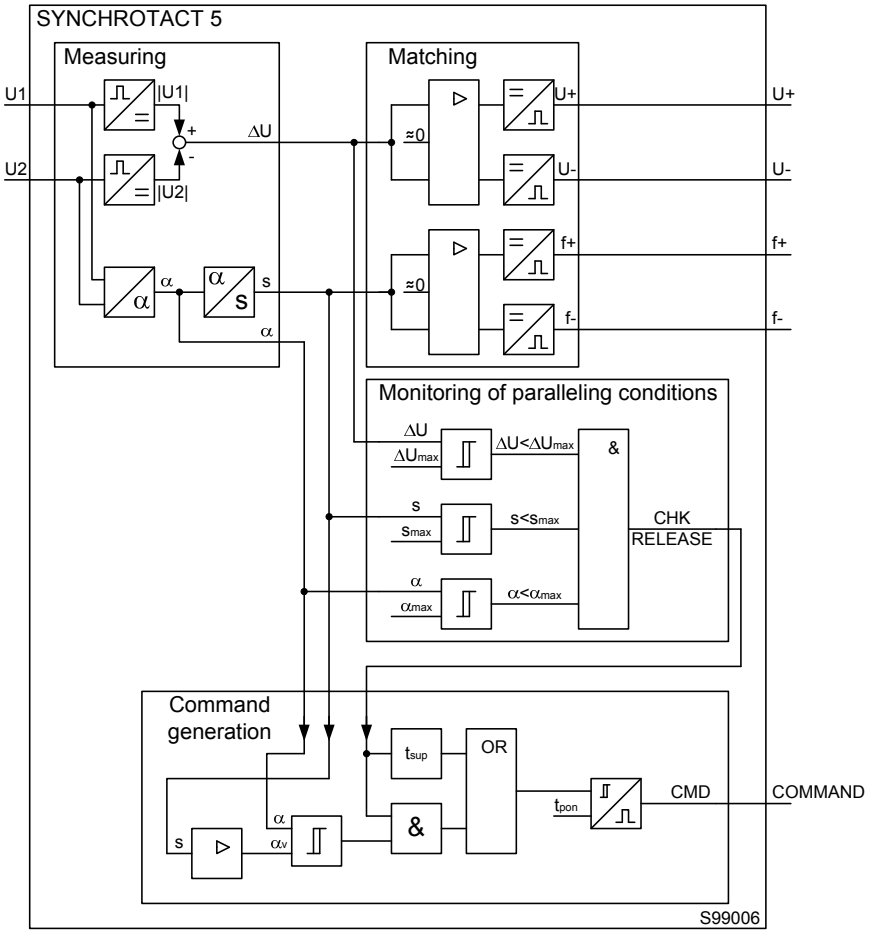
The data which are important for commissioning and for control purposes can be uploaded or downloaded using the PC tool **SynView** or, alternatively, via the keypad on the front panel of the unit.

2.2 Paralleling functions

The automatic paralleling process can basically be divided into four function blocks:

1. Measuring
2. Voltage and frequency matching
3. Monitoring of paralleling conditions
4. Paralleling command generation

In the following figure, the block circuit diagram of the basic paralleling functions of SYNCHROTACT 5 is simplified and shows a single-channel configuration. The individual functions are described more precisely in the following sections.



2.2.1 Measuring

The following measured variables are generated from the two single-phase measuring voltages:

Voltage U1, U2
U1 is the reference voltage e.g. line
U2 is the adjustable voltage e.g. generator.

Frequency f1, f2
f1 is the reference frequency
f2 is the adjustable frequency.

Voltage difference ΔU
ΔU = |U1| – |U2|
ΔU > 0 Adjustable voltage is lower
ΔU < 0 Adjustable voltage is higher

Slip s

$$s = \frac{f1 - f2}{f1} * 100\%$$

s > 0 Adjustable frequency is less (e.g. generator is sub-synchronous)
s < 0 Adjustable frequency is greater (e.g. generator is oversynchronous)

Phase-angle difference α

$$\alpha = \varphi 1 - \varphi 2$$

α > 0 Adjustable frequency is lagging
α < 0 Adjustable frequency is leading

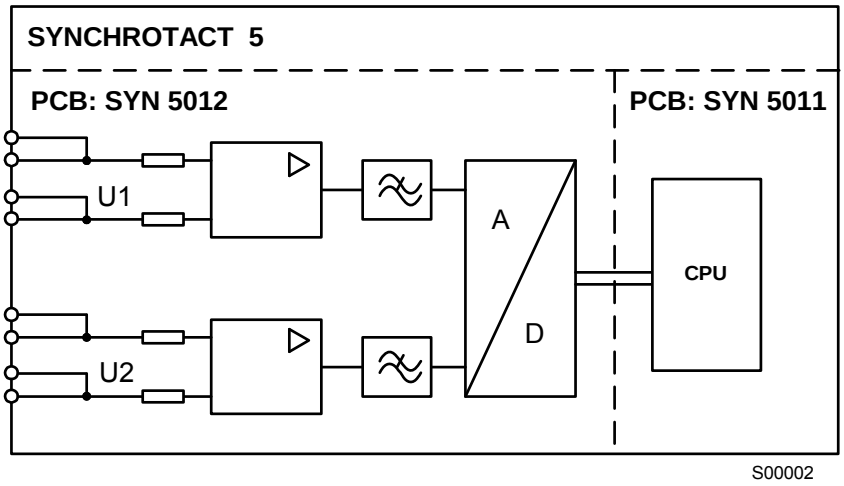
Acceleration ds/dt

$$ds / dt = 2 * \sum_{x=1}^{x=56} \Delta s_x \left[\% / s\right]$$

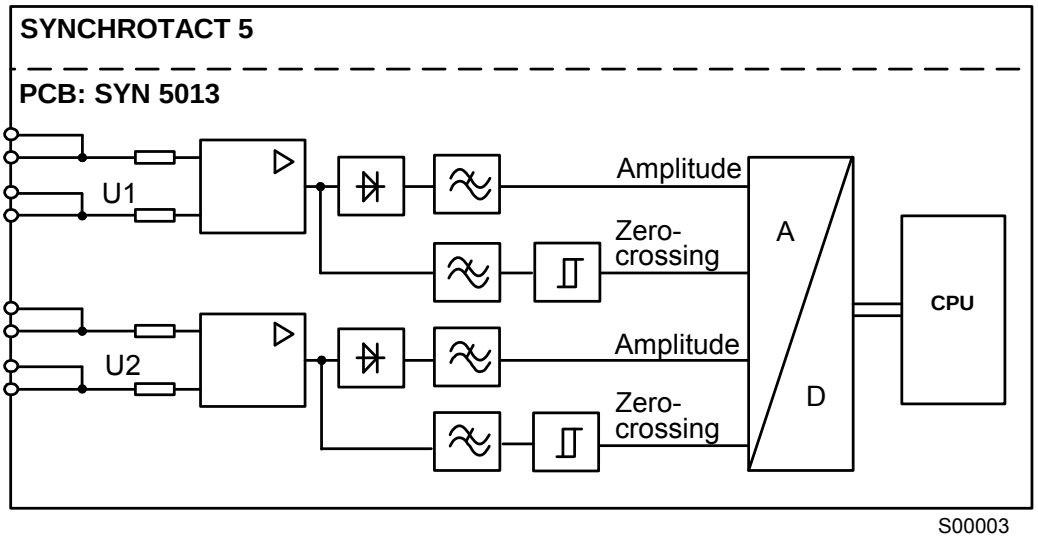
(Every 0.5 s, an average value is formed from 56 measurements; sampling period: 9 ms)
ds/dt > 0 Adjustable frequency is reduced (e.g. generator accelerates)
ds/dt < 0 Adjustable frequency increases (e.g. generator is slowed down)

With SYN 5202, the measurement is carried out separately for each channel. It is possible to carry out three-phase measurements in order to detect connection faults (rotary field, polarity) and losses of phase.

Voltage measurement (SYN 5202: channel 1)
The two input voltages U1 and U2 are passed to the processor via high-impedance input resistors, differential amplifiers, low-pass filters and A/D converters.



Voltage measurement channel 2 (SYN 5202 only)
The two input voltages U1 and U2 are passed through high-impedance input resistors and differential amplifiers. The signal for the amplitude value is formed from this by conversion and filtering . For zero-passage detection, the signal is filtered and passed through a comparator. The signals prepared in this way are passed to the processor via the A/D converter.

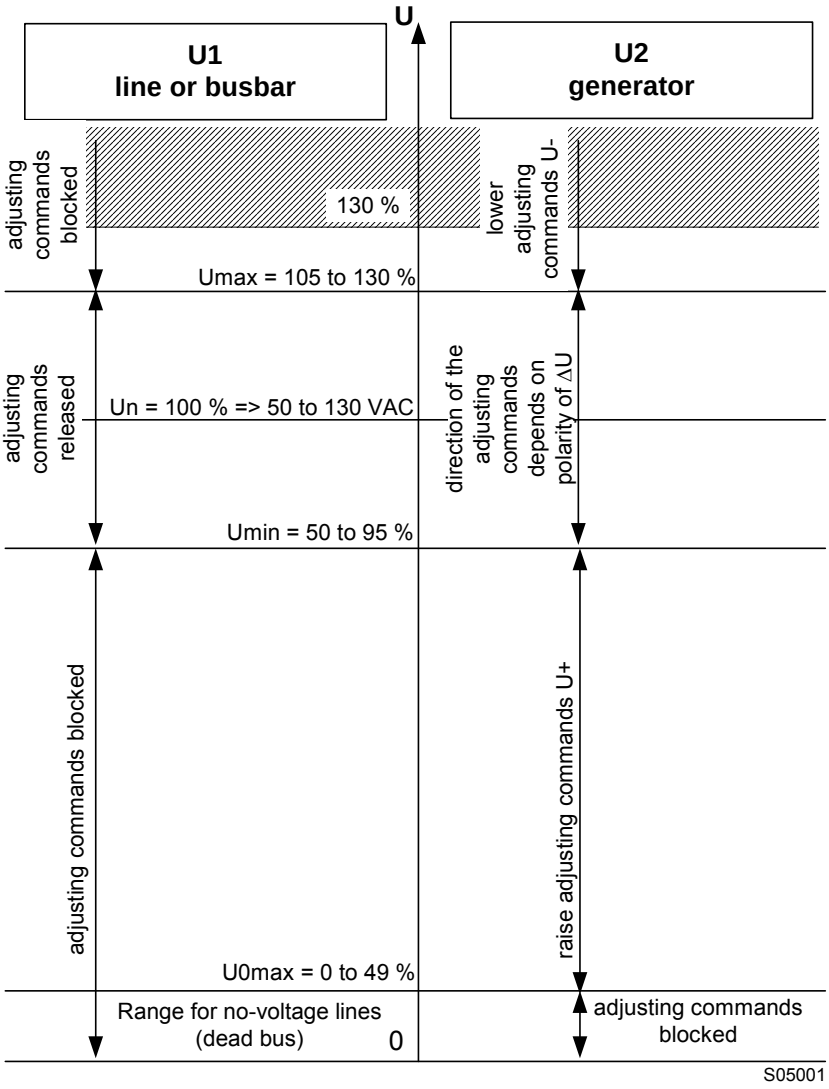


2.2.2 Voltage and frequency matching

Working range of the voltage matcher

If the voltage U1 is in the range between Umin and Umax and the voltage U2 is greater than U0max the adjusting commands are released. The direction of the adjusting commands depends on the polarity of ΔU.

As an additional condition, both frequencies must be in the range fn±5 Hz.

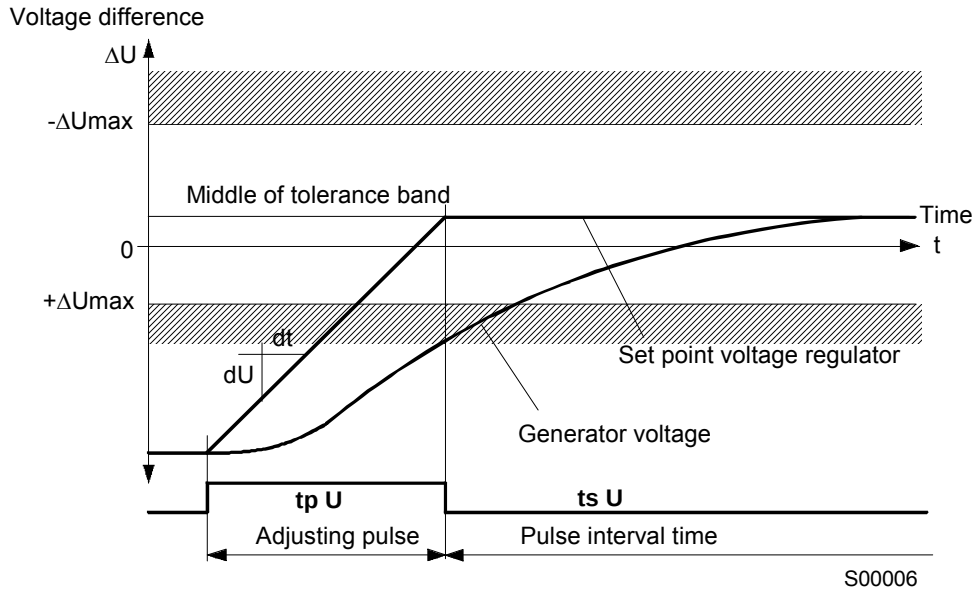


Voltage matcher with variable pulse times

The voltage matcher issues a command the length of which is proportional to the current voltage difference. The proportionality factor dU/dt can be adapted to the voltage regulator. The voltage matcher aims at a value in the middle of the set tolerance band. The adjusting command length tp U is:

$$tpU = \frac{\Delta U - \left(\frac{+\Delta U\,\max - \left| -\Delta U\,\max \right|}{2} \right)}{dU/dt}$$

The adjusting pulse is discontinued as soon as the voltage difference passes through the target value. The command length does not fall below a settable minimum value. After an adjusting command, the system waits for the set pulse interval ts U so that the actual values can stabilise to the new setpoint.



Voltage matching with variable intervals

The function INVERSE U changes the way the voltage matcher functions. The pulses are now always the same length, but the intervals are inversely proportional to the voltage difference.

Pulse length: adjustable by means of the parameter tp Umin: tp = tp Umin

Pause interval: adjustable by means of the parameter ts U; dependent on ts U and ±ΔUmax:

$$ts = ts\ U * \left\{ 1 - 0{,}325 * \left[\Delta U - \frac{\left[\left(+\Delta U\,\max \right) + \left(\left| -\Delta U\,\max \right| \right) \right]}{2} \right] \right\} \geq 0$$

Voltage matcher for tap changer

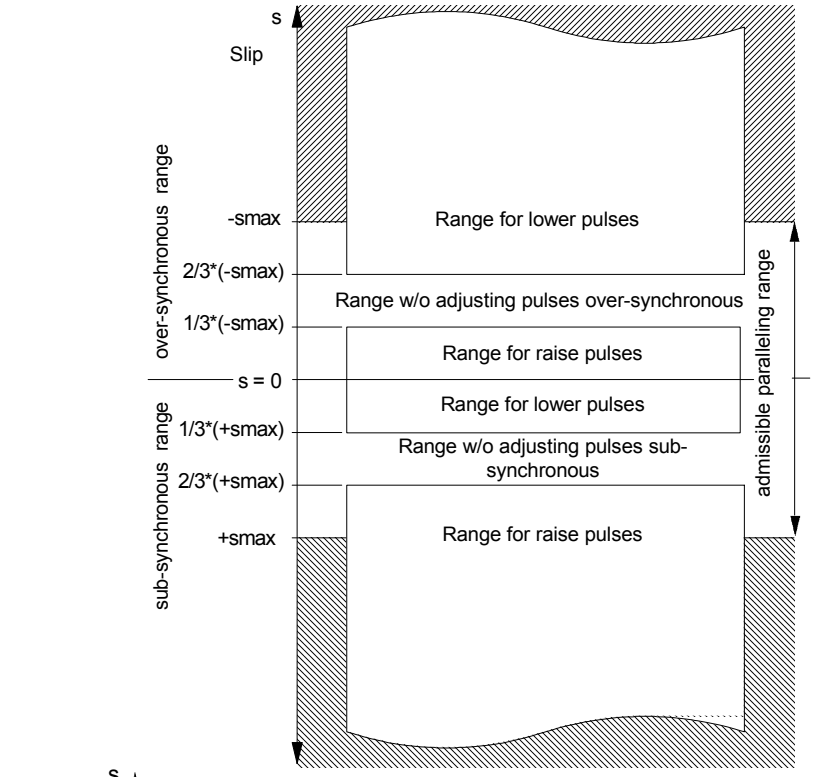
The function TAP CHANGER allows constant pulse durations and pulse intervals to be generated, which is necessary for matching by means of the tap changer.

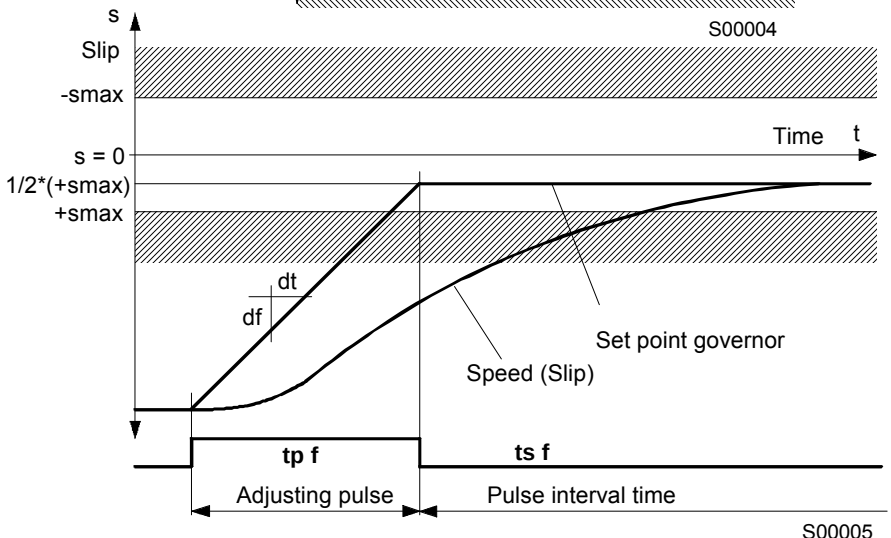
Frequency matcher with variable pulse durations

The frequency matcher issues a command the length of which is proportional to the current slip. The proportionality factor df/dt can be adapted to the governor. The frequency matcher aims at a value midway between the nearer slip limit and zero. The adjusting command length tpf is:

$$tpf = \frac{|\pm s| - \frac{|\pm s\,\max|}{2}}{df\,/\,dt}$$

Between 1/3 and 2/3 of smax there is a range where no adjustment takes place. The adjusting pulse is discontinued as soon as the slip passes through zero. The command length does not fall below a settable minimum value. After an adjusting command, the system waits for the set pulse interval ts f so that the actual values can stabilise to the new setpoint.





Frequency matcher with variable intervals
The function INVERSE f changes the way the frequency matcher functions. The pulses are now always the same length, but the intervals are inversely proportional to the slip.

Pulse length: adjustable by means of the parameter tp fmin: tp = tp fmin

Pause interval: is calculated according to the following formula (can not be set as a parameter):

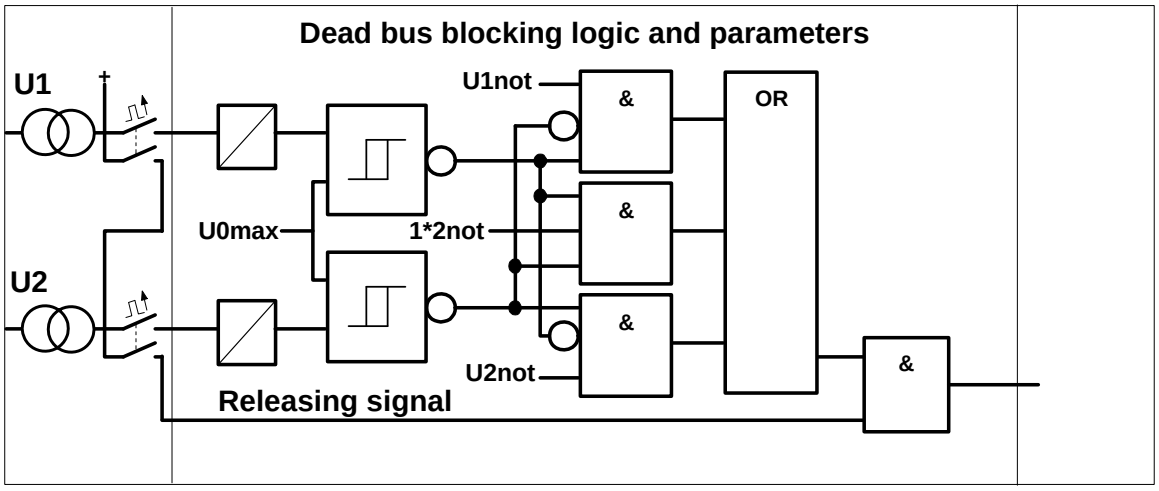
$$ts = \frac{1}{f1 - f2} = \frac{1}{f1 * |s|} \leq 30 \ [s]$$

2.2.3 Monitoring of paralleling conditions

The monitoring of the paralleling conditions can be divided into these parallel-functioning blocks:
- voltage-carrying lines
- no-voltage lines

Paralleling of two voltage-carrying lines
The monitoring of the paralleling conditions enables a paralleling command (CHK RELEASE) if the following conditions are fulfilled simultaneously:
- the phase-angle difference is within the tolerance band
- the slip is within the tolerance band
- the voltage difference is within the tolerance band
- the voltage does not fall below minimum voltage
- the maximum voltage is not exceeded
- the device is in operating status (OPERATING)
- nominal frequency deviation ≤ 5 Hz

Paralleling of no-voltage lines (dead bus)
A special case for the monitoring is the paralleling of no-voltage lines. A paralleling command release is only issued if the external release signal is active and the measuring logic enables the release at the same time. The release by the measuring logic can be enabled if both voltages are within one of the permitted ranges. The dead bus range can be defined as permissible for one, the other or both measuring voltages by means of the parameters U1not, U2not and 1*2not.



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The monitoring of the paralleling conditions (CHK RELEASE) releases the paralleling command if the following conditions are fulfilled simultaneously:

- the releasing signal for dead bus (digital input) is issued
- the zero voltage(s) does not exceed the set threshold U0max
- the current voltage does not fall below the minimum voltage
- the current voltage does not exceed the maximum voltage
- the current zero voltage situation corresponds to a configuration permitted by means of U1not, U2not, 1*2not
- the device is in Operating status (OPERATING)

2.2.4 Command generation

The command generation makes a distinction between asynchronous and synchronous sources or no-voltage lines. Two modes, one for asynchronous and one for synchronous sources, run in parallel, so that a source can be asynchronous or synchronous at any time. The paralleling command is issued in the mode in which all conditions are fulfilled first.

In SYN 5202 the actuation of the paralleling relays takes place separately in both channels.

Asynchronous sources
It is called asynchronous sources, if the two lines to be paralleled (or generator and line) are asynchronous before the circuit breaker is closed.

From the slip s, the acceleration ds/dt, the line frequency f1 and the set paralleling time t on, the command generation calculates the necessary lead angle αv by which the paralleling command is shifted forward in time so that the main contacts close exactly on phase coincidence (see following figure):

$$\alpha v = \left[3{,}6 * f1 * \left| s + \frac{ds/dt * t\ on}{2} \right| * t\ on \right]$$

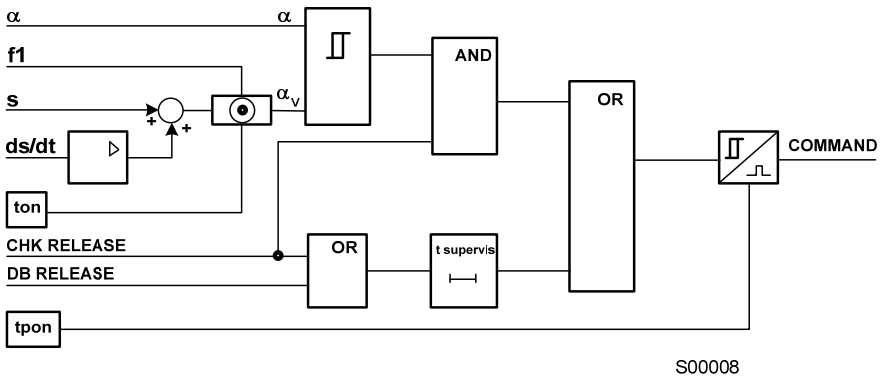
If the measured phase-angle difference α corresponds to the lead angle αv and if all paralleling conditions are fulfilled at the same time (CHK RELEASE), a command is generated (COMMAND).

The command length always corresponds to the set paralleling command length tp on. If the latter is set to OFF or zero, the command generation is no longer in operation. The device then functions like a synchrocheck; as soon as the release is given by the monitoring (CHK RELEASE) the contacts close, when the release is dropped they open again.

Synchronous sources and no-voltage lines
It is called synchronous sources, if the two lines to be paralleled are synchronous before the circuit breaker is closed.

If the paralleling conditions (CHK RELEASE) or dead bus conditions (DB RELEASE) are fulfilled during the monitoring time t supervis, a command is generated immediately after the expiry of t supervis. That means that a zero-passage of the phase-angle difference need not occur.

Command generation



Multiple commands
The multiple commands function (MULTIPLE CMD) allows several commands in a synchronization sequence or blocks command generation after the first paralleling command of each synchronization sequence.

2.3 Test functions

In order to match the SYNCHROTACT 5 to the installation, three test functions are provided:

1. TEST ton: determines the paralleling time and tunes the measuring voltages with the circuit breaker closed
2. TEST U-Match: tunes the voltage matcher to the voltage regulator
3. TEST f-Match: tunes the frequency matcher to the governor

The way the different test functions work is explained in the following:

2.3.1 TEST ton

This test function closes the circuit breaker. As a start condition, voltage must be present on one side of the circuit breaker (>Umin) and no voltage present on the other side (<U0max). After the breaker is closed, SYNCHROTACT 5 measures how long it takes until voltage is present at both measuring inputs. At the same time, after the breaker is closed the voltage difference is measured, which can then be tuned to zero by means of the parameter ΔU Offset.

2.3.2 TEST U-Match

This test function proceeds as follows:

1. The generator voltage is adjusted until this lies in the range between 95 and 97% of the line voltage, then the adjusting pulse is discontinued.
2. Ten seconds after the first adjusting pulse, the voltage difference ΔU0 is measured, then a Higher command U+ lasting 5 s is given. A further 10 s after the end of the pulse, the voltage difference ΔU is measured and dU/dt calculated according to the following formula:

$$dU/dt = \frac{\Delta U - \Delta Uo}{5}$$

3. With this dU/dt value, the generator voltage is brought back to approx. 96 %.
4. Ten seconds later, the generator voltage is brought to approx. 100 % with the same dU/dt value. After a further ten seconds, dU/dt is calculated again and shown on the display.

2.3.3 TEST f-Match

This test function proceeds as follows:

1. The slip is adjusted until this lies in the range between +1 and +3%, then the adjusting pulse is discontinued.
2. Ten seconds after the first adjusting pulse, the slip s0 is measured, then a higher command f+ lasting 3 s is given. A further 10 s after the end of the pulse, the slip s is measured and df/dt calculated according to the following formula:

$$df/dt = \frac{s - s0}{3}$$

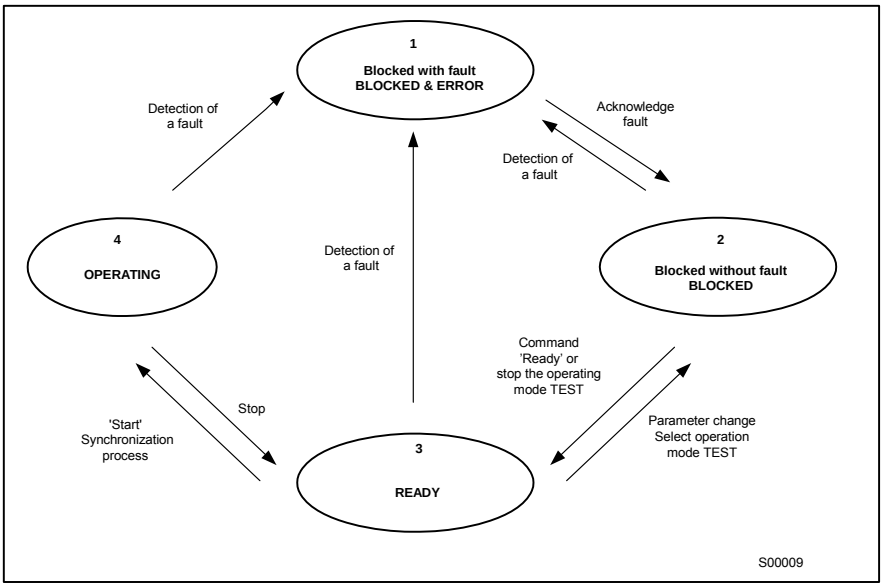
3. With this df/dt value, the slip is brought back to approx. +2 %.
4. Ten seconds later, the slip is brought to 0 % with the same df/dt value. After a further ten seconds, df/dt is calculated again and shown on the display.

2.4 Operating statuses, operating modes and sequences of the synchronization process

2.4.1 Operating statuses

No.	Status	LED	Remarks
1	Blocked with error	**BLOCKED** & **ERROR**	There is a fault, the device is blocked
2	Blocked without error	**BLOCKED**	The device is in setting mode or in test mode, i.e. in safe condition for commissioning and maintenance: Setting mode: no commands are given Test mode : • TEST mode (configurable by means of digital inputs and outputs): Test run of synchronization in which synchronization takes place normally by means of adjusting commands, but the paralleling command is sent via a configurable relay rather than the command relay. • TEST t on (parameter): paralleling command is deliberately given • TEST U-Match (parameter): voltage adjusting commands are deliberately given • TEST f-Match (parameter): frequency adjusting commands are deliberately given.
3	Ready	**READY**	Ready for operation
4	Operating	**OPERATING**	Synchronizing process is running

The four operating statuses can be regarded as levels. It is only possible to change from one level to another through the following events/manipulations:



Note The first time the device is powered up, the device is in BLOCKED status once the auxiliary voltage is present. By means of a corresponding command, the device can be set to READY status using the PC tool or the built-in control unit. On the next occasions the device is powered up, it goes directly into READY status. A start command is only accepted **after** the device is powered up (raising edge required).

2.4.2 Normal operating mode, sequences of the synchronization process

Initialisation
After the auxiliary voltage has been applied, the software is initialised. Normally, the auxiliary voltage is permanently applied (whether or not synchronization is selected) and the processor is in operation.

Parameter set selection
In devices equipped with the option providing several parameter sets, it is necessary to select the parameter set via the digital inputs before starting the synchronization process. The parameter set and the relay for selecting the paralleling points become active following the Start signal.

In Blocked Without Error status, the selected parameter set is also active and the corresponding relay is pulled down for selection of the paralleling point. This allows actual value calibration, paralleling time measurement and matcher test functions to be carried out very simply.

Selecting synchronization (Start)
By selecting synchronization in ready status (READY), the synchronizing process is started. The device starts to issue commands and to synchronize.

Stopping synchronization (Stop)
With the command “Stop”, the current synchronizing process is interrupted, normally after a paralleling command has been issued.

2.4.3 Special operating modes

The TEST mode can be used to check the correct function of synchronization by means of configurable inputs and outputs (provided with the 7 parameter sets option). After corresponding selection and the Start signal, SYNCHROTACT 5 goes into BLOCKED status and matches the generator voltage and frequency by means of adjusting commands. The paralleling command is output not via the command relay but via a configurable signal relay.

SYN 5201 and SYN 5202 can be operated purely as a synchrocheck in that the command generation, the voltage and frequency matcher are switched off in the parameter set.

If the same circuit breaker is to be switched, once automatically and once manually using synchrocheck in alternation, and in both cases the same synchronizer is to be used, this can be achieved through configuration of the inputs and outputs.

2.5 Self-monitoring of the synchronizer

Extensive monitoring includes the following functions:

2.5.1 Hardware monitoring

Auxiliary voltage: The internally stabilised (reference) voltages are monitored. In the event of inadmissible deviations, the device is immediately blocked with a corresponding error message being displayed. Failure of the auxiliary voltage is signalled via a normally closed contact (ERROR).

Paralleling command circuit: Contact monitoring is provided by means of forcibly guided contacts on all command relays. If the contacts fail to open again after a command has been given, the contact monitoring prevents the synchronization from being selected again. This signal can be made available externally through corresponding configuration of the digital outputs, so that the connection of the command circuit can be blocked. This function is also used to monitor the internal circuits for short circuits.

The internal fault and event logger records when each individual relay has opened and closed.

2.5.2 Software monitoring

The design of the SYN 5202 guarantees a degree of security against incorrect paralleling which satisfies the most demanding requirements, because the different processor types in the individual channels are equipped with different software and completely separate measuring units and command relays.

The program sequence is interrupted and reset by the internal watchdog, if an error occurs. After reset, it is again started automatically. This starting procedure is carried out three times, afterwards the device is totally blocked with the corresponding error message.

2.5.3 Monitoring of external events

After expiry of the set total paralleling time tot t, the monitoring of external events indicates failure by the control system or measuring signals to fulfil conditions, as well as implausible configuration. If necessary, t tot can be set to zero. This deactivates this monitoring function.

2.6 Stored data

The parameter values are permanently stored in a non-volatile memory, and are not affected by ageing or failure of the auxiliary voltage. The parameter settings can only be changed by means of write commands.

In the event of failure of the auxiliary voltage, the event logger data and transient recorder data are lost after a certain time. Whereas the data keep for 20 days when the device is in new condition, this period is reduced with age and through the influence of temperature. Typically, one can assume a minimum storage period of three days.

2.7 Time synchronization

A clock is used in the SYNCHROTACT 5 device for the date and timestamp of event logger and transient recorder.

