Contents

1. Introduction

1.1 Features

- Synchro-check and voltage-check functions for checking the conditions at circuit-breaker closing.

  - Synchro-check function for checking the synchronism when live lines/busbars are to be connected together.

  - Voltage-check function for checking the energizing conditions. Four energizing directions selectable for each circuit breaker.
- Two control modes available: continuous mode operation for applications where the synchro-check function gives the close permission to another module and command mode operation for applications where the synchro-check function closes the circuit breaker via its own control output.
- Alarm signal for a failed CB closing at the command mode operation.
- Virtual phase-to-phase voltage measurement channels can be used instead of the corresponding analogue measurement channels

1.2 Application

This document specifies the functions of the synchro-check function blocks SCVCSt1 and SCVCSt2 used in products based on the RED 500 Platform.

The function block SCVCSt_ is designed to be used for checking the conditions for circuit-breaker closing. The function can be used for closing ring mains, interconnecting busbars and connecting generators to the network. The harmonics are suppressed.

Table 1 . Protection diagram symbols used in the relay terminal

ABB	IEC	ANSI
SCVCSt1	**SYNC1**	**25-1**
SCVCSt2	**SYNC2**	**25-2**

For IEC symbols used in single line diagrams, refer to the manual “Technical Descriptions of Functions, Introduction”, 1MRS750528-MUM.

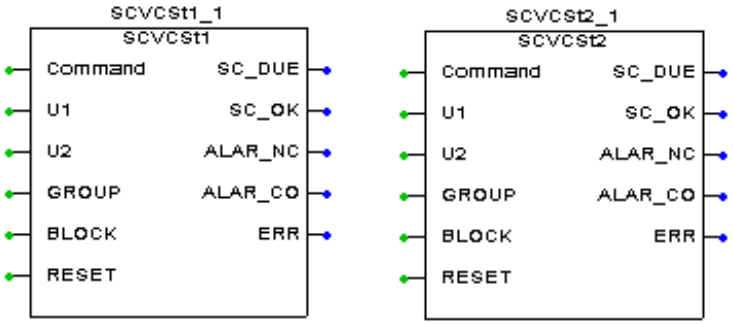


Figure 1. Function block symbols of SCVCSt1 and SCVCSt2

1.3 Input description

Name	Type	Description
Command	Digital signal (BOOL, active high)	Command signal
U1	Analogue signal (SINT)	Input for measuring main voltage 1
U2	Analogue signal (SINT)	Input for measuring main voltage 2
GROUP	Digital signal (BOOL, active high)	Control input for switching between the setting groups 1 and 2. When GROUP is FALSE, group 1 is active. When GROUP is TRUE, group 2 is active.
BLOCK	Digital signal (BOOL, active high)	Blocking signal
RESET	Digital signal (BOOL, pos. edge)	Signal for resetting the registers

1.4 Output description

Name	Type	Description
SC_DUE	Digital signal (BOOL, active high)	Synchro-check in progress
SC_OK	Digital signal (BOOL, active high)	Closing permission given
ALAR_NC	Digital signal (BOOL, active high)	CB closing failed
ALAR_CO	Digital signal (BOOL, active high)	Command signal too long
ERR	Digital signal (BOOL, active high)	Signal for indicating a configuration error

2. Description of operation

2.1 Configuration

The measuring devices and signal types for analogue channels are selected and configured in a special dialogue box of the Relay Configuration Tool included in the CAP 505 Tool Box. Digital inputs are configured in the same programming environment (the number of selectable analogue inputs, digital inputs and digital outputs depends on the hardware variant used).

The special measurements dialogue box in the configuration tool is used for selecting frequency protection for the voltage inputs.

When the analogue channels and digital inputs have been selected and configured in the dialogue box, the inputs and outputs of the function block can be configured on a graphic worksheet of the configuration tool. The phase-to-phase voltage U_{12} is connected to the U1 input and correspondingly U_{12b} is connected to the U2 input. Furthermore, digital inputs are connected to the boolean inputs of the function block, and in the same way the outputs of the function block are connected to the output signals.

If the relay is connected to measure phase-to-earth voltages on one side of the breaker, there are two ways to connect them to SCVCSt_:

- by using virtual phase-to-phase voltage channel U12s (or U12bs), or
- by using the voltage combine function of SCVCSt_, refer to section 2.3.5.2

If phase-to-earth voltages are measured on both sides of the breaker, connect the virtual phase-to-phase voltage channels U12s and U12bs to SCVCSt_.

2.2 Operation criteria

The criteria for the function are:

- Voltages must be in accordance with the energizing direction.
- In the cases “Live-Dead”, “Dead-Live” and “Dead-Dead” no other conditions are checked.
- In the case “Live-Live” also the following must be fulfilled:

  $\Delta U <$ dU setting

  $\Delta f <$ df setting

  $\Delta \varphi <$ dphase setting

Before the function block allows the CB closing, it ensures that the phase difference will remain within the setting range until the CB closes.

2.3 Operation

The function tacts of the circuit-breaker close. This duration is determined on the basis of the frequency of the voltages on opposite sides of the CB. The synchro-check function block has two parallel functions: a synchro-check function and a voltage-check function.

2.3.1 Synchro-check

The synchro-check function can be used for two different operating conditions. The most typical case is one where both sides of the circuit breaker to be closed are live and thus the synchronism is always checked before the circuit breaker is given the permission to close. In the other situation one or both sides of the circuit breaker to be closed are dead and, consequently, the frequency and phase differences cannot be measured, in which case the relay checks the energizing direction.