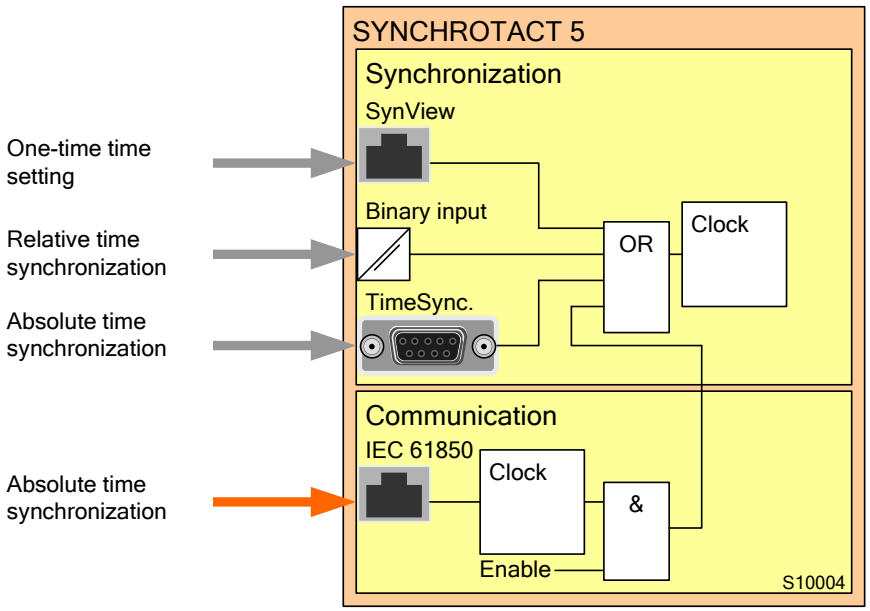
There are three ways of synchronizing these with an external clock:

- Relative synchronization by means of pulses (pulse synchronization): the time of the connected PC can be read into the device once using SynView. The synchronization prevents the clock time from drifting apart by means of periodic pulses (ClockIN input at connector -X1).

- Absolute synchronization: periodic transmission of date and time from clock to the SYNCHROTACT 5 device via serial interface (-X2 'Time Sync.'). The reference clock is in this case: Hopf type 6870.

- Absolute synchronization over IEC 61850-interface (option)

The optional IEC 61850-communication part of the SYNCHROTACT 5 device contains one additional clock per system. Upon release ("Enable"), the clock in the synchronizing part will be overwritten.



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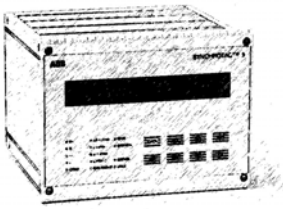
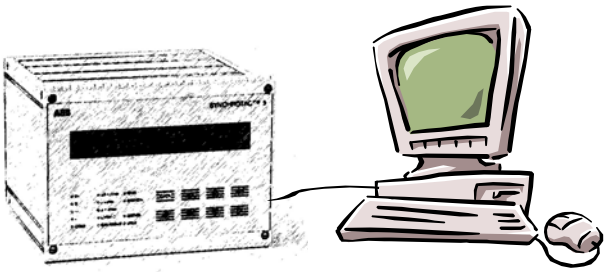
2.8 Control options

With the SYNCHROTACT 5, a distinction is made between service control and operating control:

Service control for commissioning and maintenance:
1. Controls on the unit: keypad & LCD (standard)



2. Local control using PC (SynView): direct link SYNCHROTACT to PC



3. Remote control through PC over the network either via SynView interface (Standard) or over IEC 61850-interface (Option).

Operating control for normal synchronizing operation:
1. Conventional, using wired-up digital control circuits (standard)
2. Remote control using PC: via network and optional interface (Modbus, Profibus, Lon, or IEC 61850)

2.9 Transmitted signals via interfaces

2.9.1 Service interface

The service interface is operated using SynView. The transmitted information is therefore identical to the SynView functions. Essentially, these are:

- Parameter settings (read and write)
- Put device in READY mode, block device, cancel errors
- Read out actual values
- Read transient recorder data
- Read events log and diagnostic data

2.9.2 Operating interface

The operating interface is used to transmit the data which are relevant to normal operation:

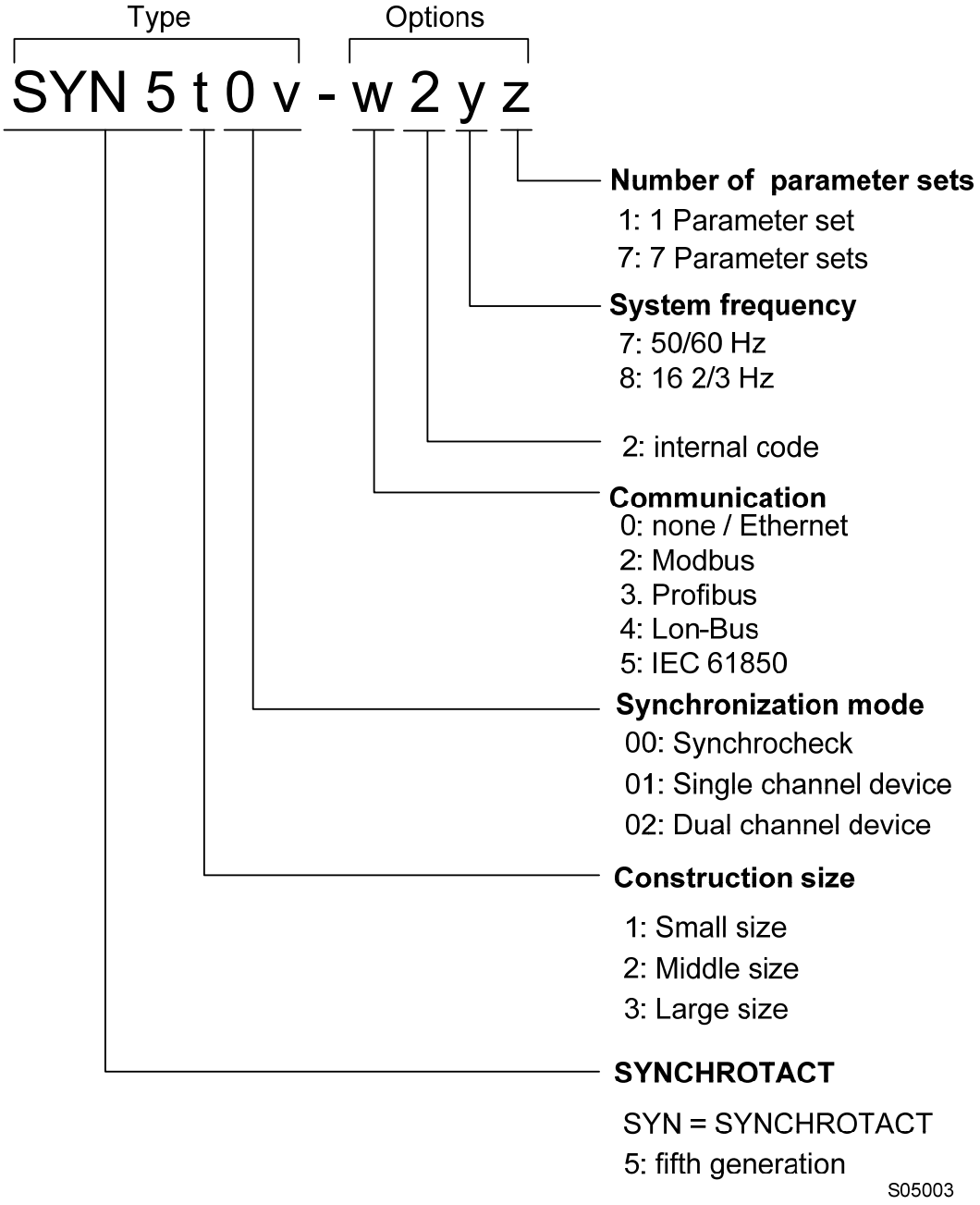
- Writing to digital inputs (Start, Stop, Release DB, selection of parameter set and paralleling point, Reset)
- Reading the digital outputs (ERROR, READY, OPERATING, U+, U-, f+, f-, back-indication of paralleling point selection, all configured output signals)
- Reading the status displays ($\Delta U < \Delta U max$, $s < s max$, $\alpha < \alpha max$, U1/U2=0, COMMAND, CHK RELEASE, BLOCKED)
- Reading the actual values (ΔU, α, s, U1, U2, f1, f2, ds/dt, selected parameter set, software version, command counter)
- Reading the last event

2.9.3 IEC 61850 - Interface

- Parameter adjustment values (exception: test functions, INVERSE and TAP CHANGER-functions, as well as t block)
- Set device to READY, BLOCKED, reset error
- Reading the actual values
- Writing to digital inputs
- Reading the digital outputs
- Reading the status displays
- Reading the actual values (exception: selected parameter set, software version and command counter).

3 Hardware construction

3.1 Type code for devices



3.2 Front panel

On the front panel of the SYN 5201 or SYN 5202 there is a block of status displays, as well as eight keys and the liquid crystal display (LCD) of the built-in service controls.

Status displays (LED)
The status display consists of 3 rows of LEDs which are sub-divided as follows:

Group	Designation	Function
Left-hand row: commands	**U+, U-, f+, f- COMMAND (colour: yellow)**	Indicate outgoing commands, i.e., the output of the Higher and Lower commands for voltage and frequency and the paralleling command
Centre row: fulfilled paralleling conditions	**ΔU < ΔUmax s < smax α < αmax U1/U2 = 0 CHK RELEASE (colour: yellow)**	Indicate if ΔU, α and s are within the tolerance band or at least one measuring voltage is lacking. Indicates paralleling release (only in synchrocheck mode)
Right-hand row: operating status	**READY (colour: green)**	Indicates readiness for operation
	OPERATING (colour: yellow)	Synchronizing process is in operation
	BLOCKED (colour: yellow)	Indicates the blocked status of the device, e.g. as when carrying out commissioning work.
	ERROR (colour: red)	Indicates that a fault message is active (the BLOCKED LED always lights up at the same time)

Built-in service controls

All manipulations, such as viewing/altering parameters, viewing actual values etc., can be carried out using the built-in service controls.

The keypad consists of 8 keys with the following functions:

	Selection key for adjusting the parameter values
	Move up and down (addresses or setting values)
	Move up and down quickly (addresses or setting values)
	Move horizontally (from parameter set to parameter set)
	Acknowledge key (line-change in actual value block)

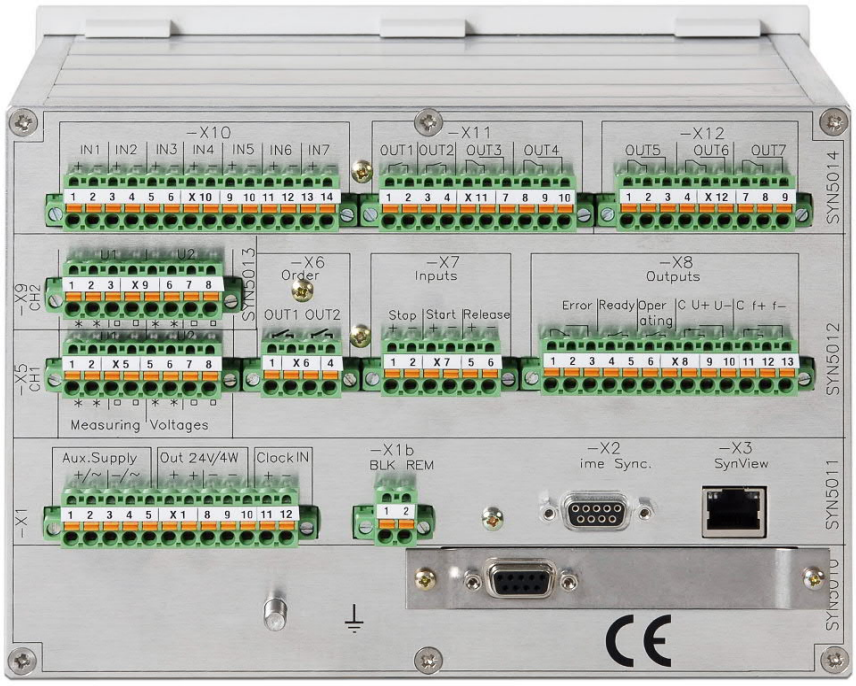
A four-line liquid crystal display (LCD) with 20 characters per line is used to display parameter values, actual values, events and faults. Example of the LCD display:

The cursor is a filled-in rectangle. It flashes and is positioned on the first space of the corresponding line.

Note As an alternative to the built-in service controls, all commissioning and maintenance work can be carried out conveniently using a PC and the SYNCHROTACT 5 PC tool SynView (accessory). The connection is performed via Ethernet interface.

3.3 Rear of unit

The electrical connections are made on the rear of the unit by means of screwed connectors and spring-clip terminals.



Measuring inputs
With SYN 5202, the measuring inputs are passed to a separate connector for each channel. Each input is connected by means of double terminals.

Paralleling command output
The command output is actuated by one safety relay per channel with forcibly guided contacts. The relay contacts of channels 1 and 2 are internally wired in series and are passed to one connector.

Digital inputs and outputs
All inputs and outputs are potential-isolated from one another and from the electronics.

SynView connection
An Ethernet interface is provided for the connection of SynView

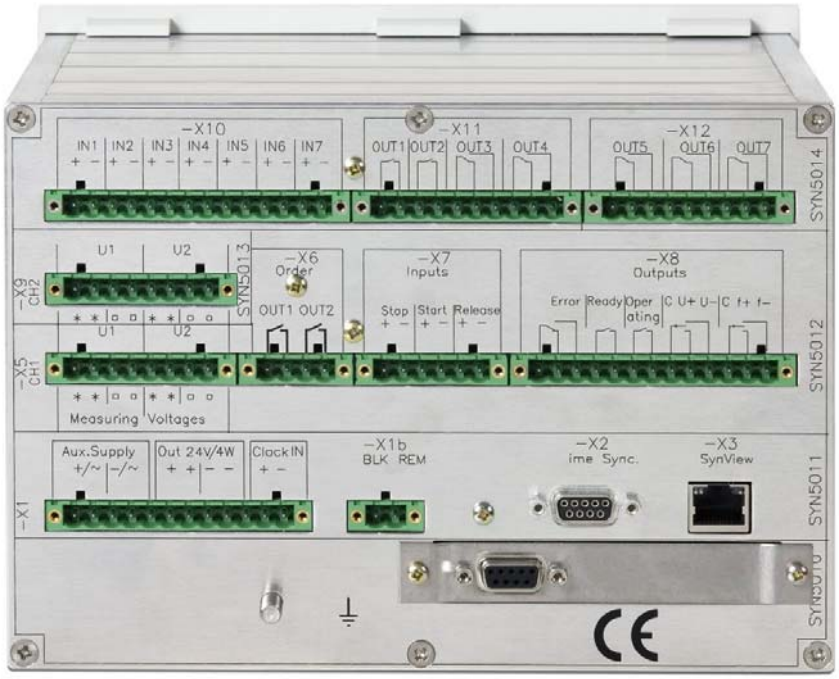
Time sync. connection
A connection for time signals from a clock is provided

Blocking input for operating remote control
With this input, the operating remote control (interface) can be blocked.

Communications connection (option)
SYNCHROTACT 5 can optionally be equipped with a connection for operating remote control (see type code, section 3.1).

3.4 Printed circuit boards

The devices consist of the following printed circuit board modules



SYN 5010 communications board (option)
Mount of a slot for the operating remote control interface.

SYN 5011 processor and electronics power supply
Electronics power supply 24 to 250 VDC and 100 to 230 VAC
Processor and memory modules
A/D converter

SYN 5012 basic I/O unit
Measuring inputs
Digital inputs for Start, Stop, Release dead bus
Digital outputs (relay contacts) for paralleling command, adjusting commands, signalling (Ready, Operating, Error).

SYN 5013 synchrocheck
Synchrocheck with separate measuring inputs, processor and command relay

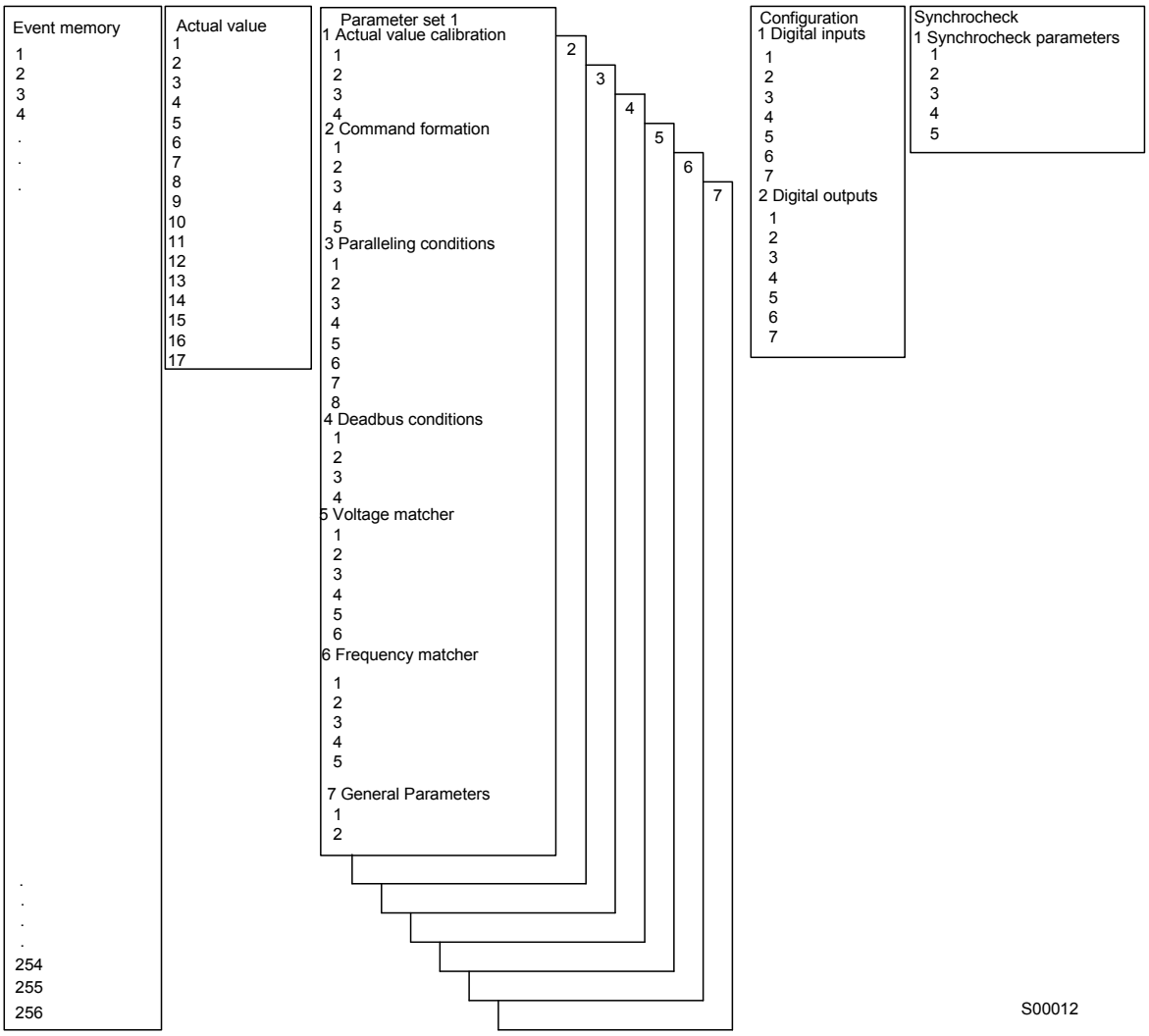
SYN 5014 I/O expansion (option)
7 configurable digital inputs
7 configurable digital outputs
For the use of several parameter sets or individually configurable signals

SYN 5015 control/display
Connecting board behind the front cover with control unit and status displays

4 Parameters, Actual values, Events

4.1 Overview

4.1.1 Menu structure



4.1.2 Event logger

The events are displayed in the following format (for meaning, see also section 9):

Line number	Timestamp	Event code
000	hh:mm:ss	Cyyy
001	. . .	.
.	. . .	.
.	. . .	.
.	. . .	.
255	. . .	.

4.1.3 Actual values

The following table shows the actual values and their position in the menu:

Actual values				
No.	**Actual value name**	**Symbol**	**Range/resolution**	**Unit**
1.	Voltage difference	ΔU	0.0 to 99.9	%
2.	Phase-angle difference	α	-179 to +180	DEG
3.	Slip	s	0.00 to 50.00	%
4.	Voltage U1	U1	0 to 130*Un	%
5.	Voltage U2	U2	0 to 130*Un	%
6.	Frequency f1	f1	10.0 to 100.0	Hz
7.	Frequency f2	f2	10.0 to 100.0	Hz
8.	Acceleration	ds/dt	0.00 to 9.99	%/s
9.	Selected parameter set	Pset selected	1 to 7	-
10.	Software version	xxxx	-	-
11.	Command counter parameter set 1	CLOSE 1	0 to 65535	1
12.	Command counter parameter set 2	CLOSE 2	0 to 65535	1
13.	Command counter parameter set 3	CLOSE 3	0 to 65535	1
14.	Command counter parameter set 4	CLOSE 4	0 to 65535	1
15.	Command counter parameter set 5	CLOSE 5	0 to 65535	1
16.	Command counter parameter set 6	CLOSE 6	0 to 65535	1
17.	Command counter parameter set 7	CLOSE 7	0 to 65535	1

4.1.4 Parameter sets 1 to 7

1 parameter set is provided in the basic version, with 7 parameter sets available as an option. The structure is the same in all parameter sets. The 7th parameter set only differs from the others in the setting values, in that the default settings are pre-set for synchrocheck operation.

In addition, each parameter is divided into seven functional parameter groups:

1. Actual value calibration
2. Command generation
3. Paralleling conditions
4. Dead bus conditions
5. Voltage matcher
6. Frequency matcher
7. General parameters

Each group contains the parameters associated with this function.

Parameter sets 1 to 7

1. Actual value calibration "Calibrate act values"

No.	Parameter name	Symbol	Range/resolution	Unit	Default setting of all parameter sets
1.	Nominal voltage	Un	50 to 130	VAC	110
2.	Nominal frequency	fn	$16^2/_3$, 50, 60	Hz	50
3.	Voltage tuning	ΔUOffset	±12.0	%	0
4.	Angle tuning	αOffset	±180	DEG	0

2. Command generation "Paralleling cmd gen"

No.	Parameter name	Symbol	Range/resolution	Unit	Default setting of parameter sets	
					1 to 6	**7**
1.	Test function	TEST ton	ON/OFF	-	OFF	OFF
2.	Paralleling time	t on	0 to 990/10	ms	100	100
3.	Paralleling command duration	tp on	OFF, 10 to 990/10	ms	990	OFF
4.	Monitoring time	t supervis	0 to 99	s	10	10
5.	Multiple commands	MULTIPLE CMD	ON/OFF	-	OFF	OFF

3. Paralleling conditions "Parallel conditions"

No.	Parameter name	Symbol	Range/resolution	Unit	Default setting of parameter sets	
					1 to 6	**7**
1.	Slip limit, oversynchronous	-smax	0.00 to 6.00	%	0.4	0.2
2.	Slip limit, sub-synchronous	+smax	0.00 to 6.00	%	0.4	0.2
3.	Angle limit, negative	-αmax	0 to 99	DEG	10	10
4.	Angle limit, positive	+αmax	0 to 99	DEG	10	10
5.	Max. voltage difference, overexcited	-ΔUmax	0 to 40	%	3	3
6.	Max. voltage difference, underexcited	+ΔUmax	0 to 40	%	3	3
7.	Maximum voltage	Umax	105 to 130	%	120	120
8.	Minimum voltage	Umin	50 to 95	%	80	80

4. "Dead bus conditions"

No.	Parameter name	Symbol	Range/resolution	Unit	Default setting of all parameter sets
1.	Maximum zero voltage	U0max	0 to 49	%	5
2.	Release U1 = no-voltage	U1not	ON/OFF	-	OFF
3.	Release U2 = no-voltage	U2not	ON/OFF	-	OFF
4.	Release for U1 and U2 = no-voltage	1*2not	ON/OFF	-	OFF

5. "Voltage matcher"

No.	Parameter name	Symbol	Range/resolution	Unit	Default setting of parameter sets	
					1 to 6	**7**
1.	Test function	TEST U-Match	ON/OFF	-	OFF	OFF
2.	Voltage adjustment characteristic	dU/dt	0.00 to 5.00	%/s	0.30	0.00
3.	Pulse interval	ts U	1 to 20	s	2	2
4.	Minimum pulse duration	tp Umin	0.05 to 2.00	s	0.05	0.05
5.	Switchover to variable intervals	INVERSE U	ON/OFF	-	OFF	OFF
6.	Switchover to tap changer	TAP CHANGER	ON/OFF	-	OFF	OFF

6. "Frequency matcher"

No.	Parameter name	Symbol	Range/resolution	Unit	Default setting of parameter sets	
					1 to 6	**7**
1.	Test function	TEST f-Match	ON/OFF	-	OFF	OFF
2.	Frequency adjustment characteristic	df/dt	0.00 to 5.00	%/s	0.20	0.00
3.	Pulse interval	ts f	1 to 120	s	20	20
4.	Minimum pulse duration	tp fmin	0.05 to 2.00	s	0.05	0.05
5.	Switchover to variable intervals	INVERSE f	ON/OFF	-	OFF	OFF

7. "General parameters"

No.	Parameter name	Symbol	Range/resolution	Unit	Default setting of all parameter sets
1.	Blocking time after selection	t block	1 to 10	s	2
2.	Total paralleling time	t tot	OFF, 0.5 to 15/ Steps: 0.5	min	5

4.1.5 Configuration parameters “Config parameters“ (option)

These allow different functions to be assigned to the inputs and outputs (see also section 4.2.8 and 5.4).

“Digital inputs “					
No.	Parameter name	Symbol	Range/resolution	Unit	Default setting
1.	Digital input 1	I 1	0 to 32	-	1
2.	Digital input 2	I 2	0 to 32	-	2
3.	Digital input 3	I 3	0 to 32	-	3
4.	Digital input 4	I 4	0 to 32	-	4
5.	Digital input 5	I 5	0 to 32	-	5
6.	Digital input 6	I 6	0 to 32	-	6
7.	Digital input 7	I 7	0 to 32	-	14
“Digital outputs “					
No.	Parameter name	Symbol	Range/resolution	Unit	Default setting
1.	Digital output 1	O 1	0 to 32	-	1
2.	Digital output 2	O 2	0 to 32	-	2
3.	Digital output 3	O 3	0 to 32	-	3
4.	Digital output 4	O 4	0 to 32	-	4
5.	Digital output 5	O 5	0 to 32	-	5
6.	Digital output 6	O 6	0 to 32	-	6
7.	Digital output 7	O 7	0 to 32	-	15

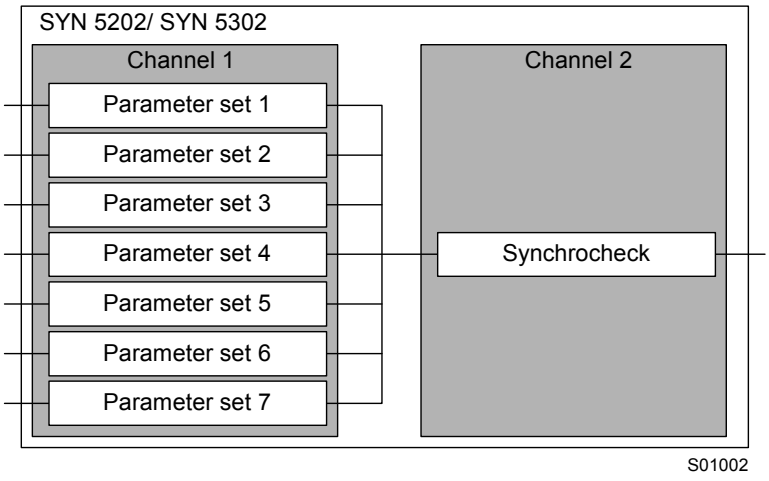
4.1.6 Synchrocheck parameters (SYN 5202 only)

These are the parameters for the second channel.

Synchrocheck parameters “synchrocheck param “					
No.	Parameter name	Symbol	Range/resolution	Unit	Default setting
1.	Slip limit	smax	0.1 to 2.0	%	0.5
2.	Angle limit	αmax	5 to 40/5	DEG	15
3.	Maximum voltage difference	ΔUmax	5 to 40/5	%	5
4.	Maximum zero voltage	U0max	0 to 50/5	%	50
5.	Nominal voltage	Un	50 to 130/5	VAC	110

4.1.7 Linking of the parameter sets in dual channel systems

The parameter set of the second channel is linked with the active parameter set of the first channel.



Template: CHIND Techn doc stand, A4 P de, R1.DOT; Filename: 3BHS109762E01 D.doc; Print: 12/6/2011 5:48:00 PM; Save: 12/1/2011 2:37:00 PM; CHIND No. 3BHS109763 ZAB D14 Rev. -; I-Q

4.2 Parameter settings

4.2.1 Parameter group Actual Value Calibration

Nominal voltage Un
The nominal voltage is set in volts. The nominal voltage is plant-dependent. It is typically 58 (100/$\sqrt{3}$); 64 (110/$\sqrt{3}$); 100; 110 VAC, but can also have a different value.

Nominal frequency fn
The nominal frequency can have the following values: 50 or 60 Hz.
In the 16 $^2/_3$ Hz version, this parameter cannot be adjusted.

Voltage tuning ΔUOffset
During the test function for the parallelling time, TEST t on, ΔU is measured in connected status. The value can be accepted for the setting of ΔU Offset.

The value ΔU can also be tuned without TEST in that one reads off the actual value ΔU in connected status and enters it with inverted +/- sign in the parameter ΔU Offset and saves this. Check once again whether ΔU is now 0 %.

Angle tuning α Offset
Small phase shifts (caused by measuring inaccuracy) can be compensated by this parameter.

With bigger phase shifts, e.g. caused by the connection group of a transformer between circuit breaker and measuring vt, a compensation vt has to be used for compensation. It has to be noted that common synchronizing instruments (synchroscope) do not have a compensation feature, for that reason they require a compensation vt anyway (see also section 5.2).

Caution An incorrectly calculated sign or incorrectly calculated amount can lead to damage to the plant! Before paralleling is carried out for the first time, it is essential to ensure that the setting is correct.

4.2.2 Parameter group Command Generation

Test function for determining the paralleling time TEST ton
When working on high voltage circuits, it is essential that the corresponding regulations on working on high voltage installations are complied with:

The test function closes the circuit breaker. The plant should therefore be prepared as described in section 8.2.11.
Further procedure:

1) Start conditions:
   - One voltage is > Umin
   - The other voltage is < U0max
   - Corresponding parameter set is selected
   - Device blocked (blocking: see section 7)
   - SYN 5202: Signal ‘Release DB‘ active (so that the paralleling release contacts of channel 2 close)
2) Change address to the parameter TEST ton in the corresponding parameter set and in the parameter group “Paralleling cmd gen“
3) Set TEST ton to ON
4) Confirm with DATA & ↵
5) Enable test function by pressing: ↵ & ▲ & ▲▲
6) Start test function within 30 s after enable ↵ & ▲
7) Wait for end of test function then read results for t on and ΔUOffset
8) Change address to parameter t on (1 * ▼) and set read value
9) Write the value into the random access memory by pressing DATA & ↵
10) Change address to parameter ΔUOffset (3 * ▲) and set read value
11) Write the value into the random access memory by pressing DATA & ↵
12) Return to TEST ton, set this to OFF and confirm with DATA & ↵
13) Set SYNCHROTACT 5 temporarily to “Ready“ and block again. This writes all the parameter settings into the ROM
14) Open the circuit breaker again and bring the plant into the status necessary for the following work.

Paralleling time t on
The time is required for compensation of the breaker closing time. The closing time of the circuit breaker, including all intermediate circuits, is measured using the test function Test t on. If the closing time of the circuit breaker is known, it can be set and stored directly.

Caution If the paralleling time is not known and the test function cannot be carried out, it must be determined empirically:
Aim:
SYNCHROTACT 5 takes into account the run time of the paralleling command and the closing time of the circuit breaker, i.e. the command is issued with a lead of this time before the zero passage of the phase-angle difference.

Procedure:

1. Pre-settings: - Set t on to 100 ms as an approximation
   - Reduce ±smax temporarily to the range from 0.1 to 0.2 %
2. All other commissioning work (especially calibration of the measuring voltages) must have been completed.
3. Connect external plotter with the following measuring values:
   Channel 1: instantaneous voltage difference u1 – u2
   Channel 2: paralleling command
   Channel 3: generator power P_G or current I_G
   Time: 20 to 50 ms/DIV
   Trigger set to paralleling command
4. Set SYNCHROTACT 5 to Ready
5. The machine must be in operation; voltages present on both sides of the circuit breaker
6. First carry out blind synchronization several times and check whether the paralleling takes place at the correct time.
7. Carry out live synchronization
   - Start SYNCHROTACT 5
   - Observe synchronizing process using SynView‘s actual values tool or synchronizing instruments
8. Wait for the end of the synchronizing process
9. Read SynView transient recorder or external plotter
10. The envelope end of the instantaneous voltage difference should be at a minimum when the main contacts (P or IG) close. If closing took place too late, t on must be increased, if it took place too early ton must be reduced.

Caution Correct value carefully!

Repeat points 7 to 10 until the circuit breaker closes at the correct time, i.e., P or IG are at a minimum following synchronizing.

Paralleling command duration tp on
Normally, this parameter does not need to be set.

The duration of the paralleling command must be at least long enough, in order to ensure that the CB (close circuit) is opened. If tp on is set to OFF or zero, the command generation is no longer in operation. The device then functions like a synchrocheck: as soon as the release has been given by the monitoring, the contacts close; when the release is dropped they open again.

Monitoring time t supervis
The monitoring time plays a role with synchronous sources or in dead bus situations. The command is given if all conditions are fulfilled for this time. With asynchronous sources (generator), the time should generally not be changed from its default value or at least it should not be set <10 s.

In synchrocheck operation, i.e. with command generation switched off (tp on = OFF or 0), t supervis has no influence. The command release occurs immediately when all conditions are fulfilled.

Multiple commands MULTIPLE CMD
With this setting one can select whether the synchronizer should only give one command or should always give a command if all conditions are fulfilled. In synchrocheck operation, i.e. with command generation switched off (tp on = OFF or 0), MULTIPLE CMD has no influence. The contacts close with each release.

4.2.3 Parameter group Paralleling Conditions

Slip limit oversynchronous –smax and sub-synchronous +smax
The setting value is based on different criteria, depending on the application:
a) normal synchronization
b) coarse synchronization
c) paralleling of synchronous lines
d) paralleling of asynchronous lines

a) Normal synchronization
The slip limit values set in practice are far from placing a serious load on the machine, even in large machines. Usual setting values: 0.1 to 0.5 %; default setting: 0.4 %
The following are a number of points which can influence the setting value:

- Smaller slip limits should be chosen for large and modern generators.
- Gas turbines are more sensitive (smaller tolerance band) than hydrogenerators.
- Lower values should be selected if fine synchronization has priority and higher values if fast synchronization is to take place.
- Lower slip values are usually selected where settings are made for synchrocheck operation to monitor manual synchronizing.
- If one wishes to prevent the tripping of the reverse power relay, the sub-synchronous limit +smax is reduced or set to zero.

b) Coarse synchronization
With coarse synchronization, i.e. synchronization without frequency adjusting commands (e.g. during run-down), in order to carry out paralleling with 100 % reliability the slip limits must be set in such a way that at least one phase zero passage occurs within the permissible range:

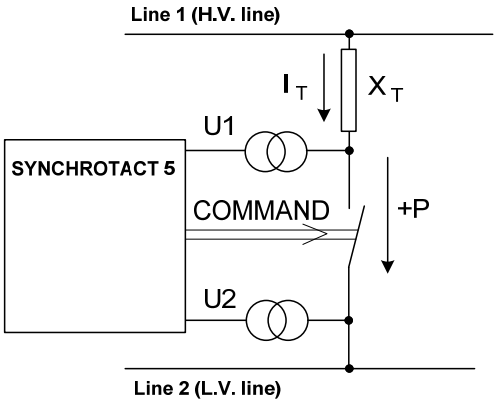
$$|s\max| \geq 10 * \sqrt{\frac{2 * ds/dt}{fn}} \; [\%]$$

Key:
fn = nominal frequency [Hz]
ds/dt = acceleration [%/s] (known or read actual value from SYNCHROTACT 5).