The purpose of the synchro-check function is to find the instant when the voltages on both sides of the circuit breaker are synchronized, i.e. they have the same frequency, are in phase and are of such a magnitude that the concerned busbars or lines can be regarded as live. When the frequency, phase angle and voltage conditions are fulfilled, the duration of the synchronized state is checked on the basis of the frequency and phase differences measured so as to ensure that the conditions will still be met when the CB closes. Depending on the circuit breaker and the closing system, the delay from the moment the closing signal is given until the circuit breaker finally closes is about 50 - 250 ms. The CB operate time selected tells the relay for how long the conditions at least have to persist.

To prevent unnecessary output relay oscillation, an internal hysteresis is implemented, which has to be taken into account when setting the parameter “dU” (see figure below).

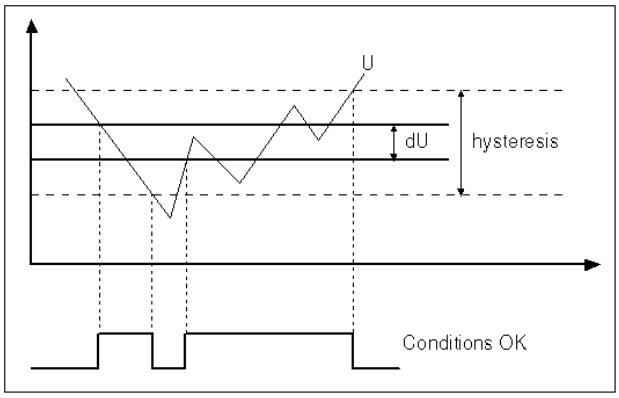


Figure 2. Hysteresis of 2.5% of U_n is applied when the amplitudes of voltages are checked

The synchro-check function is used for checking whether CB closing is permitted or not. Before CB operation the following closing conditions must be fulfilled:

- The network sections on both sides of the CB must be energized. The voltage magnitudes of the energized networks are determined by the set value for the upper threshold voltage Umax.
- The voltage difference over the CB must be small enough. The voltage difference allowed is determined by the set voltage difference value dU.
- The frequencies of the network sections (voltages) to be connected shall not differ too much from each other. The frequency conditions are fulfilled when the allowed frequency difference of the networks to be connected is smaller than the set frequency difference value df.
- The network sections to be connected (voltages) have the same phase angle. The phase angle conditions are fulfilled when the allowed phase angle difference between the network voltages is smaller than the set phase angle difference dphi.
- The validity time for CB closing conditions, achieved from frequency and phase-angle differencies, must have a duration of at least the time needed for the closing of the circuit breaker to be operated (operate time of CB).

When the closing conditions mentioned above are fulfilled simultaneously, the network voltages are considered to be synchronized and a closing command signal SC_OK is delivered to the CB.

2.3.1.1 Settings for the synchro-check function

- The threshold voltage Umax, above which the measured bus/line network voltage must be before the network is considered to be energized.
- Voltage difference allowed, absolute value dU. The set value determines the maximum allowed voltage difference for the synchro-check function.
- Frequency difference allowed, absolute value df. The set value determines the maximum allowed frequency difference for the synchro-check function.
- The phase-angle difference allowed, dphi, is an absolute value which means that there are no demands concerning the phase-angle direction. The set value determines the maximum allowed phase-angle difference for the synchro-check function.
- The operate time of a circuit breaker is set via the parameter “Oper. time of CB”.

2.3.1.2 Synchronous/Asynchronous mode

The asynchronous or synchronous mode is chosen via the control parameter “SynchroMode”. When the value of the parameter is 0, the synchro-check function is not in use.

In asynchronous mode the synchro-check function checks that the voltage, frequency and phase differences are within the set limits. From the frequency slip (Δf) the function predicts the time remaining to the moment when the phase difference exceeds the setting. CB closing is only allowed if the time required for CB closing is shorter than the predicted time.

In synchronous mode the aim is that the phase difference at the moment of CB closing is zero. The mode is only possible when the frequency slip on the network is below 0,04% of f_n and all the other conditions are fulfilled. If the time required for reaching a synchronized state exceeds the maximum check time, the function will fail.

2.3.2 Voltage-check

The energizing direction in the voltage-check function is chosen via the parameter "Energizing mode". When the value of the parameter is 0, the voltage-check function is not in use.

The voltage-check function checks the energizing direction. Energizing is defined as a situation where a dead section of the network is connected to an energized one. The user is able to define the voltage range within which the measured voltage is determined to be "live" or "dead". The conditions of the network sections to be controlled by the circuit breaker, i.e. which side has to be live and which dead, are also determined via a setting. A situation where both sides are dead is possible as well.

Energizing mode	Energizing direction
= 0	Not in use
= 1	U1 → U2 or U1 ← U2
= 2	U1 → U2
= 3	U1 ← U2
= 4	U1 → U2, U1 ← U2 or both "dead"

When the energizing direction corresponds to the settings, the situation has to remain constant for a certain period of time before the close signal is permitted. The purpose of the operate time (dead time) is to ensure that the dead side remains de-energized and that the situation is not due to a temporary interference. Should the conditions not persist for the specified time, the operate time is reset and the procedure is started over when the conditions are fulfilled again. Circuit-breaker closing is thus not permitted until the energizing situation has remained constant throughout the set operate time.

2.3.2.1 Settings for the voltage-check function

- The threshold voltage Umax, above which the measured bus/line network voltage must be before the network is considered to be energized. The set threshold value applies to the synchro-check function as well.
- The threshold value Umin, below which the measured bus/line network voltage must be before the network is considered to be non-energized.

Note!

Because the setting ranges of the threshold voltages Umax and Umin partly overlap each other, the setting conditions may be such that the setting of the non-energized threshold value Umin is higher than that of the energized threshold value Umax. The parameters should be set carefully by the user to avoid the setting conditions mentioned above.

- Operate time for the energizing operation (minimal dead time).
- The energizing direction is separately selected via the parameter “Energizing mode”. For example, when the energizing direction is selected to be U1->U2, the voltage U1 shall be higher than Umax and the voltage U2 lower than Umin before the conditions of the energizing direction are fulfilled.

2.3.3 Bypass mode

If the parameters “SynchroMode” and “Energizing mode” are both set to “Not in use”, the SCVCSt_ function block is in bypass mode. This means that in command mode, the command input is wired straight through to the SC_OK output and in continuous mode, the SC_OK output is continuously FALSE.

Note!

In bypass mode events are sent as in normal operation (i.e. when output changes occur).

2.3.4 Operation mode

The closing command conditions for the circuit breaker are checked by the synchro-check and voltage-check functions. In addition to the closing command conditions, the delivering of the final closing signal depends on the operation mode selected for the synchro-check function. Selection of the operation mode depends on whether the synchro-check function itself directly uses the output signal to close the circuit breaker (command mode operation) or if another function block (for example a control function block) performs the closing operation after having received a command signal from the synchro-check function (continuous mode operation).

The operation mode is selected via the parameter “Operate mode”. In continuous mode, the synchro-check function is running continuously checking the synchronism. When synchronism is detected i.e. the conditions are fulfilled according to the settings, the output SC_OK is set to TRUE and will remain so as long as the conditions remain fulfilled.

A distinctive difference between the two operation modes is that in the command mode operation the synchro-check function is controlled by an external command signal but in the continuous mode operation no external signal is needed. In the command mode operation the synchro-check function delivers the closing signal directly to the object to be controlled (a circuit breaker) whereas in the continuous

mode operation the closing signal is delivered via another function block that delivers the final closing signal.

2.3.4.1 Continuous mode

In the continuous mode operation the closing signal output of the synchro-check function stays active as long as the closing conditions remain fulfilled and the signal disappears when the conditions cease. The operation of the synchro-check function can be blocked by applying a blocking signal to the function.

The continuous mode can be used to provide extra information on synchronism for an external operating device.

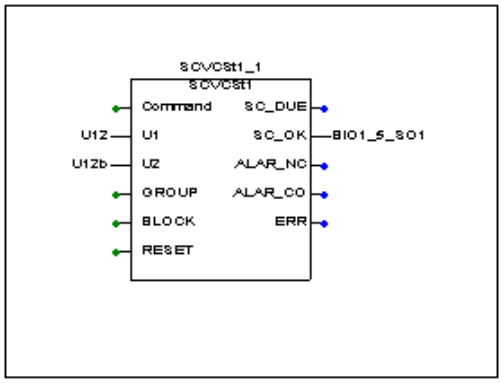


Figure 3. Example for a configuration where SCVCSt_ is used in continuous mode, i.e. the function block checks the synchronism continuously. The information is transferred to an external operating device via the signal output BIO1_5_SO1. Note that in the continuous mode, the Command input is not connected, the SC_DUE output is not active and the alarm outputs are not in use.

2.3.4.2 Command mode

In command mode operation, an external command signal, besides the normal closing conditions, is needed for delivering the closing signal. The command signal shall remain active for the set checking time. The closing signal from the synchro-check function can be blocked by applying the blocking signal to the function.

In command mode operation, the synchro-check function itself controls the selected object directly via its own output signal. In this case the control function block delivers the command signal for closing to the synchro-check function for releasing of a closing signal pulse to the circuit breaker. If, after the delivered command signal for closing, the closing conditions are fulfilled during a permitted check time, the synchro-check function delivers a closing signal to the circuit breaker.

The circuit-breaker function block COCB1/COCB2 is recommended to be configured to 10 ms task instead of the normal 20 ms task when used together with SCVCSt_.

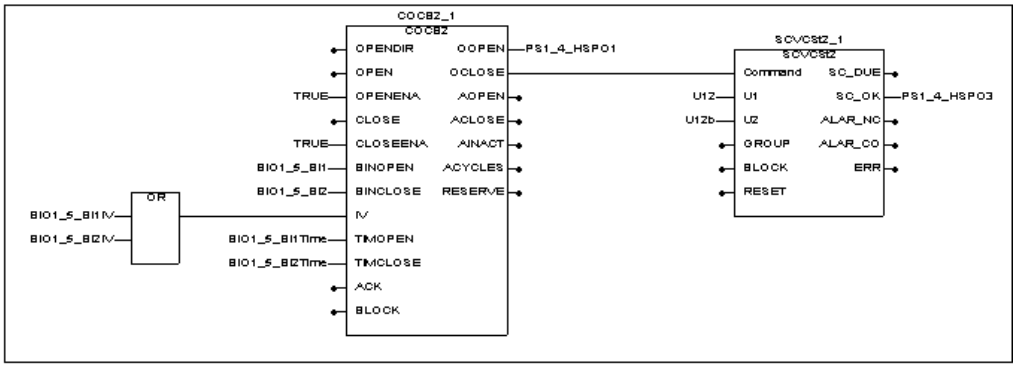


Figure 4. Example of a configuration of COCB1 and SCVCSt1 functions when the command mode is selected. SC verifies the synchronism when a close command is given and closes the circuit breaker directly via its own control output when all conditions are fulfilled.