If the determined value appears inadmissibly high, a lower value can be set. However, in this case it is not guaranteed that paralleling can be achieved with only one attempt at synchronization.

c) Paralleling of synchronous lines
If only synchronous sources are paralleled, the slip limits do not need to be set

d) Paralleling of asynchronous lines:
If two lines do not form a ring connection, the slip limits are restricted by the current limit permitted after paralleling. If the flow of power in a particular direction is to be avoided, the corresponding slip limit must be set to zero.



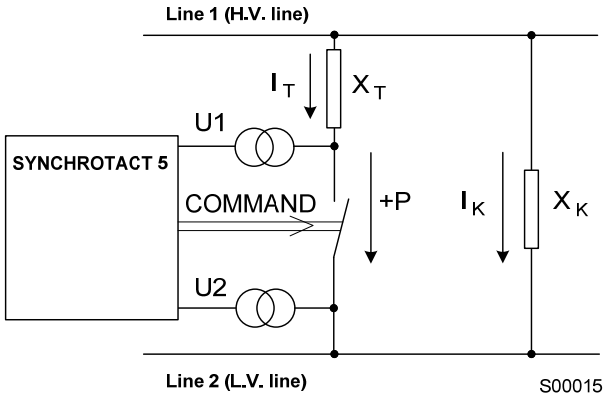
S00014

Angle limit, negative -αmax and positive +αmax
The permissible angle limit is based on different criteria, depending on the application:
a) paralleling of asynchronous sources.
b) paralleling of synchronous sources.

a) Paralleling of asynchronous sources:
The maximum permissible angle limit ±αmax should generally be set symmetrically and to 10 DEG.

If 3,6*fn*smax*t on+3 > 10 DEG, the value should be rounded up to whole degrees. Setting values above 15 DEG are not usual. If the calculation produces such a result, it should be checked whether the maximum slip can be reduced.

b) Paralleling of synchronous sources:
The coupling reactance x_K in ring mains lines and the balancing current I_K flowing through these cause a phase shift between the two voltages U1 and U2.



S00015

The maximum phase shift ±αmax permitted for paralleling is calculated from the greatest phase shift which occurs plus a reserve. ±αmax is limited by the current i_T = f(U1, U2, x_T) flowing after paralleling and if the flow of power in a particular direction is to be avoided. In the latter case, the corresponding parameter (-αmax or +αmax) is set to zero.

Maximum voltage difference, overexcited -ΔUmax and underexcited +ΔUmax
Maximum permitted amplitude difference between the two voltages.

- usual values for generators: 1 to 5 %
- usual values for synchronous lines 3 to 10 %

Recommended setting: default setting

Maximum voltage Umax
No paralleling takes place above this voltage. The default setting of 120 % can be changed if necessary.

Minimum voltage Umin
No paralleling takes place below this voltage.
The default setting of 80 % can be changed if necessary.

4.2.4 Parameter group Dead Bus Conditions

Maximum zero voltage U0max
Maximum voltage at which the SYNCHROTACT 5 still recognises the measuring voltages as zero voltage. A different value should only be set if necessary.

Release of the measuring voltages as no-voltage U1not, U2not, 1*2not
These parameters only need to be set for paralleling of no-voltage lines. The synchronization of two existing voltages is not affected by the programming. The following relationships apply:

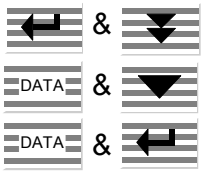
U1not	U2not	1*2not	Conditions
OFF	OFF	OFF	Both U1 and U2 must be present (default).
ON	OFF	OFF	Only the voltage U1 can be missing, U2 must be present.
OFF	ON	OFF	Only the voltage U2 can be missing, U1 must be present.
ON	ON	OFF	One of the two voltages can be missing, the other must be present.
OFF	OFF	ON	Both voltages can be missing (simultaneously)
ON	OFF	ON	The voltage U1 or both voltages can be missing.
OFF	ON	ON	The voltage U2 or both voltages can be missing.
ON	ON	ON	One of the two voltages or both voltages can be missing.

Caution A misinterpretation of the measurement can lead to serious damage to the plant. If no-voltage lines are detected, it is essential to make sure that the measuring circuits (voltage transformers, fuses and input cables) are functioning 100 % correctly. Only then should the release signal Release DB be given. In dual channel synchronizing systems, two different transformer circuits for the two channels should be connected whenever possible in order to avoid a risk in the event of loss of phase. If, instead of the star point, one of the phases is earthed on the secondary side, this does not affect normal synchronizing operation, however, a failure of the earthed phase cannot be detected by the synchronizing device.

4.2.5 Parameter group Voltage Matcher

Test function to determine the voltage adjusting characteristic TEST U-Match
This test function determines the plant-dependent setting value of the parameter dU/dt. After the test function is started, SYNCHROTACT 5 issues different Higher and Lower commands to the voltage regulator in order to test its sensitivity. The duration of the test function is generally 1 to 2 minutes.

Caution Once started, the test function is automatically cancelled if $|\Delta U|$ reaches ≥ 10 %. Nonetheless, it is recommended that you prepare for any manual cancellation by noting the following key combination:



Note If the voltage matcher is used as a tap changer matcher or with the INVERSE U-function, the test function makes no sense and is therefore blocked.

Procedure:

1. Start conditions:
   - Running machine
   - U1 and f1, both between 95 % and 105 %,
   - U2 and f2, both between 85 % and 115 %
   - Corresponding parameter set is selected
   - SYNCHROTACT 5: parameter INVERSE U = OFF
     parameter TAP CHANGER = OFF
   - Device blocked (blocking: see section 7)
2. Change address to parameter TEST U-Match in the corresponding parameter set and in the parameter group “Voltage Matcher“
3. Set Test U-Match to ON
4. Confirm with DATA &
5. Enable test function by pressing: & &
6. Start test function within 30 s following enable: &
7. Wait for end of test function (1 to 2 minutes), then read result for dU/dt
8. Change address to parameter dU/dt: (1*) and set read value

9. Write value into the random access memory by pressing: DATA & ↵
10. Return to TEST U-Match, set this to OFF and confirm with DATA & ↵
11. Temporarily set SYNCHROTACT 5 to "Ready"and block again. This writes all parameter settings into the ROM.

Note If the repeated test function does not lead to a reasonable result, the setting value should be determined empirically as described below.

Voltage adjusting characteristic dU/dt
Factor for the command length which is formed proportionally to the voltage difference. The setting value is determined using the test function TEST U-Match. Usual setting values: 0.3 to 0.7 %/s. Adjusting pulses are suppressed if dU/dt is set to zero.

Empirical determination of the setting value:
Aim: a single voltage adjusting command should bring the voltage difference approximately into the middle of the set tolerance band. To do this, the voltage matcher must adjust the machine by means of voltage adjusting commands. The operator checks the command length and corrects it if necessary until the matcher is functioning satisfactorily.

Procedure:
1. Prevent the circuit breaker from closing while work is being carried out (circuit breaker in Test position, unplug connector -X6 for the paralleling commands on the SYNCHROTACT 5,...)
2. Temporarily switch off frequency matcher: set df/dt = 0 and write into the random access memory.
3. In order that the effect of the adjusting pulse can be better judged: temporarily set pulse interval ts U to maximum and write into the random access memory.
4. Set SYNCHROTACT 5 to Ready
5. The machine must be in operation: voltages present on both sides of the circuit breaker; voltage difference outside of the set tolerance window
6. Read the initial voltage difference ΔU
7. Start synchronizing process
8. Wait for the end of the voltage adjusting command (LED), then wait until the voltage difference display shows stable values (5 to 10 s) and read this final voltage difference
9. Stop SYNCHROTACT 5
10. Calculate value according to the following formula: $dU/dt = dU/dt0*(\Delta U0-\Delta U1)/\Delta U0$

Key:
- dU/dt = newly calculated value
- $dU/dt0$ = setting value prior to test
- $\Delta U0$ = initial voltage difference
- $\Delta U1$ = final voltage difference

11. Block SYNCHROTACT 5, set calculated value and set to Ready again
12. Bring voltage difference outside of the tolerance band
13. Start synchronizing process
14. Following the first voltage adjusting command, the voltage difference must lie approximately in the middle of the tolerance band.
15. If the pulse was too long: increase the setting value, if the pulse was too short: lower the setting value
16. Repeat points 11 to 15 until the adjusting pulse length is correct and the matcher is functioning satisfactorily.
17. Activate the frequency matcher again: set df/dt to previous value and save
18. Set pulse interval ts U to previous value and save

Pulse interval ts U
This defines the time between two voltage adjusting pulses. The default setting can normally be left as it is. If problems arise with the voltage matching, tests can be carried with higher or lower values.

Minimum pulse time tp Umin
The minimum voltage adjusting pulse should be set as short as possible taking into account the manufacturer‘s specifications for the final control element. Usual setting value: tp Umin = 0.05 s.

Where the function INVERSE U is used, or for tap-changer matching, this parameter corresponds to the pulse duration.

Switchover to variable intervals INVERSE U
If this parameter is set to ON, the following applies:
- fixed pulse duration
- variable interval dependent on ts U

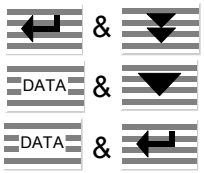
Settings recommendation for tp Umin if INVERSE U = ON: as high as possible, but so that the matcher does not overshoot (see section 2.2.2 Voltage matching with variable intervals).

Switchover to TAP CHANGER
If the voltage matcher controls a tap changer, the parameter should be set to ON. The matcher then issues fixed pulse durations (tp Umin) and fixed pulse intervals (ts U). The settings are based on the tap changer manufacturer‘s specifications.

4.2.6 Parameter group Frequency Matcher

Test function for determining the frequency adjusting characteristic TEST f-Match
This test function determines the plant-dependent setting value of the parameter df/dt. After the test function is started, SYNCHROTACT 5 issues different Higher and Lower commands to the governor in order to test its sensitivity. The duration of the test function is generally 1 to 2 minutes.

Caution Once started, the test function is automatically cancelled if $|s|$ reaches ≥ 6 %. Nonetheless, it is recommended that you prepare for any manual cancellation by noting the following key combination:



Note If the frequency matcher is used with the INVERSE f function, the test function makes no sense and is therefore blocked.

Procedure

1. Start conditions:
   - Running machine
   - U1 and f1, both between 95 % and 105 %,
   - U2 and f2, both between 85 % and 115 %
   - Corresponding parameter set selected
   - SYNCHROTACT 5: parameter INVERSE f = OFF
   - Device blocked (blocking: see section 7)
2. Change address to parameter TEST f-Match in the corresponding parameter set in the parameter group “Frequency Matcher“
3. Set TEST f-Match to ON
4. Confirm with DATA &
5. Enable the test function by pressing: & &
6. Start the test function within 30 s following enable: &
7. Wait for end of test function (1 to 2 minutes), then read result for df/dt
8. Change address to parameter df/dt (1*) and set read value
9. Write the value into the random access memory by pressing: DATA&
10. Return to TEST f-Match, set this to OFF and confirm with DATA &
11. Temporarily set SYNCHROTACT 5 to “Ready“and block again. This writes all parameter settings into the ROM.

Note If repeated use of the test function does not lead to a reasonable result, the setting value should be determined empirically as described below.

Frequency adjusting characteristic df/dt
Factor for the command length which is formed proportionally to the slip. The setting value is determined using the test function TEST f-Match. Usual setting values: 0.1 to 0.5 %/s. The adjusting pulses are suppressed if df/dt is set to zero.

Empirical determination of the setting value:
Aim: a single frequency adjusting command should bring the slip approximately to half of the maximum slip smax. To do this, the frequency matcher must adjust the machine by means of frequency adjusting commands. The operator checks the command length and corrects it if necessary until the matcher is functioning satisfactorily.

Procedure:

1. Prevent the circuit breaker from closing while work is being carried out (circuit breaker in Test position, unplug connector -X6 for the paralleling commands on the SYNCHROTACT 5,...)
2. Temporarily switch off voltage matcher: set dU/dt = 0 and write into the random access memory.
3. In order that the effect of the adjusting pulse can be better judged: temporarily set pulse interval ts f to maximum and write into the random access memory .
4. Set SYNCHROTACT 5 to Ready
5. The machine must be in operation: voltages present on both sides of the circuit breaker; slip outside of the set tolerance window
6. Read the initial slip
7. Start synchronizing process
8. Wait for the end of the frequency adjusting command (LED), then wait until the slip display shows stable values (10 to 20 s) and read this final slip
9. Stop SYNCHROTACT 5
10. Calculate value according to the following formula: df/dt = df/dt0*(s0-s1)/ (s0-0.1)

    Key:
    df/dt = newly calculated value
    df/dt0 = setting value prior to test
    s0 = initial slip
    s1 = final slip
11. Block SYNCHROTACT 5, set calculated value and set to Ready again
12. Bring slip outside of the tolerance band
13. Start synchronizing process
14. After the first frequency adjusting command, the slip must lie approximately half-way between smax and zero
15. If the pulse was too long: increase the setting value, if the pulse was too short: lower the setting value
16. Repeat points 11 to 15 until the adjusting pulse length is correct and the matcher is functioning satisfactorily.
17. Activate voltage matcher again: set dU/dt = to previous value and save
18. Re-set pulse interval ts f to previous value and save

Pulse interval ts f

This defines the time between two frequency adjusting pulses. The default setting of 20 s can normally be left as it is. If problems arise with the frequency matching, tests should be carried with higher or lower values.

Minimum pulse time tp fmin
The minimum frequency adjusting pulse should be set as short as possible taking into account the manufacturer‘s specifications for the final control element. Usual setting value: tp fmin = 0.05 s.
Where the function INVERSE f is used, this parameter corresponds to the pulse duration.

Switchover to variable intervals INVERSE f
If this parameter is set to ON, the following applies:

- fixed pulse duration
- variable interval depending on actual value, according to the formula:

$$tsf = \frac{1}{(f1 - f2)}$$

Settings recommendation for tp fmin if INVERSE f = ON: as high as possible, but so that the matcher does not overshoot (see section 2.2.2 Frequency matcher with variable intervals).

4.2.7 Parameter group General Parameters

Blocking time after selection t block
The adjustable parameter t block prevents a command being given between selection and connection of the measuring voltages. The time t block does not expire if the parameter set has not been selected or if another criterion for synchronization is not fulfilled. If the parameter set is selected subsequently, t block is then started. The default setting for t block is 2 seconds.

Caution If t block is set too short, it is possible that the measuring voltages will not yet be stably connected when the device is already “live“.This is indicated with a single flash of the LED "U1/U2=0" after the start. In this case, the setting of t block has to be increased until this flash does not occur anymore.

Total paralleling time t tot
As soon as the Start signal is activated, the monitoring of the total paralleling time t tot starts to run. If this time is exceeded before the Stop signal is activated, the unfulfilled paralleling conditions are written into the event logger at the time t tot.

If the device is used as a synchrocheck for manual synchronization, the setting t tot is based on the maximum expected manual paralleling time.

Usual setting value: 5 min. If you wish to set the device to continuous operation or if these messages are not required, t tot should be set to zero.

4.2.8 Configuration parameters (Option)

Digital inputs I1 to I7 and digital outputs O1 to O7
Normally, the configuration is fixed prior to commissioning. The settings are therefore based on the project planning data.

The following table shows all possible functions for the **inputs**:

Setting value	Function	Remarks
±1 ***	Paralleling point 1 and Parameter set 1	The parameter set is only selected if no other input programmed with values from 8 to 14 is active.
±2	Paralleling point 2 and Parameter set 2	
±3	Paralleling point 3 and Parameter set 3	
±4	Paralleling point 4 and Parameter set 4	
±5	Paralleling point 5 and Parameter set 5	
±6	Paralleling point 6 and Parameter set 6	
±7	Paralleling point 7 and Parameter set 7	
±8	Parameter set 1	These programming settings are only required if the number of parameter sets and the number of paralleling points differ. (see examples in section 5.4)
±9	Parameter set 2	
±10	Parameter set 3	
±11	Parameter set 4	
±12	Parameter set 5	
±13	Parameter set 6	
±14	Parameter set 7	
±15	Selection of TEST mode	Normal synchronizing, but the paralleling relay is not operated. A configurable output relay with the value 16 can be used in its place (see below).
±16	Blocking of synchronizing process	A running synchronizing process is stopped and is continued when the signal is dropped.
±17	Blocking of synchronizing process delayed by t block	A running synchronizing process is stopped. After the signal is dropped, the time t block elapses, then the synchronizing process is automatically continued.
±18	Stop synchronization	Second Stop command
±19	Start synchronization	Second Start command
±20	Cancel fault and set device to “Ready”	If an error is detected, the device automatically changes to the status ‘Blocked with error‘. This function can be used to cancel the error and return the device to readiness for operation.
±21	No function	
±22	No function	
±23	No function	
±24	No function	
±25	No function	
±26	No function	
±27	No function	
±28	No function	
±29	No function	
±30	No function	
±31	No function±	
±32	No function	

Note *** The "+" in front of the setting value indicates that the related function via operating control interface will be blocked as long as the blocking input "BLK REM" is active. A "-" in front of the setting value indicates that blocking of the function is disabled not (see section 5.6.2).

The following table shows all possible functions for the **outputs**:

Setting value	**Function**	**Remarks**
1	Paralleling point 1	The relay is operated if the corresponding paralleling point is active, i.e. selected, and the synchronizing process is started.
2	Paralleling point 2	
3	Paralleling point 3	
4	Paralleling point 4	
5	Paralleling point 5	
6	Paralleling point 6	
7	Paralleling point 7	
8	Parameter set 1	The relay is operated if the corresponding parameter set is active, i.e. selected, and the synchronizing process is started.
9	Parameter set 2	
10	Parameter set 3	
11	Parameter set 4	
12	Parameter set 5	
13	Parameter set 6	
14	Parameter set 7	
15	Parameter set ≠ paralleling point	The relay is operated if the number of the parameter set and the number of the paralleling point is different.
16	Paralleling command display in TEST mode	If TEST mode is active (see configurable inputs, value 15) the paralleling command is passed to this relay.
17	Release given for dead bus	The relay is operated if the signal Release DB is present at the input (irrespective of operating status).
18	Stop	The relay is operated if the signal Stop is present at the input (irrespective of operating status).
19	Phase-angle difference within tolerance band	These signals can only be active in ‘OPERATING‘ status or in ‘TEST‘ mode (configurable).
20	Slip within tolerance band	
21	Voltage difference within tolerance band	
22	Release paralleling command (CHK RELEASE)	
23	U1 leading (α = positive)	
24	U1 lagging (α = negative)	
25	Oversynchronous (s = negative)	
26	Subsynchronous (s = positive)	
27	U2>U1	
28	U2<U1	
29	U1 outside of permitted range (Umin, Umax and U0max)	
30	U2 outside of permitted range (Umin, Umax and U0max)	
31	Contact monitoring tripped	The relay is operated if the paralleling command contacts are stuck (no longer open).
32	No function with this type of device	For SYN 5302: single system operation
33	ERROR	The relay is operated on detection of an error*
34	NO ERROR	The relay is operated if no error is present *
35	READY	The relay is operated if the device is ready for operation (normal status of the device when commissioned).*
36	OPERATING	The relay is operated if the synchronizing process is running (following expiry of t block)*
37	BLOCKED	The relay is operated if the device is in ‘BLOCKED‘ status.*
38	Back indication TEST mode selected	The relay is operated if the TEST mode is selected, or during running process in TEST mode

Setting value	Function	Remarks
39	U1<U0max	These signals can only be active in 'OPERATING' status or in 'TEST' mode (configurable).
40	U2<U0max	
41	U1 and U2<U0max	
42	U1 or U2<U0max	

4.2.9 Synchrocheck parameters (SYN 5202 only)

The synchrocheck parameter settings are based on the highest setting value of the corresponding parameters of all the used parameter sets.

Slip limit smax
Settings recommendation: 0.1% greater than the highest slip limit of the first channel.

Angle limit αmax
Settings recommendation: at least 2 DEG greater than the highest angle limit of the first channel.

Maximum voltage difference ΔUmax
Settings recommendation: setting of the highest limit for the voltage difference of the first channel, rounded up to 5% steps

Maximum zero voltage U0max
Only set if Dead Bus is used
Settings recommendation: highest U0max of channel 1 rounded up to whole 5% step.

Nominal voltage Un
Nominal voltage of the plant

4.3 Addressing and configuration of the operating interface

4.3.1 Addressing Modbus RTU

28 words, each with 16 bits, are transmitted. The addressing is as follows:

Address	Content	Word type	Direction of transmission	Format	Scaling
1	Digital inputs	Bit-coded	read and write*	--	--
2	Digital outputs	Bit-coded	read	--	--
3	Digital outputs	Bit-coded	read	--	--
4	Actual value ΔU	Analog value	read	signed integer**	0.1 % of Un
5	Actual value α	Analog value	read	signed integer	0.1 DEG
6	Actual value s	Analog value	read	signed integer	0.01 %
7	Actual value U1	Analog value	read	signed integer	0.1 % of Un
8	Actual value U2	Analog value	read	signed integer	0.1 % of Un
9	Actual value f1	Analog value	read	signed integer	0.01 Hz
10	Actual value f2	Analog value	read	signed integer	0.01 Hz
11	Actual value ds/dt	Analog value	read	signed integer	0.01 %/s
12	Back-indication of selected parameter set	Analog value	read	unsigned integer ***	Number of the selected parameter set
13	Software version	Analog value	read	unsigned integer	One digit of the version number per nibble (half byte) (e.g.: 5137d = 1411h = V1.4.1.1)
14	Command counter reading parameter set 1	Analog value	read	unsigned integer	none (0 to 65535)
15	Command counter reading parameter set 2	Analog value	read	unsigned integer	none (0 to 65535)
16	Command counter reading parameter set 3	Analog value	read	unsigned integer	none (0 to 65535)
17	Command counter reading parameter set 4	Analog value	read	unsigned integer	none (0 to 65535)
18	Command counter reading parameter set 5	Analog value	read	unsigned integer	none (0 to 65535)
19	Command counter reading parameter set 6	Analog value	read	unsigned integer	none (0 to 65535)
20	Command counter reading parameter set 7	Analog value	read	unsigned integer	none (0 to 65535)
21	Current event (event code)	Analog value	read	unsigned integer	none
22	Year of the current event	Analog value	read	unsigned integer	none
23	Month of the current event	Analog value	read	unsigned integer	none
24	Day of the current event	Analog value	read	unsigned integer	none
25	Hour of the current event	Analog value	read	unsigned integer	none
26	Minute of the current event	Analog value	read	unsigned integer	none
27	Second of the current event	Analog value	read	unsigned integer	none
28	Hundredth of a second of the current event	Analog value	read	unsigned integer	none

* read = read data from the SYNCHROTACT 5

** signed integer = whole numbers

*** unsigned integer = positive whole numbers

Resolution of the bit-coded words into individual binary signals:

Address 1 (Index 0):

Bit	Binary signal
0	Start
1	Stop
2	Release DB
3	Reset
4	Blocking input BLK REM (read only!)
5	--
6	--
7	--
8	Configurable digital input 1 (only with SYN 5014)
9	Configurable digital input 2 (only with SYN 5014)
10	Configurable digital input 3 (only with SYN 5014)
11	Configurable digital input 4 (only with SYN 5014)
12	Configurable digital input 5 (only with SYN 5014)
13	Configurable digital input 6 (only with SYN 5014)
14	Configurable digital input 7 (only with SYN 5014)
15	--

Address 2 (Index 1):

Bit	Binary signal
0	LED ‘ΔU<ΔUmax‘
1	LED ‘s<smax‘
2	LED ‘α<αmax‘
3	LED ‘U1/U2=0‘
4	--
5	--
6	--
7	--
8	Relay for configurable digital output 1 (only with SYN 5014)
9	Relay for configurable digital output 2 (only with SYN 5014)
10	Relay for configurable digital output 3 (only with SYN 5014)
11	Relay for configurable digital output 4 (only with SYN 5014)
12	Relay for configurable digital output 5 (only with SYN 5014)
13	Relay for configurable digital output 6 (only with SYN 5014)
14	Relay for configurable digital output 7 (only with SYN 5014)
15	--

Address 3 (Index 2):

Bit	Binary signal
0	LED ‘ERROR‘
1	LED ‘BLOCKED‘
2	LED ‘READY‘
3	LED ‘OPERATING‘
4	LED ‘U+‘
5	LED ‘U-‘
6	LED ‘f+‘
7	LED ‘f-‘
8	LED ‘ORDER‘
9	LED ‘CHK RELEASE‘
10	‘ORDER‘ relay
11	--
12	--
13	--
14	--
15	--

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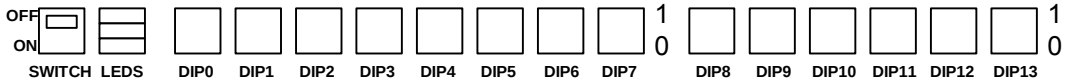
4.3.2 Configuring Modbus RTU

The configuration of the Modbus RTU is carried out using 14 DIP switches. The three LEDs on the left next to the DIP switches are used for the status display.

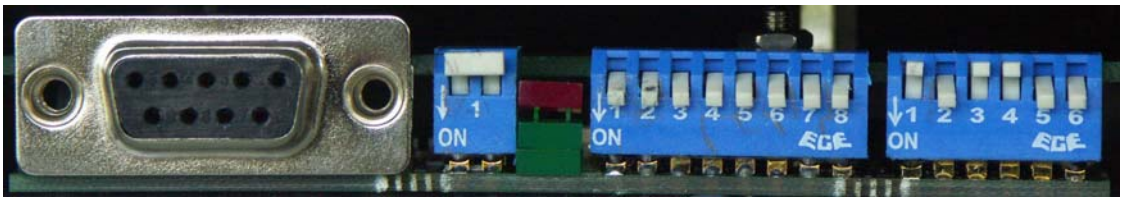
Note The device has to be restarted each time the configuration is changed (switch auxiliary voltage off and on again).



Note If the SYNCHROTACT 5 device is configured in RS485 mode and is the last component on the bus, the blue switch (SWITCH) to the left of the LED‘s has to be set to ON in order to prevent reflections on the bus line.

Function	DIP no.	DIP value	Configuration
Electrical mode	DIP 0	0	RS485
		1	RS232
Selection of slave address	DIP 1 – DIP 8	MSB - LSB	Valid range 1-247
Selection of Baudrate	DIP 9 / 10 / 11	000	1200
		001	2400
		010	4800
		011	9600
		100	19200 (factory setting)
		101	38400
		110	50000
		111	Not supported
Selection of parity mode	DIP 12 / 13	00	None
		01	Odd
		10	Even
		11	Not used

Example:



Switch	DIP0	DIP1	DIP2	DIP3	DIP4	DIP5	DIP6	DIP7	DIP8	DIP9	DIP10	DIP11	DIP12	DIP13
OFF	0	0	0	0	0	0	0	0	1	0	1	1	0	0

SWITCH OFF
Electrical mode RS485
Slave address: 1
Baud rate: 9600
Parity: None

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4.3.3 Addressing Profibus DP

28 words, each with 16 bits, are transmitted. The addressing is as follows:

Add-ress	Content	Word type	Direction of trans-mission	Format	Scaling
1	Digital inputs	Bit-coded	read and write*	--	--
2	Digital outputs	Bit-coded	read	--	--
3	Digital outputs	Bit-coded	read	--	--
4	Actual value ΔU	Analog value	read	signed integer**	0.1 % of Un
5	Actual value α	Analog value	read	signed integer	0.1 DEG
6	Actual value s	Analog value	read	signed integer	0.01 %
7	Actual value U1	Analog value	read	signed integer	0.1 % of Un
8	Actual value U2	Analog value	read	signed integer	0.1 % of Un
9	Actual value f1	Analog value	read	signed integer	0.01 Hz
10	Actual value f2	Analog value	read	signed integer	0.01 Hz
11	Actual value ds/dt	Analog value	read	signed integer	0.01 %/s
12	Back-indication of selected parameter set	Analog value	read	unsigned integer ***	Number of the selected parameter set
13	Software version	Analog value	read	unsigned integer	One digit of the version number per nibble (half byte) (e.g.: 5137d = 1411h = V1.4.1.1)
14	Command counter reading parameter set 1	Analog value	read	unsigned integer	none (0 to 65535)
15	Command counter reading parameter set 2	Analog value	read	unsigned integer	none (0 to 65535)
16	Command counter reading parameter set 3	Analog value	read	unsigned integer	none (0 to 65535)
17	Command counter reading parameter set 4	Analog value	read	unsigned integer	none (0 to 65535)
18	Command counter reading parameter set 5	Analog value	read	unsigned integer	none (0 to 65535)
19	Command counter reading parameter set 6	Analog value	read	unsigned integer	none (0 to 65535)
20	Command counter reading parameter set 7	Analog value	read	unsigned integer	none (0 to 65535)
21	Current event (event code)	Analog value	read	unsigned integer	none
22	Year of the current event	Analog value	read	unsigned integer	none
23	Month of the current event	Analog value	read	unsigned integer	none
24	Day of the current event	Analog value	read	unsigned integer	none
25	Hour of the current event	Analog value	read	unsigned integer	none
26	Minute of the current event	Analog value	read	unsigned integer	none
27	Second of the current event	Analog value	read	unsigned integer	none
28	Hundredth of a second of the current event	Analog value	read	unsigned integer	none

* read = read data from SYNCHROTACT 5

** signed integer = whole numbers

*** unsigned integer = positive whole numbers

Resolution of the bit-coded words into individual binary signals:

Address 1 (Index 0):

Bit	Binary signal
0	Start
1	Stop
2	Release DB
3	Reset
4	Blocking input BLK REM (read only!)
5	--
6	--
7	--
8	Configurable digital input 1 (only with SYN 5014)
9	Configurable digital input 2 (only with SYN 5014)
10	Configurable digital input 3 (only with SYN 5014)
11	Configurable digital input 4 (only with SYN 5014)
12	Configurable digital input 5 (only with SYN 5014)
13	Configurable digital input 6 (only with SYN 5014)
14	Configurable digital input 7 (only with SYN 5014)
15	--

Address 2 (Index 1):

Bit	Binary signal
0	LED ‘ΔU<ΔUmax‘
1	LED ‘s<smax‘
2	LED ‘α<αmax‘
3	LED ‘U1/U2=0‘
4	--
5	--
6	--
7	--
8	Relay for configurable digital output 1
9	Relay for configurable digital output 2
10	Relay for configurable digital output 3
11	Relay for configurable digital output 4
12	Relay for configurable digital output 5
13	Relay for configurable digital output 6
14	Relay for configurable digital output 7
15	--

Address 3 (Index 2):

Bit	Binary signal
0	LED ‘ERROR‘
1	LED ‘BLOCKED‘
2	LED ‘READY‘
3	LED ‘OPERATING‘
4	LED ‘U+‘
5	LED ‘U-‘
6	LED ‘f+‘
7	LED ‘f-‘
8	LED ‘ORDER‘
9	LED ‘CHK RELEASE‘
10	‘ORDER‘ relay
11	--
12	--
13	--
14	--
15	--

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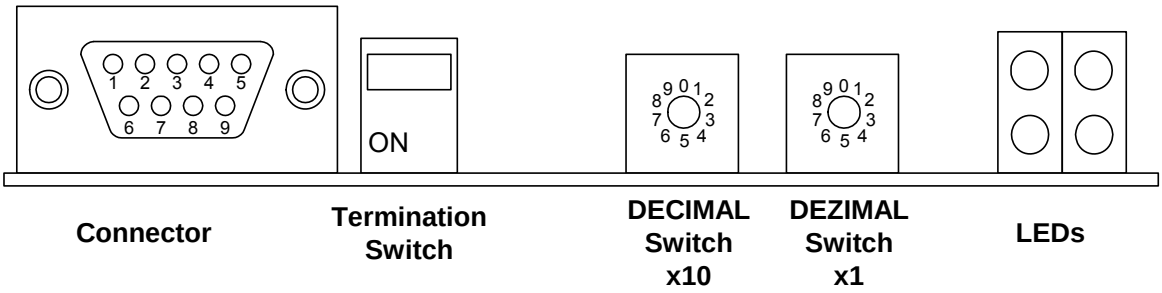
4.3.4 Configuring Profibus DP

The configuration of the Profibus is carried out using two DECIMAL switches. The switch on the left is x10 and that on the right x1.

Note The device has to be restarted each time the configuration is changed (switch auxiliary voltage off and on again).



Connector | **Termination Switch** | **DECIMAL Switch x10** | **DEZIMAL Switch x1** | **LEDs**

Note If the SYNCHROTACT 5 device is the first or last component on the bus, the termination switch must be set to ON in order to prevent reflections on the bus line. However, if an external termination plug is used, the termination switch must remain OFF.

Selecting the slave address
The address can be set between 0-99 using the DECIMAL switches described above. The left-hand switch determines the tens position and the switch on the right the units position.

Selecting the Baudrate:
The Baudrate is determined by the master and automatically recognised by the SYNCHROTACT 5. The following Baudrates are supported:

9,6 kbit/s
19,2 kbit/s
93,75 kbit/s
187,5 kbit/s
500 kbit/s
1,5 Mbit/s
3 Mbit/s
6 Mbit/s
12 Mbit/s

4.3.5 Addressing Lon-Bus

29 words, each with 16 bits, are transmitted. The addressing is as follows:

Add-ress	Content	Word type	Direction of trans-mission	Format	Scaling	Signal name
1	Digital inputs	Bit-coded	read*	--	--	NV_Syn5_inputs_out
2	Digital outputs	Bit-coded	read	--	--	NV_Syn5_output1
3	Digital outputs	Bit-coded	read	--	--	NV_Syn5_output2
4	Actual value ΔU	Analog val.	read	signed integer**	0.1 % of Un	NV_Syn5_delta_U
5	Actual value α	Analog val.	read	signed integer	0.1 DEG	NV_Syn5_alpha
6	Actual value s	Analog val.	read	signed integer	0.01 %	NV_Syn5_slip
7	Actual value U1	Analog val.	read	signed integer	0.1 % of Un	NV_Syn5_U1
8	Actual value U2	Analog val.	read	signed integer	0.1 % of Un	NV_Syn5_U2
9	Actual value f1	Analog val.	read	signed integer	0.01 Hz	NV_Syn5_f1
10	Actual value f2	Analog val.	read	signed integer	0.01 Hz	NV_Syn5_f2
11	Actual value ds/dt	Analog val.	read	signed integer	0.01 %/s	NV_Syn5_ds_dt
12	Back-indication of selected parameter set	Analog val.	read	unsigned integer ***	Number of the selected parameter set	NV_Syn5_Parameterset
13	Software version	Analog val.	read	unsigned integer	One digit of the version number per nibble (half byte) (e.g.: 5137d = 1411h = V1.4.1.1)	NV_Syn5_SW_version
14	Command counter reading par-set 1	Analog val.	read	unsigned integer	none (0 to 65535)	NV_Syn5_close1
15	Command counter reading par-set 2	Analog val.	read	unsigned integer	none (0 to 65535)	NV_Syn5_close2
16	Command counter reading par-set 3	Analog val.	read	unsigned integer	none (0 to 65535)	NV_Syn5_close3
17	Command counter reading par-set 4	Analog val.	read	unsigned integer	none (0 to 65535)	NV_Syn5_close4
18	Command counter reading par-set 5	Analog val.	read	unsigned integer	none (0 to 65535)	NV_Syn5_close5
19	Command counter reading par-set 6	Analog val.	read	unsigned integer	none (0 to 65535)	NV_Syn5_close6
20	Command counter reading par-set 7	Analog val.	read	unsigned integer	none (0 to 65535)	NV_Syn5_close7
21	Current event (event code)	Analog val.	read	unsigned integer	none	NV_Syn5_event_code
22	Year of the current event	Analog val.	read	unsigned integer	none	NV_Syn5_event_year
23	Month of the current event	Analog val.	read	unsigned integer	none	NV_Syn5_event_month
24	Day of the current event	Analog val.	read	unsigned integer	none	NV_Syn5_event_day
25	Hour of the current event	Analog val.	read	unsigned integer	none	NV_Syn5_event_hour
26	Minute of the current event	Analog val.	read	unsigned integer	none	NV_Syn5_event_minute
27	Second of the current event	Analog val.	read	unsigned integer	none	NV_Syn5_event_second
28	Hundredth of a second of the current event	Analog val.	read	unsigned integer	none	NV_Syn5_one_hundredth
29	Digital inputs	Bit-coded	write	--	--	NV_Syn5_inputs

* read = read data from SYNCHROTACT 5

** signed integer = whole numbers

*** unsigned integer = positive whole numbers

Resolution of the bit-coded words into individual binary signals:

Address 1 (Index 0):

Bit	Binary signal
0	Start
1	Stop
2	Release DB
3	Reset (cancel fault and set to "READY")
4	Blocking input BLK REM (read only!)
5	--
6	--
7	--
8	Configurable digital input 1 (only with SYN 5014)
9	Configurable digital input 2 (only with SYN 5014)
10	Configurable digital input 3 (only with SYN 5014)
11	Configurable digital input 4 (only with SYN 5014)
12	Configurable digital input 5 (only with SYN 5014)
13	Configurable digital input 6 (only with SYN 5014)
14	Configurable digital input 7 (only with SYN 5014)
15	--

Address 2 (Index 1):

Bit	Binary signal
0	LED ‘ΔU<ΔUmax‘
1	LED ‘s<smax‘
2	LED ‘α<αmax‘
3	LED ‘U1/U2=0‘
4	--
5	--
6	--
7	--
8	Relay for configurable digital output 1
9	Relay for configurable digital output 2
10	Relay for configurable digital output 3
11	Relay for configurable digital output 4
12	Relay for configurable digital output 5
13	Relay for configurable digital output 6
14	Relay for configurable digital output 7
15	--

Address 3 (Index 2):

Bit	Binary signal
0	LED ‘ERROR‘
1	LED ‘BLOCKED‘
2	LED ‘READY‘
3	LED ‘OPERATING‘
4	LED ‘U+‘
5	LED ‘U-‘
6	LED ‘f+‘
7	LED ‘f-‘
8	LED ‘COMMAND‘
9	LED ‘CHK RELEASE‘
10	‘COMMAND‘ relay
11	--
12	--
13	--
14	--
15	--

Template: CHIND Techn doc stand, A4 P de, R1.DOT; Filename: 3BHS109762E01 D.doc; Print: 12/6/2011 5:48:00 PM; Save: 12/1/2011 2:37:00 PM; CHIND No. 3BHS109763 ZAB D14 Rev. -; I-Q

Note It is practical to read the signals for the addresses 4 to 11 by polling, since otherwise the insufficient steadying of the measured values places a heavy load on the fieldbus (worst case: a telegram every 20 ms). The measured value in Operating status is of the greatest interest.

Note Address 13: The information is not generally of importance for transmission via the fieldbus, since the software in the device does not change.

Address 29 (Index 28):

Bit	Binary signal
0	Start
1	Stop
2	Release DB
3	Reset (cancel fault and set to "READY")
4	--
5	--
6	--
7	--
8	configurable digital input 1 (only if SYN 5014 is used)
9	configurable digital input 2 (only if SYN 5014 is used)
10	configurable digital input 3 (only if SYN 5014 is used)
11	configurable digital input 4 (only if SYN 5014 is used)
12	configurable digital input 5 (only if SYN 5014 is used)
13	configurable digital input 6 (only if SYN 5014 is used)
14	configurable digital input 7 (only if SYN 5014 is used)
15	--

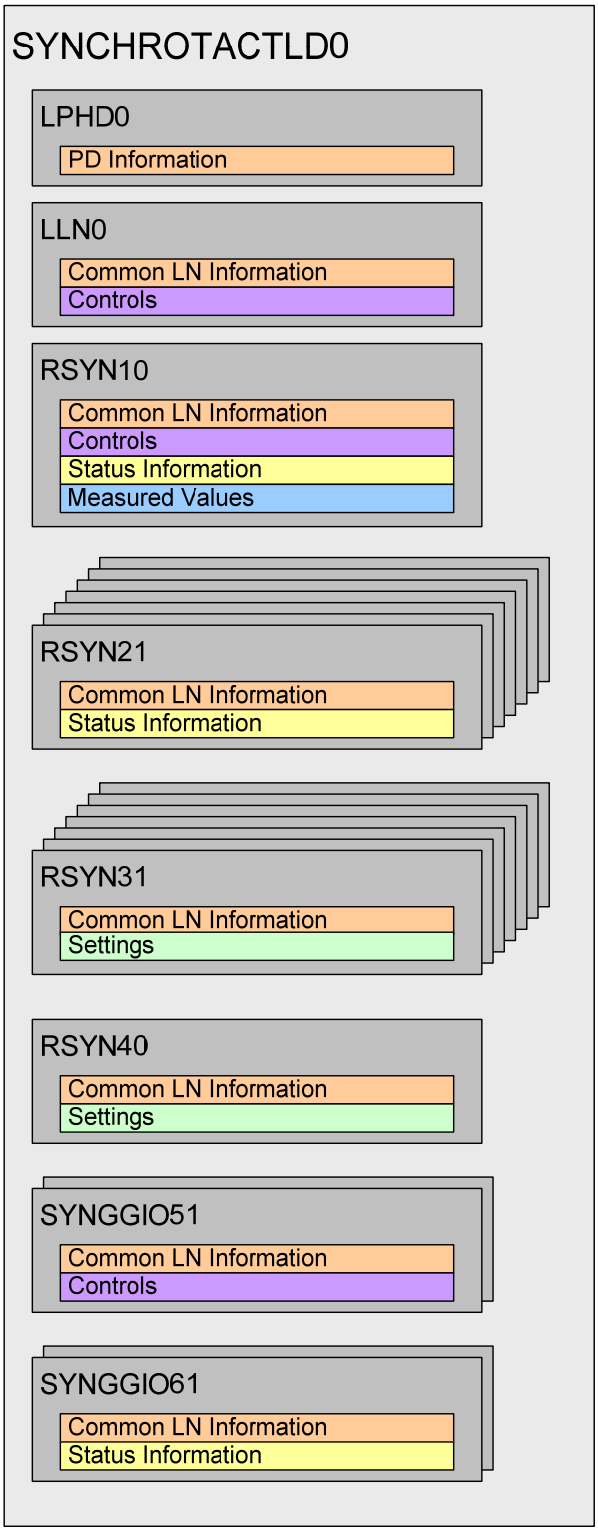
4.3.6 Configuring Lon-Bus

The transmission rate is 1.5 MBaud.

Service key
The Service key is required for configuration. By pressing the key, the request for the configuration data is sent to the master. The latter then sends the corresponding data to the SYNCHROTACT slave.
The Service key is not required during normal operation.

Template: CHIND Techn doc stand, A4 P de, R1.DOT; Filename: 3BHS109762E01 D.doc; Print: 12/6/2011 5:48:00 PM; Save: 12/1/2011 2:37:00 PM; CHIND No. 3BHS109763 ZAB D14 Rev. -; I-Q

4.3.7 IEC 61850 Data model



4.3.8 SYNCHROTACT 5 - specific logical nodes and their application

LN	Contents	Remarks	DR	GR
RSYN10	General Data	Standard	Yes	No
RSYN21	Paralleling point 1	Standard	Yes	Yes
RSYN22	Paralleling point 2	Option 7 Parameter sets	Yes	Yes
RSYN23	Paralleling point 3	Option 7 Parameter sets	Yes	Yes
RSYN24	Paralleling point 4	Option 7 Parameter sets	Yes	Yes
RSYN25	Paralleling point 5	Option 7 Parameter sets	Yes	Yes
RSYN26	Paralleling point 6	Option 7 Parameter sets	Yes	Yes
RSYN27	Paralleling point 7	Option 7 Parameter sets	Yes	Yes
RSYN31	Parameter set 1	Standard	No	No
RSYN32	Parameter set 2	Option 7 Parameter sets	No	No
RSYN33	Parameter set 3	Option 7 Parameter sets	No	No
RSYN34	Parameter set 4	Option 7 Parameter sets	No	No
RSYN35	Parameter set 5	Option 7 Parameter sets	No	No
RSYN36	Parameter set 6	Option 7 Parameter sets	No	No
RSYN37	Parameter set 7	Option 7 Parameter sets	No	No
RSYN40	Parameters channel 2	Only SYN 5202	No	No
SYNGGIO51	Digital Inputs 1-5	Option 7 Parameter sets	Yes	No
SYNGGIO52	Digital Inputs 6-7	Option 7 Parameter sets	Yes	No
SYNGGIO61	Digital Outputs 1-5	Option 7 Parameter sets	Yes	No
SYNGGIO62	Digital Outputs 6-7	Option 7 Parameter sets	Yes	No

DR = Data Report; Attributes, which are not included in a report must be read out. ("polling")
GR = GOOSE Report

Logical Node RSYN10

IEC 61850 Attribute names	SYNCHROTACT 5 Names	Remarks	DR	GR
Controls				
StrSynPrg	START		Yes	No
StopSynPrg	STOP		Yes	No
RelDeaBus	RELEASE DB		Yes	No
BlkSyn	BLOCK		Yes	No
RsSyn	RESET		Yes	No
Status Information				
Rel	CHK RELEASE	Display paralleling release im Synchrocheckbetrieb	Yes	No
Cmd	COMMAND	Display paralleling command issue	Yes	No
VInd	ΔU < ΔUmax	IEC 61850-Signal is inverted	Yes	No
AngInd	α < αmax	IEC 61850-Signal is inverted	Yes	No
HzInd	s < smax	IEC 61850-Signal is inverted	Yes	No
SynPrg	OPERATING		Yes	No
SynFlt	ERROR		Yes	No
SynRdy	READY		Yes	No
SynSetMod	BLOCKED		Yes	No
Measured Values				
DifVClc	ΔU		No	No
DifHzClc	s		No	No
DifAngClc	α		No	No
V1Clc	U1		No	No
V2Clc	U2		No	No
Hz1Clc	f1		No	No
Hz2Clc	f2		No	No
AccClc	ds/dt		No	No

Logical Node RSYN21 to RSYN27

IEC 61850 Attribute names	SYNCHROTACT 5 Names	Remarks	DR	GR
Status Information				
Rel	CHK RELEASE	Only when paralleling point is selected. With SYN 5202 and SYN 5302, CHK RELEASE is additionally linked to CHK RELEASE of the second channel.	Yes	Yes
Cmd	COMMAND	Only when paralleling point is selected. Pulse length is limited With SYN 5202 and SYN 5302, COMMAND is additionally linked to CHK RELEASE of the second channel.	Yes	Yes
RV	U+	Only when paralleling point is selected	Yes	Yes
LV	U-	Only when paralleling point is selected	Yes	Yes
RHz	f+	Only when paralleling point is selected	Yes	Yes
LHz	f-	Only when paralleling point is selected	Yes	Yes
SynPrg	OPERATING	Only when paralleling point is selected	Yes	No

DR = Data Report; Attributes, that are not contained in a report, must be polled
GR = GOOSE Report

Logical Node RSYN31 to RSYN37

IEC 61850 Attribute names	SYNCHROTACT 5 **Names**	**Remarks**	**DR**	**GR**
Settings				
VNomV	Un		No	No
HzNom	fn		No	No
VAdpFact	ΔUOffset		No	No
AdpAngDeg	αOffset		No	No
BkrTmms	t on		No	No
PlsTmms	tp on		No	No
DlTms	t supervis		No	No
MltCmd	MULTIPLE CMD		No	No
DifVNg	-ΔUmax		No	No
DifVPs	+ΔUmax		No	No
DifHzNg	-smax		No	No
DifHzPs	+smax		No	No
DifAngNg	-αmax		No	No
DifAngPs	+αmax		No	No
MinVSyn	Umin		No	No
MaxVSyn	Umax		No	No
LivDeaMod	U1not, U2not, 1*2not	LivDeaMod: 0 — U1not: 0, U2not: 0, 1*2not: 0 1 — 0, 0, 1 2 — 0, 1, 0 3 — 1, 0, 0 4 — 0, 1, 1 5 — 1, 0, 1 6 — 1, 1, 0 7 — 1, 1, 1	No	No
DeaBusVal	U0max		No	No
VChr	dU/dt		No	No
VInvTms	ts U		No	No
MinVTms	tp Umin		No	No
HzChr	df/dt		No	No
HzInvTms	ts f		No	No
MinHzTms	tp fmin		No	No
TmTot	t tot		No	No

DR = Data Report; Attributes that are not contained in a report must be polled
GR = GOOSE Report

Logical Node RSYN40

IEC 61850 Attribute names	SYNCHROTACT 5 Names	Remarks	DR	GR
Settings				
VNomV	Un		No	No
DifVPs	ΔUmax		No	No
DifHzPs	smax		No	No
DifAngPs	αmax		No	No
DeaBusVal	U0max		No	No

Logical Node SYNGGIO51

IEC 61850 Attribute names	SYNCHROTACT 5 Names	Remarks	DR	GR
Controls				
SPCS01	IN1		Yes	No
SPCS02	IN2		Yes	No
SPCS03	IN3		Yes	No
SPCS04	IN4		Yes	No
SPCS05	IN5		Yes	No

Logical Node SYNGGIO52

IEC 61850 Attribute names	SYNCHROTACT 5 Names	Remarks	DR	GR
Controls				
SPCS01	IN6		Yes	No
SPCS02	IN7		Yes	No

Logical Node SYNGGIO61

IEC 61850 Attribute names	SYNCHROTACT 5 Names	Remarks	DR	GR
Status Information				
SPCS01	OUT1		Yes	No
SPCS02	OUT2		Yes	No
SPCS03	OUT3		Yes	No
SPCS04	OUT4		Yes	No
SPCS05	OUT5		Yes	No

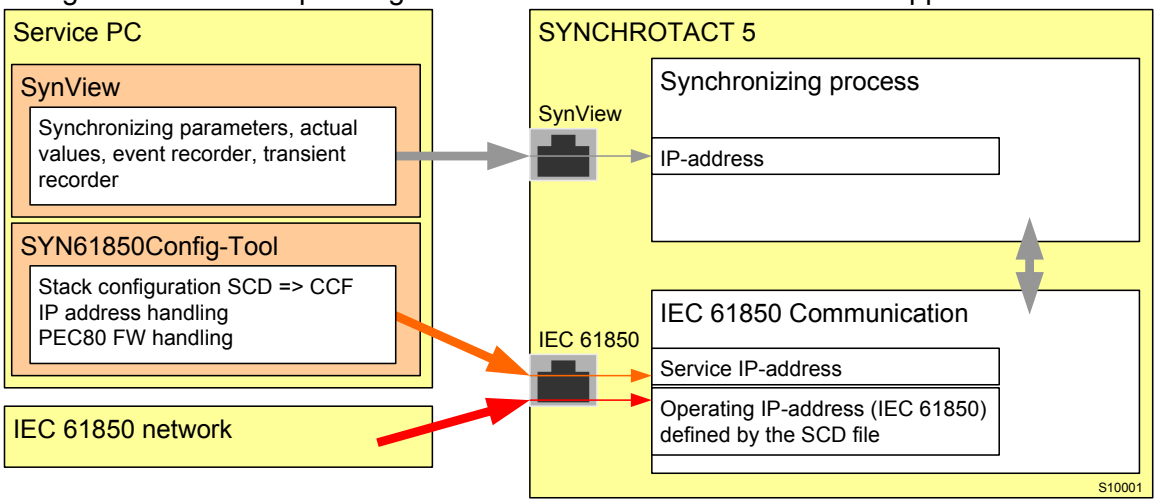
Logical Node SYNGGIO62

IEC 61850 Attribute names	SYNCHROTACT 5 Names	Remarks	DR	GR
Status Information				
SPCS01	OUT6		Yes	No
SPCS02	OUT7		Yes	No

DR = Data Report; Attributes that are not contained in a report must be polled
GR = GOOSE Report

4.3.9 Configuration IEC 61850

The IEC 61850–Interface has two IP-addresses, the Service IP-address for the configuration and the operating IP-address for the actual IEC 61850-Application.



The Service IP-address is used for the configuration of the IEC 61850-Application, resp. downloading of the SCD-file.
The service IP-address can be read out by means of the scan function of the SYN61850Config-Tool (see chapter 7.4.3).
If necessary, the address can be adapted by means of the SYN61850Config-Tool.

The Factory Default Service IP-address is configured as follows:

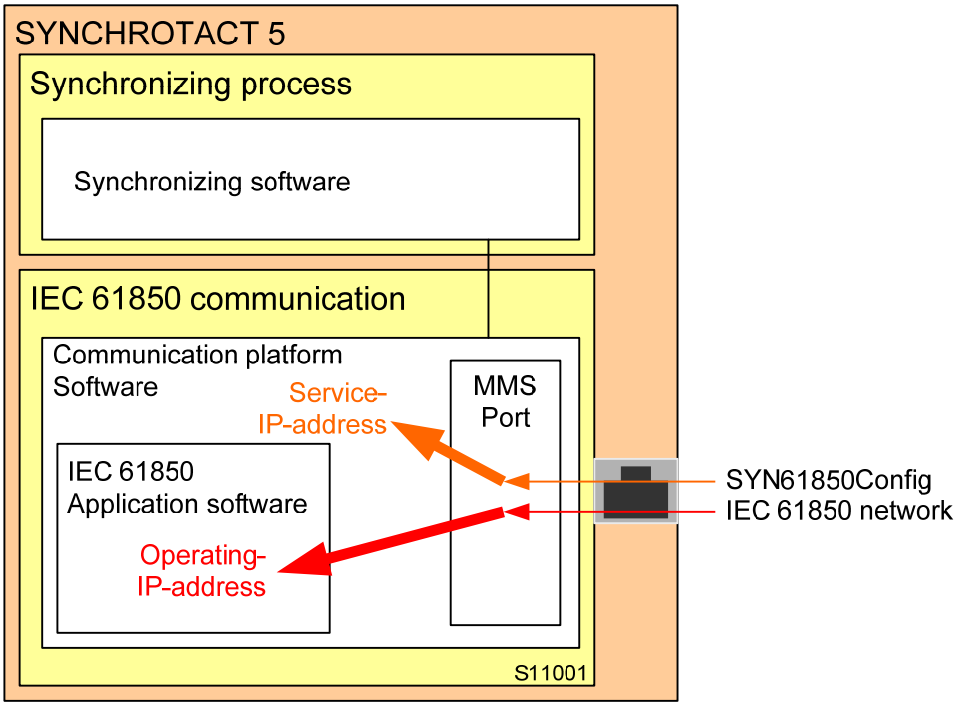
IP-address:	10.10.10.11
Subnet Mask	255.255.255.0

Note Each change requires a restart (Power up)

Caution The Service IP-address must not be re-used in the connected subnet. If there are two or more SYNCHROTACT 5 devices in the same subnet, the IP-addresses must be different.

The operating IP-address for IEC 61850 is application-specific and is defined in the SCD-File.

Both the communication platform and the IEC 61850 application software use the MMS port. In order to prevent conflicts, the service IP-address and the operating IP-address must be different.



5 Engineering instructions

5.1 General advice

5.1.1 Cable connections

Cables or wires with cross sections of 0.4 mm^2 to 2.5 mm^2 can be connected to all the connection terminals. It is recommended that 1 mm^2 should be used for control circuits and power supply connections; at least 1,5 mm^2 should be used for measuring circuits. Connection of more than one cable to a terminal is not permitted.

The casing must be connected with the earth potential via the connection provided for this purpose.

In order to prevent polarity errors, marked cables should be used for all voltage transformers (measuring circuits).

Caution It is urgently advised not to switch off the unit by interrupting the power supply, since otherwise the monitoring of the paralleling contacts is no longer guaranteed. In the event of a possible contact fault, incorrect paralleling could occur the next time synchronization is selected.

5.1.2 Recommended measures for long distances

For distances >50 m, the following measures are recommended:

- The cables for the actual value measurement should have a cross section $\geq$ 2.5 mm^2 and should be twisted pair and shielded.
- The control circuits should be operated with a nominal voltage of $\geq$125 VDC in order to prevent inductive interference.
- All cables must be laid separately from high-voltage and high-current cables.

5.2 Connection of the measuring voltages

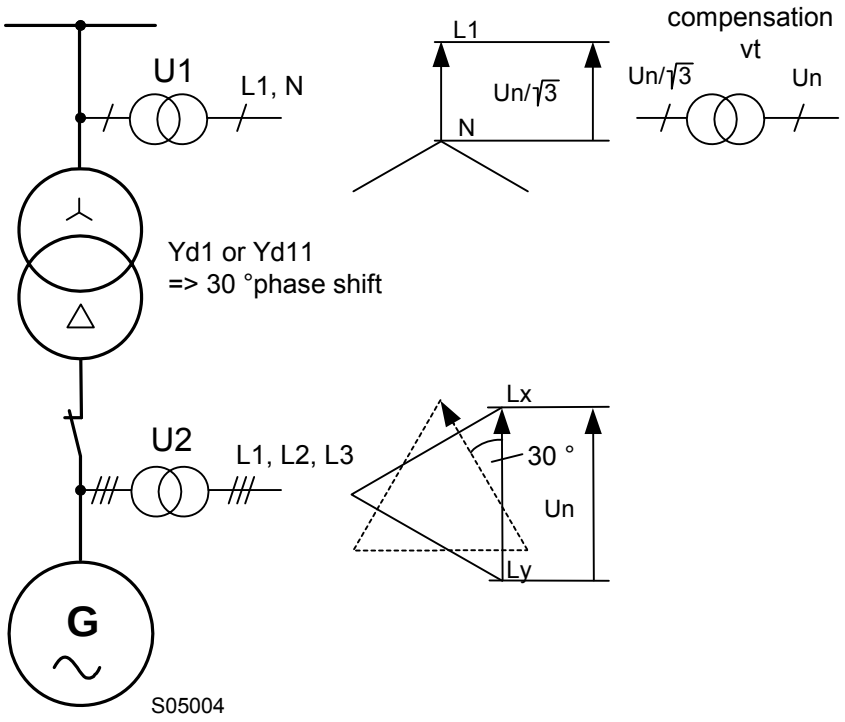
5.2.1 Three phase measuring

SYNCHROTACT 5 synchronizing devices basically operate with single-phase measuring signals, which is normally sufficient. If the synchronizing device is assigned the task of detecting a loss of phase, the first channel of each system should measure the voltage L1-L2, for example, and the second channel L3-L1. The detection of loss of phase does not function if one of the phases is earthed instead of the star point.

Caution Where the Dead Bus function is used, in particular, it should be noted that an undetected loss of phase can simulate a dead bus situation. In such a case, the active release signal for Dead Bus could trigger a synchronization error .

5.2.2 Compensation of phase-angle difference

In many cases it's possible to use a compensation vt of single phase type instead of a more expensive three phase type by choosing the most suitable connection.



Compared to the primary side, the secondary side is shifted by +30 DEG or -30 DEG (= +330 DEG). If the phase selection on the secondary side has been carried out correctly, the phase difference will be 0 DEG with closed circuit breaker.

5.3 Sequences of the synchronizing process

The switch-on sequences are as follows:

- The electronics power supply must be switched on first (Recommendation: permanent operation)
- All pre-selections (parameter set, paralleling point and possibly others) must then be made via the digital inputs.
- Once all pre-selections have been made, the synchronizing process is selected by means of the Start pulse. The pre-selections can be made at the same time as the Start pulse. The pulse must be at least 0.5 seconds long (recommended length: 1 to 2 s), can, however, also be active up until the end of the synchronizing process (Stop).
- Immediately after the Start command, the relay contacts for selection of the paralleling point close. The settable blocking time t block prevents commands being issued between selection and connection of the measuring voltages. The time t block does not expire if the parameter set has not been selected or if another criterion for synchronization is not fulfilled. If the parameter set is selected subsequently, t block is then started. The default setting for t block is 2 seconds.

- While the synchronizing process is running, changes in the parameter set selection are ignored.

Stopping the synchronizing process:

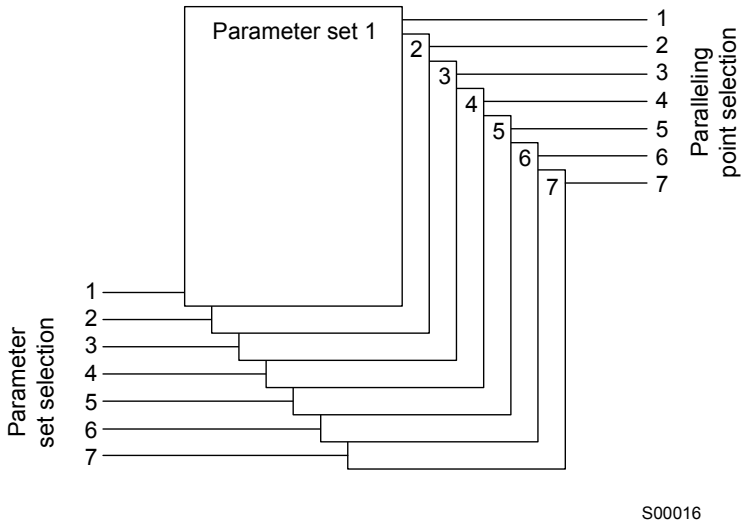
- Normally, the synchronizing process is terminated by means of an auxiliary contact of the circuit breaker (normally open). The signal is passed to the Stop input of the SYNCHROTACT 5.
- In exceptional cases, a synchronizing process needs to be terminated without closing the circuit breaker. In this case, a parallel Stop command is sent to the SYNCHROTACT 5 (triggered manually or automatically).

The Stop signal should be at least 0.5 seconds long (recommended length: 1 to 2 s), can, however, also be active up until the start of a new synchronizing process.

Locking:
Start and Stop are locked. Stop has priority.

5.4 Configurable I/Os

Note In the version with 7 parameter sets, the SYN 5014 board with seven digital inputs and outputs is fitted. Normally, each of the seven inputs and outputs is assigned a parameter set and a paralleling point (default setting), i.e., the inputs and outputs should not be configured. The following examples show special cases where a configuration is required. If no configuration is required (normal case!), it can be continued in section 5.5.



5.4.1 Assigning several parameter sets to a paralleling point

This case applies if the same generator is paralleled with different matching characteristics, e.g. in pump and turbine operation, or if SYNCHROTACT 5 is used both as automatic synchronizing device and as synchrocheck for the same circuit breaker.

Example: **Two parameter sets** are assigned to **one paralleling point**:
Input 1 is permanently selected. If a signal is applied to input IN2 before Start, parameter set 2 is selected, otherwise parameter set 1 is active.

Programming:
Parameter I1 = 1
Parameter I2 = 9
Parameter O1 = 1

Operating behaviour:

Signal to:	**Outputs:**	**Selected:**
Input IN1	OUT1 closes	Parameter set 1 and paralleling point 1
Inputs IN1 and IN2	OUT1 closes	Parameter set 2 and paralleling point 1

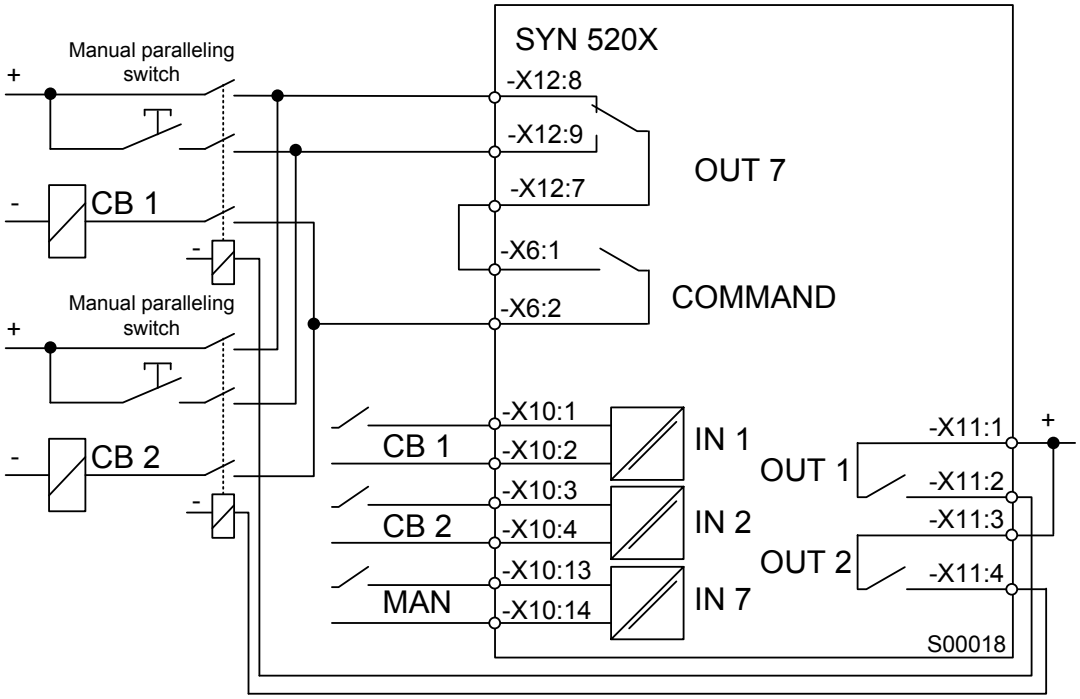
Example: **Parameter set for synchrocheck operation**:
Two circuit breakers are normally automatically synchronized by means of parameter sets 1 and 2. If, in addition to the signal at IN1 or IN2, a signal is applied to IN7, parameter set 7 is linked with paralleling point 1 or 2. Parameter set 7 is parameterised as synchrocheck. In synchrocheck mode, the output OUT7 connects the manual paralleling switch in series with the paralleling release contact.

Definitions:
Parameter set 1 = automatic synchronization for circuit breaker 1
Parameter set 2 = automatic synchronization for circuit breaker 2
Parameter set 7 = synchrocheck for both circuit breakers
Connection as shown in figure below

Programming:
Parameter I1 = 1
Parameter I2 = 2
Parameter I7 = 14
Parameter O1 = 1
Parameter O2 = 2
Parameter O7 = 15

Operating behaviour:

Signal to:	**Outputs:**	**Selected:**
Input IN1	OUT1 closes	Parameter set 1 and paralleling point 1
Input IN2	OUT2 closes	Parameter set 2 and paralleling point 2
Inputs IN1 and IN7	OUT1 & OUT7 close	Parameter set 7 and paralleling point 1
Inputs IN2 and IN7	OUT2 & OUT7 close	Parameter set 7 and paralleling point 2



Note See section 5.5 "Use of the automatic synchronizing device as synchrocheck" for parameter settings for operation as synchrocheck.

5.4.2 Assigning one parameter set to several paralleling points

This case applies if, for example, several identical circuit breakers/generators are paralleled under the same conditions.

Example: **One parameter set** is assigned to **two paralleling points**:
A signal which activates parameter set 1 is permanently present at input IN1. If a signal is applied to input IN2 before Start, paralleling point 1 is activated, a signal at IN3 selects paralleling point 2.

Programming:
Parameter I1 = I8
Parameter I2 = 1
Parameter I3 = 2
Parameter O2 = 1
Parameter O3 = 2

Operating behaviour:

Signal to:	**Outputs:**	**Selected:**
Inputs IN1 and IN2	OUT2 closes	Parameter set 1 and paralleling point 1
Inputs IN1 and IN3	OUT3 closes	Parameter set 1 and paralleling point 2

5.4.3 Further configuration options

When the inputs and outputs are not used for selecting parameter sets and paralleling points, they can be used for other functions e.g. for signaling or additional control commands (see tables in section 4.2.8 from value 15 on).

5.5 Use of the automatic synchronizing device as synchrocheck

If the device is to function as a synchrocheck, the following parameter settings have to be adjusted in the corresponding parameter set:

1. Switch off command generation: tp on = OFF or 0
2. Switch off voltage matcher: dU/dt = 0,00 %/s
3. Switch off frequency matcher: df/dt = 0,00 %/s

Note If the device is used alternatively for automatic synchronization and as a synchrocheck, the configuration described in section 5.4.1 can be used.

5.6 Communication

5.6.1 Service interface

The service interface is intended to be used for commissioning and maintenance. During operation, it may be permanently connected to an engineering workstation.

In connection with the service interface, it is intended to use SynView (see section 2.9.1). The optional password of SynView can be used to prevent writing data to the SYNCHROTACT during operation.