The closing signal is delivered only once per activated external closing command signal. The duration of the delivered closing signal is the set parameter value. If the delivered command signal disappears or the closing conditions cease before the maximum length of the command signal is reached, the closing signal will be the set parameter value. If the external closing command signal and the closing conditions persist longer than for the length of the set closing signal, the closing signal will have the length of the set parameter value.

If the command signal delivered to the synchro-check function is too long, the alarm ALARM_CO is given and the alarm state will persist until the closing command signal is removed. A failed closing attempt produces the alarm signal ALARM_NC of about 500 ms, after which the synchro-check function is ready for a new operation sequence.

The most essential features of the command mode operation are shown in Figures 6, 7 and 8.

Abbreviations used in the diagrams:

Conditions OK	Closing conditions
Command	External closing command signal
BLOCK	External blocking input
SC_OK	Closing signal delivered by SCVCSt_
SC_DUE	Synchro-check in progress
ALARM_NC	Alarm signal delivered by SCVCSt_ (CB closing failed)
ALARM_CO	Alarm signal delivered by SCVCSt_ (Command signal too long)

The length of the closing signal is determined via the parameter “Closing signal length”. If the external command signal disappears during the closing operation, the function block delivers the closing signal as a set value.

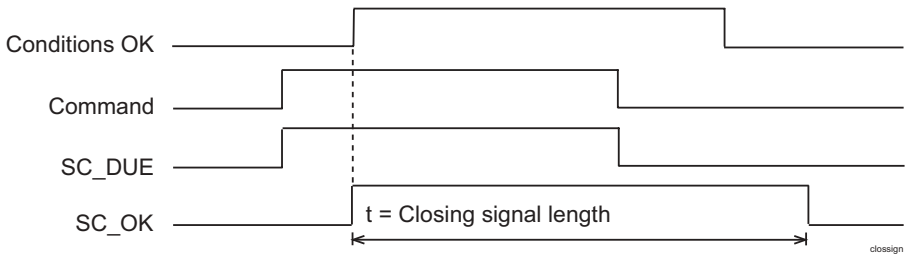


Figure 5. Closing signal length in command mode

The setting of the “Check time” parameter determines also the alarm limit for a command signal that has remained active. If the command signal is still active after the pre-set checking time + 5 seconds, the ALARM_CO signal is activated. The alarm indicates that the control function block has not removed the command signal after the performed checking operation. To avoid unnecessary alarms, the duration of the command signal should be set in such a way that the maximum length of the closing signal under normal conditions is always below checking time + 5 seconds.

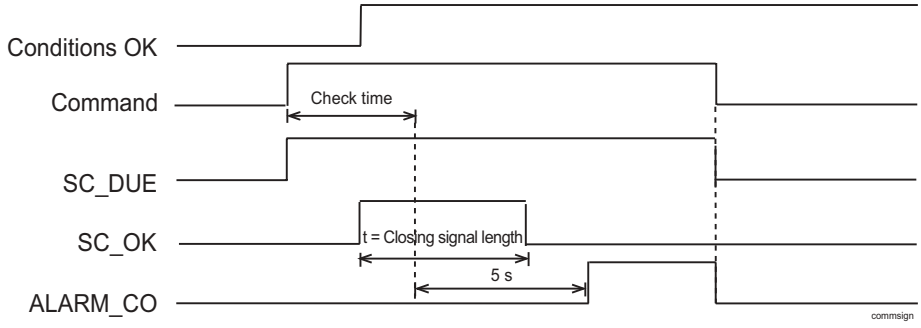


Figure 6. Determination of the alarm limit for an active command signal

Closing is permitted during the check time starting from the moment when the external command signal is activated. The command signal has to be active during the whole pre-set checking time, which means that the value of the set check time must also be considered when the length of the external command signal to be delivered to the function block is determined. If the closing conditions get fulfilled during the check time, a closing signal is delivered to the circuit breaker. If the closing conditions are not met, ALARM_NC will be activated for 500 ms after the check time ceases.

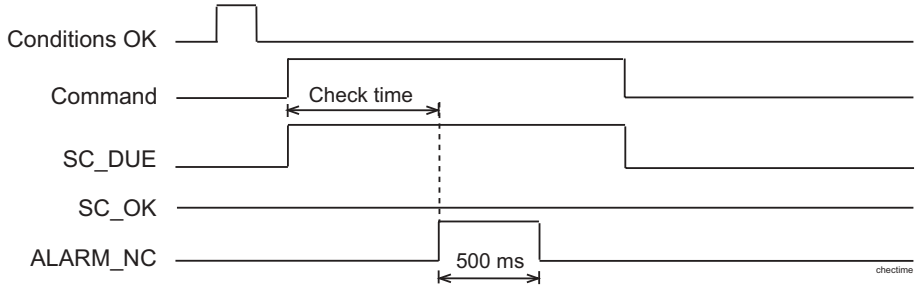


Figure 7. Determination of the checking time for closing

2.3.5 Operation with phase-to-earth voltage measurements

Operation of the synchro-check function block SCVCSt_ is based on phase-to-phase voltages. If the phase-to-earth voltages are measurement with voltage transformers or voltage dividers, the phase-to-phase can be calculated internally by virtual channels or by voltage combine function of the SCVCSt_.