5.6.2 Operating interface (option)

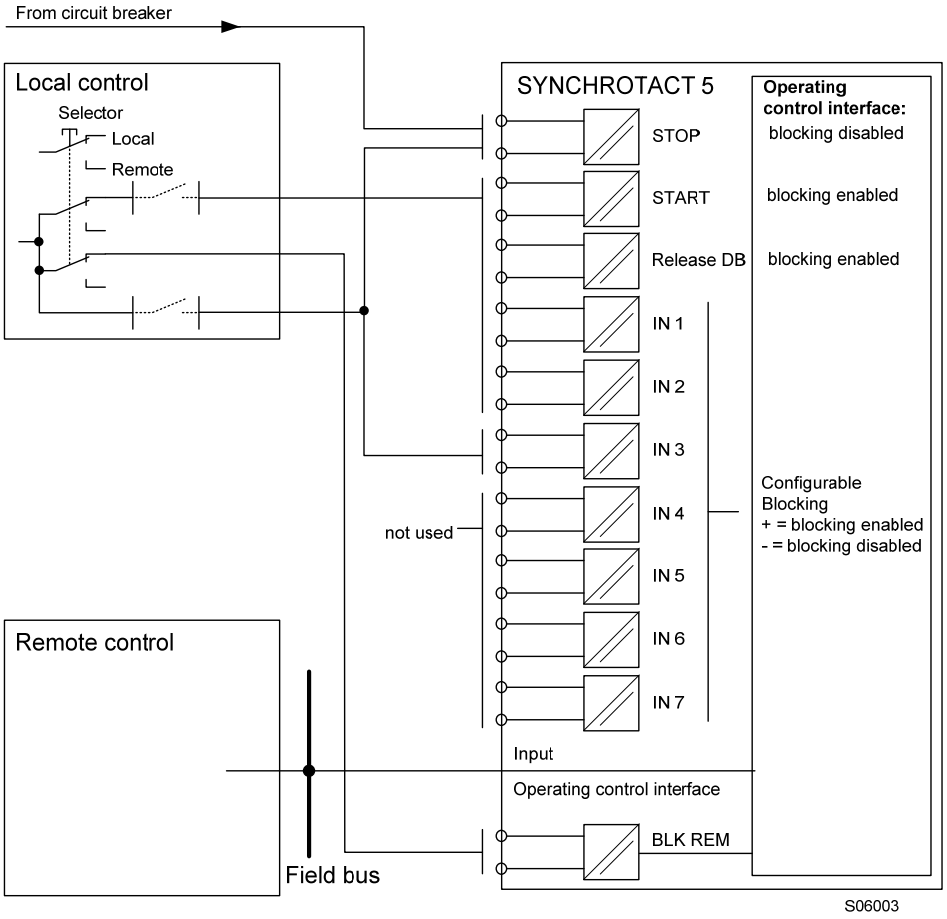
The operating interface is intended to be used for operational control. Changing the parameter setting of SYNCHROTACT 5 is not possible via this interface. Refer to section 2.9.2 for more information about transmitted signals.

Data has to be written to or read from certain addresses in SYNCHROTACT 5 (see section 4.3). The project engineer (e.g. of the control system) is responsible for the visualization on the screen.

If both, the conventional control (hardwired) and the operating interface are used alternatively (e.g., local control and remote control), the blocking input (connector -X1b) can be used to block the operating interface. The conventional control can be blocked externally by interrupting the control voltage.

The figure below shows the application of the blocking input "BLK REM" as an example. An active signal on "BLK REM" will block control via operating interface. Exceptions:

- The STOP input is permanently active, i.e., blocking is disabled
- The functional code of the configurable inputs can be set as negative value (minus as sign). This disables blocking (refer to input IN3 of the above figure).

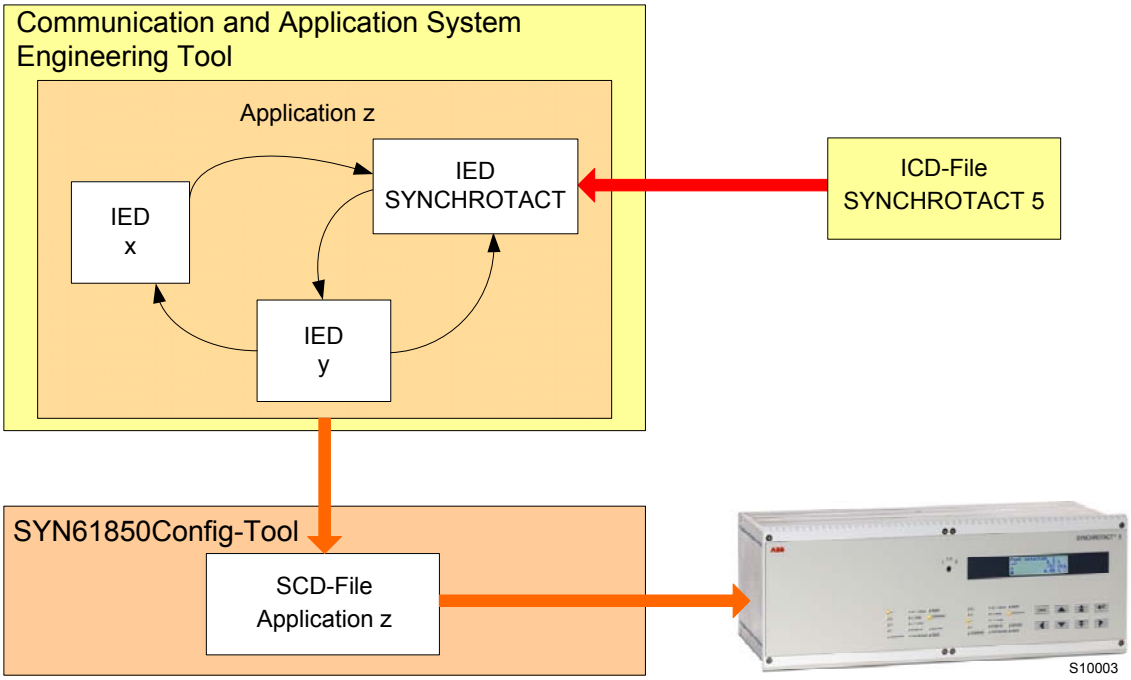


Note With the conventional control, a configurable input can be used for external reset function. As a condition, a device with 7 parameter sets has to be used and as a result, a maximum of 6 parameter sets can be used only. With the operating interface, no physical input is required, i.e., a device with one parameter set is enough for the external reset and in case of 7 parameter sets there are no restrictions.

5.6.3 IEC 61850 - Interface

The ICD-File contains the data model, resp. describes the functionality of the according SYNCHROTACT 5 – device. An IEC 61850 System Engineering Tool configures the ICD-Files of all participants in a specific application and their connections among each other and deposits them in a SCD-File.

The SYN61850Config-Tool can finally download the SCD-File to the SYNCHROTACT 5 – device.



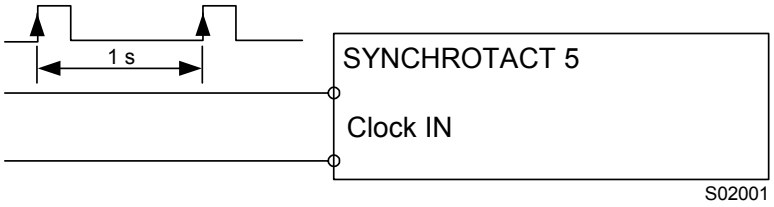
The data sets are fix and must not be changed at any time, neither during configuration time nor during operation (see also tables with logical nodes in chapter 4.3.8).

5.7 Time synchronization

5.7.1 Relative synchronization

The transmission of the time from the PC to the SYNCHROTACT device takes place once, with the aid of SynView, during commissioning.

The connection of pulse synchronization (ClockIN at the connector –X1) detects the rising edge of the pulse, which is rounded to the entire second. The pulse intervals should be therefore 1 s or the multiples of it (1 min, 1 h, 1 day).



5.7.2 Absolute synchronization

Periodic transfer of date and time from clock to SYNCHROTACT 5 – device via serial interface: 9-pole SUB-D-connector -X2 ‘Time Sync.‘
Pin assignment: see Technical Data
Protocol: RS 232
Reference clock: Hopf type 6870.

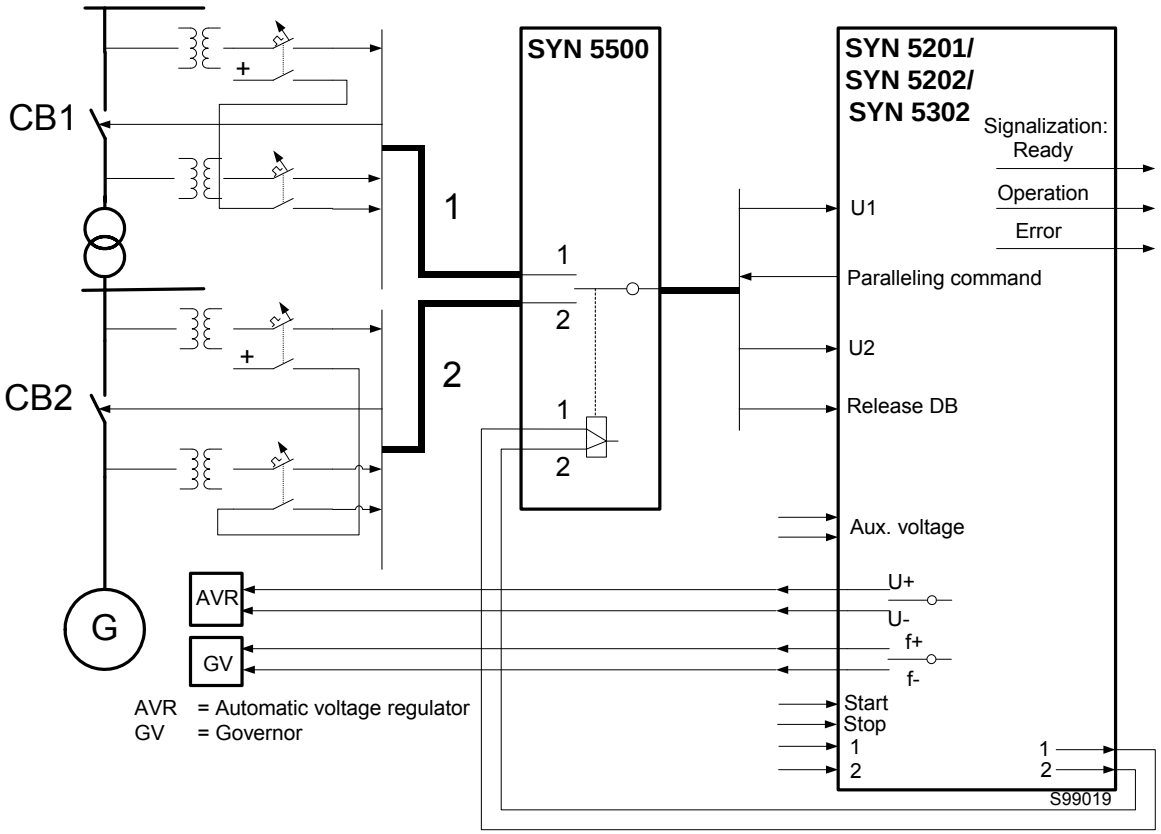
5.7.3 Absolute synchronization by means of the IEC 61850 - interface

Periodical transmission of date and time from SNTP-Server to the SYNCHROTACT 5 - device over the IEC 61850 – interface.
The adjustment is made by the configuration Tool "SYN61850Config".

Note The IEC 61850 – interface contains a clock. Upon release ("Enable"), the clock in the synchronizing part will be overwritten even when no SNTP-Server is connected.

5.8 SYN 5500: auxiliary device for connecting paralleling points

This device essentially serves to connect the measuring and command circuits of several paralleling points selectively with the synchronizer. Either 2*16 single-pole signals or 4*8 single-pole signals can thereby be connected through corresponding programming of the jumpers W1 to W6. In the latter case, the signals must be bridged at the output (see schematic section 11).



The relays used on SYN 5500 are of the same type as the paralleling relay of the SYNCHROTACT 5 – device (refer to technical data).

6 Installation and disposal

SYNCHROTACT 5 devices operate with in some cases dangerous voltages (>50 V), e.g. measuring inputs up to 170 VAC and relay outputs up to 250 VAC/VDC. Manipulations carried out on these parts can cause death or injury to the persons involved or damage to surrounding objects. If handled correctly and in the proper environment, as described in these instructions, there is no risk.

All relevant regulations must be observed during installation. It is essential that these safety regulations are read before starting any work on the SYNCHROTACT 5 equipment.

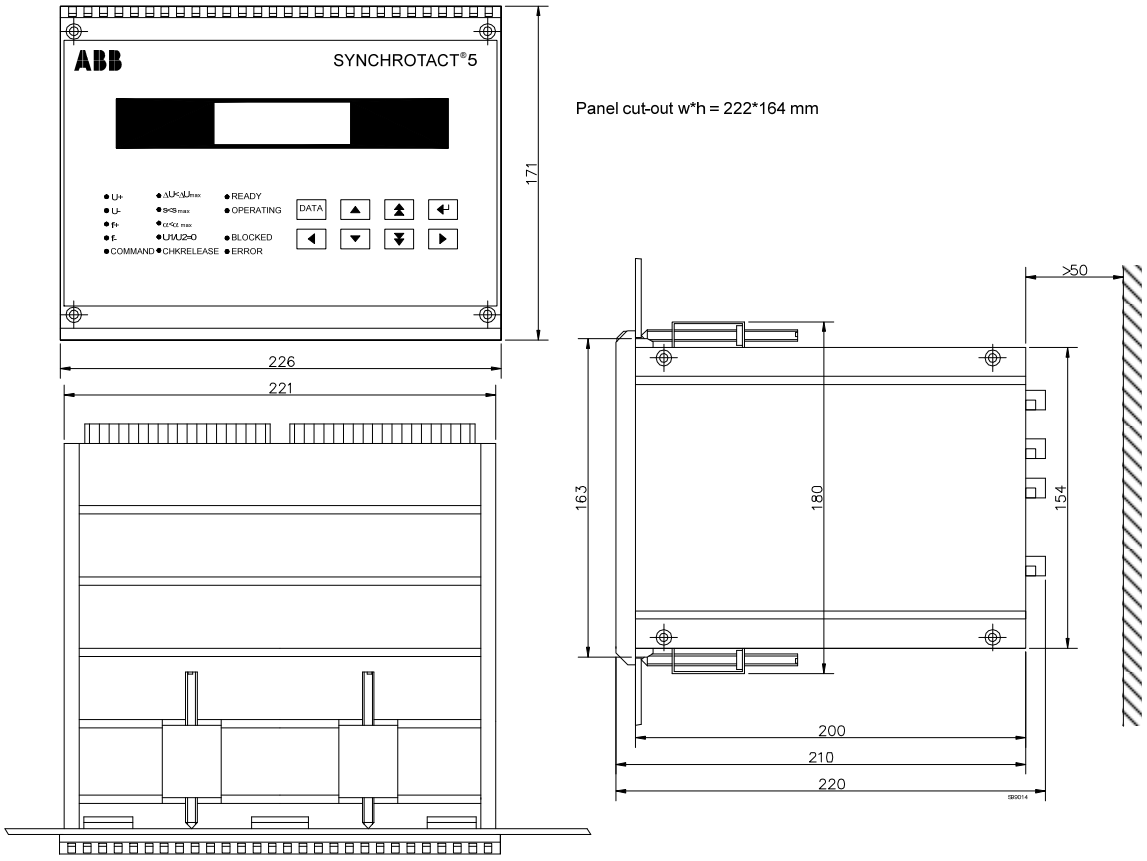
Caution The safe operation of the device requires appropriate transport and proper storage, erection and installation.

The equipment should be unpacked with the usual degree of care, without the use of force and using suitable tools.

The device should be checked visually for any damage caused during transport. Any complaints of defects caused by improper transport should be addressed immediately to the receiving station or the last carrier.

Only interior rooms which are dry and dust-free and which contain no gases, acid fumes or similar are suitable as sites for installation.

6.1 Diagram of dimensions



Template: CHIND Techn doc stand, A4 P de, R1.DOT; Filename: 3BHS109762E01 D.doc; Print: 12/6/2011 5:48:00 PM; Save: 12/1/2011 2:37:00 PM; CHIND No. 3BHS109763 ZAB D14 Rev. -; I-Q

6.2 Fixing

Fit the device into the cut-out from the front. Snap the 2 fixing clips at the top and bottom into the grooves (see diagram).

Caution When fitting the fixing clips into the grooves, ensure that the threads are not subjected to any mechanical loads.

Tighten screws evenly. Ensure that the front panel of the SYNCHROTACT 5 is flush with the facing.

6.3 Earthing and wiring

The casing must be connected with the earth potential via the connection provided for this purpose.

The use of shielded cables is not necessary. If shielded cables are nonetheless used for protection against high-frequency interference, it is recommended that the shielding be connected to the earth potential at both ends over as wide an area as possible. If it is not possible to earth the cables at both ends, one of the following procedures can be taken:

- Earthing of the shielding via a capacitor. The shielding is earthed directly at one end and via a capacitor at the other end.
- Use of a double shielded cable: one of the two shields is earthed at one end, the other at the other end.

6.4 Disposal

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

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

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

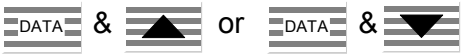
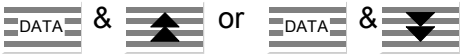
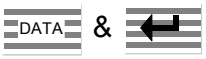
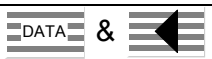
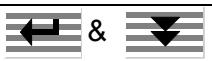
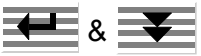
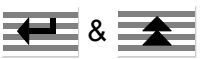
The SYNCHROTACT 5 devices are environmentally friendly designed. The circuit boards are easy to remove.

7 Operating instructions

7.1 Operation for commissioning and maintenance purposes

7.1.1 Commands

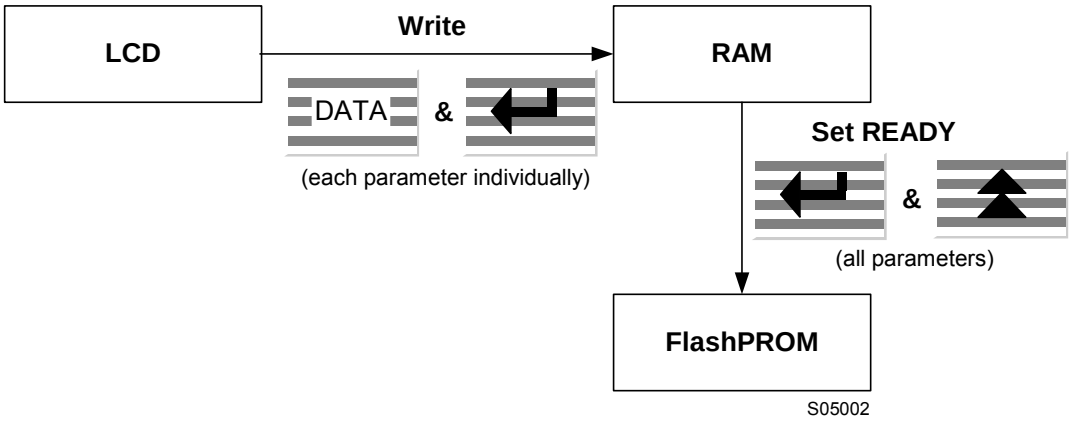
The following commands can be carried out using the keypad.

Function	Commands	Keys
LCD	Switch on LCD	Press any key
	Change line (actual value block only)	
Addresses	Address change in menu (vertical)	
	Fast address change in menu, from group to group (vertical)	
	Address change from parameter set to parameter set (horizontal)	
Parameter values	Change parameter values: slow	
	fast	
	Load single parameter value into random access memory RAM	
	Reset actual parameter value to default	
	Change polarity of ΔUOffset and αOffset parameters; enable blocking of the configurable inputs	
Changes of status	Stop synchronizing process	
	Block device (Device is in setting mode, i.e. parameter setting is released)	Hold down  in combination with another key for at least 2 s
	Cancel fault	
	Set device to “Ready“(all settings will be loaded from the RAM into the read-only memory (ROM)	
Test functions	Enable test functions	
	Start test functions	
	Cancelling test functions	

Template: CHIND Techn doc stand, A4 P de, R1.DOT; Filename: 3BHS109762E01 D.doc; Print: 12/6/2011 5:48:00 PM; Save: 12/1/2011 2:37:00 PM; CHIND No. 3BHS109763 ZAB D14 Rev. -; I-Q

Function	Commands	Keys
IP-address of the SynView Ethernet interface	Display IP-address	Switch off auxiliary voltage Hold down ↵ & ▶ and switch on auxiliary voltage again (Do not release keys before the 3 LED's READY, OPERATING and BLOCKED are lit)
	Quit display	↵
Service IP-address of the IEC 61850-interface		See section 7.4.3

Caution Each individual parameter setting must be written into the RAM after being changed. If this is not done, the old value remains in the FlashPROM when the device is set to Ready .

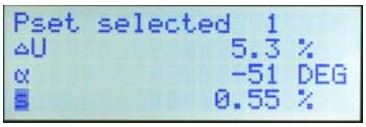
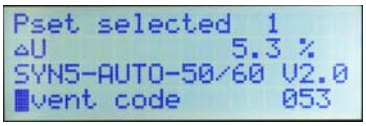
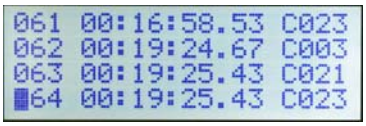
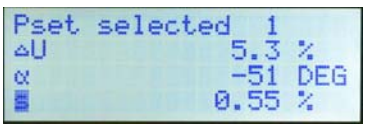
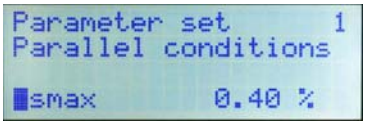
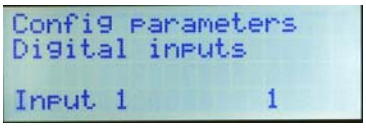


Note In order to carry out commissioning work the device must be brought into BLOCKED status.

Note Switchover from blocked without error status to ready is blocked if the start command is active at the moment of switchover.

7.1.2 Display

The display is permanently active in BLOCKED & ERROR and OPERATING statuses. Otherwise the display is dark. As soon as any key is pressed, the display is activated and remains active for 30 s after the last key operation in READY status, and for 5 minutes in BLOCKED status.

Display type	Example	Comments
Standard display (following initialisation)		After the auxiliary voltage is switched on or after a reset command, the processor is re-initialised. The standard display of actual values shown on the left then appears. The selected parameter set is displayed on the line “Pset selected” or, if none is selected, a question mark.
Fault present		The last value of the fault logger is displayed on the bottom line. The installed software version is displayed on the second line from the bottom.
Event logger		The line number appears on the left for ease of orientation. This is followed by the timestamp in hours, minutes and seconds. On the right is the code Cyyy.
Actual value block		In the actual value block, the values which are to be displayed can be selected on lines 2, 3 and 4. This user-defined display is retained after use, but switches back to standard following interruption of the auxiliary voltage.
Parameter sets		The current parameter set is displayed in the first line. The second line shows the current parameter group. The third line is normally empty. The fourth line is the working line and displays the parameters and their setting values.
Configurable inputs / outputs		The inputs I1 to I7 and outputs O1 to O7 can be configured here by changing their values (according to the table).

7.2 Control for commissioning and maintenance using the PC tool SynView

Note Minimum requirement: SynView ≥V2.0

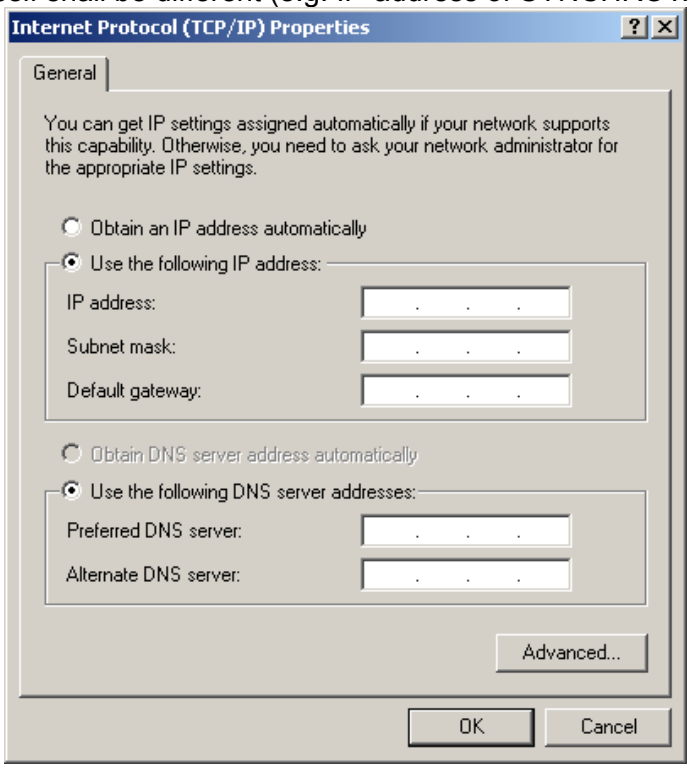
For the connection of SynView an Ethernet interface is provided.

7.2.1 Point-to-point link SYNCHROTACT - PC

Cable: crossed

Preparation of SYNCHROTACT 5: if the default IP-address is not known, display and read it on the LCD (see section 7.1.1).

Preparation of the PC: The PC has to be changed from automatically assigned IP setting to a defined address within the same subnet as the SYNCHROTACT 5 device. The IP address itself shall be different (e.g. IP-address of SYNCHROTACT + 1).



SynView can then be started and the SYNCHROTACT 5 device can be selected by the related SYNCHROTACT 5 - IP address.

Note If the PC was temporarily connected to a network which supports automatically assigned IP settings, it should be set back to "Obtain an IP address automatically" after commissioning

7.2.2 Link SYNCHROTACT - PC via network

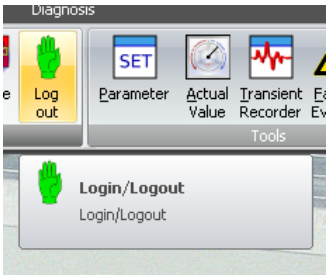
Cable: 1:1 (not crossed)

Preparation of SYNCHROTACT 5: Get the address from the local network administrator and set it in SYNCHROTACT 5 by means of SynView. For that, connect the PC directly to the SYNCHROTACT (see section 7.2.1) and start SynView with the existing IP address of the device.

Afte the setting has been carried out, the address must be activated by switching off and on the auxiliary voltage.

Preparation of the PC: open SynView and set IP address of the desired device.

7.2.3 SynView Operating Instructions



SynView can be used with an optional password. That way the access rights are limited.

The standard password after installation of SynView is 1234. As long as this password is not changed, the access is automatically unlimited (e.g. during commissioning). If the password is changed all write commands are blocked in "logout-status" (red hand). The "login" (green hand) takes place by entering the password and enables all functions.

A logout can be done manually or is automatically done 8 hours after the last write command.

Automated start of SynView:
SynView can be started with pre-defined parameters by means of a coded command line:

Explanation	Code	Setting range
Screen resolution (actual value screen and transient recorder screen only)	/R = n	1 (= low) ... 9 (= high)
Number of recent IP-addresses shown in the communication setting dialog box	/I=nn	1 ... 19
Tool to be opened automatically	/T=X	P = Parameter A = Actual values E = Event recorder T = Transient recorder B = Diagnostic
Automatic IP-address definition	/A = nnn.nnn.nnn.nnn	IP-Address

Example:
syn.exe /I=12 /T=A /A=192.168.0.240
=> The Commmunication dialog box shows the 12 most recent IP-addresses
=> The Actual value tool will automatically be opened and activated as soon as SynView is started
=> SynView will be connected to the SYNCHROTACT 5 with the given IP-address

In a further step, the command line may be written into a batch-file. The batch-file must be saved in the SynView-directory. The file "CommandLine.bat" is delivered with the SynView-software as an example. The file may be re-named and the parameters may be changed according to the table above. One separate batch-file is required for each device to be connected.

The batch-file may be started from any location using a shortcut. The shortcut itself may be directly called by the control system software. SynView can automatically be quited by means of the Alt + F4 - command.

Main menu

The following settings can be made in the main menu under Options (close all "Tools"):

- Language... SynView - language; selection: Deutsch, English, Français
- Communication... Setting of the PC interface and the SYNCHROTACT 5 IP address. In the editing area for the IP-address, an alias-name may be insterted after the address. The alias-name may also be indicated in the batch-file.
- Reset Comm. Counter: Set data transfer counter (Polls / Responses) bottom right on the statusbar to zero.
- Set Clock in SYNCHROTACT 5: transfer PC system time to SYNCHROTACT 5

- Device info: Display of firmware version and IP configuration
- Log out / Log in...: Manually activate or de-activate password request

The following five tools can be started via menu or by the related buttons:

- Parameter tool
- Actual value tool
- Transient recorder tool
- Event recorder tool
- Diagnosis tool

Subsequently the main functions are explained. Further details can be found by the help function of SynView.

Parameter tool

The parameter tool is used for parameter setting. The parameter values displayed after starting the tool have been read from a PC file in any case and not from the connected device. If the values from the device should be displayed, the "Read" button can be used. The following buttons are available:

- Block: blocking SYNCHROTACT 5
- Ready: Set SYNCHROTACT 5 to READY; all parameter values in the RAM are written to the FlashPROM
- Write: Transfer all parameter values from the PC to the RAM of SYNCHROTACT 5.
- Read: Transfer all parameter values from the RAM of SYNCHROTACT 5 to the PC.
- Compare: the settings of the connected SYNCHROTACT 5 are compared with the settings on the PC screen. Differencies are written to a text file.
- Reset Error: Reset an ERROR displayed on the SYNCHROTACT 5.
- Indication of selected parameter set

In addition the menu Edit provides the following function:

- Copy: all settings are copied into a text file (e.g. to protocol)

Tab on the bottom of the table: selection of the desired parameter set or configurable IO's or settings of channel 2 (synchrocheck).

Parameters: the parameter sets are divided in 7 groups each. The single parameters can be hidden or displayed by double click on the name of a parameter group. Minimum, maximum and default value of a parameter can be displayed in the status toolbar by click on the related parameter. A double click on a parameter value will open it for editing. A double click on the parameter name will open a window with setting recommendations.

Actual value tool

The actual value tool allows to follow a synchronizing process. The display of the values are activated by the ON button and de-activated by the OFF button. With activated actual value tool, the setting limits ±smax and ±ΔUmax as well as a tracking line of the actual value are displayed, as soon as the synchronizig process is started. To delete an old tracking line before starting a new record, the OFF and ON buttons have to be clicked in succession.

Transient recorder tool

Records of the three last synchronizing processes (buttons "t", "t-1" and "t-2") are stored in the SYNCHROTACT 5 and can be displayed by the transient recorder tool. An analogue channel records the voltage difference and three binary channels record the paralleling command ("Channel1"), the paralleling command release ("Channel2", SYN 5202 only) as well as the paralleling command of the device ("Command").
"Channel1" is used as trigger and ±0,5 s is recorded. On the top right, actual values in the instant of the trigger are displayed.

Event recorder tool

The event recorder tool displays the last 256 events which are stored in the SYNCHROTACT 5. In addition to date and time, the relative time is displayed for events taking place during the synchronizing process. The relative time is started simultaneously with the synchronizing process. Each event is displayed by a code and a short text description. Further information can be displayed in a window by double click on the text of an event.

Diagnosis tool

The diagnosis tool is a second event recorder without timestamp and with information that has to be interpreted by the ABB development engineers. In case of "not solvable" problems, this information can be sent to the responsible ABB office together with parameter and event recorder data.

Note Since the diagnosis data has no timestamp, it should be ensured that only problem related data is sent. To achieve this, save the existing data first. Then delete it using the Delete button, re-produce the problem, read and save data again.

7.3 Operational control

When commissioned and ready for operation, the device is controlled via the digital control inputs on the device.

7.3.1 Starting and stopping the synchronizing process

The Start command initiates the synchronizing process.

In the case of devices with several parameter sets or configured control inputs, the corresponding pre-selections must be made before starting the synchronizing process.

No control actions are necessary during operation. Changes to the parameter settings are not possible during normal operation.

After the circuit breaker has closed, its auxiliary contact (normally open) gives the automatic Stop command. The synchronizing process can be terminated prematurely using the Stop command.

7.3.2 Test mode (option)

If the necessary hardware (SYN 5014) is installed and appropriately configured, the TEST mode can be used. If this is selected, the device goes into BLOCKED status. The paralleling relay is blocked. The relay configured for this purpose will close in its place.

7.3.3 Switch-over hardwired control <-> operating interface

If selector switch is used to select hardwired control (e.g. local control) or operating interface (e.g. remote control), it can also be used to activate one and block the other control possibility. The selection can be done in any status of the synchronizing equipment.

7.3.4 Operating interface

Control commands and state messages can be routed over the operating interface instead of through the conventional wiring. It is not permitted to close the circuit breaker from the operating interface. It is not recommended to send voltage matching commands or frequency matching commands without consulting the manufacturer.
With the redundant dual channel device SYN 5302, the control commands must be written in parallel to both operating interfaces. The interfaces themselves are not redundant.

7.3.5 Use of the built-in control panel or SynView

The service controls are not normally required with commissioned devices. However, if one wishes to use these via the built-in control panel, e.g. in order to read out actual values, setting values or the software number, this can be done by pressing the arrow keys as shown in the table in section 7.1.1. The commands do not have any effect on the function of SYNCHROTACT 5 as long as no blocking command is given, i.e. the device remains in READY or OPERATING status (LEDs).

For better orientation within the menu, please refer to 4.1.1 Menu structure.

During operation phase, SYNCHROTACT 5 may be permanently connected to a engineering workstation. In this case, for security reasons it is recommended to use a SynView version with optional password, i.e., ≥V3.0. The optional password can be used to prevent writing data to the SYNCHROTACT 5.

Notes on the connection and on how to use can be found in section 7.2.

7.4 Operation via IEC 61850 - interface

The IEC 61850 – interface can be used for both maintenance and operating purposes. The configuration with the "SYN61850Config"-tool takes place over a direct connection, the actual operation via the IEC 61850-Network.

7.4.1 Direct connection SYNCHROTACT - PC to configuration

Cable: crossed-over

Preparation SYNCHROTACT 5: none

Preparation PC: The PC must be configured with a specific IP-address within the same subnet as the SYNCHROTACT 5 – device. The IP-address must not be obtained automatically. The IP-Address itself should be different (see chapter 7.2.1). If the Service IP-Address and Subnet are unknown, the Scan function of the SYN61850Config-Tool can search for SYNCHROTACT 5 – devices.

The SYN61850Config can afterwards be started and the SYNCHROTACT 5 – device with the corresponding Service IP-Address can be selected.

Note If the PC is temporarily operated on a network with support of the automatic IP-address allocation, the PC should be reconfigured to „obtain an IP-address automatically“. after commissioning.

7.4.2 IEC 61850 Network connection

Functional operation is made over the IEC 61850 network. The application-specific operating IP-address is configured in the SCD-File by the appropriate engineering team.