2.3.5.1 Virtual channels

When phase-to-earth voltages U1 and U2 are measured, the virtual channel U12s can be connected to SCVCSt_ in Relay Configuration Tool. Correspondingly, the virtual channel U12bs can be used when the phase-to-earth voltages U1b and U2b are measured. Virtual U12s or U12bs can be used, for example, when phase-to-earth voltages are measured on one side of the circuit breaker and the phase-to-phase voltages on the other side (see Figure 8).

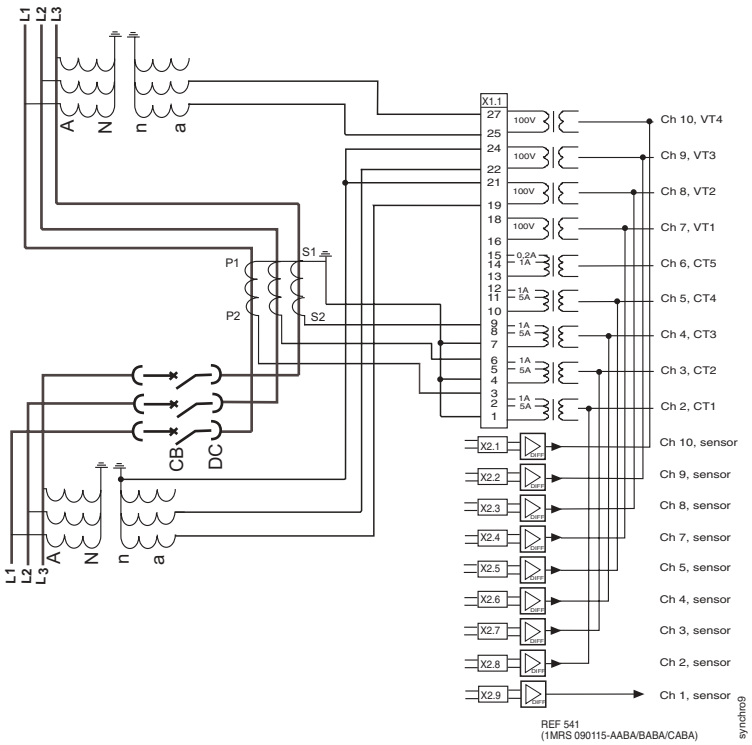
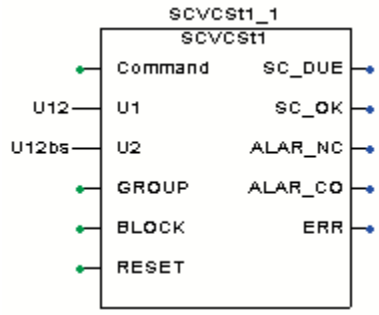
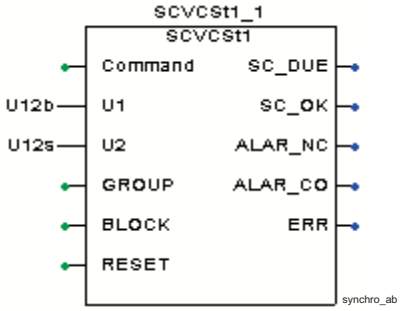


Figure 8 Connection diagram where phase-to-earth voltages are measured on one side of the circuit breaker and phase-to-phase voltages on the other side

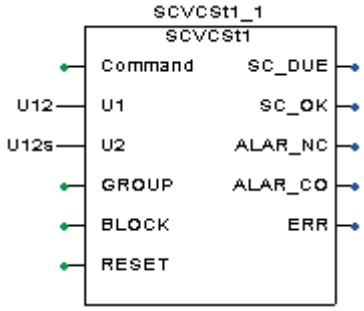
The voltage measurements used in Figure 8 can be named and connected to SCVCSt_ in different ways. The different combinations are shown in Figure 9.



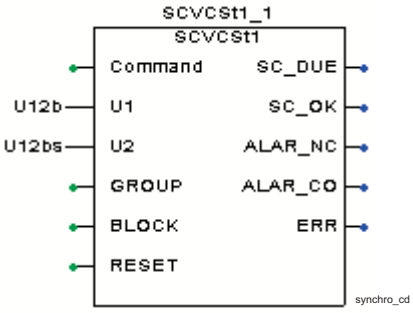
U1b	U2b	U12	U12bs
VT2	VT3	VT4	(U1b-U2b)



U1	U2	U12b	U12s
VT2	VT3	VT4	(U1-U2)



U1	U2	U12	U12s
VT2	VT3	VT4	(U1-U2)



U1b	U2b	U12b	U12bs
VT2	VT3	VT4	(U1b-U2b)

Figure 9 Connection possibilities when the connection diagram is as described in Figure 8, and the other phase-to-phase voltages are calculated internally by virtual channels

If phase-to-earth voltages are measured on both sides of the circuit breaker, the virtual phase-to-phase voltage channels U12s and U12bs can be connected to SCVCSt_ (see Figure 10).

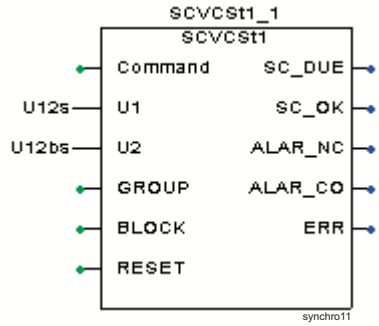


Figure 10 Connection of voltage signals to SCVCSt1 function when phase-to-earth voltages are measured on both sides of the circuit breaker.

2.3.5.2 Voltage combine function

When voltage combine function is in use, the function block calculates phase-to-phase voltage U12 internally from phase-to-earth voltages U1 and U2.

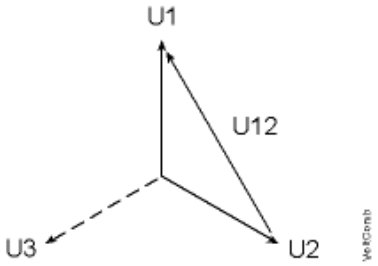


Figure 11 Definition of U12

The signals that are connected to SCVCSt_ inputs are U_1 and U_{12} or U_{12b}. Note that the phase-to-earth voltage U_2 must be available and measurable in one of the analogue channels of the protection relay. Otherwise a configuration error is generated.

When using the voltage combine function, the voltage connected to the U_2 pin should always be U_{12} or U_{12b}.

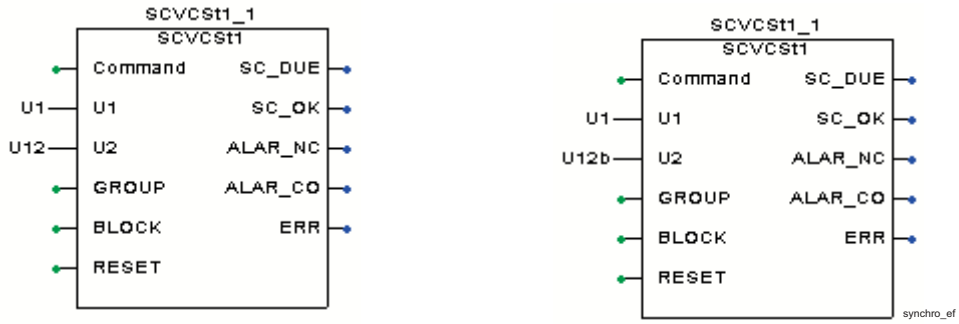


Figure 12 Connection possibilities when voltage combine function is used. In addition, U2 must be defined in one of the analogue channels.

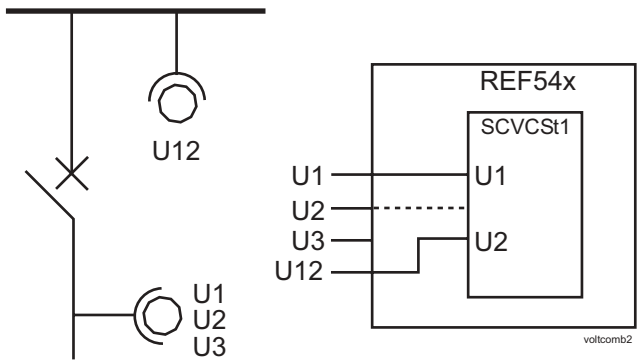


Figure 13 Example of a configuration where the voltage combine function can be used

The voltage combine function can be taken in use by setting the control parameter `VoltCombine` to 1. The `VoltCombine` is a special parameter that affects the analogue measurements of the feeder terminal. Therefore, for the parameter to take effect, the new parameter value has to be stored via the parameter `Store` and the relay has to be reset via the parameter `Software reset` in the MMI menu `Configuration/General`.

Note!

Do not reset the relay before the parameter value storing has been completed successfully.

2.4 Setting groups

Two different groups of setting values, group 1 and group 2, are available for SCVCSt_. Switching between the two groups can be done in the following three ways:

1 Locally via the control parameter `Group selection`[1)] of the MMI

2 Over the communication bus writing the parameter V9[1)]

3 By means of the input signal GROUP when allowed via the parameter `Group selection` (that is, when V9 = 2[1)]).

[1)] Group selection (V9): 0 = Group 1; 1 = Group 2; 2 = GROUP input

The control parameter `Active group` indicates the setting group valid at a given time.

2.5 Resetting

The recorded data can be reset either via the RESET input, or over the serial bus or the local MMI.

The operation indicators and recorded data can be reset as follows:

	Operation indicators	Recorded data
RESET input of the function block [1)]		X
Parameter F070V011 for SCVCSt1 [1)]		X
Parameter F071V011 for SCVCSt2 [1)]		X
General parameter F001V011 [2)]	X	
General parameter F001V012 [2)]	X	
General parameter F001V013 [2)]	X	X
Push-button C [2)]	X	
Push-buttons C + E (2 s) [2)]	X	
Push-buttons C + E (5 s) [2)]	X	X

[1)] Resets the recorded data of this particular function block.
[2)] Affects all function blocks

3. Parameters and events

3.1 General

- Each function block has a specific channel number for serial communication parameters and events. The channel for SCVCSt1 is 70 and that for SCVCSt2 71.
- The data direction of the parameters defines the use of each parameter as follows:

Data direction	Description
R, R/M	Read only
W	Write only
R/W	Read and write

- The different event mask parameters (see section “Control settings”) affect the visibility of events on the MMI or on serial communication (LON or SPA) as follows:

Event mask 1 (FxxxV101/102)	SPA / MMI (LON)
Event mask 2 (FxxxV103/104)	LON
Event mask 3 (FxxxV105/106)	LON
Event mask 4 (FxxxV107/108)	LON

For example, if only the events E3, E4 and E5 are to be seen on the MMI of the relay terminal, the event mask value 56 (8 + 16 + 32) is written to the “Event mask 1” parameter (FxxxV101).

In case a function block includes more than 32 events, there are two parameters instead of, for example the `Event mask 1` parameter: the parameter `Event mask 1A` (FxxxV101) covers the events 0...31 and `Event mask 1B` (FxxxV102) the events 32...63.