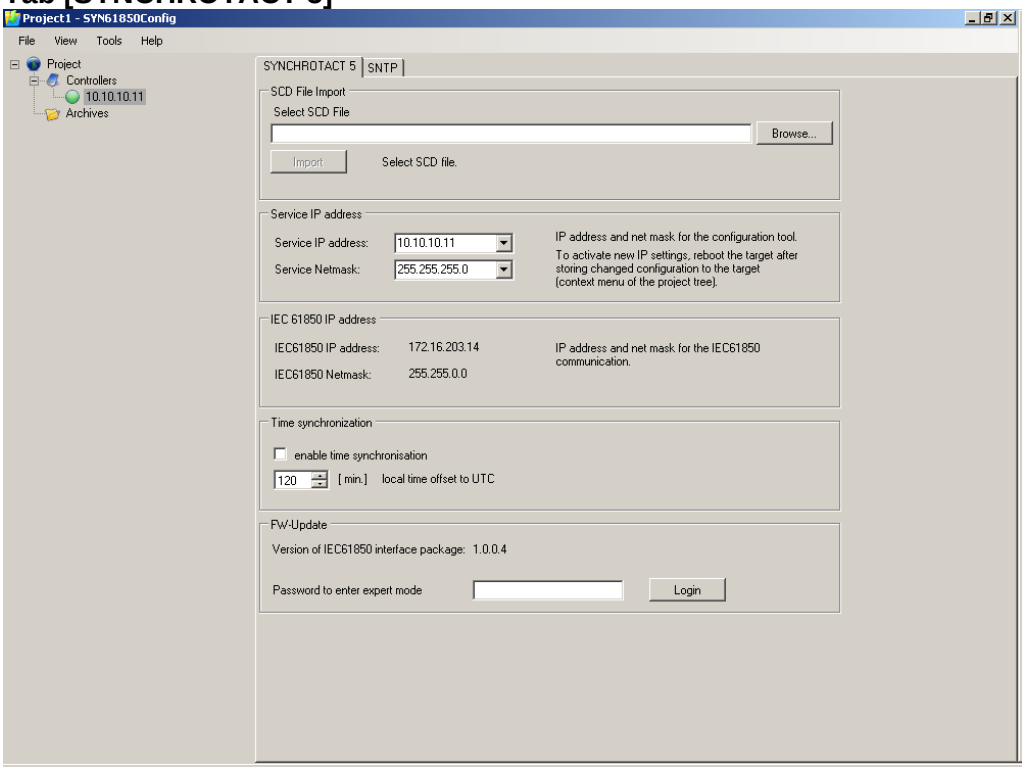
7.4.3 SYN61850Config User Manual

Projects
All data which are specific for a IEC 61850-interface, can be saved in a project-file, resp. retrieved from there.

Controller Handling
With a right mouse-click on the controller directory and subsequent selection of „Add controller to project“, new SYNCHROTACT 5-devices can be added to a project. For that purpose, the IP-address of the device which needs to be configured, is entered.

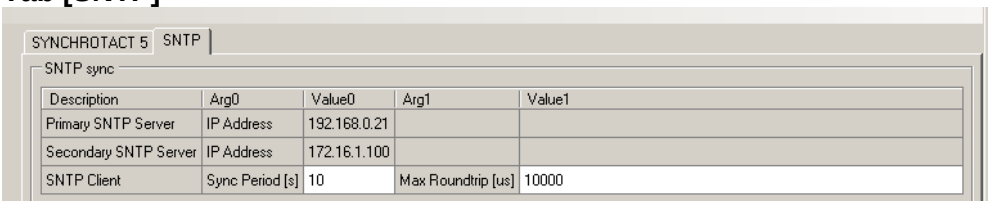
Scanner
Under the menu „Tools/Scan controllers“, a network can be scanned for SYNCHROTACT 5 – devices. If the desired device is listed, it can be added to the project. („Add to project“).

Tab [SYNCHROTACT 5]



- SCD File Import: import of the SCD-Files
- Service IP-address: Configuration and display of the Service IP-address
- IEC 61850 IP-address: Display of the actual operating IP-address (see chapter 4.3.9)
- Time synchronization: Release of time synchronization over IEC 61850-interface (see chapter 2.7) and configuration of a fixed time lag with UTC.
- FW-Update: Login to expert mode (description is not part of this manual)

Tab [SNTP]



SNTP-Server configuration:

Primary SNTP Server: Display of the address of the first time server
Secondary SNTP Server: Display of the address of the redundant time server
SNTP Client:

Sync Period: Configuration of the synchronizing period
Max Round trip: Configuration of the maximum circulation time of data packets

Note After each change, the new configuration must first of all be saved in SYNCHROTACT 5 by means of a right-click on the corresponding device and subsequent selection of „Store configuration to target“. Afterwards the device must be power-cycled.

More information regarding the handling of the SYN61850Config-Tool can be found in the Help-function.

7.4.4 IEC 61850 Service-operation

In order to be able to change the parameters, the SYNCHROTACT 5-device must first of all be blocked by means of the IEC 61850-interface. Before that, all parameters in the IEC 61850-system must correspond to the actual parameter values in the device.

If the device was previously blocked in a local manner, no parameters can be changed over the IEC 61850-interface.

7.4.5 IEC 61850 Functional Operation

Functional operation over the IEC 61850-interface is performed analogically to those for the other operational interfaces.

8 Commissioning

8.1 Warnings and instructions

SYNCHROTACT 5 devices operate with in some cases dangerous voltages (>50 V), e.g. voltage transformer inputs up to 170 VAC and relay outputs up to 250 VAC/VDC. Manipulations carried out on these parts can cause death or injury to the persons involved or damage to surrounding objects. If handled correctly and in the proper environment, as described in these instructions, there is no risk.

All relevant regulations must be observed during commissioning. It is essential that these safety regulations are read before starting any work on the SYNCHROTACT 5 equipment.

After the device has been switched off, it must be ensured, by measuring, that no measuring voltages or control voltages >50 V are present at the terminals before anything is done to the device itself, e.g. unplugging the connector to replace the device. In order to prevent open voltage circuits being accidentally closed by third parties, the circuits in question should be marked at the disconnection point (e.g. with a warning sign).

If work is being carried out in the environment of the SYNCHROTACT 5, e.g. on the relay controls, electronics power supply, synchronizing instruments, all voltages greater than 50 V which are connected to the system must be switched off.

Caution Before switching on, always check whether all connectors are plugged in**.**

Caution The device may only be opened by qualified personnel. It is essential that ESD regulations are complied with.

8.2 Work carried out with the machine at a standstill

8.2.1 Wiring check

The casing must be connected with the earth potential via the connection provided for this purpose. All electrical connections must be checked against the system schematic (connection point and cross section).

8.2.2 Check of the programming of SYN 5500

If SYN 5500 is used with 4*8 single pole signals (instead of 2*16), the position of the jumpers have to be checked according to the drawing. For that, the cover of SYN 5500 has to be removed.

8.2.3 Adjustment of the control inputs

The control inputs for the SYNCHROTACT 5 can be actuated either via potential-free contacts and the internal 24 VDC supply or directly via 24 VDC or 48 VDC from the plant‘s control system.

8.2.4 First power-up

Interrupt paralleling circuit(s): Bring the machine circuit breaker or circuit breaker to Test position, draw out the carriage, pull command relay or unplug paralleling command connector -X6 on the rear of the device.

Switch on auxiliary voltage: The yellow BLOCKED LED lights up. The standard display appears on the LCD.

Note If voltage has already been applied to the device, at least one parameter setting saved and then set to READY, instead of the yellow LED, the green READY LED lights up. In this case, in order to carry out commissioning work the device must be brought into BLOCKED status (see operating instructions).

8.2.5 Connection of PC / SynView

The point-to-point connection of the PC with the SYNCHROTACT 5 has to be carried out according to section 7.2.1.

8.2.6 Time synchronization

If SynView is used, the PC system time should always first be transmitted to the SYNCHORTACT device. Naturally, the PC system time must correspond with the local time for this purpose.

If time synchronization is being used, the corresponding electrical connections should be checked, and then a function check carried out:

Relative synchronization: adjust pulse interval smaller than one second (e.g. 0.5 s). If the pulse generation functions, the clock in SYNCHROTACT 5 – device runs faster now. Check whether the date and timestamp of the events within the event buffer run now faster.

Absolute synchronization: before connecting the clock, the date and time in the event logger must be read. These values should not correspond with that of the clock; if so, they should be set to a different value using the PC and SynView. After the clock is connected, the date and time from the clock are taken over by the SYNCHROTACT 5. Compare results in the event logger.

Note The data read from the event logger by SynView are displayed in chronological order. If the time (or the date) is reset, an event may possibly appear further up in the list, even though it occurred last.

Note In order to make sure that a new event takes place, the device can, for example, be temporarily switched from BLOCKED to READY and back again to BLOCKED.

8.2.7 Checking the communication interface

Connectors and cables to the communication interface have to be checked. For connector type and pin assignment refer to section 10.3.3.

Depending on the interface slave address, transmission rate and possibly further parameters have to be set. The required information can be found in section 4.3 under "Configuring" of the related interface.

If the hardwired control is used alternatively to the operating interface, blocking of the operating interface by means of the blocking input has to be checked (refer to section 5.6.2).

8.2.8 Function check

Caution Changing settings of the wrong device can lead to serious damage in the plant! For this reason, especially after commissioning, it has to be ensured that the correct device is accessed. For that it is recommended to get a confirmation by phone from a person standing in front of the device.

Check data transfer by sending and receiving data that is not safety relevant (e.g. change from READY to BLOCKED to READY; reading actual values).

8.2.9 Pre-setting of parameters

Note Instructions on the correct use of the service control panel can be found in section 7 Operating instructions. Advice on the parameter settings can be found in section 4.2 Parameter settings.

If several parameter sets are used, the following settings need to be carried out for all parameter sets/paralleling points.

If necessary, some parameter settings can already be determined and set while the machine is at a standstill. These are Un, fn, ±smax, ±αmax, ±ΔUmax, Umax, Umin, U0max, U1not, U2not, 1*2not and the configuration parameters, as well as the synchrocheck parameters of the second channel of SYN 5202. As a basic rule, good synchronization is achieved using the default settings.

Caution Each individual parameter setting must be written into the RAM after being changed. If this is not done, the old value remains in the FlashPROM when the device is set to Ready.

8.2.10 Comparison of measuring points and switching points

If there are several paralleling points, it is essential to check whether the paralleling command and the measuring circuits (both) go to the same circuit breaker and correspond with the correct parameter set.

8.2.11 Test of the phase sequence and tuning of the measuring voltages

Caution **The following tasks are the most important ones during the entire commissioning. They don't concern the synchronization device itself, but their right connections at the measuring voltages. In case of ignorance, damages may be caused to the plant!**

Caution It is a prerequisite for the following work and for the correct functioning of the synchronization that the two measuring voltages display the correct values in % (Un set).

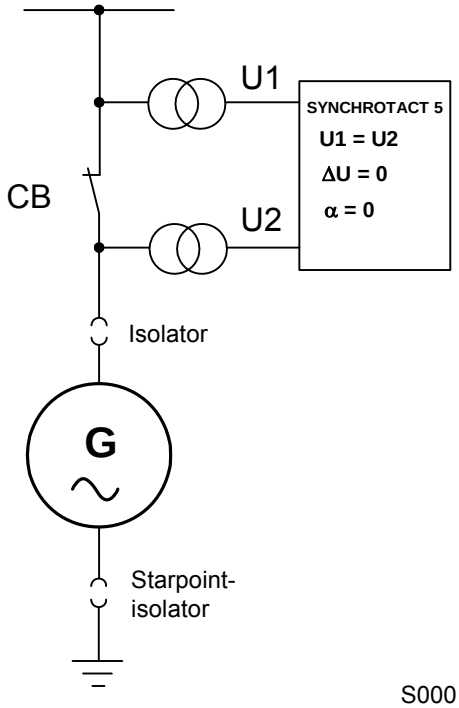
When disconnecting high voltage cables, it is essential that the corresponding regulations on working on high voltage installations are complied with.

Bring the circuit breaker to operating position so that it can be operated by SYNCHROTACT 5 or manually.

Caution Incorrect polarity cannot be detected by the synchronizer. Paralleling with incorrect polarity can lead to serious damage. Therefore, the following test has to be carried out:

Closing the CB:

- Isolate one voltage source: open either isolator on generator side or star point isolator or isolator on busbar side
- The other voltage source must be connected
- Close circuit breaker



S00013

The function TEST ton can be used to close the circuit breaker. This determines the setting values for the parameters ΔU Offset and t on at the same time. The values can be accepted if the result is realistic. ΔU should now be equal to zero.

In this status, the phase-angle difference α must be 0 DEG. Otherwise, either the measuring cables are incorrectly connected (in terms of polarity) or there is a phase shift which must be compensated.

The synchronizing instruments (double voltmeter, double frequency meter and synchroscope) if present, must be checked. The synchronoscope must stand at “twelve o‘clock”!

If this is not the case, the measuring circuits must be checked.

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

The circuit breaker should be opened again (or brought into test position) and the paralleling circuit interrupted.

Caution If it is not possible to test the phase sequence as described above, it is still essential to test the measuring circuits. For example, the phase positions can be tested using high voltage measuring sensors.

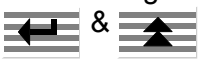
8.3 Work carried out while the machine is running

8.3.1 Adjusting the matchers to the plant

While the machine is running, the voltage and speed matchers must be adapted to the plant. Normally, the test functions TEST U-Match and TEST f-Match can be used for this purpose. The procedure is described in the corresponding section on parameter settings.

Caution In every case, the polarity of Higher and Lower commands has to be checked first. Before carrying out a test function or before a function check, you should be prepared to be able to stop the test function or the synchronization process prematurely if necessary.

A number of special cases require a matcher with fixed pulse times and variable pause intervals. In such cases, the parameters INVERSE U and INVERSE f must be set to ON. The test function cannot then be used. Procedure for correct setting: see section 4.2.5 Switchover to variable intervals for INVERSE U or section 4.2.6 for INVERSE f.

Once setting work has been completed, SYNCHROTACT 5 can be set to ready status:  & .

When the Start signal is given, the SYNCHROTACT 5 goes into operating mode. If error messages occur, they must be eliminated according to the fault list (see section on Faults).

8.3.2 Function tests

Checking the voltage matchers

Caution While checking the voltage matchers, the command circuit of the circuit breaker should be interrupted for safety reasons (bring machine circuit breaker to Test position, draw out the carriage, pull command relay or unplug paralleling relay connector -X6 on the rear of the device). Otherwise, the plant should be ready for operation.

- Manually set generator voltage to a value below the line or busbar voltage.
- Start SYNCHROTACT 5. The voltage and frequency matchers now attempt to match the voltage and frequency . The frequency matchers can be switched off temporarily (df/dt = 0) to allow the working of the voltage matchers to be better observed.

If an error message appears on the LCD, proceed in accordance with the fault list.

If the parameters $\pm\Delta$Umax, dU/dt, ts U and tp Umin are set correctly, a single adjusting command U+ is sufficient in order to achieve the tolerance band, assuming that the excitation is functioning in a stable manner.

The matching procedures should be repeated and observed several times, starting from different working points. If oscillations occur, the setting value dU/dt should be increased until no further oscillations occur. It is also possible to repeat the test function “TEST U-Match“.

Checking the frequency matchers

Caution For safety reasons, interrupt the command circuit of the circuit breaker (bring machine circuit breaker to Test position, draw out the carriage, pull command relay or unplug paralleling relay connector -X6 on the rear of the device). Otherwise, the plant should be ready for operation.

- Manually set generator frequency to a value below the line or busbar frequency.
- Start SYNCHROTACT 5. The voltage and frequency matchers now attempt to match the voltage and frequency . The voltage matchers can be switched off temporarily (dU/dt = 0) to allow the working of the frequency matchers to be better observed.

If an error message appears on the LCD, proceed in accordance with the fault list.

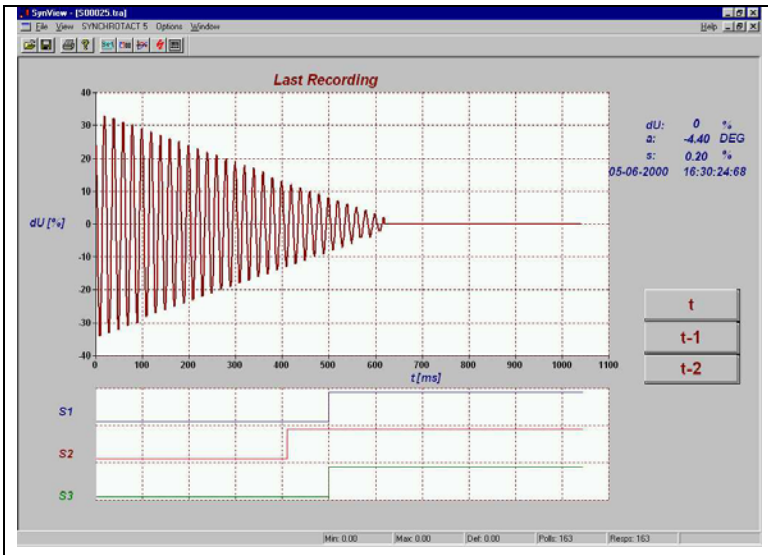
If the parameters ±smax, df/dt, ts f and tp f are set correctly, a single adjusting command f+ is sufficient in order to achieve the tolerance band, assuming that the governor is functioning in a stable manner.

The matching procedures should be repeated and observed several times, starting from different working points. If oscillations occur, the setting value df/dt should be increased until no further oscillations occur. It is also possible to repeat the test function “TEST f-Match“.

Checking the paralleling

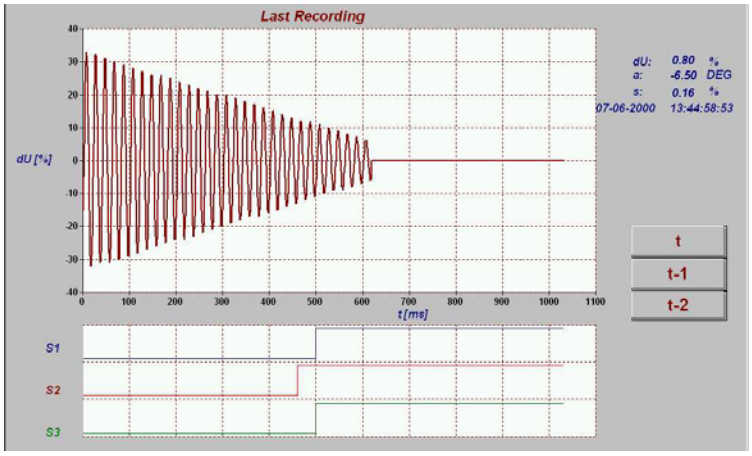
At the end of commissioning, “blind“ synchronization should be carried out several times (circuit breaker in Test position). The differential voltage and the paralleling command should thereby be recorded using the transient recorder of the PC Tool **SynView** or using an external transient recorder. At the same time, the synchronizing process should be observed using the synchronizing instruments in the plant or, if these are not installed, using the synchronizing instruments in **“SynView“**.

Bring circuit breaker to operating position, adjust voltage and frequency and carry out “live“ synchronization. Record the synchronizing process.



Correct paralleling

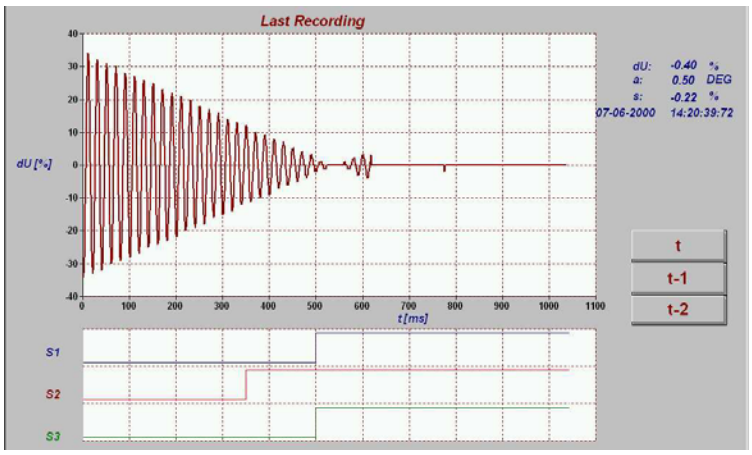
dU = Voltage difference u1 – u2
S1 = Paralleling command (channel 1)
S2 = Paralleling command release (channel 2)
S3 = Paralleling command of the system (channel 1 AND channel 2)
a = Phase difference angle at the instant of the paralleling command (channel 1)
s = Slip at the instant of the paralleling command (channel 1)
t = Last recording stored in SYNCHROTACT
t-1 = Second last recording stored in SYNCHROTACT
t-2 = Third last recording stored in SYNCHROTACT



Angle error
(switches too early)

Possible causes:

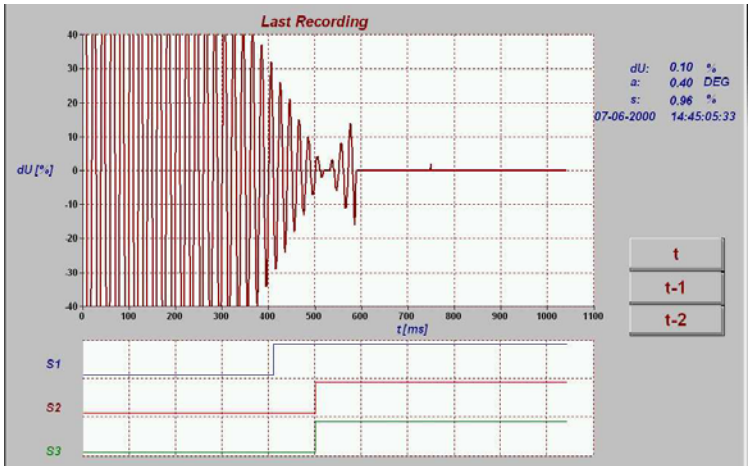
- t on set too high
- α-measuring incorrect (αOffset set incorrectly or in extreme cases phase error)



Angle error
(switches too late)

Possible causes:

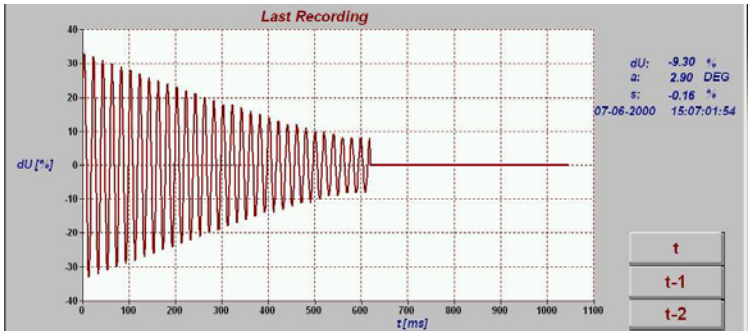
- t on set too low
- α- measuring incorrect (αOffset set incorrectly or in extreme cases phase error)



Slip too big/angle error

Possible causes:

- smax set too high
- The setting values for the two channels must be matched to one another (synchrocheck release must be given before the command is given, i.e. angle window must be wider)



Voltage difference

Possible causes:

- ΔUmax set too high
- Measuring error (actual value calibration)

8.3.3 Keeping records

If parameter settings are carried out, these should be entered in the settings record at the end of this operating manual. To simplify the keeping of records, it is recommended that the PC tool **SynView** be used.

9 Maintenance and faults

9.1 Maintenance

SYNCHROTACT 5 does not require any maintenance. Since the synchronization is not used for most of the time but the microprocessors are permanently in operation, it is possible to detect a fault in good time before the next use and rectify it. In order to detect faults which only occur during synchronization in good time before use, test synchronizing is recommended (TEST mode or external test circuit). However, the machine must be available for this purpose.

9.2 Faults

9.2.1 General

SYNCHROTACT 5 devices operate with in some cases dangerous voltages (>50 V), e.g. voltage transformer inputs up to 170 VAC and relay outputs up to 250 VAC/VDC. Manipulations carried out on these parts can cause death or injury to the persons involved or damage to surrounding objects. If handled correctly and in the proper environment, as described in these instructions, there is no risk.

All relevant regulations must be observed during fault-rectification. It is essential that these safety regulations are read before starting any work on the SYNCHROTACT 5 equipment.

If work is being carried out in the environment of the SYNCHROTACT 5, e.g. on the relay controls, electronics power supply, synchronizing instruments, all voltages greater than 50 V which are connected to the system must be switched off. In order to prevent open voltage circuits being accidentally closed by third parties, the circuits in question should be marked at the disconnection point (e.g. with a warning sign).

Caution Before switching on again, all connectors must always be plugged in.

9.2.2 Troubleshooting

A fault message from the SYNCHROTACT 5 refers not only to internal causes but also to external ones. It is therefore important to make sure that the environment of the synchronizer is in order before sending the device in for repair (pointlessly).

The following situations can be distinguished:

1. SYNCHROTACT 5 is in error status (ERROR LED and remote display contact ERROR): Try to locate the cause with the aid of the fault and event table in section 9.2.3.

2. SYNCHROTACT 5 is not in error status, but the synchronizing process cannot be started, takes a very long time or paralleling does not take place:

    1. SYNCHROTACT 5 is blocked: the BLOCKED LED lights up: the device is not ready for operation (e.g. following manipulation of the settings) or TEST mode is selected (only possible with the “7 parameter sets” option)

    2. SYNCHROTACT 5 is ready (READY LED) or in operation (OPERATING LED): temporarily set parameter t tot to a low value (e.g. 1 minute). On a further attempt, the synchronizing process will be aborted after the set time. Read error codes from the LCD or using SynView and proceed in accordance with section 9.2.3

3. Faults in connection with a communication interface: refer to section 9.3

If this advice does not lead to success, proceed in accordance with section 9.2.4.

9.2.3 Fault and event table

On the LCD, the code of the last detected fault is displayed. A description of the codes can be found in the following table. “Older” faults can be viewed using the keypad. In the case of devices without a built-in control unit, in the event of a fault the error messages can be read out in plain text using the PC tool **SynView**.

Events		
Code	**Description**	**Remarks**
001	Auxiliary voltage on	After the electronics power supply is connected
003	SYNCHROTACT selected	After the Start pulse
004	SYNCHROTACT stopped	After the Stop pulse
005	Device ready	SYNCHROTACT 5 is ready for operation
006	Device not ready	SYNCHROTACT 5 is blocked. without error = service operation; with error = fault
011	Data change	This event is displayed when the device changes from READY or OPERATING status into BLOCKED status, i.e. following a write or blocking command
021	Adjusting command U+	Higher voltage adjusting command
022	Adjusting command U-	Lower voltage adjusting command
023	Adjusting command f+	Higher frequency adjusting command
024	Adjusting command f-	Lower frequency adjusting command
025	Release contact closes	Output contact of channel 2 (synchrocheck)
026	Release contact opens	Output contact of channel 2 (synchrocheck)
027	Paralleling command contact closes	Issue of a paralleling command by the command generation (in synchrocheck mode: paralleling release)
028	Paralleling command contact opens	End of the paralleling command (in synchrocheck mode : end of paralleling release)
029	Blocking active	Blocking signal to one of the configurable inputs has interrupted synchronizing process.
030	Blocking cancelled	Blocking signal has released the synchronizing process again.
031	Operating control interface blocked	Input BLK REM active; local control only

Events			
Code	**Description**	**Remarks**	
032	Operating control interface released	Event is recorded only if the blocking signal is dropped	
Status messages (displayed after expiry of the total paralleling time t tot)			
Code	**Description**	**Remarks**	**Remedy**
051	ΔU outside of tolerance band		If these messages are not desired, they can be blocked by setting the total paralleling time t tot to 0. Otherwise, the following should be checked, depending on the combination of events: • Are both measuring voltages continually present throughout the entire synchronizing process (observe LED)?
052	s outside of tolerance band		
053	α outside of tolerance band		
054	ΔU within tolerance band		
055	s within tolerance band		
056	α within tolerance band		
057	U1 or U2 above Umax		
058	U1 or U2 below Umin		
059	f1 or f2 outside of fn±5 Hz		
060	U1/U2<U0max and no release for dead bus	If at least one voltage is <U0max, but the release for dead bus has not been given	• Was the calibration of the measuring voltages carried out correctly (see section 4.2.1)? • Are the set limit values correct? • Is the correct parameter set active? • Are the voltage and frequency matchers functioning correctly?
061	No Stop command within t tot	At least one paralleling command from channel 1 has been given. However, the expected Stop signal has not been generated	• Automatic Stop signal is not functioning • Command circuit is broken • SYN 5202: commands of ch 1 and ch 2 missed each other: measuring voltage incorrectly connected; see order of events in the event list; refer also to section 4.2.1 "αOffset"
Faults			
Code	**Description**	**Remarks**	**Remedy**
071	Synchronization fault	Collective alarm following expiry of total paralleling time t tot	• Check limit values for the parameters • SYN 5202: Check synchro-check parameters (ch 2) and whether they match ch 1 (see also section 4.2.9) • SYN 5202: Loss or error of phase in one of both channels. • Read out other events which may have been displayed at the same time. Try to identify the fault on the basis of the combination

Faults			
Code	**Description**	**Remarks**	**Remedy**
072	Actuation of SYNCHROTACT 5 defective	Fault appears after t tot: Implausible combination of control signals, or signal missing (e.g. parameter set selection must take place ≤ 1 s following start)	• Check necessary signals • Check programming of the configurable I/Os (A particular parameter set may only be selected by one input).
073	Internal fault: time exceeding	Internal transmission fault: Parameter memory or event logger cannot be deleted or written to.	• Try to cancel fault and observe whether it reoccurs: 1. Cancel fault ↵ & ⏬ 2. Switch auxiliary voltage on/off • Read out other events which may have been displayed at the same time. Try to identify the fault on the basis of the combination
074	Internal stabilised voltage outside of tolerance	Internal monitoring has been tripped. Also occurs if SYN 5012 is missing	• Check whether the auxiliary voltage is within the permitted range (check return circuit !) • Switch auxiliary voltage off and on again: if the fault is not displayed again: OK
077	Channel 2 (SYN 5013) hardware problem (SYN 5202 only)	• Data transmission to channel 2 is defective • Wrong HW SYN 5013 is used (16 2/3 Hz) • Error in channel 2	• Error between SYN 5012 and SYN 5013 • Check the type
078	Internal fault	• Checksum error during reading from FlashPROM of channel 1 • SYN 5202: The parameters of the second channel (SYN 5013) cannot be read or written	Checksum is checked after the auxiliary power supply is switched on: • Reset the error • Auxiliary power supply OFF/ON • Read out the parameters and check them or overwrite them again

Error			
Code	**Description**	**Remarks**	**Remedy**
080	Contact monitoring triggered	The paralleling command contacts have not opened again following the last command!	**Caution**: Ensure that the circuit breaker does not close accidentally! Check paralleling command circuits
081	Active Start signal blocks switchover to “Ready”	SYNCHROTACT 5 can only be brought into Ready status if no Start signal is active.	Cancel Start signal
082	Active blocking signal prevents Start	Blocking signal must have dropped on rising edge of the Start signal	Cancel blocking signal

Parameter set selection		
Code	**Description**	**Remarks**
101	Select parameter set 1	The display appears immediately after the Start command (<1 s) or if the corresponding signal is active in “Blocked“ status
102	Select parameter set 2	The display appears immediately after the Start command (<1 s) or if the corresponding signal is active in “Blocked“ status
103	Select parameter set 3	The display appears immediately after the Start command (<1 s) or if the corresponding signal is active in “Blocked“ status
104	Select parameter set 4	The display appears immediately after the Start command (<1 s) or if the corresponding signal is active in “Blocked“ status
105	Select parameter set 5	The display appears immediately after the Start command (<1 s) or if the corresponding signal is active in “Blocked“ status
106	Select parameter set 6	The display appears immediately after the Start command (<1 s) or if the corresponding signal is active in “Blocked“ status
107	Select parameter set 7	The display appears immediately after the Start command (<1 s) or if the corresponding signal is active in “Blocked“ status

Test functions			
Code	**Description**	**Remarks**	**Remedy**
121	No parameter set selected	The test function must be carried out in combination with a particular paralleling point and parameter set. It is possible that a fault was present when attempting Start. This causes the parameter set selection to be blocked internally.	• Select correct parameter set • Select test function from correct parameter set **Note**: procedure for cancelling fault: • Delete error message on LCD by changing address twice (e.g. ◀ and ▶) • Set test function to OFF and save • Cancel fault ↵ and ⏬
122	Timeout for the start of the test function expired	The test function must be started no later than 30 s after enable (display: “Test ready“)	See section 4.2 for the correct handling of the corresponding test function
123	Start conditions for the test function not fulfilled	Start conditions: TEST ton: One voltage must be <U0max, the other >Umin Corresponding parameter set selected Device blocked TEST U-Match and TEST f-Match: U1 and f1, both between 95 % to 105 % U2 and f2, both between 85 % to 115 % Corresponding parameter set selected Device blocked Parameters INVERSE U & TAP CHANGER=OFF (for TEST U-Match) Parameter INVERSE f = OFF (for TEST f-Match) Cancel criteria: TEST U-Match: $\lvert\Delta U\rvert \geq 10$ % TEST f-Match: $\lvert s\rvert \geq 6$ %	Check fulfilment of the corresponding conditions and if necessary ensure that these are fulfilled. **Caution**: It is possible that a test function other than the intended one was started. This happens if one forgets to set the previously-used test function to OFF again after use and only then start the next test function. By cancel of test function: raise and lower commands exchanged?

Test functions			
Code	**Description**	**Remarks**	**Remedy**
124	Voltage adjusting command has no effect	The measured value for dU/dt was less than 0.1 %/s The message is also displayed if TEST U-Match is still set to ON and another test function is to be carried out	Check whether: • adjusting commands are effective (LED, relay contacts, ext. circuits to voltage regulator) • adjusting commands act in the right direction • measuring voltages are permanently present during the test function
125	Frequency adjusting command has no effect	The measured value for df/dt was less than 0.05 %/s. The message is also displayed if TEST f-Match is still set to ON and another test function is to be carried out	Check whether: • adjusting commands are effective (LED, relay contacts, external circuits to governor) • adjusting commands act in the right direction • measuring voltages are permanently present during the test function
126	Possible range for ton exceeded	The measured value must lie between 0 and 1 s. The message is also displayed if TEST ton is still set to ON and another test function is to be carried out	• Check whether the paralleling commands are effective (LED, relay contacts, ext. circuits to circuit breaker) • Dual channel systems: The series-connected second channel must be bridged, ideally by applying the release dead bus signal • See section 4.2 for correct handling of the test function
127	Test function is active	One or more test functions TEST ton, TEST U-Match or TEST f-Match of the current parameter set was still set to ON, while trying to set the device to READY.	Set test function to OFF and confirm (!) DATA & ↵, then set device to READY
128	Result of the test function is not plausible	The result calculated by the test function lies outside of the settable range. This is determined by the maximum and minimum value of the corresponding parameter	See section 4.2

9.2.4 Troubleshooting unsuccessful

The following advice can be of assistance in difficult cases. In order to interpret a fault more accurately, it is important to make a distinction as to which phase the synchronizer is currently in:
1. System testing
2. Commissioning
3. Operation

System testing
- Is the wiring correct?
- Is the sequence of control commands correct? (e.g. parameter set selection first, then Start command)
- Critical examination for errors in project planning (e.g. selecting TEST mode by means of the configurable inputs puts the device into BLOCKED status. If this is followed by a Start command, commands will be issued in blocked status!)
- Does the test method correspond to reality?