3.2 Setting values

3.2.1 Actual settings

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Umax	S1	0.50...1.00	x Un	1.00	R	Upper threshold voltage
Umin	S2	0.10...0.80	x Un	0.10	R	Lower threshold voltage
dU	S3	0.02...0.50	x Un	0.02	R	Voltage difference
dphase	S4	5...90	°	5	R	Phase angle difference
df	S5	0.02...5.00	Hz	0.02	R	Frequency difference

3.2.2 Setting group 1

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Umax	S41	0.50...1.00	x Un	1.00	R/W	Upper threshold voltage
Umin	S42	0.10...0.80	x Un	0.10	R/W	Lower threshold voltage
dU	S43	0.02...0.50	x Un	0.02	R/W	Voltage difference
dphase	S44	5...90	°	5	R/W	Phase angle difference
df	S45	0.02...5.00	Hz	0.02	R/W	Frequency difference

3.2.3 Setting group 2

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Umax	S71	0.50...1.00	x Un	1.00	R/W	Upper threshold voltage
Umin	S72	0.10...0.80	x Un	0.10	R/W	Lower threshold voltage
dU	S73	0.02...0.50	x Un	0.02	R/W	Voltage difference
dphase	S74	5...90	°	5	R/W	Phase angle difference
df	S75	0.02...5.00	Hz	0.02	R/W	Frequency difference

3.2.4 Control settings

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Energizing mode	V1	0..4 [1)]	-	1	R/W	Selection of energizing mode
Operation mode	V2	0 or 1 [2)]	-	0	R/W	Selection of operation mode
Synchro mode	V3	0...2 [3)]	-	1	R/W	Selection of synchro mode
Operate time	V4	0.1...20.0	s	0.1	R/W	Operate time (dead time)
Check time	V5	0.05...300.00	s	0.05	R/W	Check time in command mode operation
Close pulse	V6	0.2...20.0	s	0.2	R/W	Closing signal length (command mode only)
Oper.time of CB	V7	0.05...0.25	s	0.05	R/W	Operate time of circuit breaker
Basic angle	V8	-90...90	°	0	R/W	Basic angle setting
Group selection	V9	0...2 [4)]	-	0	R/W	Selection of the active setting group
Active group	V10	0 or 1 [5)]	-	0	R/M	Active setting group
Reset registers	V11	1 = Reset	-	0	W	Resetting of latched trip signal and registers
Voltage combine	V12	0 or 1 [6)]	-	0	R/W	Enabling of voltage combining
Event mask 1	V101	0...255	-	255	R/W	Event mask 1 for event transmission (E0 ... E7)
Event mask 2	V103	0...255	-	255	R/W	Event mask 2 for event transmission (E0 ... E7)
Event mask 3	V105	0...255	-	255	R/W	Event mask 3 for event transmission (E0 ... E7)
Event mask 4	V107	0...255	-	255	R/W	Event mask 4 for event transmission (E0 ... E7)

[1)] Energizing mode **0**=Not in use, **1** = U1->U2 or U1<-U2, **2** = U1->U2, **3**= U1<-U2, **4** = U1->U2 or U1<-U2 or both "cold"
[2)] Operation mode 0 = Command mode, 1 = Continuous mode
[3)] Synchro mode 0 = Not in use,1 = Asynchronous mode, 2 = Synchronous mode
[4)] Group selection 0 = Group1, 1 = Group2, 2 = GROUP-input
[5)] Active group 0 = Group1, 1 = Group2
[6)] Voltage combine 0 = Disabled, 1 = Enabled

3.3 Measurement values

3.3.1 Input data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
U1	I1	0.00...1.30	x Un	0.00	R/M	Measurement value U1
U2	I2	0.00...1.30	x Un	0.00	R/M	Measurement value U2
dU	I3	-1.30...1.30	x Un	0.00	R/M	Meas. delta value (U1-U2)
f1	I4	45.00...65.00	Hz	0.00	R/M	Measurement value f1
f2	I5	45.00...65.00	Hz	0.00	R/M	Measurement value f2
df	I6	-20.00...20.00	Hz	0.00	R/M	Measurement delta value (f1-f2)
phi1	I7	-180...180	°	0.0	R/M	Measurement value φ1
phi2	I8	-180...180	°	0.0	R/M	Measurement value φ2
dphi	I9	-180...180	°	0.0	R/M	Meas. delta value (φ1- φ2)
Input Command	I10	0 or 1 [1)]	-	0	R/M	Status of Command signal
Input BLOCK	I11	0 or 1 [1)]	-	0	R/M	Status of BLOCK signal
Input GROUP	I12	0 or 1 [1)]	-	0	R/M	Status of GROUP signal
Input RESET	I13	0 or 1 [1)]	-	0	R/M	Status of RESET signal

[1)]Input 0 = Not active; 1 = Active

3.3.2 Output data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
SC_DUE	O1	0 or 1 [1)]	-	0	R/M	Status of SC_DUE signal
SC_OK	O2	0 or 1 [1)]	-	0	R/M	Status of SC_OK signal
ALARM_NC	O3	0 or 1 [1)]	-	0	R/M	Status of ALARM_NC signal
ALARM_CO	O4	0 or 1 [1)]	-	0	R/M	Status of ALARM_CO signal

[1)]Output 0 = Not active; 1 = Active

3.3.3 Recorded data

3.3.3.1 General

The information required for later analysis is recorded when the function block activates the SC_OK output.