Commissioning
Faults which occur during commissioning often have their cause in incorrect handling, incorrect settings, inadmissible external conditions or connection errors at the interface between plant and synchronizing system.

If the synchronizing process takes a long time:
Voltage or frequency matchers are not functioning correctly: optimise adjusting commands using test function or empirically (see section on Commissioning). Theoretically, only one pulse is required in order to achieve the tolerance band.

The simplest way to check the synchronization is using the synchronoscope. If the plant does not feature one of these, the synchronoscope of the PC tool **SynView** can be used. However, this display depends on the SYNCHROTACT 5, i.e. measuring errors cannot be detected.

If it seems that the SYNCHROTACT should really have acted by now, you should check which conditions could not be fulfilled. This can be seen simply from the LEDs $\Delta U < \Delta U max$, $s < s max$ and $\alpha < \alpha max$. All three conditions must always be fulfilled (LEDs lit), in order for a command to be issued. The second channel should also be considered (SYN 5202): are its settings matched to those for channel 1?

Some governors do not operate in a very stable manner. The set tolerance band for the slip can often not be achieved for a long time, or not at all. In this case the problem may be remedied by increasing the smax settings. However, you should not go beyond the usual values of 0.1 to 0.5 % without making sure that the machine can withstand this (see section 4.2.3).

If synchronization fails due to the voltage condition, it should be checked whether the limits Umax and Umin are maintained. If the voltage regulator is switched to manual regulation (field current regulator), the actual value, together with the generator voltage, is also dependent on the turbine speed. It can thus be difficult to bring the voltage within the tolerance band if the speed of the turbine varies greatly. Under certain circumstances, the voltage matcher may have to be set differently for field current regulator operation (different parameter set) than for voltage regulator operation.

Poor synchronization
If increased active or reactive power surges occur during synchronization, it is essential to connect through again and check the measurement of U1 and U2 for angle and equal voltage. Using the transient recorder of the PC tool SynView or using an external transient recorder, it should also be checked whether the breaker was actuated in the zero passage of the ΔU signal. Otherwise the breaker closing time t on must be adjusted.

Following commissioning (operation)
In this case, setting errors can usually be ruled out. It should be considered whether any changes were made to the plant prior to the failed synchronization which could affect the synchronizing process.

If the synchronizing process already took a long time beforehand, it may be that a fault message might suddenly appear due to a difference in the duration of the process. Otherwise, poor contacts, dropped connections, malfunctioning relays or tripped fuses may be the cause.

9.2.5 Fault rectification

Cancelling faults
Once the cause of the fault has been found and eliminated, the active error messages can be cancelled on the SYNCHROTACT .

Replacing a SYNCHROTACT 5

If a device is replaced, the circuit breaker must be set to test position or its command circuit must be interrupted to ensure that it can no longer be actuated.

1. Switch off SYNCHROTACT 5 and isolate all voltages which are still present from the SYNCHROTACT 5

It must be ensured, by measuring, that no measuring voltages or control voltages >50 V are present at the terminals before anything is done to the device itself .

2. Rear panel connectors: loosen screws and unplug connectors

3. Loosen fixing clips and remove device from the cut-out

The replacement unit is installed in the reverse order. The commissioning and function check of the replacement unit is carried out as described in the section on Commissioning. As soon as the settings are known, these can be used (refer to settings record).

Replacing individual printed circuit boards

To replace a circuit board, proceed as follows:

1. Isolate all voltages which are still present from the SYNCHROTACT 5

It must be ensured, by measuring, that no measuring voltages or control voltages >50 V are present at the terminals before anything is done to the device itself .

2. Rear panel connectors: loosen screws and unplug connectors
3. Detach earth strap
4. Loosen all screws on the back cover
5. Pull out defective board
6. Plug in new board in the same position
7. Reassemble in reverse order

Sending the device in for repair

If it has been definitely established that the synchronizer is defective, it must be sent in for repair. In order to guarantee that repairs proceed smoothly, it is essential that the questionnaire at the end of the document is filled in and sent to the responsible ABB department together with a copy of the settings record and the device. If **SynView** is used, please also send in the files from the transient recorder, fault/event logger and diagnostics as well as the parameter settings.

9.3 Faults in connection with a communication interface

9.3.1 Checking the PC

Check addressing (was the correct device addressed?)

Caution Changing settings of the wrong device can lead to serious damage in the plant! For this reason, especially after commissioning, it has to be ensured that the correct device is accessed. For that it is recommended to get a confirmation by phone from a person standing in front of the device.

Ethernet: read IP-address from SYNCHROTACT 5 (refer to section 7.1.1) and compare with the selected address in the SynView program of the host system (e.g. PC). If the IP-address of the device has to be changed, follow section 7.2.2. Possibly check the connection using the ping command in the "Command Prompt" program. "Command Prompt" can usually be found in the Windows Start-Menu under Accessories.

Modbus, Profibus, Lon-Bus: check configuration of the related interface according to section 4.3 and modify if required.

9.3.2 Checking the connection

Check status display of the related communication interface according to section 9.3.5 to 9.3.9. Is the LED or the interface defective? Test: When switching power supply on, both LED's shall light up at least once alternately.
Check cable connection (contact pins, connector; cable crossed or 1:1?).

9.3.3 Checking the SYNCHROTACT 5 device

Check whether the blocking input (-X1b) is active. The operating interface is blocked with active blocking input.

Check whether the SYNCHROTACT 5 device works well if the communication interface is not used. Is SYNCHROTACT 5 in READY, OPERATING or BLOCKED status?

Possibly switch off and on auxiliary voltage and wait for the end of initialization (i.e., till the alternately flashing Ethernet LED's stop or approx. 10 s).

Possibly replace the device with a spare one, if available.

9.3.4 IEC 61850 - Interface

Problem	Possible Causes	Solution
Device blocking not possible or Parameter adjustment not possible	1. Device was blocked locally 2. Parameters in IEC 61850 system not identical to parameters in SYNCHROTACT 5	Adjust SYNCHROTACT 5 to READY and afterwards block by the IEC 61850-interface.
SNTP time synchronization does not function	1. Time synchronization blocked 2. SNTP-Server-configuration wrong	1. Enable time synchronization 2. Check/change SNTP Server configuration and power-cycle
Configuration of communication interface not possible	1. Check Ethernet cable to IEC 61850-interface 2. Configuration IP-address wrong	1. Check Ethernet cable and connections 2. Check IP-address and Subnet mask at PC (Notice: Service IP-Address is relevant)
Following error message is shown upon start of the scan function. 	The firewall blocks the UDP-Ports 5002 and 5003, which are used by the scan function	Organize ports release on PC

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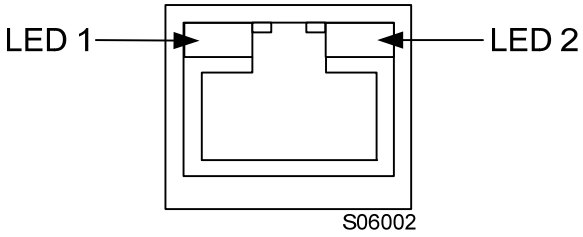
9.3.5 Status display Ethernet



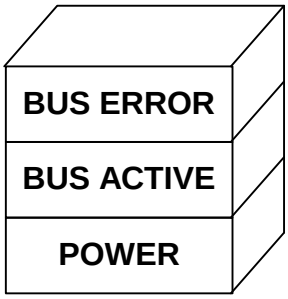
LED 1: Link indicator

Color	Description	Remarks
Dark	no link	
Yellow	Link with 10 Mbps	Transfer speed is defined by the host
Green	Link with 100 Mbps	

LED 2: Activity indicator

Color	Description	Remarks
Dark	No activity	Acutally no data transfer running
Yello	Half-Duplex Transfer	Data is transmitted or received in series
Green	Full-Duplex Transfer	Data can be transmitted or received simultaneously

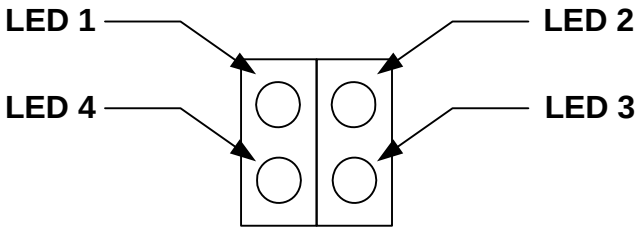
9.3.6 Status display Modbus



LEDs

Function	Description	Color
BUS ERROR	LED 0	red
BUS ACTIVE	LED 1	green
POWER	LED 2	green

9.3.7 Status display Profibus



LED 1: Not used

LED 2: Connection indicator

Color	Description	Remarks
Green	Indicates that SYNCHROTACT 5 is on-line	green = on-line (communications board enabled) dark = not on-line

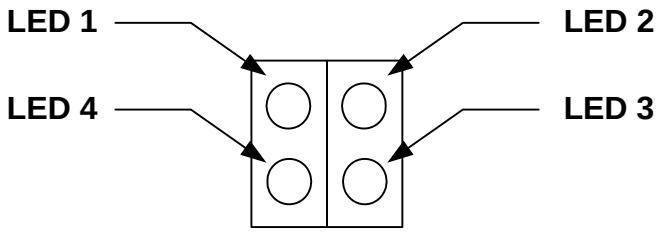
LED 3: Off-line

Color	Description	Remarks
Red	Indicates that SYNCHROTACT 5 is off-line	red = off-line (communications board blocked) dark = not off-line

LED 4: Field bus diagnosis

Color	Frequency	Description	Remarks
Red	1 Hz	Configuration error: IN and/or OUT set length during initialising of the module is not the same as the set length on configuration of the network.	Error on the fieldbus side
Red	2 Hz	Error in the user parameters: the set length or set contents of the user parameters during initialising of the module is not the same as the set length or set contents on configuration of the network.	Error on the fieldbus side
Red	4 Hz	Error during initialisation of the Profibus communication ASICs.	Error on the fieldbus side
Off	--	No diagnosis present	Normal status

9.3.8 Status display Lon-Bus



LED 1

Color	Description	Remarks
--	--	Not used

LED 2, Service LED

Color	Status	Description	Remarks
Green	flashing	Application installed, but not (yet) configured for the network.	SYNCHROTACT 5 communications board is runnable, but still needs to be configured (Service key)
Green	on	No application installed, and not configured for the network. Indicates errors which were detected by the Neuron Self-Test Routine.	SYNCHROTACT 5 communications board is not runnable (internal problem in device). Try to cancel the error as follows: 1. Switch auxiliary voltage off and on again 2. Check whether the right software is loaded into the communications module 3. Check plug connection between the communications module and the SYN 5010 base board. Otherwise the communications module is defective.
Green	off	Configured and installed in a network.	No fault!

LED 3, Error

Color	Description	Remarks
--	Indicates that an internal error has occurred in the communications module.	Try to cancel the error by switching the auxiliary voltage off and on.

LED 4, Wink

Color	Description	Remarks
--	Indicates that the node has received a LonWorks Wink command.	i.e. an internal diagnostic check is currently taking place.

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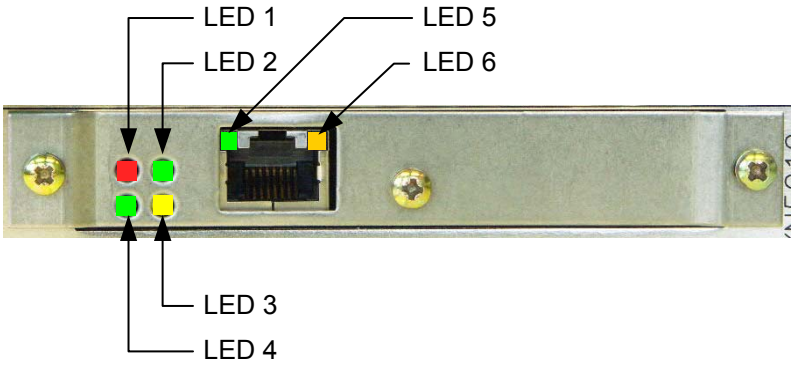
9.3.9 Status display IEC 61850



LED 1: Error

Color	Description	Remarks
Red	Indicates that an internal error occurred on the IEC 61850, communication module	No application present or processor error 1. Turn off and back on auxiliary voltage 2. Check if the communication module has the right software Otherwise communication module is defective

LED 2: Supply

Color	Description	Remarks
Green	Supply OK	Normal state

LED 3: Transmission indication

Color	State	Description	Remarks
Yellow	flashing	Indicates data traffic to the IEC 61850 communication module	SYNCHROTACT 5 – communication is functioning
Yellow	off	No data traffic to the IEC 61850 communication module	SYNCHROTACT 5 – communication does not function 1. Turn off and back on auxiliary voltage 2. Check if the communication module has the right software 3. Check the plug connection between communication module and busprint SYN 5010 Otherwise communication module is defective

LED 4: Ready Indication

Color	Description	Remarks
Green	Indicates that the IEC 61850 communication module is ready for operation	ca. 90 s after Power up

LED 5: Ethernet-Connection Indication (Link)

Color	Description	Remarks
Dark	No connection	
Yellow	10 Mbps Connection	Transmission speed is defined by outstation
Green	100 Mbps Connection	

LED 6: Ethernet-Transmission Indication (Activity)

Color	Description	Remarks
Dark	No transmission	No transmission is taking place
Yellow	Half-duplex transmission	Data packets are sent or received successively
Green	Full-duplex transmission	Data packets can be sent or received simultaneously

9.4 Disturbances related to time synchronizing

Note Devices with the optional IEC 61850-interface (see type code chapter 3.1) contain a clock. If the time synchronizing is configured to „enabled“ by means of the SYN61850Config-Tool, this clock overwrites the time and date of the SYNCHROTACT 5 - clock, even when no SNTP-Server is connected. (see chapter 2.7).

10 Technical data

10.1 Inputs

Auxiliary voltage

Nominal voltage range	24 to 250 VDC 100 to 230 VAC
Permissible voltage range	18 to 300 VDC 75 to 300 VAC
Power consumption READY	<12 W/<18 VA
OPERATING	<12 W/<18 VA

Measuring inputs U1, U2

Nominal voltage range	50 to 130 VAC
Voltage range	0 to 130 % Un
Nominal frequency	$16^2/_3$ or 50/60 Hz
Frequency range	10 to 100 Hz
Maximum power consumption per channel	<10 mVA

Digital inputs

Nominal voltages	24/48 VDC
Current consumption	6 to 8 mA
Minimum voltage for logic 1	18 VDC

Relay inputs from SYN 5500

Coil nominal voltage	24 VDC
Operate voltage	≥18 VDC
Release voltage	≤3,6 VDC
Coil resistance	1152 Ω
Coil inductivity	1000 mH

10.2 Outputs

Paralleling relay and relays from SYN 5500

Maximum contact voltage	250 VAC/VDC
Limiting breaking capacity	6 A
Limiting continuous current	10 A
Limiting making capacity	20 A
Maximum switching power ON AC/DC	1500 VA/W
Maximum switching power OFF AC/DC (resistive)	1500/150 VA/W

Adjusting command and signaling relays

Maximum contact voltage	250 VAC/VDC
Limiting continuous current	1.5 AAC/ADC
Maximum switching power ON/OFF AC/DC	50 VA/W

Auxiliary voltage output for digital inputs

Maximum output power	4 W

10.3 Interfaces

10.3.1 Service interface

Ethernet for SynView

Bridgeable distance	100 m

10.3.2 Interface for time synchronization

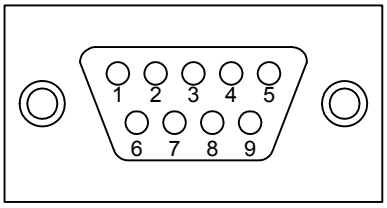
Time synchronization RS232

Pin assignment	2: TXD (not connected) 3: RXD 5: GND

10.3.3 Operating interface

Modbus RTU

Pin assignment:

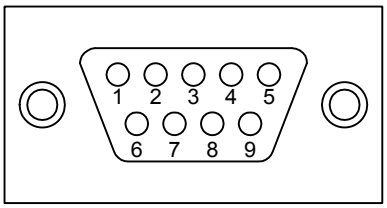


1: DE [RS485]
2: RS232-RX
3: RS232-TX
4: +5 V bus
5: Ground bus
6: RS485 A-line
7: RS485 B-line
8: Not used
9: Not used
PE: Shield

The transmission medium for the Modbus RTU connection is a two-wire twisted copper cable.

Profibus DP

Pin assignment:



1: Not used
2: Not used
3: B-line
4: RTS (Request to send)
5: Isolated Ground bus
6: Isolated +5 V bus
7: Not used
8: A-line
9: Not used
PE: Shield

The transmission medium for the Profibus DP connection is a two-wire twisted copper cable.

Lon-Bus

The optical fibre connection is made using the following pair of connectors: HFBR-2412 and HFBR-1414

10.4 Transmission values

10.4.1 Measuring ranges

Channel 1

Voltage	U1, U2	0 to 1.30*Un
Phase-angle difference	α	-179 to +180 DEG
Frequency	f1, f2	10 to 100Hz
Slip	s	0 to 50 %
Acceleration	ds/dt	0 to 10 %/s
Paralleling time	t on	0 to 1 s

Channel 2 (synchrocheck)

Voltage	U1, U2	0 to 1.30*Un
Phase-angle difference	α	-179 to +180 DEG
Frequency	f1, f2	10 to 100Hz
Slip	s	0 to 50 %

10.4.2 Accuracy

Measuring accuracy channel 1

Voltage	U1, U2	$\leq$ 0.1 V
Voltage difference	ΔU	$\leq$ 0.15 V
Phase-angle difference	α	$\leq$ 1 DEG at s $\leq$ 0.5 %
Frequency	f1, f2	$\leq$ 50 mHz
Slip	s	$\leq$ 0.02 %

Operating accuracy channel 1

Maximum and minimum voltage	Umax, Umin	$\leq$ 0.3 V
Maximum voltage difference	ΔUmax	$\leq$ 0.35 V
Phase coincidence	α	$\leq$ 2 DEG bei s $\leq$ 0.5 %
Slip limit	smax	$\leq$ 0.03 %
Paralleling time	t on	$\leq$ 10 ms
Paralleling command duration	tp on	$\leq$ 10 ms
Monitoring time	t supervis	$\leq$ 1 s
Blocking time after selection	t block	$\leq$ 100 ms

Channel 2 (synchrocheck)

Voltage	U1, U2	$\leq$ 5 %
Voltage difference	ΔU	1 %
Phase-angle difference	α	$\leq$ 2 DEG
Slip	s	$\leq$ 0.1 %

10.5 Environmental values

10.5.1 Isolation

Dielectric test	IEC 60255-5	2 kV
Impulse voltage withstand test	IEC 60255-5	5 kV

10.5.2 Climatic stability

Temperature ranges for devices without communication:

Transport/storage	-40 to +85 °C
Functionable	-25 to +70 °C
Operation (compliance with technical data)	-10 to +55 °C

Temperature ranges for devices with communication:

Transport/storage	-10 to +85 °C
Functionable	+5 to +70 °C
Operation (compliance with technical data)	+5 to +55 °C

Tests:

Cold	IEC 60068-2-1	-25 °C
Dry heat	IEC 60068-2-2	+70 °C; 16 h
Damp heat, steady state	IEC 60068-2-3	Ca 4 days
Damp heat, cyclic	IEC 60068-2-30	55 °C/2 cycles
Change of temperature	IEC 60068-2-14	Nb; 1°C/min.

10.5.3 Mechanical stability

Vibration	IEC 60255-21-1	10 to 150 Hz; Cl. 2
Vibration response		1 g
Endurance		2 g
Shocks and bumps	IEC 60255-21-2	class 2
Shock response		10 g
Withstand		30 g
Bump		20 g
Earthquake		
Single-axis sine sweep seismic test	IEC 60255-21-3	Method A
	IEEE STD 344-1987	5g in each axis

10.5.4 Interference immunity/transmission (EMC)

Emission AC mains (conducted disturbance)	CISPR 22	Class B 0.15..0,5 MHz: 66..56 dB/56..46 dB 0.5..5 MHz: 56 dB / 46 dB 5..30 MHz: 60 dB / 50 dB
Emission enclosure (radiation disturbance)	CISPR 11	Class A 30..230 MHz: 30 dB 230..1000MHz: 37 dB
Electrostatic discharges	IEC 60255-22-2 IEC 61000-4-2 IEEE C37.90.3-2001	Class IV Contact: 8 kV Air: 15 kV

Electromagnetic fields	IEC 61000-4-16	0 to 150 kHz: 30 V continuous 300 V; for 1 s
	IEC 61000-4-6	0.15 to 80 MHz 10 V; 80 % AM
	IEC 60255-22-3 IEC 61000-4-3	Frequency sweep: 80 to 1000 MHz: 10 V/m; 80 % AM 1.4..2 GHz: 20 V/m; 80 % AM Spot frequencies: 80/160/450/900 MHz: 80 % AM; Testing time >10 s
	IEEE C37.90.2-2004	25 to 1000 MHz: 20 V/m; 80% AM (max. result. field strength: 35 V/m)
Fast transient	IEC 60255-22-4 IEC 61000-4-4	Class IV; 4 kV
	IEEE C37.90.1-2002 (fast transient)	4 kV common & transverse mode
Surge voltage	IEC 61000-4-12 IEC 61000-4-5	2.5 kV Installation classification: class 3 Auxiliary voltage: line to ground: ±2 kV, 12 Ω;9 µF line to line: ±1 kV, 2 Ω; 18 µF Measuring inputs, digital I/O's: ±2/±1 kV, 42 Ω; 0.5 µF
Voltage dips, short interruptions and voltage variations	IEC 61000-4-11	AC: 30 %: 10 ms Performance criterion: B 60 %: 100 ms & 1000 ms >95 %: 5000 ms Performance criterion: C
	SN-62.1008d	DC: Polarity reversal: 1 min with -Un Short circuit to earth: 3 short circuits ±; 1 s / 10 s Short interruptions: 5 ms, 50 ms, 100 ms; 1 s Voltage dips: 50 %; 0.2 s Voltage variations: Un-0-Un linear in 2*60 s AC: Voltage dips: 100 % reduction Testing time: 5 Hz (for 120 V only)

1 MHz burst disturbance	IEC 60255-22-1	Class III 2.5 kV common & transverse
	IEEE C37.90.1-2002 (oscillatory)	2.5 kV common & transverse

10.6 Relevant standards

CE conformity

EMC directive:	89/336/EEC	
Generic standard	IEC 61000-6-4	Emission
	IEC 61000-6-2	Immunity
Low voltage directive:	73/23/EEC	
Safety of information technology equipment	EN 60950	

Product standards

Measuring relays and protection equipment	IEC 60255-6
Product standard for measuring relays and protection equipment	EN 50263
Hydro Québéc standard for electronic equipment and relays	SN-62.1008d
IEEE-standard for Relays	IEEE C37.90-1989