The data of the last three events are stored in Recorded data 1…3, beginning from Recorded data 1. These registers are updated in a cyclical manner, where the values of

the most recent event overwrite the oldest recorded data. If the recorded data has been reset or the relay has been restarted, the first event is again stored in Recorded data 1.

3.3.3.2 Date and time

The time stamp indicates the rising edge of the SC_OK signal.

3.3.3.3 Voltages, phase angles and frequencies

If the function block trips, the measured voltage, phase angle and frequency values are updated at the moment of tripping i.e. on the rising edge of the SC_OK signal. Thus the values of the voltages, phase angles and frequencies always originate from the same moment.

The voltages are recorded as multiples of the rated voltage U_n. The phase angles are recorded in degrees. The frequencies are recorded in Hertz.

3.3.3.4 Status data

The status data of the `Active group` parameter is recorded at the rising edge of the SC_OK signal.

3.3.3.5 Recorded data 1

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V201	YYYY-MM-DD	-	0	R/M	Registration date
Time	V202	hh:mm:ss.000	-	0	R/M	Registration time
U1	V203	0.00...1.30	x Un	0.00	R/M	Voltage 1 value
U2	V204	0.00...1.30	x Un	0.00	R/M	Voltage 2 value
dU	V205	-1.30...1.30	x Un	0.00	R/M	Voltage difference
f1	V206	45.00...65.00	Hz	0.00	R/M	Frequency f1
f2	V207	45.00...65.00	Hz	0.00	R/M	Frequency f2
df	V208	-20.00...20.00	Hz	0.00	R/M	Frequency difference
phi1	V209	-180...180	°	0	R/M	Phase 1
phi2	V210	-180...180	°	0	R/M	Phase 2
dphase	V211	-180...180	°	0	R/M	Phase difference
Active group	V212	0 or 1 [1)]	-	0	R/M	Active setting group

[1)] Active group 0 = Setting group 1, 1 = Setting group 2

3.3.3.6 Recorded data 2

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V301	YYYY-MM-DD	-	0	R/M	Registration date
Time	V302	hh:mm:ss.000	-	0	R/M	Registration time
U1	V303	0.00...1.30	x Un	0.00	R/M	Voltage 1 value
U2	V304	0.00...1.30	x Un	0.00	R/M	Voltage 2 value
dU	V305	-1.30...1.30	x Un	0.00	R/M	Voltage difference
f1	V306	45.00...65.00	Hz	0.00	R/M	Frequency f1
f2	V307	45.00...65.00	Hz	0.00	R/M	Frequency f2
df	V308	-20.00...20.00	Hz	0.00	R/M	Frequency difference
phi1	V309	-180...180	°	0	R/M	Phase 1
phi2	V310	-180...180	°	0	R/M	Phase 2
dphase	V311	-180...180	°	0	R/M	Phase difference
Active group	V312	0 or 1 [1)]	-	0	R/M	Active setting group

[1)]Active group 0 = Setting group 1, 1 = Setting group 2

3.3.3.7 Recorded data 3

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V401	YYYY-MM-DD	-	0	R/M	Registration date
Time	V402	hh:mm:ss.000	-	0	R/M	Registration time
U1	V403	0.00...1.30	x Un	0.00	R/M	Voltage 1 value
U2	V404	0.00...1.30	x Un	0.00	R/M	Voltage 2 value
dU	V405	-1.30...1.30	x Un	0.00	R/M	Voltage difference
f1	V406	45.00...65.00	Hz	0.00	R/M	Frequency f1
f2	V407	45.00...65.00	Hz	0.00	R/M	Frequency f2
df	V408	-20.00...20.00	Hz	0.00	R/M	Frequency difference
phi1	V409	-180...180	°	0	R/M	Phase 1
phi2	V410	-180...180	°	0	R/M	Phase 2
dphase	V411	-180...180	°	0	R/M	Phase difference
Active group	V412	0 or 1 [1)]	-	0	R/M	Active setting group

[1)]Active group 0 = Setting group 1, 1 = Setting group 2

3.3.4 Events

Code	Weighting coefficient	Default mask	Event reason	Event state
E0	1	1	Synchro-check in progress	Reset
E1	2	1	Synchro-check in progress	Activated
E2	4	1	Closing permission given	Reset
E3	8	1	Closing permission given	Activated
E4	16	1	Alarm; CB closing failed	Reset
E5	32	1	Alarm; CB closing failed	Activated
E6	64	1	Alarm; command signal too long	Reset
E7	128	1	Alarm; command signal too long	Activated

4. Technical data

Operation accuracies	At the frequency range f/f_n = 0.95...1.05: voltage measurement: ±2.5% of set value or ± 0.01 x U_n frequency measurement: ±10 mHz phase angle measurement: ±2°
Reset time	< 50 ms
Reset ratio	Typ 0.975 x U_n (range 0.96...0.98)
Operate time accuracy	±2% of set value or ±25 ms
Configuration data	Task execution interval (Relay Configuration Tool): 10 ms at the rated frequency f_n = 50 Hz

Technical revision history		
Function block	**Technical revision**	**Change**
SCVCSt1	E	-
	F	Extended dphase and df setting ranges
	G	Bypass mode added
		Control setting parameters: Operate mode → Operation mode SyncroMode → Synchro mode Closing signal length → Close pulse VoltCombine → Voltage combine
		Event mask range changed: 0…15 → 0…255
		Events E4…E7 added
	H	-
	K	-
SCVCSt2	D	-
	E	(see above: SCVCSt1, F)
	F	(see above: SCVCSt1, G)
	G	-
	H	-