10.7 Construction data

Protection type according to IEC 60529

Front	IP 54
Rear	IP 50

Weight

SYN 5201/SYN 5202	4 kg

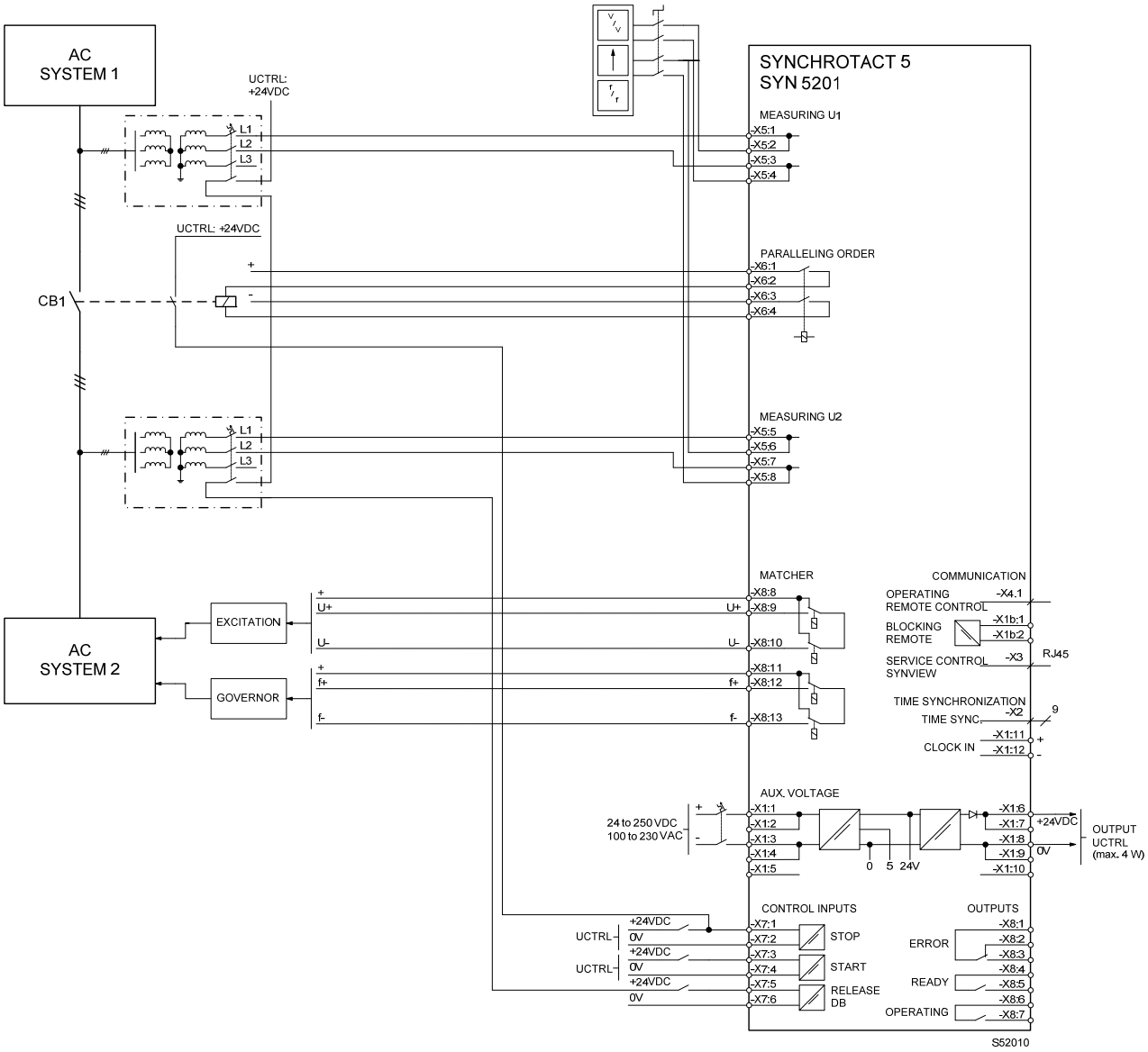
Installation altitude

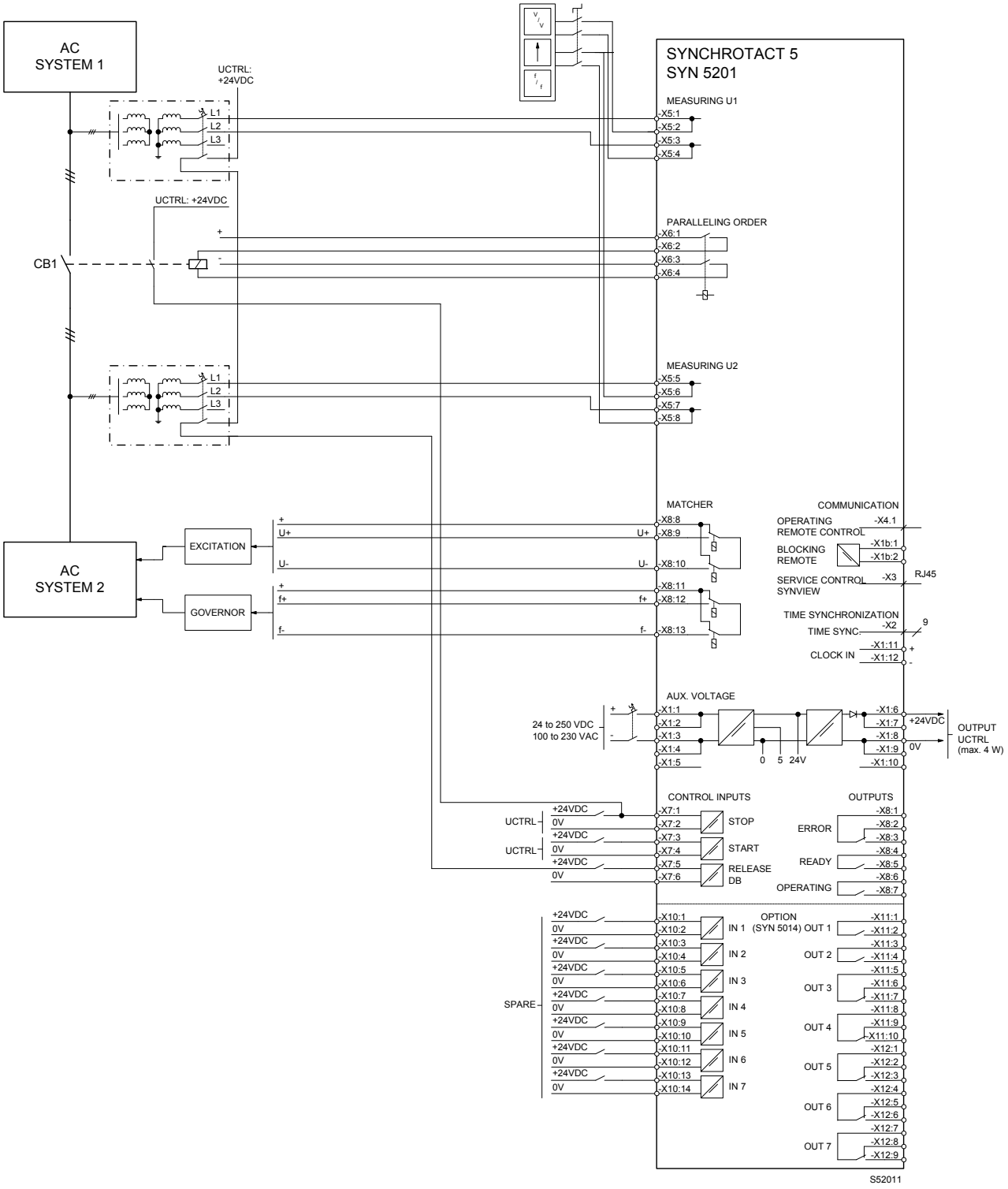
<2000 m above sea level

10.8 Flammability

Front panel	UL94HB
Connector housing, printed circuit boards	UL94V-0

11 Schematics




AC
SYSTEM 1
UCTRL:
+24VDC
L1
L2
L3
UCTRL: +24VDC
CB1
AC
SYSTEM 2
EXCITATION
GOVERNOR
SYNCHROTACT 5
SYN 5201
MEASURING U1
X5:1
X5:2
X5:3
X5:4
PARALLELING ORDER
X6:1
X6:2
X6:3
X6:4
MEASURING U2
X5:5
X5:6
X5:7
X5:8
MATCHER
X8:8
U+
X8:9
U-
X8:10
X8:11
f+
X8:12
f-
X8:13
COMMUNICATION
OPERATING
REMOTE CONTROL
-X4.1
BLOCKING
REMOTE
-X1b:1
-X1b:2
SERVICE CONTROL
SYNVIEW
-X3
RJ45
TIME SYNCHRONIZATION
TIME SYNC.
-X2
9
CLOCK IN
-X1:11
-X1:12
AUX. VOLTAGE
24 to 250 VDC
100 to 230 VAC
X1:1
X1:2
X1:3
X1:4
X1:5
0
5
24V
-X1:6
-X1:7
-X1:8
-X1:9
-X1:10
+24VDC
0V
OUTPUT
UCTRL
(max. 4 W)
CONTROL INPUTS
UCTRL
+24VDC
0V
X7:1
X7:2
X7:3
X7:4
X7:5
X7:6
STOP
START
RELEASE
DB
OUTPUTS
ERROR
READY
OPERATING
-X8:1
-X8:2
-X8:3
-X8:4
-X8:5
-X8:6
-X8:7
SPARE
X10:1
X10:2
X10:3
X10:4
X10:5
X10:6
X10:7
X10:8
X10:9
X10:10
X10:11
X10:12
X10:13
X10:14
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
OPTION
(SYN 5014)
OUT 1
OUT 2
OUT 3
OUT 4
OUT 5
OUT 6
OUT 7
-X11:1
-X11:2
-X11:3
-X11:4
-X11:5
-X11:6
-X11:7
-X11:8
-X11:9
X11:10
-X12:1
-X12:2
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-X12:4
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-X12:6
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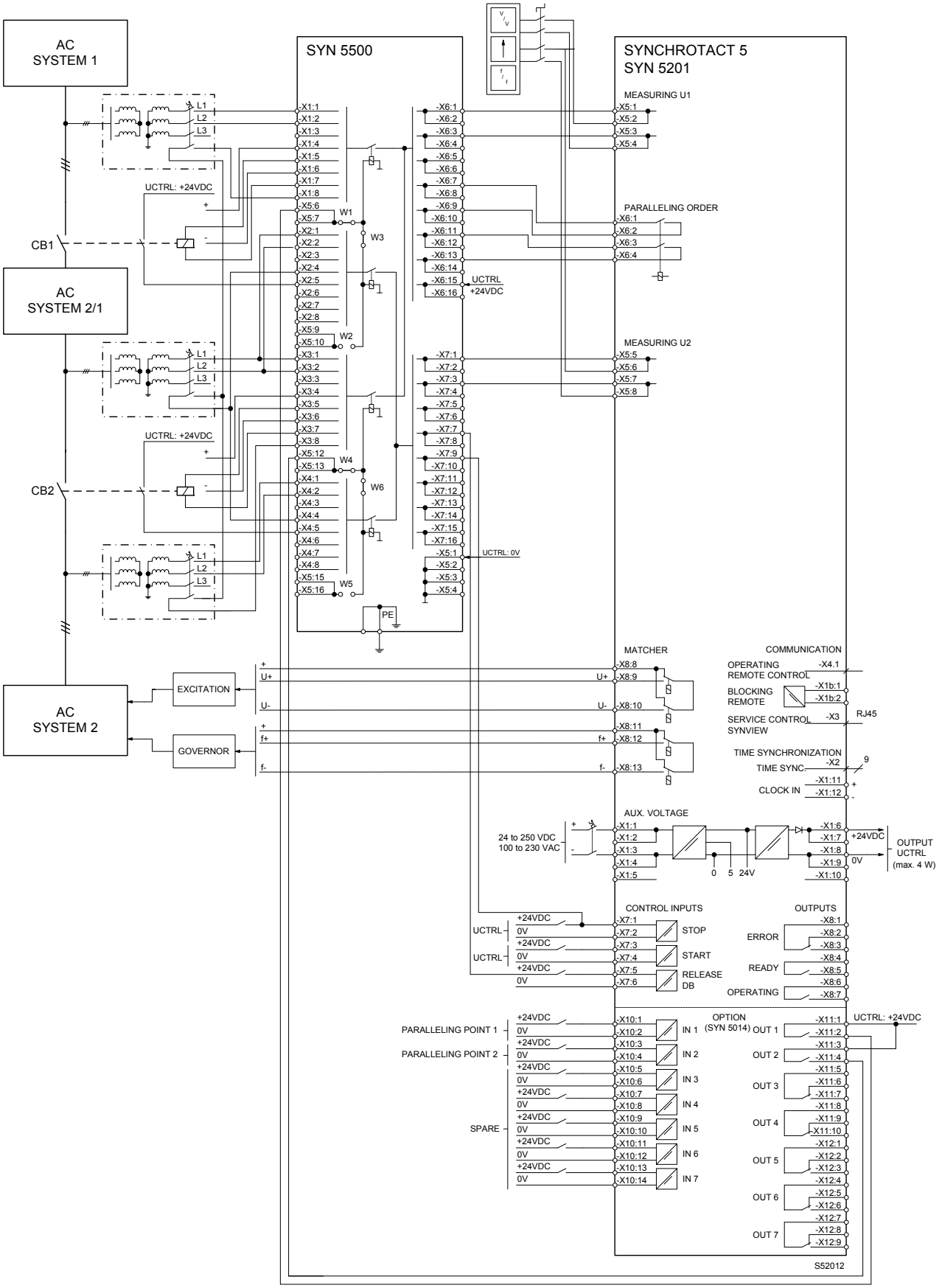
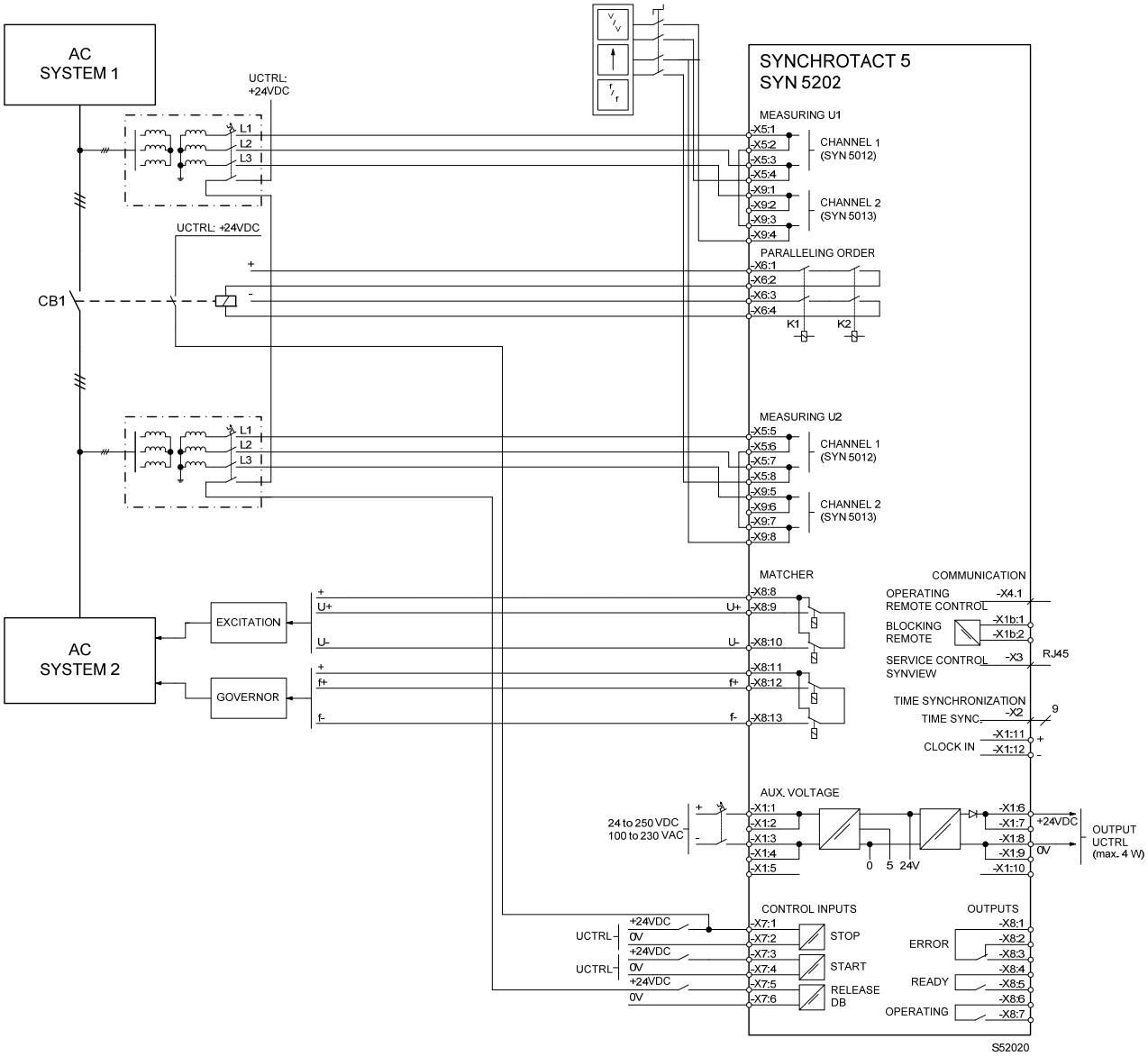
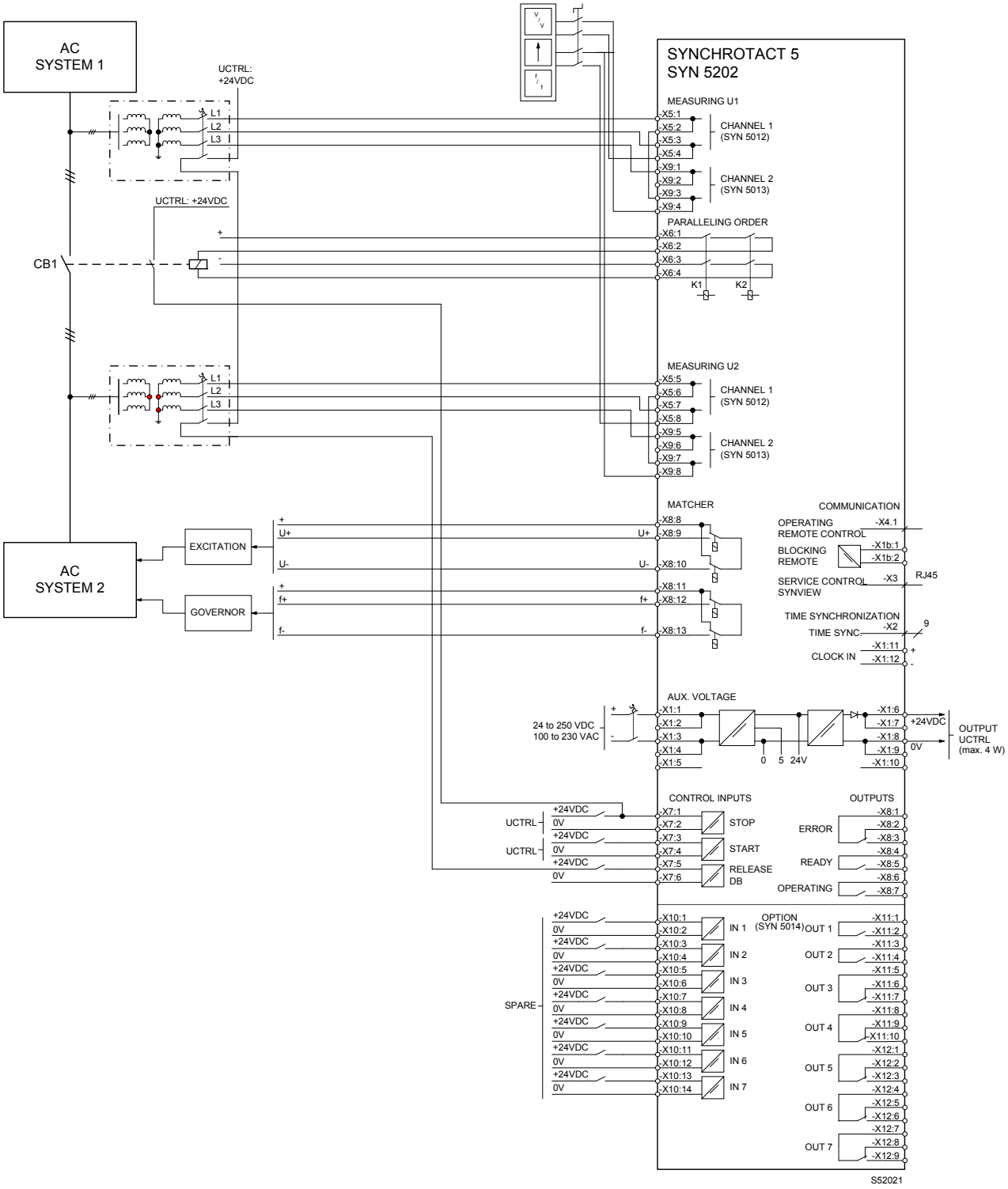
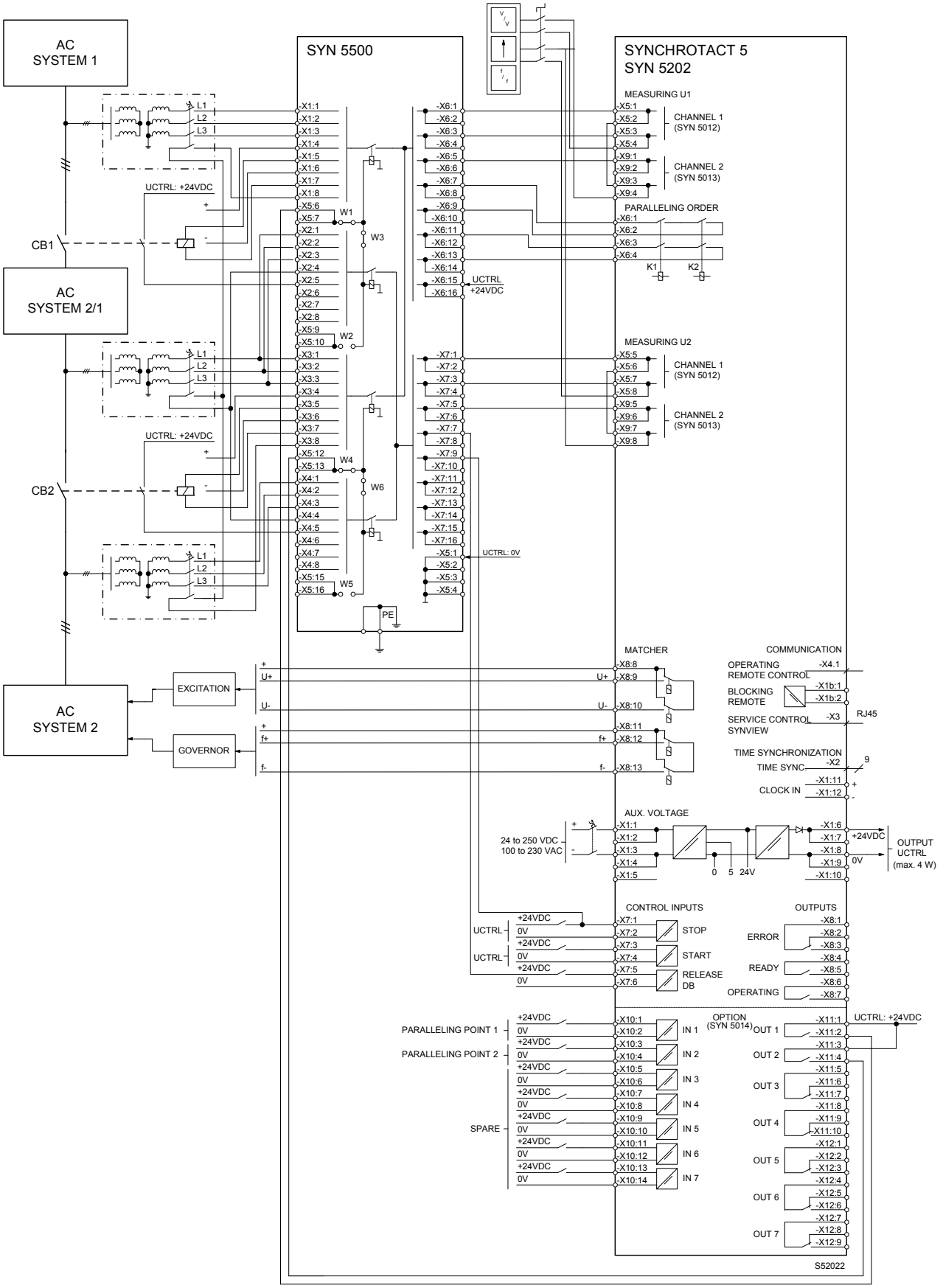
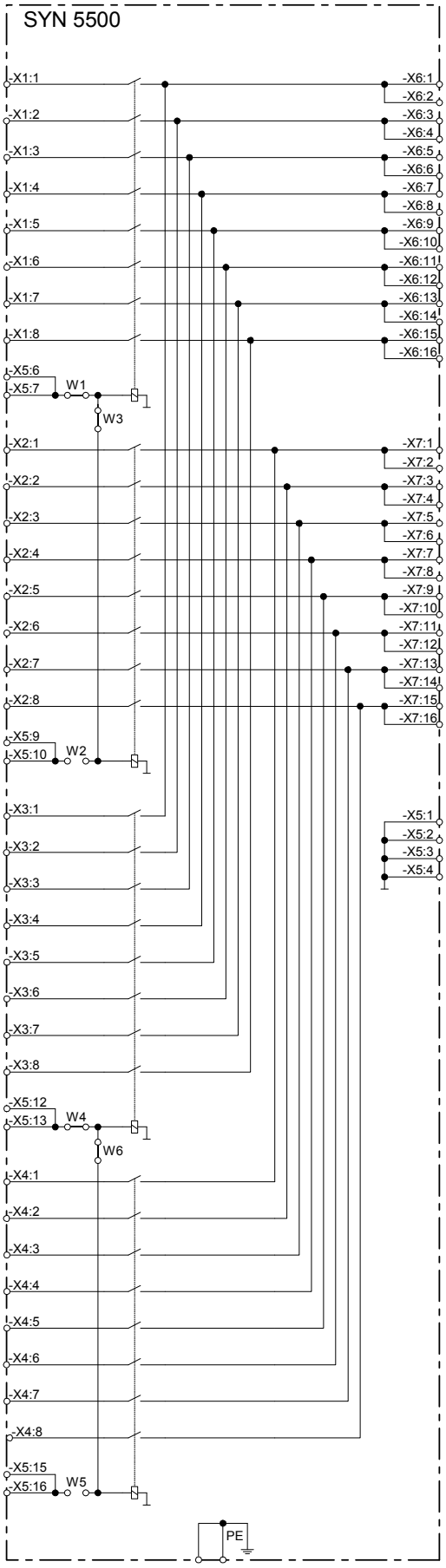
-X12:8
-X12:9
S52011


AC SYSTEM 1
AC SYSTEM 2/1
AC SYSTEM 2
CB1
CB2
SYN 5500
SYNCHROTACT 5 SYN 5201
MEASURING U1
MEASURING U2
PARALLELING ORDER
UCTRL: +24VDC
UCTRL +24VDC
UCTRL: 0V
W1
W2
W3
W4
W5
W6
PE
EXCITATION
GOVERNOR
MATCHER
COMMUNICATION
OPERATING REMOTE CONTROL
BLOCKING REMOTE
SERVICE CONTROL SYNVIEW
RJ45
TIME SYNCHRONIZATION
TIME SYNC.
CLOCK IN
AUX. VOLTAGE
24 to 250 VDC
100 to 230 VAC
+24VDC
0V
OUTPUT UCTRL (max. 4 W)
CONTROL INPUTS
STOP
START
RELEASE DB
OUTPUTS
ERROR
READY
OPERATING
OPTION (SYN 5014)
PARALLELING POINT 1
PARALLELING POINT 2
SPARE
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
OUT 1
OUT 2
OUT 3
OUT 4
OUT 5
OUT 6
OUT 7
S52012


AC
SYSTEM 1
UCTRL:
+24VDC
L1
L2
L3
UCTRL: +24VDC
CB1
AC
SYSTEM 2
EXCITATION
GOVERNOR
SYNCHROTACT 5
SYN 5202
MEASURING U1
X5:1
X5:2
X5:3
X5:4
CHANNEL 1
(SYN 5012)
X9:1
X9:2
X9:3
X9:4
CHANNEL 2
(SYN 5013)
PARALLELING ORDER
X6:1
X6:2
X6:3
X6:4
K1
K2
MEASURING U2
X5:5
X5:6
X5:7
X5:8
CHANNEL 1
(SYN 5012)
X9:5
X9:6
X9:7
X9:8
CHANNEL 2
(SYN 5013)
MATCHER
X8:8
X8:9
X8:10
X8:11
X8:12
X8:13
COMMUNICATION
OPERATING
REMOTE CONTROL
-X4.1
BLOCKING
REMOTE
-X1b:1
-X1b:2
SERVICE CONTROL
SYNVIEW
-X3
RJ45
TIME SYNCHRONIZATION
TIME SYNC.
-X2
9
CLOCK IN
-X1:11
-X1:12
AUX. VOLTAGE
24 to 250 VDC
100 to 230 VAC
X1:1
X1:2
X1:3
X1:4
X1:5
0
5
24V
-X1:6
-X1:7
-X1:8
-X1:9
-X1:10
+24VDC
0V
OUTPUT
UCTRL
(max. 4 W)
CONTROL INPUTS
OUTPUTS
UCTRL
+24VDC
0V
X7:1
X7:2
STOP
X7:3
X7:4
START
X7:5
X7:6
RELEASE
DB
ERROR
READY
OPERATING
X8:1
X8:2
X8:3
X8:4
X8:5
X8:6
X8:7
S52020


AC
SYSTEM 1
UCTRL:
+24VDC
L1
L2
L3
UCTRL: +24VDC
CB1
AC
SYSTEM 2
EXCITATION
GOVERNOR
SYNCHROTACT 5
SYN 5202
MEASURING U1
X5:1
X5:2
X5:3
X5:4
CHANNEL 1
(SYN 5012)
X9:1
X9:2
X9:3
X9:4
CHANNEL 2
(SYN 5013)
PARALLELING ORDER
X6:1
X6:2
X6:3
X6:4
K1
K2
MEASURING U2
X5:5
X5:6
X5:7
X5:8
X9:5
X9:6
X9:7
X9:8
MATCHER
X8:8
X8:9
X8:10
X8:11
X8:12
X8:13
U+
U-
f+
f-
COMMUNICATION
OPERATING
REMOTE CONTROL
-X4.1
BLOCKING
REMOTE
-X1b:1
-X1b:2
SERVICE CONTROL
SYNVIEW
-X3
RJ45
TIME SYNCHRONIZATION
TIME SYNC.
-X2
9
CLOCK IN
-X1:11
-X1:12
AUX. VOLTAGE
24 to 250 VDC
100 to 230 VAC
X1:1
X1:2
X1:3
X1:4
X1:5
0
5
24V
-X1:6
-X1:7
-X1:8
-X1:9
-X1:10
+24VDC
0V
OUTPUT
UCTRL
(max. 4 W)
CONTROL INPUTS
UCTRL
+24VDC
0V
X7:1
X7:2
X7:3
X7:4
X7:5
X7:6
STOP
START
RELEASE
DB
OUTPUTS
ERROR
READY
OPERATING
-X8:1
-X8:2
-X8:3
-X8:4
-X8:5
-X8:6
-X8:7
SPARE
X10:1
X10:2
X10:3
X10:4
X10:5
X10:6
X10:7
X10:8
X10:9
X10:10
X10:11
X10:12
X10:13
X10:14
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
OPTION
(SYN 5014)
OUT 1
OUT 2
OUT 3
OUT 4
OUT 5
OUT 6
OUT 7
-X11:1
-X11:2
-X11:3
-X11:4
-X11:5
-X11:6
-X11:7
-X11:8
-X11:9
-X11:10
-X12:1
-X12:2
-X12:3
-X12:4
-X12:5
-X12:6
-X12:7
-X12:8
-X12:9
S52021


AC SYSTEM 1
AC SYSTEM 2/1
AC SYSTEM 2
CB1
CB2
SYN 5500
SYNCHROTACT 5 SYN 5202
UCTRL: +24VDC
W1
W2
W3
W4
W5
W6
PE
MEASURING U1
MEASURING U2
CHANNEL 1 (SYN 5012)
CHANNEL 2 (SYN 5013)
PARALLELING ORDER
K1
K2
UCTRL +24VDC
UCTRL: 0V
MATCHER
EXCITATION
GOVERNOR
COMMUNICATION
OPERATING REMOTE CONTROL
BLOCKING REMOTE
SERVICE CONTROL SYNVIEW
RJ45
TIME SYNCHRONIZATION
TIME SYNC
CLOCK IN
AUX. VOLTAGE
24 to 250 VDC
100 to 230 VAC
+24VDC
0V
OUTPUT UCTRL (max. 4 W)
CONTROL INPUTS
STOP
START
RELEASE DB
OUTPUTS
ERROR
READY
OPERATING
PARALLELING POINT 1
PARALLELING POINT 2
SPARE
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
OPTION (SYN 5014)
OUT 1
OUT 2
OUT 3
OUT 4
OUT 5
OUT 6
OUT 7
S52022


SYN 5500
-X1:1
-X1:2
-X1:3
-X1:4
-X1:5
-X1:6
-X1:7
-X1:8
-X5:6
-X5:7
W1
W3
-X2:1
-X2:2
-X2:3
-X2:4
-X2:5
-X2:6
-X2:7
-X2:8
-X5:9
-X5:10
W2
-X3:1
-X3:2
-X3:3
-X3:4
-X3:5
-X3:6
-X3:7
-X3:8
-X5:12
-X5:13
W4
W6
-X4:1
-X4:2
-X4:3
-X4:4
-X4:5
-X4:6
-X4:7
-X4:8
-X5:15
-X5:16
W5
PE
-X6:1
-X6:2
-X6:3
-X6:4
-X6:5
-X6:6
-X6:7
-X6:8
-X6:9
-X6:10
-X6:11
-X6:12
-X6:13
-X6:14
-X6:15
-X6:16
-X7:1
-X7:2
-X7:3
-X7:4
-X7:5
-X7:6
-X7:7
-X7:8
-X7:9
-X7:10
-X7:11
-X7:12
-X7:13
-X7:14
-X7:15
-X7:16
-X5:1
-X5:2
-X5:3
-X5:4

12 Record and questionnaire

12.1 Settings record for SYNCHROTACT 5

Name and address of customer: _____

_____

_____

Plant: _____

Order no.: _____

Plant schematic no.: _____

Device identification:

Type plate:

Delivery date: _____

Software number: _____

SynView:
Provided: Yes: ☐ No: ☐

Remarks:

Place and date of commissioning:

Name: Company:

Important: Please send a copy of the record to the following address:

ABB Switzerland Ltd
Dept. ATPE
CH-5300 Turgi
Telefax: +41 58 589 23 33

Parameter settings

	Parameter	Abbreviation	Parameter sets							Unit
1	**Actual value calibration**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	
1.1	Nominal voltage	Un								VAC
1.2	Nominal frequency	fn								Hz
1.3	Voltage tuning	ΔUOffset								%
1.4	Angle tuning	αOffset								DEG
2	**Command generation**									
2.1	Test function	TEST ton	xx	xx	xx	xx	xx	xx	xx	
2.2	Paralleling time	t on								ms
2.3	Paralleling command length	tp on								ms
2.4	Monitoring time	t supervis								s
2.5	Multiple commands	MULTIPLE CMD								
3	**Paralleling conditions**									
3.1	Slip limit, oversynchronous	-smax								%
3.2	Slip limit, sub-synchronous	+smax								%
3.3	Angle limit, negativ	-αmax								DEG
3.4	Angle limit, positive	+αmax								DEG
3.5	Max. voltage difference, overexcited	-ΔUmax								%
3.6	Max. voltage difference, underexcited	+ΔUmax								%
3.7	Maximum voltage	Umax								%
3.8	Minimum voltage	Umin								%
4	**Dead bus conditions**									
4.1	Maximum zero voltage	U0max								%
4.2	Release U1 = zero voltage	U1not								
4.3	Release U2 = zero voltage	U2not								
4.4	Release U1 & U2 = zero voltage	1*2not								
5	**Voltage matchers**									
5.1	Test function	TEST U-Match	xx	xx	xx	xx	xx	xx	xx	
5.2	Voltage adjusting characteristic	dU/dt								%/s
5.3	Pulse interval	ts U								s
5.4	Minimum pulse duration	tp Umin								s
5.5	Switchover to variable intervals	INVERSE U								
5.6	Switchover to tap changer	TAP CHANGER								
6	**Frequency matchers**									
6.1	Test function	TEST f-Match	xx	xx	xx	xx	xx	xx	xx	
6.2	Frequency adjusting characteristic	df/dt								%/s
6.3	Pulse interval	ts f								s
6.4	Minimum pulse duration	tp fmin								s
6.5	Switchover to variable intervals	INVERSE f								
7	**General parameters**									
7.1	Blocking time after selection	t block								s
7.2	Total paralleling time	t tot								min

Parameter settings: Configuration parameters

	Parameter	Abbreviation	Value
1	**Digital inputs**		
1.1	Digital input 1	I 1	
1.2	Digital input 2	I 2	
1.3	Digital input 3	I 3	
1.4	Digital input 4	I 4	
1.5	Digital input 5	I 5	
1.6	Digital input 6	I 6	
1.7	Digital input 7	I 7	
2	**Digital outputs**		
2.1	Digital output 1	O 1	
2.2	Digital output 2	O 2	
2.3	Digital output 3	O 3	
2.4	Digital output 4	O 4	
2.5	Digital output 5	O 5	
2.6	Digital output 6	O 6	
2.7	Digital output 7	O 7	

Parameter settings: Channel 2 (SYN 5202)

	Synchrocheck	Abbreviation	Value	Unit
1	**Synchrocheck parameters**			
1.1	Slip limit	smax		%
1.2	Angle limit	αmax		DEG
1.3	Max. voltage difference	ΔUmax		%
1.4	Max. zero voltage	U0max		%
1.5	Nominal voltage	Un		VAC

SYN 5500

Device No	**Device 1**	**Device 2**	**Device 3**	**Device 4**
Name				
Jumper	open / closed	open / closed	open / closed	open / closed
W1				
W2				
W3				
W4				
W5				
W6				

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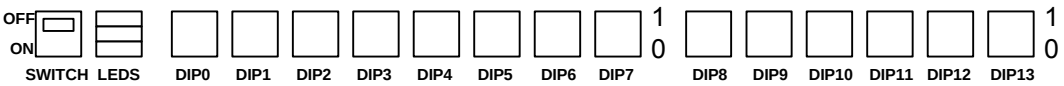
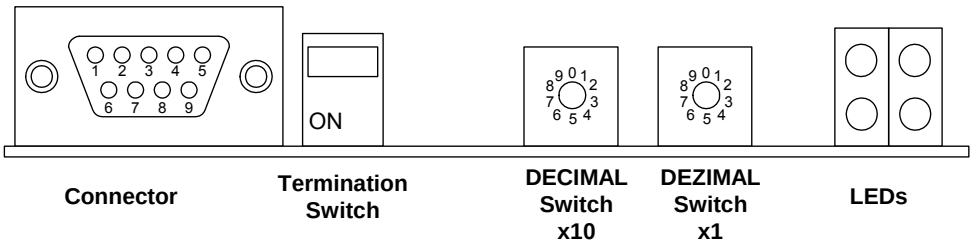
Configuration Modbus RTU



Function	DIP-no	DIP-Value Setting	Setting
Electrical mode	DIP 0	__	
Selection of slave address	DIP 1 – DIP 8	__ __ __ __ __ __ __ __	
Selection of Baudrate	DIP 9 / 10 / 11	__ __ __	
Selection of parity mode	DIP 12 / 13	__ __	

Configuration Profibus DP



Function	Setting
Termination Switch	
Slave Address	

Configuration IEC 61850

Service IP-address	
Operating IP-address	
Used ICD-file	
SCD-file name	

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12.2 SYNCHROTACT 5 Questionnaire

Plant _____ Customer's address _____ Tech. Contact Pers. _____ Telephone No. _____ Fax. No. _____	Is the unit under guarantee? Yes ☐ No ☐ Fault detection? (YY/MM/DD): _____ Commissioning date? (YY/MM/DD): _____
Type plate: Ident. number Manufacturing no. Type _____ _____ _____	
Configuration: Supply/control voltage…….VDC/.....VDC Nominal measuring voltage……..VAC Ambient temperature……..°C Replacement unit used? Yes ☐ No ☐	**Description of type of fault:** (e.g.: adjusting commands U+, U-, f+, f- and paralleling command or release ?)
Request ☐ Test only ☐ Repair and test	Status of **Display** and **LED`s** when fault occurred LCD:..... .... LED READY ☐ lit ☐ dark LED OPERATING ☐ lit ☐ dark LED BLOCKED ☐ lit ☐ dark LED ERROR ☐ lit ☐ dark
When did the failure occur?	**If the valid settings record has also been supplied, the device can be returned with the settings**
Frequency of fault Always Periodically, frequency	**Remarks**
Date: _____	**Signature:** _____

Modifications

Rev. Ind.	Page (P) Section (S)	Descriptions (or revision status)	Date Dept./Exec.
A	All sections	Completely revised	00.07.06; ICA/WZ
B	S 2.2.2	Addition to the description regarding variable pause intervals of voltage and frequency matchers	02.01.07; ATP/WZ
B	S 2.6	New	02.01.07; ATP/WZ
B	S 2.7	New	02.01.07; ATP/WZ

B	S 3 and S 4	Completely revised:
		- Division into two main sections (S 3 and S 4)
		- Adaptation of the type code
		- Addition of new functions: communication and time synchronization
		- Tables for configurable inputs/outputs revised and moved from section on engineering instructions to section 4
		- Section on parameter settings moved from the section on commissioning to section 4 and addition of the following sections:
		  - Start conditions for the test function
		  - Cancelling the test function
		  - Monitoring time t supervis
		  - Multiple command generation MULTIPLE ORD
		  - Release of the measuring voltages as no-voltage U1not, U2not, 1*2not
			02.01.07; ATP/WZ

B	Section Engineering instructions	Addition: connection of measuring voltages Addition: use of the automatic synchronizer as synchrocheck	02.01.07; ATP/WZ
B	S 7	Addition of ‘Cancel test function‘ to commands	02.01.07; ATP/WZ
B	S 8	Addition of the section: Adapting the matchers to the system	02.01.07; ATP/WZ
B	S 8.3.2	Addition of the key to the signals and values of the transient recorder	02.01.07; ATP/WZ
B	S 9	Error and event codes: New code 061 Additions to code 123	02.01.07; ATP/WZ
B	S 10	Additions to technical data: - Current consumption of the measuring inputs - Max. output power of the auxiliary voltage output - Temperature range for communication	02.01.07; ATP/WZ
B	S 11	Addition of new interfaces to the schematic diagrams	02.01.07; ATP/WZ
B		Insertion of this table	02.01.07; ATP/WZ

Rev. Ind.	Page (P) Section (S)	Descriptions (or revision status)	Date Dept./Exec.
C	S 2.2.2	Addition: Working range voltage matcher	05.09.20 ATPE/WZ
C	S 3.1	New type code	05.09.20 ATPE/WZ
C	S 3.2	Modification: Note: RS232 replaced by Ethernet	05.09.20 ATPE/WZ
C	S 3.3	Modification of the communication interfaces RS232 to Ethernet, previous option Ethernet cancelled; New blocking input	05.09.20 ATPE/WZ
C	S 3.4	Modification: previous option Ethernet cancelled and new input range fro auxiliary voltage.	05.09.20 ATPE/WZ
C	S 4.2.1	Modification and addition of paragraph "Angle tuning α Offset"	05.09.20 ATPE/WZ
C	S 4.2.8	Addition: New configuration possibilities for digital outputs	05.09.20 ATPE/WZ
C	S 5.2.2	New section for engineering: compensation of phase-angle difference	05.09.20 ATPE/WZ
C	S 5.8	Addition: Relay type of SYN 5500	05.09.20 ATPE/WZ
C	S 7.1.1	Addition: Table of commands	05.09.20 ATPE/WZ
C	S 7.1.3	Modification: RS232 replaced by Ethernet	05.09.20 ATPE/WZ
C	S 7.2.3	Modification: SynView with optional password	05.09.20 ATPE/WZ
C	S 8.2.8	Modification under "Caution": compensation of phase shifts not by α Offset	05.09.20 ATPE/WZ
C	S 9.2.3	Modificationen event list: 060, 061, 073, 127 New in the event list: 077, 078, 079	05.09.20 ATPE/WZ
C	S 10.1	Modification: range of the auxiliary voltage New: digital inputs: minimum voltage for logic 1	05.09.20 ATPE/WZ
C	S 10.2	Modification / Addition: relay data	05.09.20 ATPE/WZ
C	S 10.4	Modification: accuracy data	05.09.20 ATPE/WZ
C	S 10.5	Modification: changed values after repeating of the type test for climatic and EMC tests	05.09.20 ATPE/WZ
C	S 11	Modification: New interfaces and blocking input	05.09.20 ATPE/WZ

Rev. Ind.	Page (P) Section (S)	Descriptions (or revision status)	Date Dept./Exec.
D	S 2.7, 2.8, 3.1	Complemented by the IEC 61850 option issues	11.11.21 ATPE/WZ
D	S 2.9.3, 4.3.7 to 4.3.9, 5.6.3, 5.7.3, 7.4, 9.3.4, 9.3.9, 9.4	New section dealing with the IEC 61850 option	11.11.21 ATPE/WZ
D	S 7.2.3	Additions to SynView Operating instructions	11.11.21 ATPE/WZ
D	S 7.3.4	New section describing the operating interface	11.11.21 ATPE/WZ